Hemp:

100% Renewable Energy, Soil Remediation and Waste Diversion

Meral Cooper, Mechanical Engineer
Pueblo Permaculture

Dr. Kelly Gehlhoff
Perpetual Harvest, LLC
100% UNITED STATES

Transition to 100% wind, water, and solar (WWS) for all purposes (electricity, transportation, heating/cooling, industry)

Residential rooftop solar 8%
Solar plant 25%
Concentrated solar plant 7.3%
Onshore wind 30.9%
Offshore wind 17.5%

Commercial/govt rooftop solar 7.4%
Wave energy 0.4%
Geothermal energy 0.5%
Hydroelectric 3%
Tidal turbine 0%

Dr. Mark Jacobson, Stanford

www.solutionsproject.org
100% COLORADO

Transition to 100% wind, water, and solar (WWS) for all purposes (electricity, transportation, heating/cooling, industry)

2050 PROJECTED ENERGY MIX

- Residential rooftop PV: 4.2%
- Solar PV plants: 17.6%
- CSP plants: 15%
- Onshore wind: 55%
- Offshore wind: 0%
- Commercial/govt rooftop PV: 4%
- Wave devices: 0%
- Geothermal: 3%
- Hydroelectric: 1.2%
- Tidal turbines: 0%

www.solutionsproject.org
Dr. Mark Jacobson, Stanford
Hemp as a Bio-Fuel? Is it realistic?

2 basic ways to make hemp into fuel

- **Hemp biodiesel** – made from the oil of the (pressed) hemp seed
  - There are a variety of ester-based oxygenated fuels made from hemp oil ("Transesterification")
  - Safe to handle/transport and has a high flashpoint
  - Bio-degradable and cleaner emissions/odor

- **Hemp ethanol and/or methanol** – made from the fermented stalk
  - Requires processes such as gasification, acid hydrolysis and enzymes
  - Hemp grows faster and produces more fuel than alternative crops like corn
Hemp ethanol... **10 times** more productive than corn per acre!
Hemp’s full potential

• Diesel: Acre of hemp $\rightarrow$ **48 gallons of seed oil** [Great Book of Hemp]
  Full diesel engine power with reduced carbon monoxide and 75% less soot and particulates.

• Methanol/Ethanol: Including the hemp stalks as fuel is much more productive.
  Hemp fields can yield 5–10 tons of dried stalk per acre, which could be converted to produce **500 gallons of methanol per acre**.

• Overall, experts have concluded that “meeting US demands for oil and gas would require intensive cultivation of **only about 6% of the land area of the 48 contiguous states, or just over 116 million acres**”
Why use up the forests which were centuries in the making and the mines which required ages to lay down, if we can get the equivalent of forest and mineral products in the annual growth of the hemp fields?

— Henry Ford
Ford’s HEMP CAR

One of Henry Ford’s first cars ran entirely on Hemp ethanol. The body was also constructed from Hemp plastic, which was 10x stronger than steel.

Of course - Hemp was then outlawed in the US in 1937 due to the potential damaging effect it would have on many powerful industries at the time, including the oil, plastics & paper industry.

Imagine where we would be today had these power hungry tyrants not suppressed the amazing bio-technologies of Hemp?
How much fuel can be produced?

- In 2010, University of Connecticut designed a pilot study estimating 200,000 gallons of bio-diesel could be produced annually in a reactor.
- In 2014, scientists reported a 97% efficiency of conversion rate for hemp as a bio-diesel.
- It was also estimated that a hemp farmer could produce enough fuel from seeds to become fully self-sufficient in his energy needs (research to support small-acreage models is required...).
Hemp’s more realistic role: energy efficient building material and 5-10% of total energy

- We are moving to electrify transport and heating
- Hemp could be a profitable fuel for remaining combustion systems (5-10% by 2035)
- Energy Efficiency of buildings on the electricity grid with Hempcrete
  - (Vacuum insulated panels have next highest R-value, approximately R-45)

Hempcrete R values

<table>
<thead>
<tr>
<th>Wall Thickness (mm)</th>
<th>Wall Thickness (Inches)</th>
<th>U-value (K·m²/W)</th>
<th>R-value (Ft²·°F·h/Btu) USA</th>
<th>RSI-value International</th>
</tr>
</thead>
<tbody>
<tr>
<td>300</td>
<td>12</td>
<td>0.23</td>
<td>25</td>
<td>4.35</td>
</tr>
<tr>
<td>400</td>
<td>16</td>
<td>0.18</td>
<td>33</td>
<td>5.56</td>
</tr>
<tr>
<td>500</td>
<td>20</td>
<td>0.14</td>
<td>50</td>
<td>7.14</td>
</tr>
</tbody>
</table>
**HEMPCRETE**

Designed to build, not to smoke.

- Strong, Lightweight & Breathable
- Energy Efficient
- Incredible Insulation
- Flame, Water & Pest Resistant
- Lasts 100's of Years
- Naturally Non-toxic

**CARBON NEGATIVE**

Hemp Building & Insulation: the raw materials
- Hemp Wool
- Shives for concrete
- Shives & fibre for plaster
- Shives & fibre for finishing plaster
- Hemp wool in rolls or panel
- Hemp mat for flooring
Economic Viability of Hemp

Industrial Hemp is Four Crops

$580 Million US Market in 2014
22% Market Growth

Could hemp become legal tender once again?

Billion-dollar Crop

petition with cookie-produced foreign fiber while paying farmers fifteen dollars a ton for hemp as it comes from the field. From the farmers' point of view, hemp is an easy crop to grow and will yield from three to six tons per acre on any land that will grow corn, wheat, or oats. It has a short growing season, so that it can be planted after other crops are in. It can be grown in any state of the union. The long roots penetrate and break the soil to leave it in perfect condition for the next year's crop. The dense shock of leaves, eight to twelve feet above the ground, chokes out weeds. Two successive crops are enough to reclaim land that has been abandoned because of Canadian thistles or quack grass.

Under old methods, hemp
(Continued on page 1464)
Hemp has a multitude of end uses

What are the main categories?

- Medicinal quality CBD products
- Body/skin care, cosmetics
- Nutritional supplements and nutraceuticals
- Food products (seeds, oil, etc.)
- Livestock feed and bedding
- Fiber-based products (paper, fabrics, ropes, textiles, etc.)
- Bio-plastics/building materials
- Bio-fuels and lubricants

Tree of Life? How many uses? 50,000+
We cannot repeat history...

Why Cannabis is REALLY illegal:

Modern Uses for the Cannabis Plant

- **Industrial Textiles**:
  - Twine
  - Rope
  - Nets
  - Canvas Tarps
  - Carpet
  - Geofelt
  - Agrofiber composites & related parts
  - Brake/Clutch linings

- **Paper**:
  - Printing paper
  - Fine/pitch/paper
  - Filter paper
  - Newsprint
  - Hardboard/ Packaging

- **Building Materials**:
  - Insulation
  - Fiberglass substitute
  - Cement
  - Shutter & mortar

- **Industrial Products**:
  - Oleochemicals
  - Venetian paints
  - Printing inks
  - Solvents
  - Lubricants
  - Dye

- **Agriculture Benefits**:
  - Weed suppressant
  - Less need for pesticides than most crops
  - Soil improvement in crop rotation
  - Deep roots are natural soil aerator

- **THC**:
  - Medicine
  - Recreation
  - Sacramental

- **Leaves**:
  - Flowers
  - Seeds

- **Stalk**:
  - Fibers

- **Cell Fluid**:
  - (whole plant)
  - Boiler fuel
  - Pyrolysis feedstock

- **Seed Cake**:
  - Animal feed
  - Protein-rich fiber

Cannabis uses chart created by Domonic Comer - www.cannabismap.com
Inspired by Jack Herer's "The Emperor Wears No Clothes" www.jackherere.com
Corporate logos added by Bradley Walker - brw莒_guy@ymail.com
As Pueblo builds its capacity for processing hemp into value-added products, and shifts some of its agricultural policies, we are bound to see a significant increase in the amount of hemp being farmed and people earning a living wage doing it.
Because there are so many other end-uses of hemp with greater profit-margins, bio-fuel research has not been made a high priority in America yet. The “Economy of Scale” required to turn a profit growing solely for fuel is not realistic at this time. But Pueblo, Colorado is an appropriate hub for production and export.

Hemp bio-diesel does not require any engine modifications to use (optional carbonizing). Hemp is rated as having one of the lowest levels of insoluble impurities (Jessen, 2007). However, building the infrastructure for processing and storing hemp-based bio-fuels will be costly up-front.
Benefits of Hemp Farming

- Requires less fertilizer and water than other crops and improves quality of soil its grown in (phytoremediation/nutrient-fixing capability)
- “carbon-neutral replacement to bio-fuel” (Alcheikh, 2015)
- Carbon sequestration of hemp fields can be up to four times higher than that of typical forests
- Planting hemp does not require clear-cutting
- All parts of the plant can be utilized somehow
Hemp’s Power of Phytoremediation

- Hemp plants have been known to leach contaminants, removing them from soils.
- Although all parts of the plant absorb heavy metals, the leaves hold the most toxicity.
- Roots can grow up to 8 feet deep underground.
- Heavy metals include: cadmium, nickel, lead, etc.
- Potential to assist in wastewater treatment, too.
- Contaminated bio-mass can still be used to make industrial hemp products (Cascardi, 2012).
Radical examples of hemp use

– Cleaning up radiation after a nuclear disaster, such as Chernobyl + Fukushima (sunflowers were used due to the legal constraints of hemp)

-- Phytoremediation after closure of a mine, to aid in the removal of heavy metals or other toxins like arsenic, lead, cadmium and uranium

-- Cleaning up after fracking sites are closed

-- Contributing to city wastewater treatment

-- Reducing erosion to prevent flooding after fires

-- Making money by adding environmental value!
How can phytoremediation pay off?

- We need to develop new business models that include the concepts of “industrial ecology” and using waste streams as continued profit-drivers.
- More R&D is needed on which crops will be most effective for removing specific contaminants from both soil & water.
- Payoff- Biofuel/diesel
Don Wirtshafter of Ohio Hempery says hemp “waste” would can dictate the price of hemp fuel.

“Hemp oil is too valuable to burn up as fuel. It will be the waste products that become the fuels of the future. ... Because we sell the protein for a good price, the price of hemp oil drops. When I was selling the seed cake to make Hempen Ale, making the oil was almost free. Again, it is the waste stream from your primary processes that will go into power generation.”
The 2014 Farm Bill (Federal) officially (re)defined industrial hemp and allowed research in universities in sensible states like Colorado.

The opportunity to universities and colleges be on the right side of history and allow hemp research.
Questions?

Meral Cooper
Meral.sarper@gmail.com
719-248-9554

Dr. Kelly Gehlhoff
kellyphgs@gmail.com
719-334-9309

Please contact us if you want to take part in collaborative research.
References

http://today.uconn.edu/2010/10/hemp-produces-viable-biodiesel-uconn-study-finds/
https://www.theguardian.com/environment/blog/2008/jan/28/whyishempo ffthebiofuelme


http://toxiccleanup911.steamboats.com/phytoremediation.html