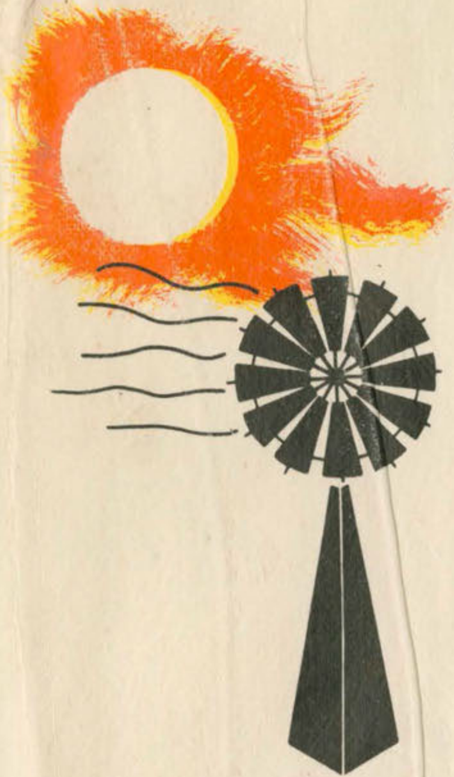

ENERGY FROM THE WIND

Annotated Bibliography

Basic Volume, August 1975

plus

First Supplement, April 1977

by

Barbara L. Burke
Libraries
Colorado State University

and

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Colorado State University
Foothills Campus
Fort Collins, Colorado 80523

Available from: Publications Department, Engineering Research Center, Colorado State University, Foothills Campus, Fort Collins, Colorado 80523

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ACKNOWLEDGMENTS

Many of the abstracts in this bibliography came directly from the following indexes:

Engineering Index
Meteorological and Geoastrophysical Abstracts
Government Reports Announcements
Scientific and Technical Aerospace Reports
International Aerospace Abstracts
Science Abstracts. Electrical and Electronics Abstracts

We are grateful to the editorial staffs of these publications for these excellent summaries which enabled us to produce an extensive annotated bibliography without having to see each original publication.

Special thanks are extended to Kathleen McKenna and the Engineering Research Center Technical Typing Department for painstaking typing of this project, and to Sally Baker, Nancy Reed, and Zeba Khalid for hours of proofreading and organizational assistance.

History of Large WECS (Wind Energy Conversion System) Designs:

Wind power programs of great potential were brought forward in a number of nations until about 1960 when they were all abandoned. At that time windpower system economic projections simply could not compete against the very favorable economic projections for nuclear and fossil fuel programs. These decisions were made despite the fact that Heronemus (1974:33) estimates as many as 54 quintillion BTU's of energy are available from moving air particles over the globe at any time on the average. Yet the total global direct fuel plus electricity use of energy in 1970 was only 1 quintillion BTU's. More recent examination of the availability of fossil fuel and the true costs of nuclear power re-open the suitability question about wind power. Thus it is appropriate to restudy the design suggestions for large scale wind power conversion from the past and update them scientifically and economically to the current situation.

There have been a series of large scale wind power system design and feasibility studies - some leading to a prototype experiment. As early as 1933 Hönnef (1948:9) of Germany proposed a 1000 ft. high tower carrying five wind turbines capable of generation of 50,000 kilowatts of energy. These early proposals lead to an ambitious system which never was built as a result of the fall of the third Reich. After the second world war Professor Ulrich Hutter of the Aviation Department of the Stuttgart Institute of Technology designed several wind power systems. In 1955 a 100 kw experimental plant was built by the West German Wind Power Research Association; but the larger scale plans never developed.

The French under sponsorship of the French Electricity Authority (EDF) invested 18 years of research in large scale wind power design. This study culminated with the construction of an 800 kilowatt amp mill near Nargent Le Roi, France in 1960. At some times the delivered power reached 1,200 kw but blade failure problems ended field experiments in 1960. The designers now believe they can design large machineries which would avoid flutter failure (Noel, 1973:16); however, no further work has been completed.

A number of other studies by the Soviet Union, England, Denmark, and Hungary have led to the construction of 100 kw experimental machines; but again most work died about 1960.

The most ambitious wind power machine constructed to date was constructed in the USA by Palmer C. Putnam in cooperation with the S. Morgan Smith Company and Vermont Public Service Corporation. Between 1939 and 1945 Putnam had a design team which conceived, designed, constructed and tested a 1250 kw wind power turbine. Putnam's experiment at Grandpa's Knob proved that wind power could work at large scale, but the project also proved that numerous changes would have to be made before the project could proceed. In addition, at costs current at the time 6 more units based on the original machine could be installed at another Vermont location for \$190/kilowatt. However, it was concluded at that time the value of an additional 9 megawatts of power would only be \$125/kilowatt. Putnam recorded the details of his project's history, finances, and design estimates for a new system in a book titled "Power from the Wind." This effort has subsequently been used as the basis for a number of paper studies of large systems.

The Federal Power Commission became interested in the Grandpa's Knob experiment in World War II, and commissioned Percy H. Thomas, a senior engineer of the commission to investigate WECPS. In a series of imaginative surveys Percy Thomas examined the feasibility of turbines in 2 sizes: a 2 blade 7.5 megawatt unit; and a 3 blade 6.5 megawatt unit. Thomas estimated to run 10 plants the cost per kilowatt would be \$68 and \$75 for the large and small machines respectively. Subsequently, a proposal based on Thomas' work before the House Committee on Interior and Insular Affairs in 1951 was killed when it appeared costs were to be \$333/kilowatt compared to \$140-225/kilowatt for fossil-fueled plants. Despite arguments that hydroelectric costs at that time were \$350-600/kilowatt the bill was killed.

Since the Energy Crisis in the early 70's, renewed interest has developed in large scale and power programs. Robert Wilson (1973:16) has reviewed Putnam's design and updated his figures to 1971 costs. Wilson estimated an installed cost of \$700/kilowatt. The major cost component in Putnam's design was the rotor which accounted for 43% of the total cost. As a result, recent attention has been focused on the structural and fatigue analyses of rotors.

A major contributor to modern thinking on wind power systems and an early proponent of their re-introduction into man's energy supply is

William Heronemus, Professor, University of Massachusetts. In a series of articles since 1970 he has proposed wide-ranging networks of huge wind generators in numerous U.S. locations to provide virtually all the nation's electricity from the wind. While thousands of individual sites exist, he and others have pinpointed the most promising U.S. locations: throughout the Great Plains; along the eastern foothills of the Rocky Mountains; the Great Lake region; the Aleutian Island chain; and the continental shelf of the northeastern United States. Professor Heronemus' proposed designs for a large wind-power installation are based largely on the work done by Palmer Putnam for the Grandpa's Knob generator. For the mid-west United States he has proposed two designs. One is based on a 210 foot diameter wind turbine mounted on a thousand foot tower or a somewhat shorter 600 foot tower with 20 smaller 2-bladed turbines mounted around the top. He assumes one such machine per square mile in a 300,000 square mile area of the Great Plains. He concludes the network would represent about 190 million kilowatts of installed electrical generating capacity.

In January 1973, Heronemus testified before the Atomic Energy Commission and proposed a range of three wind plants as candidates for an off-shore system to be employed off the New York shoals, off the Long Island shoreline. His system included the use of a hydrogen-oxygen electrolyzer station which would produce a hydrogen fuel to be stored into a series of underwater storage tanks, where it would be retained until pumped offshore for use. After being pumped ashore, the hydrogen may be burned in 5-kilowatt fuel cells installed in individual homes, or perhaps larger units - up to 20,000 kilowatts capacity - for larger scale electricity production.

As a result of the energy crisis and the philosophy behind "Project Independence," a number of U.S. Government agencies have encouraged recent WECS research. NSF, NASA, ERDA, and AEC Sandia have all developed wind power interests which range from small 3 to 15 kilowatt capacity, to the large 2 - ? megawatt systems. NASA-Lewis under the direction of Joseph M. Savino has proposed to build the first large scale wind turbine test bed since the 1960s. A 100 kilowatt WECS is proposed to be completed by 1975. Initial design decisions have been completed and Richard Puthoff has authored NASA reports which describe the proposed system. Today a number of large U.S. manufacturing organizations have committed themselves to WECS research - General Electric, Lockheed, Kaman Aerospace, Honeywell, Aerospace, United Aircraft, and Boeing are all involved to some extent. The second WECS workshop scheduled for June 8-11, 1975 in Washington, D.C. will be a forum which will soon express the extent of U.S. government and industry commitment to the large scale USA-WECS future.

A recent expression of renewed European interest in large scale WECS problems is found in the announcement by the Netherlands Industrial Council for Oceanography (April 1975) that it is working on a major wind conversion plan encompassing a chain of generators snaking along the coast or on man-made islands in the North Sea. Spokesmen claim 150 turbines would produce as much electricity as the 450 Mw nuclear plant at Flushing, South Holland. They are considering 50 three-turbine units mounted on 325-ft. steel towers using triple rotor blades 164 ft. in length. Scientists say 50 units at sea would be required, 85 units on the coast, or 125 units on an inland site to generate 500-Mw.

Interest in discovering and developing alternative sources of power and energy has never been greater than at the present time. With this imperative in mind, this in depth review of wind power literature has been prepared. It includes some 770 references spanning a time period from 1759 to the end of 1974. Although an attempt has been made to eliminate newspaper articles and short popular notes about other articles, the review should be fairly comprehensive. The authors certainly hope the reader will find this material a service to his own interests.

INTRODUCTION TO BIBLIOGRAPHY

The basis for this bibliography is a systematic search of the major abstracting and indexing tools from 1950 to 1974. This is augmented by references found in other bibliographies on windpower, publications lists of institutions known to be involved in windpower research, bibliographies of papers, and suggestions from colleagues who knew this bibliography was in preparation. Many of these were published prior to 1950. A number of older foreign papers are included which have appeared in recent indexes as translations, many available from the National Technical Information Service (NTIS), in Springfield, Va.

In an effort to prepare a comprehensive bibliography useful to many people with varied interests in windpower, all references discovered have been included, regardless of their scope or emphasis. They range from popular review to technical aerodynamic studies, from do-it-yourself homebuilt projects for house or farm to large scale commercial production for power networks.

Whenever possible, abstracts or annotations are included, these taken directly from the abstracting and indexing tools when available, or brief summaries written from the original article. If neither an abstract nor the original article was available, no summary is given. Subsequently the summaries range from nothing, to one sentence suggestions of the gist of the article, to long informative synopses.

The bibliography is organized by year, the latest references first. Within each year the references are numbered. In the Personal Author Index and the Broad Subject or Type of Material Index which follow the bibliography the year and item number are used to identify each reference.

Each journal reference contains the following elements, if they were available: author(s), title of article, journal title, volume, issue number, pages, date, language if not English, subject category number(s), and summary.

The book references contain the following elements: author(s), title, place of publication, publisher, year, number of pages, subject category number(s), and summary.

The technical report reference format for translations includes the following: author(s), title of article, volume, issue, pages, date of original article, translating agency, agency location, report number, publisher or source, date of publication of the translation, number of pages, subject category number(s), and summary. For regular technical reports: author(s), title, report number, source or publisher, date of publication, number of pages, subject category number(s), and summary.

Also included, following the main body of the bibliography, are a Personal Author Index, and a Broad Subject or Type of Material Index.

It is our intention to update this bibliography through supplemental issues or revised editions as the volume of additions warrants. We would welcome, indeed urge, that any references we've inadvertantly omitted in this edition or that occur in the future be brought to our intention for inclusion. Please send them to:

Barbara Burke
Engineering Sciences Branch Library
Engineering Research Center
Colorado State University
Foothills Campus
Fort Collins, Colorado 80523

INTRODUCTION TO THE FIRST SUPPLEMENT

This First Supplement to ENERGY FROM THE WIND includes references to books, conference proceedings, technical reports and journal articles on wind power accumulated after the publication of our basic volume in August 1975.

Much to our surprize, the total number of new references exceeds 1100, about 400 more than those contained in the basic volume. Of these, nearly 900 are references to current materials, with publication dates from 1973 to date. In addition, a number of older references missed the first time have been included. When the two volumes are combined, the resultant volume contains close to 1900 references. The new indexes provided with the First Supplement are cumulative, to cover all references in both the basic volume and the supplement.

See the INTRODUCTION TO BIBLIOGRAPHY for an explanation of coverage and format.

It is our intent to continue to gather this literature and publish frequent, hopefully annual, supplements. We expect future supplements to be smaller, almost totally composed of new references to very current literature.

We welcome your comments and suggestions, and particularly your alerting us to wind power publications for inclusion in future supplements. Please direct your comments to:

Barbara L. Burke
Engineering Sciences Branch Library
Colorado State University
Engineering Research Center
Foothills Campus
Fort Collins, Colorado 80523

April 1977

1977

1. Blake, S.R. Site analysis handbook for wind energy systems. Oskaloosa, Kansas, Appropriate Technology Group, to be published early 1977.

2, 6

This handbook reviews the history of siting practices and synthesizes the information available today. Using this information as a starting point, procedures are offered for determining the optimum location for a family/small business size (less than 10 meter diameter) wind electric system in an area. Necessary equipment is described for measuring the power in the wind with examples provided for reference. Also considered are total system economics including system life, initial and recurring costs, present status of interfacing systems with power utility grids, maintenance schedules, and various methods for examining cost/benefits of a system.

2. Kocivar, B. Tornado turbine reaps power from a whirlwind. Pop. Sci. 210(1): 78-80, January 1977.

5

Research by James Yen at Grumman Aerospace Corporation on a turbine tower which turns wind into a man-made tornado to produce electricity is described.

3. Ambler, R. Sound of the wind from Oak Creek. High Country News 9(1): 10, January 14, 1977.

4, 15

4. Halacy, D.S. Earth, wind, sun, and water: our energy alternatives. New York, Harper & Row, 1977. 192 p.

2, 4

The author asserts it is possible to drive the world on income energy with safe, renewable resources of geothermal, water, tidal and sea thermal energy, wind, biofuels, and solar energy.

5. Hand, A.J. How to use solar, wind or water energy in your home. Popular Science Books. New York, Harper & Row, 1977, to be published June 1977.

2, 4

6. Interest renewed in 30's wind generator. Solar Util. News 1(7): 8, January 1977.

4

The University of Dayton Research Institute is studying a 1930 style wind generator as a possible energy supplement for utilities.

1977

7. NM utility to test 200 kw wind generator. Solar Util. News 1(7): 2, January 1977.

4

The municipal utility in Clayton, New Mexico, has been selected to field test a 200 kw wind turbine generator for ERDA.

8. Wind powers Ma Bell. Solar Util. News 1(8): 17, February 1977.

4

1976

1. Advanced wind energy systems. Proceedings of the Workshop, Stockholm Sweden, August 29, 30, 1974. Volumes 1 & 2. Workshop sponsored by the Styrelsen for Teknisk Utveckling and Swedish State Power Board. Edited by O. Ljungstrom, Stockholm, Styrelsen for Teknisk Utveckling, 1976, Vol. 1, 220 p.; Vol. 2, 216 p.
3, 4, 6, 9

A review of important past developments in the field of wind energy systems is presented. Advanced horizontal axis rotor concepts for wind machines are studied in detail together with advanced vertical axis rotor concepts. Wind energy conversion and storage are discussed with consideration of storage via electrolysis using high pressure hydrogen, pumped hydro-storage, air storage concepts and the use of synchronous flux generators and dc generator/thyristor converter in wind power systems. The economics of wind power is considered as are international research and development programs concerning wind power.

2. Albino de Souza, A. The evaluation and use of the wind energy in North East Brazil. In: Intersociety Energy Conversion Engineering Conference, 11th. Proceedings. Stateline, Nevada, September 12-17, 1976. New York, American Institute of Chemical Engineers, 1976.
3, 6

3. Allen, L. Wind on the hill. Nebraskaland 54(2): 41, 48, February 1976.
4

The author's nostalgic memories of the wind charger at her childhood farm home are related.

4. Allison, H.J. Wind system utilizing high pressure electrolysis as a storage mechanism. World Hydrogen Energy Conference, 1st, Miami Beach, March 1, 1976. Hydrogen Energy. Veziroglu, T.N., ed. Coral Gables, Fla., University of Miami, 1976. Vol. II, p. 2B.3-2B.14.
3, 11

An energy system which has an input of solar or wind energy must have some mechanism of energy storage if it is to supply reliable power to its consumers. Conventional energy systems which consume hydrocarbons to produce electricity can use energy storage techniques to smooth their power curves to more acceptable levels. The technique of energy storage which utilizes electrolysis cells to disassociate water into its component gases, then stores the evolved hydrogen as a high pressure gas, or as a liquid, or as a hydride, has been widely discussed for the past several years. Researchers at Oklahoma State University have been developing such an energy storage system since 1961. The OSU system is described, performance parameters for those components of the system which have reached the prototype stage are presented, and the basic problems and economics that must be satisfied before such a system can become practical on a large scale are discussed.

5. American Wind Turbine begins production. Wind Power Dig. 1(4): 19, Spring 1976.

12a

6. Andrews, J.W. Energy-storage requirements reduced in coupled wind-solar generating systems. Solar Energy 18(1): 73-74, 1976.

6, 11

The development of the sun and wind as useful power sources has been hampered by the variability and unpredictability of the power that can be drawn from them. One way to partially overcome this problem could be to use the strengths of one source to overcome the weaknesses of the other. A Monte Carlo computer has simulated the operation of such a combined system, and the results indicate evident advantages. The program incorporating the model is detailed.

7. Apollo Co. unveils an energy spiral. Wind Power Dig. 1(4): 19, Spring 1976.

12a

8. Banas, J.F. and W.N. Sullivan. Engineering of wind energy systems. NTIS, SAND 75-0530, January 1976. 27 p.

5

This report addresses the engineering of wind energy systems from the point of view of component selection and performance assessment. Combinations of two load types (variable and constant speed) and three turbine types connected by a fixed-gear-ratio transmission constitute the various systems investigated. The three turbine types result from introducing the notions of nested, unnested, and hybrid power coefficients suggested by current performance characteristics of American Multiblade, Darrieus/Savonius turbines. The engineering problems associated with these systems are discussed qualitatively, emphasizing the nature, magnitude, and variability of the problems.

9. Banas, J.F. and W.N. Sullivan. Sandia vertical-axis wind turbine program. Technical Quarterly Report, October-December 1975. NTIS, SAND-76-0036, April 1976. 113 p.

9

This quarterly report describes the activities within the Sandia Laboratories Vertical-Axis Wind Turbine Program during the second quarter of the fiscal year 1976. Included are the highlights of the quarter; review of the status of general design efforts in the areas of aerodynamics, structures, systems analysis, and testing; summary of preliminary design details of the proposed 17-m turbine/60-kW generator system for power grid application; and structural analysis and operational test results for the existing 5-m turbine.

10. Beedell, S. Windmills. New York, Charles Scribner's Sons, 1976. 135 p.

1, 2

Basically a history of windmills, this book emphasizes various types of old windmills and how they work. The present status of historical windmills is covered. Numerous photographs, drawings and diagrams are included.

11. Benson, A. A small wind electric plant. Wind Power Dig. 1(4): 42-54, Spring 1976.

8, 12a

This article is a set of instructions written for the type of person who is possessed of more than average mechanical skill and ingenuity but not necessarily technically trained. Originally written in 1933, the object of this project is the design and construction of a small wind-electric plant suitable for use on farms where the requirements are confined to lights and a few small appliances.

12. Biorn, P. Rewinding a Jacobs wind generator. Wind Power Dig. 1(4): 30-33, Spring 1976.

12a

13. Biorn, P. Visiting with Fred Bruns. Wind Power Dig. 1(5): 31-34, Summer 1976.

4

14. Black, T.W. Advanced turbine designs boost wind-power potential. Mach. Des. 48: 26-28, 30-32, June 10, 1976.

5, 14

A description is given of a number of novel approaches which can be employed to utilize wind energy. A device called a diffuser shroud makes it possible to double the efficiency of a simulated rotor. Another concept for increasing the power of wind turbine-generators is based on the concept of vortex augmentation. A German company has demonstrated that even lightweight wind turbine-generators can extract substantial amounts of power from the wind. An American company has developed wheel-like rotors with narrow rims and wire spokes. Rotors which spin on a vertical axis have the advantage that the rotor blades can accept the wind from any point of the compass.

1976

15. Black, T.W. Megawatts from the wind. Power Eng. 80(3): 64-68, March 1976.

6

More than 70 U.S. utilities are investigating the utilization of wind energy and 30 are compiling wind data. Some have offered to provide sites, control rooms, and personnel for the testing of the Plum Brook wind turbine-generators (WTGs) developed by the Energy Research and Development Administration. Under ERDA sponsorship, NASA designed the 100-kW WTG, currently the largest in the world, and started construction in September 1975. Plans are now in progress for 200-kW units, 500-kW units, and later a 1.5-MW unit. Results of a study on comparative capital costs using data at Northwest Utilities are presented, but economic factors will vary from utility to utility. Some financial data from the Plum Brook WTG indicates its cost is five times higher than utilities can afford to pay. Near New Bedford, Mass., (Cuttyhunk Island), the world's largest working WTG will provide 40 to 50 percent of the small community's power in 1976. The Cuttyhunk Island WTG is an updated version of the Danish Gedser Mill, and is rated at 200-kW capacity for a wind velocity of 28 mph. It will deliver power at a lower cost per kWh than the diesel-electric system.

16. Black, T.W. Something in the wind--ERDA thinks so. Mach. Des. 48: 18-20, 23-26, May 20, 1976.

6

Objectives of ERDA with respect to the development of wind-turbine generators are examined. Development difficulties are partly related to dynamics problems which can only be adequately studied with the aid of full-scale models. Attention is given to the selection of exceptionally windy sites, designs for obtaining optimum wind conversion efficiencies, approaches for improving the cost-effectiveness of wind power, the use of composite materials for rotor blades, methods which make unattended operation of the wind turbines possible, the design of bigger blades, and questions concerning the commercial availability of components.

17. Bolt, J.B.D.H. Some experiments with a vertical axis wind rotor to study design factors and structure. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 1, p. 3-23 to 3-28.

3, 9

Fokker-VFW Schipol began its wind energy program in October 1973, attempting to transfer aircraft production technology (helicopter blades and wind tunnel rotor fans) to the development of windmill blades. A small (diameter of 1.4 m) experimental

vertical axis rotor of Darrieus type was built and mounted in the open field (at Schipol airport) for reasons of cost reduction and realism of working conditions. Enough data was obtained about the efficiency, optimum rpm and the driving forces of the small rotor to make feasible the study of the design principles of a larger rotor. Test results were compared with those of a computerized aerodynamic model of the rotor.

18. Bonnefille, R. French contribution to wind power development--by EDF. 1958-1966. In: Advanced Wind Energy Systems. Workshop Proceedings, Stockholm, STU/Vattenfall, 1976. Vol. 1, p. 1-17 to 1-22.

3, 4

During the period 1958-1966, three large windmills were developed and tested in France, by EDF--in collaboration with two companies, BEST and Neyrpic. Data and experience gained with these is very briefly outlined.

19. Burch, C.R., I.T. Parsons and R.T. Severn. Energy; a vertical axis windmill. Engineering 216: 414-415, June 1976.

5, 9

A vertical axis windmill designed at the University of Bristol and patented by Metropolitan Vickers is described.

20. A car powered by the wind! Mech. Illus. 72(582): 132, November 1976.

15

A car powered by wind, called Wind Mobile, is described.

21. Carter, J. Living with sun and wind; a natural energies homestead. Wind Power Dig. 1(4): 24-26, Spring 1976.

4, 12a

22. Carter, J. Robert Landing's homebuilt delight. Wind Power Dig. 1(5): 23-25, Summer 1976.

12a

23. Chamis, C.C. and T.L. Sullivan. Free vibrations of the ERDA-NASA 100 kW wind turbine. Presented at a Specialty Conference on the Dynamic Response of Structures, Los Angeles, March 30-31, 1976. Sponsored by the American Society of Civil Engineers and UCLA. NASA-TM-X-71879. N76-18674. NTIS, 1976. 17 p.

3, 5

The ERDA-NASA wind turbine (windmill), which consists of a 93-foot truss tower, a bed plate that supports mechanical and electrical equipment, and two 62.5-foot long blades, was analyzed to determine its free vibrations using NASTRAN. The finite element representation of the system consisted of beam and

plate elements. The free vibrations of the tower alone, the blades alone, and the complete system were determined experimentally in the field. These results were obtained by instrumenting the tower or blades with an accelerometer and impacting the components with an instrumented mass. The predicted results for natural frequencies and mode shapes were in excellent agreement with measured data.

24. Chilcott, R.E. Wind energy utilization--New Zealand's prospects. N.Z. Energy J. 49(3): 40-41, March 25, 1976.

6

Wind energy converters are expensive. This means that, although wind energy utilization is technically feasible in a variety of applications, it may not be economically attractive. The indications are that well-balanced primary-secondary wind energy converters will probably need to cost less than NZ$1000/kW at a rated wind speed of 7 m/s in order to find widespread application in New Zealand. The design and development of such equipment presents a challenge and offers plenty of scope for local ingenuity.

25. Clark, S.H. Outlook for new energy sources. J. Petrol. Technol. 28: 21-23, January 1976.

6

Uncertainty surrounds the future market outlook for most alternative energy sources. The new sources have several common characteristics: They are relatively high cost energy sources, even when compared with current oil prices; they all have high initial costs; they are in an R&D phase; their energy will be used mostly in the form of electricity; and none will achieve market penetration in this decade. Geothermal sources, solar energy, fusion, winds, and tides are all considered individually.

26. Claudi-Westh, H. Some early Danish experiences--supplement. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 1, p. 1-13 to 1-15.

3, 4

This paper deals primarily with the F.L.S. Aeromotors designed and manufactured by F.L. Smidth & Co., Copenhagen during the second world war.

27. The Coburg Elementary School "Win" generator. Mother Earth News No. 40: 94, July 1976.

4

Fifth and sixth graders' experience with a 33-foot-tall 500 watt-output Savonius rotor used to light their classroom is related.

1976

28. Collins, G. and R.J. Simpson. Tilting at windmills. Electr. Power 22(6): 347-351, June 1976.

1, 4, 9

Descriptions of some very early windmills are followed by a history of the design, fabrication, erection and control of windmills for the generation of electricity including the development of the vertical-axis machine.

29. Connors, T.T. et al. Potential of indigenous energy resources for remote military bases. Santa Monica, Cal., Rand Corporation, 1976. 137 p.

6, 8

In order to conserve petroleum and lessen oil imports, the U.S. needs to consider indigeneous energy resources at its remote bases. An analytic computer model and power system model were used to examine the potential of solar radiation, winds, and ocean waves in terms of size requirements and costs. Results show that there are enough indigenous sources available at remote bases, but only solar and wind systems are advanced enough to be used without considerable research. Total indigenous systems cannot be justified now because of high initial costs. However, a combination system using both conventional and unconventional sources could be installed (at about three times the conventional cost) to lessen the vulnerability of U.S. bases.

30. Coulter, P.E. Aerogenerator for electricity from the wind. Energies 2(2): 8-11, April 1976.

5

An investigation is described into a novel design approach to capture and contain wind in usable energy form, in a 2.5 MW power range. The rotor blade, air capture and transmission, and tower design are described, together with methods of energy conversion and output reliability of the large capacity (500 to 3000 KW) aerogenerator.

31. Discussion on major problem areas. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 2, p. 8-7 to 8-17.

3, 4

32. Divone, L.V. and J.M. Savino. The U.S.-NSF/NASA wind energy conversion systems (WECS) program. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 2, p. 7-25 to 7-33.

3, 6

The five-year research and development plan of the NSF/NASA Wind Energy Conversion Systems (WECS) program is outlined.

The program includes mission studies to determine energy use patterns and requirements and define specific applications for wind energy systems, wind energy resource assessment and development, and development of cost-effective components and subsystems. The program is also directed towards the development of energy storage systems to make wind powered systems firm power sources where appropriate. A 100 kW experimental wind generator (Model Zero) is being designed as a flexible test bed for a variety of system components. Designs will be developed for units in the 50 to 200 kW and 500 to 3000 kW size ranges.

33. Dodson, F. Harnessing the wind. N.Z. J. Agric. 132(2): 7, February 1976.

6a

Will "egg-beater" wind-powered electric generators one day sprout from the roofs of farm dairies in New Zealand? This is an intriguing possibility, following the production of a successful prototype generator. It is bound up with economics, of course, but in view of the pending rise in electricity charges, there is cause for thought.

34. Dutton, J.A. The ceaseless wind, an introduction to the theory of atmospheric motion. New York, McGraw-Hill, 1976. 579 p.

2, 4, 5

35. Eldridge, F.R. Some wind energy storage options. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976, Vol. 2, p. 5-63 to 5-65.

3, 6, 11

Results of economic studies of storage systems for energy generated from the wind are summarized. These fall into the categories of electrochemical energy storage systems (batteries or systems that store hydrogen generated by electrolysis), thermal energy storage systems, kinetic energy systems (flywheels or superconducting electromagnetic systems), and potential energy systems (pumped-hydro-systems or compressed air systems). The minimum economic sizes for utility applications, estimated capital costs per unit, estimated unit lifetimes, dispersed storage capabilities, and estimated turn-around efficiencies are given.

36. Eldridge, F.R. Wind-powered aqueduct systems. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 1, p. 4-3 to 4-10.

3, 15

An aqueduct system that would use large-scale wind-driven units to provide power for the pumping of water from the main reservoir to auxiliary reservoirs of the system is considered. The preliminary design study of this system would include a comparison of the following alternatives: the direct mechanical pumping of water; the direct power generation by wind-turbine units and the use of this power to operate water pumps; the use of wind units to pump water from an auxiliary reservoir below a hydroelectric dam back into the main reservoir and the use of hydroelectric power to operate the electrical pumps of the aqueduct system; the feasibility of reducing the number of wind units required by interconnection with a public utility network or by the use of some means of energy storage. The aqueduct system of the Canadian River Project for furnishing supplementary water to cities in the Texas panhandle is thought to be an ideal system on which to perform initial proof-of-concept experiments on the use of wind units.

37. Energy. Vol. 1. Demands, resources, impact, technology and policy. Penner, S.S. and Icerman, L., 1974. Vol. 2. Non-nuclear energy technologies. Penner, S.S. and Icerman, L., 1975. Vol. 3. Nuclear energy and energy policies. Penner, S.S. et al., 1976. Reading, Mass., Addision-Wesley Publ. Co.

2, 4

These three volumes are a compilation of the authors' lecture notes.

38. Energy for rural development; renewable resources and alternative technologies for developing countries. Report of an Ad Hoc Panel of the Advisory Committee on Technical Innovation, Board on Science and Technology for International Development, Commission on International Relations. Washington, D.C., National Academy of Sciences, 1976. 306 p.

2, 4, 6

Several articles on wind power are included in this report.

39. ERDA's costly quest for energy options brings charges, changes. Eng. News-Rec. 196(20): 22-23, May 13, 1976.

4

ERDA's energy program is described, including wind-power research, and current criticisms and problems are discussed.

40. Evans, M. Visiting NASA's 100 kW wind turbine. Wind Power Dig. 1(4): 11-15, Spring 1976.

6

41. Fischer, J. Wind power possibilities in Denmark. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 2, p. 6-23 to 6-27.

3, 6, 9

This paper presents a new design for the Darrieus windmill. Its fulfillment of the goals of pleasant design, safety and security of design, and economical soundness are discussed.

42. Fred Kale's Windmill Lane. Wind Power Dig. 1(4): 4, Spring 1976.
1, 4

43. Fry, S. Your wind energy conversion system. Step 1: Collectors. Boston Wind, No. 3: 6-10, November 1976.
5

Various rotors are described, and a "laundry list" of some wind generators with some statistics is included. Information provided is manufacturer, generator, blades, diameter, monthly output, price, and some notes on features.

44. Gilbert, L.J. A 100 kW experimental wind turbine: simulation of starting, overspeed, and shutdown characteristics. NASA-TM-X-71864. N76-18672. NTIS, 1976. 27 p.
5

The ERDA/NASA 100 kW experimental wind turbine is modeled on a digital computer in order to study the performance of a wind turbine under operating conditions. Simulation studies of starting, overspeed, and shutdown performance were made. From these studies operating procedures, precautions, and limitations are prescribed.

45. Goldman, J. and E. Pearlman. Block Island - telephones and taverns. Boston Wind, No. 3: 11, November 1976
8

Two applications of wind power on Block Island are described.

46. Goodrich, R.F. Some considerations in designing wind energy systems. Wind Power Digest 1(4): 34-37, Spring 1976.
5

This article is a brief summary of some of the considerations involved in designing wind power systems. It consists of the major principles affecting the proper match between rotor and generator characteristics to achieve optimum performance. The energy derived from the wind is influenced to a large degree by the behavior of both of these characteristics with wind velocity. Any design worth its salt must take both into consideration to be effective. Also included herein are some diverse thoughts and ideas which might be useful to those considering wind energy systems.

1976

47. Goodrich, R.F. Technical scratchpad. Experiments with rotor construction. Wind Power Dig. 1(5): 27-30, Summer 1976.
5, 12a

This article is a brief summary of two different approaches in rotor design using readily available construction techniques and materials. All of the materials used are available in hardware and/or home improvement stores. Simple hand tools were used during construction and no special skills or techniques are required. The designs described here are not final operational systems. The intent was to explore construction techniques and materials, not to fabricate an operational system.

48. Grandpa (sometimes) had a good idea, too. Mother Earth News, No. 37: 50, January 1976.
1

This is a brief, nostalgic article with a photo of a 1918 wind generator, pointing out that wind energy is not a new idea.

49. Grumman's windstream 25. Wind Power Dig. 1(4): 18, Spring 1976.
12b

50. Hardy, D.M. Wind power studies: initial regional applications (Progress report for January through March 1976). Lawrence Livermore Laboratory, University of California, Livermore, California. UCRL-50034-76-2. NTIS, March 22, 1976. 27 p.
6

This report describes results in wind-energy research conducted by the Lawrence Livermore Laboratory. Initial applications of available regional data in numerical calculations are reported, and data sources and collection procedures are discussed. Numerical examples of the principal components analysis technique are also presented.

51. Harper, E. Problems with a 6 kW Elektro. Wind Power Dig. 1(5): 11-14, Summer 1976.
4, 12b

52. Harris, I. and D. Highgate. High pressure hydrogen by electrolysis. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 2, p. 5-67 to 5-75.
3, 6

This paper addresses itself to the problems of providing a reliable energy supply for a small community, and the energy economy in the UK in future situations where adequate supplies of petroleum may be scarce, expensive, and politically unreliable. This is accomplished by identifying key items of hardware and technology which will provide a means of introducing a solution to the second problem if they are developed to provide a solution to the first problem.

53. Harris, R.I. Work at Cranfield on the characteristics of natural wind. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 2, p. 7-41 to 7-42.
3, 6

This is a summary of the research on natural wind characteristics that has been done at Cranfield. Two new studies are mentioned. One involves a new look at methods of analysis of wind statistics at a site. The other involves an experimental and theoretical attack on the problems of wind flow over two- and three-dimensional obstacles such as hills, ridges, etc.

54. Highgate, D. A brief note on vertical axis rotor research at Cranfield. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 1, p. 3-31.
3, 9

55. Hinrichsen, D. and P. Cawood. Fresh breeze for Denmark's windmills. New Sci. 70(1004): 567-570, June 10, 1976.
4, 6

Recommendations of the Danish Academy of Sciences Wind Committee Report are discussed. Comparison of production data from an existing windmill at Gedser, Denmark, with output data from the U.S. Zion 1 nuclear power plant shows that the power availability of such a windmill equipped with a hypothetical device capable of storing 24 hours' average power output is comparable to that of the Zion 1 reactor. Links with the Swedish and Norwegian power networks, which have large hydroelectric capacities and "pumped storage" capability, offer a good solution to the problem of wind availability, since the period of lowest wind activity in Denmark corresponds to the late spring runoff in Northern Scandinavia. A $9 million wind development program, including construction of large electricity-producing mills and smaller mills for heat production, has been proposed. A 50 m high variable-blade windmill capable of producing up to 3600 MWh/yr is under construction at Twind and may be linked with the electrical supply grid upon completion.

56. Holme, O. Aerodynamic design of horizontal axis wind generators. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 1, p. 2-31 to 2-35.
3, 5

A blade element vortex theory taking account of the finite number of blades (a propeller theory) is used to perform the aerodynamic design of windpowered generators and to calculate their aerodynamic loads and performance. A complete system of equations for the torque and drag coefficient of the blade element of a windmill at a given pitch angle and speed ratio is calculated on the basis of velocity, force and geometrical relations for the blade element. Corresponding coefficients for the complete windmill are obtained by integrating over the blade radius and the method is extended to cover the effects of wind shear, oblique flow and pitch and yaw oscillations. The maximum power coefficient at a given speed ratio and a given number of blades is used as a windmill optimization criterion.

57. Hughes, W.L. et al. Survey of Oklahoma State University work in energy storage, variable speed-constant frequency generators, and wind generation systems. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 2, p. 5-3 to 5-40.

3, 6, 11

An overview is presented of technical and economic aspects of the development of wind power systems. Techniques under investigation as possible means of storing and convecting wind energy are discussed, with special attention given to high pressure fuel cells, high pressure electrolysis systems, and the aphodid burner turbine generator. An economic analysis shows that wind energy systems operating in parallel with conventional power lines could significantly reduce fuel costs by pumping electricity directly when available into electric transmission line grids. On the basis of projected fuel and energy cost and consumption data, the long-term cost of wind power systems is compared with that of systems based on fossil fuels. Different types of electric generators under consideration for use with wind systems are described, and the design of wind turbines and coupling systems is discussed.

58. Hundemann, A.S. Wind power (citations from the NTIS data base). Report for 1964 - April 1976. NTIS/PS-76/0358. NTIS, May 1976. 157 p. Supersedes NTIS/PS-75/348 and COM-74-11103.

16

The feasibility, use, and engineering aspects of wind power and windmills are discussed in these citations of Federally-funded research reports. Abstracts primarily cover the use of wind power for electric power generation and wind turbine design and performance. General studies dealing with comparative analyses of wind power and alternative energy sources are included. Also mentioned are energy storage devices which can be used in these systems. (This updated bibliography contains 152 abstracts, 67 of which are new entries to the previous edition.)

59. Hundemann, A.S. Wind power (citations from the Engineering Index data base). Report for 1970 - April 1976. NTIS/PS-76/0359. NTIS, May 1976. 79 p.
16

Windmill and wind power feasibility, use, and engineering are discussed in these citations of worldwide research. Abstracts primarily cover the use of wind power for electric power generation and wind turbine design and performance. General studies dealing with the use of wind power in developing countries and comparative analyses of wind power and alternative energy sources are included, as are studies on energy storage systems. (Contains 74 abstracts.)

60. Huq, R. and J.L. Loth. Vortex kinetic energy concentrator. In: Intersociety Energy Conversion Engineering Conference, 11th. Proceedings. Stateline, Nevada, September 12-17, 1976. New York, American Institute of Chemical Engineers, 1976. p. 1773-1778.
3, 5

61. Hütter, U. Optimum design concept for wind-electric converters. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 1, p. 2-3 to 2-23.
3, 5

The optimal design criteria of windpowered generators relate to four parameter groups: (1) the outlay of the rotor blades; (2) the correlation of the rated power output, the magnitude of the disk area swept by the rotor and wind velocity statistics; (3) the parameters of energy conversion; and (4) the absolute values of the magnitude of individual units and the relative magnitude of system components such as tower height in relation to rotor diameter. Graphs are plotted for the optimal lift/drag ratio of rotor airfoils and for the optimal power coefficients versus rotor blade tip speed. The effect of power disk load on energy quality is calculated.

62. Hütter, U. Review of past developments in West Germany. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 1, p. 1-51 to 1-72.
3, 4

The paper reviews work done in the field of windpowered generators in Germany from the 1920s through the 1950s. Examples are taken from work done by Hermann Honnef, by the Ventimotor GmbH in Weimar and the Allgaier-Werke in Uhingen. In 1931 and 1932 Honnef published the results of his studies on the outlay of a multirotor windpowered generator system with a total rated power of almost 60 megawatts. The height of the tower was 250 m and it was planned to support three individual rotor systems of 160 m each. The system was a gearless one

using large ring generators. The Ventimotor GmbH project in the 1940s consisted of a 50 kW ac unit with a rotor diameter of 18 m, a rotor rated speed of 4.5 m/s and an elevation of the rotor axis of 22 m above the ground. In the early 1950s Allgaier-Werke developed a standard unit with a pitch controlled 3- and later a 2-blade high tip speed ratio rotor. The machine, including in one block rotor hub, gear, generator and an automatic positioning system was adjusted to a tubular tower.

63. Igra, O. Design and performance of a turbine suitable for an aerogenerator. Energy Convers. 15(3/4): 143-151, 1976.
5, 10

As part of a large project aimed at finding the optimal configuration for an aerogenerator to exploit wind power, an investigation was launched to find a simple and reliable way to design a turbine to operate in a shrouded aerogenerator. To check the reliability of the proposed model for the turbine design, two turbines were built and tested. The tests covered a wide range of inlet and angular velocities and were conducted for several numbers of blades. The results of these tests clearly demonstrate that the proposed design scheme can be used with confidence for the design of a turbine that is intended to work inside an aerogenerator shroud.

64. Igra, O. Shrouds for aerogenerator. American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 14th, Washington, D.C., January 26-28, 1976. Paper 76-181. 11 p.
3, 5, 10

In order to exploit the wind power as economically as possible, it was suggested that the wind-turbine be enclosed inside a specially-designed shroud. Past work has shown that such shrouds can increase the output power of a given turbine by a factor of 3 or so, as compared with the bare configuration under the same free stream conditions. However, the geometry of the first generation shrouds was unacceptable for economical use, i.e., the ratio of the shroud's total length to throat diameter was of the order of 7. The main purpose of the present work was to arrive at a compact shroud configuration without sacrificing good aerodynamic performance. The results clearly indicate that it is possible to obtain shrouds with total length to throat dimaeter ratio smaller than 3, with performance similar to the first-generation model.

65. Immega, G. Erecting a 400 lb windmill. Wind Power Dig. 1(5): 14-15, Summer 1976.
12b

1976

66. Inglis, D.R. Wind power now! Reply with rejoinder, L.W. Zelby. Don't get swept away by wind power hopes. Bull. Atom. Sci. 32: 59, March 1976.
4

67. Intersociety Energy Conversion Engineering Conference, 11th. Proceedings. Stateline, Nevada, September 12-17, 1976. 2 Vols. New York, American Institute of Chemical Engineers, 1976. 2011 p.
3, 4

Twelve articles on wind power are included in this conference (indexed individually in this bibliography), as well as articles on geothermal energy, space power, hydrogen energy systems, energy conservation and storage, electric vehicles, electrochemical power, thermoelectrics, solar power, rankine cycle engines, thermionics, MHD and other topping cycles, coal and oil shale utilization, advanced auto propulsion, biomedical power, alternative fuels, Brayton cycles and expanders, Stirling cycle engines, nuclear power, urban energy management, heat pipes and advanced concepts.

68. Jayadev, T.S. and R.T. Smith. Wind-powered electric utility plants. ASME Paper 75-WA/Pet-1, 1975. Also J. Eng. Ind. Trans. ASME 98 Ser. B No. 1: 293-296, February 1976.
13

This paper describes the general operating modes of wind-powered electric utility plants under constant-speed or variable speed classifications. It is shown that for a particular set of wind frequency-velocity spectra there are a number of attractive system configurations, so far as total yearly energy production is concerned. Thus, detailed cost effectiveness studies and additional research will be required to develop practical wind electric conversion systems (WECS).

69. Johansson, M. Today's economy of the 200 kW experimental Gedser windmill. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 2, p. 6-15 to 6-22.
3, 6

This paper presents some recent calculations concerning cost and energy production of the Gedser windmill that were made within the Research Association of the Danish Electricity Supply Undertakings.

70. Johnson, C.C. Economical design of wind generating plants. IEEE Trans. Aerosp. Electron. Syst. AES12(3): 316-320, May 1976.
6

A definitive analysis technique is proposed for designing wind generating plants to produce electrical energy at minimum cost.

The method employs variation in essential design parameters: rated power level, rated wind velocity, design wind velocity, and number of generator poles. These parameters in turn define wind turbine radius, turbine speed, rated torque at step-up gear input, and step-up gear ratio. When these are combined with site (or region) specific wind statistics, appropriate wind plant cost functions, and criteria by which they compute annual cost of ownership, the result yields the cost of produced energy for the several design variations. The selected design is that one for which the cost of produced energy is minimum.

71. Joosten, L.J.M. and O. deVries. Some considerations on the usefulness of wind power. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 2, p. 6-3 to 6-14.

3, 6

This is a brief report concerning the findings from recent studies of wind energy applications in the Netherlands that were performed at the NLR.

72. Jorgensen, G.E. et al. Design, economic and system considerations of large wind-driven generators. IEEE Trans. Power Apparat. September, 95: 870-878, May 1976.

5, 6, 13, 14

The increased search for alternative energy sources has lead to renewed interest and studies of large wind-driven generators. This paper presents the results and considerations of such an investigation. The paper emphasizes the concept selection of wind-driven generators, system optimization, control system design, safety aspects, economic viability on electric utility systems and potential electric system interfacing problems.

73. Julian, P.R. Application of the data collection system on Nimbus 6--the TWERL Experiment. COSPAR, Plenary Meeting, 19th, Philadelphia, June 8-19, 1976. 13 p.

3, 5, 6

The Tropical Wind, Energy Conversion, and Reference Level Experiment using the location and data collection system on Nimbus 6 is described. TWERLE made use of 411 instrumented balloon platforms launched July through September 1975 at three locations in the tropics and in October-February from Christchurch, New Zealand. The configuration of the system and its evaluation are described. Some scientific highlights including trajectory behavior and wave motions detected by the instrumented balloons are discussed.

1976

74. Justus, C.G. Wind energy statistics for large arrays of wind turbines (New England and Central U.S. Region). ERDA/NSF-00547/7611, 1976.

6

75. Justus, C.G., W.R. Hargraves, and A. Mikhail. Reference wind speed distributions and height profiles for wind turbine design and performance evaluation applications. Technical Report. Atlanta, Ga., Georgia Institute of Technology, ORO/5108-76/4, August 1976. 103 p.

5, 6

The purpose of this report is to provide a set of reference or standard values of wind profiles, wind speed distributions and their effects on wind turbine performance for engineering design applications. Based on measured Weibull distribution parameters, representative average, low, and high variance data are given for height profiles of mean, 25 percentile, and 75 percentile wind speeds; and for wind speed probability density (velocity frequency) functions and cumulative probability (velocity duration) functions at selected heights. Results of a sensitivity analysis of the dependence of wind turbine performance is expressed in terms of capacity factor (ratio of mean power output to rated power) and recovery factor (ratio of mean energy output to energy theoretically available in the wind). The representative high, mean, and low variance cases were determined from calculated Weibull distributions at 140 sites across the Continental U.S., and all of the representative functions are evaluated at mean wind speeds of 4, 5, 6, 7, and 8 m/s at standard 10 m level. As background to these representative design functions, the basic characteristics of the Weibull distribution are summarized, and methodologies are given for height projection from a measured level to a desired height (in relatively flat terrain). The methodologies are also described whereby wind turbine performance for input values other than given here can be calculated by design engineers.

76. Justus, C.G., W.R. Hargraves and A. Yalcin. Nationwide assessment of potential output from wind powered generators. J. Appl. Meteorol. 15(7): 673-678, July 1976.

6

A method of computing power output from wind-powered generators has been developed and applied to estimate potential power output at various sites across the continental United States. The method assumes a wind-powered generator system which can be characterized by a cut-in speed V_0, a rated speed V_1 and a cut-out speed V_2. The generator output power is assumed to be constant at the rated power P_r between V_1 and V_2 and to vary parabolically from zero at V_0 to P_r at V_1. The wind distributions at various sites have been found to vary according to a

Weibull distribution between realistic values of V_0 and V_1. Values of the Weibull distribution parameters at approximately 135 sites across the United States have been evaluated. These results have been projected to a constant height of 30.5 m (100 ft) and 61 m (200 ft) using data determined from observed Weibull parameter height variations at several meteorological tower sites across the country. A contour map is presented for generator capacity factor values (fraction of rated power output actually realizable). The capacity factor values were computed, using the above method, for wind-powered generator systems having cut-in speed $V_0 = 3.6$ m s^{-1} (8 mph), and rated speed $V_1 = 8.0$ m s^{-1} (18 mph), the characteristics of NASA's 100 kW Plumbrook unit, and $V_0 = 6.7$ m s^{-1} (15 mph), $V_1 = 13.4$ m s^{-1} (30 mph), hypothetical values for a 1 MW class unit. Results of the evaluation indicate that at a height of 61 m in the central United States and in certain portions of the New England coast over 60% of the rated output power can be achieved on an annual average basis, i.e., an average of $\geq$ 60 kW from the Plumbrook 100 kW generator. In these same areas the 1 MW system would have over 20% capacity factors, i.e., an average of $\geq$ 200 kW from the 1 MW system.

77. Kadlec, E. The Darrius "eggbeater" design. Wind Power Dig. 1(4): 21-23, Spring 1976.

6, 9

78. Kaza, K.R.V. and C.E. Hammond. An investigation of flap-lag stability of wind turbine rotors in forward flight. In: Structures, Structural Dynamics, and Materials Conference, 17th, King of Prussia, Pa., May 5-7, 1976. Proceedings. New York, American Institute of Aeronautics and Astronautics, Inc., 1976. P. 421-431.

3, 5

The flap-lag equations of motion of a torsionally rigid and centrally hinged spring-restrained rigid blade are developed using quasi-steady blade-element aerodynamic theory. These equations have periodic coefficients and are applicable to both wind-turbine rotors with velocity gradients and helicopter rotors in forward flight. By solving these equations both by the Floquet-Liapunov method and by an approximate method, the range of applicability of the latter method is established. Flap-lag and pure flapping stability boundaries illustrating the effects of flow and rotor parameters are presented. Finally, some discussion on the techniques for generating the Floquet transition matrix and on the relative merits of the coordinate axes system is presented.

79. Kocivar, B. World's biggest windmill turns on for large-scale wind power; ERDA-NASA wind machine. Pop. Sci. 208(3): 73-75, 150-151, March 1976.

4, 7

1976

80. Le Boff, J.P. Wind power feasibility. Energy Sources 2(4): 361-376, 1976.
6

The harnessing of wind power as a renewable energy source is undergoing reexamination. The proven technological feasibility of using large-scale wind turbines to produce electricity, combined with the vast amount of potential energy available, give this source its attractiveness. Given the diffuse and capricious nature of the wind, however, the actualization of this potential becomes constrained by economic considerations. The costs of both base-load and supplementary wind systems are examined. Despite the wide range of preliminary capital cost estimates, the translation of these estimates into unit energy costs points to the noncompetitive nature of wind power with alternative energy sources at the present time.

81. Lissaman, P.B.S. Some marketing and technical considerations of wind power. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 1, p. 2-39 to 2-58.
3, 4, 5, 6

A brief review of the wind power market situation is given. Three viable windmill classes are identified, in the power ranges of 0.1, 1, and 1,000 kW. Judging by the public response, and some very preliminary market surveys, the demand for the two smaller units appears attractive for private venture capital. Some common characteristics of potential purchasers for the 1 to 5 kW systems are identified. A basic aerodynamic performance analysis for the crosswind type rotor is outlined, showing that it is intrinsically less efficient aerodynamically than the wind axis (propeller) rotor. A greatly simplified structural comparison is made, also showing the crosswind type to be comparable but slightly less efficient structurally than the propeller type. It is stressed that this tentative conclusion is based on an incomplete technical analysis and ignores other considerations, such as total cost or esthetics.

82. Ljungström, O. Advanced vertical axis rotor concepts. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 1, p. 3-1 to 3-4.
3, 5, 9

New vertical axis rotor concepts for windpowered generators are reviewed. The concepts include the freedom of arranging the blades in different ways: in delta-rotor, Y-rotor and phi-rotor layouts. The straight-bladed concepts (delta and Y) have the advantage of allowing cyclic pitch change to be arranged more easily than for the curved catenary blades of the phi type. Other concepts mentioned include aerodynamic design scaling effects, and the integration of power cables in the structural support system.

83. Ljungström, O. Large scale wind energy conversion system (WECS) design and installation as affected by site wind energy characteristics, group arrangement and social acceptance. International Symposium on Wind Energy Systems, Cambridge, England, September 7-9, 1976.

3, 6, 13

84. Ljungström, O. A new era for motor-sailing ships? In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 1, p. 4-11 to 4-14.

3, 15

This paper presents ideas concerning the use of wind power to aid cargo vessels in maintaining high speeds and also conserving fuel.

85. Ljungström, O. The Swedish wind energy R&D program proposal for three years, 1975-1977. In: Advanced Wind Energy Systems. Workshop Proceedings, Stockholm, STU/Vattenfall, 1976. Vol. 2, p. 7-35 to 7-38.

3, 6

The STU-wind energy study group concluded that it may be possible to develop competitive wind energy systems with the application of modern systems technology and component developments. The presentation outlines the main features of their three year wind energy R&D program.

86. McCarthy, C.D. and G. Rosen. Wind energy--cost effectiveness is the key. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 2, p. 6-29 to 6-35.

3, 6

It has been determined that $400 (1974 dollars) per rated kilowatt capacity would be a competitive cost for a wind energy conversion system producing electricity, assuming a thirty year lifetime for the system. The cost of installation is assumed to contribute 30% of the total cost, leaving a selling price target of about $280/kW for the complete system. A rotor using variable pitch blades plus its control system accounts for about 25% of the uninstalled system cost. An allowable cost target of $42 per rated kilowatt is suggested for rotor blades, which represent 60% of the rotor cost. Ten-year projections of candidate blade materials are given.

87. McCaull, J. Storing the sun. Scientist's Institute for Public Information. Environment 18(5): 9-15, June 1976.

4, 6

The harnessing of wind power, an indirect use of solar energy, is another alternative for intermediate and peak-load demands in geographical regions where there is wind for large, modern wind turbines.

88. McConnell, R.D. et al. An experimental 200 kW vertical axis wind turbine for the Magdalen Islands. In: Intersociety Energy Conversion Engineering Conference, 11th. Proceedings. Stateline, Nevada, September 12-17, 1976, New York, American Institute of Chemical Engineers, 1976. p. 1798-1802.
3, 9

89. Merits of wind-powered generator studied. Arizona Farmer-Rachman 55(2): 9, February 1976.
8

A newly-designed windmill which has application for irrigation or pumping water, developed by the Stillwater, Oklahoma, based American Wind Turbine, Inc., is described.

90. Meyer, N.I. Some Danish experiences with wind energy systems. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm STU/Vattenfall, 1976. Vol. 1, p. 1-3 to 1-13.
3, 13

This paper is a brief summary of Danish experience with wind power for the production of electricity. The main emphasis is on the Gedser mill, although earlier work is also mentioned.

91. Migliore, P.G., J.B. Fanucci, and W. Squire. Numerical solution for the unsteady lifting characteristics of variable pitch cross-flow wind turbines. In: Intersociety Energy Conversion Engineering Conference, 11th. Proceedings. Stateline, Nevada, September 12-17, 1976. New York, American Institute of Chemical Engineers, 1976. p. 1779-1786.
3, 5

92. Miller, C.A. Windchargers you can buy...now! Mech. Illus. 72(582): 31-33, November 1976.
6, 12b

93. Modern energy technology. New York, Research and Education Association, 1976. 2 Vols. 1,824 p.
2, 4

Included in the sections on Geothermal Energy and Solar Energy is information on wind energy.

94. Moran, E. Haven Noble, wind-powered shop. Pop. Sci. 209: 93, July 1976.
4

95. Moran, E. Now you can buy an eggbeater windmill. Pop. Sci. 209(2): 26, August 1976.

4, 9, 12b

This article describes Darrieus windmills manufactured by Dominion Aluminum Fabricators, Ltd., with information about purchase.

96. Morse, F.H. and M.K. Simmons. Solar energy. Annual Review of Energy 1: 131-158, 1976.

4, 6

The status and economic feasibility of various technologies for solar energy conversion with technological or natural collection are assessed. Use of solar energy for heating and cooling, conversion to steam, photovoltaic conversion, fuel production, ocean thermal conversion, and wind energy conversion is reviewed. Solar energy is very capital intensive. By 2000, solar energy will be a conventional energy source. Factors in the near-term use of solar energy include development of a viable industry. Status of R&D programs, and national legislation. The environmental impacts of solar energy are also considered.

97. Muraca, R.J. and R.J. Guillotte. Wind tunnel investigation of a 14 foot vertical axis windmill. NASA-TM-X-72663. NTIS, N76-19551, March 1976. 33 p.

5, 9

A full scale wind tunnel investigation was made to determine the performance characteristics of a 14 ft diameter vertical axis windmill. The parameters measured were wind velocity, shaft torque, shaft rotation rate, along with the drag and yawing moment. A velocity survey of the flow field downstream of the windmill was also made. The results of these tests along with some analytically predicted data are presented in the form of generalized data as a function of tip speed ratio.

98. Musgrove, P.J. Energy analysis of wave-power and wind-power systems. Nature 262: 206, July 15, 1976.

6

The feasibility of using wave-power and wind-power systems in Britain is discussed.

99. National R&D program issues. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 2, p. 8-4 to 8-6.

3, 4

1976

100. New prototype tested. Wind Power Dig. 1(4): 16, Spring 1976.
6

101. The new technologists; solar cookers and a basement full of fish: old techniques providing new challenges. Audubon 78(1): 122-128, January 1976.
4

A number of older, simpler, technologies are discussed, including using windmills for power.

102. Norberg, L.A. Air storage power. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 2, p. 5-81 to 5-89.
3, 11

At STAL-Laval work is being done on an air storage scheme for storing energy. It has not been done in conjunction with wind power, but the ideas may be used in combination with wind storage. Ideas concerning the application of air storage to the gas turbine electric system are presented.

103. Olson, R. Raising a wincharger. Wind Power Dig. 1(5): 35-38, Summer 1976.
12b

104. Olsson, L.E. WMO/CoSAMC surveys of atmospheric energy resources. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 2, p. 7-39 to 7-40.
3, 4

Information concerning wind power is helpful to atmospheric studies. The information in atmospheric studies may also aid wind power research.

105. Oman, R.A., K.M. Foreman and B.L. Gilbert. Investigation of diffuser-augmented wind turbines. Progress Report, June 25, 1975 - December 24, 1975. NTIS, COO-2616-1, January 1976. 64 p.
5

The Diffuser-Augmented Wind Turbine (DAWT) is one of the more promising advanced concepts for decreasing the cost of wind energy conversion. The first results of an investigation designed to determine the most effective configurations for DAWT's and to assess their ultimate performance in large units are presented. Two types of compact diffusers have been analyzed and tested, using screens to simulate the turbines. A 20° half-angle conical diffuser with two tangential boundary layer control slots provided a measured augmentation ratio of 1.7 at an area ratio of 2.8, while a double ring-wing diffuser gave 2.1 at an equivalent area ratio of 3.8. Results indicate potential for considerable improvement and further size reduction. Several analyses related to diffuser development are given.

106. Panel discussion on R&D. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 2, p. 8-1 to 8-3.

3, 4

107. Park, J. Operational experience with small wind units. In: Intersociety Energy Conversion Engineering Conference, 11th. Proceedings. Stateline, Nevada, September 12-17, 1976. New York, American Institute of Chemical Engineers, 1976. p. 1795-1797.

3, 4

108. Postma, H. Other energy sources. Presented at the Energy Awareness Symposium, Knoxville, February 27, 1976. p. 120-143. NTIS, CONF-760205, 1976.

3, 4, 6

The supply, economics, applications, and development status of solar, geothermal, and fusion energy are surveyed. Alternative energy sources are clearly necessary. In addition to oil, gas, coal, and nuclear fission, to meet U.S. energy needs in the next 25 years. Present governmental strategy in developing these alternative sources is discussed. Solar energy has the largest potential. But the sun's rays are both diffuse and intermittent, and costs must be lowered for widespread use.

109. Potential of ocean energy sources probed. Chem. Eng. News 54(18): 26-28, February 23, 1976.

4

In addition to energy conversion from ocean thermal gradients, the energy potential of tides, waves, salinity gradients, currents, winds, and ocean bioconversion are being investigated. Tidal power is already exploited on a small commercial scale in France and the USSR. The U.S., Canada, and the U.K. are seriously examining tidal energy possibilities off their coasts.

110. Power to the people; H. Reuss' backyard power source. Forbes 117(12): 81, June 15, 1976.

4

111. Pruyn, R.R. and W. Wiesner. Reduction of wind powered generator cost by use of a one bladed rotor. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 1, p. 2-103 to 2-131.

3, 5, 6

Windpowered generator designs studied were sized for an output power of 1000 kW. The one-blade design seems to have significant design and cost advantages (a 30% reduction) over two or more bladed rotors. The one-bladed design has the potential of reducing acquisition cost to $680 per available kW if the unit is located in a region with mean surface winds of 15 mph. Using the one-bladed concept, it is possible to halve the minimum solidity of the rotor, to greatly simplify the rotor hub and to reduce blade costs almost in half. Vibratory loads of the one-bladed rotor appear to be compatible with a 30 year design life.

112. Puthoff, R.L. Fabrication and assembly of the ERDA/NASA 100 kilowatt experimental wind turbine. NASA-TM-X-3390. NTIS, N76-21703, April 1976. 30 p.
5

As part of the Energy Research and Development Administration (ERDA) wind-energy program, NASA Lewis Research Center has designed and built an experimental 100 kW wind turbine. The two-bladed turbines drives a synchronous alternator that generates its maximum output of 100 kW of electrical power in a 29 km/hr (18-mph) wind. The design and assembly of the wind turbine were performed at Lewis from components that were procured from industry. The machine was installed atop the tower on September 3, 1975.

113. Quinn, B. The consumer's cost of electricity from windmills. In: Intersociety Energy Conversion Engineering Conference, 11th. Proceedings. Stateline, Nevada, September 12-17, 1976. New York, American Institute of Chemical Engineers, 1976. p. 1746-1753.
3, 6

114. Radice, F.C. Siting of wind driven apparatus. In: Intersociety Energy Conversion Engineering Conference, 11th. Proceedings. Stateline, Nevada, September 12-17, 1976. New York, American Institute of Chemical Engineers, 1976. p. 1736-1740.
3, 6

115. Ramakumar, R. Wind driven field modulated generator systems. In: Intersociety Energy Conversion Engineering Conference, 11th. Proceedings. Stateline, Nevada, September 12-17, 1976. New York, American Institute of Chemical Engineers, 1976. p. 1766-1772.
3, 13

116. Rayment, R. Energy from the wind. Heat. Air Cond. J. 46(531): 20-21, April 1976.
6

This paper studies aerogenerators (windmills) as an economic way of producing electricity. Basic characteristics of the wind are presented and the effectiveness of aerogenerators is examined.

117. Reed, J.W. Meteorological studies for wind power. Second Quarterly Progress Report. Albuquerque, N.M., Sandia Labs., Schedule 189, No. 0001646, 1976.
5

118. Restaurant to be naturally powered. Eng. News-Rec. 196(20): 21, May 13, 1976.
4, 15

A roadside restaurant under construction in central California will open this fall with some wind-powered lighting, and the designers are considering means of capturing solar energy that eventually may make the 18,000 sq. ft. building completely energy self-sufficient.

119. Reuss, H. Wind energy: clean, safe and inexhaustible. Wind Power Dig. 1(5): 20-22, Summer 1976.
4, 6

Congressman Reuss describes his experience with a small windplant at his summer home in Wisconsin.

120. Review of plans [on] vertical axis machines. Wind Power Dig. 1(4): 39-41, Spring 1976.
9, 12a

Four plans are reviewed and illustrated.

121. Rosen, G., H.E. Deabler, and D.G. Hall. Economic viability of large wind generator rotors. Intersociety Energy Conversion Engineering Conference, 10th. New York, Institute of Electrical and Electronics Engineers, Inc., 1976. Part II of Proceedings.
3, 6

Earlier attempts at large scale conversion of wind energy to electricity proved abortive because of excessive capital cost, particularly that of the air turbine. Current reassessment studies based on the modern aerospace technologies in aerodynamics, structural dynamics, materials, and fabrication processes have shown the way to reduce air turbine production costs by factors of 2 to 4. When integrated into the total wind energy conversion system (WECS) comparable overall cost reductions are indicated. This magnitude of cost reduction coupled with current high fuel costs now appears to make the large WECS cost competitive with today's conventional power plants. Continuing WECS technology refinements when reflected against projected increasing fuel cost trends should further enhance the WECS economic advantage. Thus, it is recommended that the electric power industry study the potential use of WECS as a substantial source of future energy generation.

1976

122. Salieva, R. B. Optimality criteria for solar- and wind-energy systems. Geliotekhnika 1: 58-63, 1976. (In Russian)
6

It is shown that in order to design efficient solar- and wind-energy systems, it is necessary to define a goal function and to optimize the system with respect to two optimality criteria. One criterion is economic efficiency in the sense of least national-economy expenditures; the other is reliability in the sense of flawless performance probability.

123. Salieva, R.B. Principles of designing solar- and wind-energy systems. Geliotekhnika 1: 51-57, 1976. (In Russian)
6

A systems analysis approach is proposed for planning and designing solar- and wind-energy systems whose operation involves natural, engineering, and human factors. Such relatively complex systems are characterized by the presence of control, functional objectives, a hierarchical system structure, and a continuously changing state of subsystems and elements. Computer-aided solutions to the problems of optimizing the system structure, the system parameters, and the system modes of operation are presented.

124. Savino, J.M. Vertical axis rotor research at NASA-Langley Research Center. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 1, p. 3-29 to 3-30.
3, 9

125. Schönball, W. The NOAH wind energy concept. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 1, p. 2-25 to 2-30.
3, 14

The NOAH wind rotor system (a 70 kW double-rotor wind generator concept) is described. The system consists of the following: two contra-rotating propellers each with 5 blades of fixed pitch (the generator is integrated with the propeller system); a multipole generator without power transmitting couplings and with the field and the poles directly connected to the propellers, with the EM field of the generator used as a braking system; an electronic regulating system controlling the rotor speed and modulating the power output to ac or dc as necessary; a wind-operated directional system which keeps the main rotor head in the wind and which is also used as a security device to turn the main rotors away from the wind when speeds exceed the rated maximum.

1976

126. Seelhorst, E. A simple wind-powered washing machine that you can build. Mother Earth News, No. 37: 94, January 1976.
12a, 15

A wind powered washer like those used during World War II is described.

127. Seguier, F. Wind power machines receiving fresh wind. La Recherche 7: 184-187, February 1976. (In French)
5, 6

The history, current status, and future prospects of power generation by wind-activated power plants is surveyed. Vaned wind-power devices similar to those used in ancient Sumer are still in use in Iran today, while European windmills have shifted in function from flour milling to water pumping. The devices are most feasible in isolated locations where dispersed energy sources are needed, but require efficient storage equipment because of the unreliable and varying wind input. Antenna type wind pickup designs lie dormant, but turning vane and turbine blade models are still of interest. An induction type rotating wind motor generating electric power is described. The outlook for practical and economic wind-power electric generating plants in isolated areas and locations and in developing countries, and associated problems, are discussed. Combinations with solar batteries and power storage by lead batteries show some promise.

128. Shankar, P.N. On the aerodynamic performance of a class of vertical shaft windmills. Roy. Soc. Proc. Series A 349(1656): 35-51, April 13, 1976.
5, 9

The aerodynamic performance of a vertical shaft windmill developed for the purpose of energy production is analyzed. Induced velocity is derived from simple momentum theory, while a rotor blade element analysis yields equations for calculating the mean power coefficient. The uniform induced velocity theory can be linearized for high blade tip speed ratios to yield a simple formula for the mean power coefficient. Using propeller theory, the case of nonuniform induced velocity over the windmill disk is analyzed. The calculations and wind tunnel tests show that this class of windmill has efficiencies comparable to those of the best horizontal axis windmills.

129. Shapiro, J.S. A 50 kW wind powered energy system for self-supporting large households or small communities. Summary report by A.H. Stodhart. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 2, p. 5-91 to 5-93.
3, 8

Mr. Shapiro has undertaken the study and planning of a self-contained wind power system. Because much of the electrical energy we use is converted to heat energy, this system allows wind energy to produce, directly, heat energy as its main form and electrical energy as a secondary form.

130. Shephard, M.L. Introduction to energy technology. Ann Arbor, Mich., Ann Arbor Science Publ., 1976. 300 p.

2, 4

This general book on energy includes a section on wind, tidal, geothermal and ocean thermal gradient energy.

131. Sleeswijk, A.W. Low velocity panemones. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 1, p. 3-14 to 3-22.

3, 5, 9

Panemones ('all winds' in Greek) are wind turbines with vertical axis rotors that operate equally well regardless of wind direction at any given instant. The device should in principle operate under conditions when gibing does not occur: at circumferential velocities exceeding the wind velocity. The possibility of scaling up the rotor diameter without adversely affecting the angular velocity of the electric generator that may be coupled to the wind turbine led to the building of an open air test stand for low velocity panemones at the University of Groningen. The maximum dimensions of the test rotors were 3 m in diameter and 2 m in height. The power, approximately 2 kW, was dissipated by means of eddy current coupling. The load was adjusted to maintain a preset angular velocity and the torque was measured by means of a full-bridge strain gage torquemeter.

132. Smith, R.T. Analysis of polyphase commutator generator for wind-power applications. IEEE Trans. Aerosp. Electr. Systems AES 12: 39-41, January 1976.

5

This paper describes the mathematical modeling of the ac polyphase commutator generator by means of Park's equations. For clarity, a two-phase, balanced-operation machine is analyzed. Equations of performance are developed in terms of familiar parameters. The machine is shown to have attractive characteristics for variable-speed constant-frequency power generation, with possible application to wind-power systems.

133. Smith, R.T., et al. Operational, cost, and technical study of large wind-power systems integrated with existing electric utility. In: Intersociety Energy Conversion Engineering Conference, 11th. Proceedings. Stateline, Nevada, September 12-17, 1976. New York, American Institute of Chemical Engineers, 1976. NTIS, Conf-760906-8, 1976. 7 p.

3, 6

134. Smith, R.T. and T.S. Jayadev. Wind-turbine mechanical-to-electrical conversion systems. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 2, p. 5-95 to 5-114.

3, 6

The electrical energy output of Variable-Speed, Constant-Frequency (VSCF) and Constant-Speed, Constant-Frequency (CSCF) electric generation schemes for wind power plants in a power grid is analyzed on the basis of power-duration curves. A sample calculation shows that VSCF systems have a slightly higher energy output than comparable CSCF systems. In both systems the output is primarily dependent on the generator efficiency. A VSCF system with no power control but with an excessively large generator generates less energy than a VSCF system with power control and relatively small generator. VSCF systems require a large capital outlay for generators but obviate the elaborate pitch controls characteristic of CSCF systems. A two generator scheme is suggested to alleviate the problem of low generator efficiency at light loads.

135. Smulders, P.T. Research on wind energy at the Eindhoven University of Technology, Netherlands. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 1, p. 2-59 to 2-62.

3, 4

The projects concerning wind energy at the Eindhoven University of Technology are summarized.

136. Södergard, B. DC-generator and thyristor converter is a good alternative to AC synchronous for large wind-electric generators. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 2, Summary p. 5-119, Appendix 9-7 to 9-20.

3, 6, 14

The performance of a large AC-synchronous generator is compared with that of a DC generator and thyristor in a wind power system. The DC equipment provides good attenuation of gust transients and is capable of giving full voltage output at as low as 40% of the normal full speed. The acceleration time for a wind rotor at rest at low wind velocities is shorter for the DC generator than for the AC equipment. Sample calculations carried out for a 230 kW wind generator show that the annual energy output with a DC-equipped system is 8% higher than that of the AC system.

1976

137. Sorensen, B. Wind energy. Bull. Atom. Sci. 32(7): 38-45, September 1976.

4, 6

As a major source of electric power generation, windmills are technically feasible and increasingly attractive economically. Society should not overlook this energy option.

138. South, P. A high speed vertical axis wind machine. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 1, p. 3-5 to 3-18.

3, 5, 9

Various design aspects of high-speed vertical axis wind machines for power generation are conisdered. These include aerodynamic structural design of rotor blades, blade supports, optimization aspects, the role of blade number and blade manufacturing. A phi-type rotor system is considered. Graphs are plotted for power output versus tip speed ratio for single and three blade rotors and rotor drag is plotted versus speed ratio along with measured power versus wind speed ratio. The calculated power is plotted versus wind speed ratio and the aerodynamic normal force distribution for zero bending moment is examined. An optimal configuration with the following characteristics is proposed: a rotor height to diameter ratio of 1.5; the use of two or three blades designed predominantly as tensile members; the blades would be braced to the central column; the solidity would be about 0.2 to allow for a blade zero lift/drag coefficient of 0.01; and power would be taken off just above or just below the lower rotor bearing.

139. Spera, D.A. Structural analysis of wind turbine rotors for NSF-NASA Mod-0 wind power system. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 1, p. 2-63 to 2-99.

3, 5

Preliminary estimates are presented of vibratory loads and stresses in hingeless and teetering rotors for the proposed NSF-NASA Mod-0 wind power system. Preliminary blade design utilizes a tapered tubular aluminum spar which supports non-structural aluminum ribs and skin and is joined to the rotor hub by a steel shank tube. Stresses in the shank of the blade are calculated for static, rated, and overload operating conditions. Blade vibrations were limited to the fundamental flapping modes, which were elastic cantilever bending for hingeless rotor blades and rigid-body rotation for teetering rotor blades. The MOSTAB-C computer code was used to calculate aerodynamic and mechanical loads. The teetering rotor has substantial advantages over the hingeless rotor with respect to shank stresses, fatigue life, and tower loading. The hingeless rotor analyzed does not appear to be structurally stable during overloads.

140. Stodhart, A.H. Review of the U.K. wind power programme 1948-1960. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 1, p. 1-23 to 1-34.
3, 4

The UK wind power program consisted of three parts: (1) the wind survey and site selection program covering over 100 different sites in the UK and including suitable instrumentation for wind survey purposes; (2) the development of prototype machines; and (3) the establishment of testing programs for these machines. Photographs are presented of five windpowered generators - the 10 kW prototype installed at Cranfield, the 25 kW machine on the Isle of Man; and three 100 kW machines on Costa Hill, at St. Albans and on the Isle of Man. An appendix is included providing a list of Electrical Research Association published reports on wind power generation.

141. Sulzer, P.G. A direct method for selecting wind-turbine generator: parameters for maximum energy output. Wind Energy Society of America Newsletter No. 9: 8-12, January 23, 1976.
5

To achieve maximum energy transfer and minimum energy cost from the wind, the parameters of the wind turbine generator and characteristics of the wind must be matched. A method for determining the most important parameters is presented. Minimum energy cost design and fixed speed vs. variable speed rotor operation are also discussed.

142. Sumner, J. Small wind energy converter one of few radical alternatives. Engineer 242(6264): 25, April 8, 1976.
4, 8

A wind power generator designed by I. Lewis of Newcastle University is claimed to show manufacturing and other advantages over other horizontal and vertical axis types. It is designed for the needs of the smaller user.

143. Sumner, J. String of nodding ducks puts power on the crest of a wave. Engineer 242(6261): 38-39, March 18, 1976.
4, 6

Tapping the power of the sea has great long-term potential and many advantages, but wind is likely to be producing electricity first.

144. Svenningsson, P.J. Pumped hydro storage for wind energy in Sweden. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 2, p. 5-77 to 5-79.
3, 11

This paper presents ideas on hydro storage of power in combination with wind power, with special reference to its application in Sweden.

145. Svenningsson, P.J. Wind power into the Swedish electric power system. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 2, p. 6-37 to 6-40.
3, 4, 13

This paper gives a brief look at the current power situation in Sweden. It also presents information about a recent SV study concerning the introduction of wind power into the national power system.

146. Swet, C., family. Our wind-powered homestead. Wind Power Dig. 1(5): 5-6, Summer 1976.
4, 8

147. Tarver, S. Simple solution to the energy problem. Gillette, Wyoming, Wyoming Specialties, Inc., 1976. 88 p.
2, 4, 6

Present tax laws, which attract energy capital to fossil fuels and uranium, make it unlikely that clean, renewable energy sources will be developed without new tax incentives. The graduated income tax, depletion allowances, and the Tax Reduction Act of 1975 led to excessive use of our finite energy sources. Extension of the "percentage depletion allowance" would allow developers of solar, wind, and conversion equipment to deduct 50% of their net profit from taxable income based on a percentage of total production. Tax incentives for manufacturers and producers would make clean energy competitive with oil, coal, and uranium and would encourage the resolution of problems. New revenue would be generated, and employment and environmental conditions would improve. Large scale windmill farms joined in a National Grid could supply electrical needs, supplemented by solar heating. Two-thirds of the 1.5 billion tons of human and animal wastes could be recycled into methane gas and fertilizer to nearly equal current natural gas consumption. Tax benefits could be extended to those who produce non-petroleum fuels for vehicles. Taxpayers should encourage their legislators to remove the inequities which discourage these developments.

148. Taylor, D. Natural, endless, free. In: Radical Technology. Edited by Godfrey Boyle and Peter Harper. N.Y., Pantheon Books, 1976, p. 72-88.
2, 4, 6

The author summarizes current status of use of wind energy, covering windmill types, harnessing the wind, wind data and measurement, calculation of power, furling, estimation of output, windmill uses, orientation systems, blades and sails, generators and energy storage.

149. Templin, R.J. Wind energy research at the National Research Council of Canada. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 2, p. 7-3 to 7-15.
3, 5, 9

The Canadian National Research Council has developed a curved-blade high-speed vertical axis wind turbine with high aerodynamic efficiency. An aerodynamic theory has been developed (Templin, 1974) to analyze the effects of various design variables of this device. The induced velocity is assumed constant throughout the swept volume. The theory takes the correct curved blade shape into account and allows for arbitrary non-linear airfoil characteristics, which may be varied along the length of the blades. Theoretical values of the power and overall rotor drag coefficients are in good agreement with wind tunnel measurements. Theoretical results indicate that beyond a value of NC/R of about 0.2 there is no aerodynamic advantage to be gained by increasing the blade area. An analysis of the mutual interaction of large arrays of wind turbines has led to the assumption that the practical availability of wind energy over large areas is limited to that which can be obtained with turbine arrays having a total swept area not more than 1/1000 of the surface area. Two research programs undertaken with the cooperation of Canadian industries are outlined.

150. Thirring, H. Energy for man: from windmills to nuclear power. c1958. Reprint, with new 18 p. Bloomington, Indiana, Indiana University Press, 1976. 409 p.
2, 4

151. Thomas, R.L. Large experimental wind turbines: where we are now. Presented at the Third Energy Technology Conference/Exposition, Washington, D.C., March 29-31, 1976. NASA-TM-X-71890. NTIS, N76-21683, CONF-760347-1, 1976. 32p.
3, 4, 6

Several large wind turbine projects have been initiated by NASA-Lewis as part of the ERDA wind energy program. The projects consist of progressively large wind turbine ranging from 100 kW with a rotor diameter of 125 feet to 1500 kW with rotor diameters of 200 to 300 feet. Also included is supporting research and technology for large wind turbines and for lowering the costs and increasing the reliability of the major wind turbine components. The results and status of the above projects are briefly discussed in this report. In addition, a brief summary and status of the plans for selecting the utility sites for the experimental wind turbines is also discussed.

152. Thomas, R.L., et al. ERDA-NASA wind energy project ready to involve users. Energy 1(2): 27-31, Winter 1976.

6

The major objective of the national wind-energy program is to develop the technology for practical cost-competitive wind-generator conversion systems that can be used for supplying significant amounts of energy to help meet the nation's energy needs. To achieve this broad objective, a national wind-energy program has been developed. The NASA-Lewis Research Center has been assisting the NSF and now ERDA in the planning and execution of this program, particularly the design, fabrication, and testing of the major experimental wind-conversion systems. The specific objectives of that portion of the overall wind-energy program for which NASA is responsible are as follows: (1) identify cost-effective configurations and sizes of wind-conversion systems; (2) develop the technology needed to produce cost-effective, reliable wind-conversion systems; (3) design wind-conversion systems that are compatible with user applications, particularly utility networks; (4) build up industry capability in the design and fabrication of wind-conversion systems; and (5) transfer the technology obtained from the program to stimulate the rapid commercial application of wind-conversion systems. To meet the above specific objectives, the NASA has organized a Wind-Power Office, and its specific organization and objectives are outlined.

153. Thresher, R.W. and R.W. Wilson. Design consideration for the Darrieus rotor. In: Intersociety Energy Conversion Engineering Conference, 11th. Proceedings. Stateline, Nevada, September 12-17, 1976. New York, American Institute of Chemical Engineers, 1976. p. 1787-1794. 3, 9

154. Tison, R.R. and N.P. Biederman. Farm energy system employing hydrogen storage. World Hydrogen Energy Conference, 1st. Miami Beach, March 1, 1976. Hydrogen Energy. Veziroglu, T.N., ed., Coral Gables, Fla., University of Miami, 1976. Vol. II, p. 4B.3-4B.28.

3, 8, 11

Wind energy systems that supply up to 100 percent of a farm's energy requirements are technically feasible with existing technology. Short-range, small-volume storage to integrate the operation of the wind energy conversion systems with fluctuations in wind availability and load requirements appears feasible. In some cases, hot water storage for thermal loads is preferable to hydrogen. Non-optimized costs for power supplied to a 100-head dairy farm discussed are in the range of 27 to 57 cents/kWhr. Optimized costs are anticipated, however, to be as low as 10 cents/kWhr.

155. Todd, J. Pioneering for the 21st Century: a new alchemist's perspective. Ecologist 6(7): 252-257, August-September 1976.

4

156. Torginon, J. A windcharger for the attic. Mech. Illus. 72(574): 31-33, March 1976.

8, 12a

This article describes an invention of Howard Chapman, where a windcharger is laid on its side and enclosed in the attic of a house. The 20 ft diameter wheel is powered by wind which enters via intake louvers on the house. Diagrams are included.

157. vanStaveren, P. Possibilities for wind energy utilization in the Netherlands. In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 2, p. 7-17 to 7-23.

3, 6

TNO (Organization for Applied Scientific Research) has executed since early 1973 several studies to assess the feasibility of wind energy utilization in the Netherlands and participated in some studies directed at special applications. A summarizing interim report of the subjects that are treated and of the results and conclusions that have been obtained is given.

158. Vivian, C.H. Everturning windmills. Compr. Air Mag. 81(5): 8-11, May 1976.

4

This review article covers windmill technology past to present.

159. Wade, N. Windmills: the resurrection of an ancient energy technology. In: Energy: Use, Conservation, and Supply. Edited by Philip H. Abelson. Washington, D.C., American Association for the Advancement of Science, 1976.

2, 4

160. Walters, S. Hundred-kilowatt wind turbine. Mech. Eng. 98(1): 41, January 1976. 4

ERDA's 100 kW turbine at the Lewis Research Center is described.

161. Welsh, G. and J. Welsh. The testing of a hinged vane windmill. Wind Power Dig. 1(4): 28-29, Spring 1976. 6

162. Wentink, T. Study of Alaskan wind power and its possible applications. Final Report covering the period 1 May 1974 to 30 January 1976. Geophysical Institute, University of Alaska, Fairbanks, Alaska. NTIS, NSF/RANN/SE/AER74-00239/FR-76/1, February 29, 1976. 178 p. PB-253339. 6

The program objective is to determine the wind power potential of Alaska, in both the meteorological and applied senses. The wind potential of the world is also treated. Specific goals are the determination of alternative applications and users of wind systems, optimum sites for these, and environmental problems associated with windmills used in Alaska. The program consists of seven tasks. In these, wind literature is surveyed (37 sites in depth and 30 more in less detail) and new wind measurements featuring vertical profiles of velocity are reported (2 sites). Considerable efforts on analytical formulations of measured and synthetic wind spectra are detailed. An important result is that the average power for a given windmill system can be predicted well from knowledge of only the average wind speed, at least in Alaskan wind regimes. This has considerable significance for simplified wind data gathering and parametric studies in windmill design and economics. Environmental problems are treated, and several recommendations concerning the design of wind machines are made. Also, local energy use patterns and storage systems are considered, and the economics of windmill use, fuel costs, and fossil-based electricity are presented for Alaska. Guidance to a related separate Scientific Report is included. Twenty-one tables, 20 figures and 41 references are included in the main text. There are three technical appendices.

163. Wetmore, W.C. Vertical-vortex wind turbines proposed. Aviat. Week 104: 50-51, March 1, 1976. 5, 6

Grumman Aerospace Corporation is developing a wind turbine-generator concept that shows promise of harnessing wind energy economically to generate commercial electric power and to reduce substantially dependence on fossil fuels or nuclear energy.

1976

164. Wilke, J. Jack Krueger: wind power helps heat his home. Pop. Sci. 208(1): 103, 131, January 1976.
12b

165. Williams, C. The wind as an energy resource. Am. Nucl. Soc. Trans. 23 Suppl. 1: 18-19, 1976.
4

The current status of wind power research is described briefly.

166. Wind turbine slated to produce 60 kW. Electr. World 185: 32, March 1, 1976.
4

167. Yadavalli, S.R. and T.S. Jayadev. A new generation scheme for large wind energy conversion systems. In: Intersociety Energy Conversion Engineering Conference, 11th. Proceedings. Stateline, Nevada, September 12-17, 1976. New York, American Institute of Chemical Engineers, 1976. p. 1761-1765.
3, 13

168. Young, R.B., I.R. Barr, and L.R. Marianowski. Production of methane using offshore wind energy. In: Intersociety Energy Conversion Engineering Conference, 11th. Proceedings. Stateline, Nevada, September 12-17, 1976. New York, American Institute of Chemical Engineers, 1976.
3, 15

169. Zweygbergk, S.V. The synchronous flux generator (SFG). In: Advanced Wind Energy Systems. Workshop Proceedings. Stockholm, STU/Vattenfall, 1976. Vol. 2, p. 5-115 to 5-117.
3, 6, 14

This paper gives the disadvantages of an ordinary synchronous machine and provides the alternative of supplying the rotor with AC-current rather than DC. The advantages of this system are presented as well as several applications.

170. Cheney, M.C. and P.A.M. Spierings. Self-regulating composite bearingless wind turbine. In: Sharing the Sun, Proceedings of the Joint Conference of the American Section, International Solar Energy Society and Solar Energy Society of Canada, Inc. Vol. 7: Agriculture, Biomass, Wind, New Developments. Elmsford, New York, Pergamon Press, 1976.
3, 5

171. Coonley, D.R. The use of Built Form to enhance the output of wind collectors. In: Sharing the Sun, Proceedings of the Joint Conference of the American Section, International Solar Energy Society and Solar Energy Society of Canada, Inc. Vol. 7: Agriculture, Biomass, Wind, New Developments. Elmsford, New York, Pergamon Press, 1976.
3, 5

1976

172. Foreman, K.M., B. Gilbert and R.A. Oman. Diffuser augmentation of wind turbines. In: Sharing the Sun, Proceedings of the Joint Conference of the American Section, International Solar Energy Society and Solar Energy Society of Canada, Inc. Vol. 7: Agriculture, Biomass, Wind, New Developments. Elmsford, New York, Pergamon Press, 1976.

3, 5

173. Higgin, R.M.R. and C.K. Brown. Preliminary assessment of the potential for medium and large capacity wind generators used as fuel savers for AC diesel based power systems in Ontario. In: Sharing the Sun, Proceedings of the Joint Conference of the American Section, International Solar Energy Society and Solar Energy Society of Canada, Inc. Vol. 7: Agriculture, Biomass, Wind, New Developments. Elmsford, New York, Pergamon Press, 1976.

3, 6, 7, 15

174. Justus, C.G. Wind energy statistics for large arrays of wind turbines. In: Sharing the Sun, Proceedings of the Joint Conference of the American Section, International Solar Energy Society and Solar Energy Society of Canada, Inc. Vol. 7: Agriculture, Biomass, Wind, New Developments. Elmsford, New York, Pergamon Press, 1976.

3, 5

175. Kadlec, E.G. The Darrieus vertical-axis wind turbine program at Sandia Laboratories. In: Sharing the Sun, Proceedings of the Joint Conference of the American Section, International Solar Energy Society and Solar Energy Society of Canada, Inc. Vol. 7: Agriculture, Biomass, Wind, New Developments. Elmsford, New York, Pergamon Press, 1976.

3, 9

176. Malver, F.S. and L.D. Overom. The application of wind power systems to the Minnesota Power and Light Company. In: Sharing the Sun, Proceedings of the Joint Conference of the American Section, International Solar Energy Society and Solar Energy Society of Canada, Inc. Vol. 7: Agriculture, Biomass, Wind, New Developments. Elmsford, New York, Pergamon Press, 1976.

3, 13

177. Mayo, L.H. Some legal-institutional implications of offshore wind energy conversion systems. In: Sharing the Sun, Proceedings of the Joint Conference of the American Section, International Solar Energy Society and Solar Energy Society of Canada, Inc. Vol. 7: Agriculture, Biomass, Wind, New Developments. Elmsford, New York, Pergamon Press, 1976.

3, 6

178. Meyer, H. Synchronous inversion-concept & application. In: Sharing the Sun, Proceedings of the Joint Conference of the American Section, International Solar Energy Society and Solar Energy Society of Canada, Inc. Vol. 7: Agriculture, Biomass, Wind, New Developments. Elmsford, New York, Pergamon Press, 1976.
3

179. Ramakumar, R. Wind-electric conversion utilizing field modulated generator systems. In: Sharing the Sun, Proceedings of the Joint Conference of the American Section, International Solar Energy Society and Solar Energy Society of Canada, Inc. Vol. 7: Agriculture, Biomass, Wind, New Developments. Elmsford, New York, Pergamon Press, 1976.
3, 13

180. Sittler, O.D. Energy content of winds in the high plains region of southwestern U.S. In: Sharing the Sun, Proceedings of the Joint Conference of the American Section, International Solar Energy Society and Solar Energy Society of Canada, Inc. Vol. 7: Agriculture, Biomass, Wind, New Developments. Elmsford, New York, Pergamon Press, 1976.
3, 6

181. Smith, R.T., et al. Large windpower systems integrated with existing electric utilities. In: Sharing the Sun, Proceedings of the Joint Conference of the American Section, International Solar Energy Society and Solar Energy Society of Canada, Inc. Vol. 7: Agriculture, Biomass, Wind, New Developments. Elmsford, New York, Pergamon Press, 1976.
3, 7, 13

182. Corotis, R.B. Stochastic modeling of site wind characteristics. Final Report. NTIS, ERDA/NSF-00357/76/1, November 1976. 298 p.
6

183. Rogers, S.E., et al. Evaluation of the potential environmental effects of wind energy system development. Interim Final Report. NTIS, ERDA/NSF/07378-75/1, August 1976. 189 p.
6

The first phase of an evaluation of the potential for environmental effects from the development of wind energy was completed. A keyworded bibliography concerning microclimatic alterations by wind and reactions of flora and fauna to altered wind regimes is presented. This literature serves as background material for discussion of potential microclimatic and ecological effects. A baseline climatological and biological survey of the ERDA/NASA 100 kW Experimental Wind Turbine site near Sandusky, Ohio, provides input to a follow-on field program designed to provide quantification of the operational effects of the 100 kW wind energy system on the environment which is developed and currently being undertaken. The operation of wind energy conversion systems does not appear to involve any unusual environmental effects. As presently conceived, wind energy systems will produce no significant thermal or chemical effluents. Land requirements are minimal and compatible with many other land uses. Future studies will continue to evaluate the significance of the microclimatic alterations of the tower and rotating blades. A comprehensive analysis of the behavior and flight characteristics of migratory birds and insects in the vicinity of the rotor is continuing.

184. Miller, R.H., et al. Wind energy conversion. Progress Report, July 15, 1975 - February 15, 1976. NTIS, PB-256198, February 15, 1976. 183 p.

5

Testing of the wind tunnel model and aeroelastic analyses indicate the scope of the problem involved in selecting a suitable speed for a wind turbine. This report discusses the probability that at least for conventional rotor type wind turbines, a constant tip speed rather than a constant ratio of tip speed to wind speed is a more satisfactory design solution. The penalty involved in maintaining constant tip speed is investigated as part of the control strategy research (Task I) in order to determine whether control should be considered for a constant speed or for variable speed (constant tip speed ratio) wind turbine. As a result of experience with the aeroelastic analyses (Task 3), it was decided to concentrate on the constant speed configuration. Task 2 is concerned with the experimental and theoretical investigation of airloads in the presence of wind shear and gust.

185. Garland, J. and V. Pavelic. Windgenerator mechanism. Applied Mechanics Conference, 4th, Proceedings. University of Chicago, November 3-5, 1975, Paper 21. Stillwater, Oklahoma, Oklahoma State University, 1976. 9 p.

3, 5, 9

This paper describes a windmill mechanism consisting of three smoothly finished blades which are driven by the wind at fluctuating speeds. A centrifugal feathering mechanism is included to stabilize the rotation for high velocity winds and possible erratic wind gusts. The rotating blades provide driving torque to a horizontal shaft which leads to a speed increasing assembly. This assembly in turn drives a generator which provides the electrical power. A speed increaser is designed so that it rotates the generator at its maximum efficiency point. The entire windgenerator mechanism is mounted on a tower and pivots freely on a vertical shaft.

1976

186. Johnson, C.C. and R.T. Smith. Dynamics of wind generators on electric utility networks. IEEE Trans. Aerosp. Electron. Syst. AES12(4): 483-493, July 1976.

5, 13

Dynamic interaction of wind-turbine-driven generators on electric utility networks was studied by computer simulation. Nonlinear representations of wind-turbine and various drive train elements and Park equation representations of synchronous and induction generators were implemented. An infinite capacity network was assumed. Time history responses for various system configurations were computed using as the input function severe wind gust data added to cyclical torque variations occurring at turbine blade frequency. Results indicated that severe transient mechanical and electrical stresses can be induced for certain system configurations. Best results were obtained by interposing rate or damped compliant couplings between the wind turbine and a synchronous generator. The induction generator did not appear to require such means. Blade pitch control (or equivalent) was required to limit output above rated wind velocities for wind turbines configured to produce maximum specific power. The blade pitch control loop must exhibit high performance to limit transient overshoots. An aerodynamically limited turbine driving an induction generator exhibited good response without the need for blade pitch control, but at the cost of increased turbine rotor diameter. Further work is indicated, taking into account wind-turbine aeroelastic effects, finite capacity networks, and other factors.

187. Rayment, R. Wind energy in the U.K. Build. Serv. Eng. 44(3): 63-69, June 1976.

6

New analyses of the frequency distribution and geographical variation of wind speeds for the UK are used to produce a new wind-energy map for the UK. This information is used to illustrate a method for predicting the availability of wind-energy between different wind speeds for any location in the UK. The relevance of this to the operation of aerogenerators in determining their mean annual output and operating time is presented. Using current and estimated costs for conventional and vertical-axis machines, the cost-effectiveness, for applications in housing, is discussed.

188. Blackwell, B.F. Status of the ERDA/Sandia 17-METRE Darrieus turbine design. From International Symposium on Wind Energy Systems, Cambridge, September 7, 1976. NTIS, SAND 76-5683, 1976. 16 p.

3, 9

The present status of the ERDA/Sandia Laboratories 17-metre Darrieus turbine design is summarized.

1976

189. Blackwell, B.F., R.E. Sheldahl, and L.V. Feltz. Wind tunnel performance data for the Darrieus wind turbine with NACA 0012 blades. NTIS, SAND 76-0130, May 1976. 61 p.

5, 9

Five blade configurations of a 2-meter-diameter Darrieus wind turbine have been tested in the LTV Aerospace Corporation 4.6- x 6.1-m (15- x 20-ft) Low Speed Wind Tunnel. The airfoil section for all configurations was NACA 0012. The parameters measured were torque, rotational speed, and tunnel conditions. Data are presented in the form of power coefficient as a function of tip-speed ratio for the various solidities, Reynolds number, and freestream velocities tested.

190. Feltz, L.V. Low-cost blade design considerations. From Vertical-Axis Wind Turbine Technology Workshop. Albuquerque, N.M., May 17, 1976. NTIS, SAND 76-5535, 1976. 38 p.

3, 5, 9

The studies described attempt to identify and continually upgrade blade designs for a 17 meter wind turbine design. The goal of this effort is to establish several low-cost blade designs.

191. Kadlec, E.G. Darrieus vertical-axis wind turbine program at Sandia Laboratories. From Sharing the Sun, Solar Technology in the Seventies, Winnipeg, August 15, 1976. NTIS, SAND 76-5712, 1976. 11 p.

3, 9

As part of ERDA's Federal Wind Energy Program Sandia Laboratories is engaged in a technology development program for the Darrieus Vertical Axis Wind Turbine (VAWT). The application receiving current emphasis utilizes the VAWT operating at constant speed to generate electricity which is fed directly into a utility grid. The activities within the program are described.

192. Blake, S.R. A partially annotated bibliography of literature related to site selection of wind energy conversion systems. Oskaloosa, Kansas, S.R. Blake, November 27, 1976.

6, 16

This 17 page bibliography covers the siting literature thoroughly.

193. Reed, J.W. Anemometry and data processing. In: Vertical Axis Wind Turbine Technology Workshop, May 17-20, 1976. Albuquerque, N.M., Sandia Laboratories, 1976.

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194. Vertical-Axis Wind Turbine Technology Workshop, Proceedings. L. Wetherholt, ed. Albuquerque, N.M., May 18-20, 1976. Sandia Laboratories, 1976.

3, 9

1976

195. Arbo, P.E., et al. Analysis of the technical and cost feasibility of solar and/or wind energy systems for Coast Guard Public Quarters. Final Report on TASK 3. NTIS, AD-A028332, June 11, 1976. 97 p. 6

Energy requirements of existing Coast Guard-owned public quarters were assessed based on a survey of energy usage for FY1975. A computerized solar collector heat gain model was developed to identify regions in which solar heating might be cost beneficial under a conservative scenario and using generalized data. A region containing 45 structures (with 74 public quarters) at 10 sites was identified. Energy requirements and regional insolation and weather data for each specific site were then used in the model to determine solar collector requirements and cost break-even periods. Based on these results, a solar heating applications research project was outlined to capitalize on solar energy.

196. Barna, P.S. and G.R. Crossman. Experimental studies on the aerodynamic performance and dynamic response of flow direction sensing vanes. NASA-CR-2683, Rept. 75-T7. NTIS, N76-24232, May 1976. 124 p. 5

Systematic investigations were performed on a variety of aerodynamic surfaces to obtain their potential for possible application to wind vanes. Among the surfaces tested were: (1) single vanes consisting of flat plates of various planforms having aspect ratios between 0.5 and 5; (2) bi-vanes with aspect ratio 2.5; (3) various cone and box vanes; and (4) various cruciform configurations. The models were subjected to wind tunnel tests. In addition to lift and drag force measurements, damping and frequency tests were performed under a variety of flow conditions.

197. Hwang, H.H. Transient analysis of unbalanced short circuits of the ERDA/NASA 100 kW wind turbine alternator. NASA-TM-X-73459, E-8821. NTIS, N76-30650, July 1976. 29 p. 14

Unbalanced short-circuit faults on the alternator of the ERDA-NASA Mod-0100-kW experimental wind turbine are studied. For each case, complete solutions for armature, field and damper-circuit currents; short-circuit torque; and open-phase voltage are derived directly by a mathematical analysis. Formulated results are tabulated. For the Mod-0 wind turbine alternator, numerical calculations are given, and results are presented by graphs. Comparisons for significant points among the more important cases are summarized. For these cases the transients are found to be potentially severe. The effect of the alternator neutral-to-ground impedance is evaluated.

1976

198. Witwer, J.G. Costs of alternative sources of electricity. Final Report. NTIS, PB-255 765, July 1976. 64 p.
6

Interest in alternative sources of electricity has been increasing in the hope of reducing future cost increases and reducing environmental impacts of energy production. This is a study of the costs of the following alternative sources of electrical energy: solar thermal, solar photovoltaic, wind, magnetohydrodynamics (MHD), fusion, agricultural residues, geothermal energy, municipal solid waste.

199. Renewable energy sources are viable but need further development; symposium. Engineer 242: 54-55. June 24, 1976.
4

200. Dennis, L. and L. Dennis. Catch the wind. New York, Scholastic, 1976.
2, 4

Children's book.

201. Hand, A.J. How to use natural energy in your home. New York, Harper & Row, 1976.
2, 4

202. Linscott, B.S., W.R. Shapton and D. Brown. Tower and rotor blade vibration test results for a 100-kilowatt wind turbine. NASA-TM-X-3426. NTIS, N76-33628, October 1976. 40 p.
5

The predominant natural frequencies and mode shapes for the tower and the rotor blades of the ERDA-NASA 100-kW wind turbine were determined. The tests on the tower and the blades were conducted both before and after the rotor blades and the rotating machinery were installed on top of the tower. The tower and each blade were instrumented with an accelerometer and impacted by an instrumented mass. The tower and blade structure was analyzed by means of NASTRAN, and computed values agree with the test data.

203. Oetting, R.B. Small wind power machine for rural and farm use in the state of Missouri. Annual Conference on Energy, 2d, University of Missouri, Rolla, October 7-9, 1975. Proceedings. P. 116-120. North Hollywood, Western Periodical Co., 1976.
3, 5, 6

This paper describes work in progress to develop a prototype wind power generator for use by small farms, rural and isolated homes. It is anticipated that the wind power generator may supply power (1 to 10 kW) as base electric power (including energy storage), supplemental power, or in other forms (e.g. water pumping, nitrogen or hydrogen manufacture, and direct mechanical drive). Preliminary wind tunnel tests have been completed on several blade designs.

204. Loth, J.W. Wind energy concentrators. Annual Conference on Energy, 2d, University of Missouri, Rolla, October 7-9, 1975. Proceedings. P. 93-107. North Hollywood, Western Periodical Co., 1976.
3, 5

This paper presents two alternatives to the shrouded propeller wind energy concentrator. Their operation is based on generating a low pressure area, with high local wind velocity, around the windmill rotor. The two types of wind energy concentrators are considered. The performance parameters such as the power concentration ratio and the associated area ratio have been determined theoretically. Some preliminary experimental data are included.

205. Musgrove, P. Windmills change direction. New Scientist 72(1030): 596-597, December 9, 1976.
4

Bad weather can be turned to good use by tapping the energy in the wind. Britain has a large area of windy shallow waters just offshore. When the North Sea's natural gas is exhausted the installations could house windmills, and the empty reservoirs would provide ideal energy storage.

206. Reed, J.J. Assessment of the state-of-the-art of feeding wind-generated electricity into utility power grids. AD-A024278. NTIS, N76-33708, May 1976. 370 p.
13

The current state-of-the-art of supplying wind-generated electric power directly into utility power grids is assessed. The requirement for inclusion of an energy storage capability is addressed, and energy storage concepts and availability are summarized. Economic data excerpted from the literature is included.

207. Torrey, V. Wind-catchers; American windmills of yesterday and tomorrow. Brattleboro, Vt., Stephen Green Press, 1976.
1, 2, 4

208. ERDA/NASA plan largest windmill ever. Solar Util. News 1(3) 19, September 1976.
4

ERDA and NASA have selected General Electric Company and Hamilton Standard Division of United Technology Corporation to design and build the largest windmill in history.

209. ERDA selects candidates wind systems. Solar Util. News 1(3): 17, September 1976.

4

ERDA has selected 17 sites as candidates for installation and testing of four large experimental wind power electrical generation systems.

210. Largest windmill for the USA. Electr. Power 22(9): 576, September 1976.

4

A 1.5 MW wind-turbine electrical generating system--the largest windmill in history--will be built in the next two years by ERDA and NASA. The $7 million project to design, fabricate, assemble, install, and test a system in 1978 will be at a site not yet selected.

211. Matzke, D.J., D.M. Osowski, and M.L. Radtke. Energy resource alternatives competition. Progress report for the period February 1, 1975 - December 31, 1975. NTIS, COO-2698-1, January 1976. 208 p.

6

This progress report describes the objectives and results of the intercollegiate Energy Resource Alternatives competition. The one-year program concluded in August 1975, with a final testing program of 40 student-built alternative energy projects at the Sandia Laboratories in Albuquerque, New Mexico. The goal of the competition was to design and build prototype hardware which could provide space heating and cooling, hot water, and electricity at a level appropriate to the needs of homes, farms, and light industry. The hardware projects were powered by such nonconventional energy sources as solar energy, wind, biologically produced gas, coal, and ocean waves. The competition rules emphasized design innovation, economic feasibility, practicality and marketability.

212. Mensforth, T. Wind-power generation on a large scale--a design idea. Electr. Power 22(8): 530-532, August 1976.

4, 5

The author recalls the Orkney windmill project circa 1950 with which he was closely associated, and outlines the design of a 10 MW windmill generator.

213. Valeriote, E.M.L. A computer program to calculate and plot wind-generated stored energy at constant consumption. NTIS, AD-A029 977/6GA, June 1976. 49 p.

11

A computer program has been described which gives printed and plotted outputs of the quantity of wind-generated energy remaining in a storage system under given conditions. The program permits simulated variations of storage capacity, constant electrical load and conversion efficiency by simple data changes. Further alterations to the program itself are detailed, to adapt it to carry out similar calculations for wind turbines of various sizes of construction. The program has been tested by simulation of a hypothetical system of energy production, storage and consumption. It is planned that its predictions will be compared with data obtained from an experimental program currently in progress.

214. Windmill interference study on. Solar Util. News 1(3): 7, September 1976.

4

A professor of electrical engineering at the University of Michigan is studying windmills and their potential threat to television and radio reception.

Abstract for 1975:14

Wind energy is investigated as a source of energy. The wind energy program that is managed by the NASA-Lewis Research Center is described. The Lewis Research Center's Wind Power Office, its organization, plans, and status are discussed. Major elements of the wind power project included are: an experimental 100 kW wind-turbine generator; first generation industry-built and user-operated wind turbine generators; and supporting research and technology tasks.

1975

1. Banas, J.F., E.G. Kadlec and W.N. Sullivan. Application of the Darrieus vertical-axis wind turbine to synchronous electrical power generation. Sandia Laboratories Wind Energy Report SAND 75-0165, Albuquerque, N.M., March 1975. 14 p. 9

2. Banas, J.F., E.G. Kadlec and W.N. Sullivan. Methods for performance evaluation of synchronous power systems utilizing the Darrieus vertical-axis wind turbine. Sandia Laboratories Wind Energy Report SAND 75-0204, Albuquerque, N.M., April 1975. 22 p. 9

3. Blackwell, B.F. and L.V. Feltz. Wind energy - a revitalized pursuit. Sandia Laboratories Wind Energy Report SAND 75-0166, Albuquerque, N.M., March 1975. 16 p. 4

4. Blackwell, B.F. and G.E. Reis. Some geometrical aspects of troposkiens as applied to vertical-axis wind turbines. Sandia Laboratories Wind Energy Report SAND 74-0177, Albuquerque, N.M., March 1975. 47 p. 9

5. Donham, R.E., J. Schmidt and B.S. Linscott. 100 kW hingeless metal wind turbine blade design, analysis and fabrication. Presented at the 31st Annual Forum of the American Helicopter Society, Washington, D.C., May 1975. 5

6. Prenis, J. Energybook #1. Philadelphia, Running Press, 1975. 112 p. 2, 4

   The field of alternative sources of energy is surveyed through a collection of articles on wind, methane, geothermal, ocean, tidal, and solar power. Emphasis is on wind power and solar energy.

7. Reis, G.E. and B.F. Blackwell. Practical approximations to a troposkien by straight-line and circular-arc segments. Sandia Laboratories Wind Energy Report SAND 74-0100, Albuquerque, N.M., March 1975. 35 p. 5

8. Steadman, P. Energy, environment and building. N.Y., Cambridge University Press, 1975. 287 p. 4

   This book reviews, compares, and explains experimental and theoretical applications of energy conservation techniques with regard to buildings. Solar energy, space heating, wind power, small scale water power, treatment of waste products and uses of composting and methane gas are discussed with primary concern for building and developments stressing equipment and techniques.

9. Weingarten, L.I. and R.E. Nickell. Nonlinear stress analysis of vertical-axis wind turbine blades. Sandia Laboratories Wind Energy Report SAND 74-0378, Albuquerque, N.M., April 1975. 21 p. 9

1975

10. Spera, D.A. Structural analysis of wind turbine rotors for NSF-NASA Mod-0 wind power system. NASA TM X-3198. March 1975. 5

11. New Mexico.University. Albuquerque. Energy Information Office, Technology Applications Center. Wind energy utilization bibliography. TAC-W-75-700, April 1975. 496 p. 16

> This is a two volume bibliography with abstracts of approximately 500 references on wind energy organized by subject area.

12. Reed, J.W. Wind power climatology of the United States. Sandia Laboratories Wind Energy Report SAND 74-0348, Albuquerque, N.M., May 1975. 200 p. 6

13. Feltz, L.V. and B.F. Blackwell. An investigation of rotation induced stresses of straight and of curved vertical-axis wind turbine blades. Sandia Laboratories Wind Energy Report SAND 74-0379, Albuquerque, N.M., March 1975. 21 p. 9

14. Thomas, R., R. Puthoff and J. Savino. Plans and status of the NASA-Lewis Research Center Wind Energy Project. To be presented at Joint Power Conference cosponsored by the Institute of Electronic and Electrical Engineers and American Society of Mechanical Engineers, Portland, Oregon, Sept. 28-Oct. 1, 1975. NASA TM X-71701. NTIS N75-21795, 1975 31 p. See abstract before 1975:1. 4

15. Wade, G. Homegrown energy: power for the home and homestead. Oliver Press, Scribners, 1975. 81 p. 12a, 15

> This is a directory of approximately 90 companies which either manufacture equipment for generating or using homemade power or provide self-education services in this field. Also included is a product index covering approximately 125 items ranging from burglar alarms to solar cookers.

16. Stepler, R. Eggbeater windmill is self-starting, cheaper to build. Pop. Sci. 206(5): 74-76, May 1975. 4, 9

> Segmented blades and starter rotors make this windmill a contender in the search for a cost-efficient wind generator. Research was done at the AEC Sandia Laboratories combining the Darrieus and Savonius windmill concepts.

17. Simmons, D.M. Wind power. Park Ridge, N.J. Noyes Data Corp., 1975. 4, 6

> Describes technology and economics of wind powered energy. A suitably designed windmill and generator can produce electricity or convert sea water to hydrogen and oxygen. The fundamental difficulty is that of energy storage. Gas tanks, batteries, and D.C. to A.C. converters are required.

1975

18. AEA introduces Amerinalt wind turbine. Wind Power Dig. 1(2): 31-32, Summer 1975.
4, 12b

    A bicycle wheel wind turbine developed by J. Saylor and E. Stein and tested in Boulder, Colorado, is described.

19. Abstracts of NSF/RANN Research Reports October 1970 - December 1974. National Science Foundation, Washington, D.C. NTIS, PB243592, May 1975. 323 p.
16

    This bibliography contains citations and abstracts of documents received by the National Science Foundation from research sponsored by the RANN (Research Applied to National Needs) program in the area of energy research and technology. A number of these reports concern wind power.

20. Aero Power markets wind generator blades. Wind Power Dig. 1(2): 33, Summer 1975.
5, 12b

21. Aerodynamic layout of windwheel blades. Wind Power Technical Memo WTM 1. Sylmar, California, Helion, 1975.
5

    This describes a technical method for "optimum" layout.

22. Alexander, A.J. Calculation of wind velocities over hills. U.S. National Conference on Wind Engineering Research, 2d, Fort Collins, Colorado, June 22-25, 1975. Conference Preprints. Fort Collins, Colorado State University, 1975. P. V-25-1 to V-25-2.
3, 6

    The natural wind is assumed to be a boundary layer having a power law profile. The two-dimensional Navier-Stokes equations for the flow of a large boundary layer over a hill are solved by a finite-difference relaxation method. This gives wind profiles and enables an estimate to be made of the forces on structures which are placed on hills in exposed situations, e.g., radar installations, radio and t.v. masts and windmills. In the latter case, accurate siting in the most favorable place can increase power output considerably. The proposal is put forward that windmills should be sited on hills which are specifically designed and constructed or modified to predetermined shapes which maximize the velocity at the windmill position.

1975

23. Alternative energy sources for Hawaii. Proceedings of the Workshop held May 8-9, 1975, Honolulu, Hawaii. Honolulu, Hawaii University, Hawaii Natural Energy Institute, 1975. 49 p.

3, 6

Five simultaneous workshops explored ways to lower Hawaii's almost total dependence on seaborne petroleum and to develop the state's natural resources. Recommendations included: (1) top priority given to energy conservation; (2) immediate development of solid waste conversion; (3) development of high potential wind systems, with research on possible weather effects and optimum siting criteria; (4) immediate use of solar energy in some areas for water heating (Hawaii has no requirement for space heating); and (5) substantial state support for exploration in geothermal and ocean thermal energy, and moderate support for bioconversion and solar collectors. Bioconversion of Bagasse, wind, geothermal, solar, and ocean thermal energy, and liquefaction and gasification of coal were thought to have significant potential as energy sources. Bioconversion of kelp and algae, waves, tides, and ocean currents were each found to have a potential of less than 2% of the total electrical energy requirement.

24. Alternate energy sources for Hawaii. Report of the Committee on Alternate Energy Sources for Hawaii of the State Advisory Task Force on Energy Policy. Honolulu, Hawaii Natural Energy Institute, University of Hawaii, and the Department of Planning and Economic Development, State of Hawaii, February 1975. 273 p.

6

This is a report of the Committee on Alternate Energy Sources for Hawaii, which was established by the Governor's State Advisory Task Force on Energy Policy to help respond to problems created by the Arab oil embargo. Fourteen studies were undertaken--ten on alternate energy sources, and four more general studies. Included as appendices to the report are all the studies on the potential of different energy sources to minimize the State's near-total dependence on seaborne petroleum. These alternate sources of energy are: solid waste; bioconversion; hydroelectric; wind; geothermal; solar collectors; ocean thermal energy conversion; waves, tides, currents, osmosis; coal; nuclear.

25. The American Wind Energy Association gets together. Wind Power Dig. 1(2): 21-22, Summer 1975.

4

1975

26. American Wind Turbine revisited. Wind Power Dig. 1(2): 13, Summer 1975.

12b

The turbine design of Tom Chalk of St. Cloud, Florida, is described and an address for an informational packet on the turbine is provided.

27. Anderson, B. Solar energy in building design. Harrisville, N.H., Total Environmental Action, 1975.

4

This publication consists of over 600 pages of unbound manuscript. Each page contains two typewritten pages photo-reduced to fit. Topics include discussions of numerous present and past solar projects, the building of a solar collector, low-impact solutions, hot water heating, and traditional solar system design. Extensive resource sections including bibliographies, solar component manufacturers, heat theory, wind and methane introductions, solar cooling, and weather data. Over 500 photos, charts, graphs and illustrations illuminate the text.

28. Annual Symposium: Energy Research and Development, 5th, Washington, D.C., March 13-14, 1974. Proceedings. D. Falconer, B. Gerber, and W. Magee. NTIS, AD-A007799, N75-24142, January 1975. 179 p.

3, 4

Subjects covered by the symposium are: Energy research and development programs of the United States Department of the Interior; energy R and D programs of the U.S. Atomic Energy Commission; National Science Foundation energy research and development programs; the energy problem and defense; American Petroleum Institute; Coal research and development; thermonuclear fusion energy; pictorial overview of the hydrogen-energy concept; review of power from the wind; Bioconversion of solar energy-photosynthesis; enzymatic hydrolysis of cellulosic wastes; coal liquefaction and gasification; beneficial uses of waste heat from steam electric power plants; and energy systems analysis.

29. Argand, A. French investigations on large wind generators, including different types of machines and studies of sites. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 173-181.

3, 6

A review of the French research and development program on large wind turbine generators is presented. The availability of wind in France for use by wind turbines is discussed.

1975

30. Arnas, O.A. Wind power generation and storage. U.S. National Conference on Wind Engineering Research, 2d, Fort Collins, Colorado, June 22-25, 1975. Conference Preprints. Fort Collins, Colorado State University, 1975. P. V-10-1 to V-10-2.

3, 6, 11

In recent years, the harnessing of the energy available in winds and efficient and economical conversion into useful power has become of utmost concern. The discussion presented here is along the lines of innovative and untried methodologies in both generation and storage of energy derivable from the winds.

31. Around the world, alternate energy is sought. New York Times, January 26, 1975, Section 3, part 3, p. 57.

4

Last winter's Arab oil embargo alerted many governments to the dangers of being dependent on other nations for energy. Scientists are now actively experimenting with alternative energy sources--sun, wind, tides, the earth's interior, etc.--but commercial availability is speculative. Oil and coal will continue to be the main source of power in industrialized countries for years. Nuclear power is behind schedule but still considered attractive by many experts.

32. Asmussen, J. Wind system research project for the city of Hart, Michigan. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 112-120.

3, 6

The entry of wind power technology into practical application in scale, time and space in small municipal utilities and REA systems is analyzed. In particular, an initial assessment of the technical and economic feasibility of applying wind energy conversion technology to satisfy the electrical power needs of the city of Hart, Michigan, is conducted. Historical wind data as well as present (1975) wind information from nearby Coast Guard Stations are analyzed. Three permanent wind measuring stations and a portable wind measuring facility will be employed to define the wind energy potential of the Hart area and will aid in the determination of prospective wind turbine sites.

33. Asmussen, J., et al. Application study of wind power technology to the city of Hart, Michigan. NTIS, COO-2603-1, December 31, 1975. 103 p.

6

Information is presented concerning wind data collections and analysis; Hart power demand and consumer usage; wind power assessment; hydro power assessment; results of preliminary economics analysis; environmental impact of wind turbines and operation in the Hart, Oceana County, Michigan area; and systems model for the Hart power system with wind turbine.

34. Babcock, W.H., A.L. Frey and W.L. Somervell. Wind powered aeration for remote locations. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 408-411.

3, 8, 15

This application of aeration is an example of methods of direct mechanical utilization of wind power. The simplicity of a direct mechanical linkage between the wind turbine and the air compressor may reduce costs. The compressed air is to be injected into the bottom of a sewage lagoon to improve biological waste treatment efficiency and into the bottom of a high mountain lake to try to avoid the problem of fish winterkill.

35. Bae, H.M. Economic optimization models of wind power systems. Ph.D. Thesis. Oklahoma University, Norman, Oklahoma. Ann Arbor, University Microfilms, 1975. 193 p.

5, 6, 11

Models for the economic optimum design of large scale windpower systems were developed including systems without storage and systems with storage. The objective of the models is to maximize the total net value of electricity generated under assumed operating rules for the windpower systems and general conditions regarding wind speed and demand variations. In the model for windpower systems without storage, optimization is carried out with respect to the total capacity of windturbines that vary in the values of design parameters such as rotor diameter, tower height and wind speed at which maximum power is generated. The model for windpower systems with storage was developed for the case in which the average wind speeds in successive time increments show very low correlation. The model is then modified for the case of low serial correlation. An analytical storage model is used as a basis of representing storage requirements for a given system.

36. Bae, H.M. Economic optimization of windpower systems. Oper. Res. Soc. Am. Bull. 23 (Suppl. 2): B380, Fall 1975. (Abstract only)

5, 6, 11

A set of models is presented for the economic optimum design of windpower systems to supplement existing electric power networks. Two basic models are developed: (1) no-storage--all power generated is fed directly into the network, and (2) storage--the system can then either be operated as a 'baseload' or a 'peak-load' system. The objective of the models is to maximize the total net value of the windpower generated. Wind data consists of a discrete probability distribution of windspeed for several seasons and for several periods in a day.

37. Bainbridge, G.R. The hunt is on for alternative energy resources. New Zealand Energy J. 48(11): 241-244, November 25, 1975.

4

Worldwide energy conservation, reserves, waste reduction, and renewable sources are reviewed. Nuclear, solar, and hydro power are discussed. Geothermal, tidal, wave, and wind energy are detailed.

38. Bamberger, C. and J. Braunstein. Hydrogen: a versatile element. Am. Sci. 63(4): 438-447, July-August 1975.

6

Hydrogen has potential as an ideal fuel and for energy storage and distribution because it is so abundant and its combustion produces no negative environmental effects. Present and future methods of hydrogen production include: electrolytic processes, water-gas catalytic process, steam-hydrocarbon process, and thermochemical cycles. Hydrogen is not a primary fuel, and such energy sources as solar, nuclear, wind, and oceanic thermal gradients are considered for decomposing water to produce hydrogen. Characteristics of hydrogen and problems associated with its production are discussed. A few promising industrial and transportaiton uses of hydrogen are considered. Use of hydrogen for energy is likely to grow in the future, but more research is needed.

39. Base, T.E. Effect of atmospheric turbulence on windmill performance. Hydrogen Energy. Hydrogen Economic Miami Energy (THEME) Conference, Proceedings, Miami Beach, Florida, March 18-20, 1974. Part A, p. 87-105. New York, Plenum Press, 1975.

3, 5

Theoretical and experimental studies have been made to determine the effects of free stream turbulence structure on the performance of a simple airscrew windmill. A modified blade element method was developed to predict the fluctuating life forces on the rotor blades and computed vortex models of turbulence were used to represent the fluctuating velocity fields. Eventually the computer program will enable large rotor diameter windmill performance studies to be conducted and also comparisons to be made with small test rotors.

1975

40. Base, T.E. Extraction of energy from the wind. In: The Potential of Solar Energy for Canada, Conference of the Solar Energy Society of Canada, Inc., Ottawa, June 2-3, 1975. Ottawa, Solar Energy Society of Canada, 1975, p. V9-V20.

3, 5, 6

Several elementary and more advanced theories are available to predict the power produced from a particular windmill in a given uniform windspeed including the Rankine-Froude momentum, the actuator annulus, the blade element and vortex element theories. However, the actual environment in which windmills operate is the atmospheric boundary layer which can be very turbulent and gusty. The paper discusses both theoretical and experimental studies on the effects of atmospheric turbulence and wind shear on windmill performance and the performance of large windmills, for example a 1000 kW test unit with a blade diameter of 52 m (170 ft). Finally, the statistical descriptions of the wind, to aid in deciding the geographical location of future airscrew windmill sites and the maximum expectable wind loading are discussed.

41. Base, T.E., A.G. Davenport and C.J. Baynes. Meteorological aspects in the selection of sites and the prediction of the performance and fluctuating air loads on airscrew windmills. U.S. National Conference on Wind Engineering Research, 2d, Fort Collins, Colorado, June 22-25, 1975. Conference Preprints. Fort Collins, Colorado State University, 1975, p. V-23-1 to V-23-2.

3, 6

Statistical descriptions of wind, to aid in deciding the geographical location of future airscrew windmill sites, are discussed in this paper together with methods to predict the windmill performance and fluctuating drag loads.

42. Beattie, D.A. Review of current R&D program approaches to solar conversion. Presented at International Energy Engineering Congress, Chicago, November 4-5, 1975. 10 p.

3, 6

Solar energy's great potential contrasts sharply with dwindling U.S. oil and natural gas supplies. Six solar energy technologies under investigation by ERDA are: solar heating and cooling; wind energy conversion; solar thermal conversion; photovoltaics; ocean thermal conversion; and bioconversion. Solar energy applications could supply almost 1% of U.S. needs in 10 years, 7% by 2000, and 25% by 2020.

43. Bergey, K.H. Excerpts from: Wind power potential for the United States. Energies 1(2): 6-8, May 1975.

6

A research team at the University of Maryland estimated that an annual output of 1.5 x 10^{12} kilowatt hours of wind energy would be possible by the year 2000. That amount equals the total electrical demand in the United States for the year 1970. The evidence suggests that the wind represents a major energy resource and that it can provide a significant part of the U.S. energy needs for both the short term and long term futures. The magnitude of that contribution appears to depend more on the willingness to undertake supportative public policies than it does on the resource itself. There is much to recommend straightforward energy farms, each covered with a grid of identical wind generating units. Aside from the relative simplicity of the concept, it takes advantage of mass production economics and simplifies the development and demonstration of the basic windmill unit. Power densities of 45,000 kw per square mile are possible in the midwest with this approach. An interesting aspect of design for wind power energy farms is that, to the first approximation, the installed capacity per square mile is independent of rotor diameter. A large number of small units will have essentially the same output as a small number of large units. Thus, the optimum arrangement and size of the basic unit may be based on other considerations, such as capital costs and joint land use. The land itself may be purchased or the wind-power rights merely leased, since a grid of well-designed wind generators is entirely compatible with high yield farming. The questions of small-scale applications and the costs of wind-power generating systems are also considered. Recommendations for supportive public policy are made.

44. Bettignies, C. The utilization of wind power in the arctic. In: The potential of Solar Energy for Canada, Conference of the Solar Energy Society of Canada, Inc., Ottawa, June 2-3, 1975. Ottawa, Solar Energy Society of Canada, 1975, p. V25-V32.

3, 6, 8, 15

This paper describes the possible utilization of aerogenerators in isolated and/or Arctic regions. Most of the examples are actual applications or tests done in the past in other parts of the world. They could similarly be applied in Canada. A brief description of some applications is provided, i.e., to use windmill for powering lighthouses, navigation aids, geophysical data recorders, radios, telephones, microwave relay stations; for the cathodic protection of pipelines; to pump water; for the electrification of dwellings and small villages; for heating and refrigerating and for desalting water. Some experiments should be done to power a village using a windmill coupled to a stand-by unit, the wind energy being used as a fuel saver. Technico-economic studies tend to prove this concept to be valid and competitive.

1975

45. Biederman, N.P. Windpowered hydrogen/electric systems for farm and rural use. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., D.C. June 9-11, 1975. McLean, Va., Mitre Corp., 1975, NSF-RA-N-75-050, p. 400-403.
3, 6, 8, 11

The Institute of Gas Technology is conducting a study to minimize cost and expedite the use of wind energy in 5 to 50 kW systems for use in rural and farm settings. Specifically, IGT is evaluating available methods for converting the mechanical, shaft-horsepower from a wind turbine to electricity for direct use and hydrogen as a fuel and storage medium. The electricity can be applied to conventional ac and dc applications; used to generate hydrogen for fuel and energy storage; and used to generate power when wind currents are inadequate. Such a system is self-sufficient and can be synthesized by coalescing readily available components and systems. The object of IGT's study is to establish an optimum design that can lead to possible demonstration-stage feasibility studies.

46. Biorn, P. Rediscovering a Jacobs wind electric. Wind Power Dig. 1(3): 20-22, Fall-Winter 1975.
4

47. Bird, R.A. Energy in the future. Plant Eng. (London) 19(2): 25-27, February 1975.
4, 6

An analysis of Great Britain's energy situation is made, in which energy conservation is urged in order to buy time to develop to the level of commercial viability a number of resources capable of replacing oil. Such development includes both expansion of conventional resources, such as coal and nuclear power, and the development of new energy resources, such as solar energy, wind and wave power, tidal power, and geothermal energy. In addition, some of the ideas currently being explored which could lead to a more efficient use of energy and hence conserve fuel supplies are reviewed.

48. Blackwell, B.F. and L.V. Feltz. Wind energy - a revitalized pursuit. ASME Symposium, 15th Annual. Proceedings. Albuquerque, New Mexico, March 6-7, 1975. New York, ASME, 1975, p. 41-54.
3, 6, 9

An estimate of the wind energy available in the Great Plains area has been determined, and it was concluded that this energy is large in comparison to the United States electrical energy consumption. The status of the Darrieus-type vertical axis wind turbine being investigated by Sandia Laboratories is reviewed.

1975

49. Blackwell, B.F., L.V. Feltz and R.C. Maydew. Wind turbine. U.S. Patent 3,918,839. November 11, 1975. 18 p.

5, 17

The patent relates to a wind turbine rotatable about a shaft which may include a drive rotor with one or more elongated blades, each having a central outwardly curved portion of airfoil shape which produces rotary motion when the blade rotates in wind at a blade tip velocity to wind velocity ratio greater than about three or four. Additional wind rotor means are disposed at both ends of the curved portions of the elongated blade for rotatably accelerating the drive rotor to the desired velocity ratio, and means coupled to said rotors for using the rotation thereof.

50. Blackwell, B.F. and G.E. Reis. Geometrical aspects of the troposkien as applied to the Darrieus vertical-axis wind turbine. ASME Paper 75-DET-42, 1975. 4 p.

5, 9

The equations derived to define a troposkien (the shape a completely flexible cable assumes when it is spun at a constant angular velocity about a vertical axis to which its two ends are attached) are described. The implications of the solutions on the design of a vertical-axis wind turbine are discussed for cases where gravity is neglected.

51. Bockris, J.O'M. The case of sea borne wind-based power. Search 6(7): 280-284, July 1975.

6

The power obtainable from a wind driven rotor of 100 m radius, after conversion to hydrogen, transportation, and reconversion to electricity, is about 5 mw for a mean annual wind velocity of 30 KM/Hr. Large seaborne rotors in high velocity wind belts with long-distance hydrogen transmission offer more readily attainable and environmentally acceptable power than atomic or solar possibilities do. Data for a sea-based wind power system of the kind described are included.

52. Bockris, J.O'M. High intensity wind belts as massive energy sources. Energy Convers. 14(3-4): 87-91, July 1975.

6

Coal and breeders will not be ready in time to replace the shortfall in oil and natural gas. Calculations of the year-average energy available from wind generators involves a factor which relates the cube of the mean annual wind (A) to the mean of the cubes of the instantaneous wind velocities (B). B/A is 2·7. Allowance is made for a number of efficiency factors.

The practical equation for electricity obtained after conversion to hydrogen, passage and reconversion to electricity, is:

$$P_{elec} \simeq 2 \times 10^{-4} v^3 MW ,$$

for a rotor of 100 m in a location where the mean annual wind is v k.p.h. Thus, for v = 30, $P_{elec} \simeq 5$ MW per rotor. Below latitude 35, v = 30 is available over a front of about 3000 km on the sea. In many regions of the world, v - 25 (P_{elec} = 3.1 MW) is available at sea. For the total energy consumption (including those now provided by oil and natural gas) for 10^6 people, about 2500 rotors located in a wind of 25-30 k.p.h. would suffice. The practicality of wind rotors of 100 m or equivalent radius need proving. Designs are proposed. Electrolysis of seawater evolves chlorine and its reconversion to oxygen is not a difficulty, but an extra cost. Hydrogen transfer up to 4000 km would be economic. Environmental considerations are optimal. The sea is the best location. Undersea storage is preferable. A projected cost of electricity at 1000 miles from the rotor is 8 mils kWh^{-1}.

The concept of large sea-borne rotors in high velocity wind belts with long distance hydrogen transmission offers a more readily attainable (and more environmentally acceptable) prospect than atomic or solar, possibilities.

53. Bockris, J.O'M. Is massive solar energy conversion a practical prospect. Hydrogen Energy. Hydrogen Economic Miami Energy (THEME) Conference, Proceedings. Miami Beach, Florida, March 18-20, 1974. Part A, p. 9-34. New York, Plenum Press, 1975.

3, 6

Seven methods for solar energy to electricity are described; costs per kW and of the derived electricity costs are given. Availability limits the choice of photovoltaics except AlSb or AlSi. Recent technology would reduce silicon based plants to \$375 per kW. Electrolysis at site and transport of hydrogen would make far-off sources using two methods economic: desert concentrators with heat engines or ocean thermal gradient collectors. Electricity would be 10 mils per kWh^{-1}; hydrogen \$2.23 per 10^6 Btu.

54. Bockris, J.O'M. Possible means of large-scale use of wind as a source of energy. Environ. Conserv. 2(4): 283-288, Winter 1975.

6

To circumvent the coming energy crisis the development of new sources is popularly associated with the gasification of coal and with atomic breeder reactors, although solar and nuclear fusion sources are distant possibilities. But coal is limited

in supply and breeders will not be ready in time to replace the remaining oil and natural gas; wind offers a more likely possibility. The concept of large sea-borne rotors in high-velocity wind-belts with long-distance hydrogen transmission offers a more readily attainable (and more environmentally acceptable) prospect than atomic, or solar, possibilities.

55. Booth, D. Darrieus generator spins in the wind for a cheap kilowatt. Engineer 240: 33, February 13, 1975.
4, 9

Doing away with a tower, tail and feathering on the blades, the Darrieus generator appears to be a simple but efficient power source.

56. Bos, P.B. Introduction to mission and regional analyses of wind energy conversion systems. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975, NSF-RA-N-75-050, p. 79-81.
3, 6, 13

The Solar Energy Program of the Electric Power Research Institute (EPRI) is described, including their thoughts on wind energy conversion systems (WECS).

57. Braasch, R.H. Power generation with a vertical-axis wind turbine. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 417-425.
3, 9

The primary goal of the vertical-axis wind turbine program is to demonstrate feasibility of the advantages in a power grid application. In pursuit of such a demonstration additional understanding of the Darrieus vertical-axis wind turbine and experimental verification based upon scaled up hardware are required. The overall goal is to design and construct a machine at the megawatt range power level. Achievement of this goal will be pursued via a three-phase program consisting of a 30kW/sub e/research system, a 100kW/sub e/prototype system, and a megawatt range production system.

58. Brown, C.K. and D.F. Warne. An analysis of the potential for wind energy production in northwestern Ontario. Ontario Research Foundation Report. November 1975. 173 p.
6

The feasibility of generating electric power from wind generators at remote sites in northwestern Ontario was studied. The work included: a survey of commercially available and planned wind driven electric plants; analysis of existing wind

data and preparation of an isovent map for Ontario; selection of suitable sites for a demonstration unit and a prototype system; matching available plant to wind regimes to predict annual energy production; and systems analysis of pure diesel, hybrid wind-diesel, and pure wind electric systems to determine their power costs. Energy costs range from 35-38/kwh for wind-diesel and pure diesel systems, and 45/kwh for a pure wind system with a four-day battery storage capacity. A diesel generator can provide backup energy at less cost than batteries. The main disadvantage of the wind system is its high capital cost, but a major advantage is an energy requirement of about 9000 Btu/kwh compared with 25,000 Btu for diesel plants. For remote sites, wind-diesel hybrid systems are currently cost-competitive with diesel power. Selections from manufacturers' literature on wind driven power are appended.

59. Brulle, R.V. Feasibility investigation of the Giromill for generation of electrical power. Midterm report, April-November 1975. St. Louis, Missouri, McDonnell Aircraft Company, November 1975. Prepared for the U.S. Energy Research and Development Administration, Division of Solar Energy. NTIS, COO-2617-75/1, 1975. 155 p.

5, 6

The first six months of effort under the current ERDA contract has concentrated on the parametric feasibility analysis of Giromill configurations. It started with the establishment of a set of study ground rules chosen to facilitate comparison of the Giromill results with those obtained by GE and Kaman for conventional windmills. The report describes modifications to the cyclogiro computer program, obtained from Prof. H.C. Larsen of the U.S.A.F. Inst. of Technology, Giromill configuration design concepts, systems developed, an automatic electronic control concept, preliminary cost estimates for generating electrical power and cost analysis.

60. Brulle, R.V. Giromill (cyclogiro windmill) investigation for generation of electrical power. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 452-460.

3, 5, 9

A Giromill is a cyclogiro rotor mounted on a vertical axis. A cyclogiro rotor consists of a set of blades attached to the axis by means of support arms. As the rotor rotates these arms in a circular path, the orientation of the blades is changed, or modulated, to achieve maximum force from the wind. At one point on this circular path, the blades are flipped from a positive to a negative orientation, and vice versa at the diametrically opposite point. The objective of this one-year ERDA-sponsored study program is to theoretically determine the cost effectiveness of the Giromill. A cyclogiro vortex theory computer program has been developed to parametrically analyze Giromill configurations and determine their characteristics. Using this theory, a design and cost analysis of the major system components will be conducted, followed by a design synthesis and selection of promising configurations. The cost effectiveness of the selected Giromill configurations will be compared with that of conventional windmills.

61. Buckwalter, L. Watts from the wind. Mech. Illus. 71: 40-41, 96-97, March 1975.

4

62. Budgen, H.P. Commercially available wind energy systems. In: The Potential of Solar Energy for Canada, Conference of the Solar Energy Society of Canada, Inc., Ottawa, June 2-3, 1975. Ottawa, Solar Energy Society of Canada, 1975, p. V33-V43.

3, 12b, 13

This paper describes a number of commercially available wind energy systems for pumping and electrical generation. Included are a few comparisons of performance curves of different designs, under varying wind velocity regimes. Costs on an F.O.B. basis, and country of origin are shown, which include rotor and mechanical or electrical equipment only. Cost of towers has been excluded as a variable depending on height and type, which can be of concrete, steel tube, structural lattice or timber. An assessment is presented of currently accepted systems of using wind energies, and recommendations are offered, applicable to required duties. Finally, reference has been made to some experimental designs, not commercialized, but hold promise in the departure from current methods.

63. Building a better windmill. Sci. Dig. 78(5): 10, November 1975.

4

64. Camarero, R. Wind energy systems. In: The Potential of Solar Energy for Canada, Conference of the Solar Energy Society of Canada, Inc., Ottawa, June 2-3, 1975. Ottawa, Solar Energy Society of Canada, Inc., Ottawa, June 2-3, 1975. Ottawa, Solar Energy Society of Canada, 1975, p. V21-V25.

3, 4

This paper reviews the three sub-systems for utilizing wind energy. The author then describes a project at the University of Sherbrooke.

65. Carlson, P.R. Power generation through controlled convection (aeroelectric power generation). U.S. Patent 3,894,393. July 15, 1975. 8 p.

5, 17

A method and means for the generation of power from a controlled air flow is described where an enclosed air mass is cooled at high altitude below the temperature of the surrounding air. The air is isolated from the surrounding air by means of a large duct. The resulting cooler, denser air flows down the duct toward lower altitude, and the energy of the falling air mass is extracted by means of a turbine generator.

66. Carter, J. A visit to Aero Power; blade maker begins windplant production. Wind Power Dig. 1(3): 16-17, Fall-Winter 1975.
4

67. Carter, J. Wind power for the people; Dunlite wind generator. Org. Gard. Farm 22(8): 128-132, August 1975.
4, 12a

Clean, quiet and infinitely renewable wind power has become a realistic alternative for a growing number of enthusiasts around the country.

68. Carter, J. With Jerry Forcier: some thoughts on mill design. Wind Power Dig. 1(3): 9-11, Fall-Winter 1975.
4

69. Cermak, J.E. Applications of fluid mechanics to wind engineering--a Freeman Scholar lecture. J. Fluids Eng. Trans. ASME 97 (Ser. 1, no. 1): 9-38, March 1975.
4, 5

Losses due to wind, increased demand and concern for human comfort, serious attempts to control air pollution, and the development and expansion of energy-production capabilities have resulted in applications of engineering to problems for which a body of knowledge has only started to emerge in the U.S. The objectives of this review are to establish an initial subject-matter base for wind engineering, to demonstrate current capabilities and deficiencies of this base for an engineering treatment of wind-effect problems, and to indicate areas of research needed to broaden and strengthen the subject-matter base.

70. Changery, M.J. Initial wind energy data assessment study. Data Assessment Meeting. Proceedings. National Climatic Center, Asheville, North Carolina, July 29-31, 1974. NTIS, PB244132, May 1975. 132 p.
3, 6

During a 3-day meeting held at the National Climatic Center on July 29-31, 1974, discussions were held on data availability, vertical and horizontal extrapolation problems and techniques, turbulence and gust effects, additional data requirement and remote sensing techniques. This report summarizes the discussion, recommendations and conclusions of that meeting and presents the results of the survey of existing and available data. The report is divided into two sections; the first on meteorological data requirements and technique assessments, and the second on the wind data survey.

71. Changery, M.J. Initial wind energy data assessment study. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 326-335.
3, 6

A search of the data files maintained at the National Climatic Center was undertaken to determine the availability of meteorological data required for the design, construction and siting of wind turbine equipment. The purpose of the survey is to provide a comprehensive report on the availability of data and the summarizations of land and marine surface wind measurements, upper level wind measurements, gusts, turbulence, inversions, icing and tower data. The results of the wind data survey are presented.

72. Cheney, M.C. Composite bearingless rotor control concepts for wind turbines. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 249-255.
3, 5, 6

The objective of this research program is to evaluate the potential benefits the Composite Bearingless Rotor can provide in minimizing costs of wind energy conversion, particularly as related to self-regulating controls designed to maximize efficiency under all wind conditions and to protect from dangerous overloading. The research program would consist of a preliminary design of a full scale rotor, stress and loads analysis of this design, fabrication of a dynamically scaled model incorporating the capability to examine various automatic control concepts, and wind tunnel tests of this model to demonstrate the basic feasibility of the Composite Bearingless Rotor as a wind energy rotor as well as to evaluate various control concepts.

73. Chilcott, R.E. Design speeds for wind turbines. In: Australasian Conference on Hydraulics and Fluid Mechanics, 5th, Christchurch, New Zealand, December 9-13, 1974. Proceedings. Vol. 1. Christchurch, University of Canterbury, 1975, p. 35-43.
3, 5

Predictions of wind turbine performance are required in order to design and cost wind energy conversion systems. By assuming that the hourly-mean wind-speed frequency can be characterized by the Weibull distribution, an optimum rated wind speed is defined which maximizes the primary energy conversion of an ideal wind turbine. As the overall conversion system design may require a prime operating time greater than that available above the optimum rated wind speed, primary energy conversion performance and prime time are presented as functions of rated wind speed. Secondary energy conversion performance below rated wind speed is presented in a similar manner.

74. Christensen, D.L. The UAH solar and wind energy program. In: Application of Solar Energy, Proceedings of the First Southeastern Conference, Huntsville, Ala., March 24-26, 1975. Huntsville, Ala., UAH Press, 1975, p. 3-14.

3, 6

Research and design studies of the described program include an environmental analysis concerning the available energy from solar and wind sources and preliminary feasibility studies to investigate the combination of solar and wind energy conversion systems for applications related to buildings, mass transit systems, and grain drying processes. A description is given of the facilities for experimental studies. A small solar panel test stand has been designed and constructed which will simultaneously compare various materials and coatings for their characteristics regarding the absorption and emission of solar energy. Another test stand is intended for the study of high-temperature solar concentration systems.

75. Citizens' Forum on Potential Future Energy Sources, Proceedings. Portland State University, Oregon, January 17, 1974. Portland, Oregon, Oregon Department of Geology and Mineral Industries. Miscellaneous Paper No. 18, 1975. 62 p.

3, 6

Six papers presented at this forum deal with various aspects and the future potential of wind power, solar power, geothermal power, conversion of oil shale, and coal gasification and liquefaction. The data and its interpretation, as presented in this volume, should provide some of the information necessary to understand the advantages and limitations of some of the alternate sources of energy.

76. Clark. W., Energy for survival; the alternative to extinction. Garden City, New York, Anchor Press, 1975. 652 p.

2, 4, 6

Energy problems and possible solutions are provided, including a lot of material on solar energy and including wind, geothermal, hydroelectric, nuclear, coal, and bioconversion.

1975

77. Clarke, R.M. Wind power--its potential for energy saving. N.Z. Eng. 30(9): 261-4, September 15, 1975.
6

New Zealand is a country lying across the prevailing winds in the South Pacific Ocean, and the application of wind to power generation in these energy-conscious times is worth investigation. This paper broadly surveys developments in this field overseas.

78. Clegg, P. New low-cost sources of energy for the home. Charlotte, Vt., Garden Way Publishing, 1975. 252 p.
2, 8, 12a

This book covers "alternate energy," what it means, how it works and what you can do now. While it is written in clear, layman's language, it would be helpful to architects and builders. Chapter headings are: solar energy, wind power, water power, water/waste systems, and wood heating.

79. Coleman, C.C. and R.B. McKee. A high efficiency propeller type windmill. U.S. National Conference on Wind Engineering Research, 2d, Fort Collins, Colorado, June 22-25, 1975. Conference Preprints. Fort Collins, Colorado State University, 1975, p. V-14-1 to V-14-2.
3, 5, 8, 14

This paper describes the design and construction of a generator to serve the needs, about two KWHr per day, of a small research station in a primitive Sierra Valley near Reno. Wind data collected from August through October showed a diurnal wind of 10 to 20 mph with duration six to eight hours. The generators available require fairly high rpm for good performance, and the most efficient windmills are propeller type, operating at high rpm. Therefore, efforts were directed toward a propeller type windmill with a high ratio of blade velocity to wind speed (tip speed ratio), and 12 foot diameter.

80. Comet windmills harness Australian winds. Wind Power Dig. 1(2): 27-28, Summer 1975.
4, 8

81. Comments by Charlie Wright. Wind Power Dig. 1(2): 26, Summer 1975.
4

Mr. Wright, associated with Rohn Tower Company, relates his experiences with wind generators.

82. Compcop windplant kit. Wind Power Dig. 1(3): 26-27, Fall-Winter 1975.
12a

1975

83. Coonley, D.R. An introduction to the use of wind. Harrisville, N.H., Total Environmental Action, 1975. 22 p.

4

This pamphlet serves to briefly introduce some of the characteristics of wind energy use through 29 illustrations and accompanying text. It is not intended to provide the information required to design or build a wind energy system.

84. Coonley, D.R. The use of natural and man-made forms to enhance the output of wind collectors and to build in harmony with the wind. U.S. National Conference on Wind Engineering Research, 2d, Fort Collins, Colorado, June 22-25, 1975. Conference Preprints. Fort Collins, Colorado State University, 1975, p. V-22-1 to V-22-3.

3, 4

The use of wind energy has been restricted by a lack of familiarity with its characteristics and a relatively small energy output for a large expense on a wind collector system. These challenges are addressed in this paper.

85. Coonley, D.R. Wind energy manufacturers list. Harrisville, N.H., Total Environmental Action, 1975. 4 p.

12b

This is an annotated listing of 36 manufacturers and distributors of wind energy equipment.

86. Corotis, R.B. Stochastic modeling of site wind characteristics. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 341-343.

3, 6

This project is one of a series of research efforts to improve the capability for identifying and selecting sites for wind energy systems and for verifying the expected energy to be obtained from potential wind energy systems at these sites. The project began in spring 1975 and is scheduled for a one year duration.

87. Cost answers sought to harnessing the wind. Mach. Des. 47: 8, June 26, 1975.

6

88. Coty, U. Wind energy conversion systems mission analysis. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 82-87.

3, 6, 13

An ERDA directed program to study wind energy conversion systems effects on the national energy program is described. The study will be conducted by Lockheed with cooperation from Oregon State University, Peoples Utility Districts of Oregon, Bonneville Power Administration, American Public Power Association, and the Southern California Edison Company.

89. Coulter, P.E. Wind capture and diversion through pneumatic energy recovery with large capacity aerogenerators. Hydrogen Energy. Hydrogen Economic Miami Energy (THEME) Conference, Proceedings. Miami Beach, Florida, March 18-20, 1974. Part A, p. 183-196. New York, Plenum Press, 1975.

3, 5, 7

An investigation of a novel design approach to capturing and containing wind in a useable energy form in a 1.5 to 2.5 megawatt power range. Rotor blade, air entrainment and transmission, and tower design are graphically described. Methods of energy conversion and output reliability are discussed, followed by concluding remarks concerning research and development needs relative to anticipated application of the large capacity aerogenerator.

90. Crotty, C.W. and P. Solotaire. Alternate energy resources in Maine and Northern New England, 1975. A compilation of sources and resources for people interested in supplying their energy requirements from renewable resources. Portland, Maine, Allagash Environmental Institute, Center for Research and Advanced Study, 1975. 23 p.

4

91. Darrow, K. and R. Pam. Appropriate technology sourcebook. Stanford, Cal., Appropriate Technology Project, Volunteers in Asia, 1975. 74 p.

2, 16

This small book, designed to assist volunteers in foreign countries, is subtitled "a guide to plans and methods for village and intermediate technology." It consists mostly of references to articles on the various technologies covered, including a section on wind energy.

92. Darvishian, A. Wind motor. U.S. Patent No. 3,897,170. July 29, 1975. 10 p.

5, 17

A wind motor for the conversion of wind power to mechanical or electrical power is described which consists of a vertical rotatable shaft having cup-shaped wind receptors connected to it and extending horizontally from it. The receptors are mounted at the ends of arms extending from a central rotatable shaft as to move from positions of maximum resistance to the wind resistance when moving against the wind, and in positions of maximum wind resistance conform in shape with and bear against the arms.

93. de Witt, H. Prinzip eines Verbundsystems Zwischen Wasserkraft und Windkraft in der Schweiz. [Principles of a system combining water power and wind power in Switzerland.] Bull. Assoc. Suisse Electr. 66(5): 252-256, March 8, 1975. (In German)
6, 13

Problems associated with the generation of wind energy are discussed. If the idea of direct conversion of wind into electric energy is abandoned and the wind energy is stored in available installations of hydroelectric plants, interesting possibilities arise for the interaction of both energy forms. Several versions for the construction of wind motors are proposed as alternatives for conventional realizations.

94. Dealership listings. Wind Power Dig. 1(1): 16-17, January 1975.
12b

Nineteen manufacturers or distributors of wind power systems are listed with their addresses and a description of their products or services.

95. Decker, B.J. Horizontal hinged-flap windmill. U.S. Patent No. 3,920,354. November 18, 1975. 8 p.
5, 9, 17

A windmill which rotates in a horizontal plane about a vertical axis includes a plurality of aligned and usually overlapping flaps which move upwardly and downwardly about horizontal hinges to operating and feathered positions as the windmill rotates, with the flaps being held in operating or closed position.

96. Denton, J.D., et al. The potential of natural energy sources. CEGB Res.: 28-40, May 1975. [Central Electricity Generating Board, London, England.]
6

The general technology and application potential of solar power, wind power, wave power, tidal power, and geothermal power in the U.K. are evaluated. Emphasis is on wave power, since this energy source seems to be the most practical for the country. Cost is the prohibitive factor in the solar area, except for solar domestic water heating, which appears quite feasible. Wind power presents difficulties in the economic and load factor realms. Two two-basin tidal systems for use in the Bristol Channel are considered, but their prohibitive construction costs, variability from neap to spring tides and

and variability in times of high and low tides, and detrimental environmental effects tend to bar its application. Geothermal gradients in Britain are generally too low for practical, efficient power generation.

97. DeWitte, M.D. Alternative energy sources for United States Air Force installations. Final Report, July 1974 - June 1975. NTIS, AD-A014 858, August 1975. 111 p.
6, 8

This report is concerned with the consumption and cost of facilities-related energy, both present and future, at Air Force installations, and it presents a basic assessment of the potential of alternative energy sources. In particular--solar, wind, and geothermal energy resources are investigated.

98. Divone, L.V. Future federal plans. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 513.
3, 4, 6

99. Divone, L.V. Overview of WECS program. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 5-11.
3, 4

100. Divone, L.V. Wind energy technology. Am. Nucl. Soc. Trans. 21: 143, June 1975. (Abstract)
4, 6

Twenty-five percent of the total, nontransportation energy in the United States in the late 1800's was wind energy. That figure is now close to 0%. A number of experiments were undertaken between 1930-1950 on large-scale power production from wind. The author describes these projects, unique characteristics of wind systems, and the Federal Wind Energy research program.

101. Doman, G.S. Structural and dynamic limits upon the size of very large rotors for wind energy conversion systems. In: Workshop on Wind Energy conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 256-260.
3, 5, 8

This work is an iterative preliminary structural dynamics design study proposed to the U.S. National Science Foundation and U.S. Energy Research and Development Administration. It is intended to: quantify the effects of dynamics design alternatives upon vibratory loads and stresses; find the cost effective physical limits on increased rotor diameter; and define the design features needed to attain greatest reliability and cost effectiveness in very large WECS rotors.

1975

102. Don Mayer, North Wind Power Company. Wind Power Dig. 1(2): 7-12, Summer 1975.

4, 12b

An interview with Don Mayer, co-founder of the North Wind Power Company, is presented. Don Mayer is involved with the restoration and sale of Jacobs wind generators, as well as legislative action to promote wind power in his home state of Vermont.

103. Donham, R.E. 100-kW hingeless metal wind turbine blade design, analysis and fabrication considerations. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 208-223.

3, 5, 12b

The NASA-LeRC wind energy program includes the design and operation of a 100-kW experimental wind turbine generator (WTG) to be used to provide an engineering data base and to evaluate candidate components and subsystems. The Lockheed-California Company has the contract (NAS3-19235) to design and build blades for the 100-kW WTG rotor. This contract provides for design, analysis, fabrication, instrumentation, and shake testing of three blades (set of 2, one spare). A flow diagram showing how the design/fabrication of blades for the 100 kW WTG fits into the wind energy research program is given.

104. Drumheller, K. Solar energy technology. Battelle Pacific Northwest Labs., Richland, Wash. NTIS, BNWL-SA-5361, March 22, 1975. 34 p.

4

A brief discussion of the technology and status of building heating and cooling, thermal systems, bioconversion, photovoltaics, wind, and ocean thermal is given. Accompanying charts illustrate the information presented.

105. Dubey, M. and U. Coty. Economic potential for wind energy conversion. Greater Los Angeles Area Energy Symposium, Proceedings, April 3, 1975. Los Angeles Council of Engineers and Scientists, Proceedings Series, Vol. 1. North Hollywood, Cal., Western Periodical Company, 1975, p. 112-121.

3, 6

Wind-energy conversion is an attractive alternative to the conversion of fossil fuel for our future energy needs. The problem is to prove the concept is economically competitive with conventional systems, compatible with the user's applications, and acceptable to the public. To explore these questions, an approach is suggested which may succeed in defining the potential market and thus portend the birth of a new giant industry. Among the topics discussed are the availability of wind as an energy source, some wind-energy conversion system concepts, potential applications of wind power, and land-use considerations.

106. Duchon, C.E. Wind velocity as modified by geomorphology. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NAS-RA-N-75-050, p. 367-371.
3, 6

Electrical energy from the wind will be extracted from the planetary boundary layer. This layer varies in depth from 100m to 1000m above the surface and exists because of the frictional drag of the earth's surface. Surface heating coupled with the topography and vegetation cause this layer to exhibit spatial and temporal gradients of the vector wind greater than anywhere else in the atmosphere. The empirical relationships of the wind speed and wind direction in the atmospheric boundary layer to underlying terrain and the surface geostrophic wind are analyzed. The terrain under consideration would show significant relief on the horizontal scale of about 100 meters to a few kilometers, but insignificant change in surface vegetation.

107. ERDA Authorization. Part IV. 1976 and transition period: solar and physical research. Hearings before the Subcommittee on Energy Research Development, and Demonstration of the Committee on Science and Technology. U.S. House of Representatives, 94th Cong., 1st session. Washington, D.C., Committee on Science and Technology, 1975. 713 p.
6

108. Eccli, E., ed. Spectrum: an alternate technology equipment directory. Milaca, Minnesota, Alternative Sources of Energy, Inc., 1975. 64 p.
2, 12b

436 items are listed for sale in this directory.

109. Edelson, E. Alternate energy sources. Edison Electr. Inst. Bull., September 1975. 11 p.
4, 6

Over the last two decades, energy usage has increased at a rate of about 3.6%/yr, with electric power generation increasing at 6.5%/yr. The search for alternative energy sources that are inexhaustible, nonpolluting, and electrical is reviewed. The possibilities of fusion, geothermal and solar energy, and bioconversion are examined. No promising energy source, however unconventional, should be neglected by a world that is increasingly dependent on energy for its well-being.

110. The Edmund wind wizard. Wind Power Dig. 1(3): 28, Fall-Winter 1975.

12a

111. Eggers, A.J. Solar energy: status and prospects as a national resource. ASHRAE J: 41-43, November 1975.

4, 6

The current state of solar energy R&D, including objectives of the six solar program areas, is examined. Areas are: bioconversion, ocean thermal conversion, wind energy, photovoltaics, solar thermal conversion, and solar heating and cooling of buildings (including agricultural applications). Proved economically viable, power systems for heating and cooling buildings, bioconversion to fuels, and wind energy should be commercially available in the late 1970's. Power systems based on solar thermal, photovoltaic, and ocean thermal technology are expected to be available in the mid-1980's.

112. Eldridge, F.R. Wind machines. McLean, Va., Mitre Corporation, October 1975. NSF-RA-N-75-051. 77 p. NTIS, PB249936, 1975. 85 p.

1, 2, 4, 5, 6

The purpose of this document is to provide a brief survey of the present status of the viability, history, taxonomy, and future potential of various types and sizes of wind machines that might be used to help meet future U.S. energy demands. The document also discusses various possible applications of wind machines, as well as siting problems, performance characteristics and system designs for such machines.

113. Electro survives first year. Wind Power Dig. 1(2) : 14, Summer 1975.

4

An owner's experience with his 12V-500 watt Electro windplant is described.

114. Elliott, D.E. Economic wind power. Appl. Energy 1(3): 167-197, July 1975.

5

The development of a cheap rugged windmill--from the initial wind tunnel tests, through power output/capital investment optimization exercises to the final design and running--is traced. It is shown that the concept of a constant-speed, self-regulating, fixed-blade windmill appears to be a practical way of achieving a rugged low cost windmill which will produce power with a low overall cost/kWh generated. The cost reduction achieved by using extruded aluminum blades of constant cross-section far outweighs the slight loss in performance incurred in comparison with tapered blades and the fatigue life of the blades should be reasonably long. For supplying cheap kWh, a relatively small-diameter, high-speed machine designed to give its maximum output at wind speeds of about 50 mph is to be preferred to large-diameter, low-speed machines.

115. Emerson, A.D., ed. The future is now. Greater Los Angeles Area Energy Symposium, Proceedings of a Conference held April 3, 1975, in Los Angeles, California. North Hollywood, Cal., Western Periodicals Company, 1975. Los Angeles Council of Engineers and Scientists Proceedings Series Volume 1.
3, 4, 6

116. Energy: Demand vs. supply. Edited by D. Reische. The Reference Shelf Volume 47, No. 5. New York, H. W. Wilson Co., 1975.
2, 4

This book is a collection of articles or excerpts from articles on energy. Included is an article by G. Soucie on wind power, taken from his article in Audubon, May 1974. (See 1974: 19)

117. Energy crisis in America. Washington, Congressional Quarterly, 1975. 93 p.
2, 4

Wind power is discussed briefly in the chapter on "New Sources of Energy."

118. Engstrom, S. Renewable energy resources: wind energy from a Swedish viewpoint. Ambio 4(2): 75-79, 1975.
6

Interest in wind power as a natural source of energy has revived, and this article takes a look at the historical perspective, new technical developments and remaining problems, questions of economy, ecological considerations, and the future perspective.

119. Engstrom, S. Vindkraft i sverige ett realistiskt komplement? [Is wind power in Sweden a realistic source of energy?] VVS Tidskv. Vaerme Vent. Sanit. Kyltetek. 46(12): 23-29, Dec. 1975. (In Swedish)
6

The article presents a review of the current status of development of wind power plants in Sweden from both the engineering and economic points of view.

120. Euler, K.J. Are there new energy sources. Eletrotech. Z. A96(1): 52, 1975. (In German)
6

121. Executive summaries of project reports of the Council. Texas Governor's Energy Advisory Council, Austin, Texas. NTIS, PB249936, March 1, 1975. 142 p.
6

As part of the work of the Texas Governor's Energy Advisory Council a series of special projects were initiated to gather information, provide background, evolve technological assessments, and develop analyses and projections on a series of topics related to energy in Texas. This document presents brief Executive Summaries of each of the reports. A summary of the objectives, program, and management plan under which the work of the Council was carried out is included.

122. Fact sheet - solar energy. Federal Energy Administration, Wash., GPO, 1975. 9 p.
4

This brochure presents a brief review of solar energy status, including a section on wind power.

123. Ferber, R. A pilot study on public reactions to wind energy devices. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 380-384.
3, 4

This study seeks to explore, in a preliminary way, reactions of the general public in various parts of the country toward the construction of different types of windmills for generating electric energy. It should throw light on the extent to which people may object to the placement of windmills in different types of landscapes, as well as the extent to which different types of people are likely to raise such objections.

124. Finch, R.D. and H. Hahn. Texas Energy Scenarios. Texas Governor's Energy Advisory Council, Austin, Texas. NTIS, PB243357, January 1975. 93 p.
4, 6

This report presents four scenarios of the future of energy in the state of Texas. The first case is a Baseline Scenario which projects the future as it might have appeared during the relatively stable period from 1967 to 1970. This is then compared with a Market Forces Scenario in which various constraints on the operation of the U.S. market are removed. A Regulated Conservation Scenario and a New Technology Scenario are then presented to illustrate the trends that might result from government actions aimed at reducing demand or increasing supply.

1975

125. Fischer, J. The past and the future of wind energy in Denmark. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 162-166.

1, 3, 6

126. Flatau, A. Review of power from the wind. Energy Research and Development, 5th Annual Symposium, Wash., D.C., March 13-14, 1974. Wash., Edgewood Arsenal, January 1975, p. 101-116. Available from NTIS.

3, 4

A graphically and tabularly documented overview of applications is presented.

127. Focusing on energy--unclearly. New York Times, March 3, 1975, Section 3, page 3.

4

The U.S. Energy R&D Administration, the newest federal bureaucracy, was established to direct and coordinate all governmental energy activities under a single agency. ERDA is responsible for developing such disparate programs as more efficient car engines, atomic bombs, windmills for generating electricity, nuclear power plants for producing more fuel than they consume, solar panels for heating and cooling buildings, and the conversion of coal into gas.

128. Frair, L.C. Proposed allocation model of wind power systems to geographical regions. Proc. AIIE Annual Conf. Conv., 26th. Washington, D.C., May 20-23, 1975, p. 377-381.

3, 6

An allocation model is presented that may be used to generate plans for the implementation of wind power systems in suitable geographic regions. The proposed allocation model consists of four main steps. In step one, the energy requirements that are to be furnished by wind power are determined. Secondly, the number and type of wind power systems needed to satisfy the wind energy requirements specified in step one are determined. The third step consists of the application of a screening mechanism which evaluates the feasibility of the allocation from step two in regard to technological capabilities, gross economic considerations, social and political considerations, and environmental guidelines. Step four consists of a detailed benefit-cost analysis.

129. Freeman, B.E. A new wind energy site selection methodology. Quarterly Report covering period March 17, 1975, to June 16, 1975. LaJolla, Calif., Science Applications, July 1975. 57 p.

6

Progress during the first quarter year of the "New Wind Energy Site Selection Methodology" investigation is reported. Work has begun on two major tasks: field data acquisition, and mathematical model design, development, and documentation.

130. Freeman, B.E. A new wind energy site selection methodology. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 356-359.

3, 6

131. Friedlander, G.D. Energy's hazy future. The power forecasting game, played so avidly by so many in 1970, is now a cautious exercise with fewer, more expert participants. IEEE Spectrum 12(5): 32-40, May 1975.

4

This is a good review of the current status of the world's energy situation and some summarized information from the papers presented at a session entitled "Electrical Energy Technology Forecast" held at the 1975 Winter Meeting of the IEEE Power Engineering Society.

132. Friedmann, P.P. Aeroelastic modeling of large wind turbines. Presented at the 31st Annual National Forum of the American Helicopter Society, Washington, D.C., May 1975.

3, 5

A set of coupled flap-lag-torsional equations of motion for a single wind turbine blade are derived in a general, nonlinear, partial differential form. These equations are suitable for determining the aeroelastic stability or response of large wind turbine blades. Methods for solving the equations together with some possible simplification of the equations are discussed. Finally, the formulation of the complete rotor-tower aeroelastic problem is considered in general terms.

133. Gabel, M. Energy earth and everyone; a global energy strategy for spaceship earth. San Francisco, Cal., Straight Arrow Books, 1975. 160 p.

1, 2, 4, 6

This book contains a small amount of historical and general information about wind power.

134. Galanis, N., S. Narasiah and C.C. Dang. Use of wind energy for the aeration of waste waters: a case study. U.S. National Conference on Wind Engineering Research, 2d, Fort Collins, Colorado, June 22-25, 1975. Conference Preprints. Fort Collins, Colorado State University, 1975, p. V-12-1 to V-12-3.

3, 6, 8, 15

Solid wastes and waste waters of domestic and industrial origin are the damaging by-products of our modern industrial civilizations.

In the treatment of these waste waters some of the important steps are screening, sedimentation and aeration followed by disinfection. Aeration is a significant phase consisting of providing waste waters with oxygen in order to promote bacterial growth and consequent bio-degradation of the organic wastes. The design presented in this report is a first attempt to assess the feasibility of using wind energy for the aeration of waste waters.

135. Generator marketed by AeroPower. Wind Power Dig. 1(3): 29, Fall-Winter 1975.

12a

136. Glaser, P.E. New sources of power - solar energy. ASCE Eng. Issues, J. Prof. Act. 101(4): 461-470, October 1975.

6

In the very near term, solar energy can provide hot water and space heating, and in the intermediate term, space cooling for both commercial and residential buildings. In the longer term, terrestrial solar power systems based on focused solar energy, wind energy, or ocean thermal gradients are possible regional sources of auxiliary power. Photovoltaic conversion of solar energy to electricity with solar cells could provide supplemental power if the costs of solar cells are reduced. By the year 2000, a satellite solar power station could be a technically and economically viable continuous source of primary electric power whenever needed throughout the world. It will use solar cells to collect the solar radiation, which would then be converted to microwave energy. The Microwaves will be beamed to a receiving antenna on earth and be reconverted to electricity. Such solar systems can help meet future energy demands without significant detriment to man's environment.

137. God bless Mr. Savonius! Mother Earth News, No. 36: 129, November 1975.

12a

This is a report of a working S-rotor windplant.

138. Goddard, B. Wind power work at Helion. Wind Power Dig. 1(1): 27, January 1975.

4

139. Goodrich, R.F. Windspeed characteristics. Wind Power Dig. 1(3): 23-25, Fall-Winter 1975.

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140. Grace, D.J. Potential of WECS for Hawaii. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 130-132.
3, 6

Research programs for the development and use of wind turbine generators in Hawaii are reviewed.

141. Grace, D.J. Wind energy conversion research in Hawaii. U.S. National Conference on Wind Engineering Research, 2d, Fort Collins, Colorado, June 22-25, 1975. Conference Preprints. Fort Collins, Colorado State University, 1975, p. V-28-1 to V-28-2.
3, 6

Wind power is a significant alternative energy resource for Hawaii. The relatively steady tradewinds coupled with terrain enhancement and a mild climate provide excellent physical conditions for wind system R&D.

142. Greeley, R.S. Working Group B. Possible utilization schedules. [Report] In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 473-476.
3, 6

143. Greer, J.H. and C.S. Niederman. Power for data buoys and other remote stations. Presented at IEEE and Marine Technology Society Ocean 75 Conference, San Diego, September 22-25, 1975, p. 736-740.
3, 8, 15

To meet the requirements of a wide range of electrical loads, the NOAA data buoy office has developed and operated reliable power systems. Diesel electric generators and battery powered systems, including hybrid batteries, have been deployed from the tropics to the arctic. Performance of these power systems is evaluated. Other power systems, involving solar and fuel cells, seawater batteries, wind powered generators, wave active turbine generators, and radioactive power generator units, are briefly discussed.

144. Grey, J. The science and technology of nonconventional energy sources for developing countries. Office for Science and Technology, United Nations, August 31, 1975.
6

145. Griffin, O.M. Ocean as a renewable source of energy. J. Eng. Ind. 97(3): 897-908, August 1975.
6

1975

146. Hackleman, M. The Homebuilt wind-generated electricity handbook. Mariposa, Cal., Earthmind, 1975. 194 p.
2, 12a

The author of "Wind and Windspinners" brings us this larger book covering such topics as wind machine restoration, towers, installation, controlling, auxiliary generating equipment and design notes. The whole is delightfully illustrated and provides much needed information for the home-builder.

147. Hamilton, R. Can we harness the wind? Nat. Geogr. 148(6): 812-829, December 1975.
1, 4, 6

Wind power has been used in the U.S. and in Europe for many years. Today some 150,000 old windmills are still utilized in the U.S. Wind power generation is feasible in many special situations, but will not be generally available till costs come down. Examples of the use of wind, from private homes to oil exploration, are described. Many generator designs and energy storage methods are reviewed.

148. Hammond, A.L. Artificial tornadoes: novel wind energy concept. Science 190(4211): 257, October 17, 1975.
4, 5

A novel energy concept involves the utilization of intense vortices, similar to miniature tornadoes, inside large circular towers. This wind system appears capable of generating far more power than conventional wind turbines of similar size can. A combination of the tornado-like vortex and the tower in which it is generated collects and concentrates energy from a far greater volume than the air immediately around the turbine blades does.

149. Hans Meyers' talk. Wind Power Dig. 1(2): 23-24, Summer 1975.
4

150. Hardy, D.M. Wind power studies: initial data and numerical calculations. Progress report, September-December 1975. NTIS, UCRL-50034-76-1, October 15, 1975. 44 p.
6

Initial data collection and numerical modeling results in wind-energy research conducted by the Lawrence Livermore Laboratory are reported. The use of conventional and laser anemometry is described. Also discussed is the development of a data-collection and data-processing capability appropriate for a major numerical study of wind energy as well as a three-dimensional numerical model of wind fields over complex terrain. Illustrative numerical calculations of nondivergent vector wind fields are presented.

1975

151. Harrah, B. and D. Harrah. Alternate sources of energy: a bibliography of solar, geothermal, wind and tidal energy, and environmental architecture. Metuchen, New Jersey, Scarecrow Pr., 1975. 216 p.

2, 16

The Harrahs bring together here over 1,700 books, articles, and reports on solar, geothermal, wind and tidal energy. Some 150 entries deal with unconventional energy sources in general, another 1,200 are devoted to solar power, and the remainder are distributed among the other three power sources. Works cited range from popular books and magazine articles to quite technical reports. An appendix gives names and addresses of periodicals and organizations in the field.

152. Helicopter technology aids wind effort. Aviat. Week 103: 52-55, October 13, 1975.

4, 5

Substantial technology transfer from U.S. helicopter manufacturers to the federal wind energy program promises to bring the vital elements of low cost and high reliability into this area of energy research.

153. Henry Clews sells franchise. Wind Power Dig. 1(2): 15, Summer 1975.

4

154. Heronemus, W.E. The University of Massachusetts wind furnace project: A summary statement. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 404-407.

3, 8, 15

The wind furnace is a system intended to use wind energy or a combination of wind plus photo-thermal energy to provide heating at the residential level in climates characterized by about 6200 degree days of heating requirement (based on 65°F).

155. Heronemus, W.E. Wind power: a significant solar energy resource. Aware 57: 2-7, June 1975.

6

Windpower can be a significant part of our future solar driven energy system, and it is one of those few solar processes that could be exploited in the near term. From a speech presented before the American Chemical Society, Philadelphia, April 1975.

156. Heronemus, W.E. and J.G. McGowan. Ocean thermal power and wind-power systems--natural solar energy conversion for near-term impact on world energy markets. Energy Symposium: Energy Delta/Supply vs. Demand. 140th Annual Meeting of American Association for the

Advancement of Science, San Francisco, February 25-27, 1974. American Astronautical Society. A.A.S. Science and Technology Series 35: AAS74-034, p. 491-506, 1975.

3, 6

The potential of two energy conversion systems which use the natural solar collection of the earth and its atmosphere over land and sea as their power input is discussed. The first concept, for large scale power generation, is based on a Rankine cycle heat engine driven by the thermal difference (15 to 22 degrees Celsius) which exists between the warm tropical surface waters of the ocean and the great mass of cold water below. Windpower, the second concept, is discussed in the context of small to large scale systems comprising a number of methods for extracting a portion of the kinetic energy of the earth's atmosphere. A brief history and a current status report on recent research developments as well as the basic technical descriptions of these concepts are presented. Suggested configurations for energy distribution systems utilizing these natural energy resources complete with energy storage and transmission systems are given. In addition to the potential impact of these systems, the recognized technological and institutional problems standing in the way of their potential implementation are enumerated.

157. Herron, R.C. Energy conversion apparatus. U.S. Patent 3,895,236. July 15, 1975. 8 p.

17

An energy conversion apparatus is described for converting forces occurring in nature to electrical energy. Natural forces such as wind, gravity, etc. are converted to reciprocating linear motion which is then converted to electricity either directly or after a linear to rotary motion conversion.

158. Herwig, L.O. Solar energy systems: practical alternatives for the 1980's. Am. Nucl. Soc. Trans. 21: 144-145, June 1975. (Abstract)

6

The National Solar Energy Program plan to develop reliable, economically viable, solar-based power systems is described. The plan encompasses six approaches to utilization of solar energy which depend on collection, absorption, and conversion of the sun's radiation either through direct interactions, e.g., thermal, photovoltaic, or photosynthetic, or through indirect interactions in wind and ocean.

159. Herwig, L.O. U.S. Solar Energy Research Program. Am. Geophys. Union EOS Trans. 56(2): 58-61, February 1975.

4, 6

During the past four years, NSF has been developing program plans for increased federal support of terrestrial solar energy research. The status and plans of the U.S. Solar Energy Research Program are described. Research is organized under the program areas of: heating and cooling of buildings and agricultural applications; solar thermal conversion; photovoltaic conversion; bioconversion to fuels; wind energy conversion; and ocean thermal conversion. The NSF-Research Applied to National Needs solar energy budget for FY75 is estimated at $50 million. The FY71 budget was $1.2 million.

160. Hewson, E.W. Generation of power from the wind. Amer. Meteorol. Soc. Bull. 56(7): 660-675, July 1975.

4, 6

There is vast energy available in the earth's winds for man's use. It is conservatively estimated that the wind power available to man is the equivalent of the output of 1000 typical fossil fueled or nuclear power plants of 1000 megawatts (MW) capacity each. By contrast, the water power potential of the earth is only one-tenth as large. Large wind generators have been built and used during the past 50 years. Research on wind power sites in the mountainous, coastal and valley areas of the Pacific Northwest is being conducted. Terrain modification, aerogenerator "farms," special duty installations, environmental impacts, land use, and net energy costs are all taken into consideration. It is concluded that wind power shows promise of supplying substantial amounts of supplementary electrical energy and that the development of this wind power potential should proceed with the federal government taking a lead role.

161. Hewson, E.W. Wind-power potential in the Pacific Northwest. In: Citizens' Forum on Potential Future Energy Sources, Proceedings. Portland, Ore., Oregon Department of Geology and Mineral Industries. Miscellaneous Paper No. 18, 1975, p. 7-24.

3, 6

Research on the wind-power potential of Oregon and neighboring areas described in this article, was commenced in 1971 by Oregon State University under the sponsorship of the four Oregon P.U.D.'s and has continued since that time under the same sponsorship. The primary thrust of the research has been to study various possible wind-power sites, especially those at or near the Oregon coastline and in the Columbia River Valley. These studies have involved the detailed analysis of existing wind records and the establishment of new wind-measuring stations. At the same time, the wind tunnel at Oregon State University has been enlarged and improved to permit model studies of air-flow patterns around terrain features. If a comparison of model and actual air-flow patterns over and near pronounced terrain features shows satisfactory agreement, then the location of desirable wind-power sites will be greatly facilitated and expediated. Other project uses of the wind tunnel are also described.

162. Hewson, E.W., R.W. Baker and R. Brownlow. Wind power potential in selected areas of Oregon. Oregon State University, Report No. PUD 75-3, August 1975. Third Progress Report. Corvallis, Oregon, Oregon State University, 1975.

6

During the third year of the project, research centered on further analysis of potential wind power sites, the development of a promising new wind analysis technique and continued research on wind tunnel simulations of wind flow over a model of a coastal headland. Offshore coastal power sites look promising, though expensive. The report concludes with an assessment of the feasibility of wind power in Oregon after three year's research, with a recommendation.

163. Hickok, F. Handbook of solar and wind energy. Boston, Cahners, 1975. 130 p.

2, 4

164. Hillman, E.K. Wind-driven motive apparatus. U.S. Patent No. 3,899,268. August 12, 1975. 6 p.

5, 17

A wind driven apparatus having pairs of vanes mounted upon a rotatable shaft is disclosed. Each of the vanes is laterally slidable upon the shaft to cyclically vary the surface area on either side of the shaft; however, the vanes are not rotatable with respect to the shaft. Rotation of the shaft, and attached power takeoff pulleys, is effected by the wind acting upon a greater surface area on one side of the shaft than the other.

165. Hollomon, J.H. and M. Grenon. Japan. Ford Foundation Energy Policy Project Report: Energy Research and Development, 1975, p. 205-222.

4, 6

Japan may become, without any domestic natural resources, the world's second most powerful economic nation. Since 1958, various unsuccessful attempts were made to improve the coal industry situation, which reached its peak in 1961 and has been decreasing steadily. Oil covers more than 70% of the total energy mix, and will continue to do so for the next 15 years. At least 99% of this oil is imported. There is little natural gas production in Japan, but various contracts with other nations could raise the level of imports to 30 million metric tons in 1985. Electricity is generated by thermal rather than hydro capacity. With oil as the dominant fuel for thermal production, aside from power production and nuclear energy, only a small amount of R&D is performed in the energy field. Some research has been done on nonconventional energy sources, such as solar energy (and the manufacture of a solar battery), wave energy, wind energy, geothermal energy, and coal gasification and liquefaction.

166. Huge windmills may power cities. Mach. Des. 47: 12, January 23, 1975.
4

167. Hughes, W.L., H.J. Allison and R.G. Ramakumar. Development of an electrical generator and electrolysis cell for a wind energy conversion system. Final Report July 1, 1973 - July 1, 1975. Oklahoma State University, Stillwater, Okla. NTIS, PB243909, July 10, 1975. 280 p.
13

This final report describes progress made at the Oklahoma State University on wind energy utilization. The specific objectives of this research program were: (1) to develop and build a working field modulated generator system in the 10/20 kW range suitable for use in a wind energy system to deliver standard 110/220 V single-phase 60 Hz power over a 2 to 1 range of speeds; (2) to develop and build a working high-pressure moderate-temperature electrolysis system in the 2-3 kW input range in the available high pressure test facility; and (3) to design and construct a wind generator test station at the Stillwater airport using existing field modulated generators and bicycle-wheel type aeroturbines developed by the American Wind Turbine Company. Final reports are presented covering performance details on the products of each of the three objectives. A large Appendix reproduces 13 papers generated during the two year contract period.

168. Hundemann, A.S. Windpower (A Bibliography with abstracts). Report for 1964 - December 1974. NTIS/PS-75/348. NTIS, February 1975. 90 p. Supersedes COM-74-11103.
16

The feasibility, use, and engineering aspects of windpower and windmills are covered in 85 abstracts. Many of the reports are recent NASA translations of European and Russian research conducted from 1934 to 1959.

169. Hurlebaus, W.H. A perspective on wind mission analysis. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 88-91.
3, 6, 13

1975

170. Hurlebaus, W.H. Subgroup position paper. Subgroup 4: wind energy systems. In: Magnitude and Deployment Schedule of Energy Resources. Proceedings of a conference held on July 21-23, 1975, Portland, Oregon. Edited by Walter D. Loveland. Corvallis, Oregon, Oregon State Unviersity, September 1975.
3, 6

171. Hybrid windmill notes. Wind Power Technical Memo WTM 2. Sylmar, Cal., Helion, 1975.
4, 12a

This summarizes J. Park's knowledge of hybrid windmills.

172. Igra, O. Israeli work on aerogenerator shrouds. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 149-155.
3, 10

Past work in Israel has shown that wind turbines enclosed in specially designed shrouds can increase the output of power of the turbine by a factor of 3 or so, as compared with unshrouded turbines under the same free wind stream conditions. However, first generation shrouds were found to be unacceptable for economical use, i.e., the ratio of the shroud's total length to throat diameter was of the order of 7. The main purpose of the present work was to arrive at a compact shroud configuration, without sacrificing aerodynamic performance. The results clearly indicate that it is possible to obtain shrouds with a total length to throat diameter ratio that is smaller than 3, and that have an aerodynamic performance similar to the first-generation model.

173. Igra, O. Shrouds for aerogenerator. Ben Gurion University of the Negev, Department of Mechanical Engineering, Report No. 2, March 1975. 53 p.
10

In order to exploit the wind power as economically as possible, it was suggested that the wind turbine be enclosed inside a specially-designed shroud. Past work has shown that such shrouds can increase the output power of a given turbine by a factor of 3 or so, as compared with the bare configuration under the same free stream conditions. However, the geometry of the first generation shrouds was unacceptable for economical use, i.e., the ratio of the shroud's total length to throat diameter was of the order of 7. The main purpose of the present work was to arrive at a compact shroud configuration without sacrificing good aerodynamic performance. The results clearly indicate that it is possible to obtain shrouds with total length to throat diameter ratio smaller than 3, with performance similar to the first-generation model.

1975

174. Inglis, D.R. Wind power now! Bull. Atom. Sci. 31(8): 20-26, October 1975.

4

Harnessed by methods which are already well known, the wind could soon supply a substantial fraction of our energy needs at an economical cost; yet the government's pace is inexcusably slow. A prompt start might unshackle the United States from its nuclear ball and chain.

175. Institute of Environmental Sciences. Annual Technical Meeting, 21st, Anaheim, Cal., April 14, 1975. Vol. I: Energy and the Environment. Vol. II: Technical Division Proceedings, including career guidance forum notes. Mt. Prospect, Illinois, Institute of Environmental Sciences, 1975.

3, 4

176. Intersociety Energy Conversion Engineering Conference, 10th, Newark, Delaware, August 18-22, 1975. New York, Institute of Electrical and Electronics Engineers, Inc., 1975. 1572 p.

3, 4

The 227 papers presented at the conference cover solar buildings, solar heating and cooling, solar thermal electric generation, solar utilization, space solar systems, LMFBR, energy storage and components, automotive engines, fuel cells, urban systems, nuclear power systems, thermionic energy conversion, photovoltaic conversion lithium batteries, topping cycles, unique engines, molten salt/solid electrolyte batteries, synthetic liquid fuels from coal and oil shale, energy conservation, thermoelectric systems, aqueous batteries, alternative fuels, isotopic power systems, Stirling cycle engines, wind systems, Brayton cycle systems, hydrogen, biomedical power, Rankine cycle systems, wind system applications, and heat pipe applications.

177. Investigation of the feasibility of using windpower for space heating in colder climates. Third Quarterly Progress Report covering the final design and manufacturing phase of the project, September to December 1975. NTIS, ERDA/NSF/00603-75/T1, December 1975. 165 p.

6, 8

Progress during the third quarter has been inadequate. The overall project is now 4 weeks behind schedule, which means that data collection at Solar Habitat One will not begin until mid-March 1976, the twelfth month of this phase of the work. System design and cost analysis are summarized.

178. Jack Park's wind experiments. Mother Earth News, No. 32: 101, March 1975.

12a

Several photographs and a description of J. Park's "hybrid" wind turbines are shown, with information about his book, which is indexed under 1975:258.

179. Jacobs, M.L. and P.R. Jacobs. Clutch-controlled, wind-operated, power producing propeller. U.S. Patent No. 3,891,347. June 24, 1975.

5, 17

A clutch-controlled, wind-operated, multibladed power producing propeller includes a plurality of propeller blades mounted on a hub for rotation about a power output shaft, a clutch connected between the hub and output shaft and operable to remain disengaged until the propeller blades attain a predetermined speed of rotation. The clutch then engages to transmit power from the propeller to the output shaft.

180. James, E.C. Unsteady aerodynamics of variable pitch vertical axis windmill. American Institute of Aeronautics and Astronautics and American Astronautical Society, Solar Energy for Earth Conference, Los Angeles, April 21-24, 1975. AIAA Paper 75-649. 7 p.

3, 5, 9

A linearized theory is developed to treat the unsteady aerodynamics of a vertical axis windmill. The wind speed is uniform and steady. The circular orbit of the blades represents a large amplitude flight path motion. Along this trajectory the blades are free to execute small amplitude pitching. The results include blade force, moment, power required to sustain a specified windmill speed, and the rate of energy loss due to shedding of vorticity. Relative to the wind speed, the high and low speed cases of windmill operation are investigated.

181. Jayadev, T.S. Novel electric generation schemes for wind power plants. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 298-306.

3, 13

A variable speed prime mover would drive a conventional a.c. generator with d.c. excitation, resulting in variable frequency. To interconnect the wind energy system (WES) to existing power systems demands the output of WES to be of constant frequency and voltage. Constant voltage can be obtained by common voltage regulator techniques, but obtaining constant frequency from a variable frequency generator is not simple. Converting WES output to "utility grade" power by cost effective techniques is discussed.

182. Jayadev, T.S. and R.T. Smith. Generation schemes for wind power plants. IEEE Trans. Aerosp. Electron. Syst. AES11(4): 543-550, July 1975.

13

This paper reviews various electric generation schemes for wind energy conversion suitable for interconnection with a power grid. The schemes can be generally classified as constant speed constant frequency (CSCF) and variable speed constant frequency (VSCF) systems. Historically, only CSCF systems have been used for large power generation in wind power plants. However, with the advent of power electronics and the availability of solid state devices capable of handling large amounts of power, VSCF systms are becoming competitive. Various schemes under each classification are discussed and compared. It is stressed, however, that the optimum choice of the generating scheme is not decided by considering the generator alone. The optimum choice is one which minimizes the cost of energy generated by the wind power plant.

183. John M. Thalmann's wind turbine. Mother Earth News, No. 31: 82, January 1975.

12a

The author has built a wind turbine closely related to the Savonius S-rotor.

184. Johnson, C.C., R.T. Smith and R.K. Swanson. Electric utility aspects of windpower. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 307-309.

3, 13

185. Johnson, C.C., R.T. Smith and R.K. Swanson. Survey of windpower development in the United States and Europe. Interamerican Conference on Materials Technology, 4th. Proceedings. Caracas, Venezuela, June 29 - July 4, 1975, p. 577-582. Published for Southwest Research Institute, San Antonio, Texas, by Cent. Reg. de Ayuda Tec., Agencia para el Desarrollo Int.(AID), Buenos Aires, Argentina, 1975.

3, 4, 6, 11

Windpower use for electrical power generation is reviewed in terms of past and current development, both in the USA and Europe. Technical data and operating experience are presented for a number of important windpower generation systems (WGS) in Denmark, Germany, and particularly, the Putnam 1000 kW plant at Grandpa's Knob, Vermont. Recent programs initiated by the National Science Foundation are described, as well as the USA windpower R&D program proposed for the next 5-10 year period. Consideration is given to the maximum available power from the wind and how much of this power can actually be extracted and utilized. Various systems for processing the variable speed mechanical power of wind turbines are discussed in terms of complexity, cost, availability, and specific application. Systems evaluated include synchronous, induction, commutator, and solid-state power conversion techniques. The means for storage of the varying electrical energy output are described.

186. Johnson, G.L., F.W. Harris and N.R. Michal. Farm hydrogen system load factor analysis using both wind and electric utility power in southern Kansas. U.S. National Conference on Wind Engineering Research, 2d, Fort Collins, Colorado, June 22-25, 1975. Conference Preprints. Fort Collins, Colorado State University, 1975, p. V-9-1 to V-9-3.

3, 9, 14

The KSU College of Engineering is investigating a proposed fuel system that involves the use of hydrogen as a mobile fuel for farms throughout the Great Plains states. The system envisioned is that of vertical axis wind rotors driving electrical generators which supply power to electrolysis cells. Off-peak electric energy from coal and nuclear-fueled conventional generating stations could be used to insure a stable energy supply during light wind conditions. The hydrogen is collected and stored for use as needed in the farm heat engines. Rotors, control systems, and special-purpose electrolysis cells are now in the preliminary design stage.

187. Jordan, P.F. Improved rotors through utilization of aeroelastic effects. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11-1975. McLean, Va., Mitre Corp, 1975. NSF-RA-N-75-050, p. 247-248.

3, 5

188. Justus, C.G. Annual power output potential for 100 kW and 1 MW aerogenerators. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 360-366.

3, 6

Previous estimates of wind power potential in the U.S. have been based on statistics of the mean wind speed at various sites across the country. While the average power output of a wind generator will certainly depend on the mean wind speed, it will also have a dependence on other factors, e.g., variance of wind speed about the mean. A method for computing actual expected output power from a wind generator, given the observed wind speed distribution, and results of application of this method, in the form of aerogenerator plant factor (ratio of average power output to rated power) for the continental U.S. are presented. Plant factors are evaluated for aerogenerators with characteristics of NASA's 100 kw Plumbrook unit and the design characteristics of NASA's 1 MW aerogenerator.

189. Justus, C.G. National wind energy statistics for large arrays of aerogenerators. Prog. Rep. No. 1, covering the period January 15, 1975 through September 30, 1975. Atlanta, Ga., Georgia Institute of Technology, School of Aerospace Engineering, October 1975. 29 p.

5

The purpose of this study is to evaluate and analyze the wind energy output statistics of realistically simulated arrays of aerogenerators in various regions of the contiguous 48 states of the U.S. This brief report describes analysis procedures used and the results from two sample runs of one month each on limited size arrays of sites.

190. Justus, C.G. Nationwide assessment of potential power output from aerogenerators. U.S. National Conference on Wind Engineering Research, 2d, Fort Collins, Colorado, June 22-25, 1975. Conference Preprints. Fort Collins, Colorado State University, 1975, p. V-21-1 to V-21-3.

3, 6

Previous estimates of wind power potential in the U.S. have been based on statistics of the mean wind speed at various sites across the country. While the average power output of a wind generator will certainly depend on the mean wind speed, it will also have a dependence on other factors, e.g., variance of wind speed about the mean. This report presents: 1) a method for computing actual expected output power from a wind generator, given the observed wind speed distribution, and 2) results of application of this method, in the form of aerogenerator plant factor (ratio of average power output to rated power) for the continental U.S.

191. Justus, C.G. Working Group E. Wind characteristics/site survey. [Report] In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 487-490.

3, 6

1975

192. Kaplan, G. For solar power; sunny days ahead? IEEE Spectrum 12(12): 47-52, December 1975.

4, 6

The future of sun-derived electric power is clouded by budgetary constrains, institutional and public inertia, and poor incentives. Wind power is discussed as one form of solar energy.

193. The Kedco 1200. Wind Power Dig. No. 2: 14, Summer 1975.

12b

This is a news item about the sale of Jack Park's "12/16 footer" windplant design to Kedco Inc., a California firm which plans to market a 1,200 watt wind generator.

194. Kenned, A.M. and B. Parvin. The second New Zealand Energy Conference. New Zealand Energy J. 48(6): 98-108, June 25, 1975.

3, 4

Many sources are available for analyzing past energy trends and forecasting future ones in New Zealand. The activities of the New Zealand Energy R&D Committee are described. Transportation energy use, static energy production and use, raw materials, and renewable energy resources in New Zealand are reviewed.

195. Killen, R. G.E. systems studies of large-scale WECS. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp. NSF-RA-N-75-050, p. 37-45.

3, 6

The cost of generating electrical power by wind turbine generator systems is analyzed for different wind regions. Minimum cost systems are discussed. Various system configurations are studied.

196. Kling, A. Precessor system for wind energy conversion. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 465-467.

3, 5

The Precessor Wind Energy Conversion System is based on a concept which utilizes the rotor system of a wind energy converter as a gyroscope and uses the precession, which occurs whenever an external torque is exerted on a spinning rotor, to position the rotor to face into the wind and to adjust its position to the slightest changes of wind direction. The system does not fight against the precessional forces of the rotors, but puts precession to work for the system.

1975

197. Koekebakker, J. More than oil and gas to North Sea energy. Energy Int. 12(5): 18-19, May 1975.
4

198. Kolm, K., et al. Evaluation of wind-energy sites from aeolian geomorphologic features mapped from LANDSAT imagery. First results. NTIS, ERDA/NSF/00598-75/T1, December 1, 1975. 39 p.
6

This research effort relates aeolian geomorphologic features, interpreted from satellite imagery, to areas of high-wind-energy potential. Preliminary results, gathered during spring and summer months, were evaluated statistically to determine the critical interrelationships for the Killpecker test area. These tests indicate that the morphology of individual dunes is not a unique indicator of wind velocity or persistence, but the morphology of the dune field is an indicator that can be used to predict areas of high wind-energy potential. These results will be used as a guide to prediction of other areas of high wind-energy potential. Field measurements will then be used to test these predictions. Similar evaluations are being made in the Big Hollow Area where aeolian erosional phenomena dominate the geomorphologic development.

199. Krueger, J.N. Evaluation of wind energy available in North Dakota. U.S. National Conference on Wind Engineering Research, 2d, Fort Collins, Colorado, June 22-25, 1975. Conference Preprints. Fort Collins, Colorado State University, 1975, p. V-20-1 to V-20-3.
3, 6

The University of North Dakota's Wind Energy project was initiated in November of 1973. The purpose of the project was to make an evaluation of the energy in the winds blowing over North Dakota during a year's time. Energy would be extracted from the wind by a conventional high speed propeller coupled to an electric generator. Continuous readings of the wind velocity and the energy produced would be recorded.

200. Lapin, E.E. Theoretical performance of vertical axis wind turbines. ASME Paper 75-WA/Ener-1, 1975. 11 p.
9

An elementary theory is developed for the power extraction capability of a vertical axis wind turbine comprising a number of blades which operate either at fixed or at continuously variable incidence. The performance according to that theory is computed for some examples and applied to estimate the economic feasibility of a turbine of 10 megawatt rating.

201. Larsen, H.C. Summary of a vortex theory of the cyclogiro. U.S. National Conference on Wind Engineering Research, 2d, Fort Collins, Colorado, June 22-25, 1975. Conference Preprints. Fort Collins, Colorado State University, 1975, p. V-8-1 to V-8-3.

3,5

The cyclogiro was first proposed by Congreve in 1828 as a man-powered airborne vehicle. In the succeeding 147 years, it has received sporadic development. Several theories based on aerodynamics of wings combined with the momentum theorem to calculate a uniform induced flow through the rotor have been developed. An Army Air Corps study of 1943-45 recommended against the further development of the cyclogiro, although aircraft utilizing the concept were competitive or superior to fixed wing aircraft. This was because of the high level of vibration due to heavy, cumbersome mechanical blade actuation mechanisms, unsteady aerodynamic effects, and the lack of a suitable theory to predict correctly the induced flow through the rotor. The auto-rotation characteristics of the cyclogiro clearly indicated that it could be used as a windmill. The successful use of the fly-by-wire concept in modern aircraft, stability augmentation systems, and the modern high-speed digital computer have advanced technology to the point where these techniques can be utilized to design and control cyclogiros, and provided the impetus for a careful reappraisal and analysis of the problem. This paper is a brief summary of the progress so far, and an application to the design of wind energy generation devices.

202. Lawand, T.A., et al. Solar energy potential for Canada. In: International Solar Energy Congress and Exposition. 1975. Rockville, Md., International Solar Energy Society, 1975, p. 4-5.

3,6

203. Leckie, J., et al. Other homes and garbage. San Francisco, Sierra Club Books, 1975.

2,4

A section on the fundamentals of wind energy systems is included.

204. Lee, D.G. Wind power. Nat. Wildlife 13(5): 30-33, August-September 1975.

4,6

Included in this brief overview of wind energy developments and potential is a chart of wind speeds of 32 U.S. metropolitan communities.

205. Liljedahl, L.A. Wind energy use in rural and remote areas. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 393-399.
3, 6, 8

Historically, agriculture was a major user of wind generated power before inexpensive power from other sources became available. Because of this, it is reasonable to expect that agriculture, rural and remote area applications can again play an important role in the development of a future viable wind energy industry in the United States as fossil fuels become more scarce and expensive and that the wind energy used in such applications can substitute for an appreciable portion of the fossil fuel energy currently used in the current agricultural industry.

206. Lindley, C.A. Wind machines for the California Aqueduct. In: Workshop on Wind Energy Conversion System, 2d, Wash., June 9-11, 1975. McLean Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 104-111.
3, 15

The use of wind turbine generators to provide some of the electric power needed for the California Aqueduct pumping systems is analyzed.

207. Lindley, D. New Zealand's place in the energy economics of the Pacific Basin countries. Presented at Energy in the Pacific Basin, a Conference at Pepperdine University, Malibu, Cal., December 17-19, 1975.
3, 6

After a brief review of the energy economies of some ten Pacific Basin countries which draws attention to some similarities and many differences, the paper deals in some detail with the energy economy of New Zealand. In spite of considerably undeveloped coal, hydro and geothermal resources and the promise of further discoveries of natural gas and condensate, New Zealand still has the long-term problem of finding a way of reducing its considerable dependence on oil imports. The future possibilities for using bioconversion, solar, wind, geothermal, and hydro resources to reduce this dependence are discussed.

208. Lindquist, O.H. Application of wind power systems to the service area of the Minnesota Power and Light Company. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 98-103.
3, 6, 13

The objective of Honeywell's study is to define the attributes and performance requirements of a system capable of yielding a satisfactory return on investment to a utility company. An initial system definition will be developed by designing and evaluating the most cost-effective system based on available wind information and today's technology. The system will be tailored to the Minnesota Power and Light (MPandL) Company region. Within MPandL's region is located a sparsely populated, high-wind-energy area that could be used to alleviate the load problems caused by a fast-growing taconite industry. In addition, the nation's highest utility load factor and operational flexibility derived from having significant hydro and high voltage d-c sources place MPandL in an ideal position to accept the output expected from wind power systems.

209. Lindsley, E.F. First report on Smokey Yunick's total energy system. Pop. Sci. 207(2): 56-59, August 1975.
4, 6, 12b

Wind and sun will heat, cool, and make electricity, liquid fuel and fertilizer.

210. Lindsley, E.F. New inverter gives wind power without batteries. Pop. Sci. 207(4): 50, 52, October 1975.
4

Hans Meyer's device that converts dc into ac for household use and eliminates the need for storage batteries is discussed.

211. Lindsley, E.F. Robert Landing: he rides on the wind. Pop. Sci. 206(4): 116-117, April 1975.
4, 12b

212. Lissaman, P.B.S. Working Group G. Possible improvements in conventional wind energy conversion systems. [Report] In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 498-501.
3, 5, 13

213. Lissaman, P.B.S. Innovative and advanced system concepts. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 413-416.
3, 13

214. Little new under the sun. Resources for the Future, No. 48: 10-12, January 1975.
6

Solar heating and cooling is generally believed to have the best chance of making a substantial energy impact in the near term. Electricity generation from solar energy, solar cells, ocean thermal gradients, wind power, and bioconversion techniques are possible, or nearly possible today, but economically they shape up on the minus side of conventional techniques. At best, by 1980 about 1% of U.S. homes could be generating up to 80% of their energy requirements, which, given the cost of oil, could save about $2 billion/yr.

215. Ljungstroem, O. Swedish wind energy program, a three year R and D plan, 1975-1977. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 140-148.

3, 6

A first phase of a three year program was started by the National Swedish Board for Technical Development (STU) in January of 1975, and it is expected that the STU-proposed program will be carried on to form a basis for decision as regards implementation of large scale wind energy systems in the late 1980s. The main features of the STU WECS-program, its background and achievements to date are described.

216. Lotker, M. Northeast Utilities' participation in the Kaman/NASA wind power program. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 59-68.

3, 6, 7, 13

Northeast Utilities is currently supporting the Concept Selection, Optimization, and Preliminary Design of Large Wind Generators Study conducted by Kaman Aerospace Corporation under NASA contract. Our purpose in these activites, which are internally funded, is to maintain an intimate contact with the wind generator design effort in order to best be able to factor it into our generation plans, and to insure that the product of this research will meet the technical and institutional constraints of our industry.

217. McCallum, B. Environmentally appropriate technology: developing technologies for a conserver society in Canada. Ottawa, Canada, Advanced Concepts Centre, March 1975. 91 p.

2, 4, 6

This primer for government policymakers describes how a new school of thought evolved from the environmental movement, the back to the land movement and biotechnics. Renewable energy sources were rediscovered and ways to use them for architecture, agriculture and transportation are discussed. Windrotors are included in the discussion.

218. McCartney, J.F. and M.A. Cates. Selection of power sources for remote ocean oriented applications. Intersociety Energy Conversion Engineering Conference, 10th. New York, Institute of Electrical and Electronics Engineers, Inc., 1975, p. 1318-1327.

3, 15

1975

219. McCloud, J.L. and J.C. Biggers. How big is a windmill - Glauert revisited. In: American Helicopter Society, Annual National Forum, 31st, Washington, D.C., May 13-15, 1975. Proceedings. New York, American Helicopter Society, Inc., 1975. 9 p.

3, 5

The obvious similarities to propellers and helicopter rotors suggest that helicopter technology might be used to improve wind generator performance, perhaps including development of a windmill airfoil. In a back-to-basics approach, this paper reviews the analyses of Glauert to determine basic size-power relations. The energy method of Wheatley developed for helicopter/auto-gyro performance prediction is then incorporated into the basic theory. Equations and charts are presented showing ratios of power output to the ideal power capability as functions of mean blade lift and drag coefficients, solidity and rotor tip speed ratio. It is found there is little possibility for improved performance by using improved airfoils. The basic assumptions of the Glauert theory are reviewed and means are suggested for achieving the basic power capability indicated by momentum theory.

220. McCormack, M. Luncheon address. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 72-78.

3, 4

221. McGowan, J.G. and W.E. Heronemus. Ocean thermal and wind power: alternative energy sources based on natural solar collection. Environ. Aff. 4(4): 629-660, 1975.

6

This article discusses the two most important natural solar collection methods for large-scale energy production: (1) the collection of solar energy by the Earth's atmosphere that causes the winds; and (2) the natural collection of incoming solar radiation by the oceans that creates large temperature differences in the ocean waters. The size of these energy conversion systems could range from a few kilowatts for individual household windpower systems to large-scale 400-MW ocean thermal difference power plants. The historical development of systems designed to utilize these renewable energy sources and their potential for making a significant contribution to the energy supply of the U.S. are discussed. Recent research results and technological developments in total power systems and important subsystem components, including those used for the storage of energy, are discussed. An attempt is made to enumerate the recognized technological and institutional problems standing in the way of their potential implementation. A compilation of 63 footnotes completes the articles.

222. McGowan, J.G., W.E. Heronemus, and G. Darkazalli. Wind and solar thermal combinations for space heating. Intersociety Energy Conversion Engineering Conference, 10th. New York, Institute of Electrical and Electronics Engineers, Inc., 1975, p. 974-980.
3, 6, 8

This paper presents the results of an analytical study that was carried out to model and determine the feasibility of a residential heating system for the Northeastern section of the United States, designed to be powered or augmented by a wind generator system. In addition to windpowered electrical resistance heating systems (with and without thermal energy storage), the possibility of combining these systems with a flat plate solar collector is investigated.

223. MacKillop, A. Wind power. Ecologist 5(1): 23-26, January 1975.
6

Economic and consumer prejudice weigh heavily against wider use of wind energy. Existing technology is very well proven; however, little is known about supplies of wind energy particularly at the local level. Limits to energy extraction from wind, energy available in wind, wind regimes, and windmill characteristics are discussed.

224. McLaughlin, M. Windmill power. McCalls 102(9): 39, June 1975.
4

225. Magnas, H.L. Solar energy projects of the federal government. NTIS, PB241620, January 1975. 151 p.
6

This report identifies 171 Solar Energy projects administered by 14 different Federal agencies between July 1973 and January 1975. Solar categories included are: Heating and cooling of buildings; wind energy conversion; solar thermal conversion; ocean thermal conversion; photovoltaic electric power systems; and bioconversion to fuels. An introductory chapter provides an overview and analysis of the Federal effort in Solar Energy and categorizes projects by agency, the amount of funding, and the major program areas. Appendices provide brief summaries of each of the 171 projects.

226. Manalis, M.S. Airborne windmills. Energy source for communication aerostats. American Institute of Aeronautics and Astronautics, Lighter than Air Technology Conference, Snowmass, Colorado, July 15-17, 1975. Paper 75-923. 19 p.
3, 8, 15

Practical systems are described which will enable the placing of an aerogenerator on communication aerostats. These tethered aerostats are high-altitude platforms for wide-area telecommunication and broadcast functions. The purpose of this effort is to investigate the use of airborne windmills to increase the operational availability of the aerostat system. Preliminary calculations indicate that useful amounts of power could be generated economically without increasing the weight of the aerostat and without appreciably changing its angular position.

227. Manser, B.L. and C.N. Jones. Power from wind and sea--the forgotten panemone. Thermofluids Conference: Energy--Transportation, Storage and Conversion. Preprints of Papers. Brisbane, Australia, December 3-5, 1975. Sydney, Australia, Institute of Engineering, 1975. (National Conference Publ. No. 75/9) p. 37-41.

3, 6, 9

The Savonius rotor, a special form of panemone, has scientific application as a current velocity meter in hydrographic investigations, but its industrial users are limited at present to powering ventilators. The practical advantages of a machine of such extreme simplicity, and the uncertainty as to its performance or underlying principles of operation, led the Department of Mechanical Engineering of Queensland University to begin investigations into vertical-axis machines in general, and the Savonius rotor in particular. This paper reports some preliminary results. It is suggested that an extension of the Savonius rotor geometry leads to a multiblade rotor, resembling the cross-flow fan or the Banki turbine.

228. Marshall, W. Stretching energy independence. New Sci. 65(941): 695-697, March 20, 1975.

4

229. Marwitz, J. and R. Marrs. Locating areas of high wind energy potential by ERTS observations of aeolian geomorphology. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 353-355.

3, 6

The objective of the research is to test whether ERTS observations of aeolian geomorphology features can be used to locate areas of favorable wind energy conversion sites.

230. Mason, R.M., et al. Macro analysis of the potential for fuel savings using wind generators in a utility power grid. In: Modeling and Simulation. Vol. 6. Proceedings of the Sixth Annual Pittsburgh Conference, Pittsburgh, Pa., April 24-25, 1975. Part 1. Pittsburgh, Pa., Instrument Society of America, 1975, p. 121-126.

3, 6

Surveys of wind energy potential were conducted and an electric power grid model was developed to examine the potential of using wind energy as a means of conserving fuel. An economic interpretation of the results is presented.

231. Massart, G. Utilisation de l'energie eolienne. [Utilization of wind energy.] Onde Electr. 55(4): 225-230, April 1975. (In French)
6

Utilization of wind energy, which is available in important quantities on the earth's surface, cannot be conceived without having a good idea of all the factors involved. The first part of this article sums up these factors, meteorological as well as technological. The second part is a quick survey of attempts to use wind energy on more or less large scale as well as of projects actually studied.

232. Mayo, L.H. Legal-institutional implications of wind energy conversion resources. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 385-391.
3, 4, 6

The principal concern of this unsolicited project is to examine the existing legal and institutional constraints on, and the corresponding changes necessary to optimize development of a variety of possible wind power configurations in certain defined social and geographical environments.

233. Meier, R.C. Concept selection and analysis of large wind generator systems. In: American Helicopter Society, Annual National Forum, 31st, Washington, D.C., May 13-15, 1975. Proceedings. New York, American Helicopter Society, Inc., 1975. 10 p.
3, 6, 7

The increasing need to develop alternative energy sources has renewed interest in the use of wind energy for the generation of utility quality electricity. This paper discusses a program to evolve a preliminary design of a cost competitive large wind generator system. An examination of a number of technically feasible alternative wind energy configurations is reported, and the rationale used in selecting the preferred system concept is presented. In addition, preliminary results of an optimization study conducted on the preferred concept are summarized. These show that considerable latitude in the selection of the system design parameters is possible. This permits design decisions to be based on other important factors such as development risk and the suitability of common component designs for systems with different power ratings.

234. Meier, R.C. Concept selection, optimization, and preliminary design of large wind generators. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 46-58.
3, 6, 7

A preliminary design of a large wind generator system for use by electric utilities is described. The conceptual design task covered the examination of a number of suitable WGS concepts, an evaluation of three of the most promising of these concepts, and the selection of the system concept which appeared to be most suitable for the utility application. The parametric analysis covered the development of a computer program capable of optimizing the system and its components, and the system optimization. The applications and requirements analysis identified with specific utility interface requirements of a WGS in a standard electric utility application, and estimated the cost goals necessary for the system to be competitive with conventional generation equipment. These three initial tasks have been completed, and the results are presented.

235. Meliss, M., D. Oesterwind, and A. Voss. Non-nuclear and non-fossil energy resources and their possibilities for future power generation. Kerntechnik 17(7): 301-306, July 1975.

6

This paper presents a brief survey of non-nuclear and non-fossil energy resources, besides the energy of solar radiation, which could be harnessed by mankind. The discussion covers geothermal and tidal energy, wind, wave and glacier energy, and oceanic heat, the potential and the location-dependence of these energy resources and the current status of technological development for their exploitation.

236. Mercadier, Y. and R. Camarero. A design method of optimum aerogenerator systems. U.S. National Conference on Wind Engineering Research, 2d, Fort Collins, Colorado, June 22-25, 1975. Conference Preprints. Fort Collins, Colorado State University, 1975, p. V-15-1 to V-15-3.

3, 5, 13

The aim of this paper is to describe a computerized method for the design of wind energy conversion systems. For the purpose of the study the systems are composed of three components: wind characteristics, wind turbine and energy converter.

237. Meroney, R.N. Sites for wind-power installations. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 344-352.

3, 6

The objective of this research is to increase technical capacity to locate favorable wind system sites, reduce uncertainty in the prediction or validation of the characteristics of sites, and thus assist in the sizing and performance prediction of wind systems. The research will include evaluation of low speed aerodynamics over terrain and boundary flow conditions over ridges and in valley exits to mountain barriers by means of modeling and analytic techniques.

238. Meroney, R.N. Sites for wind-power installations. U.S. National Conference on Wind Engineering Research, 2d, Fort Collins, Colorado, June 22-25, 1975. Conference Preprints. Fort Collins, Colorado State University, 1975, p. V-19-1 to V-19-3.
3, 6

The objective of this research is to increase technical capacity to locate favorable wind system sites, reduce uncertainty in the prediction or validation of the characteristics of sites, and thus assist in the sizing and performance prediction of wind systems. The research will include evaluation of low speed aerodynamics over terrain and boundary flow conditions over ridges and in valley exits to mountain barriers by means of modeling and analytic techniques.

239. Michaud, L.M. Proposal for the use of a controlled tornado-like vortex to capture the mechanical energy produced in the atmosphere from solar energy. Amer. Meteorol. Soc. Bull. 56(5): 530-534, May 1975.
5

The energy of the wind could be harnessed by controlling the atmospheric process so that wind energy is released at high intensity at selected locations. An engine consisting of a controlled tornado-like vortex is proposed.

240. Miller, R.H. Research on wind energy conversion systems. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 261-264.
3, 5

241. Minardi, J.E. and M. Lawson. Electrofluid dynamic (EFD) wind generator. U.S. National Conference on Wind Engineering Research, 2d, Fort Collins, Colorado, June 22-25, 1975. Conference Preprints. Fort Collins, Colorado State University, 1975, p. V-6-1 to V-6-3.
3, 14

242. Minardi, J.E. and D.H. Whitford. The Madaras rotating cylinder concept for electric power generation. U.S. National Conference on Wind Engineering Research, 2d, Fort Collins, Colorado, June 22-25, 1975. Conference Preprints. Fort Collins, Colorado State University, 1975, p. V-7-1 to V-7-3.
3, 6. 14

Analytical, wind tunnel, and full scale studies of a novel wind powered electrical generating plant were conducted in the 1930-1934 time period. This system, invented by Julius

Madaras, using the Magnus force generated by rotating, vertically mounted cylinders to propel an endless train around a closed track. Generators geared to the car axles produced the electric power. The system was proven to be technically feasible, and preliminary cost figures were encouraging. The project was discontinued due to the lack of funds in the depression years. The system concept is presented along with current results from our study including performance data and cost estimates of the Madaras rotor system.

243. Moran, E. Gary Bregg: windpower in a drum. Pop. Sci. 207(2): 104-105, August 1975.

4, 12b

Gary Bregg's S-rotor is described.

244. Moreland, W.B. An application of a hydrodynamic wind model to wind energy prospecting in mountainous terrain. U.S. National Conference on Wind Engineering Research, 2d, Fort Collins, Colorado, June 22-25, 1975. Conference Preprints. Fort Collins, Colorado State University, 1975, p. V-18-1 to V-18-4.

3, 6

The capability to extrapolate wind data into areas where measurements are not available is vital to the selection of wind energy conversion sites. There is an urgent need to develop techniques that may be employed in evaluating, accurately and efficiently, the wind power potential of candidate wind energy conversion sites.

245. Morgan, H.O. Wind energy research. U.S. National Conference on Wind Engineering Research, 2d, Fort Collins, Colorado, June 22-25, 1975. Conference Preprints. Fort Collins, Colorado State University, 1975, p. V-27-1.

3, 4

Considerable research has been done on wind turbines throughout the past several hundred years. Some design relationships are pointed out along with other research developments.

246. Morgan, M.G., ed. Energy and man: technical and social aspects of energy. N.Y., IEEE, 1975. 521 p.

2, 4

This book includes a wide ranging collection of reprints of articles and technical reports dealing with the technical aspects of energy crisis. Although the greatest emphasis is on electrical energy, it includes geothermal, solar, wind, and oceanic sources.

1975

247. Morino, L. Nonpotential aerodynamics for windmills in shear-winds. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 229-233.
3, 5

A new formulation is presented for nonpotential (viscous and inviscid) tridimensional incompressible aerodynamic flow, with application to windmills in shear winds.

248. Mulcahy, M.J. Working Group H. Interface with utilities and users. [Report] In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 502-507.
3, 4, 6, 13

249. Muraca, R.J. Working Group F. Computer models/system design. [Report] In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 491-497.
3, 6, 13

250. Muraca, R.J., M.V. Stephens and J.R. Dagenhart. Theoretical performance of cross-wind axis turbines with results for a catenary vertical axis configuration. National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va. NASA-TM-X-72662. NTIS, N76-11032, October 1975. 85 p.
5, 9

A general analysis capable of predicting performance characteristics of cross-wind axis turbines was developed, including the effects of airfoil geometry, support struts, blade aspect ratio, windmill solidity, blade interference and curved flow. The results were compared with available wind tunnel results for a catenary blade shape. A theoretical performance curve for an aerodynamically efficient straight blade configuration was also presented. In addition, a linearized analytical solution applicable for straight configurations was developed. A listing of the computer program developed for numerical solutions of the general performance equations is included in the appendix.

251. NASA awards contracts for design of windmill generators. Space World L-3-135: 33-34, March 1975.
4

252. Nassar, E.M. Model study of the reciprocating wind machine. U.S. National Conference on Wind Engineering Research, 2d, Fort Collins, Colorado, June 22-25, 1975. Conference Preprints. Fort Collins, Colorado State University, 1975, p. V-5-1 to V-5-3.
3, 5

In this report the concept of the linearly moving, reciprocating airfoil cascade is being introduced as a possible means for the conversion of wind energy into useful mechanical energy. A small scale model of the reciprocating wind machine has been built and tested. The results assert the technical feasibility of the concept. Because of its inherent geometrical properties, the machine possesses a strong potential for use in urban areas as well as other conventional wind sites. Currently, the research efforts at the IIT aim at measuring the output power of the machine, estimating its efficiency and establishing means for further improvements.

253. Niemi, E.E. Transient response of wind power generators to wind gusts. U.S. National Conference on Wind Engineering Research, 2d, Fort Collins, Colorado, June 22-25, 1975. Conference Preprints. Fort Collins, Colorado State University, 1975, p. V-17-1 to V-17-3.

3, 5

This paper addresses itself to the turbulence scale of wind variability and describes some ongoing research and results obtained to date. To develop some insight into the effects of wind gusts on wind turbine behavior a representative wind generator configuration is chosen, and the transient response of the turbine to axial wind gusts is examined using analytical methods.

254. Noll, E.M. Wind/solar energy for radio communications and low-power electronic/electric applications. Indianapolis, Indiana, H.W. Sams, 1975. 208 p.

2, 8, 15

255. Olsson, L.E., O. Holme, and R. Kreig. Wind characteristics and wind power generation: a three year meteorological program in Sweden. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 336-340.

3, 6

A three year program for studies of meteorological aspects of wind power has been initiated in Sweden. The objective of the program is to provide a scientific base for evaluating the potential for wind energy conversion in Sweden. This includes preparation of meteorological-aerodynamic base-material for construction and site evaluation as well as studies of alternative optimal groupings and performance characteristics of various wind energy conversion systems to be used in a local, regional and national scale.

256. Oman, R.A. and K.M. Foreman. Cost effective diffuser augmentation of wind turbine power generators. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 426-432.

3, 5, 6, 10

The Diffuser-Augmented Wind Turbine (DAWT) concept to be developed in this project is aimed at increasing the output and reducing the cost, the off-duty time, and the technical risk of large wind turbine systems for commercial power production. Rotors 100 feet in diameter and larger, encased in diffuser shrouds, with the shroud supports functioning as a variable stator stage ahead of the rotor are studied. The stator blades have trailing edge flaps that need no pitch or speed change to accommodate the wind speed variations. The goals of the project are to demonstrate large aerodynamic augmentation with very compact diffusers, design and compute the performance of stator/rotor systems that give efficient performance at precisely constant rotational speeds over a broad wind range with fixed-pitch rotors, and to establish cost comparisons for these and competitive wind systems.

257. Ormiston, R.A. Dynamic response of wind turbine rotor systems. In: American Helicopter Society, Annual National Forum, 31st, Washington, D.C., May 13-15, 1975. Proceedings. New York, American Helicopter Society, Inc., 1975. 9 p.

3, 5

The basic response characteristics of wind turbine rotor blades are developed using elementary analytical techniques. The uncoupled flapping response to the vertical gradient of wind, crosswind, rotor shaft yaw precession, and gravity forces; and the uncoupled lead-lag response to gravity forces are treated. The influence of blade number and hub articulation on blade loads and tower loads is examined and basic scaling relationships are discussed.

258. Park, J. Simplified wind power systems for experimenters. 2d ed. Sylmar, Cal., Helion, 1975. 80 p.

2, 5, 12a

This book covers basics to exotica gently yet completely in workbook format with example problems next to clear drawings and graphs.

259. Parker, A. World energy resources: a survey. Energy Pol. 3(1): 58-66, May 1975.

4

Information contained in the detailed publication "World Energy Conference Survey of Energy Resources 1974" is summarized.

Resources of coals and lignites, peat and noncommercial fuels, petroleum, natural gas, hydraulic energy, nuclear energy, geothermal energy, tidal power, ocean thermal gradients, wind power, and solar energy are reviewed. The coal equivalent of world annual energy consumption rose from 4707 MT in 1963 to 7410 MT in 1972, that is, by 54.7% in 10 years. Per capita consumption of energy per annum increased by 33% in the same period.

260. Parvin, B. The sun, the wind, and the warrior. New Zealand Energy J. 48(11): 245-247, November 25, 1975.

4

Solar energy and its basic problems are surveyed in Australia, the U.S., and New Zealand. Wind power is discussed as an energy source for New Zealand.

261. Pelser, J. Wind energy research in the Netherlands. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 188-195.

3, 6

The research and development programs for wind turbine generators in the Netherlands are reviewed.

262. Porch, W.M. and S.S. Sussman. Preliminary feasibility study on using Doppler Lidar wind measurements for wind-power prospecting. California University, Lawrence Livermore Lab. NTIS, UCID-16967, December 4, 1975. 15 p.

6

A preliminary feasibility study indicates that present laser transmitters and receivers are capable of ranges applicable to wind-power prospecting and site surveying. This study shows that a CO_2 laser system is preferable, given present technology. However, in tropical areas, such as Oahu, Hawaii, the advantages of the CO_2 system are somewhat reduced due to absorption by water vapor, although they still outweigh present visible laser systems.

263. Proposal for the use of a controlled tornado-like vortex to capture the mechanical energy produced in the atmosphere from solar energy. Am. Meteorol. Soc. Bull. 56(5): 530-534, May 1975.

5

An engine consisting of a controlled tornado-like vortex to harness the energy of the wind by controlling the atmospheric process, so that wind energy is released at high intensity, is described. Based on an average of 10 w/sq m, the amount of mechanical energy produced in the atmosphere is 5100 TW, while that of humans is 10 TW. Control of the atmospheric engine could make the vast amount of mechanical energy being produced in the atmosphere available to do useful work.

264. Pruyn, R.R., W. Wiesner and P.G. Sulzer. Performance and structural design aspects of a one-bladed electric-power-generating windmill. In: American Helicopter Society, Annual National Forum, 31st, Washington, D.C., May 13-15, 1975. Proceedings. New York, American Helicopter Society, Inc., 1975. 9 p.
3, 5, 6

Design approaches to electric-power-generating windmills that may achieve economically attractive cost of energy are discussed. Innovative approaches to the design of the three highest cost components; rotor, gearbox, and tower are presented. Advantages of the one-bladed rotor are shown. The importance of rotor hub articulation is discussed. Sizing of the windmill so that there can be an adequate market to justify production is also considered. The need for standardization in assumptions made in the accounting aspects of cost analyses, and the requirements for wind prospecting to determine with assurance the geographic areas that have sufficient wind are shown.

265. Puthoff, R.L. Status of 100 kW experimental wind turbine generator project. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 21-35.
3, 5

The Energy Research and Development Administration and the NASA Lewis Research Center have engaged jointly in a Wind Energy Program which includes the design and erection of a 100 kW wind turbine generator. This test machine consists of a rotor turbine, transmission, shaft, alternator, and tower. The rotor, measuring 125 feet in diameter and consisting of two variable pitch blades, operates at 40 rpm and generates 100 kW of electrical power at a wind velocity of 18 mph. The entire assembly is placed on top of a tower 100 feet above ground level. The machine is currently in the assembly phase and will be ready for operation in August 1975.

266. Puthoff, R.L. and P. Sirocky. The 100 kW experimental wind turbine generator project. Presented at the Wind Energy Workshop, Washington, D.C., June 11, 1975. NTIS, N75-29546, 1975. 19 p.
3, 14

The Energy Research and Development Administration and the NASA Lewis Research Center engaged jointly in a Wind Energy Program which included the design and erection of a 100 kW wind turbine generator. This test machine consists of a rotor turbine, transmission, shaft, alternator, and tower. The rotor, measuring 125 feet in diameter and consisting of two variable pitch blades, operates at 40 rpm and generates 100 kW of electrical power at a wind velocity of 18 mph. The entire assembly is placed on top of a tower 100 feet above ground level. The machine was scheduled to be ready for operation in August 1975.

267. Quinn, P.J. Wind turbine. U.S. Patent No. 3,902,072. August 26, 1975. 8 p.

5, 17

A wind power generator is described which has a horizontally rotatable platform with a plurality of vertical blades mounted around its periphery, all of the blades rotating coaxially around a central axis and each rotating on its own axis. The vertical blade rotation is responsive to changes in wind direction, as well as to changes in wind velocity and the rotation of each blade is controlled in such manner that through about three quarters of the platform rotation power is absorbed from the wind, while during the remaining period in which the blades are traveling against the wind, the blades will be substantially in phase with the wind for minimum resistance.

268. Radcliff, S.V. Design for an energy self-sufficient community. In: 21st annual technical meeting of the Institute of Environmental Sciences. Vols. I and II. Mt. Prospect, Ill., Institute of Environmental Sciences, 1975, p. 180-182.

3, 4

269. Ramakumar, R. Continuous duty solar energy system concepts. Intersociety Energy Conversion Engineering Conference, 10th. New York, Institute of Electrical and Electronics Engineers, Inc., 1975, p. 759-764.

3, 6

Two continuous-duty solar energy system concepts are presented in this paper--one for the near term future (1980's) and one for the long term future (1990's and beyond). These systems have evolved as a result of a cumulative research effort at Oklahoma State University, spread over a decade and a half. Technical and economic aspects of these systems are discussed.

270. Ramakumar, R. Development and adaptation of field modulated generator systems for wind energy applications. In: Workshop on Wind Energy Conversion Systems, 2d., Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 279-289.

3, 14

The plans are summarized for the development and adaptation of field modulated generator systems for wind energy applications to be undertaken at Oklahoma State University under a National Science Foundation Grant No. AER 75-00647.

1975

271. Ramakumar, R. Harnessing wind power in developing countries. Intersociety Energy Conversion Engineering Conference, 10th. New York, Institute of Electrical and Electronics Engineers, Inc., 1975, p. 966-973.

3, 6

This paper discusses the possibilities of harnessing wind power in developing countries to mitigate the burdens imposed by high price of imported fuel and to augment total energy supply. Special emphasis is given to the use of variable-speed constant-frequency field modulated generator systems to tap wind energy in constant frequency ac form for use in conjunction with conventional utility systems and with isolated conventional generating units.

272. Ramakumar, R., H.J. Allison and W.L. Hughes. Economics of solar and wind energy systems for large scale power generation. In: Energy-Engineering-Environment. Annual Frontiers of Power Technology Conference, 7th, Stillwater, Okla., October 9-10, 1974. Proceedings. Stillwater, Oklahoma, Oklahoma State University, 1975, p. 11-1 to 11-21.

3, 6, 7

A case is made for the continued development of solar and wind energy systems to provide viable alternatives to fossil fuels in the years to come. A simplified economic analysis of solar and wind energy systems of the type being developed at Oklahoma State University is presented and the calculated generation costs in mills per kWh are compared with those of conventional fuel-burning systems for different fuel costs, load factors and interest rates. The results show that certain aspects of solar and wind energy conversion can, at present, generate energy at costs competitive with conventional systems and that more favorable conditions can be expected in the future as fossil fuels become scarce and fuel costs further go up as predicted.

273. Ramakumar, R., H.J. Allison and W.L. Hughes. The Oklahoma State University wind energy research program. U.S. National Conference on Wind Engineering Research, 2d, Fort Collins, Colorado, June 22-25, 1975. Conference Preprints. Fort Collins, Colorado State University, 1975, p. V-26-1 to V-26-3.

3, 4, 6

A vigorous research and development program was started in 1960 at OSU to investigate the possibility of tapping non-depletable energy sources such as solar and wind energy to provide a viable alternative to fossil fuels. The effort in the area of wind energy has resulted in the construction of a prototype windmill farm pumping 60 Hz ac energy into an existing power line using variable-speed constant-frequency field-modulated generator systems. This research report summarizes these activities and discusses the economic future of wind energy systems.

1975

274. Ramakumar, R., H.J. Allison and W.L. Hughes. Solar energy conversion and storage systems for the future. IEEE Trans. Power Appar. Syst. 94(6): 1926-1934, November-December 1975.

4, 11

Solar energy research under way at Oklahoma State University in solar energy technology is discussed. Several components required to engineer a continuous duty power system from intermittent energy sources, such as solar radiation and wind energy, have been developed. A solar energy storage system for the future is outlined, and the economics of such a system are presented. Present methods of solar energy collection, conversion, storage, and utilization are reviewed. Appendixes include energy storage comparisons, properties of hydrogen, electrolysis data, and information on wind power.

275. Ramakumar, R. and W.L. Hughes. An assessment of solar and wind energy from the electric utility viewpoint. In: Energy-Environment-Engineering; Proceedings of the Eighth Annual Frontiers of Power Technology Conference, Stillwater, Oklahoma, October 1-2, 1975. Stillwater, Oklahoma, Oklahoma State University, 1975, p. 14-1 to 14-16.

3, 6

The paper discusses briefly the prospects of several technologies for supplementing energy resources in the coming decade, including wind energy, biomass, solar thermal conversion, ocean thermal gradient systems, and photovoltaic conversion, and then gives an assessment of solar and wind energy economics. Break-even capital cost limits for solar and wind energy systems have been calculated for different fuel costs, interest rates, and load factors. The necessity of the electric utility sector to look into such variable power sources as solar and wind is expressed.

276. Ramakumar, R. and W.L. Hughes. Electrical technology overview and research at Oklahoma State University as applied to wind energy systems. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 265-278.

3, 4, 5

A brief overview is presented of the electrical technology research associated with wind energy conversion systems. Salient features of the research work at Oklahoma State University as applied to wind energy systems sponsored by NSF/RANN Grant GI-39457 are also included.

277. Ramakumar, R., W.L. Hughes and H.J. Allison. Wind energy utilization prospects. Annual Technical Meeting of the Institute of Environmental Sciences, 21st, Anaheim, Cal., 1975. Proceedings. Mt. Prospect, Ill. Institute of Environmental Sciences, 1975, p. 138-142.

3, 6

The chief technical, economic, and environmental aspects of wind energy utilization are considered. One approach being studied is to allow the aeroturbine RPM to vary with wind velocity and employ variable-speed constant-frequency generating systems to obtain constant-frequency power to be pumped into existing utility mains. Study of generation costs for wind energy systems indicates that wind energy has the potential to be competitive at present as a supplemental energy source. Wind energy systems appear to be environmentally benign, though more research is needed on the impact of large scale wind energy utilization.

278. Reaping the wind. Mach. Des. 47: 28-29, November 13, 1975.
4

279. Red Rocker, W. Winnie Red Rocker reports. Wind Power Dig. 1(1): 28, January 1975.
4, 12a

The author describes work with a small wind machine made from a twelve volt car generator.

280. Reed, J.W. Some climatological estimates of wind power availability. U.S. National Conference on Wind Engineering Research, 2d, Fort Collins, Colorado, June 22-25, 1975. Conference Preprints. Fort Collins, Colorado State University, 1975, p. V-16-1 to V-16-3.
3, 6

The Western Great Plains experiences a great flux of wind power that might be exploited. Even with conservative assumptions about collection efficiency, the supply exceeds total national demands by a factor of at least two. Wind speed increases with height above the ground friction layer, so that very large turbines, 30-60 m in diameter, could capture even more energy than shown by weather station anemometer data.

281. Reed, J.W. Wind climatology. Sandia Labs., Albuquerque, New Mexico. SAND-75-5531. NTIS, CONF-750615-1, 1975. 8 p.
5, 6

National assessments were made to find suitable test and evaluation locations. Detailed analyses have begun of specific station records to derive parametric relationships needed for turbine design. Characteristics of long wind-speed time-series will determine selection criteria for cut-in, cut-off, and rated speed, as well as storage system dimensions.

282. Reed, J.W. Wind climatology. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 319-325.
3, 5, 6

National assessments were made to find suitable test and evaluation locations. Detailed analyses have begun of specific station records to derive parametric relationships needed for turbine design. Characteristics of long wind-speed time-series will determine selection criteria for cut-in, cut-off, and rated speed, as well as storage system dimensions.

283. Reed, J.W. and B.F. Blackwell. Some climatological estimates of wind power availability. Sandia Labs., Albuquerque, New Mexico, SAND-75-5295. NTIS, CONF-750602-1, 1975. 6 p.

6

The Western Great Plains experiences a great flux of wind power that might be exploited. Even with conservative assumptions about collection efficiency, the supply exceeds total national demands by a factor of at least two. Wind speed increases with height above the ground friction layer, so that very large turbines, 30 to 60 m in diameter, could capture even more energy than is shown by weather station anemometer data.

284. Refining wind power. Mech. Illus. 71: 20, 22, May 1975.

4

285. Reichle, L.F.C. The economics of nuclear power. Ebasco News 28(5): 22-31, September-October 1975.

6

Energy conservation can make some contribution to solving the energy problem, but the U.S. standard of living cannot be increased or even maintained by using less energy per capita. Coal and nuclear power are the only feasible fuels for additional and replacement central station power in this century and possibly for some time thereafter. Even with a maximum effort, less natural gas and oil will be produced in 10-20 years than in 1975. Solar and fusion power utilization will be well beyond the year 2000, while geothermal and wind power have only limited potential. Synthetic gas and oil and shale oil, much of which may be environmentally unacceptable, will be very expensive. Nuclear energy, the least expensive alternative, is safe, reliable, and environmentally acceptable. Congress, the federal government, and state agencies should unshackle its development.

286. Reitan, D.K. Progress report on employing a non-synchronous AC/DC/AC link in a wind-power application. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 290-297.

3,5

This report is concerned with the experimental electrical work to date regarding building a 20 kW non-synchronous variable frequency input-fixed frequency output AC/DC/AC three-phase to single phase link.

287. Remarks by wrap-up panel. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 514-522.

3, 4, 6, 13

288. Report of Task Force on Wind Energy. Report to the Committee on Alternate Energy Sources for Hawaii, March 1975.

6

289. Report to the Secretary of the Interior. Energy Commun. 1(1): 57-103, 1975.

4

The government and the public must have a good understanding of the position and problems that the nation faces with respect to energy. The U.S. has sufficient potential energy resources from most sources to rely on continuing expansion of production as required to meet growing needs and to remain largely self-sufficient in energy, provided that the nation follows policies designed to achieve that objective. The current position, development problems, outlook for, and recommendations involving wind, solar, and tidal energy, petroleum liquid fuels, natural gas, coal, hydroelectric power, nuclear energy, synthetic oils, and synthetic gas are summarized.

290. Review of Project Independence. Blueprint-Panel Sub-Committee Reports on FEA-Interagency Task Forces. Commerce Technical Advisory Board, Washington, D.C. Report on CTAB Recommendations for a National Energy Program. Sub-Committee Working Documents. NTIS, COM-75-10500, 1975. 308 p.

4, 6

Data, assumptions, and background information used to develop Project Independence Blueprint are discussed. Topic areas covered include: Energy demand/conservation; Coal; Oil, Natural gas; Nuclear energy; Future energy sources; Oil shale; Transportation; Water and environment; Human resources; Finance; and Materials, equipment, and construction.

291. Robinson, J.P. Is the answer to the energy crisis blowin' in the wind? Ocean Ind. 10(1): 37-39, January 1975.

4, 6

The ability of a wind plant to capture power from the wind is discussed. Wind-driven power generators work; the key is how to get the costs down to make them competitive with other energy sources. Large capacity wind plants are more economical, but large wind plants in existence are primarily research models. A wind plant built to develop 1000 kW might cost $3.5 million; 4880 windmills would be required on offshore platforms to supply the same annual energy total as one 12,000 BPD oil platform.

292. Rogers, S.E. Environmental effects of wind energy conversion systems? In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 375-379.

3, 4, 6

A Battelle study designed to evaluate and give some answers regarding environmental impact of wind energy conversion systems is described.

293. Rohrbach, C. Experimental and analytical research on the aerodynamics of wind turbines. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 239-246.

3, 5

This aerodynamic research program is aimed at providing a reliable, comprehensive data bank on a series of wind turbines covering a broad range of prime aerodynamic and geometric shape variables. Such data obtained under controlled laboratory conditions on turbines designed by the same method, of the same size, and tested in the same wind tunnel are currently not available in the literature. Moreover, this research program is further aimed at providing a basis for evaluating the adequacy of existing wind turbine aerodynamic design methodology, for assessing the potential of recent, advanced theories, and for indicating the need for further method development and refinement.

294. Rohrbach, C. and R. Worobel. Performance characteristics of aerodynamically optimum turbines for wind energy generators. In: American Helicopter Society, Annual National Forum, 31st, Washington, D.C., May 13-15, 1975. Proceedings. New York, American Helicopter Society, Inc., 1975. 10 p.

3, 5

This paper presents a brief discussion of the aerodynamic methodology for wind energy generator turbines, an approach to the design of aerodynamically optimum wind turbines covering a broad range of design parameters, some insight on the effect on performance of nonoptimum blade shapes which may represent lower fabrication costs, the annual wind turbine energy for a family of optimum wind turbines, and areas of needed research.

On the basis of the investigation, it is concluded that optimum wind turbines show high performance over a wide range of design velocity ratios; that structural requirements impose constraints on blade geometry; that variable pitch wind turbines provide excellent power regulation and that annual energy output is insensitive to design rpm and solidity of optimum wind turbines.

295. Romanelli, P.J. Electrical generating equipment and electric utility requirements for high-power wind generator systems. Intersociety Energy Conversion Engineering Conference, 10th. New York, Institute of Electrical and Electronics Engineers, Inc., 1975, p. 1251-1257.
3, 6, 7

The National Science Foundation and NASA's Lewis Research Center are cooperating on a five-year Wind-Energy Program, the objective of which is to provide the technology for cost competitive wind-driven electric-power generation. The five-year program provides for development of large scale (100--3000 kW) systems and advancing technology via supporting research and technology. General Electric under contract to NASA-Lewis (NAS 3-19403) is involved in one aspect of this effort. This contract covers conceptual design, parametric analyses and preliminary design of Wind Generator Systems (WGS) for electric utility applications. In conceptual design, various approaches were investigated and trade-offs conducted to determine the most cost effective designs. Parametric analyses have been conducted to optimize the design and determine the cost sensitivity of the design to the parameters over the range of powers considered. Preliminary design will define system detail and provide more accurate performance and cost analyses.

296. Salieva, R.B. Technico-economic analysis of the utilization of inexhaustible energy sources. Geliotekhnika No. 5: 52-57, 1975. (In Russian)
6

An economic analysis is conducted concerning the design, construction and utilization of solar power plants and wind power plants. Methods are presented for determining operational costs, for reducing them, and for calculating the real cost of producing solar and wind energy. Criteria are presented for selecting cost-optimal output power.

297. Salter continues RD-7000 research. Wind Power Dig. 1(2): 30, Summer 1975.
4

The RD-7000 prototype turbine designed by E.L. Salter is described.

1975

298. The Salter RD-7000 wind turbine. Mother Earth News, No. 32: 104, March 1975.

8, 12b

Described is Edmund L. Salter's turbine, being developed by Wind Power Systems, Inc. of San Diego. The turbine can produce 7,000 watts of 120-volt current in a 25-28 mph wind and a maximum of 1000 watts at 32 mph. The unit should provide enough electricity to run a single family home in any location with a minimum average yearly wind velocity of 8 mph.

299. Savino, J.M. Introduction to wind energy conversion systems technology. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 197-201.

3, 4

NASA's wind research is discussed.

300. Savino, J.M. Wind power. In: Solar Energy for Earth, an AIAA Assessment. Edited by H.J. Killian, G.L. Dugger, and J. Grey. Sponsored by the AIAA Technical Committee on Electric Power Systems. New York, AIAA, April 21, 1975, p. 72-81.

4

A historical background on windmill use, the nature of wind, wind conversion system technology and requirements, the economics of wind power and comparisons with alternative systems, data needs, technology development needs, and an implementation plan for wind energy are presented. Considerable progress took place during the 1950's. Most of the modern windmills feature a wind turbine electricity generator located directly at the top of their rotor towers.

301. Savino, J.M. and F.R. Eldridge. Wind power. Astronaut. Aeronaut. 13(11): 53-57, November 1975.

4, 6

Small numbers of wind-energy power plants can serve locales, and conceivably, after suitable demonstrations and development for mass production, could be built and emplaced at a capacity equivalent to a 1000-MW conventional plant's in a much shorter time than the conventional plant.

302. Schmidt, F.H. Meteorological aspects of energy production. Ned. Tijdschr. Natuurkd. 41(12): 171-177, 1975.

6

The use of solar radiation and wind as sources of energy in Holland is discussed. The changes in wind speed with altitude and the resultant changes in energy are calculated and temperature changes owing to variations in the CO_2 concentration of the atmosphere are determined.

303. Seath, D.D. Testing a wind generator rotor. U.S. National Conference on Wind Engineering Research, 2d, Fort Collins, Colorado, June 22-25, 1975. Conference Preprints. Fort Collins, Colorado State University, 1975, p. V-4-1 to V-4-3.
3, 5

The purpose of this paper is to describe the design, construction and operation of a wind generator rotor test trailer.

304. Sevier, H.G. Wind-power turbine development and application. In: The Potential of Solar Energy for Canada, Conference of the Solar Energy Society of Canada, Inc., Ottawa, June 2-3, 1975. Ottawa, Solar Energy Society of Canada, 1975, p. V45-53.
3, 8, 9

This paper describes a vertical-axis wind turbine developed by Bristol to provide power for an automatic weather station on a Beaufort Sea ice island. The vertical-axis layout was selected since it meets the operational requirements for compact shipment, east of assembly, ruggedness, and high reliability in a harsh environment. The 8.7 foot diameter Bristol windmill is designed to start in a 10 mph wind, deliver one kilowatt of mechanical power from a 25 mph wind, and structurally withstand winds up to 100 mph. The turbine shaft is direct-coupled to a unique form of alternator that has negligible starting torque, and achieves optimum operation in the 100-200 rpm range. The windmill is mounted in a special support frame that permits installation on essentially unprepared sites with a minimum of assembly tools and labor, and using a very simple foundation.

305. Sforza, P.M. Harnessing a "tornado." Mech. Eng. 97(10): 65, October 1975.
4, 5

A jet-age, "super-windmill" that can produce five times more electric power than existing wind-energy systems has been invented by Pasquale M. Sforza, at Polytecnic Institute of New York.

306. Sforza, P.M. Vortex augmentor concepts for wind energy conversion. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 433-442.
3, 5

Suitably designed aerodynamic surfaces are used to generate tornado-like vortical concentration of the natural wind.

These surfaces are configured in such a way as to direct the aerodynamic vortices to an appropriately designed rotor system for the purpose of transforming the energy of the wind to shaft work. Such a system constitutes the Vortex Augmentor Concept (VAC). An illustration of the VAC is given. A triangular, or delta, aerodynamic surface at an angle of attack to the wind will generate vortices by leading edge separation of the flow. The contribution of the vortices to the total lift coefficient on such a delta surface is shown.

307. Sharman, H. Wind and water sources of energy in the U.K. Energy Options in the U.K., Symposium, London, March 1, 1975. London, Latimer New Dimens Ltd., 1975, p. 51-64.

3, 6

A survey of the development of tidal water sources and wind power generating plants is presented.

308. Shumann, W.A. Wind generator study funds sought. Aviat. Week 102: 57-58, January 13, 1975.

4, 9

The vertical-axis generator running at Sandia Laboratories in Albuquerque, N.M., is described.

309. Simon, A.L. Energy resources. New York, Pergamon Press, 1975. 165 p.

2, 4

This book on energy resources contains a chapter on wind power.

310. Sladky, J. and P. Klimas. Aerodynamics of the Savonius rotor. U.S. National Conference on Wind Engineering Research, 2d, Fort Collins, Colorado, June 22-25, 1975. Conference Preprints. Fort Collins, Colorado State University, 1975, p. V-3-1 to V-3-2.

3, 5, 10

This paper represents a summary of a continuing study of high solidity ratio cross-flow rotors in general, and the Savonius rotor in particular. At present the problem is approached from both the theoretical as well as the experimental viewpoints. An analytical model is being developed which will account for the variations of forces with the angle of rotation. The experimental study concentrates on geometric relationships of the rotor elements and on optimizing the blade configuration. The effect of various performance enhancing devices such as shrouds is also being examined.

311. Smidth, F.L. Instructions for the FLS aeromotor. Translated from the Danish report Memo 7050, date unknown. Translation: Kanner Associates, Redwood City, Cal., N75-16075. NTIS, January 1975. 28 p.

5, 14

A comprehensive study of the complete system necessary for the conversion of wind power to electrical power is reported. Complete descriptions of the propeller, gear system, dynamo, starter propeller, and braking mechanism are given, as they relate to the system manufactured by F. L. Smidth and Co. of Denmark. Complete instructions for the operation and maintenance of the system are given. The safety systems and an overall view of the system's operation are also presented. Diagrams showing the entire system in detail are included.

312. Smith, M.C. Wind power system optimization. Intersociety Energy Conversion Engineering Conference, 10th. New York, Institute of Electrical and Electronics Engineers, Inc., 1975, p. 1258-1263.

3, 6

It is shown that wind power system optimization can be achieved by consideration of the four quantities of average annual energy extracted, wind statistics, efficiency of conversion of wind energy to shaft rotation energy and the cost characteristics of the wind interaction elements (blades), the electric generator and the remaining system components. The problem reduces to the determination of two dimensionless parameters as a function of the wind statistics. These parameters determine the optimum blade diameter and the generator size. Example wind statistics and an example optimization problem are given.

313. Smith, R.T. and C.E. Burton. Effect of wind harmonic and gust torques on induction generators. Part 1. ASME Paper 75-WA/Pet-4, 1975.

5, 14

This paper presents a method of direct simulation of induction generator performance for calculation of responses to applied shaft torques arising from harmonics caused by tower shadow, wind variations, and other disturbances to a wind-powered turbine. Wind-gust induced torques are also applied to the induction generator, inertia model. It is shown that typical values of machine parameters and wind data result in stable operation of the generator. The approach can easily be extended to include refinements and detailed representations of the mechanical system.

314. Smith, R.T. and T.S. Jayadev. Electrical generation by wind power. Intersociety Energy Conversion Engineering Conference, 10th. New York, Institute of Electrical and Electronics Engineers, Inc., 1975, p. 1246-1250.
3, 6, 7

Considerable attention is now being given to investigate wind energy as a supplemental source to meet the growing energy demands. NASA is conducting proof-of-concept experiments and is currently designing a 100 kw system. Large wind generating stations (WGS) of the sizes of 1000 kw to 10,000 kw are contemplated, although most of the wind power plants of the past were of small sizes (say less than 10 kw), pumping water or generating electricity in conjunction with battery storage. This paper discusses some electric generation schemes for large wind power plants (of capacities of 1000 kw or more) which may be suitable for interconnection with a power grid.

315. Solar energy sources list, March 1975. Manufacturers, designers, and builders. Washington, D.C., National Wildlife Federation, 1975. 13 p.
2

316. Some small innovators heat homes by sun, light them by wind. Wall St. J., March 18, 1975, p. 1.
4, 8

For a small group of architects, engineers, and innovators, energy independence is not just a political platitude but a reality. Their homes are outfitted with various devices to produce and preserve energy. All employ equipment to capture heat from the sun, and some use windmill generators to provide electricity. Homemade heat is stored in large water tanks, in rocks under the floor, or in concrete walls. These efforts are privately funded since federal research money is not directed toward energy conservation at the family level.

317. Sondak plans wind museum. Wind Power Dig. 1(2): 16, Summer 1975.
1, 4

318. Sorensen, B. Energy and resources. Science 189(4199): 255-260, July 25, 1975.
6

Since World War II Denmark has developed a 90% dependence on oil from the Middle East. The country has practically no nonrenewable energy sources. A plan based on potential renewable energy resources of Denmark through which solar and wind energy would supply the nation's needs by the year 2050 is outlined. Solar and wind energy systems and requirements are described. The project is economically feasible according to estimates of the cost of various alternatives during the 25 year depreciation period adopted. However, initial cost per energy unit produced is higher than that for most alternatives, so action due to purely private initiative is not expected.

319. Soucie, G. Plugging in the oceans for future energy needs. Audubon 77(5): 115-122, September 1975.

6

Energy resources of the sea include offshore winds, ocean thermal differences, tides, ocean currents, waves, salinity gradients, and the extraction of hydrogen, fusion fuel, and phytoplankton for synthetic fuel production. The potentials of these resources vary considerably in magnitude, harnessability, geographic applicability, practicability, and environmental impact.

320. Special wind plant section. Mother Earth News, No. 32: 99-104, March 1975.

4, 12a

This special section includes notice of a windplant design service, a new newsletter, and several articles, which are indexed individually in this bibliography.

321. Spera, D.A. Structural analysis of wind turbine rotors for NSF-NASA mod-0 wind power system. NASA Lewis Research Center. NASA-TM-X-3198. N75-17712. NTIS, March 1975. 39 p.

5

Preliminary estimates of vibratory loads and stresses in hingeless and teetering rotors for the proposed 100 kW wind power system are presented. Stresses in the shank areas of the 19-m (62.5-ft) blades are given for static, rated, and overload conditions. The teetering rotor has substantial advantages over the hingeless rotor with respect to shank stresses, fatigue life, and tower loading. A teetering rotor will probably be required in order to achieve a long service life in a large wind turbine exposed to periodic overload conditions.

322. Spierings, P.A.M. and M.C. Cheney. Application of composite bearingless rotor concept to wind turbine rotor. Progress Report, June 3, 1975 - October 31, 1975. NTIS, COO-2614-1, December 1, 1975. 25 p.

5

The objective of the one year program is to explore the feasibility of the Composite Bearingless Rotor (CBR) for use as a wind turbine and to evaluate several automatic control concepts designed to improve efficiency and cost effectiveness. The program consists of the design of a full-scale wind turbine, the design and fabrication of a dynamically scaled model, wind tunnel experiments, and analytical studies. To date, the design work has been completed, the model wind turbine support tower has been fabricated and assembled with a generator. The model blades and other hardware are under construction. This interim progress report contains descriptions of the full scale and model designs, a review of the performance characteristics expected of the wind turbine, and an outline of the remaining tasks of the program. Appendices are included to provide detailed information on some of the design characteristics of the model wind turbine.

323. Stepler, R. Eggbeater windmill. Pop. Sci. 206(5): 74-76, May 1975.
4

Sandia Laboratories windmill combining Darrieus and Savonius designs is described.

324. Stever, H.G. Exotic energy resources. New Zealand Energy J. 48(11): 238-240, November 25, 1975.
4

U.S. research programs for future fuel from oil shale, geothermal energy, solar heating and cooling, solar thermal conversion, photovoltaics, wind power, bioconversion, ocean thermal conversion, and fusion are surveyed.

325. Stickney, G.H. Wind/solar energy investigation, a feasibility study. Ph.D. Thesis. Ann Arbor, University Microfilms, 1975. 489 p. U.M. Order No. 76-1311.
6, 8

The question of utilizing the wind and sun to provide the energy required by an average home for space heating, air conditioning, and a hot water supply was considered. Energy requirements were compared with the daily availability of wind and solar energy and the storage needed to reconcile the two was determined. Preliminary design procedures are shown for wind and solar energy collection and systems storage. Initial design procedures are also shown for an accompanying heating and cooling system. Although wind and solar energy are free, non-depleting and non-polluting, the high initial cost of the required hardware causes them to be economically noncompetitive with more conventional fuels. Specifically, this system was estimated to have an annual cost in 1975 of around 2-1/2 times that of a home heated by natural gas and about 13 percent higher than an all electric home. However, this cost was estimated to drop by at least one third by 1985.

326. Stodhart, A.H. Wind power in Britain; past work and present position. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 133-139.

3, 4

The development program for wind turbine generators in the United Kingdom is reviewed.

327. Stoeckert, C. Wind turbine driven generator to recharge batteries in electric vehicles. U.S. Patent No. 3,876,925. April 8, 1975. 8 p.

8, 15, 17

A wind turbine driven generator for the recharging of batteries utilized as the power source for various vehicles, and particularly an automotive electrically driven vehicle is described. Wind driven vanes of particular design are mounted to rotate about a vertical shaft disposed in or on the roof of the vehicle, the vanes being completely enclosed within a suitable housing of either rectangular or circular configuration. The wind driven vanes rotate while the vehicle is under way, or, if air currents are prevalent, even while the vehicle is not in motion, thus to drive a suitably mounted generator for more or less continuous recharge of the battery system. The generator is mounted within the hub around which the vanes rotate, and comprises a stationary stator, and rotating rotor.

328. Storable, renewable hydrogen power--key to unlocking energy from the sun, wind, tides. Pop. Sci. 206(3): 88-91, March 1975.

6

In the hydrogen economy, hydrogen would be the common element making possible generation, storage, and reuse of all other forms of energy in the most efficient, least polluting way. Thermochemical and direct thermal dissociation of hydrogen using nuclear reactors is described. Heat from solar concentrations could produce hydrogen thermochemically. Some hydrogen storage difficulties are discussed.

329. Strickland, J.H. Darrieus turbine: a performance prediction model using multiple streamtubes. Sandia Labs., Albuquerque, N. M. NTIS, SAND-75-0431, October 1975. 38 p.

5, 9

A multiple streamtube performance prediction model for the Darrieus turbine is presented. This model is shown to predict the performance of small-scale rotors, for which test data is available, much more accurately than the single streamtube model. The model is capable of predicting the overall rotor power output and the distribution of aerodynamic forces along the rotor blades. The model can be used to study the effects of rotor geometry variations such as blade solidity, blade taper, and variations in rotor height-to-diameter ratios. In addition, spacial variations in freestream velocity such as that produced by atmospheric wind shear can be easily incorporated into the model.

330. Strickland, J.H., S.R. Ford and G.B. Reddy. The Darrieus turbine: a summary report. U.S. National Conference on Wind Engineering Research, 2d, Fort Collins, Colorado, June 22-25, 1975. Conference Preprints. Fort Collins, Colorado State University, 1975, p. V-2-1 to V-2-3.

3, 9

This paper describes work which is presently in progress at Texas Tech University concerning the characteristics of the vertical axis Darrieus wind turbine. A computer model which is capable of predicting the steady-state performance of the Darrieus rotor has been developed and is presently being extended to include transient behavior as well as behavior in spatially non-uniform winds. A 14 ft. diameter two-bladed Darrieus rotor has been constructed and installed on flat, open terrain adjacent to the Texas Tech campus. Various aspects of the design and operation of this system are discussed along with analytical and experimental performance results.

331. Strickland, J.H., S.R. Ford and C.B. Reddy. A preliminary investigation of the Darrieus wind turbine. In: Application of solar energy; Proceedings of the First Southeastern Conference, Huntsville, Ala., March 24-26, 1975. Huntsville, Ala., UAH Press, 1975, p. 633-643.

3, 9

This paper describes work which is presently in progress at Texas Tech University concerning the characteristics of the vertical axis Darrieus wind turbine. A computer model which is capable of predicting the steady-state performance of the Darrieus rotor has been developed and is presently being extended to include transient behavior as well as behavior in spatially non-uniform winds. A 14 ft. diameter two-bladed Darrieus rotor has been constructed and installed on flat, open terrain adjacent to the Texas Tech campus. This rotor was instrumented such that the energy extraction rate as a function of wind speed and rotor speed could be measured and controlled. Various aspects of the design and operation of this system are discussed along with analytical and experimental performance results.

332. Summary Report. Federal Wind Energy Program. ERDA Division of Solar Energy. ERDA-84; UC-60. Washington, D.C., ERDA, October 1975. 83 p.
4

This paper presents a brief overview of the Federal research and development activities in the field of wind energy and includes abstracts of the individual projects which comprise the program.

333. Summers, C.M. Ultimate energy, the ultimate fuel, and the hydrogen link in the electrical energy system. In: Hydrogen Energy, Part B, Veziroglu, T.N., ed. New York, Plenum Publ. Corp., 1975.
4

334. Sun, sea, wind, geysers--new energy from old sources. U.S. News World Rep. 78(4): 37-39, January 27, 1975.
6

Much of the $11 billion allocated to the exploration of new energy sources will go into research of solar, wind, geothermal, and tidal energy. Solar energy heated housing is becoming popular in many parts of the nation, while the older concept of utilizing wind energy is being put to new uses. The tides, currents, and varying temperatures of the ocean also have enormous energy resource potential. Energy experts, however, agree that the major power source to replace the fossil fuels within the next few decades will be fusion energy.

335. Sun, wind, and water power: revivifies recycled buildings. Build. Syst. Des. 72(5): 7-9, 1975.
8

336. Survey of solar energy products and services - May 1975. Prepared for the Subcommittee on Energy Research, Development, and Demonstration of the Committee on Science and Technology, U.S. House of Representatives, 94th Congress, 1st Session. Science Policy Research Division, Congressional Research Service, Library of Congress. Washington, G.P.O., 1975. 555 p.
4

A section on wind energy conversion is included in this survey.

337. Swanson, R.K. and R.T. Smith. Operational, cost, and technical study of large windpower systems integrated with an existing electric utility. Progress Report, covering the period May 1, 1975 through October 31, 1975. San Antonio, Tex., Southwest Research Institute. NTIS, COO-2621-1, 1975. 30 p.
6, 13

The progress during the period 1 May 1975 to 31 October 1975 on a study of the windpower potential in the Texas Panhandle is presented with particular reference to the integration of wind-generated electrical power into an existing electric utility system. Using data from 17 wind stations in the region, it has been calculated that the specific energy output of the region can be upwards of 0.65 kwh per rated kw per hour, averaged over a yearly period. The analysis utilizes realistic wind generation system performance at three different rated wind speeds: 8, 10.7 and 13.4 m/s. Four different tower heights are assumed: 30, 46, 61 and 76 m.

338. Swanson, R.K., R.T. Smith and C. C. Johnson. Operational, cost and technical study of large windpower systems integrated with existing public utilities. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 92-97.

3, 6

The potential, the promising deployment schemes, the cost goals, and the research problems inherent in the large scale implementation of wind energy conversion systems in the Texas Panhandle are analyzed. The methodology to be developed during the program is expected to be easily transferable to other utility systems of interest.

339. Sweeney, T.E. Princeton windmill program. Princeton University, Dept. of Aerospace and Mechanical Sciences, January 1975. 29 p.

4

A non-technical description is provided of the history, present status, and future goals of the Princeton Windmill Program. Two windmills are discussed: the Sailwing windmill, which was the first windmill built at Princeton in 1966; and the auto-rotating vane wind machine, which also receives some priority in the Princeton program. A method to compute the electric power output of a modern windmill is presented. Problems with using wind power are discussed. Designing a windmill to withstand maximum winds can be accomplished by building a braking system; by providing blade pitch control; or by providing blade twist control. New technology, using constant frequency alternators, may eliminate the need for gearing, which has been used to convert the rotary motion of the windmill to production of power. In considering energy storage, the investment in storage is directly related to the constancy of winds in the area that the windmill is located. It is pointed out that this paper can not answer all the questions concerning wind power because much more research needs to be done.

340. Sweeney, T.E. Sailwing windmill technology. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 224-228.

3, 5

The major objective of the Princeton Windmill Program is easily stated. This is to understand the aerodynamics of a windmilling rotor and the effect of geometry upon the efficiency of such a device. Basically the chore has been to determine the optimum blade platform, blade twist and pitch angle. All work (other than small scale) has utilized the Princeton Sailwing largely becuase it is most easily changed in twist. It is also most simple and inexpensive to construct. A parallel program, utilizing small scale wind tunnel models, has enabled the pursuit of a second objective of determining the effect of center bodies upon the efficiency of a windmilling rotor.

341. Swett, C.L. A low-cost wind turbine. Mother Earth News, No. 32: 100, March 1975.

9, 12a

Long before the recent breakthroughs in vertical axis wind turbine design, the basic idea was conceived independently by many experimenters and worked up in several forms. One such invention in operation continuously since 1958 is described.

342. Templin, R.J. Availability of wind energy in Canada. In: The Potential of Solar Energy for Canada, Conference of the Solar Energy Society of Canada, Inc., Ottawa, June 2-3, 1975. Ottawa, Solar Energy Society of Canada, 1975, p. V1-V8.

3, 6

A wind energy map of Canada is presented to show those regions in which economical development of wind power may be possible. Although the theoretical wind energy available is very large, its successful exploitation requires development of wind turbines of much lower capital cost than those currently available. Current NRC plans to erect and test a large a.c. power turbine in the Gulf of St. Lawrence region are briefly described.

343. Templin, R.J. Canadian wind energy program. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 182-187.

3, 6, 9

The Canadian research and development program for vertical axis wind turbine generators is described. The wind availability in Canada is discussed.

1975

344. Thomas, R.L. Working Group C. Viability of large systems. [Report] In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 477-483.

3, 6, 7

345. Thomas, R.L. Introduction to large system design. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-A-75-050, p. 13-20.

3, 7

Design problems associated with large wind turbine generator systems are discussed. The development schedule in the U.S. for large wind turbine generator system is presented.

346. Thomas, R.L., et al. Plans and status of the NASA-Lewis Research Center wind energy project. NTIS, N75-21795, NASA-TM-X-71701, 1975. 31 p.

4, 6

Wind energy is investigated as a source of energy. The wind energy program that is managed by the NASA-Lewis Research Center is described. The Lewis Research Center's Wind Power Office, its organization, plans, and status are discussed. Major elements of the wind power project included are an experimental 100 kW wind-turbine generator; first generation industry-built and user-operated wind turbine generators; and supporting research and technology tasks.

347. Thomas, R.L. and J.E. Sholes. Preliminary results of the large experimental wind turbine phase of the National wind energy program. NTIS, N75-32594, October 1975. 14 p.

4, 6

Because of the recent National concern over the future availability of energy supplies, the Federal Government has initiated a program to investigate alternative energy sources. Among the alternatives under consideration is the utilization of wind energy. A major phase of the wind energy program is the development of reliable wind turbines for supplying cost-competitive electrical energy. This paper discusses the preliminary results of two projects in this phase of the program. First an experimental 100 kW wind turbine design and its status are reviewed. Also discussed are the results of two parallel design studies for determining the configurations and power levels for wind turbines with minimum energy costs. These studies show wind energy costs of 7 to 1.5 cents/kWh for wind turbines produced in quantities of 100 to 1000 a year and located at sites having average winds of 12 to 18 mph.

348. Thomas, R.L., T. Sholes and J.E. Sholes. Preliminary results of the large experimental wind turbine phase of the National Wind Energy Program. Presented at Frontiers of Technology Conference, Stillwater, Okla., October 1-2, 1975. NTIS, N75-32594, 1975. 25 p.
3, 6

The preliminary results of two projects in the development phase of reliable wind turbines designed to supply cost-competitive electrical energy were discussed. An experimental 100 kW wind turbine design and its status are first reviewed. The results of two parallel design studies for determining the configurations and power levels for wind turbines with minimum energy costs are also discussed. These studies predict wind energy costs of 1.5 to 7 cents per kW-h for wind turbines produced in quantities of 100 to 1000 per year and located at sites having average winds of 12 to 18 mph.

349. Thomas, R.N. In-situ determination of wind energy. U.S. National Conference on Wind Engineering Research, 2d, Fort Collins, Colorado, June 22-25, 1975. Conference Preprints. Fort Collins, Colorado State University, 1975, p. V-13-1 to V-13-3.
3, 6

In small scale applications of wind energy the general rule is that the windmill site is determined by the location of the user and is not selected because it is a particularly windy place. With small windmills siting is a matter of determining whether or not there is sufficient wind at a given place to economically justify installation of a windmill. A method is needed to determine wind energy based on a simple and inexpensive technique of measurement and analysis. Such a method is proposed here that requires a few months measurement of average wind speed and very little data analysis. Expenditure in equipment and time would be small.

350. Thresher, R. Working Group D. Viability of small systems. [Report] In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 484-486.
3, 6, 8

351. Tilting with windmills. Time 106: 50, July 7, 1975.
4

352. Torrey, V.W. Windmills in the history of technology. Technol. Rev. 77(5): 8-10, March/April 1975.
1

353. Translation from the Danish: windpower. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 167-172.
3, 6

The economic aspects of utilizing wind turbine generators in Denmark are analyzed.

354. Tryon, H.B. and T. Richards. Installation and initial operation of a 4100 watt wind turbine. National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio. NASA-TM-X-71831. NTIS, N76-14605, December 1975. 29 p.
4

The results are presented of 211 days of operation of the 4.1 kilowatt wind turbine, which was the largest commercially available wind turbine. The wind turbine, electric controls and load bank, and the pivoted tower are described.

355. 12/16 Windmill plans. Sylmar, Cal., Helion, 1975.
12a

These plans offer highly detailed drawings, with written instructions for construction of this all aluminum blade 2-to-5 kilowatt windmill. You get drawings for both the 12 foot, and 16 foot diameter blades, with several options for construction methods, and generators. A photo essay detailing construction methods is included, as well as the engineering information concerning the machine's design. No plans are offered for the tower, but discussion and photos show how the windmill is raised up the tower. The plans are available from Helion, Box 4301, Sylmar, Cal. 91342 at $10.00.

356. U.S. National Conference on Wind Engineering Research, 2d, Fort Collins, Colorado, June 22-25, 1975. Conference Preprints. Fort Collins, Colorado State University, 1975. 403 p.
3, 4

This wind engineering conference contains 28 papers on wind power engineering, as well as papers on boundary-layer winds, air-sea interactions, wind effects on urban areas, design for air pollution control, wind-induced noise, agricultural aerodynamics, severe storms, building code requirements, wind effects on structures, and small-scale model studies.

357. U.S. production: no turnaround expected in 1975. World Oil 180(3): 97-99, February 15, 1975.
4

Unless standby producing capacity in California's Elk Hills Petroleum Reserve is put onstream, U.S. crude production is expected to decline in 1975 by 2.5%. For 1975 U.S. natural gas production is expected to continue a moderate increase. Estimates of production in key states for 1975 are included. Geothermal capacity could be equivalent to twice California's needs by the year 2000, but other alternative energy sources will be high cost supplements for the next several years.

358. Uzzell, R.S. Method and apparatus for generating power from wind currents. U.S. Patent No. 3,883,750, May 13, 1975. 4 p.
5, 17

A wind-powered energy producing device is described which comprises a Venturi-shaped chamber mounted for rotation on a support, a rudder adapted to be acted upon by the wind to orient the openings of the chamber into the wind, and a fan positioned within the throat of the chamber to be acted upon by the wind entering the chamber. The fan is connected to an energy producing device such as a generator or the like.

359. Vale, B. and R. Vale. The autonomous house; design and planning for self-sufficiency. New York, Universe Books, 1975.
2, 4, 8

This book contains a chapter on "Harnessing the Wind" and a brief bibliography.

360. Van Waning, L.R. My experience with winchargers. Wind Power Dig. 1(2): 19-20, Summer 1975.
4

361. Vernon, R.W. Summary of NASA Lewis Research Center solar heating and cooling and wind energy programs. Presented at the Southeastern Conference on Applications of Solar Energy, Huntsville, Alabama, March 24-26, 1975. Sponsored by Alabama University. NTIS, N75-26497, 1975. 23 p.
3, 6

Plans for the construction and operation of a solar heating and cooling system in conjunction with an office building being constructed at Langley Research Center, are discussed. Supporting research and technology includes: testing of solar collectors with a solar simulator, outdoor testing of collectors, property measurements of selective and nonselective coatings for solar collectors, and a solar model-systems test loop. The areas of a wind energy program that are being conducted include: design and operation of a 100-kW experimental wind generator, industry-designed and user-operated wind generators in the range of 50 to 3000 kW, and supporting research and technology for large wind energy systems. An overview of these activities is provided.

1975

362. A vertical axis wind turbine. Mother Earth News, No. 32: 102-103, March 1975.

9

The South-Rangi "eggbeater" wind turbine is described.

363. Videan, D. Rotors in reverse. Shell Aviat. News, No. 431: 12-15, 1975.

5

In an application of helicopter rotor technology to wind power, a two bladed rotor of the teetering type is employed. There is no mechanism for keeping the rotor headed into wind, for the simple reason that it is designed to trail down wind. The blades are attached to the steel hub by means of a patented torsion link which gives a high degree of stiffness to the rotor both in the flapping and the drag planes, and furthermore imparts a low and controllable stiffness about the blade pitch axis. By this method, mechanical bearings and pitch change mechanisms are eliminated, giving the rotor infinite life with no maintenance. In operation, the rotor will start to turn in a light breeze and will achieve its operating speed of 645 revolutions per minute very quickly. Should the speed of the rotor increase owing either to a decrease in the load or an increase in the wind velocity, the self-governing characteristic comes into action. To transmit the power downwards from the rotor and hub at the top of the pylon, use is made of an automotive right-angled bevel gearbox. Power for a private house and direct heat conversion for a greenhouse are only two of a number of possible uses.

364. vonHippel, F. and R.H. Williams. Solar technologies. Bull. Atmos. Sci. 31(9): 25-31, November 1975.

4

In this overview the authors show how the varied technologies for exploiting solar energy compare to one another. They feel that a good understanding of the physical advantages and limitations of different options is necessary to provide a solar R and D program with a rational basis. With a few examples they attempt to dispel the notion that solar energy is inherently pollution free. Compared to other energy technologies capital costs of solar energy are high, but the era of cheap fossil fuels is over and there is little likelihood that we are entering an era of cheap nuclear energy. Moreover, the authors feel the resource holds very great promise, especially in the forms of wind power and photosynthetic energy, for the energy-hungry developing nations, where conditions for exploiting the resource are often favorable and per capita energy consumption is low.

365. Vukovich, F.M. and A. Clayton. A technique for optimally locating wind energy systems. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 372-374.
3, 6

366. Wade, N. New Alchemy Institute: Search for an alternative agriculture. Science 187(4178): 727-729, February 28, 1975.
4

The New Alchemists are a small group who consider modern U.S. agriculture to be a mighty edifice built on sand. They expect it to collapse, within the next 10-20 years, either from intolerable price increases in fuel and fertilizer or from the accumulating weight of biological damage caused by agricultural chemicals. The New Alchemy Institute, on a 12 acre farm near Falmouth on Cape Cod, Mass., is supported by more than 1000 associate members and funds from foundations. Greenhouse complexes, solar heating devices, and windmills are evidence of the Institute's unusual experiment. The agricultural theory of members at the New Alchemy Institute is discussed.

367. Walters, R.E. Innovative vertical axis wind machines. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 443-451.
3, 5, 9

Aerodynamic performance and structural requirements will be studied theoretically and experimentally, and initial cost estimates obtained, for two wind machine concepts. The first, a revision of the vertical axis panemone, utilizes high-lift, variable angle-of-attack, circulation-controlled airfoils; and the second, a wind energy concentrator, uses a vertical airfoil to form a strong wing tip vortex harnessed by a relatively small, highspeed turbine downstream of the wing tip.

368. Walters, R.E., et al. Innovative wind machines. Report for 1 March - 31 August 1975. NSF/RA/N-75/223. NTIS, PB252617, September 1975. 160 p.
5, 9

This report describes theoretical and experimental research concerning the evaluation of two concepts for wind (energy conversion) machines. The first concept is that of a vortex concentrator: a high-lift vertical airfoil in the ambient wind generates a trailing vortex which has its energy harnessed by a relatively small high-speed turbine located just downstream of the wing tip. The device concentrates wind energy so that for a given size turbine the potential power output is greatly increased. Work summarized in this report includes a partial review of available papers on the subject of wing trailing vortices, and some calculations concerning the anticipated output of such a device. Future theoretical and experimental efforts on this project are also discussed. The second concept described is that of a vertical axis panemone device with circulation controlled airfoils for the blades. A preliminary theoretical analysis utilizing strip theory has shown the effect of different design features on its operation, and has led to the design of a test model. The configuration, instrumentation, and control systems of the test model are discussed. Also contained is an outline for a more exact flow theory, which properly takes into account the unsteady aerodynamics involved.

369. Warren, E. Feedback on wind generator notes in TMEN [The Mother Earth News]. No. 30. Wind Power Dig. 1(3): 12-15, Fall-Winter 1975.

4

370. Wave motion can be used to tap wind energy. Energy Int. 12(4): 19-20, April 1975.

4, 6

371. Weber, W. Optimal configuration of rotor blades for horizontal wind energy converters. Z. Flugwiss. 23(12): 443-447, December 1975. (In German)

5

Considerations, methods as well as some results dealing with the aerodynamic problems of rotor blades configurations for wind energy converters are reported. The aerodynamically optimal layout of rotor blades is calculated according to a procedure presented in a block diagram. Results show some typical parameter influences on the layout and performance of two-bladed wind energy converters.

372. Weingarten, L.I. and L.V. Feltz. Material and manufacturing considerations for vertical-axis wind turbines. National SAMPE Technical Conference, 7th. Albuquerque, N.M., October 14, 1975. Materials review '75, p. 153-166. Azusa, Cal., Society for the Advancement of Material and Process Engineering, 1975. NTIS, SAND-75-5512, 1975. 14 p.

3, 5, 9

Since 1973, Sandia Laboratories has been studying wind turbines and in particular Darrieus-type vertical-axis wind turbines (VAWT) for use in remote areas and as a fuel saver for electrical power grid application. The VAWT being investigated at Sandia employs curved blades which minimize bending stresses. The tension-only stresses in the blades provide a variety of manufactured methods to be considered. Mathematical procedures that are being developed for structural analysis are discussed.

373. Weingarten, L.I. and R.E. Nickell. Nonlinear stress analysis of vertical-axis wind turbine blades. ASME Paper 75-DET-35, 1975. 4 p. Also J. Eng. Ind. 97(4): 1234-1237, November 1975.
5, 9

A Darrieus-type vertical-axis wind turbine has been proposed as an alternate to conventional horizontal axis, propeller-type machines. An advantage is that the blades will be primarily in tension, thus making for a more efficient design. In connection with its vertical-axis wind turbine program, Sandia Laboratories has developed the "troposkien" (Greek for turning rope) shape for the blade design. The prototype blade shape is similar to that of the troposkien, but more easily manufactured. The effect on the stress distribution of this alternate blade shape is investigated.

374. Wentink, T. Informal note on wind speed distribution functions. Fairbanks, Alaska, University of Alaska, Geophysical Institute, August 20, 1975.
5

Possible probability density functions and the corresponding integrals (probability distributions) describing the frequency and duration of near surface wind speeds (V) are the "Planck," Incomplete Gamma, Weibull, and another we call the TWF, functions. These are compared, using synthetic and actual wind data as inputs in computed fits to the integral functions. The TWF may be a useful quick approximation for duration curves ($\% \geq V$ vs V), being based on one constant and the mean speed, $\overline{V}$; it is

$$\% \geq V \approx 100\ e^{-a(V/\overline{V})^2},$$

where a is about 0.70 to 0.80.

375. Wentink, T. Study of Alaskan wind power and its possible applications. Annual Progress Report. Geophysical Institute, University of Alaska, Fairbanks, Alaska. NTIS, NSF/RA/N-75-263, PB-254822, January 31, 1975. 71 p.
6

376. Wentink, T. Summary of Alaskan wind power and its possible applications. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 121-129.
3, 6

The potential and possible applications of Alaskan wind power are examined. Wind data are collected at selected sites, and climatological, logistical and operational problems are identified. Alternative possible uses of wind derived power are compared.

377. Wentink, T. Wind power potential of Alaska, Part II: Surface wind data from specific coastal sites. Geophysical Institute Report, February 1975.
6

378. Westh, H.C. Comparison of wind turbine generators. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 156-161.
3, 14

The "Comparative Table" contains some information about Danish propeller-driven, highspeed, 50-200 kW wind turbine generators which were in service during the period 1940-1968; and for the sake of comparison, some informative data regarding two actual NASA WTG-projects are also quoted in the table.

379. Wilcox, C.J. Design considerations for large wind mills. In: American Helicopter Society, Annual National Forum, 31st, Washington, D.C., May 13-15, 1975. Proceedings. New York, American Helicopter Society, Inc., 1975. 5 p.
3, 5

The paper discusses considerations for calculating power output and blade loadings of large wind turbines. Procedures are outlined for determining blade loadings under several operating conditions: constant wind velocity condition, varying velocity condition, gust condition, electrical disturbance condition, overspeed condition, and under idling and locked conditions, with or without ice. Failure of the Smith-Putnum wind turbine, constructed in 1939, is discussed.

380. Wilson, D.G., et al. Windmill development by model testing in water. Intersociety Energy Conversion Engineering Conference, 10th. New York, Institute of Electrical and Electronics Engineers, Inc., 1975, p. 981-986.
3, 5

The investigation of parametric changes in two designs of slow-speed windmills for pumping duty by means of testing similar small-scale models in water is described. The use of water models enables an optimum design to be rapidly approached. It is recommended for the development of high-power high-speed windmills.

381. Wilson, D.G. Windmill development by model testing in water. U.S. National Conference on Wind Engineering Research, 2d, Fort Collins, Colorado, June 22-25, 1975. Conference Preprints. Fort Collins, Colorado State University, 1975, p. V-11-1 to V-11-2.
3, 5

The investigation of parametric changes in two designs of slow-speed windmills for pumping duty by means of testing similar small-scale models in water is described. The use of water models enables an optimum design to be rapidly approached. It is recommended for the development of high-power highspeed windmills.

382. Wilson, R.E. Applied aerodynamics of wind power machines. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 234-238.

3, 5

383. Wilson, R.E. Current problems in performance modelling. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 202-207.

3, 5

Work on the Applied Aerodynamics of Wind Power Machines has been sponsored by NSF/RANN Grant GI-41840 and has resulted in the publication of a monograph by Wilson and Lissaman. The present status of performance analysis for horizontal axis rotors is summarized.

384. Wilson, R.E. Working Group A. Standards, testing, and nomenclature. [Report] In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 469-472.

3, 4, 5

385. Wind. CoEvolution Q. No. 5: 19-20, Spring 1975.

1, 4

A brief summary of windpower is presented, including a historical chronology and advantages and disadvantages.

386. Wind energy for survival; a visit with Environmental Energies, Inc. Wind Power Dig. 1(1): 14-15, January 1975.

4

387. Wind generator promises greater efficiency. Prod. Eng. 46(9): 15-16, September 1975.

4, 5

Sforza's vortex augmentor generator which may generate eight times the power of conventional rotor-type wind-energy converters is described.

388. Wind power. Nat. Wildl. 13(5): 30-33, August-September 1975.

4

As a source of electrical power, the wind has a number of outstanding advantages, not the least of which is pollution-free transportation. At least five major U.S. universities are conducting research programs aimed at developing the highly renewable resources. NSF and NASA awarded $1 million in contracts for the design of large wind energy systems. More funds are promised next year. Some large windmill construction projects, past and present, are described.

389. Wind power and windmills. Bibliography Series No. 58. Bangalore, India, National Aeronautical Laboratory, July 1975. NTIS, NP-20897, July 1975. 161 p.

16

The 583 references listed consist of published documents including books, technical reports, and articles from 1960 to 1974. Bibliographies providing access to the literature prior to 1960 are also included.

390. Windmill studies in the United States. Electr. Rev. 196(9): 301, March 7, 1975.

6, 7

The U.S. National Science Foundation and National Aeronautics and Space Association have awarded 1/2 mill dollar contracts for preliminary designs of large wind energy systems. GE Space Division and Kaman Aerospace will examine modern versions of windmills at sizes that generate 100 kW for small communities to 3MW for possible connection into the networks of electric utilities. NASA plans 30 m dollar investment into wind energy research over next 5 years. Some of these projects are described.

391. Windplants. Wind Power Dig. 1(1): 3-13, January 1975.

12b

Information about the following windplants is provided: Aerowatt, Gillette Wind Dynamo, American Wind Turbine, Wincharger Windplant, Lubing Windmills, Electro GmbH Windplants, Dunlite Windplants, Jacobs Wind Electric, Sailwing Windmill, "12/16" footer prototype (Jack Park of Helion), water-pumping windmills, S-rotor, and Sencenbaugh.

392. Windworks presents a wind energy exposition. Wind Power Dig. 1(2): 15, Summer 1975.

4

393. Windy Ten; a Dutch windmill you can build. Wind Power Dig. 1(2): 17-18, Summer 1975.

12a

Plans for building an authentic scale replica of a wooden Dutch windmill at a cost of $350.00 are discussed.

1975

394. Wolff, A. Second wind. Sat. Rev. 2: 5, February 8, 1975.
4

395. Woolley, M. and J. Platts. Energy on the crest of a wave. New Sci. 66(947): 241-243, May 1, 1975.
4, 6

396. Workshop on Wind Energy Conversion Systems, 2d, Washington, June 9-11, 1975. Proceedings. Edited by F. R. Eldridge. Sponsored by ERDA, Solar Energy Division and NSF-RANN. Coordinated by the Mitre Corporation, with the cooperation of the American Institute of Aeronautics & Astronautics. NSF-RA-N-75-050; MTR-6970. McLean, Va., Mitre Corp., 1975. 536 p. Cover title: Wind Workshop/2.
3, 5, 6, 13

More than 70 papers were presented in sessions on design of large systems, mission and regional analysis, international activities in wind energy, technology development, energy storage, wind characteristics, institutional issues, agricultural and rural applications and innovative and advanced system concepts.

397. Yen, J.T. Tornado-type wind energy system. Intersociety Energy Conversion Engineering Conference, 10th. New York, Institute of Electrical and Electronics Engineers, Inc., 1975, p. 987-994.
3, 5

A new type of wind energy system is described. Data from wind tunnel tests of a small model are presented and compared with several rough analyses. It is found that one of the analyses gives a good agreement with the data on shaft power output. Applying the analyses to larger systems one finds that for the same sized turbine and the same wind speed, power outputs of this design may be 100 to 1000 times that of the conventional design. It appears that the new system can be developed to achieve multimegawatt unit capacities.

398. Young, M.I. Dynamic optimization of weathercocking oscillations. U.S. National Conference on Wind Engineering Research, 2d, Fort Collins, Colorado, June 22-25, 1975. Conference Preprints. Fort Collins, Colorado State University, 1975, p. V-1-1 to V-1-3.
3, 5

Changes in wind direction result in transient weathercocking oscillations of conventional horizontal axis wind energy converters. This reuslts in substantial bending fatigue loadings of the individual blades and vibration of the system. The structural dynamic problem of minimizing the maximum cyclic bending stress in the windmill blades is formulated and solved as an optimal control problem where the natural frequency and fraction of critical damping are determined to minimize an integral square cyclic stress penalty function over a very long time interval. It is found that the optimum fraction of critical damping for the weathercocking oscillation varies between .55 and .65 as a variety of windmill design parameters are varied. The technique developed for optimizing the dynamics of the weathercocking oscillation is seen to apply to a variety of windpower dynamical problems.

399. Young, R.B. A concept for converting wind energy to methane. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 461-464.
3, 6, 15

In April 1975, AAI Corporation received a contract from NSF to study a concept for converting wind energy to methane. The basic approach consists of using off-shore wind to obtain hydrogen through the electrolysis of seawater. Carbon dioxide is obtained from carbonate deposits. These gases are combined to form methane. The present effort includes analysis of the processes involved, identification of the equipment and resource requirements, and an assessment of the probable cost of methane produced by this process.

400. Young, R.B., et al. Production of methane using offshore wind energy. Executive summary. NSF/RA-N-75/295A. NTIS, PB 252308, November 1975. 35 p.
6, 15

This study has assessed the potential of the electrical generation by wind energy of hydrogen, converting it to methane, and introducing it into the present natural gas pipelines. This study is limited by NSF direction to the basic objectives of defining the electrochemical process, the theoretical feasibility, and the estimated cost of producing methane gas from wind energy using calcium carbonate from underwater sands. Two primary site locations were used; Nantucket Shoals off the coast of Massachusetts and Cape Hatteras shoal water areas. The study does not include any wind energy design optimized for the electrolysis process, or the special design requirements for offshore wind power.

401. Young, R.B., et al. Production of methane using offshore wind energy. Final Report. NSF/RA/N-75/295. NTIS, PB 252307, November 1975. 79 p. Also ERDA/NSF/933-75/T1, November 1975. 131 p.
6, 15

This report describes the work accomplished during a program to investigate the feasibility of converting wind energy to methane gas. The basic approach consists of using off-shore winds to drive generators which supply electricity to electrolysis cells, Electrolysis of distilled sea water produces hydrogen. Carbon dioxide is derived from underwater carbonate deposits. These gases are combined to form methane. The methane gas produced by the process can be used in existing natural gas-burning equipment, thus conserving a valuable capital investment.

402. Zelby, L.W. Hydrogen as energy storage element. Hydrogen Energy. Hydrogen Economic Miami Energy (THEME) Conference, Proceedings. Miami Beach, Florida, March 18-20, 1974. Part A, p. 339-343. New York, Plenum Press, 1975.

3, 8

A residential wind-driven power system, using hydrogen for storage is described. The advantages of the system are that it is self-contained, and utilizes off-the-shelf components. The system is based on minimum wind velocity of 10 km/h, which represents the average wind speeds in about 50% of the conterminous states.

403. Zephyr unveils 7.5 kw generator. Wind Power Dig. 1(2): 29, Summer 1975.

4, 12b

404. Zimmer, R.P., et al. Benefit-cost methodology study with example application of the use of wind generators. Georgia Institute of Technology, Atlanta. Engineering Experiment Station. NASA-CR-134864. NTIS, N75-31571, July 1975. 411 p.

6

An example application for cost-benefit methodology is presented for the use of wind generators. The approach adopted for the example application consisted of the following activities: (1) surveying of the available wind data and wind power system information, (2) developing models which quantitatively described wind distributions, wind power systems, and cost-benefit differences between conventional systems and wind power systems, and (3) applying the cost-benefit methodology to compare a conventional electrical energy generation system with systems which included wind power generators. Wind speed distribution data were obtained from sites throughout the contiguous United States and were used to compute plant factor contours shown on an annual and seasonal basis. Plant factor values (ratio of average output power to rated power) are found to be as high as 0.6 (on an annual average basis) in portions of the central U.S. and in sections of the New England coastal area. Two types of wind power systems were selected for the application of the cost-benefit methodology. A cost-benefit model was designed and implemented on a computer to establish a practical tool for studying the relative costs and benefits of wind power systems under a variety of conditions and to efficiently and effectively perform associated sensitivity analyses.

1975

405. Zimmer, R.P., et al. An impact analysis of a micro wind system. In: Modeling and Simulation. Vol. 6. Proceedings of the Sixth Annual Pittsburgh Conference, Pittsburgh, Pa., April 24-25, 1975. Part 1, Pittsburgh, Pa., Instrument Society of America, 1975, p. 127-131.

3, 15

A process for the recovery of steel mill stack dust has been developed and is being used to recover secondary metals by a small company in Georgia. The process is energy intensive and wind generators were studied as a means of supplying energy for part of the recovery process. Some of the results of this study are presented.

406. Zlotnik, M. Energy storage for wind energy conversion systems. In: Workshop on Wind Energy Conversion Systems, 2d, Wash., June 9-11, 1975. McLean, Va., Mitre Corp., 1975. NSF-RA-N-75-050, p. 311-318.

3, 11

The technology is discussed for storing energy in a form that will allow it to be recovered economically as electrical energy. One of the goals for energy storage R and D applied to WECS is to make the combined WECS/energy storage system economical as an independent base-load power supply for a wide range of circumstances. One approach that would make such a goal more accessible in the near term would be to recover only a portion of the stored energy--only as much as necessary--in electrical form, with the balance used or stored.

407. Browning, J.A. Windmills. U.S. Patent 3,952,723. February 14, 1975.

5, 17

A system for extracting useful energy from the wind is described which consist of a windmill, a closed circuit containing a liquid, pump means driven by the windmill to place the liquid under pressure in the circuit; and a flow control impedance to permit a predetermined constant volumetric flow of the liquid in the circuit per unit of time and across which the pressure drops to yield heat.

408. Developments in the wind. Electr. & Power 21: 299, March 20, 1975.

4

409. Lane, J.A. Outlook for alternative Energy Sources. IAEA Interregional Seminar on Nuclear Power Planning, Kingston, Jamaica, 1975. NTIS, CONF-750614-1, 1975.

3, 4, 6

410. Fields, J.C. Heating and cooling system. U.S. Patent 3,956,902. March 25, 1975.

8, 17

A system for heating and cooling an enclosure is described which comprises: first energy converting means for converting wind energy to mechanical energy; second energy converting means associated with the first converting means and adapted to convert the mechanical energy to varying amounts of electrical energy in proportion to the amount of the wind energy for use in the heating and cooling system; and thermoelectric heating and cooling means comprising a plurality of parallel connected thermoelectric devices connected to the second energy converting means for converting the electrical energy to thermal energy, the thermal energy being employed to heat and cool the interior of the enclosure.

411. Lois, L. Apparatus for extracting energy from winds at significant height above the surface. U.S. Patent 3,924,827. December 9, 1975. 8 p.

5, 17

A buoyant wing is tethered to a line an appreciable distance above the surface where the winds are at higher speed than at ground level. The other end of the line(s) is attached, for example, to an electrical generator, and provision is made for adjusting the position of the wing so that when a series of wings are utilized together with an electrical generator, one wing may be retracted while at least one other wing which is positioned to catch the wind is drawn away from the generator.

412. Solar energy resources. In: Magnitude and deployment schedule of energy resources. Proceedings. Conference on the Magnitude and Deployment Schedule of Energy Resources, Portland, Oregon, July 21, 1975, p. 9-58.

3, 6

ERDA responded to Congressional solar legislation by developing a detailed program described in a "Definition Report, the National Solar Energy Research, Development and Demonstration Program" (ERDA 49) on eight different applications of solar energy. Contributions of new energy sources of wind, photovoltaic, thermal-electric, and ocean thermal gradient are given in addition to hydroelectric expansion for 1985 to 2000. Applications of solar heating and cooling, agricultural and industrial applications, solar electric capacity, wind energy, photovoltaic systems, ocean thermal systems, and fuels from biomass are briefly discussed. Solar energy implications for the long term are summarized with specific implications indicated for the Northwest. Five subgroup papers are included:

Space Heating and Cooling, by Arnold Cohen; Electric Power Generation, by L.L. Vant-Hull; Hydroelectric Power Generation, by Frederick H. Warren; Wind Energy Systems, by W.H. Hurlebaus; and Ocean Thermal Energy Conversion, by E. Lee Leventhal. A Review of Solar Energy Resources was presented by Dwain F. Spencer.

413. Taminini, R.J. Wind driven power generator. U.S. Patent 3,924,966. December 9, 1975. 4 p.

5, 17

A rotor body is provided including a generally cylindrical side wall open at its opposite ends and supported for rotation about an axis generally coinciding with the center axis of the body. The body includes a plurality of circumferentially spaced longitudinally extending slots similarly slightly inclined relative to radial planes passing through the slots and the edge portions of the cylindrical side wall defining corresponding longitudinal edges of the slots include inwardly projecting vanes inclined at least thirty degrees relative to planes tangent to the cylindrical side wall edges inwardly from which the vanes extend.

414. Sohn, C.W. Wind power plant site selection. Thesis. Texas Tech University, May 1975.

6

A test of Putnam's ratio method using data from a number of sites is described. Data from Reese Airforce Base and Lubbock, Texas, is analyzed, and the error is found to be roughly 25%.

415. Sumner, J. Some answers to power generation lie blowing in the wind. Engineer 241: 30-31, October 2, 1975.

4

416. Sumner, J. Using wind to generate warmth and business. Engineer 241: 24-5, December 18-25, 1975.

4

417. Sumner, J. Windmill will generate heat for agriculture. Engineer 241: 9, December 4, 1975.

15

418. Chiu, A.N. Wind engineering research digest, vol. 2. Prepared in cooperation with the Wind Engineering Research Council. NTIS, PB-252838/8, 1975. 113 p.

4

A partial listing of the contents includes: Structure of wind; wind wave effects; effects on urban areas; wind loading on structures; design for hurricanes and tornadoes; environmental factors; legal factors; special problems; wind considerations in urban planning; building codes and regulations; socioeconomic effects; and wind energy.

419. Smetana, F.O. A new wind energy conversion system. NTIS, N76-20629, NASA-CR-146539, November 1, 1975. 16 p.
5, 9

It is presupposed that vertical axis wind energy machines will be superior to horizontal axis machines on a power output/cost basis and the design of a new wind energy machine is presented. The design employs conical cones with sharp lips and smooth surfaces to promote maximum drag and minimize skin friction. The cones are mounted on a vertical axis in such a way as to assist torque development. Storing wind energy as compressed air is thought to be optimal and reasons are: (1) the efficiency of compression is fairly high compared to the conversion of mechanical energy to electrical energy in storage batteries; (2) the release of stored energy through an air motor has high efficiency; and (3) design, construction, and maintenance of an all-mechanical system is usually simpler than for a mechanical to electrical conversion system.

1974

1. Allison, H.J. and R. Ramakumar. Energy of the future tied to wind, sun. Okla. Prof. Eng. 28(1): 4-5, January 1974.

4

2. Alternative sources of energy. Practical technology and philosophy for a decentralized society. Book one. Edited by Sandy Eccli and others. Kingston, N.Y.; Alternative Sources of Energy, 1974

4, 8, 12a

Contains 23 pages of reprints of articles on wind power from the magazine Alternative Sources of Energy and other sources. Includes a bibliography of 79 references, many of which are not included in this bibliography. Slant is toward small homebuilt electric plants.

3. Blackwell, B.F. et. al. The Sandia Laboratories Wind Energy Program. Sandia Laboratories Energy Report, Albuquerque, N.M., May 1974. Report No. SLA-74-0282. 13 p.

9

4. Blackwell, B.F. The vertical-axis wind turbine "how it works". Sandia Laboratories Energy Report, Albuquerque, N.M. April 1974. Report No. SLA-74-0160. 9 p.

9

A qualitative description of how a vertical-axis wind turbine works is presented, and some of the advantages over a conventional propeller-type wind turbine are discussed.

5. Bruckner, A. Taking power off the wind. New. Sci. 61(891): 812-814, March 28, 1974.

6

With its maritime climate and hilly terrain, Britain is well suited for generating electrical power from the wind. Even with a 25 per cent load factor, aerogeneration coupled to a pumped storage scheme would be economically feasible today.

6. Clark, W. Energy for survival: the alternative to extinction. New York, Doubleday, 1974.

2

7. Defense Documentation Center, Alexandria, Va. Energy Conversion. Report bibliography. January 1954 - August 1973. AD 771-750/7. NTIS, January 1974. 407 p.

4, 16

The bibliography is a compilation of 287 references on Energy Conversion. Citations are sequenced numerically within each of the following categories: (1) Fuel Cells

(2) Mineral Fuels; (3) Nuclear Energy; (4) Solar Energy; (5) Steam Power; (6) Thermionic Generators; (7) Thermoelectric Generators; (8) Geopolitical Energy Studies; and (9) Miscellaneous Studies. Corporate Author-Monitoring Agency, Subject, Title, Personal Author, Contract Number, and Report Number Indexes are included.

8. Galanis, N. and A. Delisle. Performance and evaluation of wind driven heating systems. Intersociety Energy Conversion Engineering Conference, 8th. AIAA 739065. p. 376-381. See 1973:7 for abstract.

13

9. Lawand, T.A. The potential of solar and wind energies in meeting Canadian energy needs. Excerpts from talk presented to La Societe des Ingenieurs Civils de France, Section Canadienne and the Engineering Institute of Canada, Montreal Branch, March 26, 1974. Brace Res. Inst. Publ. No. R88.

4, 6

10. Lawand, T.A. and R. Alward. The potential of wind power in meeting Canadian energy needs. Speech given to Canadian Science Writers Assoc. Varennes, Quebec, January 25, 1974. Brace. Res. Inst. Publ. No. R85.

4, 6

11. Lindsley, E.F. QUIRK: high output wind generator. Pop. Sci. 204: 52, March 1974.

12b

12. Oklahoma State University. Stillwater, Oklahoma. Engineering Energy Laboratory. Basic information on the economic generation of energy in commercial quantities from wind. Report to the Committee on Science and Astronautics, Subcommittee on Energy, House of Representatives. Rept. ER 74-EE-7, May 21, 1974.

6

Enormous quantities of energy are obtainable from the wind. If conventional fuels become scarce, wind can probably become economically competitive as an energy source for many applications.

13. Oklahoma State University. Stillwater, Oklahoma. Engineering Energy Laboratory. A synopsis of energy research 1960-1974. 1974.

13

14. Oklahoma State University. Stillwater, Oklahoma. Engineering Energy Laboratory. Energy for the future -- the OSU effort. 1974.

13

15. Power from wind. Mech. Eng. 96(4): 55, April 1974.
8, 9

A brief report of current research underway at NASA's Langley Research Center with a vertical axis windmill used for conversion of wind power to electricity, with emphasis on the potential for home use.

16. Preston, D.J. One man's answer to the energy crisis: Spocott windmill. Am. For. 80: 20-23+, February 1974.
8

17. Ringe, A.C. Solar energy and wind power. A selected bibliography. (1964-December 1973). COM 74-10392/0. NTIS, February 1974. 80 p.
16

The bibliography contains 74 selected abstracts of research reports retrieved using the NTIS on-line search system - NTISearch. Included are abstracts of reports on solar heating of buildings, solar electric power generation, solar cells, solar energy as a national resource, solar stoves, and a special section on wind power generation.

18. Schwartz, M. Can windmills supply farm power? Org. Gard. Farm. 21(1): 155-157, January 1974.
4, 6

An answer to the energy crisis may be the wind. The big question is whether windmills are technically and economically feasible. Based on experiences in a number of other countries, the answer appears to be a qualified "yes" However, the scale on which they are feasible is uncertain.

19. Soucie, G. Pulling power out of thin air. Audubon 76(3): 81-88, May 1974.
4

Review article covering history, potential, and economic feasibility of wind as a power source, with emphasis on Heronemus' proposal for utilizing offshore winds.

20. Templin, R.J. Aerodynamic performance theory for the NRC vertical-axis wind turbine. National Research Council of Canada, Laboratory Technical Report LTR - LA-160, June 1974.
9

1974

21. Wade, N. Windmills: the resurrection of an ancient energy technology. Science 184(4141): 1055-1058, June 7, 1974.

4

A brief, popular review of the historical use of windmills, and potential for modern production of power.

22. Wilson, R.E. and P.B.S. Lissaman. Applied aerodynamics of wind power machines. Oregon State University, May 1974. 106 p. NTIS PB 238 595, 1974. 116 p.

5

This paper reviews the aerodynamics of various type of wind power machines and indicates advantages and disadvantages of various schemes for obtaining power from the wind.

23. Wind turbine for power generation; or , is there a windmill in your future? Pub. Util. Fortn. 94(6): 59-60, September 12, 1974.

14, 12b

Supplementary electricity could be only three or four years away with the use of windmills. A project at Stillwater, Oklahoma is described that is expected to be pumping power into the power lines at about the 10-kilowatt level from two wind turbines. Wind blowing 20-25 mph can turn a wind turbine big enough to supply a town of 1,000, but storage is a problem. University researchers are experimenting on high pressure electrolysis systems as a means of storage, and others are experimenting with compressed air in storage and with massive flywheels that are spun when the energy is available and produce power when needed. Research has begun on lightweight windmill blade designs made from cloth and wire, fiberglass, or metal, to increase speed and reduce the number of grears necessary to convert the wind's force to mechanical energy to turn a generator.

24. Energy primer; solar, water, wind, and biofuels. Menlo Park, California, Portola Institute, 1974. 200 p.

4, 8, 12a

The Energy Primer is a fairly technical book about renewable forms of energy - solar, water, wind, and biofuels. The focus is on small-scale systems which can be applied to the needs of the individual, small group, or community. More than one-fourth of the book is devoted to reviews of books and hardware sources. Hundreds of illustrations and a dozen original articles are used to describe the workings of windmills, wind generators, solar water heaters, space heaters and dryers, waterwheels, wood burning heaters, alcohol stills and methane digesters. The final section of the book focuses on the need for energy conservation and some of the problems and potentials of integrated energy systems.

1974

25. Gross, A.T.H. Wind power usage in Europe. Ergeb. der Jahrestagung der Studienges. Windkraft Ev. Stuttgart, Dk 621.311.24.003.1, No. 4., p. 1-6. Translation: Techtran Corporation, Glen Burnie, Maryland, N 74-31534. NTIS, August 1974. 19 p.

4, 6

The development of wind power technology has led to basic discoveries which will make standardized large-scale production possible. Its economical use is regarded as a possible extra source of electrical energy for already existing systems, since there is an abundance of wind in the plains stretches of Central Europe. Equipment cost for system-sized, self regulating wind power machines which now produce a respectable 100 to 300 kilowatts are estimated at about 600 to 700 marks per kilowatt in large-scale production. In those areas which still have no electricity, underdeveloped countries for instance, an individual wind machine could well compete with the diesel engine.

26. Haggart, B. The Street farmers windworkers manual. London, Peace News, 1974. 16 p.

8, 12a

A pamphlet containing some quick basics and some solid design plans. It discusses Dynamos versus Alternators, maintenance and power storage, and presents plans for a cheap water-pump attachment and for an airscrew generator built out of bicycle parts.

27. Puthoff, R.L. and P.J. Sirocky. Preliminary design of a 100 kW turbine generator. Paper presented at the International Solar Energy Society Conference, Fort Collins, Colorado, August 1974. N 74-31527. NTIS, 1974, 22 p.

14

The National Science Foundation and the Lewis Research Center have engaged jointly in a Wind Energy Program which includes the design and erection of a 100 kW wind turbine generator. The machine consists primarily of a rotor turbine, transmission, shaft, alternator, and tower. The rotor, measuring 125 feet in diameter and consisting of two variable pitch blades operates at 40 rpm and generates 100 kW of electrical power at 18 mph wind velocity. The entire assembly is placed on top of a tower 100 above ground level.

28. Savino, J.M. A brief summary of the attempts to develop large wind-electric generating systems in the United States. Paper presented at the Wind Energy Conference, Stockholm, August 1974. N 74-34540. NTIS, 1974. 17 p.

4, 1

Interest in developing large wind-electric generating systems in the United States was simulated primarily by one man, Palmer C. Putnam. He was responsible for the construction of the 1250 kilowatt Smith-Putnam wind-electric plant. The existence of this system prompted the U.S. Federal Power Commission to investigate the potential of using the winds as a source energy. Also, in

1933 prior to Putnam's effort. there was an abortive attempt by J.D. Madaras to develop a wind system based on the Magnus effect. These three projects comprise the only serious efforts in America to develop large wind driven plants. In this paper the history of each project is briefly described. Also discussed are some of the reasons why wind energy was not seriously considered as a major source of energy for the U.S.

29. Stoner, C.D., ed. Producing your own power; how to make nature's energy sources work for you. Emmaus, Pennsylvania, Rodale Press, Inc., 1974.

4 12a

Presents a series of articles on wind, water, wood, methane and solar power, emphasizing smaller applications for home and farm use. Technical consultants are Eugene and Sandra Eccli, co-editors of Alternative Sources of Energy.

30. This is how you can heat your home with a little windmill. Nv. Teknik (Sweden) No. 3: 8-9, January 1974.
Translation: Kanner Associates, Redwood City, California. N 74-21681. NTIS, April 1974. 13 p.

6, 4, 8, 12a

For many years, small windmills with generators and storage batteries have been available for supplying electricity to remote locations; but storage batteries are so expensive, that this type of electrical supply is normally unrealistic. A better way of utilizing wind power in a smaller installation is to let the electrical current take care of home heating via a heat accumulator, which has low maintenance cost and simple electrical equipment. One such installation is described in this article and figures on its economic feasibility are provided.

31. Park, J. Hybrid windmills. Alt. Sources Energy, No. 16: 23-25, December 1974.

9, 5

The article summarizes the author's recent research and experiments on "hybrid" windmills, vertical axis machines which make use of aerodynamic lift to produce power,

32. Veneruso, A.F. Electrical system for extracting maximum power from the wind. NTIS. SAND-74-0105, December 1974. 29 p.

13

A proposed electrical system design is described that takes full advantage of the fact that the power available from the wind varies as the cube of the wind's speed. When a varible voltage-variable frequency AC polyphase approach is used to match the system's source and load characteristics, the electrical transmission system is capable of maximum power conversion. System complexity and cost are minimized through the use of direct mechanical connections from wind turbine shaft to electric generator, the use of standard squirrel-cage induction motor(s) to drive the mechanical load(s), and the absence of moving electrical connections.

33. Heronemus, W. E. Windpower: look backward, then move forward confidently. Pre-print, to be published by IEEE in 1974. ~~88 p.~~ 7 p. Published as: Energy Development, IEEE Power Eng. ~~Pap~~ Soc. Pap., p 82-88. Available from IEEE (74CH0913-4-PWR) 4, 6

Windpower meant supremacy to those who used it best in the past. Windpower technology has actually been excellent technology even within the past 15 years, and the most exciting current activities in aerodynamics are directly relatable to improved windpower technology. Windpower has failed the test of economics when pitted against heat engines for the generation of electricity in the recent past: now that the costs of fossil fuels are on the rise again and the real cost of nuclear generated electricity is becoming painfully apparent, windpower could be economic. The pocketbook alone should not settle these matters, however, no matter what energy produced by combustion, fission or fusion costs in the future; there may be few truly contented human beings on the face of the earth to use it, if we continue with exponentially increasing use of those processes. Mankind must shift to solar energy processes and the sooner the better. The United States as leader of the world in technology should lead that march, starting right now.

34. Vargo, D. J. Wind energy developments in the 20th century. N75-13380. NTIS, 1974. 29 p.

6

Wind turbine systems of the past are reviewed and wind energy is reexamined as a future source of power. Various phases and objectives of the Wind Energy Program are discussed. Conclusions indicate that wind generated energy must be considered economically competitive with other power production methods.

35. Dambolena, I.G., F.C. Kaminsky and R.F. Rikkers. Planning methodology for the analysis and design of wind power systems. Intersociety Energy Conversion Engineering Conference, 9th, Proceedings, Paper 749009, p. 281-287, 1974.

6

Alternative windpower systems are being evaluated in terms of cost and performance through use of a computer-based planning model.

1974

36. Griffin, O.M. Energy from the ocean: an appraisal. U.S. Naval Research Laboratory, Washington, D.C., May 1974. 47 p. 6

37. Hughes, W.L., H.J. Allison and R.G. Ramakumar. Development of an electrical generator and electrolysis cell for a wind energy conversion system. Progress Report (Report period ending Sept. 30, 1974). Oklahoma State University, Stillwater, Okla. PB 239 272. NTIS, October 15, 1974. 123 p. 13

This project for NSF-RANN has three objectives. The first objective--is to design, build, and experimentally operate a high pressure, moderate temperature electrolysis system. This objective is to include work on electrode design, efficiency improvement and is to develop techniques for valving gases out of the system. Section II of this report gives complete details of the Electrolysis System Development. The second objective of this project--is to design and fabricate a field modulated generation system suitable for operation with an aeroturbine in the 10-20 kw level. In addition, it is proposed to investigate the possibility of improving the magnetic circuit design in Field Modulated Generation Systems. The details of this development are given in Section III. The third objective of this project is to construct, debug, and gain significant operational experience on a "windmill farm." In this system, multiple (2) wind turbines are erected, each driving a field modulated alternator. Construction of the pilot system is now completed at a site on the Stillwater Municipal Airport. Details are given in section IV.

38. Rangi, R.S., P. South and R.J. Templin. Wind power and the vertical-axis wind turbine developed at the National Research Council, Canada. National Research Council, Division of Mechanical Engineering and National Aeronautical Establishment. Quarterly Bull. No. 2: 1-14, 1974. 9

The design features, performance and economics of a vertical-axis wind turbine are discussed.

39. Lehman, E.J. and A.C. Ringe. Solar energy and wind power. A bibliography with abstracts. National Technical Information Service, Springfield, Va., July 1974. 162 p. 16

40. Snyder, R.E. Oil industry plunges into alternate energy search. World Oil 178: 61-62, 64, 66, 1974. 6

Oil companies will explore potential of shale oil, coal, nuclear, tar sands and geothermal energy. They consider solar, tidal and wind power not practical.

1974

41. Sweeney, T.E. Optimization and characteristics of a sailwing windmill rotor, Semi-Annual Progress Report (Covering the period February 15, 1974-June 20, 1974). Princeton University, Dept. of Aerospace and Mechanical Sciences, Princeton, N.J. Report No. NSF/RANN/SE/GI-41891/PR/74/2, July 1974. 34 p. 5

An adequate number of center body ratios (body diamater/rotor diameter) have been tested in the Princeton 2 foot x 3 foot wind tunnel to determine the optimum value of this geometric parameter. A series of experiments defining the effect of various diameters of center discs and completely streamlined center bodies are reported upon herein. Thus the effect of these bodies incorporated into a windmill are begun to be understood insofar as both power coefficient and drag are concerned. During this reporting period the 25 foot diameter Princeton Sailwing Windmill was disassembled, fitted with new 4.5 oz Dacron sails, a brake and a strain gage torque bridge. The calibration of the site has been completed and preliminary power tests begun. It is expected that it will be late August, 1974 when the winds usually freshen before a wide range of data may be taken. This report also refers to an extensive literature review of Windmill publications.

42. Blackwell, B.F. and G.E. Reis. Blade shape for a troposkien type of vertical-axis wind turbine. Sandia Laboratories Wind Energy Report SLA-74-0154, Albuquerque, N.M., April 1974. 24 p. 9

43. Reed, J.W., R.C. Maydew and B.F. Blackwell. Wind energy potential in New Mexico. Sandia Laboratories Wind Energy Report SAND 74-0071, Albuquerque, N.M., July 1974. 42 p. 6

44. Reed, J.W. Wind power climatology. Sandia Laboratories Wind Energy Report SAND 74-0435, Albuquerque, N.M., December 1974. 17 p. 6

45. NASA and energy. Washington, D.C., National Aeronautics and Space Administration, 1974. 16 p. 4

A summary of NASA contributions to the energy field is presented including direct solar heating and cooling systems, wind generation of electricity, solar thermal energy turbine drives, solar cells, and techniques for locating, producing and collecting organic materials for conversion into fuel.

46. Shuster, D.B., V.L. Dugan and R.H. Richards. A wind-powered fresh water condensation air conditioning, mariculture, and aquiculture integrated system for Pacific atolls. Sandia Laboratories Wind Energy Report SLA-74-0298, Albuquerque, N.M., June 1974. 11 p. 8, 15

1974

47. Wentink, T. Wind power potential of Alaska: Part I, Surface wind data from specific coastal sites. PB 238 507. NTIS, August 1974. 122 p. 6

Emphasis in this report is on characterization of the wind regimes as these may apply to the design and installation of windmills for power generation at specific sites in Alaska. Selection of optimum sites for wind powered plants and estimates of the wind power are beyond the scope of this basic survey. However, it is already clear that Cold Bay is of major importance for possible plants, and energy export. Also, Adak and Shenya have considerable potential for local power generation from winds, for military use. St. Paul, Kotzebue, and Tin City have similar above average (for Alaska) potential for civilian use of wind power. Empirical and analytical formulae for the velocity duration curves are covered in the text, and in an appendix. The results from these have strong implications for improved simplified wind data gathering systems, especially for large area surveys and from automatic unmanned stations. Recommendations for further work are given.

48. April 1 - June 30, 1974 [Report] National Research Council, Division of Mechanical Engineering and National Aeronautical Establishment. Quarterly Bull.: June 1974. 78 p. 9

The interests and current activities of the Division of Mechanical Engineering and the National Aeronautical Establishment of the National Research Council of Canada are reviewed.

49. South, P. NRC's vertical wind turbine. Agric. Eng. 55(2): 14-16, February 1974. 9

50. Bryson, F.E. Tilting at the energy crisis. Machine Design: 20-25, January 10, 1974. 4

1974

51. Abelson, P.H. Energy supply and demand during the next decade. Amer. Gas Assoc. Mon. 56(12): 12-15, 36, December 1974.

4

52. Aerospace firm to build wind-generator blades. Mach. Des. 46:10, October 17, 1974.

4

53. Are windmills feasible. Electr. Times 4287: 9, June 27, 1974.

6

The interest and activity in the windpower field around the world and the opinions of two U.K. scientists, A. Bruckner (City Univ.), and A.E. Stodhart (ERA) are presented. Dr. Bruckner's "buffer lake" concept study was made in Ulster where he believes a system build around Lough Neagh could provide 25 percent of Ulster's energy requirements. He calls for a two year programme to construct aero-generators based on existing designs.

54. Bacher, K. Putting the sun to work: a history and directory of currently available solar energy applications. NTIS, PB238189, 1974. 30 p.

4

A brief history of solar thermal energy is provided and a directory is presented of current economically and technically feasible applications. Heliothermal systems for water and space heating are at the present time more practical for short-term private and commercial uses than helioelectric and heliochemical systems. Basic background information on the use and construction of solar equipment is followed by a listing of company names, addresses, prices, and specifications. Information is provided on hot water heaters, collectors, swimming pool heaters, total home systems, glazing systems for solar control, wind power, and solar cells. A bibliography of 20 books and articles on the experimental applications of solar energy is included.

55. Back to the windmill to generate power. Bus. Week No. 2330: 140, 142, May 11, 1974.

4, 6

If any aspect of the energy shortage is considered humorous, it is the idea of erecting hundreds of giant windmills across the landscape to do their age-old job of converting the wind into power. But to a growing number of people, windmills are not such an absurd idea after all. Companies are now spending their own money to develop a new generation of windmills that will come to market as early as this year.

1974

56. Becker, I. Energy research in Providence. Nation 218(9): 262-264, March 2, 1974.

8

The Research and Design Institute plans to turn an abandoned 19th century mill in Providence, R.I., into a prototypical electric energy conservation station and use it as headquarters. About 60% of the building's electricity will be generated from solar collectors, solar cells, a wind-powered generator, and a water turbine. A nuclear device may run the aircraft signals on the chimney.

57. Bergey, K.H. Wind power potential for the United States. Aware, No. 49: 2-5, October 1974.

6

Large-scale wind power generating systems can be built for about $200 per installed kw. This compares with today's costs of $200-$350 for conventional fuel plans and $500 for nuclear plants. Assuming a 25 year pay back of capital along with a 25% load factor, 10% interest on debt, and a conservative allowance for operating costs, a typical unit will produce electricity at an average of 2.5/kwh, which is competitive in some parts of the country today. If wind power is introduced into multi-regional power grids as base load capacity, the emergency fill-in and peaking can be accomplished by existing fossil fuel units. If the wind energy system is broad enough, the need for energy storage can be eliminated.

58. Bergey, K.H. Wind power potential for the United States. In: Wind Energy, publication of Hearing before the Subcommittee on Energy, Committee of Science and Astronautics, U.S. House of Representatives. Committee Publication No. 49, May 21, 1974. 392 p.

6

59. Bloom, G.I. Achieving Pennsylvania's energy goal. Pub. Util. Fortn. 93(12): 38-40, June 6, 1974.

4

60. Blowing in the wind. Sci. Am. 230(5): 16, May 1974.

4

NASA's sailwing windmill is described.

61. Bonnefille, R. Wind power projects of the French Electrical Authority. Translation into English of "Les Realisations de Electricité de France Concernant 1 Energie Eolienne." Report F40/74, no. 4. Electricite de France, Direction des Etudes et Recherches, Service Generateurs et Echangeurs de Chaleur Thermiques

et Nucleaires, April 1974, p. 1-45. Translation: Kanner Associates, Redwood City, Cal. NTIS, N75-13384, December 1974. 61 p.
6

Systematic measurement of the wind power distribution in France has shown that the design of wind generators involves two basic problems: the irregularity of the energy supply and the mechanical strength of the assembly. Since these problems have largely been solved for generators less than 10 kW, the main body of this discussion deals with practical tests on one average-power and two high-power generators. Other variants tested in France and other countries are described in less detail. Further development of average-power generators with an output on the order of 100 kW is recommended.

62. Booda, L.L. Ocean based solar-to-hydrogen energy conversion concept. Sea Technol. 15(2): 21-24, February 1974.
4

The lengthy paper "Ocean Based Solar-To-Hydrogen Energy Conversion Marco System," by William J.D. Escher and Lee A. Hanson is condensed and interpreted. Solar energy would be used to produce hydrogen as an energy form in a wholly ocean-based complex. Hydrogen is an excellent energy form since it has high energy conversion efficiency, and is plentiful, non-polluting, naturally recycled, easily transported, and storeable. The advantages of an oceanic operation include its virtually unlimited area, enormous thermal sink, immediate source of feedstock water, excellent logistics, low friction bearing surface, and the availability of the ocean thermal gradient method of energy conversion. Platform technology, and the five methods of solar conversion under study (photosynthesis, direct thermal, photovoltaic, OTG, and wind) are discussed.

63. Booth, D. When the Kuwaitis look at power from the wind. Engineer 239: 55, 59, August 22/29, 1974.
4

64. Booth, D. Winds of change might blow through the sails again. Engineer 238(6162): 44-46, April 18, 1974.
6, 12b

The present status of wind generators and currently available models and research in the USA and France are reviewed. NASA is developing a 100 kW unit with plans for 50-250 kW and 1-3 MW units. The only commercial models (1 kW and 10 kW) in U.K. are produced by Industrial Instruments.

65. Boulet, L. Innovations in generation, storage, and transportation of energy. Proceedings of the Canadian National Energy Forum. Ottawa, Canadian National Committee, World Energy Conference, 1974.
3, 4, 11

1974

66. Brand, D. It's an ill wind, etc.: energy crisis may be good for windmills. Wall St. J., January 11, 1974. 1 p.

4, 6

67. Buonicore, A.J. Environmental implications of energy use. Presented at AICHE Energy & Environment Conference, Ohio, November 13-15, 1974. 9 p.

3, 4, 6

Much of the environmental damage from the use of energy lies in those systems that provide energy for the consumer. If these systems were to function more efficiently coupled with more efficient use by consumers, both energy production and environmental damage would be reduced. The use, potential use, advantages, and disadvantages of coal, oil, nuclear fission, hydroelectric, geothermal, oil shale, and coal gasification are surveyed. Fusion, solar, geothermal, ocean thermal, wind, tidal, and advanced chemical energy systems are all potential energy sources of the future that would cause minimum environmental damage.

68. Butler, T.W. Wind and solar energy conversion system for multistory buildings. U.S. Patent No. 3,832,853. September 3, 1974.

8, 17

69. Carter, F.H. Multi-windmill wheel power generator. U.S. Patent No. 3,944,839. July 18, 1974.

5, 9, 17

A power generator is described which comprises a supporting stationary column, a windmill wheel module rotatably supported from the column for swivelling movement about a substantially vertical axis, vertically spaced horizontal shafts rotatably journaled on the module and extending dimetrically of the vertical axis, and a plurality of windmill wheels mounted on each end of each horizontal shaft for rotating the shaft in response to axial flow of wind. A vertical shaft is supported from the column and drivingly connected to the horizontal shafts. A generator assembly is supported at the lower end of the column and is connected to the vertical shaft.

70. Carter, F.H. Wind turbine generator. U.S. Patent No. 3,793,530. February 19, 1974.

5, 17

71. Carter, F.H. Wind turbine with governor. U.S. Patent No. 3,942,026. June 11, 1974.

5, 9, 17

A wind turbine assembly is described which comprises a supporting framework including a rigid elevated platform, a turntable rotatably supported from the platform for swivelling movement about a substantially vertical axis, a horizontal shaft rotatably journalled from the turntable with the end portions of the shaft projecting diametrically therefrom, a plurality of wind wheels mounted on each end of the horizontal shaft outwardly of the turntable for rotating the shaft in response to axial flow of wind through the wind wheels. The area peripherally of the wind wheels is unconfined to provide unrestricted and untrapped wind flow in relation to the wind wheels. A vertical shaft is supported from the framework and connected to the horizontal shaft. A generator assembly is supported at the lower end of the framework and is connected to the vertical shaft.

72. Cherry, W.R. Prospects for conversion of solar energy into electrical power. Missouri Energy Council Conference on Energy Resources and Management, 1st. University of Missouri, Rolla, Missouri, April 24, 1974, p. 40-42.

3, 6

73. Chiu, A.N.L. Wind engineering research digest. Vol. 1. Hawaii University, Honolulu, Hawaii. NTIS, PB 241010, 1974. 115 p.

4

74. Clark, P. The new and revised natural energy workbook. Berkeley, Cal., Visual Purple, 1974. 97 p.

2, 4

This is basically an idea book, introducing a wide variety of energy alternatives, including 20 pages on wind power.

75. Consroe, T., et al. Alternative strategies for optimizing energy supply, distribution, and consumption systems on naval bases. Volume II. NTIS, AD 786757, January 31, 1974. 231 p.

4, 8

The report describes five advanced strategies for optimizing energy supply, distribution, and consumption systems on naval bases: (1) Solar energy applications; (2) automated building control and monitoring systems; (3) electrochemical sources--fuel cells; (4) advanced transportation technology; and (5) total energy systems. For each advanced strategy, the report contains a technology assessment, a discussion of applicability to the Navy, a discussion of costs and benefits, and recommendations for Navy implementation.

76. Coonley, D.R. Design with wind. Harrisville, N.H., Total Environmental Action, May 1974. 140 p.

2, 5, 12a

This project explores the creative use of wind in the design of buildings. Experiments on architectural models were conducted in a wind tunnel. Results indicate that substantial amounts of energy can be provided by incorporating wind turbines into the design of buildings and, simultaneously, that wind flow problems around buildings can be reduced to a minimum and structural wind loads upon buildings can be greatly reduced. Master's thesis.

77. Dambolena, I.G., F.C. Kaminsky and R.F. Rikkers. Model for the economic evaluation of wind-power systems. Joint National Meeting of the Operations Research Society of America and the Institute of Management Sciences, Boston, April 22, 1974. Amherst, Mass., University of Massachusetts, Department of Industrial Engineering, 1974.

3, 6

78. Dambolena, I.G., F.C. Kaminsky and R.F. Rikkers. A planning methodology for the analysis and design of wind-power systems. Intersociety Energy Conversion Engineering Conference, 9th, San Francisco, 1974. New York, American Society of Mechanical Engineers, 1974, p. 281-287.

3, 6

This is a review of the results obtained from the analysis of a specific wind-power system for the New England area performed by means of a described computer-based planning model designed to aid in the cost evaluation and performance simulation of alternative wind-power systems. Based on the low-cost promise of these results, it is argued that further research on wind-powered systems should be pursued and that similar planning models should be developed for the evaluation of other alternative energy systems.

79. Daniels, F. Direct use of the sun's energy. Westminster, Maryland, Ballentine Books, 1974. 271 p.

2, 4

Included in this book is a section on wind energy.

80. Davis, A.J. and R.P. Schubert. Alternative natural energy sources in building design. Blacksburg, Va., Passive Energy Systems, 1974. 252 p.

2, 8

Information needed to design a building using alternative natural energy sources is presented in this book. In the first chapter the energy consumed in buildings is studied, considering current technological solutions to energy problems, and practical alternatives to present technology. Chapter Two

examines the effect of climate on building design. Chapter Three, "Energy Conservation," covers these topics: life cycle costs; conservation through the use of materials; the exclusion or inclusion of natural environment; windows; the collection, distribution, and utilization of waste heat; lighting systems; and heat transmission coefficients. Natural methods of cooling and ventilation are reviewed in Chpater Four. Chapters Five through Eight discuss the use of these alternative energy sources: water power, wind power, solar energy, and organic fuels. Integrated systems, using more than one alternative energy source, are described in Chapter Nine.

81. Dorner, H. Approaches to the optimal design of wind energy generators. Seminar Windenergie, Julich, Germany, 12 September 1974. Julich, Germany, Kernforschungsanlage, 1974, p. 53-116. (In German)
3, 5

A comprehensive survey, including an outline of the history of wind energy engineering, with discussions of the more important recent experimental projects of sizes up to 1200 kW is described. The current state of development of the aerodynamic theory of wind energy generation is described, with illustrations by comparative performance curves for the various experimental generators.

82. Eldridge, F.R. Excerpts on wind energy and related subjects. A report submitted to the Subcommittee on Energy, Committee on Science and Astronautics, U.S. House of Representatives, June 10, 1974.
6

83. Eldridge, F.R. Wind powered aqueduct systems and wind energy storage options. Mitre Corp. Report No. M74-108, October 1974.
11, 15

84. Emerson, F. Energy: the search is on. New York Post, March 18, 1974, p. 4.
4

Discussions on future sources of energy examine the potential of coal gasification and nuclear, solar, geothermal, tidal, and wind energy. Technological and economic limitations are discussed for each solution.

85. Energy crisis and energy from the sun. Symposium on Solar Energy Utilization and Panel Discussion on Solar Energy Programs and Progress, Washington, D.C., 1974. M.P. Thekaekara, ed., Washington, National Science Foundation, November 1974.
3, 4, 6

86. Energy in Oklahoma. Vol. 1. Final Report of Oklahoma Energy Advisory Council, February 1, 1974. Oklahoma City, Ok., Oklahoma Energy Advisory Council, 1974.
6

87. Energy-related research and development. Prepared at the request of Frank E. Moss, Chairman, Committee on Aeronautical and Space Sciences, U.S. Senate. U.S. Senate, Committee on Aeronautical and Space Sciences. Washington, D.C., G.P.O., 1974.
4, 6

The NASA energy-related R&D programs discussed are intended to complement government-wide plans and programs now being developed and implemented. NASA's 1974 energy-related R&D comprises work in various technical fields in which technology developed for space and aeronautics has useful applications to energy needs and problems on earth. The projects include: work in solar energy utilization; wind energy systems; energy conversion, transmission and storage; transportation systems; and energy and environmental conservation. NASA projects directed to the near-term use of solar energy include a demonstration test of a residential solar heating and cooling unit and a technology program to advance the state of the art of the components and subsystems for solar heating and cooling systems. Work on solar energy utilization that could be significant in the future includes technical and economical studies of some of the components of space-based systems in which solar energy would be collected and converted to electricity in space and transmitted to earth by microwave beams.

88. Environmental action, special issue: Energy alternatives. Environ. Action 5(18): 15 p., February 1974.
4

89. Exciting concepts but with long roads to power. Coal Age 79(4): 106-110, April 1974.
4

90. Fedotov, V., and V.P. Kharitonov. Standardized wind electric power unit. Mekhanizatiya i Elektrifikatsiya No. 7: 43-44, 1971. Translation: Army Foreign Science and Technology Center, Charlottesville, Virginia. NTIS, AD783764, May 9, 1974. 6 p.
14

91. Ford Foundation. Energy Policy Project. Exploring energy choices; a preliminary report of the Ford Foundation's Energy Policy Project. Washington, D.C., Energy Policy Project, 1974. 81 p.
2, 4, 6

This report gives an excellent summary of our present energy situation. It is well documented, with plenty of facts and

figures. The most interesting part, however, is an examination of three possible energy futures which could result from today's decisions. The first, which assumes that present trends continue, strains our resources to the utmost. The second uses conservation and high efficiency technology to reduce demand. In the third, energy growth is reduced to zero through changes in our way of life.

92. Ford Foundation. Energy Policy Project. A time to choose: America's energy future; final report. Cambridge, Mass., Ballinger Publ. Co., 1974. 511 p.

2, 4, 6

93. Fuller, R.B. Energy through wind power. New York Times, January 17, 1974, p. 39.

4

Possible use of solar and wind energy is discussed. Wind power is in a class by itself as the greatest terrestrial medium for harnessing and conserving solar energy.

94. Fuller, R.B. Written on the wind. Harper 248: 101, June 1974.

4

95. Gabel, J. Utilisation of unconventional energy resources. Elektrotech. Z. (ETZ) B 26(10): 264-6, May 3, 1974.

4, 6

Discussed are methods of utilizing solar, water, wind and geothermal energy. Several suggestions are described of their possible realization.

96. Glaser, P.E. An overview of solar energy applications. In: NEREM 74; Northeast Electronics Research and Engineering Meeting, Boston, October 28-31, 1974. Record. Part. 1, p. 45-50. Newton, Mass., Institute of Electrical and Electronics Engineers, Inc., 1974.

3, 6

The paper reviews briefly some of the main approaches under study and development for harnessing the sun's energy. This includes solar heating and cooling systems, renewable gas and oil fuels, solar heat engine power plants, wind energy, ocean thermal gradients, direct energy conversion using solar cells, and solar energy conversion in space for use on earth. It is pointed out that although a solar heating and cooling system is still more expensive to install than a fossil fuel system, the total costs during the operational life of the two systems are expected to be comparable in view of the spiralling prices of fossil fuels.

1974

97. Glaser, P.E. Solar power options. Symposium on Solar Energy Utilization and Panel Discussion on Solar Energy Programs and Progress, Washington, D.C., 1974. M.P. Thekaekara, ed., Washington, National Science Foundation, November 1974, p. 75-87.

3, 6, 7

Solar power potential is discussed vs. future needs. with particular attention to large-scale solar energy conversion to power by using wind, ocean thermal gradients, solar-powered heat engines, and photovoltaic energy conversion on earth and in space. The past development and the state of the art of this technology are reviewed with a projection into the future. Cost projections are given on the basis of available data. The prospects of solar energy applications are believed to be bright but slow, with significant advances over the next few decades.

98. Glaser, P.E. Tomorrow solar energy. Ind. At. Spat. 18(1): 26-30, 1974.

4, 6, 7

The worldwide concern with increasing energy consumption and the resulting undesirable effects on the environment have led to a reassessment of the potential of solar energy to meet future energy demands. Solar energy represents an inexhaustible energy source which is usefully converted and has the potential to meet a significant portion of the world's future energy requirements. The technology underlying solar energy applications is known, although substantial developments, particularly to achieve mass production and resulting cost reductions will be required. Solar energy for heating and cooling of buildings shows promise of wide-scale application over the next decade and represents not only a major means for energy conservation but also a potentially significant market for industry. Several options for the large scale use of solar energy for production of electricity, including solar thermal conversion, the direct conversion of solar energy by the photovoltaic process and the utilization of wind power and the temperature difference of sun-warmed oceans waters, if successfully developed would provide society with a significant energy alternative for the future.

99. Gohar, M.K. Improve gas turbine efficiency. Presented at 9th World Energy Conference, Detroit, September 22-27, 1974. Part 4, p. 1-21.

3, 5

1974

100. Hackleman, M. The Savonius super rotor! Mother Earth News, No. 26: 78-81, March 1974.
8

Use of the S-rotor at Earthmind, a California farm research center, is described.

101. Hackleman, M.A. Wind and windspinners: a nuts and bolts approach to wind-electric systems. Saugus, Cal., Earthmind, 1974. 115 p.
2, 12a

This book is strong on "how to" basics of building your own windplant and includes complete plans for a Savonius rotor wind system.

102. Hambraeus, G. Alternative sources of energy. Foeren. Elektr. Ration. Anvaendning 47(3): 46-50, 1974. (In Swedish)
4

103. Hammond, A.L. Individual self-sufficiency in energy. Science 184(4134): 278-282, April 19, 1974.
4, 12a

The modern autonomous house, using solar power, is described, as well as wind as a source of energy and electric cars.

104. Hartley, W. and E. Hartley. The wind shifts to windmills. Pop. Mech. 142(5): 80-85, November 1974.
4

Henry and Retta Clews built a windmill complex for their home in the Maine woods a few years ago, and people like William Heronemus are thinking in terms of how to use the wind to provide energy for large sections of the country. Heronemus foresees a vast network of windmills floating off the New England coast used to electrolyze seawater into oxygen and hydrogen. Large and small wind energy schemes by individuals and research organizations are discussed. Information on sources of small wind generators in the U.S. is included.

105. Heronemus, W.E. Alternate energy sources from the ocean. Marine Technol. Soc. J. 8(2): 35-38, February 1974.
6

106. Heronemus, W.E. Large-scale exploitability of wind energy for electricity supply. Seminar Windenergie, Julich, Germany, 12 September 1974. Julich, Germany, Kernforschungsanlage, 1974, p. 117-48. (In German)
3, 6, 7

The background of wind energy as an energy source in industrialized countries is reviewed and discussed, particularly with reference to recent R&D developments in the USA. Problems associated with the unpredictable fluctuating character of wind energy and the various possible proved and proposed energy storage media and methods are discussed. The production, collection, transport and use of wind-energy-generated synthetic fuels are discussed. Consideration is given to the economic integration of networks of wind energy generators into conventional electrical energy distribution systems.

107. Heronemus, W.E. Oceanic and atmospheric energy sources. Presented at the Solar Energy Lecture 6, Washington, D.C., March - May 1974: Sponsored by IEEE, Washington Academy of Sciences and Washington Society of Engineers. NTIS, N75-24101, April 18, 1974. 59 p.
3, 4, 6

Solar energy processes are discussed in terms of decreasing consumption of fossil fuels and utilization of renewable energy sources. Emphasis is placed on the windpower process and the ocean thermal differences process which are based on natural collection of solar energy.

108. Heronemus, W.E. A survey of possible use of windpower in Thailand and the Philippines. NTIS, PB245609, November 1974. 143 p.
6

This work was performed in an attempt to answer the question: 'Could windpower be used by the peasant farmer in Thailand or the Philippines to improve the quality of his life.' It was found that windpower was being used to a very limited extent in Thailand to move water, thus relieving either a backbreaking manual labor task, or a very expensive out-of-pocket expenditure for fuel for engine driven pumps. No evidence of existing wind pumping could be found in the Philippines.

109. Heronemus, W.E. Using two renewables. Oceanus 17: 20-27, Summer 1974.
6

The technical and economic feasibility of extracting energy from winds over the oceans and from the thermal differences in the oceans is discussed. A concept for a large wind power electric generating system has been analyzed. The wind power system could service the entire New England electricity market by 1990. The system can produce 360 billion kwh using both electricity in cable and pipeline hydrogen gas energy transmission at a cost well below that of conventional power. Discussed is an ocean thermal differences power plant, which could produce electricity or hydrogen gas at a cost that would allow either product to be transmitted from the gulf stream to almost any point in the U.S. and sold at a competitive price.

1974

110. Heronemus, W.E. Windpower--look backward, then move forward confidently. In: Energy development; Proceedings of the Energy Sources Conferences, Anaheim, Cal., July 14-19, 1974. New York, Institute of Electrical and Electronics Engineers, Inc., 1974, p. 82-88. (Updates entry 1974:33)

3, 6, 8

This is a discussion of the potential of wind power utilization, and review of some wind power electricity systems for use in rural areas. Wind power has failed the test of economics when pitted against heat engines for the generation of electricity in the recent past. Now with rising costs of fossil fuels, wind power could be economic.

111. Herwig, L.O. Solar research and technology. In: Physics and the energy problem - 1974. Edited by M.D. Fiske and W.W. Havens, Jr. American Institute of Physics Conference Proceedings No. 19, New York, A.I.P., 1974, p. 379-400.

3, 4

Wind energy conversion is included in the author's description of the Federal role in solar energy research and technology for terrestrial applications, the solar energy technologies and plans in the National Solar Energy Program, and the research and technology problems that must be solved before practical systems become possible.

112. Hewson, E.W. Wind power potential in selected areas of Oregon. Oregon State University, Report No. PUD 74-2A, August 1974. Second Progress Report (Part I). Corvallis, Oregon, Oregon State University, 1974. 84 p.

6

The research conducted during the second year of the project has been a continuation of that of the first year, along with the development of a new center of activity. The collection and analysis of wind data from various sources, including the wind instruments established in the course of the present research project, has proceeded and a number of conclusions have been drawn from the data analysis. Substantial progress has been made in the wind tunnel simulations of wind flow patterns over a model of a coastal headland. A limited program of pilot balloon observations has been continued in the gorge section of the Columbia River Valley to gain more conclusive information on the severity of atmospheric turbulence in that portion of the valley. The work done in these areas is described in this portion of the report, Part I. The new focus of activity is in the analysis of the structural components of aerogenerators. This program is described in Part II of the Second Progress Report, by R.W. Thresher.

113\. Hicks, N. Energy crisis impels many to study and erect windmills as power source. New York Times, May 20, 1974, p. 33. 6, 8

Wind energy is certainly not being considered as the answer to America's voracious energy needs. But for efficiency and economy it is being investigated as one of several alternative sources in what most experts believe will be a needed energy mix to light homes for the next few decades. NSF and NASA are spending $865,000 in the next two years to test an experimental 100 kw wind generator at the Lewis Research Center in Sandusky, Ohio.

114\. Hiss, W.L. and J.W. Shomaker. Energy Crisis Symposium, Albuquerque, N.M., May 3, 1973. Socorro, N.M., New Mexico Bureau of Mines and Mineral Resources, 1974. 3

115\. Honnef, H. Wind power turbogenerator for high altitude wind utilization. Final Report, October 1970 - September 1973. Translation of German Patent 855,284. NASA-TT-F-15455. NTIS, N74-21677, April 1974. 12 p. 17

116\. Honnef, H. Wind electric power station. Final report, October 1970 - September 1973. Translation of German Patent 871,580. NASA-TT-F-15522. NTIS, N74-21682, April 1974. 14 p. 17

117\. How to cut fat out of the home energy budget. Am. Gas Assoc. Monthly 56(9): 16-20, September 1974. 4

Four ways of reducing the amount of energy used to heat the average American home are: (1) lessen the amount of heat required by lowering the temperature 6°F. The fuel bill can be cut about 20%; (2) keep the heating plant working at top efficiency; (3) retain heat in the house as much as possible through improved insulation; and (4) reduce the amount of cold outside air that enters and must be heated through better caulking and weatherstripping around doors and windows. By decreasing the amount of hot water used and by improving insulation on hot water pipes, the energy bill can also be substantially cut. Alternative sources of energy are also discussed.

118\. Hughes, W.L., et al. Basic information on the economic generation of energy in commercial quantities from wind. Stillwater, Oklahoma, Oklahoma State University, College of Engineering, May 1974. 50 p. 6, 7

If conventional fuels become less available or available at prices comparable to oil at $8.00 to $10.00 a barrel or higher, wind power is expected to become economically competitive for certain applications. Energy from wind can probably be harnessed through simple systems at acceptable capital costs. Wind is not considered the solution to the energy crisis. Because of the intermittency of wind availability, and, therefore, the need for huge storage systems, wind will not replace conventional central power stations. However, electric power from wind could be pumped directly into existing electric transmission line grids. Wind as a fuel supplement for electric utilities is thought to be both economically and technically feasible in the short term. Rather than concentrating on one or two energy sources, a broad energy research policy, which includes wind and solar energy, is recommended. A bibliography of energy research at Oklahoma State University as well as resumes and recent publications of five staff members are included in this document.

119. Hull, A. and L. Pitt. New NOAA Laboratory for Environmental Assessment. Env. Data Serv., May 1974, p. 8-10.

4

Specific objectives of the new NOAA Laboratory for Environmental Assessment are to (1) model the environmental impact on: grain production in major crop regions of the world; energy distribution/demand for electric power, natural gas, fuel oil, and other conventional energy sources; production/yield of fish in oceans and coastal waters; energy production from solar radiation, tides, winds, and geothermal sources; (2) systematically assess large scale climate/weather changes and interpret their impact on energy demand, major grain-producing areas, and fish production; (3) develop new applications of historical data bases to environmental problems; and (4) utilize climatic assessments in the planning and siting of refineries, nuclear and other power and industrial plants to help reduce man-caused accidents.

120. The hydrogen economy--state of the art. Presented at 9th World Energy Conference, Detroit, September 22-27, 1974, p. 5.1-18.

3, 4

The present state of the art of the hydrogen economy is presented. The majority of references are taken from presentations of the Hydrogen Economy Miami Energy Conference held at Miami Beach in March 18-20, 1974. The conference provided a forum for discussions of all aspects of hydrogen technology, which could offer the world an alternative to the fossil fuel economy. Much work is necessary before a fully implemented hydrogen economy is economically and technically feasible. The basic assumption is that the environmental and societal benefits of implementing a full hydrogen economy will be worth the time and effort, and the certain amount of risk involved. Utilization of hydrogen energy in transportation (automotive and aviation), as an appliance fuel, in electrical energy systems, and in other capacities is discussed.

121. International Solar Energy Society. U.S. Section Annual Meeting, August 20-23, 1974, Fort Collins, Colorado. Technical Program and Abstracts. Fort Collins, International Solar Energy Society, 1974.
3, 4

122. Jensen, N.O. Wind power. In: Physics Department Annual Progress Report, 1 January - 31 December 1974. Moeller, H.B. and B. Lebech, eds. Risoe, Denmark, Danish Atomic Energy Commission. Research Establishment, December 1974. NTIS, RISO-320, 1974, p. 82-83.
4

123. Johansson, M. Exploiting wind power for the production of electricity. Translation from the Danish Report TR-152, date unknown. Translation: Kanner Associates, Redwood City, Cal. NTIS, N75-13385, December 1974. 55 p.
6

The economic, energy-economic, and environmental issues involved in any prospective exploitation of wind power intended to cover a minor part (10%) of Denmark's consumption of electricity are discussed. The chief basis for the calculations involved is the 200 kW experimental windmill built at Gedser in 1956-57, which ceased to produce electricity in 1967. However, in exploring the ramifications of making Denmark partially dependent on wind energy power, estimates are made on the basis of projected larger series of mills of the Gedser type. Windmill projects abroad, such as Vattenfall, NSF and NASA, are also discussed, as is Denmark's dependence on power from Sweden and Germany.

124. Johnson, C.C., R.T. Smith and R.K. Swanson. Wind power development and applications. Power Eng. 78(10): 50-53, October 1974.
4, 6

125. Johnson, K.E. Non-conventional systems. Chem. Can. 26(10): 31-33, November 1974.
4

MHD, electrohydrodynamic power generation, piezoelectric generators, ferroelectric generators, thermoelectric generators, fuel cells, wind energy, and geothermal energy are discussed. In Canada, wind energy, fuel cells, and thermoelectric power generation could be researched and developed usefully in the next few years.

1974

126. Jufer, M. The NOAH wind energy plant on Sylt: design, experience, prospects. Seminar Windenergie, Julich, Germany, 12 September 1974. Julich, Germany, Kernforschungsanlage, 1974, p. 27-51. (In German)
3, 6, 7

A detailed account is given, followed by a discussion, of the NOAH wind energy generator project, the 70 kW generator of which was installed on the North Sea Island of Sylt in 1973. Particular attention has been paid in this project, to the study of economic as well as engineering aspects of large-scale wind energy generation.

127. Keller, M.A. Windmill power to the people! Parents Mag. 49: 30-31, 52, December 1974.
4, 8

Henry Clew's wind-powered home is described.

128. Larsen, J. Alternate energy pipe dreams. New York Times 2(7): 30-35, April 5, 1974.
4

Alternate energy sources--windmills, solar battery stations, even barnyard droppings--are a long way from breaking the fossil fuel lock on energy and closing the widening gap between U.S. reserves and needs. While every effort should be made to develop these energy sources to new levels of productivity, billions of dollars will have to be spent in R&D and capital expenses before alternate energies can begin to make a significant contribution.

129. Lean, B. Flywheels. Pasadena, Cal. California Institute of Technology, January 8, 1974. 13 p.
5

130. Lerza, C., et al. How to kick the fossil fuel habit. Env. Action 5(18): 3-11, February 2, 1974.
4

Alternative energy sources to fossil fuels are discussed. The technological potential, economic feasibility, and environmental aspects of solar, wind, geothermal, tidal, thermal sea, fission, fusion, and organic energies are explained in simple language. Pursuit of shale oil and production of synthetic natural gas are also described.

131. Lindsley, E.F. Wind power: how new technology is harnessing an age-old energy source. Pop. Sci. 205(1): 54-9, July 1974.
4, 6

The largest and most costly wind power project to date is NASA/NSF's Mod-Zero 125 foot diameter windmill which is expected to produce 100 kw. A preliminary schematic is shown. The project is in the basic systems analysis phase, where various configurations are first run through a computer to see how they'll perform. Earlier wind power projects started first with the mechanics--and were doomed to failure. The systems approach put men on the moon; it could put the wind to work, too.

132. Love, S. The overconnected society. Futurist 8(6): 293-295, December 1974.

4

Society today is so overconnected that a disturbance in any are may threaten the whole system. To regain stability, people should seek to disconnect themselves--at least to some degree--from the world's heavily centralized systems. The clues to dynamic stability in natural ecosystems are explained. Future communities built around solar and wind power, and complexes of city rooftop food production are described.

133. McKee, J. Rewinding alternators. Alt. Sources Energy, No. 16, 22, December 1974.

12a

The author's experiments adapting an automobile alternator for wind generator use are discussed.

134. MacKillop, A. Low energy area systems. Ecologist 4(8): 298-300, October 1974.

4

The concept of decentralized energy systems is explained. National-scale grids, especially for supplying high-grade electricity, will become more and more difficult to maintain on economic ground. Domestic and local-area scale methods for servicing energy needs will become more important. Greatest use of new energy sources with least environmental damage calls for decentralized supply systems. Wind energy systems are briefly discussed.

135. McNerney, N.C. and T.F.P. Sullivan, eds. Energy reference handbook. Washington, D.C., Government Institutes Inc., 1974. 280 p.

2, 4

136. Magoveny, G.S. and E.J. Forgo. U.S. Patent 3,938,907. June 24, 1974.

9, 17

A horizontal multidirectional windmill is described which comprises a fixed housing and a rotor, the housing being constituted by upper and lower horizontally disposed members and a plurality of vertically disposed vanes extending between the members. The rotor is constituted by upper and lower horizontally disposed members lying in the planes of the housing members. A vertical axle is secured to the rotor members. A vertical axle is secured to the rotor members. Buckets are mounted between the rotor members and extend inwardly from the periphery thereof. Each bucket has a flexible vertically disposed surface portion and supports for the inner and outer edges of the portions. The distance between the supports is varied automatically as a function of rotational speed of the rotor.

137. Maitre, J., J. Girard and R. Plantadis. Les Sources d'energie autonomes dans les telecommunications. [Autonomous power sources in telecommunications.] Commutation Electron 44: 85-96, January 1974. (In French)

8, 15

This paper describes two autonomous power sources directly supplied by nature, i.e., light and wind, which may be utilized for telecommunication systems. It is not the purpose of the article to discuss thoroughly the principles used, for this may be easily found elsewhere; it only explains what can be now expected from the utilization of these power sources.

138. Marine, G. Alternate energy: here comes the sun. Ramparts 12(8): 33-37, March 1974.

6, 8

Throughout the energy crisis, public discussion is being conducted as though energy must come from some large central source. Yet it may be just as efficient and far cheaper for an apartment building or a small group of homes to provide its own energy through a combination of simple methods. In a small town with an imaginative citizenry such power would be easy to produce. Solar, tidal, wind, and human waste energy systems are described.

139. Marshall, O.W., R.T. Morash and R.J. Barber. Independent energy systems for better efficiency. Intersociety Energy Conversion Engineering Conference, 9th, San Francisco, 1974. New York, American Society of Mechanical Engineers, 1974.

3, 4

140. Martin, J. Energy from the wind, tomorrow? Ing. Tech. 291: 25-32, December 1974. (In French)

6, 11

This is a descriptive article about the use of, and possible use of windmills as prime movers in electrical power generation. The total amount of wind energy available has been put at about 2.5×10^{15} kWh per annum over all the world. In France it represents an average of 800 kWh/m^2 of exposed surface and per annum, but can reach 4000 kW/m^2 per annum in some regions such as the Breton or Roussillon coasts. Numerous types of windmills are described with the aid of diagrams and notes on their characteristics. Reference is made to electricity storage, e.g., in secondary batteries and other chemical means, thermal storage, etc.

141. May, T.H. and W.R. Kube. Review of alternate energy sources. University of North Dakota, Engineering Experiment Station. NP-20606. Grand Forks, N.D., 1974. 127 p.

4

142. Meador, R. Future energies. Ann Arbor, Mich., Ann Arbor Science Publ., 1974. 63 p.

2, 4

When fossil and atomic fission fuels are gone, when shortages become permanent, what then? Future energies, including wind, are discussed.

143. Merriam, M.F. Wind energy for human needs. Lawrence Berkeley Lab., California University. NTIS, UCID-3724, November 1974. 100 p.

1, 6

A review of the history of wind utilization is presented. Wind machines that are in use or have been considered are categorized as small when the power output is up to 2 kW; medium, up to 100 kW; and large, when output is over 100 kW. The largest wind machine that ever operated was the 1250-kW Smith-Putnam wind turbine; the largest factory-produced machine today is a 6-kW model. A 100-kW test unit is being erected near Sandusky, Ohio by NASA to be operational in 1975. Environmental and engineering aspects, application areas, and geographical regions of greatest promise are discussed. To fully utilize the intermittent wind energy, an interruptible load, an energy storage system, or a standby source able to respond on demand is required. Examples of these alternatives are: interruptible load (pumping water for livestock or irrigation, driving refrigeration compressor for large-thermal-capacity cold-storage plant); energy-storage system of electrochemical storage batteries, flywheels, or pumping water for later generation of electric power through a hydraulic turbine; or a standby source of hydroelectric power dam, diesel generator, gas or steam turbine. Using wind-generated electricity to electrolyze hydrogen is interruptible load if the hydrogen is used for cooking fuel; it is an energy storage system if the hydrogen is stored to be reconverted to electricity with a fuel cell or an engine generator set. A 5-kW wind-hydro scheme is analyzed for Amarillo, Texas in Appendix A. It is concluded that the system is expensive and cumbersome, requires a large reservoir and a lot of equipment for providing only a small amount of firm power, but provides reliable electric power with zero fuel consumption and minimal maintenance.

144. Metz, W., et al. How to kick the fossil fuel habit. Environ. Action 5(1): 3-11, February 2, 1974.
4, 6

145. Meyer, J.W., W.J. Jones and M.M. Kessler. Energy supply, demand/need and the gaps between. Volume II. Monograph, Working Papers and Appendix Papers. Final Report. NTIS, PB243977, December 1, 1974. 300 p.
4, 6

This report contains a number of working papers and monographs written in non-scientific language for the general public describing the state-of-the-art and possibilities of several alternatives, including wind, for helping in the near- and long-term energy crisis.

146. Morse, F.H. Solar energy as a national energy resource. Presented at the 9th World Energy Conference, Detroit, September 22-27, 1974, p. 3.1-11.
3, 4

The U.S. Solar Energy Panel assessed the potential of solar energy as a national energy resource and found three areas where solar energy could supply significant amounts of the U.S. future energy needs: energy for heating and cooling of buildings, production of fuels, and generation of electrical power. With adequate R&D support, by the year 2020 solar energy could provide at least 35% of the heating and cooling of future buildings, greater than 30% of the methane and hydrogen needed in the U.S., and greater than 20% of the electrical power needs of the U.S. All of this could be done with minimal effect on the environment and substantial savings of nonrenewable fuels. Various solar energy applications are described, and the goals, objectives, and status of the R&D programs for each of these applications is summarized.

147. The Mother Earth News handbook of homemade power. By the Staff of the Mother Earth News. New York, Bantam Books, 1974. 374 p.
2, 4, 8, 12a

This book is packed with information about alternative energy systems, including windpower, which you can put to work right now. Emphasis is on homebuilt small scale systems. Six articles on windpower are included.

148. NSF/NASA Utility Wind Energy Conference, December 17, 1974, Cleveland, Ohio. CONF-741242, 1974.

3, 4

The charts, graphs, data tables, illustrations, and photographs used in the 5 papers on wind turbine generator development programs are presented.

149. Nelson, V. and E. Gilmore. Potential for wind generated power in Texas. Final Report. Prepared in cooperation with Amarillo College Department of Physical Science and West Texas State University. NTIS, PB243349, October 15, 1974. 168 p.

6

General information on wind energy and a summary of current information on wind energy conversion systems are presented. The data from 15 National Weather Services staitons in Texas (1959-1972) and 7 neighboring stations (1964-1973) are analyzed for average energy by month and year, wind speed histograms, wind velocity and power duration curves, and probability of calm periods. Contour maps for energy at 23 ft height and 300 ft (estimated) and probability contours for wind speeds are plotted. Estimations of power possible uses and number of units to be built, estimations of costs, and storage are discussed for wind energy conversion systems. The overall conclusion is that the state should support a program to advance the utilization of wind energy. Recommendations are made for policies, procedures, specific research, and a proof of concept experiment.

150. New look for windmills. Sci. Dig. 75(6): 71, June 1974.

4

The Princeton sailwing windmill is discussed.

151. Other technical concepts are exciting but their roads to power are long. Coal Age 79(4): 106-110, April 1974.

6

Space heating, followed by solar-derived electricity, will be the first widespread use of solar energy. Solar climate control technology, solar generation of electricity, and photovoltaic conversion are described. The concept of MHD is of obvious interest because it has potential to boost thermal efficiency of fossil-fueled power plants by as much as 50% over their best present performances. MHD, which bypasses the need to transform fuel first into mechanical energy for driving turbines, is briefly explained. The Federal government has a small but definite commitment to wind research; NASA is now testing a twin-bladed unit and a large wind machine is being examined at the Lewis Research Center near Cleveland. Unfortunately, governmental expenditures are too low to yield enough information on wind power. Solid waste energy--attractive even though it probably will not account for more than 2% of the nations total energy generation--is a clean, environmentally sound method for urban waste disposal. Synthetic fuel and direct use of waste are briefly discussed.

152. Park, J. Hybrid windmills. Alt. Sources Energy, No. 16: 23, December 1974.

9, 12a

The author's experiments with windmills are described. A "Hybrid" is a vertical axis machine which makes use of aerodynamic lift to produce power.

153. Parr, H., et al. Alternative energy sources. VII. Report from the Norwegian Nature Conservancy Association, Prepared by the Associations's Energy Group. Oslo, Norges Naturvernforbund, 1974. (In Norwegian)

4, 6

154. Passi, R.M. Wind determination using Omega signals. J. Appl. Meteorol. 13: 934-939, December 1974.

6

This paper is from the Omega Windfinding Workshop, Boulder Colorado, September 18, 1974.

155. Pesko, C. Solar Directory. Ann Arbor, Michigan. Ann Arbor Science Publishers, 1974. 650 p.

2, 4

This book includes manufacturers of solar equipment; government agencies, academic institutions, industries, and individuals in solar energy research and development; descriptions of current solar projects; and an annotated bibliography of pertinent literature. Some wind power information is included.

156. Plumlee, R.H. Perspectives in U.S. energy resource development. Environ. Aff. 3(1): 1-45, 1974.

6

157. Powe, R.E., et al. Wind energy conversion system based on the tracked-vehicle airfoil concept. Intersociety Energy Conversion Engineering Conference, 9th, Proceedings, Paper 749010, p. 288-297, 1974.

3, 5

A unique momentum interchange device for extraction of energy from the wind is described in this paper. It is shown that the maximum possible energy extraction with this tracked-vehicle airfoil device is greater than that for a conventional windmill. A comprehensive mathematical model is developed for the device, and this model is programmed for solution on a digital computer. This program is written so that wind spectrum data for any geographic location can be used to determine the monthly energy output for that location. Results from this program indicate that this device could make significant contributions to electrical power requirements.

158. Power from windmills; questions and answers. Electr. Constr. & Maint. 73: 109+, October 1974.

4

159. Program solicitation: research on wind energy conversion systems. Division of Advanced Energy and Research and Technology, National Science Foundation, Washington, D.C. NTIS, NP-20408, July 17, 1974. 15 p.

6

The Research Applications Directorate of the National Science Foundation intends to provide approximately $3,000,000 for research on advanced systems, subsystems and associated problem areas related to advancing the capability of extracting useful energy from the wind. Proposals are being sought in six categories: wind energy mission analysis; applications of wind energy systems; wind characteristics; subsystems and components research and technology; advanced or innovative system concepts; and advanced farm and rural use systems. Information on research categories and requirements for submitting proposals are described.

160. Project Independence Blueprint, Final Task Force Report. Solar Energy. Prepared by Interagency Task Force on Solar Energy under direction of National Science Foundation. U.S. Gov. Printing Office, November 1974. 582 p.

4, 6

Section IV is an 81-page report of the WECS - Wind Energy Conversion Systems - program of Project Independence.

161. Prototype wind generator uses semi-rigid airfoil. Avaiation Week & Space Technol. 100(13): 41, April 1, 1974.

5, 12b

Grumman Aerospace Corporation's new small wind generator, Sailwing, is described. The complete system, weighing only 300 lbs., will sell for as little as $3,500 to $4000. The generator should be on the market by January 1, 1975. The Sailwing airfoil was developed from a high-performance light aircraft wing.

162. Quigg, P.W. Eggbeater windmills. Sat. Rev. World 1: 37-8, June 15, 1974.
4, 9

Vertical axis windmills are discussed.

163. Ramakumar, R. Prospects for tapping solar energy on a large scale. Solar Energy 16(2): 107-115, October 1974.
6

Because of the energy conversion and storage research under way at Oklahoma State University since 1961, several components needed to engineer a continuous-duty energy system operating on replenishable solar energy have been developed to the prototype stage and are being tested. These components are presented and discussed, and how they fit into the solar energy system envisioned for the long-term and immediate future is considered. A simplified economic analysis of solar systems is presented, and the calculated generation costs are compared with those of conventional fuel burning systems for difference fuel costs, load factors, and interest rates. One result of the study is that wind energy systems are found to be competitive with conventional systems.

164. Ramakumar, R., H.J. Allison and W.L. Hughes. Solar energy conversion and storage systems for the future. Energy Sources Conference, Anaheim, Cal., 1974. Proceedings. New York, IEEE, 1974, p. 12-20.
3, 6, 11

The possible utilization of solar energy in its various manifestations such as heat, winds, tides, and ocean thermal gradients is reviewed. Methods of solar energy collection, conversion and utilization are examined, along with the solar energy potential. Special attention is given to various systems for meeting the needs of solar energy storage. The systems considered include: (1) thermal energy storage using hot water or hot rocks; (2) potential energy storage by pumping water to a higher elevation, by compressing air or springs; (3) chemical energy storage using hydorgen or secondary batteries; (4) kinetic energy storage as in flywheels; and (5) energy storage in electromagnetic fields using capacitors or superconducting magnets. It is argued that solar energy must play a significant role in solving the energy problem of the world.

165. Ramakumar, R., W.L. Hughes and H.J. Allison. Economic and technical aspects of wind generation systems. International Conference on Systems, Man and Cybernetics. Proceedings. Dallas, Texas, October 2-4, 1974, p. 88-92. New York, IEEE, 1974.
3, 6

Wind energy systems have the potential to provide a viable alternative to fossil fuels to satisfy the ever increasing

energy appetite of the world. A simplified economic analysis of wind energy systems of the type being developed at Oklahoma State University is presented and the calculated generation costs in mils per kWh are compared with those of conventional fuel-burning systems for different fuel costs, load factors and interest rates. The results show that certain aspects of wind energy conversion can, at present, generate energy at costs competitive with conventional systems and that more favorable conditions can be expected in the future as fossil fuels become scarce and fuel costs further go up as predicted.

166. Red Rocker, W. Wind design feedback. Alt. Sources Energy, No. 16: 22-23, December 1974.

12a

The author's experiences in using a wind generator discussed in an earlier issue of A.S.E. are described. (A.S.E. #8, 1973)

167. Reed, J.W. Some notes on wind power climatology. Climatology Conference and Workshop, Asheville, N.C., October 8, 1974. SAND-74-5439. NTIS, CONF-741045-1, 1974. 14 p.

3, 6

The history and states of wind turbines and the meteorological considerations of the wind energy potential in New Mexico are analyzed.

168. Reed, J.W. Wind power climatology. Weatherwise 27(6): 236-242, December 1974.

6

Wind power maps that are primarily useful in determining where wind power projects could be most beneficial are included. Atlanta, Phoenix, or Los Angeles might not be competitive. Array fields in the Texas panhandle or Wyoming are remote from the major energy markets and close to supplies of competitive fossil fuels.

169. Rittelmann, P.R. Using solar energy in residential housing. Constr. Specifier 27(7) 20-25, 27, 29-32, July 1974.

8

The author describes a solar demonstration project house that shows the integration of mechanical systems with contemporary and functional architectural design--a design that responds to the severe energy conservation requirements of a solar system. Mechanical systems include a solar thermal collection system, a photovoltaic conservation system, a wind-driven electrical generation system, and an aerobic composter for organic wastes.

1974

170. Rodgers, W. Research & corruption--the Exxon-Nixxon axis. Nation 218(1): 11-16, January 5, 1974.

4

Taking place under cover of the energy panic is an incestuous merger of economic and political forces represented by the Exxon-Nixxon axis, beneath which remains of an open market are being interred. R&D in wind, solar, and geothermal energy have not been established because Nixon and industrial advisory councils have eliminated worthwhile proposals that failed to offer optimum opportunities to the oil industry.

171. Salieva, R.B. Generalizations of composite studies involving combined use of wind and solar energy. Appl. Solar Energy 10(5-6): 39-42, 1974.

6, 8

Sample calculations were made using the composite method for the situation of water supply to pastures and electrical power supply to radio relay stations; results of these calculations are presented. Wind and solar installations were assumed to operate simultaneously and to have a common electrical accumulator; this accumulator supplies power when neither of the installations is functioning. The advantages of combined utilization of wind-solar energy are demonstrated, particularly in the case of relatively small-scale consumers spread out over an extensive, transportationally rigorous terrain.

172. Salieva, R.B. Principles of a composite study involving combined use of solar and wind energy. Appl. Solar Energy 10(5-6): 35-38, 1974.

6

A theoretical comparison of the productivity of wind and solar power installations, as determined from variations in wind speed and solar radiation intensity, is given. The productivities are represented as regular stochastic processes. The complementary nature of the annual chronological variation patterns of wind and solar energy fluxes suggests combined use of these sources.

173. Savino, J.M. The U.S. wind power program. In: Energy resources and management, Zung, Z.T., ed. Rolla, Mo., University of Missouri-Rolla, 1974, p. 43-45.

4

174. Scala, S.M. and K. Sittel. Considerations regarding a utilization of solar energy. V.D.I. Ber. 224: 93-110, 1974. (In German)

6

The characteristic data regarding solar energy are considered, giving attention to solar radiation intensity at the boundary of the terrestrial atmosphere and at the surface of the earth. Questions of spectral distribution are examined along with aspects of radiation absorption, the latitude dependence of radiation, and temporal variations in radiation intensity. Systems for the utilization of solar energy are discussed, taking into account the current state of development of the available utilization methods and approaches for overcoming existing technical problems. Attention is given to the utilization of solar energy in buildings, the generation of electric power from solar energy, and the use of wind energy.

175. Schultz, W.C. Wind power plant. U.S. Patent 3,930,750. April 8, 1974.

9, 17

A power plant of the windmill type is described comprising: a supporting structure, a propeller unit mounted on the supporting structure for rotation about a vertical axis and including a hub, a plurality of vanes affixed to the hub, each of the vanes having a shell of a generally parabolic cross-section defining a leading edge with a symmetrical air foil configuration and further defining an open trailing edge, and a zig-zag shaped webbing member mounted within the shell to define a series of essentially triangular individual cells extending the length of the shell and exposed to the open trailing edge.

176. Seaborg, G. Finding a new approach to energetics--fast. Sat. Rev. World 2(7): 44-47, December 14, 1974.

4

The foundation of a coherent and realistic national energy policy must be based on equal doses of energy conservation and the development of additional sources. Large reductions in energy use are possible, as high as half of the current 4.5%/yr growth rate. The long-term outlook for solar, geothermal, fusion, and wind energy is good. In the short term, only coal and nuclear energy can make large contributions to domestic energy supplies. Eventually a recycle society, in which virtually all materials will be reused indefinitely, will be necessary.

177. Selected papers on energy research. Stillwater, Oklahoma, Oklahoma State University, 1974.

4

178. Shaheen, E.I. Is the energy crisis fabrication or miscalculation. Env. Sci. Technol. 8(4): 316-20, April 1974.

4

179. Shell platforms utilize wind and sun power. Pet. Eng. 46: 14, September 1974.

8, 15

180. Shell tests windmill generators offshore. Oil Gas J. 72(36): 92, September 9, 1974.

8, 15

Shell Oil Co. is studying installation of windmill generators on nearly 250 unmanned platforms in the Gulf of Mexico to save energy and operational costs. The generators provide power for fog horns and navigational lights. Details of existing trial units are presented.

181. Shoupp, W.E. Involving the oceans in solving energy problems. Marine Technol. Soc. J. 8(2): 18-24, February 1974.

6

182. Shumann, W.A. NASA spurs wind generator program. Aviation Week & Space Technol. 100(13): 41, April 1, 1974.

4, 14

NASA's Lewis Research Center will erect and operate a 100-kw wind turbine generator at its Plum Brook Station. The generator and NASA's plans for it are described.

183. Shupe, J.W. Natural energy systems for Hawaii--and the world. U.N. Non-Government Organization Conference, Nairobi, March 1974. 4 p.

3, 4, 6

The economy of Hawaii is particularly vulnerable to dislocations in the global energy market. This is a travesty, since there are few places in the world so generously endowed with natural energy: geothermal, solar radiation, ocean temperature differential, wind, waves, and ocean currents. Included in the bills recommended for passage in the 1974 state legislature is an act to establish the Hawaii Natural Energy Institute at the University of Hawaii. The Institute would communicate with research organizations throughout the world to hasten replacement of fossil fuel and nuclear fission power plants by nonpolluting renewable natural energy systems. Natural energy systems are briefly explained.

184. Smith, F.G.W. Power from the oceans. Sea Frontiers 20(2): 87-99, March-April 1974.

4

The solar energy cycle heating the ocean surface can be tapped through: wind; hydroelectric power from the water vapor in the form of rain; waves; and thermal ocean currents. Each of these power sources is described and illustrated with simplified drawings. The combination of these energy sources may provide the answer to the search for an unlimited source of clean energy. Geothermal energy is also briefly described.

185. Smith, G.E. Environmental outlines 13. The autonomous house. Dev. Forum. 2(5): 10, June 1974.
4

An autonomous house is largely independent of electricity, fossil fuel, food and sewage disposal. Such a project in the U.K. uses solar heat, batteries for electric storage, and aerobic and anaerobic decomposition for waste disposal. Energy collection, conservation, and storage; water collection and storage; and organic nutrient conservation are described.

186. Smith, R.T., et al. Wind energy utilization. Final report. National Science Foundation Grant GZ-2932, October 1974.
6

187. Snarbach, H.C. Wind powered rotating device. U.S. Patent 3,941,504. August 28, 1974.
17

An omni-directional windmill device is described which consists of a plurality of blades circumferentially symmetrically disposed with respect to each other. Each of the blades has a lower edge and upper edge. Each of the blades has a wind reaction surface being arcuate in transverse cross section and helically formed longitudinally from the lower to the upper edge.

188. Soderholm, L.H. Wind-electric power. ASAE Annual Meeting, 67th, Oklahoma State University, June 23-26, 1974, and Winter Meeting, Chicago, December 10-13, 1974. Paper 74-3503, March 1974. 12 p.
3, 6

Some basic theoretical and practical considerations for the use of wind power as an energy source are discussed. Estimates of available wind energy are given for Des Moines, Iowa from 1973 weather data. The effect of wind velocity measurement interval and transducer response speed on estimating wind power is also considered. Tables, curves, and plate illustrate use.

189. Solar energy and advanced concepts. Washington, D.C. USAEC. NTIS, TID-26752, November 11, 1974. 87 p.
4

The solar energy R and D for FY1975 is presented and an addendum is provided for additional information. The program scope and major components for solar energy, wind energy, and advanced concepts are described. A survey is given on on-going and planned activities for heating and cooling of buildings, solar thermal conversion, photovoltaic conversion, photochemical conversion, bioconversion, ocean thermal conversion, wind energy conversion, and advanced concepts. A summary of the budget breakdown by Agency for each activity is given. Additional data are provided on the R and D programs, with emphasis on the role of ERDA in the solar energy program.

190. Solar energy research and development. Joint Committee on Atomic Energy. Hearings. 93d Congress, 2d Session, May 7-8, 1974. Hearing Transcript. 850 p.

4, 6

Hearings were held to consider two bills, S. 2819 and S. 3234, that would establish an office of solar energy research. The first bill introduced, S. 2819, would authorize a five-year $600 million program of solar energy research within AEC. The present status and prospects for solar energy utilization and technology by the government and industry in the U.S. and throughout the world are investigated. The second bill, S. 3234, would concentrate solar energy research within ERDA, if and when that office is established. Witnesses included: congressmen; officials from NASA, AEC, NBS, ANL, and NSF; and representatives from Sandia Labs., the General Electric Corp., the Ford Foundation Energy Policy Project, the Arthur D. Little Co., the Mitre Corp., and other private firms. Statements and studies by NSF, the Mitre Corp., UNESCO, NASA, NSF/NASA, and the Lawrence Livermore Lab. are transcribed.

191. Spaulding, J. Solar energy now. Sierra Club Bull. 59(5): 4-9, May 1974.

4, 6

The NSF's $13 million research program for solar energy has begun. Trials of solar heating in schools in Maryland, Massachusetts, Minnesota, and Virginia have started. RCA and NASA propose incorporating solar heating and cooling into buildings. Burgeoning government programs are the most obvious sign that the economic climate for solar energy is improving. Lack of codes, standards, practices, manufacturers, designers, and builders skilled in solar energy must be overcome before solar energy is used for heating on a large scale. Some solar energy techniques are explained.

192. Status report: Energy resources and technology. Atomic Industrial Forum, Inc., New York. 1974.

4, 6

1974

193. A study of wind energy conversion for Oahu. Prepared by the Center for Engineering Research, University of Hawaii, for the City and County of Honolulu, October 15, 1974.

6

194. Szczelkun, S.A. Survival scrapbook #3 - Energy. N.Y., Schocken Books, 1974. 57 p.

2, 4

This is an idea book which ranges more widely than most, even getting into mental energy. No one topic is covered in much detail.

195. Texas energy resources, final draft. Texas Governor's Energy Advisory Council, Austin, Texas, 1974. 31 p.

4, 6

A summary of the energy resources including lignite, coal, geothermal energy, uranium ores, and petroleum and the potentiality of solar, solid waste, and wind energy is presented. It is indicated that Texas has about 146 billion barrels of oil-in-place. As of January 1, 1973, Texas had 94.9 trillion cu ft remaining reserve of natural gas that is being used faster than new finds are made. It is estimated that Texas has over 6 billion tons of bituminous coal resources and that there are about 20 billion tons of lignite within surface minable depths and over 100 billion tons of deep basin lignite resources. Three areas for potential geothermal resources are the Rio Grande Rift System, the Trans-Pecos Hot Rocks, and the Gulf Coast Geothermal Sands. The solid waste generation rates for agricultural and municipal-industrial sources are estimated. Generation of electrical energy from wind is of great potential in the Texas Panhandle. Texas qualifies as a potential area for the utilization of solar energy according to the isopleths of mean daily direct solar radiation. Texas has significant quantities of uranium, and more than six nuclear power plants are in the planning stage for the state.

196. Thomas, R.L. Utilization of solar energy to help meet our nation's energy needs. Energy Crisis Symposium, Albuquerque, N.M., May 3, 1973. Socorro, N.M., New Mexico Bureau of Mines and Mineral Resources, 1974.

3, 4

197. Thomas, R.L. Wind energy conversion. In: Energy, Environment, Productivity; Proceedings of the First Symposium on RANN: Research Applied to National Needs, Washington, D.C., November 18-20, 1973. Washington, D.C., G.P.O., 1974, p. 39-41. (See also entry 1973: 29)

3, 6

Wind generators are technically feasible as illustrated by the description of several moderate sized machines that have been built and tested in the past. Some reasons why wind machines have not been used more freely are listed, and possible solutions to the problems are advanced. Aspects of research programs aimed at wind power as an energy source are listed, and the part of the NSF Solar Energy Program aimed at wind conversion is discussed. The planned experiment to be carried out in Puerto Rico in 1975 as a part of the NSF program is described briefly. Some conclusions relevant to the use of wind energy as a source to help meet the energy needs are drawn.

198. Thresher, R.W. Structural aspects of wind machines. Oregon State University, Report No. PUD 74-2B, August 1974. Second Progress Report. (Part II) Corvallis, Oregon, Oregon State University, 1974. 42 p.

5

This report presents a collection of papers which consider the structural aspects of wind machines. Part I, on Wind Power potential in selected areas of Oregon, is listed under E. W. Hewson.

199. Thring, J.B. and G.E. Smith. Integrated power, water, waste, and nutrient system. Intersociety Energy Conversion Engineering Conference, 9th, Proceedings. New York, American Society of Mechanical Engineers, 1974.

3, 13

200. Transcript of third public hearing, Boston, Massachusetts, August 26-29, 1974. Appendix. FEA Project Independence Blueprint. 243 p.

4, 6

Testimony, definitions, and statements submitted for the record at a public hearing in Boston on project independence and its implications are presented. The meeting provided a forum for representatives of the public and private sector, consumer and environmental groups, the business community, and private citizens to express their views on energy alternatives. Subjects include: solar energy, air pollution control equipment, the nuclear power controversy, energy consumption, urban development patterns, U.S. energy independence, siting of offshore energy facilities, electric power generation in Vermont, oil allocation programs, energy conservation design guidelines for office buildings, conservation of utilities, and energy for New England.

201. Troll, J.H. Wind power conversion system. U.S. Patent No. 3,944,840. August 7, 1974.

5, 17

A wind to electric system is described which comprises a wind collecting structure having an entrance and exit opening, a means for varying the areas of the entrance and exit openings relative to one another, means for sensing the velocity of an incoming wind, means coupled to the sensing means for adjusting the ratio between the areas of the entrance and exit openings in accordance with the sensed velocity, and a wind-driven blade set disposed at the exit opening to receive the wind. A flywheel is coupled to the wind-driven blade set. A clutch for decoupling the flywheel and blade set is provided and an A.C. generator is coupled to the flywheel.

202. Twine, J. Synerjy, a directory of energy alternatives. N.Y., Synerjy, 1974.

2, 4

203. Utilities in the 80's: an overview. Power Eng. 58(6): 40-50, June 1974.

4, 6

204. Vargo, D.J. Wind energy developments in the 20th century. Annual Regulatory Information Systems Conference, 4th, St. Louis, September 10-12, 1974. 28 p.

3, 4, 6

Wind turbine systems for generating electrical power have been tested in many countries. Representative examples of turbines which have produced from 100 to 1250 kW are described. The advantages of wind energy consist of its being a nondepleting, nonpolluting, and free fuel source. Its disadvantages relate to the variability of wind and the high installation cost per kilowatt of capacity of wind turbines when compared to other methods of electric-power generation. High fuel costs and potential resource scarcity have led to a five-year joint NASA-NSF program to study wind energy. The program will study wind energy conversion and storage systems with respect to cost effectiveness, and will attempt to estimate national wind-energy potential and develop techniques for generator site selection. The studies concern a small-systems (50-250 kW) project, a megawatt-systems (500-3000 kW) project, supporting research and technology, and energy storage. Preliminary economic analyses indicate that wind-energy conversion can be competitive in high-average-wind areas.

205. Vermeulen, H. The economics of using wind power for electricity supply in the Netherlands and for water supply on Curacao. Translated from the Netherlands reports/TW-555 and GCV-R-128, date unknown. Translation: Kanner Associates, Redwood City, California. NTIS, N75-10587, October 1974. 64 p.

6

It is shown to be economically feasible to harness the wind for electricity supply in the Netherlands in terms of power and production costs. Different wind power plants are discussed in detail. An abridged account of a Danish proposal to harness wind power, and calculation of the efficiency Danish aeromotor are included. Comparisons are made with the power need situation in Curacao, and it is determined that a similar wind power conversion capability recommended for the Netherlands is feasible for the West Indies as well.

206. Vertical axis wind turbine assembly. Albuquerque, N.M., Sandia Labs., August 15, 1974.
5

Drawings are given for a vertical axis turbine designed to harness the wind to create electric power. Details of the alternator mount, air foil, and strut are included.

207. Villecco, M. Wind power. Archit. Plus 2(3): 64-77, May-June 1974.
5

Electric generation is a relatively new role for windmills. Wind turns a propeller attached to a shaft that rotates and, either directly or through a system of gears and couplings, spins the rotor of a power generator. The generator feeds electric current into a transmission line or storage unit for eventual consumption. Ideally, a windmill extracts 59.3% of an airstream's energy. This is the theoretical maximum, but modern devices generally obtain only 70% of that, with some exceptions. Windmills are expensive to build and their power yield, like the wind that fuels them, is often intermittent.

208. Von Arx, W.S. Energy: natural limits and abundances. Am. Geophys. Union EOS Trans. 55(9): 828-832, September 1974.
4

The power available from "natural" systems, including hydroelectricity, solar and geothermal energy, wind, thermal sea differentials, and photosynthesis, is evaluated. These power sources are discussed in terms of loops in the uses of materials, food, and energy. Energy management will not only present an engineering challenge in the future, but will also require fundamental readjustment of economic and political decision-making processes.

209. Von Arx, W.S. Energy: Natural limits and abundances. Oceanus 17: 2-12, Summer 1974.
4

The energy of the sunshine reaching the earth is some 1017 watts. The present power demand of world civilization is close to 1013 watts. The heat production from human use of power disturbs the solar-terrestrial heat balance by only 0.01%, seemingly a tolerable level. Were power production to be increased to 1014 (0.1% of the heat balance) or 1015 watts by adding heat to the solar-terrestrial balance, climate could be significantly altered. Wind energy, thermal sea power, hydroelectric power, photosynthesis, and solid waste energy from organic sewage are discussed as ways to produce more power without adversely influencing the earth's heat balance.

210. Voss, A., et al. Other primary energy resources. V.D.I. Ber. 224: 117-125, 1974. (In German)

6

Discussed is a way to use the temperature difference between the water at the surface of the sea and the water at a greater depth as a basis to supply power. It is pointed out that in general a utilization of the indicated energy resources will require the solution of problems related to the transportation of energy to the power consumer locations. It is concluded that the energy resources examined will in the near future not provide a solution to the current energy crisis.

211. Wade, G. Homegrown energy - power for the home and homestead. Willits, Cal., Oliver Press, 1974. 86 p.

2, 4

This is a directory to the hundreds of available products involved in the production of power from water, solar, wind, and steam.

212. Walters, S. Power from wind. Mech. Eng. 96(4): 55-65, April 1974.

4, 9

NASA's vertical-axis windmill at Langley Research Center is described.

213. Walton, J. Water-mills, windmills and horse-mills of South Africa. Cape Town and Johannesburg, C. Struik Publ., 1974. 224 p.

1, 2

This is the first comprehensive account of the hand-mills, water-mills, windmills and horse-mills of South Africa. Their history is traced from the mid-17th century to today. The author is well known for his pioneer studies in vernacular architecture of many countries in Africa, Europe, and the Far East.

214. Wellesley-Miller, S. Bio shelter. Archit. Plus 2(6): 90-93, November-December 1974.

4

Technological limitations have inhibited the realization of two energy saving housing schemes: enclosures built to maintain a stable interior microclimate without mechanical heating or cooling; and buildings designed to provide shelter from the weather, liquid and solid waste disposal, space heating and cooling, power for cooking and refrigeration, and electricity for communications, lighting, and household appliances.

215. Wendler, C. Conversion of wind energy to mechanical energy. U.S. Patent 3,957,397. December 30, 1974.
5, 17

An apparatus for converting wind motion to mechanical motion is described which consists of an endless track means defining an endless path, carriage means on the track means, and an omnidirectional windmill means carried by the carriage means. The windmill is connected to the traction wheel. An energy transducer is driven by movement of the carriage means about its endless path.

216. Williams, J.R. Solar energy technology and applications. Ann Arbor, Michigan, Ann Arbor Science Publishers, Inc., 1974. 120 p.
2, 4

Chapter 14 is entitled "Power from the wind."

217. Wilson, R. and W.J. Jones. Energy, ecology, and the environment. New York, Academic Press, 1974. 353 p.
2, 4

218. Wilson, R.E. and P.B.S. Lissaman. Applied aerodynamics of wind power machines. NTIS, PB-238595, July 1974. 116 p.
5

Aerodynamics of various types of wind power machines and advantages and disadvantages of various schemes for obtaining power from the wind are reviewed. Simple, one-dimensional models for various power-producing machines are given along with their performance characteristics and presented as a function of their elementary aerodynamic and kinematic characteristics. Propeller-type wind-turbine theory is reviewed to level or strip theory, including both induced axial and tangential velocities.

219. Wind energy. In: World Energy Conference. Survey of energy resources. 1974. N.Y., United States National Committee of the World Energy Conference, 1974, p. 236-239.
3, 6

The historical and potential of wind power are discussed briefly.

1974

220. Wind energy. Hearing before Subcommittee on Energy of Committee on Science and Astronautics. 93d Congress, 2d. Session, No. 49. May 21, 1974. Washington, G.P.O., 1974. 393 p.

6

Wind energy as a resource base was investigated in a Congressional hearing whose purpose was to ascertain the amount of power available from wind, the maximum amount recoverable, and the relationship between the maximum amount recoverable and the present capacity of U.S. electric power generating systems. Basic information on the economic factors associated with the generation of energy from wind in commercial quantities is provided. Such concerns as implementation costs, environmental impacts, land use and water requirements, visual and noise effects, social acceptability, and institutional constraints are also discussed, and several demonstration projects are proposed.

221. Wind energy studies started by NASA. Aviat. Week 101(23): 49, December 9, 1974.

4

222. Wind power. Public Interest Report, 1974. 2 p.

6

Self-renewing, nonpolluting, abundant wind energy is capable of producing harnessable power that could contribute significantly to future energy needs. The basic pursuit now is to design windmills that are efficient and that operate at low cost. Some advances toward harnessing wind energy are briefly discussed.

223. Wind power: how new technology is harnessing an age-old energy source. Pop. Sci. 205(1): 54-61, July 1974.

4, 6

The major stumbling block to wind power utilization is cost-producing a wind generator that does not cost more per kwh than a coal-steam or nuclear plant. Three trends are noted: single site, power production with battery storage (1-6 kw outputs); multimode commercial power combining electrolysis of water to make hydrogen and possibly fuel cells, or a turbine to convert back to electricity or mechanical power; and megawatt-size wind turbines feeding ac directly to the main power bus. Several systems are described.

224. Wolf, M. Solar energy utilization by physical methods. Science 184(4134): 382-386, April 19, 1974.

4

Wind power, ocean thermal gradient power, solar heat, and solar-to-electric power conversion are considered as means of solar energy utilization by physical methods. An evaluation is made of total solar energy delivery on the projected U.S. energy economy. It is estimated that the potential sales in photovoltaic arrays alone can exceed $400 million by 1980 to meet the projected capacity buildup.

225. Wolff, B. Wind energy bibliography. 2d ed. Wukwonago, Wisconsin, Windworks, 1974. 70 p.
2, 16

This extensive bibliography includes references on wind, windmills, aerodynamics, electrical, towers and storage.

226. Blake, S.R. Interim report to Karl J. Bea Associates. Brace Research Institute, November 1974.
6

An exploratory site analysis for a fifty foot diameter wind turbine system proposed for Saskatchewan by Ultramar Oil Company of the United Kingdom is described. The report provides access to the workings of the Department of Transport, Meteorological Branch-Environment Canada and the procedures for accessing wind data from them.

227. Blake, S.R. Site analyses for locating wind energy conversion systems. Unpublished Master's Thesis. University of Kansas, Lawrence, 1974.
6

228. Davidson, B. Sites for wind power installations. World Meteorological Organization. WMO Tech. Note No. 63, 1974.
6

This is a comprehensive overview of siting techniques and information, considering all aspects of siting. The paper is aimed at large installations and assumes that the availability of wind power is the major factor in determining the location of a wind power installation. He concludes that sites must be analyzed individually and that no rules of thumb with respect to topographic influences on wind or to wind profiles may be applied out of hand. This paper synthesizes the work of other research and field work and is not based solely on the author's research in the field.

229. Energy development. IEEE Power Engineering Society Papers. N.Y., IEEE, 1974. 104 p.
2

Sixteen papers review the energy options, including hydrogen, solar and wind power.

1. Archibald, P. B. University of California. Lawrence Livermore Lab. An analysis of the winds of site 300 as a source of power. UCRL-51469. NTIS, October 2, 1973. 6

Site 300 is a strategically located area lying east of the Lawrence Livermore Laboratory at Livermore, California. The prevalent wind is from the west; its driving force is the pressure gradient between the hot interior valleys and the cool marine air of the Pacific Ocean. Wind measurements indicate that this is a good site for electrical power generation.

2. Bodek, A. How to construct a cheap wind machine for pumping water. Brace Res. Inst. Publ. No. L.5, February 1965, revised February 1973. 12 p. 12a, 15

3. Clews, H. Electric power from the wind. Solar Wind Publication, 1973. 12a, 14

4. Cullen, J. F. Power from wind waves. Nat. Eng. 77(2): 14-15, February 1973. 13

A device designed to produce electric power by using energy available in wind waves is described. The power unit consists of two side walls and a series of vertical chambers with open outlets at or near the nodal line. The upper end of each chamber is provided with an intake one-way valve for intake from the intake plenum, and a discharge one-way valve for discharge to the discharge plenum.

5. Delafond, F. Problems concerning automatic connection of an aerogenerator to a network. Translated from the French to English from the Algerian Report.
Transl: Linguistic Systems, Inc., Cambridge, Massachusetts. N 73-21238. NTIS, April 1973. 14 p. 7

Modifications were made to the 100 kW Andreau-Enfield experimental aerogenerator, supplying a three-phase network with the results that: (1) connection to the network was automated and rendered almost instantaneous; (2) propeller starting and stopping were automated; and (3) the amplitude of pumping in high wind was reduced by altering the change-of-pitch speed of the propeller. The machine is functioning. Problems of power oscillations with wind gusts are still being worked on. It is believed that the aerogenerator is suitable for supplying a large network; for small networks three or more smaller machines would have to work in connection to even out power variations.

1973

6. Energy technology on the village scale. Altern./Perspect. Soc. Environ. 3(1): 20-21, 1973. . 8

7. Galanis, N. and A. Delisle. Performance evaluation of winddriven heating systems. Intersociety Energy Conversion Engineering Conference, 8th, Philadelphia, August 13-17, 1973. P. 376-381. 13

   The performance of three wind-driven heating systems - with a heating load of 73,000 BTU/hr at the design point - has been evaluated over a period of four months for typical Canadian winter conditions. In the first case, the wind turbine's mechanical energy is dissipated in water pumped through a coiled pipe; the required wind turbine diameter is 72.8 feet and the system, operable at any wind speed, provides more heat than the instantaneous load during 34.5% of the time. In the other two instances the mechanical energy serves to drive a reverse closed Brayton cycle with air as the working fluid and a Freon-12 heat pump, both absorbing heat from the ground; the wind turbine's diameter is 30.9 feet and 21.5 feet respectively, while both systems provide more heat than the instantaneous load during 32.6% of the time and require a minimum wind of 8 mph for operation.

8. Gravel, M. Atlantic-Richfield ridicules windpower while others make it work. Congressional Record (daily edition) 93d Congress, 1st Session, Volume 119: E3518-3520, May 29, 1973. 4

   This reports Senator Gravel's comments on the Atlantic-Richfield commercial depicting a dying windmill and includes substantial excerpts from J. Sencenbaugh's article in Mother Earth News, March 1973.

9. Harnessing the wind for power. Conserv. News 38(10): 8-9, August 1973. 4

10. Hertzog, S. Windmills and wind power. Elements of Technology 5:13-20, April 1973. 4

11. Hewson, E. W. et al. Wind power potential in selected areas of Oregon. Oregon State University, Report No. PUD 73-1, March 1973. First Progress Report. 6

12. MacPherson, R. B. Optimization and development of the Savonius wing rotor for power generation. University of Massachusetts, Department of Civil Engineering, September 11, 1973. 9

1973

13. McCaull, J. Windmills. Environment 15(1): 6-17, January 1973.
4, 7

A state-of-the-art review of production of electricity from windmills.

14. Marier, D. A hexcellent idea. Alternate Sources of Energy, No. 8, January 1973.
4, 12a

15. Montesano, F. and A. Fernandez. Windmill tower design. Brace Res. Inst. Publ. No. EP.2, 1973.
12b

16. National Aeronautics and Space Administration, Lewis Research Center. Savino, J. M., Ed. Wind energy conversion systems, Workshop Proceedings. PB 231 341. NTIS, December 1973. 258 p.
5, 6, 13

A collection of short summaries of talks that were given at the NSF/NASA workshop on wind energy is presented in this report. The workshop covered the following main topics: Important Past Developments; Wind Characteristics and Siting Problems; Rotor Characteristics; Energy Conversion Systems; Energy Storage; Small Wind Power Systems for Remote and Individual Applications; Wind Power Systems for Large-Scale Applications; Tower Structures; Committee Reports; and Panel Discussions.

17. NSF/NASA Conference on Wind Driven Generators, Proceedings. NASA, Lewis Research Center, June 1973.
3

18. Roberts, R. Energy sources and conversion techniques. Amer. Sci. 61(1): 66-75, January-February 1973.
4, 13

Discusses various energy sources currently in use or under consideration and their compatibility with each other in developing energy systems and networks.

19. Sencenbaugh, J. I built a wind charger for $400.00 Mother Earth News, No. 20: 32-36, March 1973.
12a

The author summarizes experiences in designing and building a wind charger for a cost of $400, for use in providing power to his home. Includes order blank for plans.

1973

20. Sichel, D. Could wind ease energy crisis in the United States? Christ. Sci. Mon. June 9, 1973. p. 11.

4

21. Spurgeon, D. Natural power for the third world. New. Sci. 60: 694-697, December 6, 1973.

4

While the developed nations are worrying about the security of their energy supplies, the developing world faces an increasingly grim prospect. Geothermal energy, solar power, and wind power could make a significant contribution, but the developed countries will have to help exploit these systems.

22. Thring, J. B. Autonomous heat and power. Heat. Vent. Eng. 47: 229-232, November 1973.

4

23. U.S. Library of Congress Reference Section. Science and Technology Division. L.C. Science Tracer Bullet: Wind power. TB 73-17. A Bibliography. September 1973.

16

24. Wind generators use sun's energy more effectively than solar cells. Electr. Rev. 192(22): 782-783, June 1, 1973.

4

25. Windmill without arms. Compr. Air Mag. 78: 14, March 1973.

6, 12b

Describes a wind turbine developed by the National Research Council of Canada as a possible cheap power source for energy and irrigation in developing countries and isolated stations in northern Canada.

26. Alternative Sources of Energy, No. 9, February 1973. 40 p.

16

Updates Alternative Sources of Energy, Number 2, September 1971. An extensive bibliography on wind, solar, tidal, and geothermal energy.

27. Soedergard, B. Analysis of the possible use of wind power in Sweden. Part 1: Wind power resources, theory of windpower machines, preliminary model 1 and 10 mw wind generators. Sweden Board for Technological Development, Report, December 18, 1973.
Translation: Kanner Associates, Redwood City, California. N 74-19708. NTIS, April 1974. 55 p.

4, 6

Aspects are discussed that must be considered in respect to the possible use of wind power in Sweden, such as availability and nature of wind resources, cost of this type of energy, etc. The basic theory of calculating the power of wind-power machine are presented with tables and diagrams. Data for several large wind-power machines constructed in the U S.A., Great Britain, etc., are given. The conclusion is reached that the use of wind power in Sweden is not feasible, primarily because of its high cost per kWh.

28. Syverson, C.D. and J.G. Symons. Wind power. 1973. 19 p. From: J.G. Symons, Jr., Ph.D., Box 233, Mankato, Maine.

8, 12a

This pamphlet presents a concise description of wind energy on an individual user scale. Includes a glossary, list of references, and consultants. Also includes discussion of a backup system for use during short periods of no wind. A major part discusses assessing one's electric needs, called the "Demand Analysis", including sample calculations and cost accounting.

29. Thomas, R.L. and J.M. Savino. Status of wind-energy conversion. Paper presented at the RANN Symposium, Washington, D.C., November 1973. N 74-19705. NTIS, 1973. 9 p.

6

The utilization of wind energy is technically feasible as evidenced by the many past demonstrations of wind generators. The cost of energy from the wind has been high compared to fossil fuel systems; a sustained development effort is needed to obtain economical systems. The variability of the wind makes it an unrealiable source on a short term basis. However, the effects of this variability can be reduced by storage systems or connecting wind generators to: (1) fossil fuel systems; (2) hydroelectric systems; or (3) dispersing them throughout a large grid network. Wind energy appears to have the potential to meet a significant amount of our energy needs.

1973

30. Appa Rao, V. Unconventional sources of energy for millions. Sci. Cult. (India) 39(4): 157-63, 1973. 4

Solar, wind, geothermal, and tidal power are discussed as possible solutions to the growing energy needs of India.

31. Heronemus, W.E. Energy: windpower in the 1970's. Amer. Geophys. Union. EOS - Trans. 54: 224, 1973. 6

Heronemus provides a detailed analysis to support the theory that windpower is practical and feasible in the northern hemisphere.

32. Boer, K.W. The solar house and its portent. Chemtech ACS 3(7): 394, July 1973. 4

This article mentions other energy sources briefly: hydroelectric power, wind, ocean currents.

33. Bush, C.G. "Supercore" eliminates household waste and pollution at the source. Concepts and directions. Catalyst for Environmental Quality 3(2): 22, 1973. 13

This paper describes the "Supercore" system, a waste-recovery, energy gathering, and storing system to enable new houses to be 75% more self sufficient. Features are recycling of house heat for energy, capturing solar and wind energy, utilization of household wastes and better scheduling of use of water.

34. Jagadish, S.R. The prospects of utilization of solar energy and wind power for generation of power, air conditioning and refrigeration in the climatic conditions similar to India. Paris Symposium on Solar Energy, July 1973. 6

35. Note on the utilization of wind power for providing industry electric power. Aerowatt Company, 1973. 7

36. Pickering, W.H. Important to examine possibilities of unconventional energy sources. Aware, No. 31: 5, April 1973. 4

37. Powe, R.E., H.W. Townes and D.O. Blackketter. Development of a large capacity wind powered electrical generating system: a concept. Bozeman, Montana. Montana State University, September 1, 1973. 7

Red Rocker, W.

38. ~~Rocker, R. Winnie,~~ Build a wind generator. Altern. Sources Energy No. 8: 12-13, 1973. 12a

1973

39. Solar energy research program alternatives. Proposed research tasks, costs and schedules for the National Science Foundation Five-Year Solar Energy Research Program. McLean, Va., Mitre Corp, Dec. 1973. 149 p. 6

Wind energy systems are included as part of the two alternative research plans presented in this report.

40. Stodhart, A.H. Natural conversions of solar energy. Colloquium Digest on Solar Energy, 1973. 3 p. 4

This paper discusses conversion of solar energy to other forms, including wind and ocean heat.

41. Systems analysis of solar energy programs. McLean, Va., Mitre Corp. December 1973. 325 p. NTIS, PB 231 142, 1973. 6

This is one of several reports which cover a study of the NSF Five-Year Solar Energy Research Program. Each of seven major applications of solar energy have been analyzed in terms of cost and benefits.

42. U.S. Federal Power Commission. Staff report on wind power. Washington, D.C., September 1973. 13 p. 4

43. Van Sant, J. Economic considerations of utilizing small wind generators. Quebec, Institute for Research, 1973. 6

44. Savino, J.M. Wind turbines--a nondepletable, nonpolluting energy system. NASA Lewis Research Center, February 1973. 4

45. Clews, H. Solar windmill. Altern. Sources Energy No. 8: 14, January 1973. 4

46. Sweeney, T.E. The Princeton windmill program. Princeton University, March 1973. 4

47. Oliver, P. Windmills of Murcia. Shelter: December, 1973. 4

48. Fan, L.T. Center for energy studies. Kansas State University, Institute for Systems Design and Optimization Rep. No. 50, July 1973. 24 p. 4

This report summarizes the past accomplishments and present capabilities of Kansas State University in energy research through abstracts of reports, journal articles, theses, presented papers etc. Some material on wind power is included.

1973

49. Lighting some candles. Architect. For. 139(1): 89, July-August 1973.
4

Discussed are possible solutions to energy problems, including nuclear fusion, geothermal power, wind energy, and solar energy, and their potential impact on architecture.

1973

50. Abrahamson, D. Energy technology: status and needs. Ambio 2(6): 186-195, 1973.
4, 6

51. Aiken, R. Solar and wind power as alternatives to fossil fuels. Sci. Forum 6(5): 7-11, October 1973.
4

52. Allen, R. Solar Heating and Cooling for Buildings Workshop, Washington, D.C., March 21-23, 1973. Proceedings. Part I. Technical sessions. NTIS, PB 223536, July 1973. 231 p.
3, 4

The Proceedings contain thirty-six technical papers on solar energy for U.S. building applications areas; namely, solar collectors, energy storage, domestic hot water heating, energy conservation and insolation, solar air-conditioning, and systems for solar heating and cooling. Some foreign activities are also reviewed. Each technical paper is a report on: Proposed research, on-going research, proposed systems, or operating systems. Questions and answers from the discussion periods are included, as in an agenda and list of attendees.

53. Allison, H.J. Electrical generator with a variable speed input: constant frequency output. National Aeronautics and Space Administration, Lewis Research Center. Savino, J.M., ed. Wind energy conversion systems, workshop proceedings. NTIS, PB 231341, December 1973, p. 115-120.
3, 5

54. Bergey, K.H. Wind power demonstration and siting problems. National Aeronautics and Space Administration, Lewis Research Center. Savino, J.M., ed. Wind energy conversion systems, workshop proceedings. NTIS, PB 231341, December 1973, p. 41-45.
3, 6, 15

Technical and economic feasibility studies on a small windmill to provide overnight charging for an electrically driven car are discussed. Optimization of a windmill/storage system requires detailed wind velocity information which permits rational siting of wind power system stations.

55. Bettignies, C. Wind energy - its utilization in isolated and arctic regions (1/4 to 100 kW). Northern Eng. 5(4): 13-17, Winter 1973-1974.
4, 6, 8

This article discusses the possible uses of small and medium sized modern wind power plants. Due to the remoteness of most sites in arctic regions, and the resultant high costs of fuels,

modern aerogenerators can provide a viable non-polluting alternative to local power needs in the North.

56. Bettignies, C. Wind energy - its utilization in isolated regions of the Americas. Presented at an Inter-American Meeting organized by the American Association for the Advancement of Science and the Mexico National Council for Science and Technology. Science and Man in the Americas: Session on Non-Nuclear Energy for Development, Mexico City, June 20 - July 4, 1973.

3, 6, 8

57. Champly, R. Wind motors: theory, construction, assembly and use in drawing water and generating electricity. Translation into English of book "Theorie, construction, montage, utilisation au puisage de l'eau a la production de l'electricite," Paris, Dunod Publ, 1973. 270 p. Translation: Kanner Associates, Redwood City, Cal. NTIS, N75-19821, April 1975. 253 p.

2, 5, 6

A brief history of windmills is given. Various models are described, with discussions of their pros and cons, especially in regard to number of blades and method of orientation to the wind. Systems for transmission of power from the wind motor to a pump, generator, or other type of equipment are described. A method for computing the tension and compression stresses on the wind motor pylon is given and the construction of pylons and water tanks is discussed. Foundation and anchoring systems are described, as are several methods for assembling and raising the wind motor on its pylon. Systems using wind motors to draw and elevate water by means of pumps and systems using wind motors in conjunction with generators, storage batteries, etc., to generate electricity are described. Efficiency tables and comparative cost price tables are provided for each of these applications.

58. Chang, H.H. Bucket rotor wind-driven generator. National Aeronautics and Space Administration, Lewis Research Center. Savino, J.M., ed. Wind energy conversion systems, workshop proceedings. NTIS, PB 231341, December 1973, p. 107-108.

3, 5, 14

59. Clark, W. Interest in wind is picking up as fuels dwindle. Smithsonian 4(8): 70-77, November 1973.

4

60. Clews, H.M. Wind power systems for individual applications. National Aeronautics and Space Adminstration, Lewis Research Center. Savino, J.M., ed. Wind energy conversion systems, workshop proceedings. NTIS, PB 231341, December 1973, p. 165-169.

3, 8, 12a

1973

61. DeKorne, J.B. The answer is blowin' in the wind. Mother Earth News, No. 24: 67-75, November 1973.

4, 12a

This is a good introduction to the technology and feasibility of home-built wind power generators.

62. Devlin, J.C. Engineers look again to wind as answer to ship fuel crisis. New York Times, April 22, 1973, section 1, page 52.

4, 15

West German engineers and the Federal Maritime Administration are working on replacing fuel-driven ships with wind-driven ships. This effort is a response to the growing fuel shortage and scientists' opinions that atomic energy is not the solution people had hoped it would be.

63. Divone, L.V. Wind energy technology. Am. Nucl. Soc. Trans. 21: 143, June 1973.

4

64. Dodge, R. Economic considerations of utilizing small wind generators. National Aeronautics and Space Administration, Lewis Research Center, Savino, J.M., ed. Wind energy conversion systems, workshop proceedings. NTIS, PB231341, December 1973, p. 170-174.

3, 6, 8

65. Duffett, J.W. Energy crisis: revision in U.S. policy to preserve national security. Army War College, Carlisle Barracks, Pa. NTIS, AD778886, October 22, 1973.

4

66. Eggers, A.J. Solar energy program. Subpanel Report IX used in preparing the AEC chairman's energy report to the President. Washington, D.C., National Science Foundation. NTIS, WASH-1281-9, November 13, 1973. 223 p.

4, 6

The goal of the Solar Energy Program is to develop and demonstrate economically competitive and environmentally acceptable solar energy systems at the earliest practical time. For each of the six subprograms, (1) heating and cooling of buildings, (2) solar-thermal conversion, (3) wind energy conversion, (4) ocean thermal conversion, (5) bioconversion, and (6) photovoltaic conversion, the objective is to develop proof-of-concept experiments and demonstration projects that will allow industry and user agencies to begin aggressive commercialization of each of these technologies, thus assuring its widespread application. Funding for the five-year program is distributed among the six subprograms to permit the earliest proof-of-concept experimentation to be carried out. This will allow program management to concentrate at an early date on those technologies that show the most promise toward providing the Nation's energy requirements. The objectives that will have been accomplished by 1979 in each of the six subprograms are specifically delineated. Each of the six subprograms is analyzed under the following headings: (1) subprogram summary, (2) status of technology, (3) rationale for federal involvement and institutional arrangements for implementation, (4) criteria and priorities, (5) alternative R and D programs, and (6) implementation. Finally, in an appendix, research project titles and submitting organization of the proposals considered by the panel are listed.

67. Energy research and development and space technology. Hearings before Subcommittee on Space Science and Applications and Subcommittee on Energy, House Committee on Science and Astronautics, 93d Congress, 1st Session, May 7-24, 1973. Washington, G.P.O., 1973. 570 p.
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68. Federal Power Commission. Staff Report on Wind Power. Annual Report, January - December 1973. NTIS, PB231955, September 1973. 13 p.
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69. George, D.W. Alternative energy sources: a research challenge. Sydney University, Sydney, Australia. NTIS, CONF-730560-1, 1973. 21 p.
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This is a paper from the Symposium on the Energy Crisis: Implications for Secondary Industry. Sydney, Australia, May 23, 1973.

70. Green, R., et al. Energy. Presented at NSF RANN Symposium, Wash., November 18-20, 1973, p. 3-59.
3, 4, 6

There is an urgent need of strengthened innovation and imagination in the search for alternative resources to meet U.S. energy requirements, and to conserve its existing non-renewable resources. Research concerning energy systems, conservation programs, energy under the oceans, improved techniques for gasifying coal, and energy conversion and storage technology is reported. Also presented is research concerning energy transmission systems, geothermal and solar energy, wind energy conversion, and solar heating and cooling of buildings. Economic factors and problems of commercialization are considered.

71. Herwig, L.O. Current research and development in solar energy applications. New Resources from the Sun. Proceedings of the 34th Annual Conference, Washington, D.C. November 1-2, 1973. New York, Chemurgic Council, 1973, p. 1-17
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Wind energy conversion is discussed along with other solar energy applications.

72. Herwig, L.O. U.S. solar energy research program. Presented at International Solar Energy Society Meeting, October 3, 1973. 65 p.
3, 4

NSF has been designated as the lead federal agency in coordinating solar energy research and technology. Elements of NSF's solar energy program, objectives and plans, and special issues that may provide increased understanding of the operation of the federal program are viewed. NSF program grants and objectives for solar energy R&D are listed.

73. Hewson, E.W. Wind power research at Oregon State University. National Aeronautics and Space Administration, Lewis Research Center. Savino, J.M., ed. Wind energy conversion systems, workshop proceedings. NTIS, PB231341, December 1973, p. 53-61.
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74. Hughes, W.L. Energy storage using high-pressure electrolysis and methods for reconversion. National Aeronautics and Space Administration, Lewis Research Center. Savino, J.M., ed. Wind energy conversion systems, workshop proceedings. NTIS, PB231341, December 1973, p. 123-136.
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75. Hütter, U. Past developments of large wind generators in Europe. National Aeronautics and Space Administration, Lewis Research Center. Savino, J.M., ed. Wind energy conversion systems, workshop proceedings. NTIS, PB231341, December 1973, p. 19-22.
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76. Johnson, D.E. Environmental energy sources: their use and storage. Energy, environment, and engineering. Stillwater, Oklahoma, Oklahoma State University, 1973, p. 6.1-6.17.
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This selection is from the Proceedings on Frontiers of Power Technology in Stillwater, Oklahoma, October 10, 1973.

77. Lawand, T.A. Review of the windpower activities at the Brace Research Institute. National Aeronautics and Space Adminsitration, Lewis Research Center. Savino, J.M., ed. Wind energy conversion systems, workshop proceedings. NTIS, PB231341, December 1973, p. 159-164.
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78. McCaull, J. Oil drum technology. Environment 15(7): 13-15, September 1973.

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Ways to use inexpensive technology without massive social and environmental disruption are under study at the Brace Research Institute of McGill University, Canada. Projects are intended for arid sections of the world, where solar energy can be utilized by relatively simple devices.

79. Nelson, V. and E. Gilmore. Need for a national wind survey. National Aeronautics and Space Administration, Lewis Research Center. Savino, J.M., ed. Wind energy conversion systems, workshop proceedings. NTIS, PB231341, December 1973, p. 33-40.

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80. Noel, J.M. French wind generator systems. National Aeronautics and Space Administration, Lewis Research Center. Savino, J.M., ed. Wind energy conversion systems, workshop proceedings. NTIS, PB231341, December 1973, p. 186-196.

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81. Oman, R.A. and K.M. Foreman. Advantages of the diffuser-augmented wind turbine. National Aeronautics and Space Administration, Lewis Research Center. Savino, J.M., ed. Wind energy conversion systems, workshop proceedings. NTIS, PB231341, December 1973, p. 103-106.

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82. Ormiston, R.A. Rotor dynamic considerations for large wind power generator systems. National Aeronautics and Space Administration, Lewis Research Center. Wind energy conversion systems, workshop proceedings. NTIS, PB231341, December 1973, p. 80-88.

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83. O'Rourke, J.J. Clean energy--how soon. Let's Live 41(12): 51-57, December 1973.

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Clean energy from the sun, wind, sea, and inner earth is available if money is provided for necessary R&D. Nuclear energy should account for 21% of the nation's total power by 1980. Hydrogen fuels and laser beams can provide electrical energy for the same price as crude oil. Solar energy devices, by utilizing 14% of the nation's desert area, could meet energy needs until the year 2000.

84. Pings, W.B. Energy crisis and coal gasification. Colo. Sch. Mines Miner. Ind. Bull. 16(4): 1-20, July 1973.

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85. The Plowboy interview: Marcellus Jacobs. Mother Earth News, No. 24: 52-58, November 1973.
4, 12a

A wind power pioneer-manufacturer discusses his career, and windplants and what he sees in the future for wind power.

86. Rabenhorst, D.W. Superflywheel energy storage system. National Aeronautics and Space Administration, Lewis Research Center. Savino, J.M., ed. Wind energy conversion systems, workshop proceedings. NTIS, PB231341, December 1973, p. 137-146.
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87. Ray, D.L. The Nation's energy future. Report to Richard M. Nixon, President of the United States of America. December 1, 1973. Washington, D.C., G.P.O., 1973. 171 p.
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88. Reitan, D.K. Wind-powered asynchronous AC/DC/AC converter system. National Aeronautics and Space Administration, Lewis Research Center. Savino, J.M., ed. Wind energy conversion systems, workshop proceedings. NTIS, PB231341, December 1973, p. 109-114.
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89. Rittleman, R. Solar demonstration residence. Proceedings of the solar heating and cooling for buildings workshop, Washington, D.C. NTIS, PB223536, March 21, 1973, p. 171-9.
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90. Sabin, R.J. Survey of non-polluting energy sources. Las Cruces, N.M., New Mexico State University, 1973.
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91. Sbarra, N.H. Historia de las aguadas y el molino. Buenos Aires, Argentina, Editorial Universitaria de Buenos Aires, 1973. (In Spanish)
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92. Schumacher, E.F. Western Europe's energy crisis: a problem of life styles. Ambio 2(6): 228-232, 1973.
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93. Schwartz, H.J. Batteries for storage of wind-generated energy. National Aeronautics and Space Administration, Lewis Research Center. Savino, J.M., ed. Wind energy conversion systems, workshop proceedings. NTIS, PB231341, December 1973, p. 146-151.
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94. Seaborg, G.T., J.L. Bloom and E.L. Nelson. Nuclear and other energy. N.Y. Acad. Sci. Ann. 216: 79-88, 1973.
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Fossil fuels now supply over 95 percent of the U.S. commercial energy, and, even with a maximum effort to develop alternatives, the bulk of our cumulative requirements between now and the end of the century will have to be met from oil, gas, and coal resources. Nuclear, geothermal, and most other alternative forms of energy are restricted to a few specific uses, such as the generation of electricity. Consequently, fossil fuels cannot be replaced in many uses even after we have developed practical technologies to produce energy from other sources.

95. Section 4 - Wind energy conversion. In: Solar Energy Program. Subpanel Report IX. Solar and other Energy Sources. Eggers, A.J., Chairman. Washington, National Science Foundation, November 13, 1973. NTIS, WASH-1281-9, 1973, p. 4-1 - 4-25.
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Progress of the subprogram on wind energy conversion is discussed, including research and other objectives of the program.

96. Sherman, M.M. Sail wind windmill and its adaptation for use in rural India. National Aeronautics and Space Administration, Lewis Research Center. Savino, J.M., ed. Wind energy conversion systems, workshop proceedings. NTIS, PB231341, December 1973, p. 75-80.
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97. A short update on Henry Clew's miraculous wind-powered homestead (and brand new business). Mother Earth News, No. 24: 82, November 1973.
12b

H. Clew's 50 acre farm is run on power from a 2,000 watt, 120 volt Quirk windplant from Australia. (See entry 1972:2)

98. Smith, G. The economics of solar collectors, heat pumps and wind generators. University of Cambridge, Department of Agriculture. Working Paper 3, April 1973.
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99. Solar energy proof of concept experiments. Final report. McLean, Va., Mitre Corp. NTIS, PB231143, December 1973. 106 p.
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Critical experiments to prove the technical feasibility and socioeconomic desirability of specific applications or techniques for the widespread utilization of solar energy are

described. The following experimental areas are covered: heating and cooling of buildings, process heat, solar-thermal-electric energy, photovoltaics, ocean thermal power, wind energy, organic materials, and common applications. Each experiment is described, and costs for two levels of funding are estimated: a moderate risk "minimum program," and a low risk, "accelerated program."

100. South, P. and R.S. Rangi. The performance and economics of the vertical axis wind turbine. National Research Council of Canada, October 1973. 20 p.
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101. Stodhart, A.H. Wind data for wind driven plant. National Aeronautics and Space Administration, Lewis Research Center. Savino, J.M., ed. Wind energy conversion systems, workshop proceedings. NTIS, PB231341, December 1973, p. 62-63.
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102. Summers, C.M. Ultimate energy, the ultimate fuel, and the hydrogen link in the electrical energy system. In: Energy, environment, and engineering. Stillwater, Oklahoma, Oklahoma State University, 1973, p. 5.1-5.19.
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103. Sweeney, T.E. The Princeton windmill program. Princeton University Department of Aerospace and Mechanical Sciences. AMS Report No. 1093, March 1973.
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104. Systems analysis of solar energy programs. NSF RANN Report NSF-RA-N-73-111A. December 1973. 328 p.
6

Seven major solar energy applications are analyzed according to the costs and benefits expected to accrue from their implementation. Three applications--heating and cooling of buildings, wind energy systems, and utilization of organic materials--appear most capable of achieving commercial application within a few years. The other four-process heat, solar thermal systems, photovoltaics, and ocean thermal gradient systems-need continued federal support with different funding levels and extending in varying lengths of time beyond the initial NSF five-year program for solar energy systems.

105. Systems analysis of solar energy programs. Appendix. Research tasks. Final report. McLean, Va., Mitre Corp. NTIS, PB231145, December 1973. 150 p.
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106. Szczelkun, S.A. Energy. Survival Scrapbook #3. New York, Shocken Books, 1973. 112 p.
2, 4, 12a

This book includes a collection of basic ways to make solar, wind, tidal, bio-gas and animal power, including how-to-do-it, illustrations, a good windmill construction section and more.

107. Szego, G.C. Energy storage by compressed air. National Aeronautics and Space Administration, Lewis Research Center. Savino, J.M., ed. Wind energy conversion systems, workshop proceedings. NTIS, PB231341, December 1973, p. 152-158.
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108. Tompkin, J. Introduction to Voight's wind power plant. National Aeronautics and Space Administration, Lewis Research Center. Savino, J.M., ed. Wind energy conversion systems, workshop proceedings. NTIS, PB231341, December 1973, p. 23-26.
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109. Tompkin, J. Voight variable speed drive. National Aeronautics and Space Administration, Lewis Research Center. Savino, J.M., ed. Wind energy conversion systems, workshop proceedings. NTIS, PB231341, December 1973, p. 121-122.
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110. Van Sant, J.H. Wind utilization in remote regions: an economic study. National Aeronautics and Space Administration, Lewis Research Center. Savino, J.M., ed. Wind energy conversion systems, workshop proceedings. NTIS, PB231341, December 1973, p. 174-176.
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111. Vance, W. Vertical axis wind rotors, status and potential. National Aeronautics and Space Administration, Lewis Research Center. Savino, J.M., ed. Wind energy conversion systems, workshop proceedings. NTIS, PB231341, December 1973, p. 96-102.
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112. Wentink, T. Surface wind characteristics of some Aleutian Islands. National Aeronautics and Space Administration, Lewis Research Center. Savino, J.M., ed. Wind energy conversion systems, workshop proceedings. NTIS, PB231341, December 1973, p. 46-52.
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113. Wentink, T. Wind power for Alaska? Northern Eng. 5(4): 8-12, Winter 1973-1974.
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The utility of the wind in Alaska is unquestionable. Windmills are the result of an old and high developed technology, and

Alaskan winds permit the exploitation of this technology over wide areas.

114. Wiesner, W. Effect of aerodynamic parameters on power output of windmills. National Aeronautics and Space Administration, Lewis Research Center. Savino, J.M., ed. Wind energy conversion systems, workshop proceedings. NTIS, PB231341, December 1973, p. 89-95.
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115. Wilson, R.E. Oregon State University wind studies. National Aeronautics and Space Administration, Lewis Research Center. Savino, J.M., ed. Wind energy conversion systems, workshop proceedings. NTIS, PB231341, December 1973, p. 180-185.
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116. Wind generators more effective than solar cells. Electr. Rev. 192(22): 782-783, June 1, 1973.
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117. Windworks. Wind energy bibliography. Mukwonago, Wisconsin, Windworks, October 1973.
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118. Frost, W. Review of data and prediction techniques for wind profiles around man-made surface obstructions. In: AGARD Conference Proceedings No. 140, Flight in Turbulence, Woburn Abbey, Bedfordshire, England, May 1973.
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119. Tattelman, P. and I. Gringorten. Estimated glaze ice and wind loads at the earth's surface for the contiguous United States. Technical Report 73-0646. Bedford, Mass., Air Force Cambridge Research Laboratory, L.G. Hanscom Field, October 1973.
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1. Brown, D. M. Scripps Institution of Oceanography, La Jolla, California. Windmill generator for the Bumblebee Buoy. AD 744-202. NTIS, June 1972. 18 p.

15

The problem of supplying power to a small buoy that must stay at sea for a year to a year and a half is a problem with many facets. There are various schemes for providing buoy power, but in nearly all cases the problem revolves around two flaws -- cost and weight; and in many cases the schemes don't work at sea. Due to a variety of problems, the windmill generator has been passed over as a power source, yet for small buoys it remains one of the most practical. Its potential led the author to select a windmill and design a buoy which would make the windmill work. This windmill has now been tested at sea for 13 months and proven its ability to survive the ocean environment and storms.

2. Clews, H. Henry Clews' miraculous wind-powered homestead. Mother Earth News, No. 18: 25, November 1972.

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Describes author's experience in setting up a complete and self-contained wind generated electrical systems for lights, shop tools, water pump, hi-fi, television, etc., using a QUIRK propeller and generator.

3. Coon, D. Giant wind machine for generation of electricity gets federal scrutiny. Nat. Observ., p. 13, June 24, 1972.

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4. Energy from the winds. United Power News, United Power Association, January 1972.

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5. Freese, S. Windmills and millwrighting. New York, Great Albion Books, 1972.

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6. Gawain, T. H. Naval Postgraduate School, Monterey, California. Generalized performance limits for propellers, windmills and lifting rotors with axes parallel to the undisturbed flow. AD 754-072. NTIS, December 1972. 103 p.

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The report generalizes the classical momentum theory as usually applied to propellers, windmills, and lifting rotors into a single unified treatment. It also extends the analysis to include the regime in which flow through part or all of the actuator disc is reversed with respect to the remote flow field. Dimensional analysis is used in a systematic manner to reduce the final results to their simplest and most significant forms. It is shown that the performance of these devices can always be represented by a single parameter family of curves in which the parameter expresses the extent to which the performance of the actual device falls short of the theoretical limit. Detailed algebraic solutions are derived in closed form for the actuators; these represent performance limits which any comparable real device may approach but never exceed. A qualitative analysis is presented concerning the development of the vortex ring state. The fundamental dynamic stability of the ideal lifting rotor is also analyzed. While this paper deals with a classical topic in fundamental fluid mechanics, the approach employed is original and many of the results derived here are in a form which is essentially new.

7. Heronemus, W. E. Power from the offshore winds. Annual Conference, and Exposition on Applications of Marine Technology to Human Needs, 8th., Washington, D.C., September 1972. Preprints: Washington, D.C., Marine Technology Society, 1972. p. 435-466.

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It has been estimated that the total rate of conversion between available potential energy and kinetic energy in the atmosphere of the whole Northern Hemisphere in winter is about 10^{14} kilowatts reducing to about sixty per cent of that value in summer. The Westerlies are of particular significance to the United States because in a sense they are a bonus of solar energy. The atmospheric and oceanic processes which create their energy occur over the adjacent and distant oceans as well as over the land mass. The result is felt particularly along land-to-water boundaries. It is suggested that man might once again turn to those winds and to the ocean currents which they help to sustain to help satisfy his need for energy. If such energy were used, it would be essentially pollution-free and would have a neutral effect on global heating. A number of concepts for Offshore Wind Power Systems are proposed.

8. Heronemus, W. E. The United States energy crisis: some proposed gentle solutions, presented before the ASME and IEEE. Congressional Record (daily ed.) 92d Congress, 2d Session, Vol. 118: E1043-1048, February 9, 1972.

4, 6

Introduced by Senator Gravel, included is the full text of Heronemus' paper, covering cost and feasibility of using wind power.

9. Hills, L. D. Down to earth: the wind is free. Ecologist 2(5): 36, May 1972.
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10. Kidd, S. and D. Garr. Can we harness pollution-free electric power from windmills? Pop. Sci. 201(5): 70-72, November 1972.
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Many attempts have been made to tap the wind's power -- all failures. Now a unique blade design, developed at Princeton University, may make windmills serious business again.

11. Merriam, M. F. Decentralized power sources for developing countries. East-West Technology and Development Institute, Honolulu, Working Paper Series No. 19, March 1972.
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12. Merriam, M. F. Windmills for less developed countries. Technos 1(2): 9-23, April-June 1972.
4, 8, 12b

The present status of windmill technology is reviewed in the context of less developed country requirements for small amounts of electrical and mechanical power at the village level. Capacity range considered is from a few tens of watts to a few tens of kilowatts. A summary of the characteristics of existing designs and a list of manufacturers is included.

13. Meyer, H. Wind energy. Architect.Des., December 1972.
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14. Meyer, H. Wind generators: here's an advanced design you can build. Pop. Sci. 201(5): 103-105, 142. November 1972.
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15. Nakra, H. L. A report on preliminary testing of a Lubing Windmill generator (MO22-3G 024-400) of the Brace Research Institute. Brace Res. Inst. Publ. No. T 75, 1972. 5 p.
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16. Shefter, Y. Problems of agricultural wind power. Vestnik Selkhoz. Nauki 17(5): 102-111, 1972.
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Small and dispersed farms can efficiently use wind-energetic installations to produce mechanical and electrical energy. The renewing energy sources - wind and sun - can be efficiently used for the lifting and freshening of water on pastures, home electrification, water heating and cooking.

1972

17. Shefter, Y. I. Wind-powered machines. Vetroenergeticheskiye Agregaty, Moscow, Mashinostroyeniye Press, 1972. 288 p.
Translation: Kanner Associates, Redwood City, California. N74-15742/1GA NTIS, February 1974.
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The basic problems connected with the selection of layouts and calculation of parameters of wind machines, their energy-producing characteristics and technical and economic indices are presented. Methods of optimal matching of wind engines with working machines, calculators for strength, and construction and automation of wind machines are analyzed in detail. A description is given of the setup of domestic and foreign wind installations for various purposes. Basic characteristics of wind as a source of energy, brief information from aerodynamics, the theory of the wind engine and calculation of its aerodynamic characteristics are presented. In conclusion, recommendations are presented for use of wind machines according to zone. The book is intended for engineers, designers and workers of scientific and research institutes connected with creation and utilization of wind machines and for engineers and mechanics in agriculture.

18. Smith, G. List of windmill manufacturers. Cambridge, England. University of Cambridge, 1972. 8 p.
12b

19. South, P. and R. S. Rangi. Wind tunnel investigation of a 14 foot diameter vertical axis windmill. National Research Council of Canada, Laboratory Technical Report LTR-LA-105, September 1972.
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20. Stabb, D. Wind. Architect. Des. 43: 253-254, April 1972.
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21. Trunk, E. Free power from the wind. Mother Earth News, No. 17: 60-64, September 1972.
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A short survey on the use of windmills for power generation.

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This article reviews the world's power needs, supply, and future potential, including consideration of the use of wind for power production.

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23. Whaley, J. C. Power generation alternatives. Seattle City Light, Engineering Division, Seattle, Washington, 1972.

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24. Wind energy conversion. In: Solar Energy as a National Energy Resource. NSF/NASA Solar Energy Panel. December 1972. p. 65-81. NTIS, PB 221 659, 1972.

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25. Bossel,H. Low cost windmill for developing nations. Mt. Rainier, Maryland, VITA, 1972. 40 p.

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Construction details for a low cost windmill are presented. The windmill produces one horsepower in a wind of 6.4m/sec (14.3 mph), or two horsepower in a wind of 8.1 m/sec (18.0 mph). The windmill uses the rear axle and differential of a small car. Other parts are made from sheet metal, pipe, steel ribbon, rod angle iron, or channel welded or bolted together, and wood. No precision work or macnining is required, and the design can be adapted to fit different materials for construction skills. The rotor blades feather automatically in high winds to prevent damage. A fullscale prototype has been built and tested successfully.

26. Konovolov, B. Wind and solar power engineering. Izvestiya 273:2, November 21, 1972.
Translation: Army Foreign Science and Technology Center, Charlottesville, Virginia. AD786 844. NTIS, April 1974. 11 p.

6

The need for small wind and solar powered installations for use at small settlements and installations is briefly discussed.

27. Merriam, M.F. Is there a place for the windmill in the less developed countries? East-West Technology and Development Institute, Honolulu, Working Paper Series No. 20, 1972. 20 p.

4, 6

This is a good overview of wind energy, its economics and problems in less developed countries, and also applies to this country. Discusses: windmill use, windmill versus other systems, use of output, and a listing of windmill manufacturers and their characteristics.

28. Notebaart, J.C. Windmuhlen: der Stand der Forschung uber das Vorkommen und den Ursprung. The Hague, Mouton Verlag, 1972, 405 p. Includes 30 page English summary.

1, 2

The purpose of this volume is to examine the origins and growth of the windmill throughout the world.

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29. Gravel, M. Clean energy via the wind. Cong. Rec. 117: 17-ii, February 9, 1972. 4

30. Greenlee, L.E. Electric power from the wind. Altern. Sources Energy No. 4: 1-3, January 1972. 4

31. Marier, D. Some practical advice. Altern. Sources Energy 5: 7-9, April 1972. 4

32. Ramakumar, R. and H.J. Allison. Design-fabrication and layout of a 60 kw three-phase field modulated generator system. Frontiers of Power Technology Conference, Proceedings. Stillwater, Oklahoma State University, October 1972. p. 16-1 to 16-9. 14

33. Richards, L. OSU scientists seek long-scale control of wind's energy. The Sunday Oregonian, June 25, 1972. 4

34. U.S. House Task Force on Energy. Energy research and development, Report of the House Committee on Science and Astronautics, 92 Congress II Serial EE, December 1972. 418 p. 4

35. Weintraub, R. A review of a possible scheme of power generation on a local level. Altern. Sources Energy No. 4: 4-8, January 1972. 4, 8

36. Hughes, W.L. and R.G. Ramakumar. Apparatus for providing a.c. electrical energy at a preselected frequency. U.S. Patent No. 2,663,945. May 16, 1972. 14, 17

37. National Research Council wind turbine. Can. Mag.: October 7, 1972. 9

38. Harvey, P. Back to the windmill. Norwalk Hour, July 5, 1972. 4

1972

39. Anderson, R.J. Promise of unconventional energy sources. Battelle Res. Outlook 4(1): 22-25, 1972.
4, 6

40. Barbour, E.H. Windmills of the 1890's. Water Well J. 26(2): 30-31, February 1972.
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A photographic history of older windmills is provided.

41. Clark, P. The natural energy workbook. Berkeley, Village One, Zygote Graphics, June 1972. 44 p.
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42. Fetters, J. Windmills, phenomena in the atomic age. Water Well J. 26(2): 27-29, February 1972.
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A brief review of the American windmill is provided.

43. Jopp, M. Energy from the winds. United Power News. Elk River, Minn., United Power Association, 1972.
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44. Life Support Technics Conference. Proceedings. Albuquerque, N.M., Biotechnic Press, 1972.
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45. Ortega, A., et al. The ecol operation. Montreal, Canada, McGill University, 1972.
2, 4

46. Our energy supply and its future. Battelle Res. Outlook 4(1): 1-41, 1972.
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Predictions are made concerning the production, transmission, and consumption of energy during the period from 1975 to 2000 A.D. The subjects discussed include: getting energy to the user; methods for reducing energy consumption; advancements in energy storage; unconventional energy sources, including wind; and the development of power reactors.

47. Smith, G. List of windmill manufacturers and other publications. Cambridge, Eng., Cambridge University, 1972. 8 p.
12b, 16

48. Thring, M.W. Fuel and power in the 21st century. Electron. Pow. 18: 3-4, January 1972.
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49. Windmill with no arms, new source of power. Sci. Dimen. 4(5): 22-25, October 1972.

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1. Alternative Sources of Energy, No. 2., September 1971, 18 p. No. 9, February 1973, 40 p.

16

The original 1971 publication is updated in 1973 to include an extensive bibliography on wind, solar, tidal, and geothermal energy.

2. Chilcott, R. E. Implications of the utilization of wind power for the development of small Caribbean communities. Brace Res. Inst. Publ. No. R25, November 1971

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3. Chilcott, R. E. et. al. Specifications of the Brace 10 Hp airscrew windmill, 15 assembly and 70 detail drawings. Brace Res. Inst. Publ. No. T43, February 1971.

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4. Duggal, J. S. Dynamic analysis of high speed wind-turbine systems. (M. Sc. thesis). Brace Res. Inst. Publ. No MT.9, 1971.

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5. Gravel, M. Clean energy via the wind. Congressional Record, 92d Congress, 1st Session, Vol. 117: S45180-45183, December 7, 1971.

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Includes M. Gravel's comments on using wind energy plus excerpts from "A National Network of Pollution-Free Energy Sources; a Research Proposal" prepared at the University of Massachusetts under the leadership of Engineering Professor William E. Heronemus.

6. International Symposium on Molinology, 2d, Denmark, 1969. Transactions. Edited by Anders Jesperson. Lyngby, Danske Møllers Venner, Brede Vaerk, 1971. 590 p.

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7. Merriam, M. F. Is there a place for the windmill in less developed countries? Brace Res. Inst. Publ. No. R.25, 1971.

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8. Meyer, H. Wind energy. Dome Book II: 121, 1971.

4, 12a, 8

Drawings and suggestions for building small wind power plant for generation of electrical needs of home or farm.

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Windmills have been harnessed to perform a variety of tasks in the Netherlands over the centuries. Interest has focused in recent years on generating electricity by these means. Several examples of engineering ingenuity are incorporated in a windmill now producing power in the Island of Texel.

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Malakal (09°33'N, 31°39'E;Elev; 456 m) and Juba (04°32'N, 31°33'E; Elev. 388 m) are two important airfields in the Sudan, situation on the main trunk route through Africa. First class meteorological observatories equipped with self-recording instruments exist at both airports. This memoir contains a statistical analysis of the frequency, diurnal variation and duration of thunderstorms, squalls, low clouds, and poor visibility which constitute aviation hazards at both airfields. The analysis is based on data for the years 1955-57, except for the squall data which cover the periods 1953-57 and 1957-59 for Malakal and Juba, respectively. Criteria used in the selection of events considered in the analysis of the phenomena are presented. General synoptic conditions, including the intertropical front line squalls; role of the Arabian anticyclone; and the passage of cold fronts are described. The data and results of the analysis for each airfield are given in a set of tables accompanied by explanatory notes. Climatological normals are given at the end of the discussion on each station.

3. Davidson, R. et al. Sites for wind-power installations. Report on a working group of the (WMO) Commission for Aerology. World Meteorological Organization Tech. Note. 63, 1964. 38 p.

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For relatively uniform flat ground of defined roughness, it is show that the logarithmic law is roughly valid up to at least 100 m above ground for adiabatic and slightly unstable conditions. The importance of ground roughness in selecting a wind-power site is emphasized. The vertical wind shear increases markedly with onset of stable thermal stratification and for climates where these conditions occur often increments in height of a wind generator may often yield significant power additions. The height characteristics of diurnal wind circulations (sea breeze and valley wind) is discussed in some detail. Favorable topographic-synoptic wind configuration are suggested. Characteristics of flow over hills and mountain ridges are discussed in detail. Available information on the vertical profiles of wind speed and gustiness over hill summits is summarized. Some observations are produced which show the existence of speed-up factors on hill and mountain summits, but it is pointed out that such speed-up factors occur under relatively specialized synoptic conditions. The effect of air-mass stability, local insolation (upwind or downwind side) on speed-up factors is discussed in some detail.

4. Hütter, U. Operating experience obtained with a 100 kW wind power plant. Brennstoff-Waerme-Kraft 16: 333-340, 1964.
Translation: Kanner Associates, Redwood City, California. N 73-29008. NTIS, August 1973. 27 p.

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An excerpt is given from the report on experiments and experience associated with the wind power plant and covering design data and those aspects which were decisive in its layout and the type of regulating provisions used, as well as results of the detailed operational tests. The regulating system and the automatic cut-in provisions permit the system to be connected automatically to the public power supply network on the basis of a specific program. The various types of wind conditions considered in designing the power plant are described.

5. Hütter, U. The use of wind energy for generating electric current in Western Germany. World Power Conference, Sectional Meeting, Rio de Janeiro, 1964.

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6. Morasca. N. Calculation of the annual wind energy available at a place. Riv. Meteorologia Aeronautica 24(1): 35-37, January - March 1964. (In Italian)

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The geographical calculation of the wind energy that could have been utilized at Punta Raisi in 1962 by means of a windmill generator is given as an example. The purpose of this short note is to show that only the 06 and 18 GMT wind observations are quite enough for such calculations, at least for the considered station.

7. Power from the wind. UNESCO Courier 17: 52-53, July 1964.

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8. Sachs, P. Wind generation of electric power for radio-relay repeaters. Point to Point Telecommunications 8(2): 15-34, February 1964.

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The power consumption of a solid-state repeater for a low capacity radio-relay system is so low that it could be supplied by storage batteries charged by a small wind generator, provided that the wind characteristics of the site are satisfactory. Suitable sites, where the annual mean wind speeds exceed 8 miles/hour, will be found in almost all coastal belts throughout the world and on many inland hills and ridges. Wind generators for this application are not commercially available at present but it is considered that reliable designs could now be developed on the lines outlined.

9. Simonds, M. H. A 1 Kw wind driven domestic lighting plant at Spring Head, St. James, Barbados. Brace Res. Inst. Publ. No. T 7, 1964.
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10. Simonds, M. H. and A. Bodek. Performance test of a Savonius rotor. Brace Res. Inst. Publ. No. T.10, January 1964.
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11. Solar and aeolian energy; Proceedings of the International Seminar on Solar and Aeolian Energy, Sounion, Greece, September 4-15, 1961. Edited by A. G. Spanides. New York, Plenum Press, 1964. 491 p.
3, 4, 6

Contains 11 articles on windpower, ranging from design of windmills to feasibility and potential in specific areas.

12. Summers, C. M. A quantitative evaluation of power density and storage capacity for solar and wind energy. Conference on Energy Conversion and Storage, Proceedings. Stillwater, Oklahoma, Oklahoma State University, August 1963. Published July 1964. p. 15-33.
3, 11, 13

Increasing efficiencies of fuel cells that convert and reconvert hydrogen and oxygen fuel and electricity directly makes the age-old dream of utilizing solar energy more feasible. Calculations of the annual mean power-density value, of the efficiency of solar conversion units, and of the storage capacity required show that this method is not economically feasible at present. The same calculations made for wind energy (another form of solar energy) show that wind energy conversion is technically and economically feasible.

13. Szokol, G. Problems of wind energy utilization in Hungary. Hungary. Orszagos Meteorologiai Intezet, Hivatalos Kiadvanyai 27(2): 89-94, 1964, issued 1965. (In Hungarian with English and Russian summaries.)
6

Using available data and a method described in the paper, the author calculates the available electrical output. The obtained values exhibit rather important deviations in different parts of the country, even by using data from a rather sparce network of stations.

Therefore, reliable values of the wind power conditions in Hungary could be obtained in full detail only by performing an analysis of energetical conditions for all stations of a projected network and on the basis of recordings for a period of several years.

14. United Nations Conference on New Sources of Energy. Solar Energy, Wind Power, and Geothermal Energy. Rome, August 21-31, 1961. Proceedings. New York, United Nations, 1964. Vol. 1: General Sessions, 218 p. (17 papers on wind power), Vol. 7: Wind Power, 408 p. (43 papers on wind power).
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15. Ward, G. T. Proposal for the installation of an autonomous electricity network supplied by a 20 Kw wind generating plant at Sedge Pond Estate, Barbados. Brace Res. Inst. Publ. No. T.6, 1964.
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16. Frankfurt, M.O. Investigation of aerodynamics and regulation of wind-pumping installations by means of turning the windmill away from the wind. Dissertation, Moscow, 1964.
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17. Kolodin, M.V. Methods for wind energy-producing and energy-economic calculations for wind powered installations. Izvestiya AN Turkm. SSSR Seriya FTKh i G Nauk 1(2): 1964.
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18. Rao, D.V.L.N., K.N. Narasimhaswany and S.R. Radhakrishnan. A study of hourly wind speeds at Jogdalpur and Jamshedpur from the point of view of wind power utilization. Bangalore, India, National Aeronautical Laboratory, 1964.
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19. Shefter, Y.I. Basic principles and experience in creating models of wind pumping installations. Nauchnye Trudy VIESKh. Elektrifikatsiya sel'skogo Khozyaystva [Scientific Works of the Scientific Research Institute of Rural Electrification. Electrification of Agriculture], 12: Moscow, Kolos Publications, 1964.
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20. Shefter, Y.I. Principles of calculation for optimization of wind machine parameters. Mekhanizatsiya i electrifikatsiva sotsialisticheskogo sel'skogokhozyaystrva 6: 1964.
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21. Shefter, Y.I. Effectiveness of using wind motors. Vestnik sel'skokhozyaystvennoy nauki 6: 1964.
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22. Argand, A. Mesure de paramètres caractéristiques de l'énergie éolienne en vue du choix des sites favorables a l'installation d'aéromoteurs. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 21-47; English summary: Measurement of the characteristic parameters of wind power for the selection of favourable sites for wind-driven generators, p. 47-48.

3, 6

Time constants of Robinson, Papillon, and Ailleret anemometers are considered as well as the Best-Romani type. Variation among these suggest that standards be established for presenting wind power data. World-wide wind power potential is discussed, a standard anemometer height above 20 meters is suggested, and projections with respect to the direction of wind power development in Europe and in developing countries are offered.

23. Armbrust, S. Regulating and control system of an experimental 100-kw wind electric plant operating parallel with an AC network. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 201-205.

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24. Arnfred, J.T. Developments and potential improvements in wind power utilization. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 376-381; French summary, 381.

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25. Askegaard, V. Testing of the Gedser wind power plant. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 272-277; French summary, 277.

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26. Ballester, M. Speculative methods in wind surveying. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 49-59; French summary, 59-60.

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This paper assumes the site can be selected and is not predetermined by the load center. Discusses field procedures and statistical procedure for comparing sites. Three sites in Spain were instrumented and statistically compared. The author suggests that site analysis is in its exploratory stage and that a mixture of subjective evaluation and rigorous scientific method must of necessity be used in site selection.

1964

27. Barasoain, J.A. and L. Fontán. Prospecting for wind power with a view to its utilization. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 61-73; French summary, 73-74.

3, 6

This paper analyzes methods used in compiling statistics for use in studies of wind power utilization from the data furnished by meteorological services and the results obtained from specific wind prospecting networks. Pertinent results based on all available data are given in relationship to mainland Spain, and the most important wind basins are outlined and described. A general study of the winds prevailing in the region which embraces the Canary Islands and the coastline of the Sahara Desert is included and includes results from forty stations in this area and subsequent analyses of the wind.

28. Cambilargiu, E. Wind measurements in southern Argentina and remarks on wind and solar energy in that country. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 75-83; French summary, 83-84.

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29. Cambilargiu, E. Expériences faites avec génératrices a aéromoteur dont l'hélice est installée derrière une tour a profil aérodynamique. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 206-211; English summary: Experiences with wind-driven generators with propeller behind a mast of streamline section, p. 211.

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30. Clausnizer, G. Various relationships between wind speed and power output of a wind power plant. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 278-284; French summary, 283-284.

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31. Crispis, C. Ameliorations a l'exploitation de l'energie eolienne ou de l'energie des fluides a vitesse variable. [Improvements in the exploitation of aeolian energy or of the energy of fluids at varying speeds.] Solar and aeolian energy, Proceedings of the International Seminar on Solar and Aeolian Energy, Sounion, Greece, September 4-15, 1961. Edited by A.G. Spanides. New York, Plenum Press, 1964, p. 182-191. (In French)

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32. Delafond, F.H. Méthodes d'essais employées sur l'aérogénérateur 100 kw Andreau-Enfield de Grand Vent. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 285-292; English summary: Test

methods applied to the Andreau-Enfield 100 kw wind-driven generator at Grand Vent, p. 292-293.
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33. Delafond, F.H. Problèmes concernant le couplage automatique d'un aérogénérateur sur un réseau. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 390-394; English summary: Problems of automatic coupling of a wind-driven generator to a network, p. 395.
3, 6, 13

34. Frenkiel, J. Wind flow over hills, in relation to wind power utilization. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 85-111; French summary, 111-113.
3, 6

Starting in 1953, Frenkiel undertook the study of wind power potential in Israel. He instrumented two types of peaks: 1) a mountain ridge athwart the prevailing wind direction with a steep leeward side; 2) an isolated peak in a valley in the general direction of prevailing winds. He concludes that criteria for a good wind power site emerges from his investigations, namely that the mean wind vertical gradient for the height interval from 10 to 40 m above the ground be: 1) less than five percent for optimal sites; 2) five to ten percent for very good sites; 3) ten to fifteen percent for good sites; 4) a mean power law exponent of no greater than .14 for fair sites. Further, he concludes that the slope of the hill determines this mean wind vertical gradient and relates to the above conditions as follows: 1) results from slopes of 1 in 3 1/2; 2) results from smooth, regular slopes of about 1 in 6; 3) results from smooth regular shallow slopes of about 1 in 10, or fairly rough but regular slopes of about 1 in 6; 4) results from a variety of topographic conditions such as low-level coastal sites, smooth aerodynamically very shallow slopes of about 1 in 20, very rough aerodynamically but regular steep slopes of about 1 in 6, and very steep slopes with gradual slope gradient within a radius of about 50 m from the hilltop. These statements of Frenkiel's are rare in the literature of topographic affects on wind power sites.

35. Frenkiel, J. Wind power plant in Eilat. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 326-334; French summary, 334-336.
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36. Golding, E.W. The combination of local energy resources for power supplies. Solar and aeolian energy, Proceedings of the International Seminar on Solar and Aeolian Energy, Sounion, Greece, September 4-15, 1961. Edited by A.G. Spanides. New York, Plenum Press, 1964, p. 197-200.

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37. Golding, E.W. Methods of assessing the potentialities of wind power on different scales of utilization. Solar and aeolian energy, Proceedings of the International Seminar on Solar and Aeolian Energy, Sounion, Greece, September 4-15, 1961. Edited by A.G. Spanides. New York, Plenum Press, 1964, p. 152-157.

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38. Golding, E.W. Studies of wind behaviour and investigation of suitable sites for wind-driven plants. United Nations Conference on New Sources of Energy, Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 3-8; French version, 9-14; Rapporteur's summation 15-17; Résumé du rapporteur, 18-20.

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39. Havinga, A. Classical designs of small drainage windmills in Holland, with considerations on the possibilities of their improvement and adaptation in less developed countries. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 212-216; French summary, 216.

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40. Hütter, U. The aerodynamic layout of wind blades of wind-turbines with high tip-speed ratio. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 217-228; French summary, 228.

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41. Hütter, U. Layout optimisation of wind power plants. Solar and aeolian energy, Proceedings of the International Seminar on Solar and Aeolian Energy, Sounion, Greece, September 4-15, 1961. Edited by A.G. Spanides. New York, Plenum Press, 1964, p. 173-181.

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42. Hütter, U. Recent developments and potential improvements in wind power utilization. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 307-313; French translation, 314-321; Rapporteur's summation, 322-323; Résumé du rapporteur, 324-325.

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43. Jacobs, M.L. Experience with Jacobs wind-driven electric generating plant, 1931-1957. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 337-339; French summary, 339.
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44. Jensen, M. Wind measurements. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 114-123; French summary, 123-124.
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45. Juul, J. Economy and operation of wind power plants. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 399-408; French summary, 408.
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46. Juul, J. Recent developments and potential improvements in wind power utilization for use in connection with electrical networks in Denmark. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 396-398; French summary, 398.
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47. Juul, J. Design of wind power plants in Denmark. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 229-240; French summary, 240.
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48. Kiss, A.L. Wind power plants suitable for use in the national power supply network. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 241-247; French summary, 247.
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49. Lange, K.O. Some aspects of site selection for wind power plants on mountainous terrain. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 125-128; French summary, 128.
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50. Moriya, T. and Y. Tomosawa. Wind turbines of new design in Japan. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 249-253; French summary, 253.
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51. Morrison, J.G. The testing of a wind power plant. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 294-304; French summary, 304.
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52. Nilakantan, P., K.P. Ramakrishnan and S.P. Venkiteshwaran. Windmill types considered suitable for large-scale use in India. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 382-388; French summary, 389.

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53. Papagianakis, S. Proposed method of wind energy computation. Solar and aeolian energy, Proceedings of the International Seminar on Solar and Aeolian Energy, Sounion, Greece, September 4-15, 1961. Edited by A.G. Spanides. New York, Plenum Press, 1964, p. 204-207.

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54. Perlat, A. La mesure du vent en météorologie. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 129-132; English summary: Wind measurement in meteorology, p. 132.

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55. Petterssen, S. Some aspects of wind profiles. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 133-136; French summary, 136.

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56. Ramakrishnan, K.P. and S.P. Venkiteshwaran. Wind power resources of India with particular reference to wind distribution. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 137-146; French summary, 146.

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Using wind run data from nearly 150 recording stations and hourly wind speeds for nearly 25 stations, the wind power potential of India is considered by the authors. Velocity duration curves of eight stations are derived. The use of water pumping equipment at a selected station is also included.

57. Rao, M.S.P. and S.R. Radhakrishnan. A study of the hourly wind speeds at Kodiakanal from the point of view of wind power utilization. Bangalore, India, National Aeronautical Lab., December 1964. 14 p.

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58. Santorini, P. Considerations sur un aspect naturel de l'amenagement de l'energie du vent. [Considerations regarding a natural aspect of the harnessing of aeolian energy.] Solar and aeolian energy, Proceedings of the International Seminar on Solar and Aeolian Energy, Sounion, Greece, September 4-15, 1961. Edited by A.G. Spanides. New York, Plenum Press, 1964, p. 161-166. (In French)

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60. Sanuki, M. Wind measurement techniques. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 147-151; French summary, 151.
3, 6

The errors in cup anemometers due to their non-linearity of indication and the influence of atmospheric turbulence is discussed. Windmill anemometers not affected by turbulence are described and the over-estimation of wind speed by both cup and windmill type anemometers is considered. Site selection for wind measurement is considered as well as instrumentation technique. The presentation is constructed to point up the difficulties in comparing wind data taken with different equipment and in changing equipment at an existing station.

61. Soliman, K.H. Study of wind behavior and investigation of suitable sites for wind-driven plants. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 152-160; French summary, 160.
3, 6

A detailed study of the wind on the coast of Egypt looks at monthly and diurnal variations in wind velocities and concludes that four synoptic observations at six hour intervals provides a good indication of wind power potential.

62. Stam, H. Adaptation of windmill designs, with special regard to the needs of the less industrialized areas. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 347-356; French summary, 356-357.
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63. Stam, H., H. Tabak and C.J. van Vlaardingen. Small radio, powered by a wind-driven bicycle dynamo. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 340-345; French summary, 345-346.
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64. Sterne, L. The need for simplicity in the design of windmills. Solar and aeolian energy, Proceedings of the International Seminar on Solar and Aeolian Energy, Sounion, Greece, September 4-15, 1961. Edited by A.G. Spanides. New York, Plenum Press, 1964, p. 158-160.
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66. Survey of existing wind observational information. World Meteorological Organization, Geneva. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 167-176; French summary, 176-177.

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67. Tagg, J.R. Wind measurements in relation to the development of wind power. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 161-166; French summary, 166.

3, 6

This paper reviews the various types of anemometers and examines their suitability for different kinds of wind measurement. An outline scheme is given for the investigation of wind flow over an area. Comments are made on the installation of anemometers. The use which can be made of existing wind data is considered in relation to the wind measurements actually carried out. Two specially developed wind speed recorders are illustrated and described. A method is shown for comparing the value of one site with another in terms of specific output. Mention is made of several methods of recording extreme wind speeds for design purposes.

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69. Venkiteshwaran, S.P. Operation of Allgaier type (6-8 kw) wind electric generator at Porbandar, India. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 358-361; French summary, 362.

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70. Venkiteshwaran, S.P. and K.R. Sivaraman. Utilization of wind power in arid and semi-arid areas in India. Bangalore, India. National Aeronautical Lab., November 1964. 19 p.

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1964

71. Villinger, F. Small wind-electric plant with permanent magnetic generator. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 267-271; French summary, 271.
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72. Walker, J.G. A method for improving the energy utilization of wind-driven generators, and their operation with conventional power sets. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 363-369; French summary, 369.
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73. Walker, J.G. Utilization of random power with particular reference to small-scale wind power plants. United Nations Conference on New Sources of Energy. Proceedings. New York, United Nations, 1964. Vol. 7. Wind Power, p. 370-374; French summary, 374-375.
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Possibilities of improving efficiency of wind powered generator were investigated; performance of shroud was tested by simulating action of turbine rotor by energy dissipating screen; 3 shroud configurations were investigated; each shroud was tested with 13 screens; experiments revealed dependence of generator power coefficient on shroud geometry and turbine load factor; diffuser pressure recovery and overall pressure ratio were found to depend on shroud geometry and screen solidity ratio, and influenced by deflection angle of shroud; maximum power coefficient and optimum load factor were found for each shroud geometry.

2. Lo Giudice, G. Una stazione eolica a Palermo. Termotecnica 17(1): 44-48, January 1963.

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Aeolian station in Palermo, Italy; report on 2 year operation (1957-1958) of experimental wind power plant; d-c motor drives alternator for connection with Sicily electrical net: efficiency is about 50%; Inst. of Techn. Physics of Palermo is studying transistorized circuit for static conversion of d-c into a-c power.

3. Methods of analysis of wind power potential to give regional characteristics. Academy of Sciences, USSR. 1963. 190 p.

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4. Morasca, N. Considerations concerning the utilization of the energy of the wind. Riv. Meteorol. Aeronaut. 23: 31-40, January - March, 1963 (In Italian)

4, 6

Computation of the energy which can be recovered from the wind by means of a wind engine. It is estimated that $\sim 10^{18}$ kwhr of solar energy reach Earth yearly. Of this amount, approximately 10^{13} kwhr/yr are used to keep the atmosphere in motion. Various methods are examined for the utilization of this energy. Evaluations of aeolian energy available at some Sicilian sites are given. Comparisons are made with wind data obtained in Algeria and in Northern Europe.

5. Ramanathan, R. A comparative study of the estimated output and the economics of certain types of wind electric generators with reference to selected stations in India. Bangalore, India. National Aeronautical Lab., Tech. Rep. 1-63, May 1963.

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Very little information is available about the types of wind driven generators that will be suitable for the wind regimes in India and their relative economics. This study provides this information about the estimated performance and the economic aspects of certain types of wind driven machines at different places in India.

6. Rao, D. V. L. N. and K. N. Narasimhaswamy. A study of the hourly wind speeds at Amritsar from the point of view of wind power utilization. Bangalore, India. National Aeronautical Lab. April 1963. 25 p. (STAR: N64-13323).

6

Frequencies of different wind speeds and cumulative frequencies were computed to determine the energy extractable from the wind by a machine with an overall power coefficient of 12 per cent and 30 m^2 swept area. The annual energy works out to 984 kwh. The quantity of water that can be pumped on each day of a typical year was computed; the annual quantity is 31,000 kl (68,200,000 gal) of water pumped by a windmill of overall power coefficient of 12 per cent and swept area of 23.6 m^2.

7. Rao, M. S. P. A study of hourly wind speeds at Bhopal from the point of view of wind power utilization. Bangalore, India. National Aeronautical Lab. April 1963. 21 p. (STAR: N64-13345).

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Frequencies and cumulative frequencies have been worked out and used to estimate the amount of energy extractable from the wind under certain assumptions. Durations of spells of low wind (less than 8 km/hr) and the diurnal variation of wind have also been discussed. The yearly average wind speed at Bhopal is 11 km/hr. The annual energy output is 1,370 kwh for a wind electric generator with an overall power coefficient of 12 per cent. The annual water pumping capacity of a WP-2-type windmill is estimated at about 42,000 kl (9,240,000 gal).

1963

8. Rao, M.S.P. and S R. Radhakrishnan. A study of the hourly wind speeds at Jaipur from the point of view of wind power utilization. Bangalore, India. National Aeronautical Lab. April 1963. 19 p. (STAR: N64-13346). 6

Certain characteristics of wind, such as frequency distribution, spells of low winds, and the diurnal variation are discussed. The annual energy output of an aerogenerator of 30 m^2 swept area and an overall power coefficient of 12 per cent is estimated at 561 kwh The annual water pumping capacity of a direct-acting windmill with the same overall power coefficient but with a swept area of 23.6 m^2 (WP-2-type windmill), is estimated at about 17,550 kl (3,861,000 gal), i.e., 10,580 gal/day. The annual mean wind speed is 7 km/hr.

9. Sanchez-Vilar, C. Wind electric research report (evaluation of the performance of a commercial aerogenerator). Brace Res. Inst. Publ. No. DT.4. August 1963. 30 p. 14

10. Wailes, R. Windmills - their rise and decline. Eng. Heritage 1: 7-10, 1963. 1

11. Shefter, Y.I. Some questions of utilizing wind energy in arid zones, problems of complex study of arid zones of the USSR for the purpose of their mastery. Moscow, Russia, AN SSSR Publication, 1963. 6

12. Halas, E. Analytical design method for Lundell alternator. IEEE Trans. Aerosp. AS-1: 1043-1055, 1963. 5, 14

13. Grinevich, G.A. Basic power-producing characteristics of wind rate, methods of developing a wind energy-producing cadaster. Moscow, Russia, Izd. AN SSSR, 1963. 6

14. Venkiteshwaran, S.P. and K.R. Kivaraman. Utilization of wind power in arid and semiarid areas in India. National Aeronautical Laboratory, Bangalore, India. 1963. 6

15. Wonderful windmill of Mykonos. Architect. For. 119: 116-117, September 1963. 1

16. Hughes, W.L., H.J. Allison and C.M. Summers. An energy system for the future. Conference on Industrial Electronics, Proceedings, Illinois, 1963. 4

1963

17. Introducing the windmill. Bangalore, India, National Aeronautical Laboratory, 1963. 8 p.
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18. Janardhan, S. Some preliminary considerations in the choice of rated speeds for wind machines. Bangalore, India, National Aeronautical Lab., January 1963. 20 p.
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19. Janardhan, S., and S. Viswanath. A study of the hourly wind speeds at Gopalpur from the point of view of wind power utilization. Bangalore, India, National Aeronautical Lab., May 1963. 20 p.
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20. Ramanathan, R. and S. Viswanath. A study of the hourly wind speeds at Jodhpur from the point of view of wind power utilization. Bangalore, India, National Aeronautical Lab., September 1963. 19 p.
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21. Ramanathan, R. and S. Viswanath. A study of the hourly wind speeds at Lucknow from the point of view of wind power utilization. Bangalore, India, National Aeronautical Lab., April 1963. 18 p.
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22. Ramanathan, R. and S. Viswanath. A study of the hourly wind speeds at New Delhi from the point of view of wind power utilization. Bangalore, India, National Aeronautical Lab., November 1963. 18 p.
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23. Rao, D.V.L.N. and K.N. Narasimhaswamy. A study of the hourly wind speeds at Gaya from the point of view of wind power utilization. Bangalore, India, National Aeronautical Lab., December 1963. 17 p.
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24. Rao, D.V.L.N. and S.P. Venkiteshwaran. Performance of the 6-8 kW Allgaier wind electric generator at Porbander. Bangalore, India, National Aeronautical Lab., December 1963. 26 p.
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25. Rao, M.S.P. and S.R. Radhakrishnan. A study of the hourly wind speeds at Allahabad from the point of view of wind power utilization. Bangalore, India, National Aeronautical Lab., January 1963. 17 p.
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26. Rao, M.S.P. and S.R. Radhakrishnan. A study of the hourly wind speeds at Vishakhapatnam from the point of view of wind power utilization. Bangalore, India, National Aeronautical Lab., January 1963. 17 p.
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27. Rao, M.S.P. and S.R. Radhakrishnan. A study of the hourly wind speeds at Calcutta (Dum Dum) from the point of view of wind power utilization. Bangalore, India, National Aeronautical Lab., April 1963. 18 p.
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28. Sivaraman, K.R. and S. Venkiteshwaran. Utilization of wind power for irrigation of crops in India with special reference to the distribution of wind and rainfall. Bangalore, India, National Aeronautical Lab., November 1963. 15 p.
6, 8

29. Summers, C.M. Quantitative evaluation of power density and storage capacity for solar and wind energy. Proceedings of a Conference on Energy Conversion and Storage. N64-29484. October 28, 1963, p. 15-33.
3, 6, 11

1962

1. Development, testing and operation of a 200 kW wind power station in Denmark. Report of the Windpower Committee of the Association of Danish Electricity Undertakings (OEF), Copenhagen, Denmark. 1962. Translation: Elect. Res. Assoc. Transl. No. IB2158. also: Kanner Associates, Redwood City, Cal. NTIS, N75-15154, Jan. 1975, 117 p. 7

2. Fateev, E. M. Wind turbines and their application to agriculture. State Scientific and Technical Publishing House of Mechanical Engineering Literature, Moscow. 1962. (In Russian) 8

3. Frenkiel, J. Wind profiles over hills (in relation to wind power utilization). Roy. Meteorol. Soc. Q. J. 88(376): 156-169, April 1962. 6

Following a previous country-wide wind survey, two sites - each typical of one of the following two topographical categories; (a) a hill forming a part of a mountain ridge athwart the prevailing wind direction with steep leeward slopes and (b) an isolated peak in a valley in the general direction of prevailing winds--were chosen for detailed investigation of wind behavior with the purpose of correlating the characteristics of the wind flow over the hill to its topography. At each site, wind vertical gradient, wind direction, and temperature vertical gradient were measured in the height interval of interest to wind-power utilization (10m to 40m above the hilltop) for a period of about a year. These measurements have shown: 1) There is no close relationship between mean wind profile and mean temperature profile over hills. 2) Whilst the directional wind profiles are practically uninfluenced by wind speed, they are largely determined by: (a) the hill profile in the immediate neighborhood of the site of measurements and (b) the hill profile further upwind in relation to that near the measurements site. 3) The effect of thermal stratification is important for all wind speeds with the curves of wind ratio as a function of temperature gradient exhibiting both a minimum and a maximum, the location of which on the scale of temp. gradient depending on the hill profile. A classification of wind-power sites is given based on a single criterion, i.e., mean wind vertical gradient for the height interval from 10m to 40m. For optimal conditions for wind-power utilization this gradient must vanish, a flow condition resulting from: (a) small hilltop area; (b) regular and smooth slopes of about 1 in 3-1/2 in the nearest few hundred metres from the hilltop.

1962

4. Gandin, L. S. Selecting optimum parameters for wind machines. Glavnaia Geofizicheskaia Observatoriia, Trudy, No. 131: 10-14, 1962. (In Russian.)

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The author develops formulas for calculating the parameters of a wind machine most suitable for a given point on the basis of the curve of distribution of wind frequencies at the given point.

5. Golding, E. W. Energy from wind and local fuels. UNESCO. Arid Zone Research 18: 249-258, 1962.

4

Discusses research and development work done in recent years on the utilization of energy from wind and local fuels in arid zones. Progress is noted in the study of the development of small windmills and large-scale wind power plants in various parts of the world.

6. Golding, E. W. Water pumping and electricity from windmills. Agriculture 69: 19-24, 1962.

2, 4, 15

A review of the feasibility and advantages of using wind power for the production of electricity and pumping water in isolated or underdeveloped areas is presented.

7. Hosain, A. Generation of power from wind in East Pakistan. Inst. Eng. (Paskistan) Annual Convention Tech. Papers 13: 1-6, April 1962.

4, 6

Developments in field of wind power are described, including wind driven Smith-Putnam turbine rated at 1250 kw constructed in 1941 at top of 2000 ft high peak in Vermont, United States, feeding alternating current synchronously to high-line of utility systems, investigation of possibilities of generating cheap electricity by utilizing power from wind is recommended; tables of mean wind speed for 6 stations in East Pakistan and average speeds of wind 1600 ft above ground in one station are given.

8. Masson, H. Les nouvelles sources d'energie. Annales des Mines: 37-62, March 1962; 37-54, April 1962.

4

New sources of energy; sources and utilization of geothermal energy, wind power, and solar radiation.

9. Stokhuyzen, F. The Dutch windmill. Translated from the Dutch by C. Dikshoorn. London, Merlin Press, 1962.

1, 2

1962

10. Thirring, H. Energy for man: from windmills to nuclear power. New York, Harper Torchbooks, 1962. (c. 1958)
2, 4

11. Venkiteshwaran, S. P. and K. P. Ramakrishnan. Harnessing the winds of India. New. Sci. 15(295): 75-78, July 12, 1962.
4

Discusses the possibilities of using wind power in an "energy hungry" country like India. The principle of a windmill is explained. A figure shows a windmill model developed at the National Aeronautical Lab., Bangalore, India. It is planned to install about 200 windmills in various parts of India. A map shows the annual mean wind speeds in various parts of India. The relationship between the wind speed and a wind electric generator is discussed.

12. Wind- , Sonnen- und Geothermische Energie. Brennstoff-Waerme-Kraft 14(7): 309-353, July 1962.
3, 4

Nine articles presented at United Nations Conference August 1961, Rome; Economical and social points of view concerning power supply of underdeveloped countries, H. KRUACH, 310-12; Geothermal energy, N. GASPAROVIC, 313-20; Wind power, G.CLAUSNIZER, 321-6; Available solar energy and instruments for measuring radiation, K. GRAEFE, 326-9; Photoelectric, thermoelectric and thermionic conversion into electric power, C. TING-WALDT, F.W. SEEMANN, 329-33; Solar power plants, H. KRAUCH, 334-6; Direct use of heat load, K. JECHT, A. Th. GROSS, 337-47; Energy storage, 347-8; New materials for solar energy utilization, H. KRAUCH, K. JECHT, 349-53.

13. Nielson E.V. Report of the Wind Power Committee of 1962. Danish Association of Electric Supply Undertakings. Report, 1962. Translation: Kanner Associates, Redwood City, California. N74-19710. NTIS, April 1974. 32 p.
6

The Danish Wind Power Committee's experiments with propeller windmills are described. specifically the 25-m-high windmill at Gedser. Wind measuring stations were established and the wind energy available and optimum locations determined. A cost comparison was made of electricity from wind and steam power, and the committee concluded that wind power plants were economically unfeasible to develop at that time.

1962

14. Gandin, L.S. On optimal selection of wind motor parameters. Trudy Glavnoy Geofizicheskoy Observatorii (Leningrad) 131: 1962. 6

15. Golding, E.W. Power supplies. An Overseas Development Institute Pamphlet, London, England, 1962. 4

16. Rao, M.S.P. and S.R. Radhakrishnan. Velocity measurements for converting wind energy to power for wind electric generator operation. Bangalore, India, National Aeronautical Laboratory, 1962. 14

17. Shefter, Y.I. On the question of combining wind motors with water lifting equipment. Nauchnye Trudy VIESKh. Elektrifikatsiya sel'skogo khozyaystva [Scientific Works of the Scientific Research Institute of Rural Electrification. Electrification of Agriculture] 10: Moscow, Kolos Publications, 1962. 8, 15

1962

18. Golding, E.W. Wind power potentialities in India. Preliminary Report. Bangalore, India, National Aeronautical Lab., July 1962.
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19. Ramanathan, R. and K.N. Narasimhaswamy. A study of the hourly wind speeds at Bombay (Santa Cruz) from the point of view of wind power utilization. Bangalore, India. National Aeronautical Lab., December 1962. 17 p.
6

20. Report of the Wind Power Committee. Translation into English from Dan. Elvaer Foren., Copenhagen, 1962. Translation: Kanner Associates, Redwood City, California. NTIS, N75-15154, January 1975. 117 p.
6

Wind-generated electricity was studied at an experimental mill and at wind measuring stations which consisted of a measuring cylinder mounted on a steel mast at elevations of 25 and 50 m. The mill is evaluated in terms of its cost and performance and is compared to other experimental mills in these terms. A system of economic models is presented which compares the costs for wind- and steam-generated electricity, with the conclusion that a wind power plant such as the one studied is unable to compete with a steam power plant. Wind power is held to be useful as a replacement for imported fuel and as a power reserve. Supplementary material on effect calculations and performance characteristics is also provided.

21. Thirring, H. Energy for man; windmills to nuclear power. Bloomington, Indiana, Indiana University Press, 1958. New York, Harper Torchbooks, 1962.
2, 4

22. Problemas del aprovechamiento de la energia edlica en la Republica Argentina. Rev. Electrotec. 38(1): 1-20, January 1962. (In Spanish)
4, 6

The historical development of the windmill is sketched and photographs of modern types are shown. The problems of design, of storage of energy, regulation, interconnection with networks, effects on wind velocities, are discussed, and the special importance wind power stations might have as introducing electric power in regions beyond the extensions of a network is considered. The characteristics of wind over the area of the Republic are described and illustrated by maps. An intensive study of the question is advocated.

23. Nilakantan, P. and R. Varadarajan. Studies on the utilization of wind power in India. Bangalore, India, National Aeronautical Lab., 1962.
6

1961

1. Bernfield, D. Present position and future prospects on the use of wind power in the R.P.R. (Roumania). Energetica (Roumania) 9(9): 358-371, September 1961. (In Roumanian.)

4, 6

Part 1: Meteorological records and their utilization for computing and charting wind potentials.
Part 2: Present installations, giving quantitative and design data.
Part 3: Future applications and descriptions of projected plants.

2. Golding, E. W. The influence of aerodynamics in wind power development. NATO, AGARD Report 401, 1961. 43 p. NTIS. N63-80507.

1, 4, 5, 6, 7

After a brief account of the recent history of windmills the paper deals with the characteristics of the wind as a source of power and outlines the methods of obtaining and analysing wind data as a basis for assessment of the economic potentialities of wind power utilization. The selection of favourable sites for wind power installations is then discussed, and this subject is followed by notes on the design and performance of windmills of different types and sizes under various conditions of use. Later sections cover the utilization of wind-generated energy and the needs for research and development along specified lines.

3. Golding, E. W. Solar and wind energy. Research 14: 82-87, March 1961.

4

4. Golding, E. W. Three unconventional sources of energy. Engineering 192: 198-199, August 18, 1961.

4

Of the many under-used sources of energy in the world, three--wind energy, solar radiation and geothermal energy--are receiving serious attention.

5. Golding, E. W. Windmills for water lifting and the generation of electricity on the farm. United Nations FAO Informal Working Bull. No. 17, 1961.

8, 15

6. Kogan, A. and E. Nissim. Shrouded aerogenerator design study. 1. Two-dimensional shroud performance. Israel Inst. Technol. Dept. Aeronautical Eng. Report No. 17, January-June 1961. 21 p.

10

Performance of shrouded windmill; 1-dimensional approximation analysis revealed dependence of generator power coefficient on turbine load factor, diffuser pressure recovery coefficient and overall pressure coefficient; performance of 2-dimensional symmetrical and "half-model" configurations; small dependence of diffuser pressure recovery coefficient and overall pressure coefficient upon turbine load factor demonstrated; maximum power coefficient and corresponding optimum load factor calculated.

7. Ramakrishnan, K. P. and S. P. Venkiteshwaran. Wind power resources of India with particular reference to wind distribution. National Aeronautical Lab., Bangalore, India, Tech. Note TN-WP-1-61, June 1961. 15 p.

4, 6

The wind data used in this paper are those already collected by the Indian Meteorology Department. These are of two categories. The first consists of values of total run of wind on each measured day by nonrecording types of anemometers. Long period averages for nearly 150 stations in India are available and using these, maps of isovents for alternate months, the year and the highest monthly mean are shown. The second category consists of hourly values of wind speed tabulated from the records of Dines anemographs, for nearly 25 stations in India.

8. Shapaev, V. M. Wind energy resources of islands and of the Arctic coast of the U.S.S.R. Problemy Arktiki i Antarktiti 7: 45-49, 1961. (In Russian.)

4, 6

Using data of wind speed from 54 polar stations at which observations have been carried out from 10 to 39 years, and 6 stations with observations for 7-9 years, the author attempts a preliminary estimate of the wind energy resources of the Arctic. Data are presented on the frequency of mean annual wind speeds for various intervals, the mean annual velocity in different regions of the Arctic and per cent of annual total of hours when wind is observed.

9. Shefter, Y. Problems of design and strength calculations of high speed windmills. Sb. Trud. Seml. Mekh., No. 6: 548-562, 1961. (In Russian.)

5, 12b

10. Wilson, R. G. Windmill cut-out works on back pressure. Queensland Agric. J. 87: 621-622, 1961.
5

11. Wind as a source of energy in India. Curr. Sci., Bangalore 30(3): 95, March 1961.
4, 6

A brief discussion on the utilization of wind power in India. The project on the utilization of wind power initiated by M.S. Thacker in 1952 is described. E.W. Golding, an authority on wind power utilization, made several recommendations which were accepted. The government has formed a Wind Power Division and laboratory facilities have been arranged. Two prototype windmills have been built. A wind electric generator installed at Porbandar may serves as a model. It is hoped that before long similar types of wind electric generators will be designed and constructed by the laboratory from indigenous material.

12. Windmill power needed in developing areas. Sci. News Letter 80: 224, September 30, 1961.
4

13. Golding, E.W. Windmills for water lifting and the generation of electricity on the farm. FAO Farm Informal Working Bulletin No. 17, 1961. same as 1961:5
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14. Golding, E.W. New power for the underdeveloped areas. Engineering 192: 348, 1961.
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15. Solar and wind energy. Research: 82-87, 1961.
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1961

16. Golding, E.W. Power from local energy resources. In: UN Conference on New Sources of Energy. Rome, Italy, 1961. 13 p.
3, 4

17. Nilakantan, P., K.P. Ramakrishnan, and S.P. Venkiteshwaran. Windmill types considered suitable for large scale use in India. Bangalore, India, National Aeronautical Lab., April 1961. 33 p.
5

18. Terry, C.W. Unfueled power supply for isolated bases on sea ice. Naval Civil Engineering Lab., Port Hueneme, California. NTIS, AD263905, October 1961. 19 p.
8, 15

19. Alaka, M.A. The airflow over mountains. World Meteorological Organization. W.M.O. Tech. Note No. 34, WMO-No. 98TP,43, 1961.
6

1960

1. Azcarraga, L. de The harnessing of solar and wind energy. World Power Conference. Sectional Meeting, Madrid, June 1960. Paper IIC/3, 18 p. (In Spanish.) 4

With rising standards of living and increasing demands for energy, inexhaustible sources, such as solar and wind energy should supplement the diminishing conventional sources. Although only a small fraction of the available solar and wind energy can be captured and used, the total quantities are considerable. A table gives daily (24 hours) averages of solar power received at the earth's surface ranging from 0.266 kW/m^2 at El Paso, Texas, to 0.116 in London. Between the latitudes of 30° and 45°, the maximum summer figure may be from 0.35 kW/m^2 up to 1 kW/m^2. The average annual wind speeds quoted range from 11.2 m/s in Orkney to 4.3 m/s in Moscow. The choice of wind power sites is of great importance. Some uses are suggested for solar energy, such as the demineralization of saline water, the cultivation of chlorella, which grows very rapidly under favourable conditions and is rich in protein, and the drying of vegetables. Wind energy could be used for the generation of electricity, with accumulators to ensure continuity of supply, or in conjunction with other sources of energy, or, where practicable, with direct connection to the network. It is particularly suitable for applications like water pumping, where continuous operation is not necessary. Solar energy is more suitable for small power uses. The combination of the two sources also offers interesting possibilities.

2. Akimovich, N. N. Available wind power in the Black Sea steppes. In: Konferentsiia po Prikladno' Klimatologii, Leningrad, 1958. Voprosy prikladnol klimatologii. Leningrad, 1960. p. 149-153. 3, 6

The wind energy can be calculated by the formula $K=0.000491\ d^3c^3$ kwt=sec, where d=diameter in meters of the wind wheel with vanes and c=velocity of the air mass. In order to compute the energy resources the concept kilometer power, the mean annual power of wind over an area of 1 km^2, was introduced so that $K=5X64c^3$kwt-sec. The utilization of wind, which depends upon the type of wind engine, and the maximum value of utilization is given by $\xi=0.687$. Data on the wind energy resources in the Black Sea steppes (Odessa, Kherson, Crimea, etc. economic districts) and on the number of hours of different wind speeds per year are presented in tables and the wind energy resources of the area are analyzed.

3. Blanco, P. and L. Fontan. Power resources other than those regarded as basic. Investigation and effective use of these. World Power Conference. Sectional Meeting, Madrid, June 1960. Section IIC, General Report, 8 p.

3, 4

This general report discusses eight papers on inexhaustible sources of energy, such as wind power, solar energy and tidal power, which can be used either directly or for the generation of electricity. The use of these sources, as fuel savers, would greatly help to solve the problem of the shortage of power, even in some of the more advanced countries, while in many underdeveloped and remote areas they are practically the only sources because the cost of transport of conventional fuel is prohibitively high. Tidal and geothermal power can be used in only a comparatively few places, but wind power and solar energy are more generally available; even in England the latter has been shown to have an economically exploitable value. A table of efficiencies of solar energy conversion is given, with values ranging from 1.5% to 5% for conversion to electrical energy, using flat-plate collectors, and from 40% to 70% for conversion to thermal energy using concentrating collectors. The authors suggest that a thorough investigation should be made into the potentialities of these resources, with the consent of the countries where they occur. The question of international collaboration is raised, particularly the basis on which it should be established and the order of priorities to be followed.

4. Cambilargiu, E. Experiments with anemometers for studying the use of wind power. World Power Conference. Sectional Meeting, Madrid, June 1960. Paper IIC/4, 15 p. (In Spanish.)

3, 6

The average wind speed measured at a site, since it ignores fluctuations and turbulence, cannot be taken as a sure indication of the wind regime. The author describes different types of anemometers, including instantaneous wind speed recorders, integrating instruments recording the continuous run-of-wind, and those manufactured in France which measure the energy in kWh/m^2. He explains the methods of making wind surveys in an area and the data required by the designers of an aerogenerator. Velocity duration and velocity-frequency curves are traced from the wind speed measurements made at a site and used in determining its suitability for the installation of a wind-driven generator. The report contains two diagrams of record charts and table of recorded wind speeds in Uruguay. The anemometers at present available are not ideally suited for use in wind surveys and it is suggested that meteorological services should cooperate with organizations interested in wind power to develop an anemometer which would reduce the labour involved in analysing the measurements. Methods of testing the performance of aerogenerators are also described.

1960

5. Cambilargiu, E. Experiments on the variation of wind speed with height in Uruguay. World Power Conference. Sectional Meeting, Madrid, June 1960. Paper IIC/5, 14 p. (In Spanish)

3, 6

A programme of five series of experiments have been planned in Uruguay to determine, in different places, the variation of wind speed with height and, consequently, the power which can be captured and used by an aerogenerator. The first series was made on a metal tower, 56 m high, at the radio station at Cerrito de la Victoria in Montevideo, about 55 m above sea level. Six anemometers were mounted on the tower, the first at a height of 8 m, the second at 16 m, and so on to the sixth at 48 m. The measurements are given in a table showing that the relative mean velocities V_h/V_3 range from 1.00 to 1.72. The second series was made at the lighthouse near La Paloma, situated between 30 m and 40 m from the sea and about 1 m above sea level. The same Munro Mark II anemometers as were used for the first series were mounted at heights of 4.80 m, 12.20 m, 28.50 m and 38.50 m. The relative mean velocities $V_h/V_{4.80}$ of all winds coming from the sea arranged from 1.00 to 1.35. Three more series of experiments are to be made in other parts of Uruguay with the object of finding the most suitable altitude for the installation of aerogenerators.

6. Cambilargiu, E. and F. de Medina. Investigations on the utilization of wind energy in Uruguay. World Power Conference. Sectional Meetind, Madrid, June 1960. Paper IIC/8. (In Spanish.)

3, 6

7. Cisa, A.G. Use of asynchronous generators for producing electrical energy by wind motors. World Power Conference. Sectional Meeting, Madrid, June 1960. Paper IIC/2, 10 p. (In Spanish.)

3, 14

Two uses are described: the generation of electricity to charge storage batteries and the generation of electricity to be fed into a network, and the results are compared with those obtained with conventional a.c. generators. In the first case, diagrams are given of the three-phase generator excited through capacitors and of its characteristics under load. In the second case, diagrams show the mechanical characteristics of the aeromotor, the characteristics of the generator for various voltages of the grid, the input and output power, and the main and control circuits of the generator. The asynchronous generator is recommended for feeding into the grid as there is no need for any synchronizing device; a simple switch operated by the tachometer of the aero-generator connects to or disconnects from the network. From wind speed data for Uruguay, it is estimated that a maximum output of some 270,000 kWh per year can be obtained with a 140 kW generator having a rated wind speed of 10 m/s. The paper gives some notes on the operation and control of an induction generator when connected to an a.c. network.

8. Emslie, K. Industrial uses of wind tunnels with particular reference to wind machines. NATO AGARD-306. Presented at AGARD Fluid Dynamics Panel held in October 1960, Istanbul, Turkey.

5

The report describes the equipment and test techniques at the English Electric Company's wind-tunnel facilities at Warton Aerodrome, together with a number of industrial-type tests carried out recently by this company.

9. Fateev, E.M. Wind energy - in the service of agriculture. Tekh. Sel. Khoz. 20(2): 31-34, 1960.

4

10. Golding, E.W. Using the wind for power. Weather, No. 15: 113-121, 1960.

4

11. Gourdine, M.C. Wind energy convertors provide high power. Electronics 33: 148+, August 12, 1960.

7

Wind-energy convertors may be capable of producing several million volts at one ampere. Only about one microampere of current is provided by the Van de Graaf generator at a potential of about one million volts. Many applications are foreseen for the high-power, high-voltage generator including providing power for space vehicles.

12. Tagg, J.R. Wind driven generators. The difference between the estimated output and actual energy obtained. Elect. Res. Assoc. Tech. Rep. C/T123, 1960. 7 p.

5, 14

1960

13. Walker, J.G. Automatic operation of medium-sized wind-driven generators running in isolation. Elec. Res. Assoc. Tech. Rep. C/T122, 1960. 14p.

8

Method adopted for testing of wind-driven generator when used to supply energy to isolated house or farm; results obtained during initial testing period; details of main control circuits used.

14. Wysocki, J. Przyblizona metoda obliczanie wiatrakow o danymksztalcie geometrycznym lopat. Archiwum Budowy Maszyn 7(3): 335-350, 1960.

5

Approximate method of calculating windmills with arms of given geometrical shape; method is based on stream theory and on theory of arm element of windmill and on method, given by Professor Witoszynski; aerodynamic characteristics, i.e., coefficient of wind energy utilization and velocity distribution along assumed geometrical arms, are represented graphically and compared with experimental curves.

15. Andrianov, V.N. et al. Vetroelektricheskiye stantsii [Wind electric stations] Moscow, Gosenergoizdat Publications, 1960. 2

1960

16. Ley, W. Engineer's dreams. N.Y., Viking Press, 1960. 240 p.
2, 4

Engineers dream on a grand scale and their concepts frequently go beyond what is presently possible in our mundane world. About half this book is devoted to energy. While this book is somewhat dated now, it's exciting to see how many of these once far-out ideas are becoming reality.

1959

1. Akaev, A.I. A method of determining the capacity of the wind power electric station in the non-wind power system. Akademiia Nauk SSSR. Energeticheskii Institut, Voprosy vestroenergetiki. Moscow, 1959. pp. 106-117. (In Russian.)

13

Operational advantages of the parallel work of the electric power stations of different types (water, wind, oil, coal, etc.) are discussed in view of specific characteristics of the wind power changeable in time, space and in intensity. Preservation and accumulation of excess of wind power requires additional costly installations. Therefore, the author discusses set of specific conditions for combined work of the wind and non-wind electric power installations. Under these conditions, the capacity of the non-wind power station is required to be equivalent to the wind power station, operation of which is much cheaper than the non-wind power stations. In consideration of maximum economical effect of the parallel operation, the first problem concerns determination of the optimum relation of outputs of the wind and non-wind power electric stations united into such a power system, which is more economical. The second problem concerns the selection of such a method, which permits the use of wind power installation during the whole year round. Solution of these problems are described in detail with tabulated data and set of curves.

2. Ekbote, M.S. et. al. Criteria for design of windmills for low to moderate wind velocities. J. Sci. Ind. Res. 18A(8): 372-376, August 1959.

5, 12b

3. Fateev, E.M. Power parameters of wind power installations. Akademiia Nauk SSSR. Energeticheskii Institut, Voprosy vetroenergetiki. Moscow, 1959. p. 22-36. (In Russian.)

5, 7

In connection with the construction or large wind power and electric installations operating on a definite load, the wind and power characteristics are extensively studied. Attention was given to the development of a method of parallel and group operation of powerful wind-electric stations with nonwind electric stations of indefinite power. Preparation of daily graphs for wind energy and load are described in detail and in reference to average daily and monthly wind velocities recorded during many years. The wind energy parameters are interrelated to average wind velocities and correlation coefficients are used to compute the wind power output. Minimum working wind velocity and working hours for definite types of wind motors are tabulated for different average daily velocities. An empirical formula is presented for the computation of the motor output for actual wind data. Determination of various parameters and efficiency coefficients are described with the mathematical formulas and graphical illustration of their variations and tabulated data.

4. Golding, E.W. Possibilities for utilization of wind power in tropical Africa. In: Joint Symposium on Tropical Meteorology in Africa, Nairobi, Kenya, December 1959. Papers. STM/Doc 21, 1959. 7 p.

3, 6

Methods are suggested which can be used in locating and using wind power plants in tropical Africa and the part of meteorologists in wind power development is indicated. The cost in pence per kwh of a wind power installation is 2.4p X c/T_s, where c = capitol cost, in pounds per kwh of installed capacity; p = interest, depreciation and maintenance, charges in %. T_s = output, expressed in kwh/annum/kw installed. The power of the wind stream varies with the third power of wind speed (V^3) which is usually very variable. In tropical climates there is often a more regular pattern of wind so that the diurnal variations can be predicted with some assurance. Records of hourly wind speeds, preferably 10 meters above ground, from which monthly means and diurnal variations can be computed; and maximum duration of calms, maximum gust speeds and wind direction are data which the meteorologist can provide. Rainfall and temperature data are also needed in connection with power utilization in pumping and heating or refrigeration. The practical considerations determining the choice of a site are discussed but the author emphasizes the principle that the windier the site, the better the economy. The nonelectric and electric types of wind power stations are discussed. The latter include small ones with storage batteries and large ones (100 kw) intended to run in connection with large electrical networks. The possibility of combining wind power and solar radiation plants is mentioned. The paper is concluded with a suggestion that wind surveys similar to that conducted by the author in the Somaliland protectorate in 1954 should be made in other parts of tropical Africa to determine potentialities of wind power.

1959

5. Gross, A.T. Windkraftnutzung in Europa. Brennstoff-Waerme-Kraft 11(9): 414-419, September 1959.

3, 6

Use of wind power in Europe; summary of results of Annual Conference held in Stuttgart, Germany, June 1959; economic use of standard plants for additional power generation is seen possible in Central European countries with favorable wind conditions; cost estimation; program of British research.

6. Kolodin, M.V. Wind regime and wind utilization conditions in the Turkmen S.S.R. Akademiia Nauk SSSR. Energeticheskii Institut, Voprosy vetroenergetiki, Moscow, 1959. p. 11-21. (In Russian.)

6

The data on the wind regime of a given locality must be evaluated for actual possible use of the wind energy for agriculture and other needs. The wind characteristics of Turkmenistan are reviewed from data of various investigators listed in sixteen references. Attention is given to average daily and annual intensity of wind in different localities of this region, daily variations in direction and intensity, frequency of wind velocity, possible time of wind motor action at given velocities. Average wind velocity, determined by the meteorological observation, is statistically analyzed and plotted against working days for slow and fast moving wind motors. The distribution of the wind motors of various types at different localities of Turkmenistan is described in the text and shown on a map.

7. Koshechkin, V.V. The problem of energy capacity of a combined wind and power generator using a hydrogen storage system. Akademiia Nauk SSSR. Energeticheskii Institut. Voprosy vetroenergetiki. Moscow, 1959. (In Russian).

11, 13

Utilization of wind energy for generating electricity (by electric generator) and for production of hydrogen by the electrolysis of water is described in detail. Accumulated and compressed hydrogen are used for the operation of the heat engine in place of wind motor installation during periods of weak winds. Data on the efficiency of wind energy in the production of power by a simple hydrogen storage system or by a more efficient engine, operated by hydrogen-oxygen fuel, are extensively discussed, with analysis of favorable factors in the electrolysis and efficiency of hydrogen fuel in engines. Some results of computation and experimental research of the working processes with carburetion and injection of hydrogen fuel are described with tabulated data and comparative indicator diagrams of the engine operated on hydrogen and gasoline fuels. The effects of air ratio or oxygen ratio are illustrated graphically for different cases.

8. Largest aircraft propeller provides electricity in Algeria. Power Eng. 63: 89, January 1959.

4

A 100 kW generator producing energy from the wind in Algeria is described.

9. Rosseler, G. Wind-power supply for the decimeter range directional radio site at Schoeneberg (Eifel) and the experience gained. Nachrichtentech. Z. 12: 352-360, July 1959.

15

The Schoeneberg direction radio station is located far from public power lines on a hilltop where the average wind velocity is 5.6m/sec. The station, as first designed, required 26 kWh/day of dc power. It uses two Allgaier wind power systems, Dr. Hutter type WE/G 6, with a nominal output of 6 kW at 9 m/sec and 1 kW at 4.2 m/sec wind velocity mounted on two 10-m high tubular poles. The dc generators are differentially compounded, shunt-wound. Lead storage batteries of 110 cells and 216 Ah are used to stabilize the output and store the energy. A diesel generator system is available as an emergency system. Tests show that more than 90% of the power required for the initial unmodified communications system could probably have been supplied by the wind power system. The results were completely positive. Wind power stations are economically advantageous where it is very expensive to connect to the public power system, where adequate wind is available and especially when only a moderate amount of power is required.

10. Sabinin, G.K. Theory of regulation of high speed wind motors by the centrifugal governor changing the angularity of the blades. Akademiia Nauk SSSR. Energeticheskii Insitut, Voprosy vetroenergetiki, Moscow, 1959. p. 37-49. (In Russian.)

5

Mathematical formulation of the static equilibrium for changing of angular position of the blades is presented with a brief outline of the governing arrangement.

11. Schefter, I.I. Investigation of the performance of the wind motor D-18 with an inertial accumulator. Akademiia Nauk SSSR. Energeticheskii Institut. Veprosy vetroenergetiki. Moscow, 1959. p. 66-81, In Russian.

11

The problems of the accumulation of a periodic excess of kinetic energy of the wind motor and the giving out of the energy to other non-wind motors at the periods of weak winds or higher loads, are discussed with a description of the arrangement and mathematical formulation of the energy compensating process. During a strong wind the energy is stored in the fly-wheel and during weak winds the fly-wheel is automatically disconnected from the propeller shaft and is turned by inertia forces, transmitting to the electro-motor of the power installation. Various conditions and efficiencies of the operation are studied with respect to the relation of the active dynamic and stored inertia forces recorded by the oscillograph. All sudden variations in the forces and speeds and also compensatory reaction of the inertia accumulator are clearly marked on the oscillograms and can be precisely analyzed.

12. Something about windmills. Comp. Air Mag. 64: 26-27, March 1959.

1, 4

Although windmills are often thought to be Dutch in character, they are used commonly throughout the world. Their history is long, and the future of the mechanism is likely to be equally extensive, especially in view of our rapidly dwindling fossil fuel supplies. Like solar energy, wind power will always be with us.

13. Sukhishvili, E.V. Wind energy resources of Georgia (data for computation). Tiflis. Nauchno-Issledovatelskii Gidrometeorologicheskii Institut, Trudy No. 5: 107-114, 1959. (In Russian.)

6

A statistical analysis of wind velocities at 100 weather stations in Georgia (USSR) over a period of 15-20 years of observation has enabled the establishment of 5 regions and a series of individual points with usable resources of wind energy. The regions are as follows: the Kolchida plain, the Kartalinia Imeretinskaya elevation, Vnutrennyaya-Kartalinia intermontane depression, the districts of the Tiflis and Samgorskaya plain, and the southern part of the Zhavakhalt foothills The probabilities of wind velocities by intervals of 0-2, 3-5, 6-8, 9-11, 12-14, 15-17, 18-20, and > 20 m/sec were determined and duration of effective wind velocities (≥ 3, $\geq 4 \ldots \geq 14$ m/sec) in hours per year were calculated for the region and points where the annual wind velocities are ≥2 m/sec. In order to reduce to a minimum the error of wind velocities computed on the basis of 4 standard observations the durations are computed on the basis of hourly observations. Tables giving the data on probabilities of different wind velocities, duration of effective wind velocities and transition coefficients for each duration from four standard observations to hourly observations are presented.

14. Vadot, L. The generation of electricity by windmills. La Houille Blanche 13(5): 536-539, 1959; (6): 15-22, 1959.
4

15. Vashkevich, K.P. Dynamics of the regulation of high speed wind motors. Akademiia Nauk SSSR. Energeticheskii Institut. Voprosy vetroenergetiki. Moscow, 1959. p. 50-65. In Russian.
5

The regulation of wind motors, operating parallel to other non wind power electric stations of different capacities, requires a special arrangement of many coordinated governors. General theoretical problems on the regulation of various types of governors were reviewed.

16. Windmill machinery. Engineering 188: 262, September 25, 1959.
1

The dismantling of Jolesfield windmill built about 1790 at Littleworth in Sussex presented Mr. Edwin Hole, the millwright, with some tricky problems, which his long experience in dealing with all types of mill helped him to meet. With the aid of a dismantling fluid, he was able to free and detach undamaged a lot of interesting mechanical contrivances, which will be restored to full working order when the mill is re-assembled and rebuilt at Gatwick Manor Inn this winter.

17. Clausnizer, G. Kurzzeitmessungen zur Bestimmung des Zusammenhanges zwischen Windgeschwindigkeir und Lestung einer Windkraftanlage [Short-term measurements to determine the relationship between wind velocity and the output of a wind power plant]. Dissertation, Karlsruhe Engineering College, 1959.
6

18. Vashkevich, K.P. and V.N. Volostnykh. Calculating rotation of a wind motor head into the wind using a tail. Promyshlennaya Aerodinamika [Industrial Aerodynamics] No. 13, Moscow, Oborongiz Publications, 1959.
5

1959

19. Abbott, I.H. and A. von Doenhoff. Theory of wing sections. N.Y., Dover Publ., 1959. 693 p.
2, 5

This is the standard reference on airfoil design. It includes the aerodynamic characteristics, geometry, and associated theory for the NACA wing sections that continue to be the ones most commonly used for aircraft, helicopter rotor blades, propeller blades and fans. Sample chapter titles are: The significance of wing section characteristics, theory of thin wing sections, the effects of viscosity, basic thickness forms, and airfoil ordinates. The publisher states: "Math has been kept to a minimum, but it is assumed that the reader has a knowledge of differential and integral calculus and elementary mechanics."

20. Fateev, E.M. Wind power installations. Present condition and possible lines of development. Translation into English of Vetrosilovyye Ustanovki Sosttoyaniye i puti Razvitiya, Moscow, 1959. 80 p. Translation: Kanner Associates, Redwood City, Cal. N75-21796. NTIS, March 1975. 80 p. [NTIS has author's name Fateyev, Y.M.]
6

Wind power is discussed as a source of energy, past, present and future. A brief summary of the history and development of windmills is presented. Tables of average wind velocity are included for different zones in the U.S.S.R. compiled from meteorological stations over a period of years. It is shown that the development of highly efficient wind power theory and engineering has led to the development of highly efficient wind-driven motors which use up to 42% of wind energy. The agricultural uses of wind-driven motors are also discussed. The matching of piston and centrifugal use of millstones with wind-driven motors are included. The use of free and unlimited wind energy is concluded to be efficient, particularly in agricultural and rural areas.

21. Glauert, H. The elements of aerofoil and airscrew theory. Cambridge, Eng., Cambridge University Press, 1959.
2, 5

1958

1. Aerogenerateur experimental type Best-Romani. Description-Montage Programme d'Essai. Paris, Elec. de France, 1958. 54 p.
Translation: Scientific Trans. Serv., Santa Barbara, Ca, N73-29004. NTIS, August 1973.
7, 12b

The characteristics of a propeller-driven electrical generating machine using wind power are presented. The construction of an installation for the equipment is described. The measurements conducted during the performance tests are analyzed.

2. Les aerogenerateurs a helices in alliage leger de l'electricite de France. Revue de l'Aluminum 35(260): 1229-1236, December 1958.
4

Aerogenerators with light alloy propellers of Electricite de France company, research on harnessing wind power and two French generator installations are described.

3. Diesel standby makes wind-driven generator practical, cuts costs. Diesel Power 36: 33, June 1958.
13

4. A giant wind-engine. L'Usine Nouvelle, Paris, 14(32): 25, August 7, 1958. (In French.)
7

It is composed of a rotor driven by the wind and acts as a current-generator. The rotor is 24 m in diameter and runs at a speed of only 100 revolutions a minute, when turbine and generator run at 1000 revolutions a minute. This wind-engine will give its peak load of 100 kW for a wind speed reaching 50 kilometers an hour.

5. Gimpel, G. The windmill today. Engineering 185: 686-690, May 30, 1958. Also: Elect. Res. Assoc. Tech. Rep. IB/T22, 1958. 11 p.
4

Attempt to follow thread of development of wind driven generator to present day, by examining construction of some of more important machines built, both in Great Britain and overseas.

6. Gimpel, G. and A.H. Stodhart. Windmills for electricity supply in remote areas. Elect. Res. Assoc. Tech. Rep. C/T120, 1958. 24. p.
4

1958

7. Golding, E.W. Wind power in Denmark. Elect. Times 133: 83-86, January 16, 1958.

4

Cost of construction in 1942, when eighty windmills were in operation, was from 41 to 77 pounds per kW. Details are given of a 200 kW machine which was recently put into experimental operation. Estimated costs in 1954 prior to construction were 10,000 pounds for a 200kW unit and 15,850 pounds for a 400 kW machine which corresponds to only 50 pounds per kW for the 200 kW size and under 40 pounds per kW for the 400 kW size. With annual charges of 10% for interest, depreciation, and maintenance, and an annual output of between 3000 and 4000 k-wh/kW, energy costs corresponding to a capital cost of 50 pounds per kW would be 0.3 to 0.4d per kWh.

8. Research inspired by the Dutch windmills; an account of an extensive programme of research and development initiated and organized by the Ptunsenmolen Committee. Wageningen, H. Vienman, 1958. 184 p.

2, 4

9. Shefter, Y. and I. Rozhdestvenskii. Problems in calculating the strength and design of high-speed windmills. Trakt. Selkhozmash. 28(8): 19-27, 1958. (In Russian.)

5

10. Soviets to wind up their industry. Prod. Eng. 29: 24, June 16, 1958.

4

In the Steppes Region of Kazakhstan, seven hours travel distance from Alma Ata, a wind-electrical power station has been set up for the storage of wind energy. It consists of a wind motor of 25 kw, an electrolizer, and an internal combustion engine suitable for work on hydrogen gas. With the use of electrolysis, hydrogen is obtained without the need of compressors. The speed of the wind here is often from 18 to 20 meters per second which enables the windmill to produce electric energy and at the same time, by means of electrolysis, to produce from 18,000 to 20,000 cu meters of hydrogen. This amount of hydrogen, collected in gas holders, is sufficient for the production of from 18,000 to 20,000 kw hours of electric power during periods when there is no wind.

1958

11. Thompson, C. Requiem for a noble engine. Sat. Eve. Post. 231: 44-45+, July 12, 1958.
1

The history of the use of windmills on American farms for various purposes including production of power is described.

12. Vadot, L. The generation of electricity by windmills. La Houille Blanche 13(5): 526-539. October 1958.
4

Two fundamental problems of windmill design are considered in this article: determining the dimensions of the machine and its output. Economic and engineering considerations make it possible to define the most advantageous characteristics for a windmill. It would seem that, in view of available wind power, in the Atlantic region, it is of immediate interest to use wind generators.

13. Wailes, R. Old-fashioned windmill generates electricity. Engineering 186: 138, August 1, 1958.
4

Particulars of Kraai (Crow) mill at Westbroek, near Utrecht, opened July 12, equipped for electric generation with shuttered sails and provided with servo motor, controlled by wind vane, for turning cap.

14. Windpower; British machine in Algeria. Engineering 185: 297-298, March 7, 1958.
7

The 100 kW Enfield-Andreau alternator, originally commissioned by the British Electricity Authority, is now installed on a site in Algeria. On its initial run there it achieved an output of 130 kW.

15. Winds generate electrical power. Electron. Ind. 17(Supp O): 3-4+, October 1958.
4

16. Shefter, Y.I. Semiautomatic wind-electric stations with inertia storage batteries. Vestnik Sel'skokhozyaystvennoy Nauk 12: 1958.
8

17. Shefter, Y.I. Semiautomatic wind-electric stations for electrification of live-stock farms. Byulleteny Nauchnotekhnicheskoy Informatsii po Electrifikatsii Sel'skogo Khozyaystva [Bulletin of Scientific and Technical Information on Electrification of Agriculture] No. 4, Moscow, 1958. 8

1958

18. Solomon, J. Wind energy in the aid of mechanization and electrification of agriculture. Mecan. Electr. Agr. 3(5): 1958. 8

1958

19. Les aérogénérateurs à helices en alliage leger de l'Electricité de France. Rev. Alum. 35(260): 1229-1236, December 1958. (In French) 4, 6

Aerogenerators with light alloy propellers of the Electricité de France company are described, as well as two French generator installations.

20. Lorenz, E.N. Energy from the winds. NTIS, AD209301, 1958. 4

1957

1. Bagdasarian, A.B. Winds in the Sevan Basin and prospects of their utilization for power. Akademiia Nauk Armianskoi SSR, Erivan, Doklady 24(2): 91-96, 1957.
6

The water power resources of the Armenian SSR are limited and they should be even more restricted if the water level of Lake Sevan is to be conserved. Hence solar and wind power potentialities are important, and studies were made in the Institute of Economics of the Armenian SSR Academy of Sciences in 1952-54 to determine the extent to which these resources could be developed; meteorological data from the Hydrometeorological Network for 1936-1952 was used, with supplementary expenditionary data. Wind rises for January and July are included and diurnal and annual variations of wind are shown in graphs and tables and the conclusion reached that special wind stations could be used to raise the level of the mountain lakes in the Sevan Basin, using the lakes as reservoirs of power.

2. Buhl, S.M. Operating experience of wind power plants. World Power Conference. XIth Sectional Meeting, Belgrade, 1957. Sect. B.4, Paper 37, 11 p.
3, 13

In order to investigate the possibilities of producing electricity by means of wind power in connection with networks for the public supply the Southeast Zealand Electric Company Ltd. (called "SEAS" in Denmark) since 1947 has had wind energy measured in various places in Denmark, and after certain other preliminary investigations a 12 kW wind power plant has been erected for experimental purposes. On the basis of experiments with this plant, a second one of 45 kW was built in 1952. Since the end of 1953 both plants have been working regularly in connection with the SEAS network. An account is given of the daily, monthly, and annual outputs of the plants as well as of the way in which their output fits in with consumption of power from the SEAS network. This grid is normally supplied with energy from several thermal power plants in Zealand which are run in parallel with power stations in the southern part of Sweden A third experimental wind power plant, of 200 kW, is being constructed in Denmark.

3. Electrical energy from the wind: discussion. Inst. Elec. Eng. Proc. 104 A: 399-400, October 1957.
4

A summary of discussion by several experts on the feasibility of producting electrical energy from the wind

1957

4. Golding, E.W. Electrical energy from wind. Eng. J. 40(6): 809-819, June 1957.

4

Characteristics of wind as source of power and its possibilities for generation of electrical energy; types of windmill; description of main features of some recent designs; wind power research and development work in Great Britain; economy of wind power on three scales of utilization.

5. Golding, E.W. Sources of energy. UNESCO Arid Zone Research 9: 176-187, 1957.

4, 6

Includes general characteristics of wind power, solar radiation and water power, and methods of using local power resources, followed by a more detailed account of the measurements and estimations of energy available from wind and solar radiation.

6. Golding, E.W. and P.G. Finn-Kelcey. The economic possibilities of local energy resources to supply power for agriculture in underdeveloped areas. World Power Conference. XIth Sectional Meeting, Belgrade, 1957. Section B.4, Paper 13, 15 p.

3, 8

A common feature of underdeveloped areas it the lack of power for the development or improvement of agriculture which is often the only possible means of assuring a livelihood for their inhabitants. Becuase of the remoteness of many of these areas from supply centres, the importation of energy, either in electrical form through transmission lines or as oil fuel, is costly. Even if bulk supplies of energy could be furnished, distribution within the territory itself may be difficult and expensive because of the low density of population. The paper advocates the exploitation of locally-available energy resources, particularly wind, solar radiation, small-scale hydro power and organic wastes, to avoid importing energy and distributing it to widely scattered consumers. Equipment which might be used for this purpose is briefly described and its probable economy is discussed in relation to that of the alternatives. The authors suggest that the most effective method would be to use this equipment, as a combination, to cater for the agricultural loads, with varying characteristics, which occur in different climatic zones, and also that some experimental schemes should be initiated to determine the best techniques to be followed.

7. Kolodin, M.V. Wind and wind technology. Ashkhabad, Izdatvo. Akademii Nauk Turkmenskoi SSR, 1957. 138 p. (In Russian.)

2

The first 4 chapters of this technical monograph cover the usual subjects of wind and its characteristics, wind measuring techniques and equipment (anemometry), wind mills (history and contemporary construction), uses of wind machines in agriculture and industrv (grinding, water pumping, mechanization, heat and electric power production) and use of wind energy throughout the world today and tomorrow. The 5th chapter consists of a thorough survey of the climatic and wind conditions of Turkmenistan. Extensive tables give frequencies of various wind speeds (in percent) for various mean and annual wind speeds in different situations: mountain, piedmont, plains, Caspian shore. The charts show regions of greatest wind power potential and isarithm charts show wind frequency in the whole area of Turkmenistan. Nomograms are presented and described for use in wind energy calculations.

8. Lilley, G.M. and W.J. Rainbird. A preliminary report on the design and performance of ducted windmills. Elect. Res. Assoc. Tech. Rep. C/T119, 1957. 65 p.

10

9. Marrison, W.A. A wind-operated electric power supply. Elect. Eng. 76(5): 418-421, May 1957.

4

System described has single rotating member and no moving electric contacts; turbine type of wind rotor is mounted on vertical shaft rotating within set of stationary deflecting blades; all wind directions are equally favorable;electric generator is of multipole rotating magnet wound stator type and generates a-c having frequency 30 times rotation speed.

10. Morrison, J.G. The development of a method of measurement of strains in the blades of a windmill rotor. Elect. Res. Assoc. Tech. Rep. C/T117, 1957. 28 p.

3

Description of electric resistance strain gages used for blade measurements and of techniques for their positioning, fixing and proofing; details of amplifying and recording equipment, and of steps taken to ensure synchronization between recordings of power output of generator driven by mill, wind speed, and strain.

1957

11. Mullet, L.F. Surveying for wind power in Australia. Inst. Eng. Aust. J. 29(3): 69-73, March 1957.

6

Wind survey operated by Electricity Trust of South Australia is described, and general level of accessible wind energy is deduced from wind recordings; cost of electricity obtainable from wind is estimated not to exceed 0.25/kw-hr for large machines and 1.5 kw-hr for small machines suitable for isolated rural systems.

12. Sektorov, V.R. Windmill generators of 25 kW output with diesel engine reserve. Mekh. Elektrif. Sots. Sel. Khoz., No. 2: 21-25, 1957.(In Russian.)

8, 13

13. Tagg, J.R. Wind data related to the generation of electricity by wind power. Elect. Res. Assoc. Tech. Rep. C/T115, 1957. 52 p.

6

Presents the results of a wind survey of British Isles. Height of hill and mast and duration of wind measurements at 101 places are shown in a table and diagram and sites are described with sections. A large folding tables gives monthly and yearly average wind speeds. Directions were measured continuously at 3 sites and velocity/frequency curves at 6 sites are converted into velocity/duration ogives. The operating limits and relationship between specific output and wind speed in British Isles are discussed. Variation of wind speed with height is next taken up, and represented by a power law with α (66 ft) between 0.095 and 0.15. Diurnal variations of wind speed are discussed and, finally, wind measurements overseas listed. Appendices describe anemometers and supporting structures, and recording instruments, used in the survey.

14. Vadot, L. A synoptic study of the different types of windmills. La Houille Blanche 12(2): 204-212, March-April 1957.

4, 7, 8

Synoptic study of different types of windmills; survey of all possible ways of utilizing wind power to drive rotary machinery; only machine that can be applied industrially is propeller type with its axis parallel to wind direction; designs for main components are summarized; improved "Dutch type" sail equipped, hollow bladed and fixed blade machines, "bicycle wheel" windmills, etc.

15. Vadot, L. Water pumping by windmills. La Houille Blanche 12(4): 524-535, September 1957.
15

Water pumping by windmills; historical review; utilization of meteorological data to determine characteristics of installation; equipment used; calculations for slow speed windmill driving piston pump, and for high speed windmill with centrifugal pump.

16. Vezzani, R. New sources of energy and economic development. United Nations Department of Economic and Social Affairs, New York, 1957.
4

17. Villers, D.E. The testing of wind-driven generators operating in parallel with a network. Elect. Res. Assoc. Tech. Rep. C/T116, 1957. 22 p.
7

Method for establishment of steady state relationship between generator output and wind speed; tests carried out in 10-kw machine connected to public supply network; comparison of results with calculated output characteristics of machine; suggestions for further work on testing of wind driven machines connected to network or running as isolated unit.

18. Fateev, E.M. [Methodology for determining parameters of wind power-producing calculations of wind-powered installations] Moscow, Russia, AN SSSR Publications, 1957. (In Russian)
6

19. Shefter, Y.I. Combined use of wind machines with internal combustion engines for output of electric power. Doklady VASKhNIL (6): 1957.
13

20. Marrison, W.A. Power supply. Novel sources of electric power. Bell Laboratories Rec. 35: 406-410, 1957.
8, 15

Research at Bell Labs on use of small wind and thermoelectric generators in rural telephone carrier systems is discussed.

21. Freese, S.W. Windmills and millwrighting. Cambridge, 1957.
2

1957

22. Fateev, E.M. Eoliennes et leurs installations. Editions officielles des revues techniques et agricoles. Moscow, 1957. (In French)
4

23. Frenkiel, J. and S. Zacks. Energie d'origine éolienne en fonction du régime des vents. Res. Counc. Isr. Bull. 64(3-4): 189-214, April-July 1957. (In French)
4

24. New sources of energy and economic development: solar energy, wind energy, tidal energy, geothermic energy, and thermal energy. New York, United Nations, Department of Economic and Social Affairs, 1957. 150 p.
2, 6

25. Vashkevich, K.P. Recherches sur un rotor d'éolienne en courant oblique. Institut Central Aérohydrodynamique (ZAGI), Moscow, Misc. No. 8, 1957. (In French)
5

1956

1. Fixed-speed wind motor. Engineering 181: 410, May 25, 1956.
5, 8

This is a brief description of an exhibit at the 1956 Leipzig Fair of a Russian wind motor designed for farm use or other small power projects.

2. Frenkiel, J. Wind power research in Israel. UNESCO Arid Zone Research 7: 108-114, 1956.
6

This article contains an account of the development of research on the wind energy in Israel, the possible role of wind power in the overall energy problem of Israel, the results of the first year of wind surveys made in 1953, and the results of operating of a wind generator with a Jacobs unit of 3 kw about 30 mi from Eilat. Quantitative data on wind speed at wind survey sites are presented.

3. Fukuoka District, Japan Central Meteorological Observatory. Meteorological study of large-scale generation of electricity by wind power, pt. 2. Japan. Meteorological Agency, Tokyo. Memoirs of Industrial Meteorology 19(2): 117-147, March 1956. (In Japanese with English summary.)
6, 7

The main problems concerned with the building of a wind mill are: maximum wind speed and its altitude, fixed windmill and wind direction, wind direction and speed in the free atmosphere, topographical effect on acceleration of wind speed, changes of wind direction and speed due to mountain ranges, altitude and speed of the air over the mountain, available amount of wind power and meteorological elements concerning the utilization of wind power.

4. Golding, E.W. The combination of local energy resources to provide power supplies in underdeveloped areas. Elect. Res. Assoc. Tech. Rep. C/T118, 1956, 21 p.
4, 6

5. Golding, E.W. Economic potential of wind energy. Rev. Cienc. Aplicada 10(50): 226-232, May-June, 1956. (In Spanish.)
4, 6

Selection of sites for wind power stations and meteorologic prospecting, features of wind driven power generators used in Europe, and the economic potential of wind power are reviewed.

1956

6. Golding, E.W. Electrical energy from the wind. Discussion by J. Venters, et.al. Inst. Elec. Eng. Proc. Pt. A, 103(12): 616-618, December 1956.
4

Numerous comments and questions on use of wind generators in various parts of the United Kingdom. Experience has shown that wind generators become less in demand as National power networks spread into isolated regions (e.g., in N. Scotland). Matters of esthetic values,time when calms prevail over a whole region or network, use of wind power to supplement water power which can meanwhile be stored, comparative usefulness of small, medium and large generators, low medium and high wind speeds, etc. are discussed.

7. Golding, E.W. and M.S. Thacker. The utilization of wind, solar radiation and other local energy resources for the development of a community in an arid or semi-arid area. UNESCO Arid Zone Research 7: 119-126, 1956.
6

The authors make a practical approach to the problem of a synthesized and balanced use of wind, solar and fuel power in an arid or semi-arid area. A brief discussion is given of the energy obtained from wind power, solar radiation, and wood, and other vegetable matter. This is followed by a more detailed discussion of possible combinations of different energy sources for various areas in a rural community with reference to timing requirements and quantity estimates of energy loads for various operations.

8. Iwasaki, M. The experimental and theoretical investigation of windmills. Reports of Research Institute for Applied Mechanics, No. 8: 181-229, 1956. Japan.
5

9. Kakas, J. and M. Mezosi. Investigation of wind conditions in Hungary and the national power industry. Idojaras 60(6): 350-364, November-December, 1956. (In Hungarian.)
6

Possibilities of wind energy utilization in Hungary are limited but in view of the scarcity of other sources of energy it is desirable to make a survey of the amount of wind energy available in that country. In this paper the studies made in Hungary on the subject are reviewed. Data obtained in 1955 by means of five anemographs in the Budapest region are analyzed with special attention to the parameters significant from the point of view of energy utilization (frequency distribution of wind velocities, annual variation of available energy, frequency of unusable wind speeds, distribution of wind speed with height, local differences, etc.). It is found that the amount of wind energy available warrants further research into Hungary's wind energy resources. The establishment of a nation-wide network of 26 stations is proposed for such research and their suggested locations (and those of stations already existing) are shown in a map.

10. Ledacs-Kiss, A. Industrial utilization of wind energy. Magyar Energiaguzdasag 9(4): 127-132, April 1956. (In Hungarian.)

7

The use of high power-output wind generators was tried in two instances (Balaklava, Crimea, 1931-1941 and Grandpa's Knob, Vermont, 1941-1943); experiments are being conducted in the U.S.S.R., England, France and Germany. Construction problems of such powerful units (with outputs up to 10,000 kw) are discussed. Several existing or planned models, including one designed by the author, are described and illustrated. A diagram of wind conditions on Kekes Mt.,Hungary, is presented, comprising curves of 1) annual frequency of wind speeds up to 20 m/sec, 2) corresponding specific energies and 3) annual useful energies.

11. Nilakantan, P. Utilization of wind power in India. World Meteorological Organization WMO Bull. 5(2): 49-51, April 1956.

6

The CSIR of India set up a Wind Power Sub-committee in December 1952, to make preliminary investigations of available wind power and economic aspects of use of wind energy. Work was started by examining available meteorological data on surface winds. Speed, duration, and power duration curves were prepared by the India Met. Dept. A correlation factor was established between the annual mean hourly wind speed and available power in specified speed ranges for various regions. Extrapolation is now being undertaken from weather stations to favorable wind sites which usually have higher speeds. Uses in rural areas for pumping, grinding, etc. are being explored. E.W. Golding of the United Kingdom made a survey which was encouraging.

12. Sarwal, S.S. Harnessing wind energy in arid zones of Rajasthan. Inst. Eng. India J. 36(11 pt.2): 1917-1925, July 1956.

6

1956

13. Sarwal, S.S. Harnessing wind energy in arid zones of Rajasthan. Irrig. Pow. 13(3): 382-388, July 1956.
6

14. Utilization of wind power in India. Curr. Sci., Bangalore, 25(6): 180-181, June 1956.
6

The India Meteorological Department is assisting the Wind Power Sub-Committee of the Council of Scientific and Industrial Research in making a survey of available wind data, anemograph records, etc. to compile velocity-duration and power duration curves and correlation between average hourly wind speed and available power in various regions. More detailed surveys are now being made to assess the power available at optimum sites not represented by meteorological stations. Over 20,000 small windmills for rural areas, a few hundred middle-sized plants for electric supply, pumping, etc. and 20 wind survey stations in different regions are contemplated.

15. Wax, M.P. An experimental study of wind structure (with reference to the design and operation of wind-driven generators). Elect. Res. Assoc. Tech. Rep. C/T114, 1956. 24 p. (Also Engineering 183: 554-555, May 1957).
6

Previous investigations of gustiness factor are described. An investigation of wind speeds and gusts was carried out at Costa Hill, Orkneys, 500 ft high. Gust anemometers for horizontal and vertical components responding to changes of 0.1 sec were mounted on a 120 ft cruciform mast at points (top, right, left, bottom). Specimen records are shown, and histograms of 10 sec means. Effects of changes of speed on output and structure (blades) are discussed.

16. Wind driven generator for Algiers. Engineering 182: 325, September 14, 1956.
4

This article is a brief news item on the wind generator initially tested at St. Albans, England, which was moved to Algiers.

1956

17. Wind-generated electricity, Prototype 100 Kw Plant. Engineering 179: 371-374, March 25, 1955.
7

This article is on the wind driven alternator installed near St. Albans, England, and covers "depression" principle for flexibility, mechanical design, alternator controls, selection of sites and storing electrical energy. Includes photographs and diagrams.

18. Wind and solar energy; Proceedings of the New Delhi Symposium, October 22-25, 1954. UNESCO Arid Zone Research 7: 1956. 238 p.
3, 4, 6, 7, 8, 15

Contains ten papers on wind power, from general articles, discussion of machinery, to siting and feasibility studies for specific locations.

19. Bauer, L. et al. General report, survey of the development of the national power economies from 1950 to 1954. World Power Conference, 5th. Vienna, Austria, 1956. 20 p.
4

20. Fateev, E.M. Vetrodvigateli i vetroustanovki [Wind motors and wind installations] Moscow, Sel'khozgiz Publications, 1956.
2

21. Frenkiel, J. Exploitation of wind energy in Israel. J. Assoc. Eng. Arch. Israel. 14(5): 50-52, 1956.
6

22. Markin, A. Problema galuboi energii. Moscow, Russia. Izvestia, October 3, 1956. (In Russian)
6

This paper surveys wind-power utilization in the Soviet Union.

23. Ministry of Fuel and Power. Energy resources of the United Kingdom and trends in their utilization. World Power Conference, 5th. Vienna, Austria, 1956. 26 p.
6

24. Shefter, Y.I. Some questions in designing and calculating for strength of high-speed wind machines. Sbornik Trudov po Zemledel'cheskoy Mekhanike [Handbook of Works on Farming Mechanics] VI, Moscow-Leningrad, Russia, Sel'khozgiz Publications, 1956.
6

25. Thacker, M.S. Brief review of energy development in India. World Power Conference, 5th. Paper 204 a/36. Vienna, Austria, 1956, 13 p.
4

1956

26. Van Heys, J.W. Wind und Windkraftanlagen. Berlin, Germany, G. Siemens, 1956. 147 p. (In German) 2, 7

27. Wright, W.C. Harnessing the winds: wind turbines. Am. Mercury 83: 105-107, November 1956. 4

28. Lilley, G.M. and W.J. Rainbird. A preliminary report on the design and performance of ducted windmills. Elect. Res. Assoc. Tech. Rep. C/T119, 1956. 72 p. 14

A ducted windmill is compared to an unshrouded windmill.

1956

29. Association for Applied Solar Energy. World Symposium on Applied Solar Energy. Stanford, Cal., Stanford Research Institute, 1956.
3

30. Bhatt, U.J. Possibility of wind power utilization in Saurashtra. UNESCO Arid Zone Research 7: 115-116, 1956.
3, 6

31. Dresden, D. General review paper. UNESCO Arid Zone Research 7: 27-31, 1956.
3, 4

This general review was presented in 1954 at the New Delhi Symposium on Wind and Solar Energy.

32. Golding, E.W. The economic utilization of wind energy in arid areas. UNESCO Arid Zone Research 7: 90-95, 1956.
3, 6

33. Hütter, U. Planning and balancing of energy of small-output wind power plant. UNESCO Arid Zone Research 7: 76-86, 1956.
3, 5, 8

34. Juul, J. Wind machines. UNESCO Arid Zone Research 7: 56-72, 1956.
3, 4, 6

This substantial article covers the technology of wind energy at the time of writing, with charts, photographs, and graphs.

35. Nilakantan, P. Some considerations affecting the choice of areas for preliminary wind power surveys in India. UNESCO Arid Zone Research 7: 38-39, 1956.
3, 6

36. Ramdas, L.A. and K.P. Ramakrishnan. Wind energy in India. UNESCO Arid Zone Research 7: 42-53, 1956.
3, 6

37. Ramiah, R.V. Some problems in the utilization of wind power in India. UNESCO Arid Zone Research 7: 102-105, 1956.
3, 6

38. Golding, E.W. The generation of electricity by wind power. New York, Philosophical Library, 1956.
2

1955

1. Attempt to make electricity from wind power successful. Eng. N. 155: 64, August 18, 1955.

4

After four years of research and experiment, a British attempt to generate electricity from wind power has culminated in success. The pilot project consists of a 100 kw windmill erected on the Orkney Islands north of Scotland.

2. Aubert de la Rue, E. Man and the winds. Chapter XII: The wind as a source of energy. London, Hutchinson and Company, Ltd, 1955. P. 123-136.

4

3. Barasoain, J.A. and L. Fontan. Wind energy and its utilization. Spain. Consejo Superior de Investigaciones Cientificas. Comision Nacional de Energia Eolica, Informe EE/101, May 1955. 41 p. (In Spanish.)

4

A report on the work on the utilization of wind energy in Spain which has been conducted during the past three years by the National Commission for Wind Energy. The author discusses the wind pattern of Spain giving isolines of mean annual wind velocity and mean monthly isolines of wind velocity for January and July (in m/sec) and a table giving wind observation stations in Spain with type of anemometer, duration of observations, mean annual wind velocity, etc. Also the following are considered: calculation of wind force, including a nomogram for computing the maximum usable wind energy per m^2 as a function of wind velocity; the duration of wind velocity; causes being given for various localities in Spain; the duration of wind force; estimation of energy obtainable by a wind generator and appropriate formulas, and calculations of wind energy for various points of Spain and abroad for these types of wind generators.

4. Baumeister, F. A wind-power station for operating harbour lights. Elektrotech. Z (ETZ)B, 7(12): 437-441, December 1955. (In German.) Translation: Linguistic Systems, Inc. Cambridge, Massachusetts. N74-16803. NTIS. February 1974. 17 p.

15

5. Britain develops 100 Kw prototype wind power plant. Eng. N. 154: 50+, April 28, 1955.

7

In England a new type of wind-mill has a generating capacity of 100 kw and the turbine is driven by a rapidly moving column of air, not by any mechanical linkage with the propeller. With wind speeds between

30 and 65 mph output is held at 100 kw; when wind speeds are over 65 mph the blades are feathered and rotation ceases. With wind speeds below 30 mph, output decreases rapidly.

6. English windmill generates 100 Kw. Elec. World 144: 66-67, August 8, 1955.

7

What is said to be the most powerful windmill in the world for the generation of electricity has just been completed in Scotland. It is a 100-kw unit on a 400-ft high Costa Head on the Orkney mainland. The windmill was designed for the North of Scotland Hydro-Electric Board to feed into the local electricity network which is normally supplied by diesel engine generators.

7. Fukuoka District, Japan. Central Meteorological Observatory. Meteorological study on the large-scale generation of electricity by wind power, Part 1. Japan. Meteorological Agency, Toyko. Memoirs of Industrial Meteorology 19(1): 51-70, December 1955. (In Japanese with English Summary.)

5, 6, 7

This paper reports the results of meteorological investigations in Japan on large-scale generation of electricity by wind power. Includes equations used to compute wind power energy and types of data gathered.

8. Golding, E.W. Electrical energy from the wind. Inst. elect. Eng. Proc. Pt. A 102(6): 677-695.

1, 4

The history of the use of wind power is traced briefly to provide a background to the present renewal of interest in the subject. The characteristics of the wind as a source of power are discussed together with its possibilities for the generation of electrical energy. A short review of the different types of windmill is given, leading to a description of the main features of some recent designs. Wind-power research and development work in Great Britain is described with an account of the progress made during the last six years. The economy of wind power on three scales of utilization is dealt with and suggestions are made for making the most effective use of the energy available.

1955

9. Golding, E.W. The generation of electricity by wind power. New York, Philosophical Library, 1955.

2

10. Golding, E.W. Wind energy. Inst. Elect. Eng. J., New Series 1(2): 70-72, February 1955.

1, 4

Brief history of rise and decline in the use of wind power in last 2000 years, and recent revivial of interest in 30 or 40 countries which have committees to investigate use of wind. Increasing cost of fuel power generation and exhaustion of resources, plus technical developments resulting from aerodynamic studies for aeronautics have been responsible for this interest. Problems are enumerated, locations where such generation would be practicable are cited, and results of E.R.A. research in Britain mentioned.

11. Harnessing wind power. Elect. Rev. 156: 1021-1022, June 10, 1955.

4

12. Ledacs-Kiss, A. Problem of wind power utilization at the Rio de Janiero World Energy Conference and its applications to Hungary. Magyar Energiagazdasdg, Budapest 8(4): 121-130, April 1955. (In Hungarian.)

3, 4, 6

Three papers on progress in wind energy utilization in the USSR (Adrianov and Sanov), Germany (Hütter) and Great Britain (Golding) are reviewed. Construction details of various high and low power output wind generators are discussed and illustrated. Golding recommends resurveying and consideration of utilization of wind power in Hungary.

13. Now there's a turboprop windmill. Pop. Sci. 167: 177, September 1955.

5

A windmill at St. Albans, England, with a new idea behind it is described. The propellers turn freely in the wind - no gear train hold them down. But-the blades are hollow. As they turn, centrifugal force causes them to shoot air **out** through vents at their ends. That creates a semivacuum inside the 100-foot-high pedestal the propeller sits on. Air rushes in through ports and, on its way up turns a turbine that drives a generator. As in airplanes, the blade pitch is varied automatically. So the turbine stays at reasonably constant speed in changing wind velocities.

1955

14. 100 Kw wind-driven generator. Beama J. 62(5): 185-188, November 1955. 7

An electric generator at Costa Head in the Orkneys is an important step in the development of windmills for connection to small networks in isolated communities normally supplied by diesel generators. The windmill consists of a triangular steel tower on top of which is a nacelle carrying the rotor and containing a step-up gear box and the electric generator. The electric control gear is mounted in the building at the foot of the tower. The generator is connected to island's 11-kW supply network.

15. Orkney's windmill. Elect. J. 154: 2027, June 24, 1955. 7

16. Orkney's windmill. Elect. Rev. 156: 1131, June 24, 1955. 7

17. Pigge, H. Characteristic lines (yearly permanent level lines) and characteristic wind variables for wind energy production. Elektrizitaets wirtschaft 54(20): 704-709, October 1955.
Translation: Scientific Translation Service, Santa Barbara, California. N74-15747 NTIS, February 1974. 6

Optimum design methods for wind driven electrical generating plants are presented, based on yearly permanent wind level lines for selected erection sites. Wind conditions at any site are divided into five classes, of which only a few can be exploited by a given system. General purpose design curves are given.

18. Rosenbrock, H.H. Vibration and stability problems in large wind turbines having hinged blades. Elect. Res. Assoc. Tech. Rep. C/T113, 1955. 53 p. 5

19. Shevko, E.I. Wind machines. Kiev, Gosud. Nauchno-Teknich. Izdat. Mashinostroi-tel'noi Literatury, Ukrainskoe Otdelenie, 1955. 114 p. (In Russian.) 12b

A standard bulletin for wind equipment, construction and maintenance personnel, giving the latest details on the various types of wind machines used in the agricultural regions of the U.S.S.R. (Types TV-5, UTV-5, D-5, TV-8, D-12, and D-15). A short chapter discusses wind and wind power calculations.

1955

20, Suction principle may revive windmill to produce electrical energy. Sci. News Lett. 68:8, July 2, 1955.
5

21. White, P.T. About windmills. N.Y. Times Mag: 66, September 25, 1955.
4

India is planning on putting in 20-30,000 windmills in the next 5 years. Eventually 100,000 may dot the arid areas from Saurashtra in the northwest to Madras in the southeast, so the job of pumping water wouldn't be left just for the bullocks. Windmills as compared to bullocks are relatively cheaper since they don't need food and supervision. Author also described different types of windmills, i.e., old Dutch windmills in America.

22. Wind-power electric generator. Engineer 200(5189): 43-44, July 8, 1955.
7

This article describes the 100 kW windpowered generator erected on the Orkney mainland of Scotland.

23. Juchem, P. The present status of Honnef wind power plants. Electrotech. Z. Ausgabe B 7(5): 187-191 May 21 1955.
Translation: Linquistic Systems, Inc., Cambridge, Massachusetts N74-17787. NTIS, February 1974. 19 p.
4, 6

The most important energy sources on earth next to the sun and water, are coal and oil. However, it seems that these deposits will be exhausted in the forseeable future. Large windpower plants are destined to play an important role in the tapping of new energy sources. Their viability must be judged from the research and development work carried out in the U.S.S.R., the U.K., U.S.A. and Germany.

24. Denzel, P. Operation of wind-driven power plants in parallel with low-capacity hydro and thermo plants. United Nations Economic Commission for Europe, 1955.
13

25. Fox, J.A. Effect of line resistance on the stability of synchronous machines with particular application to wind generation, 100 kW Enfield cables. The English Electric Co., Ltd., December, 1955.
7

1955

26. Schmidt, K.O. Die Windkraftanlage der Deutschen Bundespost auf dem Schöneberg. Elektrotechnik 37(51/52): December 17, 1955. 8, 15

A Shöneberg/Eifel wind power installation supplying a radio relay station is described, with performance data.

27. Vadot, L. Eolienne de 8 m pour production d'energie electrique. Grenoble, France, Neyrpic, 1955. 10 p. 4

An 8 metre diameter wind motor is described which can produce 4, 7 or 10 kw electricity.

28. Wind-driven generator on Costa Head. Engineering 180: July 8, 1955. 7

A description is presented of the Costa Head (Orkneys) 100-kw plant.

29. Wind-generated electricity--prototype 100-kw plant. Engineering 179: 371-74, 1955. 14

1955

30. Daniels, F. Solar energy and wind power. Science 121: 121-122, 1955.

4

31. Pigge, H. Annual availability and speed characteristics of the wind for wind power utilization. Elektrizitatswirtschaft 54: 704-709, October 1955.

6

Optimum design methods for wind driven electrical generating plants are presented, based on yearly permanent wind level lines for selected erection sites. Wind conditions at any site are divided by five classes, of which only a few can be exploited by a given system. General purpose design curves are given.

1954

1. Argand, A. Note on factors concerning the economy of wind power generation. In: National Research Council of Canada, Technical Papers presented to the Wind Power Working Party (Of the O.E.E.C.) London, H.M. Stationery Office, 1954. p. 9-10.

3, 6

Two types of preliminary research should be undertaken: First, selection of sites by determining the available energy per square metre per annum and in addition the corresponding wind speeds. Second, an endeavor must be made to determine as accurately as possible in advance the price per unit of installed capacity or better, per unit of area exposed to the wind of the proposed windmills; allowance being made for the expected efficiency it will then be possible to calculate the capitalized value of a KWh per annum for a given site.

2. Britain tests revolutionary wind generator. Power 98(1): 154, 250, January 1954.

4

Described is the giant wind generator erected at St. Albans which was subsequently moved to Algiers.

3. Cadambe, V. Harnessing of wind power: some technical aspects in relation to its future development in India. Irrigation and Power 11(4): 528-535, October 1954.

4, 6

Wind power utilization, investigations and projects in Vermont (1500 kw), Orkneys (100 kw), Germany (100 kw) Yalta (100 kw), Denmark (30-70 kw) and India are described. The program in India involves study of wind power for irrigation, for small scale power generation, wind surveys in selected localities, and collection of technical data and popularization of the project. Power increases as the cube of the wind speed; hence very little is available at low wind speeds. In India highest average wind speeds are 6-10 mph whereas foreign generators are designed for 12-18 mph. Design and economic problems are discussed. Cost with small units is 4 to 7.5 d/kwH. Biggest cost is initial cost of generator; biggest problem is to provide constant output with fluctuating winds. Thorough meteorological studies must be made of sites.

4. Caspar, W. Auswertung und Vertiefund der Windunterlagen für die Windkraftnutzung. Bericht Nr. 4 der Studiengesellschaft Windkraft e.V., Stuttgart, 1954.

4

5. Duquennois, H. Associating wind-driven generators with hydroelectric storage plant. World Power Conference. Sectional Meeting, Rio de Janeiro, 1954. Titulo 4, Assunto 4.2, 8 p. (In French.)
3, 11, 13

The additional revenue and cost of diverting a stream into an existing catchment are analyzed and compared with the case of wind power supplementing a mainly hydroelectric system. In North Africa, peak run-off does not coincide with peak wind power, so that a given hydraulic storage volume can provide more energy when wind power is added. The breakeven cost of wind-driven generators is estimated.

6. Golding, E.W. Economic aspects of the utilization and design of wind power plants. World Power Conference. Sectional Meeting, Rio de Janeiro, 1954. Tituto 4, Assunto 4.1. 21 p.
3, 4

This review draws attention to problems likely to be met in the development of wind power and to some of the investigations to be undertaken rather than to offer solutions. It is considered that wind power can fill a definite want in remote places. The need for energetic investigation and for co-operation between potential users and designers is stressed.

7. Golding, E.W. Local energy sources for underdeveloped areas. Impact V(1): 27-46, Spring 1954.
4

8. Golding, E.W. and A.H. Stodhart. The use of wind power in Denmark. Elect. Res. Assoc. Tech. Rep. C/T112, 1954. 18 p.
4

Progress in development of wind driven electric generators in Denmark from 1891 to present day; developments and background against which they have taken place; object is to enable Danish work to be considered in light of that which is now being done in Great Britain and other countries, aiming at use of wind power for electricity generation on significant scale.

9. Gordon, A.H. Harnessing the wind. World Meteorological Organization, WMO Bull. (3): 102-107, July 1954.
6

The general circulation is described briefly. The author then discusses wind energy, efficiency of wind turbines, the data available for calculating wind energy, survey of wind energy potentialities as indicated by favorable circulation, selection of sties, etc. and developments in the use of wind power.

1954

10. Hütter, U. The development of wind power installations for electrical power generation in Germany. Z. Brennst.-Waerme-Kraft 6(7): 270-278, 1954.
Translation: Scientific Translation Service, Santa Barbara, California. N 73-29009. NTIS, August 1973.
4, 12b

The development of installations for reducing electrical energy from wind energy is beginning in Germany. The wind tower generation installations built by German firms have a wheel area of between 50 to 250 square meters for installed power levels between 3 and 50 kW. In the last 30 years, there has been a tendency to increase the design rotation rate coefficient from 2-4 to a level between 8-16. At the present time, there are reliable installations with nominal power levels between 3 and 22 kW. Successful Danish, American, Russian, and German experiments over prolonged time periods proved that it is possible to operate wind power generation unit parallel with public high-voltage installations without any difficulty. This means that wind energy is now available to satisfy the energy requirement which is continuously increasing all over the world. A rough calculation shows that the energy capacity of the ocean of air is unlimited.

11. Hütter, U. The use of wind energy for generating electric current in Western Germany. World Power Conference. Sectional Meeting, Rio de Janeiro, 1954.
3, 6

12. Hütter, U. Windkraftmachinen, Hutte, des Ingenieurs Taschenbuch. IIA: 1030-1044, ~~1944~~ 1954. 28th ed. rev., Berlin. (In German) 4
Translation of p. 1030-1044: Kanner Associates Redwood City, Cal. NTIS, N75-17786, Feb. 1975. 26 p.

13. Kroms, A. Wind power plant in interconnected systems. Bull. Assoc. Suisse Elect. 45(5): 135-144, March 6, 1954.
Translation: Elect. Res. Assoc. Transl. IB 1371.
Also: Scientific Translation Service, Santa Barbara, California. N74-25617. NTIS, June 1974, 32 p.
7

The general characteristics of wind power are discussed; an overall generating efficiency of 65% is estimated with an annual utilization of 2000 days. By interconnecting wind and controllable water power plants it becomes possible to store the equivalent of the wind energy. An approximate expression for the energy interchange is derived and the storage required is shown to be comparatively small. The economics of wind power stations are discussed mathematically and it is pointed out that their use in different parts of a large system may provide sufficient diversity to reduce storage requirements very considerably.

1954

14. Ley, W. What future for wind power? Excerpt from Engineers' Dreams. Sci. Dig. 36: 82-86, August 1954.

4

15. National Research Council of Canada. Technical papers presented to the Wind Power Working Party (of the Organization for European Economic Cooperation, Committee for Productivity and Applied Research). London, H.M.S.O., 1954. 435 p.

3, 4, 5, 6, 12b

A volume devoted to 45 technical papers presented at the various meetings of the Group, organized by categories: (1) economy and potentialities of wind power, (2) wind regime studies, (3) selection of wind power sites, (4) wind measurements and instruments, and (5) design and testing of prototype machines.

16. A new wind power generator. Umschau 54(10): 303, May 15, 1954.

5

Description of a new installation at St. Alban's England, in which air is expelled from hollow vanes by centrifugal force and sucked in below past a turbine which drives a generator.

17. Nilberg, R.H. American wind turbine. Can. J. Phys. 32(10): 639-652, October 1954.

4

Theory of low speed wind turbine showing that shape of airfoil blade is predetermined by theoretical de-function of air stream; efficiency of 20% is predicted.

18. Petry, P. A characteristic of the wind: its irregularity. In: National Research Council of Canada. Technical Papers presented to the Wind Power Working Party (of the O.E.E.C.) London, H.M. Stationery Office, 1954. p. 121-128.

3, 6

The irregularity of the wind makes it of questionable value for the generation of electricity but the irregularity is less inconvenient in considering its use for pumping water for irrigation.

1954

19. Power from the wind: Great Britain carrying on research. Sci. Am. 190: 48, February 1954.
4

Summarizes briefly current research in Great Britain and other European countries on the possibility of harnessing wind power.

20. Power from the wind. Pop. Mech. 101: 124-125, June 1954.
4, 12b

An experimental windmill in Britain capable of supplying 100 kW of electricity to the national power system is described.

21. Stodhart, A.H. The economic value of hydrogen produced by wind power. Elect. Res. Assoc. Tech. Rep. C/T111, 1954. 8 p.
11

Circumstances under which possible use of windpower to produce hydrogen might be considered; estimated costs of providing heat, light, and power in this way are compared with those of obtaining energy in similar forms by use of either paraffin or diesel oil; examples based on cost of fuel at semi-desert site and at Island site are given.

22. Studiengesellschaft Windkraft e. V., Stuttgart Records on the distribution of wind velocity in Germany for wind power exploitation. Mitteilungen, No. 3, April 1, 1954. 107 p. In German.
6

Wind data for 50 stations in western Germany are thoroughly analyzed and presented in graphical and tabular form with respect to use in wind power projects. The sites of each station are described and shown on charts or surrounding topography etc. Mountain, coastal, and urban locations are included.

23. Thomas, P.H. Fitting wind power to the utility network. U.S. Federal Power Commission Report 099558, February 1954.
7, 13

1954

24. Vinter, A.V. and N.M. Tikhomirov. Wind energy as a basic factor in the economic utilization of deserts. In: Akademiia Nauk SSSR Botanicheskii Institut, Pustyni SSSR i ikh osvoenie, Vol. 2: 520-565. Akademiia Nauk SSSR, 1954.

6

A most comprehensive survey of the progress made in the Soviet Union in the utilization of wind energy in the deserts and semideserts of the Soviet Union. Detailed descriptions with the aid of diagrams and photographs are given of various types of wind generators and wind power installations used in various parts of the U.S.S.R. Data are given on the hourly productivity of a wind generator in lifting water to various levels as a function of wind velocity and the annual productivity of wind generators in lifting water as a function of mean annual velocities, and graphs showing the results of experiments with and without the use of inertial accumulation up to the beginning of actions of the regulator tables giving the fundamental indices of the most important Soviet wind generators and the variations of their power as a function of varying wind velocity, etc. The efficiency and economics of wind generators are considered.

25. Voigt. H. Principles of steel construction engineering in the building and operation of wind driven power plants. Der Stahlbat 23(8): 184-188, August 1954.
Translation: Kanner Associates, Redwood City, California. N73-21253. NTIS, April 1973.

~~12~~ 5

The factors which affect the designing of wind-driven power plants are discussed, including purpose and nominal output, wind velocity as a function of height, wind forces as a function of height, and the torques to be expected. Design features of the ZYKLON wind-driven power plants are summarized, and sample calculations are made, based on the ZYKLON-D 30 project. The optimal shaft height for a 30-m wind turbine is found to be 50 en 1 m above ground, with a yearly output of 2,125,000 kWh at a cost of 2.68 German pfennigs per kWh.

26. Wailes, R. The English windmill. London, Routledge and Kegan Paul, 1954.

1, 2

1954

27. Wailes, R. Tower windmills in Lincolnshire; abstract. Engineer 197: 650, April 30, 1954.

1

This abstract summarizes a paper on the various kinds of windmills in Lincolnshire, emphasizing historical and design aspects.

28. World Meteorological Organization. Energy from the wind. Assessment of suitable winds and sites. WMO, No. 32, TP 10, 1954. (Also Tech. Note, No. 4, 1954) 205 p.

6, 16

This report contains a simple discussion of the general physical prinicples underlying the general circulation with special reference to wind flow, the nature of wind energy calculation of a mean scalor wind velocity, wind measurement, the application of wind energy potentials by the use of empirical and statistical techniques vertical profile of wind speed, selection of suitable sites for installing wind turbines and the topographical effects of sites. Criteria for selection of sites are discussed. Has extensive bibliographies.

29. Andrianov, V.N. and N.A. Sazonov. Utilization of wind energy for the electrification of agriculture in the USSR. World Power Conference, Sectional Meeting, Rio de Janeiro, 1954. 13 p.

6, 8

Various wind power stations in the USSR are described and technical and economic considerations of parallel operation of wind and non-wind systems are discussed.

30. Golding, E.W. Wind-generated electricity for the farm. Agriculture 61: 15-19, 1954.

8

31. Meyer, G.W. Windkraft. Leipzig, Germany. Fachbuchverlag, 1954. 143 p. (In German)

2

32. Oniga, T. Caracteristicas brasileiras para o aproveitamento da energia eolica. World Power Conference, Sectional Meeting, Rio de Janeiro, 1954. 12 p.

6

This paper reviews the wind power potential in Brazil.

33. Vadot, L. Etude synoptique des differents types d'eoliennes. Grenoble, France, Neyrpic, 1954. 25 p. (In French)

2

1954

34. Vadot, L. Etude des eoliennes de pompage pour pompes a piston. Grenoble, France, Neyrpic, 1954. 38 p. 2

1954

35. Kroms, A. Wind power stations working in connection with existing power systems. A.S.E. Bull. 45(5): 135-144, March 1954. Translation: Elect. Res. Assoc. Transl. No. IB 1371.

13

36. Vezzani, R. Organisation systématique des observations concernant la disponibilité et l'utilisation de l'énergie éolienne pour la production de l'électricité. World Power Conference, Sectional Meeting. Brazil, 1954. (In French)

3, 6

37. Hütter, U. Wind power machines. From book "Huette, des Ingenieurs Taschenbuch." Berlin, Wilhelm Ernst and Son, 1954. Translation of p. 1030-1044: Kanner Associates, Redwood City, California. N75-17786. NTIS, February 1975. 26 p.

5

Basic aerodynamic features of wind power and wind wheels are discussed. The adaption of wind power to running machinery is described. Developments in wind power are illustrated, and operating properties are briefly outlined.

1953

1. Asta, A. Experience in the utilization of wind energy by means of aero-electric sets. Elettrotecnica 40: 405-416, August 1953. (In Italian.)

4

After a review of the principal installations which have been erected in various countries, the problems which have arisen under many conditions are discussed. Since the results obtained from test-plants and experience are not conclusive from the economic point of view, a plea is made for coordinated research based specifically on the utilization of the energy in the wind. A bibliography is added.

2. Asta, A. Experience in the utilization of wind energy for the production of electric energy. Ricerca Sci. 23(14): 537-558 April 1953. Translation: Elect. Res. Assoc. Transl. No. 1B 1305.

4

The fundamental problems of wind power generation are recalled and the results of the most recent research carried out principally in Italy are given and discussed. Problems dealt with are low power-weight ratio; variable pitch impeller design, and d.c. and a.c. generators with suitable characteristics. Coordination of activities, field experiments and the formation of a national body to carry out an anemometric survey are advocated.

3. Britain tries a new approach to power from the wind; anemoplant. Elect. World News 139: 32-34, April 13, 1953

4

The first wind-driven generating station is soon to be added to British Electricity Authority's power system. The 100 kw machine works on the depression principle, an arrangement whereby the generator is directly coupled to an air turbine, both being at or near ground level and neither being mechanically connected to the propeller. The propeller, by extracting air from the system through centrifugal force, sets up a pressure difference across the turbine sufficient to cause rotation.

4. Cambilargiu, E. The wind energy in Uruguay. Bol. Fac. Ingen. Montivideo 4: 633-656, September 1953. (In Spanish.)

6

Tables and graphs give data on calm periods, frequency, and direction of strong winds, and energy p.a. that could be obtained by exploitation of wind power compared with calculations relating to France. A plea is made for systematic study of the problem, and some notes on measuring instruments and utilization of available meteorological stations are given.

5. Clausnizer, G. and U. Hütter. Parallelbetrieb einer 8, 8kw. Windkraftanlage mit einem Stromversorgungsnetz, Bericht Nr. 1 der Studiengesellschaft Windkraft e.V., Stuttgart, 1953.

13

6. Czcina, L. Theoretical problems of energy utilization and its possibilities in Hungary. Idojaras 57(4): 221-227, July/August 1953. (In Hungarian.)

6

Tables of monthly frequency distribution of wind speeds at 10 m above the ground and of seasonal frequencies of relative calm duration (<2 m/sec) are presented for Tiszaörs, eastern Hungary (1940-1941). It is found that a wind generator would be idle in that region during 1/3 of the time. A comparative table of seasonal average wind speeds (a value irrelevant in itself from the point of view of wind energy utilization) suggests that there are regions in Hungary where better wind conditions can be expected than in Tiszaörs. The author explains how to calculate useful energy from wind speed. He also gives a description of operational details of the wind generator at Ai Petri (Crimea) which is believed to be the world's largest.

7. Golding, E.W. Electricity generation by wind power. Research 6(4): 138-144, April 1953.

6

The author discusses the emergence of wind power generation in it's quantitative aspects, wind regions and the selection of sites for aerogenerators, the physical and engineering aspects of the extraction of power by wind driven machines, needed wind power research and development and possible role of international cooperation in wind power investigation.

8. Golding, E.W. Harnessing the wind. Discovery, 1953, p. 373.

4

9. Golding, E.W. The utilization of wind power in desert areas. Elect. Res. Assoc. Tech. Rep. C/T110, 1953. 11 p.
(Also published as: International Symposium on Desert Research, Jerusalem, May 7-14, 1952. Proceedings: 592-604, 1953)

3,6

The author discusses the general aspects of the availability of power from wind energy such as in wind velocity and duration, the calculation of power derived from wind energy and the annual energy available; the economics of wind power generation; the utilization of wind power in water heating; refrigeration, water pumping, etc.; and the planning and execution of wind surveys in a semiarid region such as Israel.

10. Golding, E.W. Wind-generated electricity and its possible use on the farm. Farm Mech. 114: March, 1953.

8

11. Golding, E.W. Wind generated electricity for desert areas. Sci. Couns. 1: 44-46, June 1953.

6

An account of the conditions in various parts of Israel which make wind power the only, or in some cases the most economical, form of power for various purposes (such as irrigation, farm lighting, etc.) The program being conducted there under the sponsorship of UNESCO is outlined in some detail.

12. Grinrod, J. Wind-to vacuum-to power. Power Eng. 57(9): 91, 111-112, September 1953.

11

Status of British Electricity Authority project to achieve practical system whereby wind power could be used to generate electricity; adoption of "Depression" principle of design which permits trim tower structure with no heavy equipment on top; turbine and generator are located at base and are actuated by inrush of air which wind rotated hollow propellers suck up through hollow tower.

13. Juul, J. SEA's wind-power investigations 1952. Elektroteknikeren 49: 193-197, May 22, 1953. (In Danish.)
Translation: Linguistic Systems, Inc., Cambridge, Massachusetts. N74-29417. NTIS, July 1974. 19 p.

4

An illustrated description of the rebuilding of a 30kW d.c. windmotor generator to 40kW a.c. The 3 wings, with an outer diameter of 13 m, provided with braking-flaps operated by springs, are installed on a 20 m tower. The generator is one of the induction type, so controlled, that when the speed of the generator exceeds synchronous speed 5%, a contactor connects the generator to the a.c. network. When the windmotor slows down, the generator takes current from the network, whereby a return-current relay opens the contactor. The characteristics are shown, data on generation are given, and the variation of wind with height is discussed.

1953

14. Kleinhenz, F. Berechnung und Konstrucktion eines Windrades von 130 m Durchmesser Stahlbau 22(3): 49-55, March 1953.

12b

Calculation and construction of windmill of 130 inches diameter, with four blades, position of which can be adjusted by means of mechanism in wheel axle; static conditions and loading of blades; example of wind power plant; tables, diagrams.

15. Munro, H. Prospects for windpower development in Ireland. Inst. Civ. Eng. Ire. Trans. 79: 129-167, 1953.

6

List of long term annual average wind speed m/sec; pattern of windmill operation; choice of rated wind speed; aerodynamics of windwheel blade; construction of windmill; present position in windpower development and prospects.

16. 100 kW wind-driven electric generator. Engineering 175(4542): 213-214, February 13, 1953.

7

Some preliminary details are given in this article of an experimental wind-driven 100 kW electric generator now undergoing erection on a provisional site. Its design is distinguished by the elimination of a mechanical coupling between the propeller and generator. It is later to be erected in a locality where "isovents" in the region of 30 mph prevail and will become the first wind-driven generating set in the British Electricity Authority system.

17. Parson, H.E. Wind power history and present status. Eng. J. 36(1): 19-21, January 1953.

1, 4

Development in the last 30 years; A. Flettner in Germany and J.D. Maderas in U.S. sought to harness Magnus effect, i.e., side thrust exerted by cylindrical surface revolving in wind stream; installations of 6-blade windmill connected to vertical shaft generator in 1920 by Kumme in Germany; other installations in Germany, Finland, U.S., and Russia; largest and best engineered experiment in large scale wind power generation, was Grandpa's Knob experiment in Vermont.

18. Patrichi, S. and S.M. Stoenescu. Wind energy potential in the Rumanian Plain. Rumania. Inst. Meteorologie Bucharest, Culegere de Lucrari, 1965. p. 295-310. (In Rumanian.)

6

The analysis of the hourly wind observations has led to the conclusion that in the Rumanian Plain, the energy of the wind ensures, on the whole the operation of wind engines equipped with a great number of blades, all through the year. In winter and spring the wind engine productivity is approximately 20-30% greater during summer and autumn. The diurnal variation of the wind velocity is likewise subjected to analysis.

19. Possibilities of wind power. Engineering 176(4563) 33, July 10, 1953. (Also Machy Market No. 2747, p. 25-26, July 10 1953).

4

Some applications reviewed: exhibition of equipment for application of wind power staged by Enfield Cables, at Prae Wood, near St. Albans, include 100-kw wind generator erected at Prae Wood, working on "depression" principle, and 8.5-m 8-kw plant, of similar type built by Ateliers et Chantiers de France, SA, Paris.

20. Putnam, P.C Energy in the future. New York Van Nostrand 1953. 556 p.

2

This large volume on energy contains a few brief discussions on the Vermont wind turbine experiment and potential for using wind as a power source.

21. Sankaran, K.M. Minimum research and investigation needed in initial stages of development of wind power in India. Irr Power J. Cent. Board Irr. Power (India) 10(4): 445-452, October 1953.

6

This paper covers windmills for irrigation, harnessing of wind for generation of electricity, and gust measurements.

22. Sektorov, V. R. Ispol'zovanie energii vetra dyla elektrifikatsii. Elektrichestvo No. 3: 11-16, March 1953.
Translation: Linguistic Systems, Inc. Cambridge Massachusetts. N74-16801 NTIS, February 1974, 18 p.

4, 8

Utilization of the energy of wind for electric power generation and characteristics of existing power generators utilizing the energy of wind and its application in agriculture are discussed.

23. Serra, L. Wind in France and possibilities of its utilization. La Meteorologie 4th Series, No. 32 273 292 October/December 1953. (In French.)

6

Network of experimental wind energy stations has been set up in France, with wind indicators calibrated to give the energy received per square meter of surface rather than in speed (m/sec). The energy is proportional to the cube of the speed. The network is shown on a chart. The mountainous regions are neglected since the instruments would be subject to icing failure and furthermore there is enough hydroelectric power available there. Elsewhere the network is quite uniformly distributed. A graph shows the normal (1890-1909) values of monthly wind speed which will occur at the Eiffel Tower (or) 10%, 25%, 50%, 75%, and 90% of the time. The stability of the monthly mean wind speed frequencies is represented by an index which varies greatly from one place to another and even more sharply when energy (v^3) is used as basis for index instead of speed (v).

24. Studiengesellschaft Windkraft e.V., Stuttgart. Parallel operation of a 8.8 kw wind power installation with a power supply net. Mitteilungen, No. 1: 1-16, April 1953. (In German.)

7

A report on a 6 months test of a wind power plant with wheel 10 m in diameter, equipped with a 8.8 kw asynchronous generator in conjunction with a power net, is presented. The test was carried out at the experimental plant of Uhingen (Württemberg, Germany). The experimental equipment consisting of complete wind power plant, measuring apparatus and mains connection with main lines (transformer station) and the results obtained are described in detail. Suggestions for improvement are outlined.

25. Vinter, A.V. Utilization of wind energy. Priroda 2: 23-28, February 1953. (In Russian.)

4

General considerations of the possibility and necessity of utilizing wind energy in line with other sources of energy supplying industry, transportation and agriculture with power are presented and discussed. Proceeding from the principle that "wind energy must be directed to the elimination of the harmful effect of the wind itself" - the author presents approximate calculations giving a general picture of the scale of potential utilization of wind-driven generators in newly irrigated areas, as well as the Arctic region, where atmospheric and climatic conditions are unfavorable for the construction of extended power transmission lines.

26. Wind power progress. Elect. J. 150: 528, February 13, 1953.

4

1953

27. Wind-driven generator. Engineer 195(5064): 242, February 13, 1953.

4

Preliminary details of experimental 100-kw electric generator undergoing erection by Enfield Cables Ltd; design is distinguished by elimination of mechanical coupling between propeller and generator; it is later to be erected in locality where "Isovents" in region of 30 mph prevail; illustrations.

28. Honnef, H. Wind electric power station. German Patent No. 871580 March 23, 1953.
Translation: Kanner Associates, Redwood City, California. N74-21682 NTIS, April 1974, 14 p.

5, 14, 17

A wind power station is described in which the structure on which the rotors are mounted may tilt as wind speed changes so that the rotors leave the vertical plane to anticipate increase wind speeds. The power station may have pulse generators located in front of the turbine rotors on extensions of the turbine shaft or on separated booms under the turbine; winches to tilt the turbine platform, normally locked by means of a brake, which is released when a predetermined wind thrust is reached; flexible tension members to transmit the thrust of the wind to the nontilting portion of the structure; provisions to change the direction of the winches as wind speed changes; an auxiliary vane to control an electrically driven propeller to rotate the power plant into the wind; and auxiliary generators to be used when wind speeds are too low for normal synchronous operation.

29. Honnef, H. Wind power turbogenerator for high altitude wind utilization. German Patent No. 885284 August 3, 1953.
Translation: Scientific Translation Service, Santa Barbara, California. N 74-21677. NTIS, April 1974 12 p.

14, 17

A windpowered electrical generator is reported that consists of two counter-rotating wheels, one being the armature and the other being the field. Means of compensating for varying wind speed are described.

30. Juchem, P. Are wind driven power plants possible. Koelnische Rundschau 96A, April 26, 1953.
Translation: Techtran Corp., Glen Burnie, Maryland. N 74-31531. NTIS. August 1974. 10 p.

6

A great deal has been written about the project to exploit wind energy to produce electrical energy. The controversy over the tremendous wind wheels has not died down and, in the age of an evergrowing demand for energy, it has again

become a subject of discussion. The following is a contribution to this subject and reflects the personal opinion of the author about the project.

31. Cassens, J. Windmotor. German patent No. 892,130, October 5, 1953. 14, 17

32. Juchem, P. Are wind-driven power plants possible? Koelnische Rundschau 96a: April, 1953. 6

33. Sabinin, G.K. [Theory of a high-speed stabilizer vane] Moscow, Russia, BNTN TsAGI Publications, 1953. (In Russian) 2, 5

34. Darrieus, G. Utilisation de l'énergie éolienne. Ses perspectives, principes et modes de réalisation. Conférence du 7 Mai 1953. Bulletin de la Société d'Encouragement Pour l'Industrie Nationale (paraître ultérieurement). (In French)
3, 4, 9

35. Fedotov, B.E. Etudes sur le fonctionnement d'une éolienne ayant une roue située derrière la tour. Laboratoire Central de Recherches Scientifiques sur les Eoliennes (ZNILV-1), Moscow, 1953. (In French)
5

36. Golding, E.W. Electricity generation by wind power. Research 6(4): 138-144, April 1953.
4, 6

The author discusses the emergence of wind power generation in its quantitative aspects, wind regions and the selection of sites for aerogenerators, the physical and engineering aspects of the extraction of power by wind driven machines, needed wind power research and development and possible role of international cooperation in wind power investigation.

37. Iwasaki, M. The experimental and theoretical investigation of windmills. Reports of Research Institute for Applied Mechanics, No. 8: 181-229, 1953.
5

38. Land, sea, and air. Survey of some auxiliary sources of energy for electricity generation. Electr. Times 124: 321-325, August 20, 1953.
4

This article includes information on geothermal heat, underground gasification, tidal air, wind power, and solar energy.

39. Singer, I.A. and M.E. Smith. Relation of gustiness to other meteorological parameters. J. Meteorol. 10: 122, April 1953.
6

Two years of data have been processed to show relationships between wind gustiness and other meteorological parameters. The gustiness classification used at Brookhaven National Laboratory is defined by the range and appearance of the horizontal wind direction trace. The seasonal and diurnal variations are presented. Gustiness is closely related to lapse rate and solar radiation, while its association with wind speed and Sutton's index of turbulence is not as distinct.

1952

1. Andrianov, V.N. and A.I. Pakataev. Regulation of the output of a wind-power station. Elektrichestvo, No. 6: 19-24, 1952. Translation: Elect. Res. Assoc. Transl. No. IB 1249.

14

2. Bhatia, K.L. Energy available for windmills in India. J. Sci. Ind. Res. 11: 329-333, 1952.

6

3. Fateev, E.M. and I.V. Rozhdestvenskii. Achievements of Soviet wind power engineering. Vestnik Mashinostroeniya, No. 9: 24-27, 1952. Translation: Elect. Res. Assoc. Transl. No. IB 1334.

4

4. Fellgett, P.B. Generation of electricity by wind power. Polar Record 6(44): 535-537, July 1952.

8

Summary of experiences in use of small wind generators, especially in the Arctic.

5. Golding, E.W. and A.H. Stodhart. The selection and characteristics of wind - power sites. Elect. Res. Assoc. Tech. Rep. C/T108, 1952. 32 p.

6

Development, throughout its various stages, of wind survey covering areas of British Isles most likely to contain sites suitable for large scale generation of electricity by wind power; results of measurements analyzed and comparison of wind flow at sites is made; estimates of wind energy available and proportion which may be usable by air generator.

6. Juul, J. Supplement to report on results obtained with the SEAS experimental wind-power generator. Elektroteknikeren 48: 65-79, 1952.
Translation: Kanner Associates, Redwood City, California. N 74-20700. NTIS, April 1974. 40p.

4

Experience gained concerns (1) possible annual energy production; data on actual daily production are given and the question of calculating obtainable energy from design data and meteorological observation is discussed (2) relation between wing-tip speed and efficiency· this is dealt with in detail and regulation and control, and starting, are considered. (3) strain on wings, fatigue.

The economy of wind power stations of about 100 kW is discussed with special reference to conditions in Denmark.

7. Marshall, C.W. Power generation by wind. Engineering 173(4497): 445-446, April 4, 1952.
4

Experience with wind motors, it is claimed, does not encourage large scale investment in wind power developments; tentative conclusion reached that most economical capacity of generator for operation with British grid system lies between 1000 and 2000 kw· North of Scotland Hydro-Electric Board machine is 100-kw geared unit, with 3-bladed propeller and asynchronous generator; British Electricity Authority machine is Andreau type, with pneumatic transmission and synchronous generator.

8. Pigge, H. Antenna towers as wind power generation plants. Elektrotech. Z (ETZ) 73(4): 95-96, February 15, 1952.
Translation: Scientific Translation Service, Santa Barbara, California. N 74-15763/7. NTIS, February 1974. 5, 9

A variety of wind power generating plants are considered to be installed on FM antenna masts. These include: Savonius rotor, horizontal axis wind wheels, multi-rotor configurations. Power levels may vary between 10-20 kW for 100 meter mast heights.

9. Problems of utilization of wind power in the Argentine. Rev. Electrotec. B. Aires 38: 1-20, January 1952. (In Spanish.)
6

The historical development of the windmill is sketched and photographs of modern types are shown. The problems of design, of storage of energy, regulation, interconnection with networks, effects on wind velocities, are discussed, and the special importance wind power stations might have as introducing electric power in regions beyond the extensions of a network is considered. The characteristics of wind over the area of the republic are described and illustrated by maps. An intensive study of the question is advocated.

10. Rosenbrock, H.H. An extension of the momentum theory of wind turbines. Aircr. Eng. 24: 226-227, August 1952.
5

Momentum theory of wind turbine, as usually stated, does not allow interference factors greater than one-half, although experiment shows that values approaching unity are possible; theory is extended to remove this contradiction and assumptions are at same time slightly generalized.

11. Sankaran, K.M. Possibilities of wind power plants in India. Power Engineer 2(1): 14-18, January 1952.
6

Wind power, if harnessed, would substantially aid hydro power systems to firm up their capacity; possibilites in India; exmaples of installations abroad.

12. Sanuki, M. A short note on the maximum possible power of windmills. Geophysical Mag. Tokyo 23(4): 303-304, May 1952.
5

Results of experiments on the power generated by a particular windmill are plotted and compared with the theoretical curve calculated by the formula of H. Glauert. The experiments show that the maximum power is realized with the three bladed windmill and attains about 63% of the theoretical value. The difference between the theoretical and experimental results may be attributed to the loss occasioned by the profile drag of the windmill sections and also the finite number of blades.

13. Seidel, G.R. Modern wind power utilization. Elektrotechniker 4: 61-66, March 1952.
Translation: Elect. Res. Assoc. Transl. No.IB 1283.
4

Modern windmill utilization; various types of wind wheels and their applications; use of windmills for water pumping wind driven electric generators; examples of American, Russian, and Dutch windmills.

14. Serra, L. Estimation of the quantity or wind energy annually utilizable in France. O.E.E.C. Committee for Productivity and Applied Research. Tech. Paper No 5. London, 1952.
6

15. Sil, J.M. Windmill power. Indian J. Meteorol. Geophys. 3(2): 77-90, April 1952.
8

Output of windmill power for irrigation purposes is compared with anemograph observations at Poona.

16. Sykes, J.H.M. Review of wind power developments. Elect. Eng. Merchand. 29(5): 148-150, August 1952.

4

Design of wind generator that would product satisfactory output of a-c power which could be fed into public supply network has been attended by number of difficulties, especially need with orthodox windmill to mount generator at top of tower; description of Enfield-Andreau generator; by novel method of using wind pressure, electric generator can be mounted at foot of tower; machine of this type is now under test in England, and will be installed on Welsh coast for further experimental operation.

17. Thomas, P.H. Critical intermittent impact factor in wind-turbine design. Water Power 4(1): 35-36, January 1952.

5

Function of impact in performance of wind turbined; proper appreciation of this factor can lead to more efficient designs.

18. United States Congress. House Committee on Interior and Insular Affairs. Production of power by means of wind-driving generator. Hearings, 82d Congress, first session, on H.R. 4286. September 19, 1951. Washington, G.P.O., 1952. 41 p.

4

19. Venkiteschwaran, S.P. Measurement of wind for a wind power survey in India. J. Sci. Ind. Res. 11A(10): 442-451, October 1952.

6

Instruments and methods used in measuring wind at Indian weather stations are described and illustrated. Various characteristics of wind are discussed in respect to their effect on wind power utilization. The general equation $P=0.0000071\ BV^3$ is given for the relation between wind speed (V) in mph, swept area of wind wheel (B) in sq. ft, and power available (P) in Hp. The author also deals with wind data available for India, presenting a chart of observatories conducting hourly wind measurements, and a table giving frequency values of wind speeds above 10 mph for 31 stations.

20. Wind-power generator for North Wales. Engineering 173: 343, March 14. 1952.

6

The article describes the plans and design of an experimental 100 kW generator to be installed on the North Wales coast.

1952

21. Wireless masts with wind power machinery. Umschau 52(13): 392, July 1, 1952. (In German.)

4

Proposes the erection of wind electric generators (blades or rotors) on ultra-short-wave masts, which are often on high peaks. These supply power for the transmissions.

22. Toegepast Natuurwetenschappelijk Onderzoek. Rapport-Omtrent de proefnemingen in de benthuizer molen, betreffende tandeinbedrijf en electriciteitsopwekking [Report on the experiments with an old Dutch windmill to combine pumping with generating electricity] The Hague, Netherlands, 1952. 20 p.

14

Operation of a Dutch windmill is described which feeds from 34,000 to 50,000 kilowatt-hours of electricity per year into the low-tension grid.

23. Karmishin, A.V. Vetrodvigateli dlya mekhamizatsii zhivotnovodcheskikh ferm [Wind motors for mechanization of livestock farms] Moscow, Mashgiz Publications, 1952.

8

24. Grinevich, G.A. [Experience in development of elements of small wind energy-producing cadasters of Central Asia and Kazakhstan.] Tashkent, Russia, Izd. Uz. SSR, 1952. (In Russian)

4, 8

1952

25. Boonenburg, K. Windmills in Holland. The Hague, Netherlands Government Information Service, 1952. 40 p.
1

26. Brun, E.A. and T. Oniga. Utilizacao da energia dos ventos. Dados gerais. A situacao no Brasil. Inst. Nac. Technol. Rio de Janeiro, 1952. (In Portuguese)
6

27. Energy in the service of man. UNESCO/MS/91, Paris, 1952, p. 31.
4

28. Marshall, C.W. Power generation by wind. Engineering 173(4497): 445-446, April 4, 1952.
4

This is an excerpt from a paper entitled "Supplementary Sources of Power: Wind, Volcanic Heat, Sun and Tide," delivered at a meeting of the Royal Society of Arts, held in London on March 19, 1952.

29. Nilakantan, P. and Varadarajan, R. Studies in the utilization of wind power in India--preliminary survey. Organization for European Economic Cooperation, Tech. Pap. No. 6, 1952.
6

30. Power from the wind. Engineer 193(5016): 387, March 14, 1952.
4

31. Rosenbrock, H.H. An extension of the momentum theory of wind turbines. Aircr. Eng. 24: 226-227, August 1952.
5

32. Sanuki, M. Experiments on the start and stop of windmill- and cup-anemometers with particular reference to their over-estimation factors. Pap. Meteorol. Geophys. 3: 41-53, 1952.
5

33. Satakopan, V. Wind power in the semi-arid zones of Peninsular India. Paper read at the Symposium on the Semi-Arid Tracts of Peninsular India and Their Development, Poona, August 1952.
3, 6

1951

1. Albright, P.S. Power from the wind. Comp. Air Man. 56: 263-266, October 1951.

1, 4, 6

This article contains a historical review of American windmills, followed by feasibility consideration of use of windpower for production of electricity in Kansas.

2. Andrianov, V.N. and D.N. Bystritskii. Parallel operation of a wind power station with a powerful grid. Elektrichestvo, No. 5: 8-12, 1951.
Transl: Elect. Res. Assoc. Transl. No. IB 1161.

7, 13

3. Arzt, T. Wind conditions in the Rhon range with special reference to the utilization of the wind as a source of energy. Deutscher Wetterdienst in der U.S.-Zone, Berichte, No. 21, 1951. (In German.)

6

4. Aujesky, L. Computation of quadratic and cubic mean values of wind velocity for the estimation of available wind power. Idojaras 55(3/4): 79-81, March/April 1951. (In Hungarian.)

6

Convenient representations of wind conditions by average values of wind velocity are insufficient for the estimation of the available wind power at a given locality, theoretical wind power being proportional to the third power of wind and velocity, whereas the wind power utilizable in synchronic generators is found to be proportional to the square of wind velocity. Consequently, the necessity of computing quadratic and cubic means of wind velocity is emphasized.

5. Christaller, H. Nutzbarmachung der windenergie Elektrizitaetswirtschaft 50(11): 320-322, November 1951.
Translation: Linguistic Systems, Inc., Cambridge, Massachusetts. N 74-16756. NTIS, February 1974. 12 p.

4

Utilization of wind power; measurements of available energy from air currents; wind turbulence and determination of average power; construction features of windmills and possible industrial applications.

6. Dubrosedov, A.S. and E.I. Medovar. Windmotor TV-8. Moscow, Mashgiz, 1951. 119 p. (In Russian.)

4

A technical work on the particular type of wind-electric generator in use throughout the U.S.S.R. is preceded by a chapter on the general nature and measurement of wind and calculation of energy of the wind.

1951

7. Gibbs, R.G. Favorable technical and economic aspects of wind-driven generators to supplement hydroelectric plants. Chem. Eng. News 29: 4056-4057, October 1, 1951.

4, 13

A summary of favorable technical and economic aspects of wind-driven generators to supplement hydroelectric plants emphasized at a Congressional hearing is presented.

8. Houdet, E. L'establissement des helices d'eoliennes electriques a usage domestique. Genie Civil 128(11): 207-210, June 1, 1951.

8

Windmills for power generation in rural areas in France; economic aspects; relation between available energy per square meter and wind velocity; width and number of vanes; diagrams.

9. Juul, J. Report of results obtained with SEAS experimental wind power generator. Elektroteknikeren 47: 5-12, January 7, 1951.

4

The design of the windmill driving a 3-ph. asynchronous generator is described. The tower was 12 m high and the diameter of the rotor 8m. Originally a 3 kW generator for low wind speed and a 10 kW generator for high speed were installed, but one machine was found adequate. Wing shape was adopted, after tunnel experiments, with hinged flaps for regulation of speed. Power developed was measured and some data on power developed per m^2 of rotor surface are given. Regulation, automatic operation and optimum wing tip speed are discussed.

10. Karmishin, A.V. Wind and its utilization. Moscow, Gos. Izd-vo Tekhniko Reoret, Litary, 1951. 62 p. (In Russian.)

2

A popular work on wind, wind power and wind generators, dealing specifically with causes of atmospheric circulation and local winds, effects of windbreaks, topography, insolation, snow, etc.; observation of wind on land and sea; sand and other storms and, finally, the engineering and practical aspects of windmills and machines.

1951

11. Kloss, M. Power generation by wind motors. Elektrotech Z (ETZ) 72(7): 201-202, April 1, 1951.
Transl: Scientific Translation Service, Santa Barbara, California. N 74-15739/7. NTIS. February 1974.
4

The development of a wind wheel for electric power generation is discussed. The interaction between the wind wheel and the generator is accomplished with a power control device to prevent overloading the generator when the wind velocity increases. The self-controlled running wheel of the wind motor adjusts the blade angle of attack to compensate for the wind velocity. The generator must be dimensioned for the greatest wind intensity in order to accept the entire wind wheel power. The wind generation installation delivers all of the produced energy to the network so that other generating stations operating in parallel and the storage units must adjust the power level to the consumers.

12. Mackenthun, W. Neuwerk windmill power generation plant. Elektrizitaetswirtschaft 50(11): 322-325, November 1951.
Transl: Techtran Corporation, Glen Burnie, Maryland. N 74-15740/5GA. NTIS, January 1974.
4

The installation and characteristics of a windmill power generation plant are discussed. The meteorological parameters of the German North Sea Coast which influenced the location of the windmill power generating system are analyzed. The regulating devices for compensating for changes in wind velocity are described. Results of the power generation operation for the year 1950 are tabulated.

13. Pigeaud, F.D. Beschouwing betreffende het jaarrendement van moderne windkrachtinstallaties. Ingenieur 63(47): W137-140, November 1951 (In Dutch.)
7

Method of calculation of annual overall efficiency of modern wind power plants equipped with asynchronous generators taking into account annual velocity duration curve at Den Helder, Holland; comparison between variable pitch windmotor and fixed blade windmotor equipped with movable flaps; careful calculation recommended in view of rather small difference in efficiency of both systems.

14. Roginski, S. Utilization of wind energy. Gazeta Observatora PIHM 4(6): 8-14, June 1951. (In Polish.)

4

After having given some basic theoretical information on the nature and dynamics of winds, the author presents a historical outline of the consecutive development and technical improvements achieved recently in utilization of wind energy for diverse industrial purposes but mainly for windmills and power generating wind turbines. The details of various models of European, American, and Soviet design are described and shown in photographs or drawings and their efficiency and peculiarities are considered.

15. Rosenbrock, H.H. The design and development of three new types of gust anemometer. Elect. Res. Assoc. Tech. Rep. C/T106, 1951. 37 p.

6

16. Rosenbrock, H.H. An extension of the momentum theory of wind turbines. Elect. Res. Assoc. Tech. Rep. C/T105, 1951. 12 p.

6

17. Rosenbrock, H.H. and J.R. Tagg. Wind- and gust-measuring instruments developed for a wind-power survey. Elect. Res. Assoc. Tech. Rep. C/T104, 1951. 10 p.

6

18. Rosenbrock, H.H. and J.R. Tagg. Wind and gust-measuring instruments developed for a wind power survey. Inst. Elect. Eng. Proc. 98, Pt. 2, No. 64: 430-484. In: Inst. Elect. Eng. Proc. 98, Pt 2, No. 64: Session I, p. 430-460; Session II p. 461-484, 1951. Symposium of Papers on Electrical Meteorological Instruments.

6

19. Simon, F.R. Energy in the future. UNESCO NS/79, February 1951.

4

20. Stein, D.R. The collection and evaluation of statistics on electricity generation from wind power stations. Elektrizitatswirtschaft 50: 279-285, October 1951; 325-329, November 1951. Part 2: 50(11): 325-329 November 1951.
Translation: NTIS N 74-25618 1974, 23 p. and N 74-22708, 16 p.

6

Evaluation of detailed statistical data concerning the operation of from 43 to 88 wind power plants in Denmark from 1941 to 1944. The power plants are divided into groups by type and size, and from the data given the actual-as against the theoretical-utilization of the energy of the wind, diversity, peak production, load factor and the economic utilization are discussed.

1951

21. Sterne, L.H.G. and G.C. Rose. The aerodynamics of windmills used for the generation of electricity. Elect. Res. Assoc. Tech. Rep. C/T102, 1951. 12 p.

5

22. Thomas, P.H. Wind power. Water Power 3: 302-306, August 1951.

13

Discusses various aspects of using wind power and its potentialities as contribution of energy to utility network system; appraising probable value of wind energy for power purposes; measurement of wind energy in United States; comments on aerogenerators.

23. Vinter, A.V. Wind energy and prospects of its utilization. Moscow. Izdatel'stvo Pravda, 1951. 23 p.

4

A popular account of the economic importance of wind energy to the national economy of the U.S.S.R, its relative cost as compared with coal and oil, and its application to various aspects of economic activity; brief descriptions of various types of wind energy devices; and a listing of the regions of the U.S.S.R. where wind energy can be utilized most efficiently namely the Far East, Eastern Siberia, Kamchatka, Sakhalin, Kara Kum and the Caspian Sea region.

24. Whetstone, G.A. What can wind power do for us? Power Eng. 55(3): 72-73, March 1951.

4

Appraisal of value of wind power to public utility system indicates that wind power is technically feasible; it is probably noncompetitive at present; there are few duties for which wind alone is adequate; combination of wind power with internal combustion power, and combination with hydro power with seasonal storage both have some strong advantages.

25. Stein, D.R. Statistical summary and evaluation on electric power generation from wind power stations. Elektrizitaetswirtschaft 50(10): 279-285, October 1951.

6

26. Stein, D.R. Statistical summary and evaluation of vento-electric power station output (part 2 of 2). Elektrizitaetswirtschaft 50(11): 325-329, Nov. 1951.

6

1951

27. United Nations. Proceedings of the United Nations Scientific Conference on the Conservation and Utilization of Resources, III. Fuel and Energy Resources, New York, 1951. 3

28. U.S. Congress. House Interior Committee. Hearing on H.R. 4286. Production of power by means of wind-driven generator. 82d Congress, 1st session, September 19, 1951. 6

1951

29. Boudineau, A. A new solution for the utilization of wind energy. Rev. Gen. Elect. 60: 191-3, May 1951. (In French)

5

A form of wind turbine is described, using a 3-bladed propeller with a hollow helix. Various sizes have been made; two described are of 8·5 and 55 m respectively, the latter having a peripheral speed of 800 Km/h. For electrical drive, methods have been devised to maintain the speed constant at 750 r.p.m., but many drives are direct, such as for pumping, etc. One form comprises a d.c. generator which electrolyses water; the resulting hydrogen is used for driving other engines. The oxygen is sold for other purposes. Several such installations are in use and are claimed to give entire satisfaction.

30. Production of power by means of wind-driven generator. U.S. Congress House Interior Committee Hearing on H.R. 4286, 82nd Cong., 1st Session, September 19, 1951. Washington, D.C., U.S. Gov. Printing Off., 1951.

4

1950

1. Asta, A. The utilization of wind power. Ric. Sci. 20: 53-59, January/ February 1950.
Translation: Kanner Associates, Redwood City, California. N 74-21679. NTIS, April 1974. 14 p.

5

An investigation into a system comprising a d.c. generator coupled to the windmill, together with exciting machines, and connected to an a.c. network through a mercury-arc inverter. The connections of the exciters are arranged so that the curve of power against speed approximates to a cubic parabola. The blade-pitch is fixed and no speed-regulator is used. Test results are given.

2. Golding, E.W. Generacion de energia electrica en gran escala por la accion del viento. Revista Electrotecnica 36(6): 216-230, June 1950.

4

Large scale generation of electricity by wind power - preliminary report.

3. Haldane, T.G.N. and E.W. Golding. Recent developments in large-scale wind power generation in Great Britain. World Power Conference. 4th, London, 1950. Section K, Paper 1, 8 p.

3, 7

After a brief historical review of wind power in Great Britain, the reasons for the recent consideration of its possibilities as a means of generating electricity on a large scale are given; the high annual energy content of the winds in coastal districts of Scotland, Wales and southwest England is made clear. The establishment of a research committee to study these possibilites is described. The paper discusses the economics of utilizing wind-generated energy in an electricity supply network, and gives estimates of generating costs which might apply to such utilization. The influence of the choice of rated wind speed upon constructional costs and specific outputs at different sites is dealt with, and a practical example is given to emphasize the importance of this choice. Investigations being carried out by the wind power generation committee are described, as are the steps taken to obtain operating experience with pilot plants of 100kW capacity. Further developments envisaged, if the present investigations prove them to be justifiable, are outlined. An appendix gives some results already obtained in wind-velocity measurements at favourable sites, and also some estimates of the specific outputs which might be obtained under stated conditions of operation.

4. Lacroix, G. Electrical problems raised by the utilization of wind power. Bull. Soc. Franc. Elect. 10: 211-215, April 1950.
Transl: Elect. Res. Assoc. Transl. No. IB 1266.
13

5. London Science Museum. Science Library. The generation of electricity by wind power. SCIBI No. 329, December 14, 1950.
4, 16

Bibliography

6. Middleton,A. Harnessing Britain's gales. Comp. Air Mag. 55(3): 70-71, March 1950.
1, 4

Illustrated notes on ancient and modern windmills used in Great Britain.

7. Mogilnitskii, I.D. On the regulation of slow-running wind-power generators. Paper of the Lenin Academy of Argicultural Sciences, No. 5: 36-40, 1950.
Transl: Elect. Res. Assoc. Transl. No. IB 1064.
14

8. Peronaci, F. Determination of wind energy for the purpose of its utilization by wind machines. Annali di Geofisica 3(2): 223-230, April 1950. (In Italian.)
6

In order to install wind machines capable of generating electricity on a small scale the following wind data are required: the number of hours per year in which the wind velocity does not fall below a given strength, the frequency distribution of wind direction, and the intensity of squalls. The wind regime of several zones in Calabria is studied with reference to the possible installation of wind machines.

9. Power plant on stilts. Pop. Sci. 156: 157, April 1950.
7

The article describes a windmill design by P.H. Thomas for the Federal Power Commission of a 475 ft tower topped by two giant rotors, each 200 ft in diameter. These are mounted on a large turntable that also houses the generating equipment. Plans are based on experiments near Rutland, Vt. Batteries of these two-bladed, wind-powered generators, each with a 7,500 kW capacity, could be used to supplement conventional hydroelectric or coal system. The U.S. Bureau of Reclamation likes the idea for dry western areas short on water power.

10. Raghavan, V.R. and K.M. Sankaran. A note on electrical power from the wind. Govt. of India, Ministry of Works, Mines, and Power, Central Electricity Commission, Simla, July 1950.
6

11. Venters, J. The Orkney windmill and wind power in Scotland. Engineer 189: 106-108, January 27, 1950.
7

Describes the 100 kW windmill ordered by North of Scotland Hydro-Electric Board; considerations which led Hydro Board to embark on experiment, why windmill is being erected in Orkney, and why its rating is 100-kw; wind power as source of energy; estimate of accessible wind energy; practical aspects of problem.

12. Vezzani, R. Study of a project of a wind-power generating station of medium power driving a pumping station for hydraulic accumulation. Elettrotecnica 37(9): 398-419, September 1950.
Transl: Kanner Associates, Redwood City, California. N 74-15755/3GA. NTIS, February 1974.
8, 13

Describes air motor power plant to be erected on island of Giglio, Italy; slow speed orientable windmill designs are replaced by high speed air motors, protected and fixed in space; entire air motor is placed in tubular system similar to Venturi tube; operation of enclosed air motor may be regarded as similar to that of Kaplan turbine; diagram.

13. Windmill as a power plant in the Orkneys. Sci. Dig. 28: 76-77, August 1950.
7

14. Golding, E.W. Economical utilization of wind power. Elektrizitaetsverwertung 25: 235, 1950.
6

15. Sidorov, V.I., et al. Samoregulirijuscijsja vetrovigatel [D-18-GUSMP] Fast-moving, self-regulating wind turbine D-18-GUSMP. Masgiz, 1950. 182 p.
14

Handbook of the D-18-GUSMP machine.

16. Wind power production in Great Britain. Arch. Energiewirtsch, Sonderdienst. No. 239, 1950.
4

1950

17. Witte, H. Windkraftwerke. Possneck, Germany, R.A. Lang, 1950. 194 p. (In German) 2

18. Andreau, J. L'eolienne nouvelle formule n'a ni mecanisme ni engrenage. Science et vie: April 1950. 5

The inventor describes a wind turbine working on the "depression" principle.

19. Juul, J. Report on results attained with the experimental windmill of Sydstjaellands elektrizitets Aktieselskab (SEAS), Committee for Productivity and Applied Research (PRA), Working Party No. 2, OEEC, London, 1950. 4

1950

20. Borsuk, V.N. On the techniques of wind power calculations. Meteorol. Gidrolog. No. 3: 57-59, November 1950.
6

21. DeLong, H.H. Electric light and power systems for your home. Bulletin 402. Brookings, S.D., South Dakota State College, Agricultural Experiment Station, June 1950.
4, 8

22. Instruction pour la recherche des sites favorables à l'installation d'aérogénérateurs. Comité Technique de l'Energie des Vents, Paris, May 1950. (In French)
6

23. Power plants on stilts. Pop. Sci. 156: 157, April 1950.
4

24. Santorini, P. Memoire technique no. 45, dans Wind Power, présenté au Groupe de Travail de l'OECE pour l'énergie éolienne. Conférence sur le vent, Londres, 1950. (In French)
3, 4

25. Weinig, F. Aerodynamik der Luftschraube. Springer, Berlin, 1950. (In German)
2, 5

26. Windmill as a power plant in the Orkneys. Sci. Dig. 28: 76-7, August 1950.
4

1949

1. Andrianov, V.N. Stability of a synchronous generator driven by windpower and working on a power system. Elektrichestvo, No. 10: 26-32, October 1949.
Transl: Elect. Res. Assoc. Transl. No. IB 1015.

13, 14

The maximum wind speed compatible with stable operation of the generator is determined. The conditions to be satisfied by the regulating system of a wind power station with a synchronous generator are also found. Measures are indicated for ensuring the stability of the operation of the generator in a wind power station in a region with an annual average speed greater than or equal to 6 m/sec.

2. Batria, J. New designs of wind powered generators. Elektrotech. Obzor 38: 582-585, November 1949.
Transl: Elect. Res. Assoc. Transl. No. IB 1027.

4, 14

3. Carrer, A. Utilization of wind power with Ward-Leonard type circuit in inverted operation. Elettrotecnica 36: 383-385, August 1949.
Transl: Scientific Translation Service, Santa Barbara, California. N 74-15751/2. NTIS, February 1974.

13

An electric circuit is described comprising two direct current machines and one three-phase synchronous or an asychronous induction machine suitable for transforming and feeding the energy from the wind into a three-phase conventional electric power network.

4. Golding, E.W. Large-scale generation of electricity by wind power. Preliminary report. Elect. Res. Assoc. Tech. Rep. C/T101, 1949. 15 p.

7

Tests conducted on hills of suitable shape in Orkneys' gave mean wind speeds up to 15.1 mph in summer. Structure of wind on Costa Head investigated up to 66 ft. Other trials in progress in North Wales and Cornwall. It is concluded that several hundred sites could be found in Britain for economical wind-driven generators giving 3500-4000kWh/kW. More information required about flow of wind over hills.

5. Golding, E.W. and A.H. Stodhart. The potentialities of wind power for electricity generation (with special reference to small-scale operation). Elect. Res. Assoc. Tech. Rep. W/T16, 1949. 26 p.

4, 8

This report includes general considerations regarding wind statistics and the selection of data significant for aerodynamical studies. The relation between wind velocity and power available is analyzed in detail and data on available aerodynamic energy are presented for various British localities. The effects of contour, altitude and of changing wind direction or speed are considered.

6. Juul, J. Investigation of the possibilities of utilization of wind-power. Elektroteknikeren 45(20): 607-635, October 22, 1949. (In Danish.) Transl: Elect. Res. Assoc. Transl. No. IB 1025.

4

Climatic conditions of Denmark are briefly surveyed and results of a series of measurements on wind velocity at different points and at different heights are tabulated, with data on annual kWh generation obtainable with various types of wind motor. The velocity-meters and motors are described. Annual variation of kWh obtainable is shown in graphs. Aerodynamical characteristics of the motor types, air flow and wing shape are discussed. A series of wind-tunnel experiments, reported in detail, resulted in establishing the best wing cross-section for a motor. The application of wind motors to d.c. generation is only feasible on a small scale since variations in wind velocity make delicate regulation of the generator necessary. A scheme of application to 3-ph. generation is described and illustrated and the economics of wind-power utilization are discussed in detail, with special regard to local conditions.

7. Karmishin, A.V. Small power wind-electric generating units. Priroda (Nature) 11: 24-31, November 1949.

8

8. Kromann, C. and J. Juul. Investigation of the possibilities of using wind power. Elektroteknikeren 45: 711-714, December 1949. Transl: Kanner Associates, Redwood City, California. N 74-15760/3, NTIS, February 1974.

4, 6

Kromann's critique of several of Juul's articles in Elektroteknikeren and of Juul's riposte is reported. For example, Kromann argues that it should not be expected that wind tunnel experiments, necessary as these are for finding the best vane design, will yield the same results as real conditions. Juul counters that the same efficiency can be obtained in the open air as in a wind tunnel and that, in any case, this point will be investigated in greater detail in the near future. Kromann has misgivings about building windmills on the west coast of Jylland because he fears that the force of the wind there is too variable; Juul counters that wind force measurements show that this fear is unfounded (the corresponding curves are given).

1949

9. Lacroix, G. The energy of the wind. Technique Moderne 41(5-6): 77-83, March 1949.
Transl: Kanner Associates, Redwood City, California. N 74-15764/5GA, NTIS, February 1974.
4

The technical and economic problems involved in the use of wind engines as a source of power are discussed, with detailed descriptions of the operative principles behind several basic types.

10. Lacroix, G. Wind power, part 2 - economic feasibility, 1949. Technique Moderne 41(7-8): 1-5, April 1949.
Transl: Kanner Associates, Redwood City, California. N 74-17792/4GA, NTIS, March 1974. 23 p.
6

11. Seidel, G.R. Small wind-electrical installations for export. Elektrotechn. Z. 70(5): 158-160, May 1949.
Transl: Scientific Translation Service, Santa Barbara, California. N 74-15770/2. NTIS, February 1974.
12~~a~~b

The design and operational problems are reported that are associated with wind power generating plants similar to the American wind charger. The potential market for such devices is discussed.

12. Sektorov, V.R. Operating conditions and type of wind-power installations for rural districts. Elektrichestvo, No. 10: 33-37, October 1949.
Translation: Linguistic Systems Inc., Combridge, Massachusetts. N 74-26512. NTIS, May 1974. 17 p.
6

The efficiency of wind power stations working on a system supplied by power stations of other types is investigated, constant and variable wind motor speed neing considered. A method is given for determining the fraction of supply of rural districts that can be handled by wind stations. If the generator type is suitable for variable speeds, the use of wind motors without adjustable propellers is an economic proposition.

13. Sembera, F. Prospects for the utilization of wind energy in Czechoslovakia. Elektrotechnicky Obzor 38: 477-484, September 1949.
Translation: Kanner Associates, Redwood City, California. N 74-1576610. NTIS, February 1974.
6

Technical and economical conditions for the utilization of airstreams in Czechoslovakia are considered. The probable mean wind velocities in various districts of the country, their number and the probable daily and yearly charts at

various altitudes, the most windy districts, the possibilities and extent of utilizing the airstreams by power stations equipped with prime movers with a 50 m propeller diameter and a 30-35 m high tower are investigated and presented on the basis of many years of observation. It is determined that the power stations in Czechoslovakia should have a maximum output of 500 kW and a yearly production of about 700,000 the 800,000 kWh, so that 1000 such stations could replace the power plant in Ervenice. The probably cost per kWh generated in the wind power plant is calculated on the basis of the proposed estimate for the capital investment and economical results are evaluated based on this solution, which are not practical in the near future.

14. Taylor, C.C. Windmills for India. American News File, Agricultural Supplement, March 2, 1949.

6

15. Thomas, P.H. Aerodynamics of the wind turbine. U.S. Federal Power Commission, January 1949.

5

Treats the aerodynamics of the wind turbine in a manner suitable for the utility engineer. Companion volume to two other Federal Power Commission monographs by Thomas: "Wind power aerogenerator twin-wheel type", March 1946, and "Electric power from the wind", 1945.

16. Wind power research. Elec. Rev. 145: 1155-1156, December 16, 1949.

4

17. Wind-electric power. Electrician 143: 743-744, September 2, 1949.

4

18. Carrer, A. The DC generators for utilizing wind power. Elettrotecnica 36: 376-383, August 1949,
Translation: Scientific Translation Service, Santa Barbara, California. N 74-17789. NTIS, March 1974. 26 p.

14

Theoretical considerations are explained and experimental findings pertaining to the possibility of utilizing wind power with electromechanical units comprising various types of direct current machines.

1949

19. Hütter, U. Der Einfluss der Windhaufigkeit auf die Drehzahlbestimmung von Windkraftanlagen. Z. Elektrotech. 2: 10-15, 1949. 6

20. Thomas, P.H. Harnessing the wind for electric power. United Nations Scientific Conference on the Conservation and Utilization of Resources III, Fuel and Energy Resources. Proceedings, New York, Lake Success, 1949. 4

21. Thomas, P.H. Fitting wind power to the utility network. Washington, D.C., Federal Power Commission, 1949. 4

22. Windmill power generation plants. Elektrizitaetsverwertung 24(9): 1949. 4

1949

23. Abbott, I.H. and A.E. von Doenhoff. Theory of wing sections; including a summary of airfoil data. 1st ed., N.Y., McGraw-Hill, 1949. 603 p.
2, 5

24. Electricity generation by wind power. Engineering 168(4377): 647-648, December 16, 1949.
4

This is a review of two reports published by the Electrical Research Association.

25. Fardin, R. Wind power: its advantages and possibilities. United Nations Scientific Conference on the Conservation and Utilization of Resources, Proceedings. Lake Success, 1949, Vol. III, p. 322.
3, 4, 6

26. Preat, L. L'énergie éolienne. Revue des élèves des écoles spéciales. (Université Catholique, Louvain, Belgique), No. 2 (1949/50). (In French)
4

27. Report on the utilization of wind-power in the Netherlands. United Nations Scientific Conference on the Conservation and Utilization of Resources, Proceedings. Lake Success, 1949, Vol. III, p. 319.
3, 6

28. Stumpf, F. Energie aus der Luft. Nat. Tech. 3(6): 175-177, 1949. (In German)
4

1948

1. Ailleret, P. Investigation of sites suitable for the utilization of wind energy. La Meteorologie, Ser. 4, No. 10: 145-152, April-June, 1948. (In French.)
6

Graphs shows amount of energy available from wind power as a function of wind speed (force) and hours per year; various speeds were obtained at the Eiffel Tower (1901-1921). The strong winds (15 m/sec or over) and feeble winds (4 m/sec) are discounted as being unavailable for practical use with an aeromotor. Data from a station on Cape Bear is also shown graphically, and methods for choosing sites and stations for studying wind power are outlined.

2. Cisman, A. and N.V. Botan. Considerations on the possibility of utilizing wind energy in Roumania. Rev. Stiint. 34: 35-42, January-June 1948. (In Roumanian.)
6

Details of seasonal wind observations recorded throughout the Balkan countries are employed in a rather inconclusive attempt to determine such a possibility. Further necessary observations are being carried out.

3. Cisman, A. and N.V. Botan. Second preliminary report on the possibilities of utilizing wind energy in Roumania. Bull. Inst. Rech. Tech. Roumanie 3(1): 95-99, 1948. (In Roumanian.)
6

Continuing their study on the utilization of wind energy in Roumania, the authors here report wind speeds in 14 other localities and suggest that wind turbines might be installed in the Jumatatea, Dobrogea and Bucharest regions.

4. Doraiswamy, I.V. and S.K. Banerji. Wind data for windmills. India Meteorological Department, New Delhi, India. Scientific Notes VI(63): 1948.
6

5. Fateev, E.M. Wind mills and wind installations. Moscow, Gos. Izdat. Sel'skokhozialstvennoi Literatury, 1948. 543 p. (In Russian.)
2

This large text contains the basic aerodynamic theory and engineering details of wind power, wind machines (windmills) and wind utilization. Many nomograms and useful tables for wind energy computations as well as line drawings and simple photographs of various types of equipment are included, and applications to agriculture are stressed. The 17 chapters are divided into two sections: Pt. 1, windmills (theory, experimental basis, systems, ideal and actual wind forces, experimental windmills; construction in the field, regulation and efficiency). Part 2, wind power equipment (wind energy anemometry, characteristics of wind gustiness, profiles, accumulation of wind energy, wind pumps, windmills for grain, wind power stations (electric) and construction of wind stations.)

6. Hütter, U. The effect of wind fluctuations on the choice of speed for wind-power plants. Zeitschrift für Elektrotechnik 1: 117-122, 1948 and 2: 10-15, 1949.

6

7. Hütter, U. Influence of wind frequency on rotational speed adjustments of windmill generators. Z. Elektrotech. 1(6): 117-122, 1948. Transl: Linguistic Systems, Inc. Cambridge, Massachusetts. N 74-10948. NTIS, November 1973. 17 p.

5

In installing groups of windmill generators to produce electric power from the force of the wind, it is important to locate the units of such a network in such fashion that the so-called two-minute variation of the wind velocity can be overcome. This is done by using at least three windmill generators located an appropriate distance apart. When the wind velocity is insufficiently great to drive the blades of the windmills, a source of power should be available, (battery, power from other windmills) to keep the blades turning. Contrary to popular misconception, changing the angle of attack of the windmill blades does not improve the efficiency of their operation or increase the power of the windmill.

8. Linner, L. Parallel operation of a synchronous generator and an infinitely high-powered network when driven by a Honnef-Gross wind turbine. Elektrotech. Z. 69(9): 293-296, September 1948. Transl: Scientific Translation Service, Santa Barbara, California. N 74-15762/9. NTIS, February 1974.

13

An infinite high powered network is described as a network whose voltage is independent of the load states of the connected machines, and whose voltage amplitude and angular velocity is always the same. The three-phase generator operating in conjunction with this network must operate at a constant rotation rate, as must the wind wheel according to the number of its poles and the frequency of the network. The variation in the power output of a wind wheel is discussed for constant rotation rate as a function of wind velocity in order to evaluate the operational characteristics of a synchronous machine.

1948

9. Putnam, P.C. Power from the wind. Toronto, Van Nostrand, 1948. 224 p. 2

A complete book giving in 13 chapters the history and the scientific and technical results of the Smith-Putnam wind turbine Project of 1934-1935. The huge wind generator designed by the author and Thomas S. Knight was erected and operated on Grandpa's Knob, 12 miles west of Rutland, Vermont. The turbine generated 1200 kw and fed power into the network of central Vermont utilities whenever the wind was 17 mph or greater. This was the first time wind had been used to drive a synchronous generator feeding into a utility network. Costs were about equal to water or stream power generators.

10. Sidorov, V.I. Windpower generators in the Arctic. Moscow, Izdat. Glavsevmorputi, 1948. 2d ed. 182 p. (In Russian.) 8

A technical "manual" describing and giving details of construction and operation of wind power generators in the Arctic. Actual examples of their use and difficulties encountered under severe gale or ice conditions, and efficiency at a place like Cape Zhelania are given.

11. Vezzani, R. Experimental data on models of devices for accumulating wind energy in space. Elettrotecnica 35: 488-493, December 1948. Transl: Elect. Res. Assoc. Transl. No. IB 1046. 5

12. Wailes, R. Windmills in England. London, The Architectural Press, 1948 1

13. Gänger, B. Elastic power transmission for wind power generation. Z. Elektrotechn. 1: 59, 1948. 5

14. Kaspar, F. [Wind motors and wind electric power stations], Elektrotechnicky Svaz Seskoslovensky 1: Prague, Czechoslovakia, 1948. (In Czechoslovokian) 2

15. Loebl, O. Grossraum-Verbundwirtschaft [Wind power] Essen/Kettwig, Germany, West-Verlag, 1948. (In German) 7

Feasibility of wind power for large scale production of electricity is discussed.

1948

16. Pederson, M. 18 Millioner kWh ud af Luften, Oversight over Vindelectritetsproduktion fra 1940 til 1948 [18 million kilowatt-hours from air, a survey of wind-generated electricity production from 1940 to 1948]. Maaneds--Meddelsen, Denmark, March 1948. 6

Monthly summaries of electricity produced by wind generators in Denmark are presented for 1940-1947.

17. Prokofiev, V. An. Vetrodvigateli [Wind turbines] Chapter 6: Masinostroenje [Machine Construction] p. 207-252, 1948. 14

This is a chapter on wind turbine construction, with a bibliography, in a technical encyclopedia.

18. Bathe, G. Horizontal windmills, draft mills and similar airflow engines. Philadelphia, Allen, Lane and Scott, 1948. 81 p. 2

1948

19. Day, G.W.L. Britain's windmills point way to more electric power. Christ. Sci. Mon. Mag.: 24, September 11, 1948.

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20. Dory, B. Wind power for electrification of villages. Electrotechnika 40: 132-6, June 1948.

4, 8

21. Fateev, E.M. Les Moulins à vent. Institut Soviétique de Recherches Scientifiques sur la Méchanisation et l'Electrificatition de l'Agriculture. Moscow, 1948. (In French)

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22. Power from the wind. Engineering 166(4320): 469-470, November 12, 1948.

4

23. Progress in power generation--1940-46. An AIEE Committee Report. Electr. Eng. 67(1): 59-75, January 1948.

4, 6

Nuclear energy, gas turbines and wind turbines are discussed.

24. Watts from wind. Bus. Week: 50-1, November 24, 1948.

4

25. Wind powered turbine. Electr. Eng. 67(7): 1159, December 1948.

4

This is a brief summary of a paper by H. Honnef in Electrical Review, September 17, 1948.

26. Zlatovski, D. Vent et soleil, sources d'électricité. Etudes Soviétiques, 8. Paris, Rue de Prony, August 1948. (In French)

4

1947

1. Deparis, G. Generateur eolien d'energie electrique a axe vertical. Le Genie Civil, September 15, 1947.
9

2. Ganger, B. Elastic power transmission in wind power installations. H.V. Institute of Karlsruhe Technical High School, March 1947. 12 p. Transl: Elect. Res. Assoc. Transl. No. IB 1072.
14

3. Juuls, J. Application of wind power to rational generation of electricity. Elektroteknikeren 43: 137-148. August 7, 1947. Transl: Kanner Associates, Redwood City, California. N 75-15759. NTIS, February 1974.
4

   The history and development of windmills in Denmark and elsewhere is sketched. The costs and problems of generating electricity by stream water and wind power are compared. Pointing out that the wind is Denmark's only major natural source of power and dividing the application of wind power into an economic and a technological part, it is discussed how the Danish wind could be harnessed to supply power not only in the requisite amounts and at the lowest cost, but also under all circumstances, so as to make Denmark self-sufficient in the matter of energy.

4. Kleinhenz, F. Utilization of wind power by means of elevated wind power plants. Technik 2(12): 517-523, December 1947. Transl: Scientific Translation Service, Santa Barbara, California. N 73-23011. NTIS, May 1973. (NTIS has indexed incorrectly under Kelinhenz.)
6, 7

   Exploitation of wind power by power plants at high altitudes is considered. A design of a wind power plant is proposed and its efficiency and economy in the framework of present conditions in Germany is demonstrated. Although costs are higher than for a coal fired steam plant, they compare favorably with hydroelectric power plants and the saving of coal is a great advantage. The erection of an experimental plant is recommended.

5. Kloss, M. Problems in the electrical equipment of wind power plants. Technik 2: 471-479, November 1947. Transl: Kanner Associates, Redwood, California. N 74-15749. NTIS, February 1974.
14

   Problems encountered in electric installations of wind power plants are discussed. Difficulties involved necessitate close cooperation of aerodynamic and electrical engineer in implementing wind power plants for d-c and a-c currents. Examples of actual installations in

Germany are presented; a present task is erection of small wind power plants for farms.

6. Lanoy, H.M. Les aeromototeurs modernes. Paris, Gerardot and Cie, 1947. (In French.)

2

7. Mayer, H. The large scale wind driven electrical generating station. Technik 2(12): 527-528, December 1947.
Transl: Scientific Translation Service, Santa Barbara, California. N 74-15750/4. NTIS, February 1974.

7

Large wind power plants and their use to alleviate coal shortage in Germany are discussed. It is stipulated that there is no economic necessity for development of large scale wind power plants before possible improvements in steam power plants, such as combined heating and power plants, high pressure plants, etc. have been exhausted. A table gives comparison of costs and efficiency of wind and steam power plants.

8. Pantell, K. Ideas on the development of wind power machines. Technik 2(11): 480-482, November 1947. (In German.)

4

An introduction on the history of windmills and wind power machines ends with the application of aerodynamics to the form of the vanes. The present position is that rapidly revolving turbines have been developed for small pumping installations, limited to vane diameter of 12-15 m and larger machines up to 30 m diameter for generating electricity. The peculiarities of wind, namely wide and rapid variations of speed and direction and low average speed are considered. A table of performance of various types of blade systems shows that for a diameter of 10 m and a mean wind speed of 7 m/s, a 3 blade system with an edge speed 5 times wind speed gives the best results (8 kw). Future developments in the direction of blade systems of greater diameter are possible; including systems rotating on a horizontal axis, but author considers that probably future development is rather trains of blade systems of the most favorable diameter for the prevailing winds.

9. Serragli, G. Observations on modern wind-electric power plants. Elettrotecnica 34: 494-498, December 1947.
Transl: Kanner Associates, Redwood City, California. N 74-15745/4. NTIS, February 1974.

6

Development of the aeronautical type windmill design and the installation of wind-powered electricity plants is held feasible for Italy undergoing post-war reconstruction. It is possible to build from 200 to 300 small capacity power plants for a total output of 10,000 to 15,000 kW in areas of Italy which have the minimum necessary wind speed of 5.5 m/sec. Among the designs required for such wind electricity plants are windmill blades with variable pitch, automatic pitch control system which does not use the costly servomotor, and reversible wheels. These features enable a windmill of limited orientability to function with high efficiency. The effect of wind rose patterns, the surface area of the blade, and some possible local uses of the electricity produced by such plants are also discussed.

10. Skilton, C.P. British windmills and watermills. London, Collins, 1947.
1

11. Vezzani, R. The utilization of the wind energy. Elettrotecnica 34: 463-464, November 1947.
Transl: Scientific Translation Service, Santa Barbara, California. N 74-15769/4. NTIS, February 1974.
4

Wind energy exploitation by very large wind power generating stations is discussed. This system is compared to other types of power generation.

12. Witte, H. The position of wind power utilization. Technik 2(11): 465-470, November 1947. (In German.)
6

Shortage of coal in Germany makes use of wind power imperative. Available wind power is summarized in a chart of percentage frequency of winds (force 4-8) and frequency table of different wind speeds; with examples of gusts and squalls, and increase of wind speed with height above ground. Best loading conditions, represented by $(v^3/27)$ $(D^2\pi/4)$ are evaluated for different wind speeds (v) and diameter (D), and the useful work of small and large wind power installations calculated. Wind blades are classified and, finally, the economics of wind power are compared with those of water, coal, and oil.

13. König, G. Combined operation with coal, wind and water. Die Technik 2(12): 1947.
4

1947

14. Andreau, J. Utilisation de l'énergie du vent. Société des Agriculteurs de France. Les journées d'études sur l'utilisationd de la force motrice dans l'entreprise agricole, May 21-22, 1947, p. 48. (In French)

6

15. Brecher, R. and E. Brecher. Power from the wind. Sci. Illus. 2: 34-5+, January 1947.

4

16. Colomarino, R. Possibilità di utilizzazione dell'energia eolica mediante generatori a corrente alternata. XLVIII Riunione Annuale dell'A.E.I. Memoria No. 134, 1947. (In Italian)

3, 6

17. Glauert, H. The elements of airfoil and airscrew theory. Cambridge, Eng., Cambridge University Press, 1947. 232 p.

2, 5

18. Going with the wind. Newsweek 29: 62, February 24, 1947.

4

19. Kent, J.L. Can cities harness the wind? Pop. Mech. 87: 171-3+, February 1947.

4, 6

20. Vezzani, R. L'accumulazione dell'energia del vento nel tempo e nello spazio nelle grandi centrali aeroelettriche. XLVIII Riunione Annuale dell'A.E.I., Memoria No. 132, 1947. (In Italian)

3, 4

21. Vezzani, R. Le caratteri stiche costruttive dell grandi centrali aeroelettriche. XLVIII Riunione Annuale dell'A.E.I., Memoria No. 131, 1947. (In Italian)

3, 4

22. Vezzani, R. Nuove direttive e finalità per una razionale valutazione delle risorce soliche per forza motrice. Confronto con la statistica dell risorce i driche. XLVIII Riunione Annuale dell'A.E.I., Memoria No. 130, 1947. (In Italian)

3, 4

1946

1. Ailleret, P. Wind energy; its value and the choice of site for exploitation. Rev. Gen. Elec. 55: 103-108, March 1946. Transl: Kanner Associates, Redwood City, California. N 74-15734, NTIS, January 1974. 6

The problem of wind power utilization is discussed, including determination of wind power per square meter obtained yearly from surfaces subjected to wind action, and systematic prospecting for favorable sites using a simple anemometric device which calculates wind speed with the aid of a special electric meter. A description is given of a program for site selection which will make it possible to determine the energy which can be produced by the wind engines used.

2. Kloeffler, R.G. and E.L. Sitz. Electric energy from the wind. Kansas State College Bulletin XXX(9), September 1, 1946. 2

3. Kloeffler, R.G. and E.L. Sitz. Electric power from winds. Manhattan, Kansas, Kansas State College, 1946. 2

4. Thomas, P.H. The wind power aerogenerator twin-wheel type. U.S. Federal Power Commission, March 1946. 5

Presents results of a study conducted to determine the character of structures suitable for aerogenerators devoted to utility power supply and of analyzing the mechanical and aerodynamic problems involved. Companion volume to two other Federal Power Commission monographs by Thomas; "Electric power from the wind", 1945 and "Aerodynamics of the wind turbine", 1949.

5. U.S. War Production Board. Office of Production Research and Development. Final report on the wind turbine. Research conducted by New York University, College of Engineering, Engineering Research Division. Washington, 1946. (its. W.P.B. 144). 5

6. Congres du Vent. Proceedings of the wind-power conference held at Carcassonne, France, 1946. 163 p. (In French) 3

7. Betz, A. Windenergie und ihre Ausnutzung durch Windmuhlen [Wind energy and exploitation by windmills]. Gottingen, Germany, Vandenhoeck and Rupprecht, Publ., 1946. 2

1946

8. Carter, D. Putting the wind to work. Sci. Dig. 19: 31-4, February 1946.
4

9. Makowiecki, S. Technique aérodynamique du vent en tant que force motrice. Revue Dyna, May 1946. Revue de l'Association Nationale des Ingenieurs Industriels, Bilbao, Espagne. (In French)
5

10. New wind-power unit planned for Vermont. Electr. World 125(8): 7-8, February 23, 1946.
4

The project at Grandpa's Knob, Vermont, is briefly described.

11. New wind-power unit planned for Vermont. Power 90(4): 130, 162, April 1946.
4

12. Power sources. Mech. Eng. 68(7): 655-656, July 1946.
4, 6

This is a summary of an article by Edward Podolsy in Industry and Power, February 1946, on "Power Sources other than Atomic with Future Possibilities." Wind is discussed, with others.

13. Sidorov, V.I. Moteurs éolien dans l'Arctique. Direction des voies maritimes du nord de Moscou, Leningrad, 1946. (In French)
6

14. Wind-turbines seen cheap power source. Eng. News Rec. 137(6): 72, August 8, 1946.
4

This is a report on model studies by the Federal Power Commission of the most desirable erection procedure for building a 6500-kw aerogenerator mounted on a steel tower 475 feet high. Power will be developed by two 200-ft diameter impellers each with three fixed blades.

15. Winged wheel turns into power. Pop. Sci. 149: 114, November 1946.
4

1945

1. Kaspar, F. The asynchronous generator and its use in wind power stations. Elektrotech. Obzor 34(4): 60-63, 1945, and Elektrotech. Obzor 34(5-6): 81-89, 1945.

14

2. Thomas, P.~~E~~H. Electric power from the wind. U.S. Federal Power Commission, 1945.

4, 6, 7

Presented are the preliminary results of a survey undertaken by the Federal Power Commission to determine potentialities of wind as a source of energy. Included are data concerning the construction and operation of a 1000 kw wind turbine (Vermont). Companion volume to two other Federal Power Commission monography by Thomas: "The wind power aerogenerator twin-wheel type", 1946 and "Aerodynamics of the wind turbine", 1949.

3. Lo Surdo, A. The extraction of wind energy for purposes of its industrial utilization. Ricerca Scientifica e Ricostruzione 116, 1945.

7

1945

4. Basiaux-Defrance, P. L'energie du vent dans l'Aude. La Nature (Paris), No. 3099: 321-3, November 1, 1945. (In French)
6

This article discusses wind power in the Department of Aude, France, characteristics of wind power, and includes a brief description of its use in a section of Southern France where meteorological conditions are particularly favorable for exploitation of wind power.

5. Burne, E.L., J. Russel, and R. Wailes. Windmill sails. Paper read at a meeting of the Newcomen Society held in London on March 28, 1945. Summary in Engineering 160: 277-280, October 5, 1945.
1, 5

This article describes various kinds of sails used on windmills and includes pictures of many of them.

6. Cranston, M.M. Rhode Island windmills. Christ. Sci. Mon. Mag., September 22, 1945, p. 6.
1

7. Huge wind turbine is designed by F.P.C. Eng. News Rec. 134(22): 58, May 31, 1945.
4

Percy H. Thomas' design is described.

8. LeJay manual. Belle Plaine, Minn., LeJay Manufacturing Co., 1945.
2, 4

This vintage classic describes the processes of rewinding automotive generators for use in direct-drive wind machines and other applications. How to make arc welders, soldering irons, an electric scooter, electric fence, small wind generators, an insect-zapper, transformers and an armature-growler, all from salvaged materials, is described.

9. Putnam, P.C. Wind turbine power plant will be rebuilt. Power 89(6): 363-4, June 1945.
5

This paper describes what happened when one blade, 65 feet long and weighing 15,300 lbs., came off the wind turbine power plant atop a 110-ft structural steel tower at Grandpa's Knob, Vt. The performance of the turbine prior to the accident, causes of failure, and rebuilding are discussed.

1944

1. Mattioli, G.D. Theory and calculation of a wind turbine. Padua, October 1944.
Transl: Elect. Res. Assoc. Transl. No. IB 1381.
5

2. Kaspar, F. The synchronous generator of a large wind-power station in varying wind speed. Elecktrotchn. Obz. 33:145-151, 1944. 7

3. Stein, D.R. Neuartige Windkraftanlage zur Energieversorgung landwirtschaftlicher Betriebe. Reichsarbeitsgemeinschaft "Windkraft," Denkschrift 8: 1-15, 1944. (In German)
8

Rural applications of a wind electric generator are discussed.

1944

4. Scrase, F.J., et al. The errors of cup anemometers in fluctuating winds. J. Sci. Instr. 21: 160-161, 1944. 6

1943

1. Dieterich, G. Large wind power installations. Reichsarbeitsgemeinschaft "Windkraft", Denkschrift No. 6: 3-7, 1943. (In German.)

7, 12b

Dieterich sets out principles of construction of wind generators of over 5000 kw, designed to use winds of 8-20 m/s, at heights of over 200m.

2. Grenet, G. and A. Joset. Utilization of the energy of wind to supply electricity to mountain observatories. La Meteorologie: 194-200, 1943. (In French.)

8, 15

Characteristics of six types of wind generators are set out. At Puy-de-Dôme a helix of 1.80 m diameter gives 1 kw with a wind of 15 m/s, which suffices for ordinary purposes. Successful trials have been made at Contadour on Mt. Ventoux (1200 m) using a helix 1 m in diameter. Robust construction is essential and limits size.

3. Kleinhenz, F. The Kleinhenz large wind power installation. Reichsarbeitsgemeinschaft "Windkraft", Denkschrift No. 6: 7-18, 1943. (In German.)

7

Kleinhenz describes an installation of 20,000 kw, which can supplement power from coal and water.

4. Kleinhenz, F. Comparison of weight and cost of large wind power installation of different height for the same vane diameter. Reichsarbeitsgemeinschaft "Windkraft", Denkschrift No. 6: 19-29, 1943. (In German.)

7

Kleinhenz goes into cost of construction and maintenance. A tower of about 200 m is most economical to build (485 RM/kw) one of 250 m to run (3.25 Pf/kw-hr).

5. König, G. The automatic wind generator. Reichsarbeitsgemeinschaft "Windkraft", Denkschrift No. 6: 30-35, 1943. (In German.)

8

Konig describes and illustrates a small light 3 bladed installation suitable to the light winds of Bornim, which starts up in a wind of only 1 m/s.

6. Op de Hipt, H. Comparison of working of three wind vanes. Reichsarbeitsgemeinschaft "Windkraft", Denkschrift No. 6: 36-39, 1943. (In German.)

5

Op de Hipt compares the mechanics of wind vanes: a) straight b) wedge shaped and c) Odeh vane with staggered surfaces compensated for turning moment of the blades. The latter has less side pressure and is therefore less liable to damage.

7. Rogge, E. and D. Stein. New wind power station. Elektrizitaetswirtschaft 42(14): 358-363, November 5, 1943.
Transl: Kanner Associates, Redwood City, California. N 74-15767/8, NTIS, February 1974.
7

A wind power plant is described which was used during the fuel shortage that occurred in World War II. Unlike ordinary wind power plants which produced usable power only at wind velocities above 4 or 5 m/s, this power plant was designed to operate over a wide range, charging its battery at low wind speeds, delivering usable power from generator and discharging battery at intermediate speeds, and delivering power and charging its batteries at high wind speeds. The result was exploitation of the wind for a larger number of hours per year and lower costs per kWh of output.

8. Utilization of wind energy in Denmark. Tech. Mod. 35(13-14): 106-109. July 1-15, 1943.
Translation: Scientific Translation Service, Santa Barbara, California. N 74-31535. NTIS, September 1974. 16 p.
6

Use of wind energy in Denmark during World Wars 1 and 2 is reviewed. It presents statistical data on other energy sources and compares costs of all types of energy. Some technical discussion of the Lykkegaard 5.5 m diameter and F.L.S. 17.5 m diameter mills is given.

9. Kleinhenz, F. Weight and cost comparison for large wind power plants of different heights for the same wheel diameter. Stahlbau No. 17/18:1943.
6

10. König, G. Der Windstromautomat 5 bis 7.5 kw in Bornim-Potsdam. Reichsarbeitsgemeinschaft "Windkraft," Denkschrift 6: 7-18, 1943.
5

11. Voaden, G.H, The Smith-Putnam wind turbine. Turbine Topics: June 1943.
14

1943

12. Einsatz von Windkraft in den Ostgebieten. Reichsarbeitsgemeindschaft "Windkraft," Berlin, Denkschrift 4, 1943, p. 36-44. Abstract, p. 44. (In German)
6

13. Just, W. Windmotor mit vertikaler Achse bei Auftriebsausnutzung. Reichsarbeitsgemeindschaft "Windkraft," Berling, Denkschrift 7, July 12, 1943. (In German)
9

14. Monney, C.R. Le problème des aéromoteurs. Son importance économique en France. Principes concernant l'étude et l'emploi des aéromoteurs. Soc. Ing. Civ. Fr. Bull. No. 1/2, 1943. (In French)
4, 6

15. Stein, D. Windkraftanlagen in Dänemark. Reichsarbeitsgemeindschaft "Windkraft," Berlin, Denkschrift 4: 1-35, 1943. (In German)
6

16. Ueber die Arbeiten der Reichsarbeitsgemeindschaft "Windkraft" im Geschäftsjahr, 1942-1943. Berlin, Denkschrift 7, 1943, p. 3-10. (In German)
4

17. Wall, T.F. Large wind-driven synchronous generators. Engineering 155(4037): 421-423, May 28, 1943.
6

    Data related to wind currents, economics of wind power installations and problems of construction are discussed.

18. Wall, T.F. Large wind-driven synchronous generators. Engineering 155(4039): 461-3, June 11, 1943.
14

    The running of synchronous 3-phase generators and an investigation applied to the consideration of design data prepared by Maschinenfabrik Augsburg-Nurnburg in cooperation with the Mannheim firm of Brown, Boveri are covered.

19. Wall, T.F. Large wind-driven synchronous generators. Engineering 155(4041): 501-3, June 25, 1943.
14

    Wind driven asynchronous generators are compared with synchronous generators.

1942

1. Bilau, K. Die Windausnuizung für die Krafterzeugung, P. Parey, 1942. 35 p.

4

2. Eredia, F. The Italian problem of wind utilization. Soc. Meteorol. Ital., Bull. No. 4, 1942. 11 p.

6

The principles of obtaining electrical energy from wind motors are set out and the cost per kw-hr estimated; in Italy it compares favorably with coal-driven motors.

3. Friedrich, A. Wind power in the large-scale European economy. Reichsarbeitsgemeinschaft "Windkraft", Denkschrift, No. 5: 11-38, October 1, 1942. (In German.)

4, 6

Friedrich sets out the great power needs of the world and especially of "Greater Germany", which double every 10 years. He then sets out the possibilities and limitations of wind power, depending on location, season, time of day, height above ground and diameter. General descriptions are given of economics of small, medium and large installations and evaluation of the possible part of wind power in Europe. The work ends with some useful tables.

4. Hütter, U. Contribution to the creation of basic design concepts for wind power plants. Ph.D. thesis. Technische Hochschule, Vienna, May 1942. Translation: Kanner Associates, Redwood City, California. N 74-32469/0GA. NTIS, July 1974. 97 p.

4

5. Kloss, M. The direct drive of synchro-generators by large wind power machines in parallel with a timing connection. Reichsarbeitsgemeinschaft "Windkraft", Denkschrift, No. 5: 39-58, October 1, 1942. (In German.)

7

Kloss goes into the technical problems of synchronized versus non-synchronized generators.

6. Kloss, M. The direct driving of synchronous generators by large scale wind electrical power generating plants in parallel operation with a synchronizing network. Part 1. Elektrotech. Z. 63: 362-367, August 13, 1942.
Transl: Scientific Translation Service, Santa Barbara, California. N 74-15757/9. NTIS, February 1974.

7, 13

The damped eigen oscillation of a synchronous generator connected with a fixed network is investigated. It is assumed that the generator is driven by a wind propeller wheel. The influence of the variation of the characteristic of the propeller wheel on the variation of the transient oscillatory behavior is investigated. First the wind velocity increase occurs suddenly and then in a continuous fashion. The power control measures including propeller pitch displacement are investigated for preventing overloads on the generator. The danger of resonance is pointed out. This depends on the number of propellers. The question is discussed of whether it is better to use an asynchronous generator instead of a synchronous generator.

7. Kloss, M. Using large wind power plants to directly drive synchronous generators in parallel operation with a governing network. Elektrotech. Z. 63: 388-392, August 27, 1942.
Transl: Kanner Associates, Redwood City, California. N 74-15765/2. NTIS, February 1974.

7, 13

Various aspects of wind powered synchronous generators are described. The influence of the fan wheel characteristic on damping of transients is slight. Altering vane position is the only feasible method for regulating power in order to avoid overloading the generator. In designing the fan wheel, and choosing the number of vanes, the operating behavior of the generator and the danger of resonance must be considered ahead of efficiency. Practical operating characteristics of the fan wheel must be known to the electrical engineer if he is to calculate the course of events during a transient.

8. Schieber, W. Energiequelle Windkraft. Berlin, G. von Bodenhausen/ Bonnhausen Verlag,1942.

4

9. Stein, D. Air power plants in Russia and the United States. Bull Assoc. Suiss Electriciens 33(1): 17-18, 1942. Elektrizitaetswirtsch 40(16): 1941).
Transl: Kanner Associates, Redwood City, California N 74-15761. NTIS, February 1974.

4, 15

Various types of wind power plants in the USSR and in the USA are discussed. The VIME D-12 in Crimea, a large power plant, is described. Uses mentioned for the USA are running farm machinery, protecting pipes from corrosion due to leakage currents, and supplying power to amplifiers for telephone wires.

1942

10. Stein, D. The importance of and progress in the utilization of wind power in Denmark. Elektrizitaetswirtschaft 41(15): 346-349, August 5, 1942.
Transl: Kanner Associates, Redwood City, California. N 74-15758/7. NTIS, February 1974.
7

Denmark was one of the first countries to turn its attention to generating electric energy from wind power, because it has to import all oil and coal it uses, and it has virtually no hydroelectric power. A large number of wind power stations were built in the early years of World War 1 when fuel was scare. The total production of wind power was estimated at approximately 1.8 million kWh in 1941. The installation of wind power stations was generally considered to be a temporary measure.

11. Stein, D. Importance and progress of wind power utilization in Denmark. Elektrizitaetswirtschaft 41(16): 370-374, August 20, 1942.
Transl: Scientific Translation Service, Santa Barbara, California. N 74-15754/6. NTIS, February 1974.
7

The designs of various wind power plants in Denmark are discussed. Price lists for the plants are given along with prices for direct current generators for wind power plants.

12. Stein, D. Importance and progress of wind power utilization in Denmark. Elektrizitaetswirtschaft 41(17): 390-392, September 5, 1942.
Transl: Scientific Translation Service, Santa Barbara, California. N 74-15746/2. NTIS, February 1974.
7

Experience derived in operating wind power systems in Denmark is described. A study is made of the efficiency of the Danish power plants.

13. Kleinhenz, F. Large wind power plant project. Bauingenieur No. 23/24: 1942.
7

14. The problem of wind utilization in Italy. Rev. Meteorol. 4(1): 1942.
6

15. Körfer, C. and D.R. Stein. The significance of wind power to the production of electricity. Elektrizitatsverwertung 17: 193-197, 1942/43.
4

1942

16. Lush, C.K. Flying bird windmill. Ind. Arts Voc. Ed. 31: 255-6, June 1942.

4

17. Miller, A. Holland puts its windmills back to work. Travel 78: 18-19+, January 1942.

4

18. Noetzlin, U. Die strömungstechischen Grundlagen der Windkraftmaschinen. 2. Aufl. Berlin, Reichsarbeitsgemeindschaft "Windkraft," Denkschrift 2: 28, 1942. (In German)

5

19. Ueber die Arbeiten der Rechsarbeitsgemeindschaft "Windkraft" in Geschäftsjahr 1941-1942, Berlin, Denkschrift 5, 1942, p. 3-10. (In German)

4

20. Wind-power plant continues operation. Power Plant Eng. 46(10): 78-79, October 1942.

4

A 1000 kw wind-power plant at Grandpa's Knob, Vermont, in operation since October 1941, has been considered generally satisfactory by the engineers of the project. Preliminary experience points to the probability of obtaining power from the unit at least 50% of the time, with full rated output available about 25% of the time.

21. Wind-power plant operations going on. (Abstract) Franklin Inst. J. 234(3): 308, September 1942.

4

This is a brief summary of an article in Electrical World, Vol. 118, No. 6, about the Grandpa's Knob project.

1941

1. Meyer, G.W. Progress in the utilization of wind power. Elektrizitaets-verwertung 16(6/7): 109-113, September-October, 1941/1942. Translation: Kanner Associates, Redwood City, California. N 74-15753/8. NTIS, February 1974.

4

Wind power continues to be of interest as a source of energy for isolated locations. In order to distribute the capital costs over many service hours, the wind motors should be able to exploit low wind speeds. Low speed wind motors can be used only for driving slow machinery. High speed wind motors to drive small dynamos are now available which are self starting at low wind speeds. Large scale wind power stations have not yet passed the experimental stage.

2. Shenfer, K.I. and A. Ivanov. Lines of development of rural wind-power plants. Elektrichestvo, No. 5: 21-22, May 1941.
Translation: Elect. Res. Assoc. Transl. No. IB 703.
Techtran Corp, Glen Burnie, Maryland. N 74-20701. NTIS, May 1974. 7 p.

8

3. Stein, D. Utilization of wind power in agriculture in the USSR. Elektrizitaetswirtschaft 40(4): 54-56, February 5, 1941. Translation: Kanner Associates, Redwood City, California. N 74-15752/0. NTIS, February 1974.

8

Wind motors are being used in Russian agriculture for milling and pumping water. Plans call for rapid expansion of the utilization of such power plants. The extent of present utilization, problems, and forecasts are outlined.

4. Stein, D. R. Advances in the utilization of wind power for generating electricity. Elektrizitatswirtschaft 40: 268-271,1941.

4

Small wind generatorplans.

5. Fasching, L. Whirlwind.1 Mech. Illus., April 1941. p. 102-103 4

6. Fleischmann, A. Die Ausnutzung der Windkraft, Bericht Nr. 4 der Ventimotor GmbH. [Exploitation of wind force. Report No. 4 of the Ventimotor GmbH.] Weimar, Germany, p. 15-20, 1941. (In German) 4

7. Meyer, G.W. Utilization of wind power. Elektrotech. u. Masch. Bau., No. 27, 1941. 6

8. Mørch, O.V. Modern wind power plants. Ingeniøren No. 40: 1941. 4

9. Revessi, G. Wind and self-sufficiency. L'Elettrotecnica 6, 1941. 4

10. Stein, D.R. Air power plants in Russia and the United States. Elektrizitaetswirtsch 40(16): 1941. 4

Wind power plants in both countries are discussed.

1941

11. Big windmill; great experiment on Grandpa's Knob, Vermont. Fortune 24: 84-5, November 1941.
4

12. Harnessing the wind; Vermont's mountain winds harnessed to generate electricity. Time 38: 50, September 8, 1941.
4

13. Kleimann, W. Für und wider Windmühlen. Reichsarbeitsgemeindschaft "Windkraft," Berlin, Denkschrift 3: 29-46, 1941. (In German)
4

14. Lykkegaard, H. Winden og dens uduyttelee. Maaneds-Meddelslse, Copenhagen, Denmark, March 1941. (In Danish)
4

15. Mountain-top windmill to feed Vermont electric lines. Pop. Sci. 139: 114-17, July 1941.
4

16. The Smith-Putnam 100 kW wind-turbine. Mech. Eng. 63(6): 473-4, June 1941.
4

17. Ueber die Arbeiten der Reichsarbeitsgemeindschaft "Windkraft" im Geschäftsjahr 1940-1941, Berlin, Denkschrift 3 : 51, 1941. (In German)
4

18. Wind-electric plant to operate soon. Power 85(5): 87, May 1941.
4

The Grandpa's Knob wind-driven electric-power generating plant is described. Photos of the blades are included.

19. Windmill on a Vermont mountain top. Bus. Week: 22, May 10, 1941.
4

20. World's largest wind-turbine plant nears completion. Power 86(6): 56-9, June 1941.
4

1940

1. Vanheys, J.W. Utilization of wind power. Elektrotech.Z. 64(34): 787-790, August 22, 1940.
Translation: Techtran Corp., Glen Burnie, Maryland. N 74-15756/1. NTIS, February 1974.
4

The possible power of wind in a wind turbine is determined. From available wind measurements the wind frequency line is plotted to provide the basis for the design of a wind turbine. Favorable results are not obtained if work is continued on the previous principle of mill construction. There are only two ways of achieving adequate power: enlarging the circumference described by the vane and utilizing higher wind velocities. The latter are present at an altitude of about 200 meters above the ground. Satisfactory performance is attained with a vane length of 60 meters. Thus is is recommended that tests running at least one year be instituted with these dimensions.

2. Shenfer, K.I. and A. Ivanov. DC generator for Kolkhoz wind powered generators. Elektrichestvo (USSR) 61: 14-16, 1940.
Translation: Linguistic Systems, Inc., Cambridge, Massachusetts. N 74-17786. NTIS, March 1974. 11 p.
14

The use of carborundum-graphite resistors to control the voltage output from small wind-powered generators is described. Experiments were performed for devising methods of regulating dc generators to supply constant voltage, and a new type of nonlinear resistor was developed for use as a regulator.

3. Fateev, E.M. The role of wind-powered motors in cattle raising. Vestnik Sel'skokhozaistvennoy Nauki--Mekhanizatsiya i Elektrifikatsiya. No. 1: 1940.
8

4. Fateev, E.M. Mechanization of cattle raising on the basis of the TV-8 wind motor. Mekhanizatsiya i Elektrifikatsiya Sel'skogo Kozaistva No. 8/9: 1940.
8

1940

5. Ueber die Arbeiten der Reichsarbeitsgemeindschaft "Windkraft" im Geschäftsjahr 1939-1940, Berlin, Denkschrift 1 : 15, 1940. (In German)

4

1939

1. Krasovskiy, N.V. Project of wind motor with aerodynamic transmission for capacities of 100 kW to 3000 kW. Izv. Otd. Tekh. Nauk., Akad. Nauk SSSR, No. 5: 65-77, 1939.
Transl: Kanner Associates, Redwood City, California. N 73-30976. NTIS, September 1973. 21 p.

5, 7

To reduce excessive weight requirements in the design of a 100-3000 kW capacity wind motor, aerodynamic transmission is employed. Aerodynamic transmission involves mounting secondary small windmills at the ends of the main wheel blades of the wind motor. The secondary small windmills operate in a high-velocity relative stream of 40-70 m/sec and can produce energy directly from the wind with the windmills turning at 500 or more rpm. with an efficiency of 80 per cent or higher.

2. Shekhovtsev, N. Wind energy utilization in the far North. Sovetskaia Arktika No. 10: 75-77, 1939.

4, 8

Description and illustrations of wind generator such as is used in Soviet Arctic regions (to save fuel oil) for a great number of purposes. Installations were made on Dickson Island, at Cape Zhelaniia, Belyi Island and other polar stations, and had been in operation 2-4 years. An estimate is made of the amount of energy (in thermal units) obtained in 24 hours from one of the D-12 type wind generators.

3. Honnef, H. High wind power plants. Elektrotech. Maschinenbau (Berlin) 57(41 & 42): 501-506, October 1939.
Translation: Scientific Translation Service, Santa Barbara, California. N 74-19709. NTIS, April 1974. 19 p.

6, 14

In comparison to the usual power plants in which the machines are installed in special buildings, the high wind power plant is described as a power source in which the structure as a whole makes up the machine. New large structures are supports for generators with large diameters but with the other dimensions small. The use of the advantageous high wind flow leads to unusually high structures, but these are completely storm safe and stable, as well as economical. Details of the counter-rotating turbine and some experimental results are presented.

1939

4. Martini, C. The measurement of large wind energy generators. Electrotech. Maschinenbau 57(7/8): 83-89, February 17, 1939.
Translation: Techtran Corp., Glen Burnie, Maryland. N 74-22703. NTIS, May 1974. 16 p.
14

The weight comparison of energy generators according to the Honnef System is represented in curves wherein the weight is plotted as a function of three variables: the number of poles, air induction, and diameter.

5. Ackeret, J. and C. Caille. Investigations on a wind power plant model. Schweizer Bauzeitung 114(4): 1939.
5

1939

6. New schemes for harnessing the winds. Pop. Sci. 135: 100-1, August 1939.
4

1938

1. Witte, H. Economy and practical applications of large wind-driven power plants, Part 1. Elektrotech. Z. 59(51): 1373-1376, December 22, 1938. Transl: Scientific Translation Service, Santa Barbara, California. N 74-15741/3. NTIS, February 1974.
6, 7, 14

    The question of the economy of large scale wind electrical generating stations is investigated based on present findings. By exploiting wind energy for producing electrical power, large amounts of coal could be made available for other uses, and would also ease our foreign currency situation. The practical aspects of large scale wind electrical power generating plants are discussed. The construction of a ring generator is described.

2. Witte, H. The economy and practicality of large scale wind generation stations (Conclusion). Elcktrotech. Z. 59(52): 1404-1407, December 1938. Translation: Scientific Translation Service, Santa Barbara, California. N74-16802. NTIS, February 1974. 15 p.
6, 7, 14

    Discusses the design and operational problems of wind power generating stations. Wind power generating stations are found to be economical for operation in conjunction with existing generating stations. Very large ring generator stations are described.

3. Lock, C.N.H. A graphic method of calculating the performance of an airscrew. Aeronautical Research Committee, 1938.
5

1938

4. Electric plants offer power to everyone. Pop. Mech. 69: 850-2+, June 1938.
4

5. Ford, K. Wind driven generator. Pop. Sci. Mo. 133(2): 62-63, 93, August 1938.
12a

The author built a wind driven generator from a used automobile generator for supplying electric current to his summer home. Directions and diagrams for building the generator are supplied.

6. Hawthorn, F.W. Farm experience with wind electric plants. Agric. Eng. 19: 7-8, January 1938.
4, 8

7. Lubinski, K. Language of the mills; for generations the people of the Netherlands have read the news from the sails. Christ. Sci. Mon. Mag.: 6, September 7, 1938.
4

8. Van Vlissingen, A. Riches from the wind; how the Albers brothers started a brand-new industry. Pop. Sci. 132: 54-5+, May 1938. Abridged in Read. Dig. 32: 100-2, June 1938.
4

9. Windmill power on the phone line. Sci. Am. 158: 358, June 1938.
8, 15

1937

1. Benson, A. Plans for the construction of a small wind electrical plant. Okla. State Univ. Eng. Exp. Station Publ. 33, June 1937.
8

2. The design of high speed windmills suitable for driving electrical generators. Report No. PAA-32. National Res. Lab, Ottawa, 1937.
5

3. Golding, E.W. Electrification of agricultural and rural districts. English Universities Press, London. 1937.
2, 8

4. Sauer, T. Wind power plants in Russia. Ver. Deut. Ing. Z. 81(32): 947-948, August 7, 1937.
Transl: Kanner Associates, Redwood City, California. N 74-15743/9. NTIS, February 1974.
7

Several measures relative to wind power plants have been taken by the Soviet government, and are outlined. The large Balaklava wind power plant is described briefly. The wind power experimental facility in Moscow is illustrated in a diagram and its operation discussed in some detail.

5. Cordell, F.G. and N. Thomsan. Improved wind motor. Australian Patent 103,671, May 4, 1937.
14, 17

1937

6. Carter, B.C. Airscrew blade vibration. 619th Lecture of the Royal Aeronautical Society, March 11, 1937. 5

7. Morris, J. Airscrew blade vibration. Aeronautical Research Committee, Reports and Memoranda No. 1835, June 9, 1937. 5

8. Windmills come back as protectors of pipeline networks from corrosion. Sci. Am. 156: 344, May 1937. 15

9. Windmills return to keep pipelines from corrosion. Sci. Newsl. 31: 169, March 13, 1937. 15

10. Zhukovskiy, N.E. Vetryanaya mel'nitsa NEZh. Polnoye sobraniye sochineniy N.E. Zhukovskogo. [The NEZh windmill. Complete Collection of N.E. Zhukovskiy's Works.] Vol. VI, 1937. (In Russian) 4

1936

1. Benson, A. Wind electric power for small Oklahoma farms. Okla. State Univ. Eng. Exper. Station Publ. No. 29. March, 1936. 8

2. Grinault, C. The wind as white coal, producer of energy. La Science et la Vie, May 1936. 4

3. Krasovskiy, N.V. Wind energy-producing resources of the USSR and prospects for their utilization. Atlas Energoresursov SSSR 1. Moscow, Russia, Energoizdat Publications, 1936. 6

4. McColly, H.F. and F. Buck. Homemade six-volt wind-electric plants. North Dakota State University, 1936. 8, 12a

1936

5. Egloff, G. Modern energy supplies. Sci. Mo. 42: 296-7, April 1936. 4

6. Turnbull, W.J. Yacht-race windmill. Pop. Sci. 129: 94, October 1936. 4

1935

1. Glauert, H. Windmills and fans. In: Durand, W.F., Ed. Aerodynamic theory IV: 324-341. Berlin, Julius Springer, 1935. 5

   This chapter discusses types of windmills, the ideal windmill, windmill characteristics, the lifting windmill, the windmill anemometer, and fans.

2. Havinga, A. Experiments with a model of a scoop wheel. Koninklijk Institute van Ingenieurs, the Hague, 1935. (In Dutch.) 5

3. Stalker, E.A. The extraction of energy from the wind. J. Aeronaut. Sci. 2: 162-167, 1935. 4

4. Iyer, V.D. Wind data for windmills. Ind. Met. Dep. Sci. Notes VI: 63, 1935. 6

1935

5. Cape Cod objects to losing its roving landmark, America's oldest windmill. Newsweek 6: 13, November 23, 1935. 1

6. Exit: Spain's windmills. Christ. Sci. Mon. Mag.: 19, November 6, 1935. 4

7. Metz, A.W. Dutch windmill; diagrams. Ind. Arts Voc. Ed. 24: 276-7, September 1935. 4

1934

1. Sektorov, V. R. The first aerodynamic three-phase electric power plant in Balaklava. L'Elettrotecnica 21(23-24): 538-542, August 1934. Translation: Scientific Translation Service, Santa Barbara, California. N 73-24268. NTIS, June 1973. 13 p. 7

   The assembly and functional characteristics of an experimental 100 kW power plant built in Crimea are described. The operating data obtained during the first two years of operation are reported.

2. Gunn, R. Constant speed air motor. U.S. Patent No. 1,954,811, April 17, 1934. 14, 17

3. Madaras rotor power plant. Sci. Amer. 150(2): 146, 1934. 7

4. Sektorov, V.R. 100 kw from Russian winds. Elect. World: April 14, 1934. 7

5. Volf, . Cyclone wind mill. Sci. Mechan. 5(9): 550, October 1934. 5

6. Spinning towers produce electric current from wind. Pop. Sci. Mo. 124: 18, January, 1934. 7

1933

4. Champly, R. Les moteurs à vent. Paris, Dunod, 1933. 270 p. (In French) 2, 4

5. Harnessing the winds with rotating towers; Madaras rotor power plant, Burlington, N.J. Lit. Dig. 116: 17, December 30, 1933. 4

6. Wind rotor experiments "decidedly satisfactory." Electr. World 102: 548, October 28, 1933. 4, 6

    Results of an experimental wind power plant project at West Burlington, N. J.,are briefly reported.

1932

1. Madaras, J.D. Big electric plant run by wind. Pop. Sci. Mo. 120: 37 and cover, 1932. 7

2. Ackerman, J. Industrial production of electric power from the winds. Minn. Technol. 12: 90-91, 98, 1932. 7

3. Madaras, J.D. Wind-driven electric power plant on wheels. Pop. Mechan. 57: 50-51, 1932. 7, 14

4. Smith, D. English windmills. Vol. II, London, Architectural Press, 1932. 1, 2

1932

5. Freeman, H. Wind-driven power plants you can build. Pop. Mech. 57: 1043-5, June 1932.
4, 12a

6. Honnef, H. Windkraftwerke. Braunschweig, F. Vieweg, 1932. 111 p. (In German)
2

7. Metral, A. Origine, nature et utilisation des forces éoliennes. Sci. Ind. 6(218): 99-108, March 1932. (In French)
5, 6

After having characterized main air currents this paper defines, in accordance with recent researches, the internal structure of winds. A mathematical theory on air displacements based on the work of Fortant is suggested. Conditions under which wind power can be utilized and wind motors and their theory are also discussed.

8. New kind of windmill. Lit. Dig. 114: 16, September 10, 1932.
4

9. Skyscraper windmills to harness air for power. Pop. Sci. 120: 21, June 1932.
4

10. Vetchinkin, V.P. Principles of wind utilization elaborated by A.G. Ufimtsev. Proceedings of the First All-Union Conference on Aerodynamics, Moscow, 1932.
3, 5

1931

1. Bach, G. Investigation concerning Savonius rotors and related turbo-machines. Forschung auf dem Gebiete des Ingenieurwesens, Vol. 6: 218-231, June 1931.
Transl: Ward, G.T. Brace Res. Inst. Publ. No. T.41. 9

Describes experimental investigations of Savonius and similar rotors, with special regard to efficiency, torque lift and resistance of different types; investigations of flow conditions; measurements of pressure inside of rotor of axis; applications.

2. Hopkins, R.T. and S. Freese. In search of English windmills. London, C. Palmer, 1931. 1

3. Hopkins, R.T. Old Windmills of England. New York, William Farquhar Payson, 1931. 1

4. Savonius, S.J. The S-rotor and its applications. Mechanical Eng. 53(5): 333-338, May 1931. 9

Bi-vane power wheel of S-shaped cross-section working in wind or water, and its application in pumping, electric-current generation, and ventilation, and as current and wave motor where moderate amounts of power are required.

5. Madaras, J.D. Wind engine. U.S. Patent 1,791,731, February 1931. 14, 17

6. Serragli, G. A unique regulation system for the pitch of airscrews. Aerotecnica, March 1931. 5

7. Siwag Propeller-Rotorenbau G.m.b.M. A device for extracting power from flowing media. British Patent 337,899, July 28, 1931. 12b

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8. Bach, G. Investigation on Savonius rotors and related fluid flow engines. Forsch. Geb. Ingenieurw. 2(5): 218-231, 1931. Translation: C.A. Henkel. NTIS, SAND-74-6018, 1974.

9

9. Hopkins, R.T. Old windmills of England. New York, William Farquhar Payson, 1931. 245 p.

1, 2

10. Hopkins, R.T. Windmills. Haywards Heath, Sussex, C. Clarke, 1931. 25 p.

1, 2

11. Six large light and power companies back experimental wind rotor plant. Electr. World 98: 574, October 3, 1931.

4, 6

This news article describes an experimental wind power project planned for West Burlington, N.J.

1930

1. Dutch windmills; photographs. School Arts M. 29: 340-1, February 1930.
1

2. Hopkins, R.T. Old watermills and windmills. London, P. Allan & Co., Ltd., 1930. 245 p.
1, 2

3. Hughes, A.F. Windmills in Sussex. London, Walker's Galleries, Ltd., 1930.
1, 2

4. Sektorov, V.R. Die Arbeiten des Z.A.H.I. auf dem Gebiete der Aushutzung der Windenergie in der U.d.S.S.R. Rapport No. 307 à la 2ème Conférence Mondiale de l'Energie, 1930. (In German)
3, 6

5. Wailes, R. Windmills of old times which we should appreciate and help to preserve. House and Gard. 57: 88-9, June 1930.
1

1929

1. Aerodynamic windmills. Sci. Am. 140: 525, June 1929. 5

2. Old favorites in new forms. Pop. Mech. 52: 663-4, October 1929. 4

3. Savonius, S.J. Rotor motor drives pump. Mod. Mech. Invent. 1(10): 78, March 1929. 8

4. Serragli, G. Studies on the deployment of the self-rotating airscrew. Aerotecnica, June 1929. 5

1928

1. Betz, A. Windmills in the light of modern research. U.S. National Advisory Committee for Aeronautics. Tech. Mem. 474, August 1928. 29 p.

4

2. Bilau, K. Cost of wind power. Elektrotech. Z. 49: 819-21, May 31, 1928.

6

An experimental station has been constructed by the Oxford Institute of Agricultural Engineering for the purpose of studying the application of wind power. The chief difficulty is the intermittent and variable nature of the wind. Estimation of efficiency also introduces considerable difficulty, "propeller" and "turbine" types of prime mover indicating widely different results. The propeller type of motor has the advantage that it operates with lower wind speeds than other types. This allows the use of smaller batteries or reserve plant. Experimental work at Oxford and Göttingen has indicated a cost in pf. per kWh as given by the expression $6 \cdot 65.10^6/v^3h$, where v is the wind velocity in metres per sec and h the number of hours per annum during which the wind is blowing.

3. Browne, L.R. Make this Tim Turner windmill. Pop. Mech. 50: 155-6, July 1928.

4, 12a

4. Davis, W. Electric windmill. Curr. Hist. 27: 712, February 1928.

4

5. Delsol, E. Sur un moyed de transformer en travail mecanique l'energie interne de l'atmosphere. [Means of transforming internal energy of air into mechanical work.] La Vie Technique et Industrielle 10(102): 149-155, March 1928. (In French)

5

6. Electric current from the wind. Compr. Air Mag. 33(4): 2380, April 1928.

4

7. Fales, E.N. A new propeller-type, high-speed windmill for electric generation. ASME Trans. 19: Paper AER-50-6, 1928. 15 p.

5

This new improved type of windmill resembles an airplane propeller and is the result of windmill research adopted from aeronautics. The article describes wind tunnel and other tests, empirical coefficients for relating effects of widely ranging winds with steady wind conditions, and study of available energy in wind and selection of a suitable windmill diameter.

1928

8. Jensen, R.J. Modern plants for wind-electric power stations. Rapport No. 193 à la lère Conference Mondiale de l'Energie (World Power Conference), 1928. (In French)
3, 4

9. Nerli, N. The important question of wind-driven motors. Aeronautica: June 1928.
4

10. Powerful wind motor generates electricity. Sci. Am. 139: 156, August 1928.
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11. Self-governing wind-power wheel. Sci. Am. 138: 566-7, June 1928.
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1927

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2. Hopkins, R.T. Old English mills and inns. London, C. Palmer, 1927.
1, 2

3. Levi. R. Teoria e calcolo del motore a vento ad asse orizzontale. Ing. Rev. Tecn. Mengile 6(8 and 9): 272-280, 314-324, 1927. (In Italian)
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4. Savonius, S.J. Windmill. Iberica de Suplemento 14(28): No. 691: 10-11, 1927.
4

5. Verdeaux, F. Fonctionnement des roues eoliennes. Rev. Gen. Sci. Pure Appl. 30(19): 541-548, October 15, 1927. (In French)
4

1926

1. Betz, A. Wind energy and its utilization by windmills. Gottingen, Vandenhoeck and Ruprecht, 1926.
2, 4

2. Betz, A. Wind-energie und ihre ausnutzung durch Windmühlen. Gottingen, Vandenhoeck and Ruprecht, 1926. 64 p. (In German)
2, 4

3. Flettner, A. The story of the rotor. New York, F.O. Willhofft, 1926. 111 p.
1, 2

4. Ingalls, A.G. Power from the wind. Sci. Am. 134: 114-15, February 1926.
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5. Roscher, P.A. Windmotor. Swiss patent no. 117,848, December 1, 1926.
17

6. Sabinin, G.K. The gyroscopic effect of wind motors and calculation of rotating vanes. Trudy TsAGI [Works of the Central Institute of Aerohydrodynamics imeni N. Ye. Zhukovskiy], Issue 28, Moscow, 1926.
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1. Aitkenhead, W. Electric windmills. Purdue Eng. Rev. 21: 1-3, November 1925.
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2. Bilau, K. Rapid wind motors. Elektrotech. Z. 46: 1405, 1925.
4

3. Botke, C. Last stand of the windmill in Holland. Scrib. M. 77: 471-9, May 1925.
1

4. Church, I.P. Mechanical paradox, or mechanical fact? The wind-locomotive. Sci. Am. 132: 407, June 1925.
4, 15

5. Darrieus, G. Théorie élémentaire du moulin à vent. Note publiée, reproduite in extenso dans les "Moteurs à vent" de R. Champly. February 1925. (In French)
4, 9

6. Famous German sail-less ship driven by same wind forces that make baseball curve. Sci. Am. 132: 12, January 1925.
15

7. Hoelling, J.H. and O. Flamm. New harness for the wind; application of Magnus effect to propulsion of vessels. Liv. Age 324: 7-10, January 3, 1925.
15

8. Hullen, H. The economic utilization of wind energy. Z. VDI 69: 132, 1925.
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9. Lubowsky, K. Small wind generation plants for foreign countries. Elektrotech. Z. 46: 949, 1925.
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10. Nottelmann, H. Von. Ein Fortschritt in der Ausnutzung der Windkraft zur Erzeugung elektrischer Energie. Elektrotech. Z. 46(11): 365-368, March 12, 1925. (In German)
5

Rapid development of aerodynamics, brought about by airplane practice, has been responsible for a radically different wind turbine recently designed and built. The main characteristic of the windmill is a 4-vane propeller similar to airplane type. The first of these mills has been erected on a tall, slender tower constructed of reinforced concrete and gives a wheel of 19-sq. m. surface average output of 10 kw. A switchboard with 4 relays makes the entire plant fully automatic.

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12. Plans for a giant windmill. Science 61 (Suppl. 10): March 27, 1925. 4

13. Sailless sail boat, invented by Flettner. Rev. of Rev. 71: 102-3, January 1925. 15

14. Underwood, A.J.V. The aerodynamo: a new wind power machine. Electr. Rev. 96(2426): 166-167, January 30, 1925. 4

15. Wind-generated electricity. Engineering: March, 1925. 4

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2. New French windmills for electric power. Lit. Dig. 82: 27, September 27, 1924. 4

3. Preston, H. Windmills. Arts and Dec. 22: 82, December 1924. 4

4. Rotor ship. Liv. Age 323: 682-3, December 27, 1924. 15

5. Rotor ship moves on baseball curve principle. Lit. Dig. 83: 22-3, December 27, 1924. 15

6. Slosson, E.E. Free air. Sci. Mo. 19: 218-21, August 1924. 4

7. Utilization of wind power. Science 60(Suppl): 10-12, July 25, 1924. 4, 6

8. Windmills of Holland give way to oil engines. Pop. Mech. 41: 99, January 1924. 4

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1, 2

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2. Waterbury, I.C. Electrically harnessing the winds. Sci. Am. 127: 184-5, September 1922.
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2. Wind power. Sci. Amer. Mo. 3: 342, March 1921. 4

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5

The area-efficiency may be taken as the ratio of nf of the useful output of the windmill at the shaft to the kinetic energy which flows per sec. through a plane equal in area (F) to that of the windmill and assumed to be placed normally to the direction of the wind. If the wind velocity be v, and ρ the density of the air, then the energy flowing through that area per sec. is $E = 1/2\rho F v^3$. Then the area-efficiency $nf = 2L/\rho F v^3$, where L is the useful work delivered by the wheel at the shaft. If v^2 is the velocity of the wind at the rear of the mill, the author shows that the maximum of work is done at the wheel when $v^1 = v/3$, so that $L_{max} = 8\rho F v^3/27$ and $nF_{max} = 2L_{max}/(\rho F v^3) = 16/27$ is the upper theoretical limit of efficiency of the wheel.

3. Hoff, W. Theory of the ideal wind power machine. Z. Flugiechn. II: 223, 1920.

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2. Robitzsch, M. Beiträge zur Kenntnis der Struktur des Bodenwindes. Lindenberger Jahrb. 13/66, 1919. (In German)
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2. Carlill, J. Wind power. Edin. R. 228: 343-54, October 1918. 4

1916

1. Villers, R. Anemometric paradox; a wind motor that is not affected by the direction of the wind. Sci. Am. Suppl. 81: 108, February 12, 1916.

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