ENERGY FROM THE WIND

Annotated Bibliography

by

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August 1975

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CER74-75BLB-RNM-44

TABLE OF CONTENTS

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:

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Engineering Research Center
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Fort Collins, Colorado 80523

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. 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.

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 work". 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.
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

1974

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.
5

This paper reviews the aerodyanmics 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.

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

1973

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.

1973

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

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. 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.

1972

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.

8, 12a

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.

7

4. Energy from the winds. United Power News, United Power Association, January 1972.

4

5. Freese, S. Windmills and millwrighting. New York, Great Albion Books, 1972.

1, 2

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.

5

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.

7, 3

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.

4

10. Kidd, S. and D. Garr. Can we harness pollution-free electric power from windmills? Pop. Sci. 201(5): 70-72, November 1972.

4

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.

8

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.

4

14. Meyer, H. Wind generators: here's an advanced design you can build. Pop. Sci. 201(5): 103-105, 142. November 1972.

8,12a

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.

14

16. Shefter, Y. Problems of agricultural wind power. Vestnik Selkhoz. Nauki 17(5): 102-111, 1972.

8

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.
2

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.
9

20. Stabb, D. Wind. Architect. Des. 43: 253-254, April 1972.
4

21. Trunk, E. Free power from the wind. Mother Earth News, No. 17: 60-64, September 1972.
4

A short survey on the use of windmills for power generation.

22. Weaver, K. F. The search for tomorrow's power. Nat. Geograph. Mag.142(5): 650-681, November 1972.
4

This article reviews the world's power needs, supply, and future potential, including consideration of the use of wind for power production.

23. Whaley, J. C. Power generation alternatives. Seattle City Light, Engineering Division, Seattle, Washington, 1972.
4

24. Wind energy conversion. In: Solar Energy as a National Energy Resource. NSF/NASA Solar Energy Panel. December 1972. p. 65-81.
3

25. Bossel,H. Low cost windmill for developing nations. Mt. Rainier, Maryland, VITA, 1972. 40 p.
8, 12a

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 machining 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.

1972

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. Ramahumar. 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

1971

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

4, 8

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.

8, 12b

4. Duggal, J. S. Dynamic analysis of high speed wind-turbine systems. (M. Sc. thesis). Brace Res. Inst. Publ. No MT.9, 1971.

5

5. Gravel, M. Clean energy via the wind. Congressional Record, 92d Congress, 1st Session, Vol. 117: S45180-45183, December 7, 1971.

4

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.

3

7. Merriam, M. F. Is there a place for the windmill in less developed countries? Brace Res. Inst. Publ. No. R.25, 1971.

4, 8

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.

1971

9. Patrichi, S. Potential energy from wind in Moldavia, Rumania. Institutul de Meteorologie si Hidrologie, Buchurest, Culegere de Lucrari de Meteorologie, 1968. Bucharest, 1971, p. 215-229.

6

In Russian with an English summary. The paper looks into some important items of wind data, such as the mean hourly, monthly, annual, and seasonal values as well as the possibility and impending expectancy for the various wind speeds, to occur. Going through the hourly wind-speed values, one concludes that in Moldavia, the wind pattern sets a useful rating for the installation of less sturdy windmills, with many blades, which are driven by a wind exceeding 3 m/s, in the south and mid-Sereth Plain, Birlad, Vaslui, and the Bahlui Plains.

10. Pigeaud, F. D. Method of calculation of annual overall efficiency of modern wind-power plants. Ingenieur (The Hague) 63(47): W137-140, November 23, 1971.
Translation: Linguistic Systems, Inc., Cambridge, Massachusetts. N74-15748/8. NTIS, February 1974.

6, 7

A method of calculating the annual overall efficiency of modern wind power plants equipped with asynchronous generators is reported that takes into account the annual velocity duration curve at Den Helder, Holland. A comparison is made between variable pitch windmotor and fixed blade windmotor equipped with movable flaps. A careful calculation is recommended in view of rather small differences in efficiency for both systems.

11. Shefter, Y. et al. Solar and wind power to be harnessed. Pravda, p. 3, May 11, 1971.
Translation: Army Foreign Science and Technology Center, Charlottesville, Virginia. AD 765 783. NTIS, November 1972. 6 p.

4

The state-of-the-art of wind and solar power installations are discussed.

12. South, P. and R. S. Rangi. Preliminary tests of a high speed vertical axis windmill model. National Research Council of Canada, Laboratory Technical Report LTR-LA-74, March 1971.

9

13. United States Department of the Interior. Advisory Committee on Energy. Report to the Secretary of the Interior of the Advisory Committee on Energy. PB 201-071. NTIS, June 30, 1971. 45 p.

4

Results are given of a one year effort, employing an interdisciplinary approach, to study the situation and problems of the Nation's energy economy. Topics include: A general view of U.S. energy production and resources:

potential and problems of new energy sources; liquid fuels; natural gas; coal; water power; nuclear power; synthetic oils; synthetic gas.

14. Wind power. McGraw-Hill Encyclopedia of Science and Technology. New York, McGraw-Hill, 1971. Vol. 14, p. 573-574.

4

15. Wind yields power for telephones. Elec. World 175: 64, April 1, 1971

15

A pole-top, wind-driven generating plant has been constructed and is now under test by the Swedish Telecommunications Administration for supplying electricity to an automatic telephone exchange in a sparsely populated area not reached by commercial power. This venture into isolated generation was inaugurated at Ruoto, a small village in the north of Sweden, which have only ten telephone subscribers. The wind-driven electric plant is in two sections, the generator and the regulator. The generating set, which is of modern design, has a propeller with three regulating and three stationary blades. By means of a speed gear, the propeller drives a 3-phase permanent-magnet ac generator. The propeller, measuring about 8 ft in diameter, starts revolving at a wind speed of 16 fps and stops when the wind drops below 12 fps.

16. Windmill. Encyclopedia Britannica, Vol. 23, p. 570-571. Chicago, Illinois 1971.

1, 4

History and concise summary of developments in use of windmills for producing power for water, electricity, and irrigation, etc.

17. Fedotov, V. and V.P. Kharitonov. Standardized wind electric power unit. Mekhanizatiya i Elektrifikatsiya No. 7: 43-44, 1971.

8

The output and engineering characteristics of the standardized UVEU- (1-4)-6 wind electric power unit, suitable for operation at small sites distant from power networks, are discussed.

1971

18. Holderness, A.L. East-west microwave radio relay system power plant. Telecommun. J. Aust. 21: 80-94, 1971. 8, 15

Wind generators are used in an integrated system with diesel generators and lead acid batteries to supply d.c. power for the east-west broadband radio relay system in Australia.

19. U.S. Federal Power Commission. The 1970 national power survey--Part I. Washington, D.C., 1971. 4

20. Riccio, T. and A. Grassetti. The use of wind-driven electro-generators for feeding small radio and television rebroadcast stations. EBU Rev. A (Belgium) No. 130: 238-43, 1971. 8, 15

Eleven wind-driven generators for supplying power to radio rebroadcast stations in Belgium are discussed.

21. Wilson, R.E. The Oregon State University wind studies. Oregon State University, 1971. 6

Feasibility of use of wind generated power in Oregon is discussed.

22. Windpower. Sierra Club Bulletin: Sept., 1971. 4

23. Windmills. Mother Earth News No. 7: 14, January 1971. 4

24. Windmill powers telephones. Compressed Air Mag. p. 19, April 1971. 8, 15

1970

1. Barton, T. H. and K. Repole. A simple electric transmission system for a free running windmill. Brace Res. Inst. Tech. Rep. No. T-68, August 1970. 29 p.

13

2. Bettignies, C. Potential of wind power utilization in the Arctic environment, house heating. Brace Res. Inst. Publ. No. DT.8, August 1970. 40 p.

8

3. Bossel, H. Low-cost windmill for developing nations. VITA, Item 20, 1970. 45 p.

4, 12a

Describes construction of a 13-foot diameter mill using readily available materials and basic tools. Also available are plans for fan blade, helical sail, and Savonius rotor windmills.

4. Chilcott, R.E. L'utilisation de l'eolienne rapide Brace comme source d'energie motrice. L'Ingenieur 8-12, August 1970.

4

5. England, D. Windmill is a couris thing. Milling 152: 25+, December 1970.

1

6. Kadivar, M. S. Potential for wind power development. (M.Sc. Thesis) Brace Res. Inst. Publ. No. MT.10, July 1970.

4

7. Mayr, O. Origins of feedback control; mechanisms for controlling windmills. Sci. Am. 223: 115-118, October 1970.

5

8. Ramanathan, R. The economics of generating electricity from wind power in India. Ind. Q. J. Econ.: 245-255, January 1970.

6

9. Reynolds, J. Windmills and watermills. New York, Praeger Publ., 1970. 196 p.

1

A picture book of wind and watermills.

10. Urosov, L.D. et. al. Series of no-contact synchronous generators with outputs up to 100 KV for wind-driven electric units. Elektrotekhnika (USSR), No. 1: 56-58, 1970.
Translation: Army Foreign Science and Technology Center, Charlottesville, Virginia. AD 742-641, NTIS, October 7, 1971.

13

The need for design of a specialized series of no-contact synchronous generators with outputs up to 100 KV for wind-driven electric units and the basic technical characteristics of the series of generators are discussed.

1970

11. Shefter, Y.I. and V.F. Mosalev. Some questions on increasing reliability and effectiveness in operation of wind power-producing installations in desert conditions. Problemy Osvoyeniya Pustyn' 4: 1970. 13

12. Gladwell, J.K. New techniques for marine lights. New Zealand Eng. 25: 125-128, 1970. 15

13. Mosalev, V.F. On the question of evaluating reliability of wind motor blades. Trudy VNIIEM [All-Union Scientific Research Institute of Electromechanics] 34: 1970. 5

14. Gorland, S.H. and E.E. Kempke. Experimental windage losses for a Lundell Generator operating in air in the turbulent flow regime. NASA, Lewis Research Center, Cleveland. NASA-TM-X-52905, October 1970. 12 p. 5

15. Roddis, L.H. Unconventional power sources. Presented at the Edison Electric Institute Executives Conference, Scottsdale, Arizona, December 4, 1970. 4

MHD, fuel cells, solar power, tidal energy, thermal sea power, electro-gas dynamics and wind power are discussed.

16. Shefter, Y.I., V.F. Mosalev, and R.S. Abshanov. Investigation of reliability and loads of agricultural pumping wind installations. Doklady VASKhNIL 5: 1970. 8

17. Babintsev, I.A. and V.F. Mosalev. On the dynamic effect of a load on a high-speed windmill blade. Trudy VNIIEM [All-Union Scientific Research Institute of Electromechanics] 34: 1970. 5

1969

1. Chilcott, R. E. The design, development, and testing of a low cost 10 Hp windmill prime mover. (M.Sc. thesis) Brace Res. Inst. Publ. No. MT 7, July 1969. 126 p.

8, 12a

2. Chilcott, R. E. Notes of the development of the Brace Airscrew Windmill as a prime mover. Aeronaut. J. 73(700):333-334, April 1, 1969.

5

A 32 foot diameter airscrew windmill, fabricated of fiber-glass reinforced exposy resin, is used as a prime mover in irrigation and vapor compression distillation applic-cations. The three-blade fixed pitch screw is coupled to a deep-well turbine pump through truck transmission parts. The success of this installation demonstrates the feasibility of using such a system of built readily available parts, for harnessing wind power economically.

3. Chilcott, R. E. and G. T. Ward. The potential for medium power wind turbines in Canada and the Caribbean. Paper No. D.50.853 AGM, presented to the Engineering Institute of Canada Annual General Meeting, Vancouver, British Columbia, September 10, 1969. Brace Res. Inst. Publ. No. R 39.

3, 8

4. Croney, D. and G. Thierstein. Performance characteristics of the Macdonald College fanmill. Brace Res. Inst. Publ. No. CP 18, May 1969.

8

5. Easter, B. H. An energy storage system. Simulation 13(3): 155-164, September 1969.

11

To harness energy contained in such unconventional sources as winds, tides, and sunlight, power systems must incorporate energy storage devices to act as buffers between the source and the load; since size of energy storage device depends upon relative timing of availability of energy and load demand, system simulation is logical approach to study and design of such power systems; GPSS is presented as excellent simulation vehicle; physical properties to be simulated are discussed and resulting GPSS programs are presented; example of electrochemical energy storage system in which wind-powered generator can provide electrical power to electrolysis cell which converts water into hydrogen and oxygen at high pressures.

6. Ghosh, P. K. Estimation of the maximum drag and root bending moment on a stationary Brace airscrew windmill blade and variation of air screw starting torque with blade angle. Brace Res. Inst. Publ. No. CP.19, May 1969.

5

1969

7. Ghosh, P. K. Low drag, laminar flow aerofoil section of windmill blades. Brace Res. Inst. Publ. No. CP.20, May 1969.

5

8. Gibson, L. A. Wind analysis in relation to the development of wind power. Ph.D. thesis, Oklahoma State University, Stillwater, Oklahoma, 1969.

6

9. Ionson, J. M. The field performance of a windmill powered sprinkler irrigation system. (M.Sc. thesis) Brace Res. Inst. Publ. No. MT.8, July 1969. 96 p.

8, 15

10. Mercer, A. G. Study of factors affecting feasibility of low head hydro-electric generation. Colorado State University, Civil Engineering Dept. CER 68-69AGM26, 1969.

4, 5

11. Ramakumar, R. et. al. A wind energy storage and conversion system for use in underdeveloped countries. Proceddings of 4th Intersociety Energy Conversion Engineering Conference, Washington, D.C., September 22-26, 1969. Paper 699074, pp. 606-613.

3, 6

The feasibility of fabrication, installation, and operation of a wind energy conversion and storage system in a small remote rural community in a developing country is discussed. Details of a preliminary analysis of the economics of the energy package are given and the results are shown to be encouraging. Experimental results obtained from a prototype model are presented and discussed.

12. Wilson, A. Ministry of Overseas Development, Barbados. Comments on Brace Research Institute windmill. Brace Res. Inst. Publ. No. I.76, February 1969.

13

13. Zlokovic, V. S. Wind-power plant and energy storage. Elektroprivreda (Yugoslavia) 22(9-10): 377-end. September 1969. (In Croatian).

6, 11, 7

Description of more important wind-power electric plants, including methods of energy storage, costs, and economic feasibility.

1969

14. Foshag, W.F. and G.D. Boehler. Review and preliminary evaluation of lifting horizontal axis rotating-wing aeronautical systems (HARWAS). Washington, D.C., Aerophysics Co., March 1969. 420 p. 2

15. Weiss, H.B. and G.M. Weiss. The early windmills of New Jersey and nearby states. New Jersey Agricultural Society, 1969. 33 p. 1

1968

1. Allison, H. J. A wind energy storage technique utilizing a hydrogen oxygen electrolysis cell system. Presented at the Frontiers of Power Technology Conference, October 29, 1968. Oklahoma State University.

   3, 11

2. Altfelder, K. Battelle Institute, Frankfurt am Main. The importance of unconventional methods of energy conversion for developing countries. Battelle Inform. No. 1: 22-23, March 1968. N70-38878. NTIS.

   4

   This report discusses the use of nuclear, solar, wind and geothermal power for generating electric power in the 50 - 1000 kW range in developing countries.

3. Chilcott, R. E. Implications of the utilization of wind power for the development of small Caribbean communities. Conference on Technology and Development in Small Transitional Societies, Trinidad, West Indies, February 1968. Proceedings. 12 p. Brace Res. Inst. Publ. No. R-25.

   8, 4, 6

4. Chilcott, R. E. and G. T. Ward. Potential for medium-power, fixed-pitch, variable-speed airscrew wind machines in Canadian agriculture. Presented to the Agricultural Institute of Canada - Canadian Society of Agricultural Engineers, Hamilton, Ontario, June 27, 1968. Brace Res. Inst. Publ. No. R47.

   5, 8

5. Chilcott, R. E. Putting the wind to work. Engineering 206(5353): 760-761, November 22, 1968.

   4, 15

   Work at the Brace Research Institute in Canada has shown that the wind might be harnessed to provide competitive power for water desalination systems, particularly if the reverse osmosis technique is further developed.

6. Ghaswala, S. K. Windmill design for economical power. Sci. News 93: 148, February 10, 1968.

   4, 14

7. Levy, I. N. Current state of wind power research in the Soviet Union. Edited by G. T. Ward. Brace Res. Inst. Tech. Rep. No. T 56, September 1968. 10 p.

   4

1968

8. McCollom, K. A. Use of energy storage with unconventional energy sources to aid developing countries. Intersociety Energy Conversion Conference, 3d, Oklahoma State University. Proceedings. 1968.

3, 11, 4

9. Shefter, Y. New wind power units. Tekh. sel. Khoz. 28(4): 17-20, 1968. (In Russian)

4

10. Shefter, Y.I. On optimal parameters and dimensional orders of low powered wind power-producing machines. Mekhanizatsiya i Eletrifikatsiya Stsjalisticheskogo sel-skogo Khozyaystva 4: 1968.

5

11. Hütter, U. Eine Windturbine mit 34 m Rotor-Durch-messer. DFL-Mitteilungen No. 8: 1968.

14

1967

1. DiLecce, F. Utilization of wind power by means of aeroelectric units. III. On the use of variable speed synchronous generator-aeromotor units, coupled with three-phase asynchronous motorcentrifugal pump units. Energia Elett (Italy) 44(3): 155-162, March 1967. (In Italian.)

14

Discusses the operation problem under static and dynamic conditions, of the unit consisting of a synchronous generator, driven by a variable speed aeromotor, which feeds an asynchronous motor for operating a centrifugal pump. The results of the theoretical investigation and of some checks made on a small unit in laboratory show the operation regularity of the unit compared with the simplicity of the plant.

2. Fales, E. N. Windmills. Standard Handbook for Mechanical Engineers, 7th Ed, New York: McGraw Hill, T. Baumeister, ed. 1967. p. 8-13.

4, 5

3. Finnegan, B. Windmills. Hobbies 71: 118-119, February 1967.

1

A collection of photographs of post cards depicting windmills through the centuries.

4. Kachhara, N. L. Utilization of wind power in arid areas of Rajasthan. Ind. J. Power River Valley Dev. 17(8): 21-26, August 1967.

6

Estimation of available wind power in Rajasthan shows that it is possible to have outputs of 10, 20, 50 and 100 kW with various rotor diameters; use of wind power for irrigation, corn grinding, fodder cutting and similar jobs. 10 refs.

5. Lawand, T. A. The economics of wind-powered desalination systems. Brace Res. Inst. Publ No. T.36, June 1967, Revised September 1967.

13

6. Roberts, C. Wind-driven generating plant. Elect. Eng. Merchand., June 16, 1967.

7

7. Tabor, H. Z. Power for remote areas. Int. Sci. Technol.: 52-59, May 1967.

8

1967

8. Wailes, R. The English windmill. London, Routledge, and K. Paul, 1967.
1

9. Wind generator for remote light. Engineering 204: 291, August 25, 1967.
8, 15

This article describes an inexpensive wind powered generator working on Kawau Island off Auckland, New Zealand, to provide current for the navigation light.

10. Windpower. Mech. Eng. 89: 64, February 1967.
4

A lowcost windmill has been designed for use in India. Using bamboo mats and poles, Indian farmers with some assistance will be able to make their own windmills to provide inexpensive power for pumping water or generating small amounts of electricity.

11. Shefter, Y.I. and I.V. Rozhdestvenskiy. Vetronasosnye i Vetroelektricheskiye Agregaty [wind-pumping and wind-electric machines], Moscow, Kolos Publications, 1967.
14

12. Oklahoma State University. Office of Engineering Research, Research proposal, developing unconventional energy sources for use in developing countries. Stillwater, Okla., Oklahoma State University, 1967.
4

13. McCollom, K.A. Use of small scale power systems in developing countries. Conference on Engineering in International Development, Estes Park, Colorado, August 1967.
4, 8

1966

1. DiLecce, F. Utilization of wind power by means of aeroelectric units. I. The most recent researches and studies and their results. Energia Elett. (Italy) 43(1): 13-19, January 1966. (In Italian) 4, 13

Mentions the trends of the research being carried out in various countries, the results obtained and the solutions adopted.

2. DiLecce, F. Utilization of wind power by means of aeroelectric units. II. Sizing and choice of aeroelectric units. Energia Elett. (Italy) 43(2): 94-99, February 1966. (In Italian)

4, 13

3. India gets low-cost windmill for farmers. Sci. News 90: 329, October 22, 1966.

8, 12a

This article describes a design for windmills to be constructed and used in India, utilizing bamboo mats and poles for horizontal and vertical shafts. Bamboo materials are readily available in rural areas and with a little help farmers can made their own windmills at a low cost. In addition to pumping water it may also be able to generate small amounts of electrical power.

4. Nevot, M. S. Comparacion de difirentes terorias para el calculo de la performance de molinos. Brace Res. Inst. Publ. No. DT.7, August 1966.

5

5. Repair of Chesterton windmill. Engineer 222: 241, August 12, 1966.

1

Described is the restoration of an old English windmill, thought to have been originally built in 1632.

6. "SOKOL" 15 Kw wind turbines destined for Cuba. Izvestia, Moscow, August 23, 1966.

7

1966

7. Hakkarinen, W. Wind driven generator. U.S. Patent 3,473,038, June 24, 1966. 14, 17

8. Scientific, technical and economic bases for development of wind power production and recommendations on use of wind machines. Moscow, BTI VIESKh [Office of Technical Information, Scientific Research Institute of Rural Elecktrification] 1966. 6

9. Shefter, Y.I., V.A. Orlov and V.N. Kolodin. Some questions of statics and dynamics in the centrifugal regulator of the D-18 wind motor. Trudy VIM [All-Union Scientific Research Institute of Agricultural Mechanization] 22: 1966. 5

10. Shefter, Y.I. [Condition, scientific, technical and economic bases for development of wind power production and recommendations on use of wind machines] Moscow, Russia, BTI VIESkh [Office of Technical Information, Scientific Research Institue of Rural Electrification] 1966. (In Russian). 6

11. McCollom, K.A. and V.N. Haneman. Development of unconventional energy sources for use in developing countries. Eng. Res.: 1966. 4

1965

1. Hütter, U. Wind power glossary. Beitrag zum Lueger Lexikon der Technik Bd 6/7, Stuttgart, Deutsche Verlagsanstalt, 1965. (In German)

13

2. Pigeaud, F. D. and R. Wailes. Power in the wind. New Sci. 26: 451-452, May 13, 1965.

7

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.

3. Talking of windmills and watermills. Engineering 200(197): 684, November 26, 1965.

3, 4

Information on First International Symposium of Molinology held in October 1965 at Estoril-Cascais, Portugal, and organized by Portuguese Association of Friends of Wind and Watermills; object was study and discussion of questions relating to history, technology, etc. and preservation of traditional wind and watermills of every country; 23 papers were presented.

4. Venkiteshwaran, K. R. et al. A note on the feasibility of wind generation of electric power for communication links in India. N 65-33046. NTIS, February 1965. 19 p.

6, 8

The power requirements of solid-state microwave radio links are very low, and could be adequately met by storage batteries charged by small wind electric generators. This would be possible at sites that are sufficiently windy to operate the generator to give a stable output. Wind electric generators in this range are not commercially available in this country at present. The paper describes a wind electric generator designed in the laboratory for this purpose. The estimates of output in watt-hours using such a generator at five stations in India have also been computed in the paper.

5. Windmills and copper walls of Barbados. J. Barbados Mus. Hist. Soc. 31(2): 43-60, 1965.

1

1965

6. Bodek, A. How to construct a cheap wind machine for pumping water. Brace Research Institute Do-It-Yourself Leaflet No. 5: 11, February 1965. 8, 12a

7. Glausnizer, R. The importance of wind power to the German energy economy. Elektrizitatswirtschaft 64(7): 1965. 4

8. Rozhdestvenskiy, V.I. Some results of creation and investigation of a high-speed wind pumping machine with a high-frequency electric transmission. Doklady Vsesoyuznoy Nauchno-tekhnicheskoy Konferentsii po Sel'khozvodosnabzheniyu [Lectures of the All-Union Scientific and Technical Conference on Agricultural Equipment] Moscow, Kolos Publications, 1965. 8

9. Shefter, Y.I. Questions of calculating for strength of high-speed wind motors. Tractory i Sel'khozmashiny 8: 1965. 6

10. Shefter, Y.I. Use of a pneumatic drive in wind machines. Traktory i sel'khozmashiny 2: 1965. 5

11. Wilson, B. Automatic windmill shut-offs. Power Farming in Australia and New Zealand, July 1965. 14

1964

1. Bodek, A. Performance test of an 8-meter diameter Andreau windmill. Brace Res. Inst. Publ. No. T.12, 1964.

5, 8

2. Bhalotra, Y. P. R. Wind energy for windmills in Sudan. Sudan Meteorological Service, Memoir No. 7, March 1964. 22 p.

6

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.

6

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.

7

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.

3, 6

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)

6

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.

4

8. Sachs, P. Wind generation of electric power for radio-relay repeaters. Point to Point Telecommunications 8(2): 15-34, February 1964.

8, 15

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.

8

10. Simonds, M. H. and A. Bodek. Performance test of a Savonius rotor. Brace Res. Inst. Publ. No. T.10, January 1964.

9

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).
4

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.
7

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.
5

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.
6

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.
6

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.
8

20. Shefter, Y.I. Principles of calculation for optimization of wind machine parameters. Mekhanizatsiya i electrifikatsiva sotsialisticheskogo sel'skogokhozyaystrva 6: 1964.
6

21. Shefter, Y.I. Effectiveness of using wind motors. Vestnik sel'skokhozyaystvennoy nauki 6: 1964.
6

1963

1. Kogan, A. and A. Seginer. Shrouded aerogenerator design study. 2. Axisymmetrical shroud performance. Israel Soc. Aeronautical Sciences. Conference on Aviation and Astronautics, 5th. Proceedings, 1963. p. 49-56.

3, 10

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.

7

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.

6

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.

1963

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.

4, 6

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).

6

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

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.

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.)
5

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

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

1961

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.

8

14. Golding, E.W. New power for the underdeveloped areas. Engineering 192: 348, 1961.

4

15. Solar and wind energy. Research: 82-87, 1961.

4

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.

1960

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

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.

1959

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

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

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

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.

1957

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.

1957

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

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. Niklakantan, 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

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.

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.

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

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

1954

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 hydro-electric 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. 28th ed. rev., Berlin. (In German)
4

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

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

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

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.

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

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

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.

1950

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.

1950

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 vic: 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

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-Leonàrd 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.
12a

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

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

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

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

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. 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

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.

1943

1. Dieterich, G. Large wind power installations. Reichsarbeitsgemeinschaft "Windkraft", Denkschrift No. 6: 3-7, 1943. (In German.)
7, 12

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

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/OGA. 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

1941

1. Meyer, G.W. Progress in the utilization of wind power. Elektrizitaetsverwertung 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

5. Fasching, L. Whirlwind. Mech. Illus., April 1941.

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

1941

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.

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

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

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). Elektrotech. 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

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

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

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

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

1. Brown, C.A.C. Windmills for the generation of electricity. Oxford University. Institute for Research in Agricultural Engineering. January 1933. 15 p.

7

Summarizes and extends the Institute's Bulletin No. 1, 1926. Nine types of windmills were tested at Harpenden. The output of each plant for 12 months is tabulated as a total and for different wind speeds. The main advance since 1926 is the high-speed wheel with aerofoil-section blades.

2. Coles-Finch, W. Windmills and watermills. London, C.W. Daniel Company, 1933.

1

3. Sektorov, V.R. The present state of planning and erection of large experimental wind-power stations. Elektrichestvo, No. 2: 9 - 13, 1933.
Transl: Elect. Res. Assoc. Transl. No. IB 1052.
Also: NTIS. N 74-21677, April 1974. 12 p.

7

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

1931

1. Bach, G. Investigation concerning Savonius rotors and related turbomachines. 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

1930 and Earlier

1. Hughes, A.F. Windmills in Sussex. London, Walker's Galleries, Ltd. 1930.

1

2. Fales, E.N. A new propeller-type, high-speed windmill for electric generation. ASME Trans 19: Paper AER-50-6, 1928. 15 p.

5

Inproved type of windmill resembles airplane propeller; result of windmill research adopted from aeronautics; extensive windtunnel and other tests; empirical coefficients for relating effects of widely ranging winds with steady wind conditions; study of available energy in wind and selection of suitable windmill diameter.

3. Betz, A. Windmills in the light of modern research. U.S. National Advisory Committee for Aeronautics. Tech. Mem. 474, August 1928. 29 p.

4

4. Bilau, K. Windcraft theory and practice. Berlin, Paul Parey, 1927.

2

5. Betz, A. Wind energy and its utilization by windmills. Gottingen, Brandenhoek and Ruprecht, 1926.

2, 4

6. Brangwyn, F. and H. Preston. Windmills. New York, Dodd, Mead and Company, 1923.

1

7. Manikowske, W. Windmill electric lighting and power. North Dakota Agricultural Experiment Station Bull. No. 105, August 1913.

8

8. Chatterton, A. The value of windmills in India. Superintendent, Government Press, Madras, 1902.

2 , 6

9. Murphy, E.C. The windmill: its efficiency and economic use. Wash., U.S.G.P.O., 1901. 2 v.U.S.G.S. Water Supply and Irrigation Paper No. 41-42.

4, 5

10. One year's work done by a 16 foot geared windmill. University of Wisconsin Agricultural Experiment Station Bull. No. 68, June 1898.

8

11. Wolff, A.R. The windmill as a prime mover. New York, J. Wiley and Sons, 1885. 159 p.
2

12. Smeaton, J. On the construction and effects of windmill sails. Royal Society Paper, 1759.
1, 5

13. Smeaton, J. Experimental inquiry concerning the natural powers of water and wind to turn mills and other machines, depending on a circular motion. London, I. & J. Taylor, 1794.
2

14. Hoff, W. Theory of the ideal wind power machine. Z. Flugiechn. II: 223, 1920.
1, 4

15. Bilau, K. Rapid wind motors. Elektrotech. Z. 46: 1405, 1925.
4

16. Hullen, H. The economic utilization of wind energy. Z. VDI 69: 132, 1925.
6

17. Lubowsky, K. Small wind generation plants for foreign countries. Elektrotech. Z. 46: 949, 1925.
8

18. Wind-generated electricity. Engineering: March, 1925.
4

19. Roscher, P.A. Windmotor. Swiss patent no. 117,848, December 1, 1926.
14, 17

20. 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.
5

21. Nerli, N. The important question of wind-driven motors. Aeronautica: June 1928.
4

22. Savonius, S.J. Rotor motor drives pump. Mod. Mech. Invent. 1(10): 78, March 1929.
8

23. Serragli, G. Studies on the deployment of the self-rotating airscrew. Aerotecnica, June 1929.
5

24. Burnham, J.P. Self-regulating wind-wheel. Sci. Amer. 11(1): 1, July 2, 1864.
5

25. Savonius, S.J. Windmill. Iberica de Suplemento 14(28): No. 691: 10-11, 1927.
4

INDEX

PERSONAL AUTHOR

All known personal authors have been included in this Index. For each reference the year and item number are given.

INDEX

BROAD SUBJECT OR TYPE OF MATERIAL

Each reference in this bibliography has been assigned one or more broad subject or type of material category numbers according to the list below. These category numbers appear on or beneath the last line of the basic citation, to the right of each entry. In this Index all references for each category have been accumulated under the category number. For each reference the year and item number are given.

CATEGORY	SUBJECT OR TYPE OF MATERIAL
1	Historical
2	Books
3	Conferences
4	Popular Review
5	Aerodynamics
6	Siting, Meteorology, Methods including feasibility studies
7	Large Scale Generation
8	Small Scale Generation
9	Vertical Axis
10	Shrouded
11	Storage
12	Design
	12a Homebuilt
	12b Commercial
13	General - Systems
14	Generators
15	Novel Applications
16	Bibliographies
17	Patents

INDEX

1 HISTORICAL

2 BOOKS

3 CONFERENCES

4 POPULAR REVIEW

4 POPULAR REVIEW(continued)

1949: 2, 5, 6, 8, 9, 16, 17, 20, 21, 22
1947: 3, 8, 11, 13
1945: 2
1942: 1, 3, 4, 8, 9, 15
1941: 1, 4, 5, 6, 8, 9, 10
1940: 1
1939: 2
1936: 2
1935: 3
1928: 3, 21
1927: 25
1926: 5
1925: 15, 18
1920: 14
1901: 9

5 AERODYNAMICS

1975: 5, 7, 10
1974: 22, 31, 41
1973: 16
1972: 6
1971: 4
1970: 7, 13, 14, 17
1969: 2, 6, 7, 10
1968: 4, 10
1967: 2
1966: 9, 10
1965: 10
1964: 1, 16
1963: 12
1962: 4
1961: 2, 9, 10
1960: 8, 12, 14
1959: 2, 3, 10, 15, 18
1958: 9
1956: 1, 8
1955: 7, 13, 18, 20
1954: 15, 16
1953: 28, 33
1952: 8, 10, 12, 17
1951: 21
1950: 1, 18
1949: 15
1948: 7, 11, 13
1946: 4, 5
1944: 1
1943: 6, 10
1939: 1, 5
1938: 31
1937: 2
1935: 1, 2
1934: 5
1931: 6
1929: 23
1928: 2
1926: 20
1901: 9
1864: 24
1759: 12

6 SITING, METEOROLOGY, METHODS, FEASIBILITY STUDIES

1975: 12, 17
1974: 5, 9, 10, 12, 18, 25, 30, 33, 34, 35, 36, 40, 43, 44, 47
1973: 1, 11, 16, 25, 27, 29, 31, 34, 39, 41, 43
1972: 8, 26, 27
1971: 9, 10, 21
1970: 8
1969: 8, 11, 13
1968: 3
1967: 4
1966: 8
1965: 4, 9
1964: 2, 3, 5, 6, 11, 13, 17, 18, 20, 21
1963: 3, 4, 5, 6, 7, 8, 11, 13, 14
1962: 3, 7, 13, 14
1961: 1, 2, 7, 8, 11
1960: 2, 4, 5, 6
1959: 4, 5, 6, 13, 17
1957: 1, 5, 11, 13, 18
1956: 2, 3, 4, 5, 7, 9, 11, 12, 13, 14, 15, 18, 21, 22, 23, 24
1955: 7, 12, 17, 23
1954: 1, 3, 9, 11, 15, 18, 22, 24, 28, 29, 32
1953: 4, 6, 7, 9, 11, 15, 18, 21, 23, 30, 32
1952: 2, 5, 9, 11, 14, 19, 20
1951: 1, 3, 4, 15, 16, 17, 18, 20, 25, 26, 28
1950: 8, 10, 14
1949: 8, 10, 12, 13, 14, 19
1948: 1, 2, 3, 4, 6, 16
1947: 4, 9, 12
1946: 1
1945: 2
1943: 8, 9
1942: 2, 3, 14
1941: 7
1939: 3
1938: 1, 2
1936: 3
1935: 4
1925: 16
1902: 8

7 LARGE SCALE GENERATION

1973: 5, 13, 35, 37
1972: 3, 7
1971: 10
1969: 13
1967: 6
1966: 6
1965: 2
1964: 4, 15
1963: 2
1962: 1
1961: 2
1960: 11
1959: 3
1958: 1, 4, 14
1957: 14, 17
1956: 3, 10, 17, 18, 26
1955: 5, 6, 7, 14, 15, 16, 22, 25, 28
1954: 13, 23
1953: 16, 24
1951: 2, 13
1950: 3, 9, 11, 13
1949: 4
1948: 15
1947: 4, 7
1945: 2, 3
1944: 2
1943: 1, 3, 4, 7
1942: 5, 6, 7, 10 11, 12, 13
1939: 1
1938: 1, 2
1937: 4
1934: 1, 3, 4, 6
1933: 1, 3
1932: 1, 2, 3

8 SMALL SCALE GENERATION

1974: 2, 15, 16, 24, 26, 30, 46
1973: 6, 28
1972: 2, 11, 12, 14, 16, 25, 35
1971: 2, 3, 7, 8, 17, 18, 20, 24
1970: 2, 16
1969: 1, 3, 4, 9
1968: 3, 4
1967: 7, 9, 13
1966: 3
1965: 4, 6, 8
1964: 1, 8, 9, 19
1962: 2, 17
1961: 5, 13
1960: 13
1958: 16, 17, 18
1957: 6, 12, 14, 20
1956: 1, 18
1955: 26
1954: 29, 30
1953: 10, 22
1952: 4, 15, 23, 24
1951: 8
1950: 12
1949: 5, 7
1948: 10
1944: 3
1943: 2, 5
1941: 2, 3
1940: 3, 4
1939: 2
1937: 1, 3
1936: 1, 4
1925: 17
1929: 22
1913: 7
1898: 10

9 VERTICAL AXIS

1975: 1, 2, 4, 9, 13, 16
1974: 3, 4, 15, 20, 31, 38, 42, 48, 49
1973: 12
1972: 19, 37
1971: 12
1964: 10
1952: 8
1947: 1
1931: 1, 4

10 SHROUDED

1963: 1
1961: 6
1957: 8

11 STORAGE

1969: 5, 13
1968: 1, 8
1964: 12
1959: 7, 11
1954: 5, 21
1953: 12

12 DESIGN — 12a Homebuilt — 12b Commercial

12a Homebuilt

1975: 15
1974: 2, 24, 26, 29, 30
1973: 2, 3, 14, 19, 28, 38
1972: 2, 14, 25
1971: 8
1970: 3
1969: 1
1966: 3
1965: 6
1949: 11
1936: 4

12b Commercial

1974: 11, 23
1973: 15, 25
1972: 12, 18
1971: 3
1961: 9
1959: 2
1958: 1
1955: 19
1954: 10, 15, 20, 25
1953: 14
1943: 1
1931: 7

13 GENERAL SYSTEMS

1974: 8, 13, 14, 32, 37
1973: 4, 7, 16, 18, 33
1970: 1, 10, 11
1969: 12
1967: 5
1966: 1, 2
1965: 1
1964: 12
1959: 1, 7
1958: 3
1957: 2, 12, 19
1955: 24
1954: 5, 23
1953: 5
1951: 2, 7, 22
1950: 4, 12
1949: 1, 3
1948: 8
1942: 6, 7

14 GENERATORS

1974: 23, 27
1973: 3
1972: 15, 32, 36
1968: 14, 11
1967: 1, 11
1966: 7
1965: 11
1963: 9, 12
1962: 16
1960: 7, 12
1956: 28
1955: 29
1953: 28, 29, 31
1952: 1, 22
1950: 7, 15
1949: 1, 2, 18
1948: 17
1947: 2, 5
1945: 1
1943: 11
1940: 2
1939: 3, 4
1938: 1, 2
1937: 5
1934: 2
1932: 3
1931: 5
1926: 19

15 NOVEL APPLICATIONS

1975: 15
1974: 46
1973: 2
1972: 1
1971: 15, 18, 20, 24
1970: 12
1969: 9
1968: 5
1967: 9
1964: 8
1962: 6, 17
1961: 5
1959: 9
1957: 15, 20
1956: 18
1955: 4, 26
1943: 2
1942: 9

16 BIBLIOGRAPHIES

1975: 11
1974: 7, 17, 39
1973: 23, 26
1971: 1
1954: 28
1950: 5

17 PATENTS

1972: 36
1966: 7
1953: 28, 29, 31
1937: 5
1934: 2
1931: 5
1926: 19