University of Washington Focus the Nation
1/31/2008

Title:	Where will we find the energy? Technological Solutions to Global Warming		
Time:	3.00 – 4.30pm	**Location**:	HUB, Room 310

Moderator:	Michael Lazarus	Senior Scientist, Stockholm Environment Institute
Panelists:	Renata Bura	Assistant Professor, College of Forestry Resources, UW
	Guozhong Cao	Professor, Department of Materials Science & Engineering, UW
	Caroline Harwood	Professor, Department of Microbiology, UW
	Bart Nijssen	Chief Technology Officer, 3tier
	Brian Polagye	PhD Student, Department of Mechanical Engineering, UW

Summarized by Louise Leahy

***Opening Remarks by* Michael Lazarus**:
Technology must form the core of any strategy designed to address global warming and climate change. U.S. federal spending on energy R&D is down by 50% since the early 1980s, and private sector energy R&D has also declined. However, a recent turnaround in global private sector investment resulted in a rapid growth of the clean energy market, now worth $150bn. There appears to be a renewed awareness of the urgency of the problem among federal agencies and Congress. In his recent State of the Union Address, President Bush urged support for entrepreneurs and researchers working to "pioneer a new generation of clean energy technology" and making "the breakthroughs of tomorrow". While technological innovation is vital for developing clean energy, two Princeton researchers contend that current technology will see us through the next 50 years in our attempts to stabilize CO_2 emissions (Pacala and Socolow, 2004). There is no "silver bullet" solution to the clean energy issue; rather, we need to adopt a "silver buckshot" approach. This is a strategy which appeared to be well-supported by the breadth of research presented by the panelists.

Presentations:
Caroline Harwood described the production of hydrogen gas (H_2) for use in fuel cells, using the bacterium *Rhodopseudomonas palustris* as a biocatalyst. The energy crop for this process is organic waste and the bacterium uses sunlight as its energy source. The process has a conversion efficiency of 75% and is most efficient under conditions of diffuse sunlight i.e. cloudy days, rather than direct sunlight, making it ideal for Seattle's often overcast conditions. This is a carbon neutral fuel - the only combustion by-product is H_2O. 10kg of cells will produce 100g of H_2 per hour, for several weeks. This is equivalent to approximately 2 gallons of gas per day. Ongoing research involves mixing the bacteria with latex to form a latex coating (akin to a fruit rollup) and placing these latex strips in tubes containing organic material. Under these conditions H_2 production can be maintained for up to three months. The strips can be easily transported or kept in freezer storage until required. The current process is quite water-intensive which may be a limiting factor in a water-scarce future environment. However, a marine version of the bacterium exists, so it may be possible to use salt water not fresh water in this process.

Renata Bura presented research on the bioconversion of lignocellulosic biomass to ethanol. The feedstock used for this lab-based extraction process is agricultural biomass e.g. corn stover or wheat straw. The biomass is pre-treated by subjecting it to high pressure and temperature, termed “steam explosion”, which separates the biomass into cellulose, hemicellulose and lignin. Cellulose, a long-chain polymer, is then broken down into sugars (e.g. glucose) using enzymes, followed by a fermentation process using brewer’s yeast, and finally, distillation to produce ethanol. Challenges include addressing feedstock diversity, as different types of feedstock will require different production methods, and making the process economically competitive with cheaper methods e.g. bioethanol from sugar cane. Costs involved include the cost of the biomass ($40-$100/tonne), and the cost of the enzymes ($0.30-$1.00 per litre). However, in terms of reducing greenhouse gas emissions, lignocellulosic ethanol has the largest impact with a 91% reduction compared to corn-based ethanol at 22%. There are plans to develop the use of switchgrass for feedstock. Existing ethanol production infrastructure can be used to manufacture lignocellulosic ethanol, but pre-treatment capability would need to be added.

Guozhong Cao explained how he uses nanotechnology for solar energy conversion and storage. An hour’s worth of solar energy can meet the world’s energy needs for one year. However, despite the abundant supply of energy, the challenge lies in cost effectively raising conversion efficiency. There are three basic types of solar cells: silicon based which are widely available and are 36-38% efficient but very expensive; dye-sensitized with maximum efficiency of 11% but are very cheap; and organic which are 6.5% efficient. Dr Cao’s research is focused on increasing the conversion efficiency of dye-sensitized solar cells using nanorod array structures to increase the surface area for conversion of photos to electrons. Energy storage is another challenge for the solar energy sector. Ideally, the storage mechanism would have a large capacity, fast charge and discharge capability, and cyclic fatigue resistance.

In-stream tidal power and its environmental footprint were the topics presented by **Brian Polagye**. It is a developing sector; the current knowledge base is similar to where wind energy was 15-20 yeas ago. Also, like wind energy, a turbine is used to harness the energy. Ideal sites would be in long narrow inlets with fast currents, e.g. Admiralty Inlet (between Port Townsend and Whidbey Island). The technology is emission free. Unlike wind however, it is predictable because tidal cycles are known. Some challenges facing this technology are high costs, intermittent supply, degradation of the marine ecosystem, finding suitable sites that do not compromise existing marine user groups e.g. recreational, naval or commercial users, transmission capacity and proximity to the electrical grid.

A commercial perspective on wind energy was provided by **Bart Nijessn.** While the wind may be free, each turbine costs $1-2 million, and a wind farm may have 50-100 turbines. With such a hefty initial capital investment, the optimal siting of wind farms is key. 3tier, a company founded in 1989 by a UW alumnus, provides 5,600MW of wind energy forecasting, 3,500MW of hydropower forecasting, and solar assessment and forecasting. Once a wind farm becomes operational, wind forecasts are essential for planning and optimizing potential output. Clients receive forecasts tailored to their needs e.g. energy companies may require one day forecasts, while energy traders would prefer one hour forecasts or large public energy organizations can receive within-the-hour forecasts to ensure power grid stability.

Question and Answer:

Question

How will global warming affect the future of wind energy?

Answer

Wind energy infrastructure has a 30-50 year investment horizon; therefore potential changes in usage or siting due to changes in climate/wind patterns are important for planning. IPCC scenarios provide some information, and 3tier plans to develop its own Climate Group to further research this issue.

Question

What are the limits on clean energy technology?

Answer

Lack of infrastructure for transmission of clean energy, and environmental impacts.

Question

What are the prospects for funding?

Answer

More funding is required. Politics can be a hindrance; competing interests within federal funding agencies affect funding decisions. Millions of dollars for lignocellulosic biomass to ethanol research is available from the U.S. Department of Energy (DOE) and the United States Department of Agriculture (USDA), but is not comparable to the funding received by health sciences. If clean energy research had received funding on par with that for health sciences for the last 20 years, we would be in a stronger position to address today's energy challenges. Recently, the DOE withdrew its support for the first 'clean' coal-fired power plant (using carbon capture and storage technology) in the U.S. (the FutureGen project), citing a financing disagreement with its private funding partner as the reason.

Question

How do wind turbines affect birds?

Answer

Every new wind project undergoes an environmental review, including bird impact studies.

References

Pacala, S., and R. Socolow, (2004), Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies, *Sci,***305,** 968, doi:10.1126/science.1100103.