Supporting Delaware's Clean Energy Business Community Work Group Report to the Governor's Energy Advisory Council

Work Group Composition

The work group was developed to represent a cross section of large and small energy related companies, utilities, state and local government, universities, energy or environmental non-profits and energy consultants. Members of the workgroup are shown in Appendix A.

Work Group Process (May through December, 2008)

Monthly meetings of the workgroup were held, with each meeting devoted to specific sectors of the energy industry. At the meeting, experts in that sector provided an educational overview of the sector, Delaware's positioning in that sector, current industry participants, economic impact of jobs, investment and research funding and straw man recommendations for group discussion.

Subjects covered were: solar photovoltaics, biofuels, hydrogen and fuel cells, vehicle to grid, wind, clean coal, batteries and storage, conservation and energy efficiency, recycling and an update on the Sustainable Energy Utility and its potential economic development stimulus.

Subgroups were formed with expert leadership for each to prepare first drafts of a brief report for Work Group discussion, clarification, and additions. Common and overarching themes were identified for inclusion in comprehensive recommendations. After Work Group discussion a second draft was prepared (shorter and with sharp recommendations) for further Work Group review. In addition to the regular work group members, we had subject experts join us for both presentations and discussions on specific technologies and energy resources. The work group is greatly appreciative of the time and effort made by the presenters and their companies in allowing them to devote the time to assist the work group. All the presentations are available on the energy plan website.[1]

The timeline for adoption of alternative energy options and the priority for Delaware support of each one are quite different. The basic criteria considered were: commercialization status/need for more research and development, cost to customers now and in future, impact on the environment, overall economic and work force development and investment, tax credits or legislation required by Delaware to attract new companies.

Overview

Delaware, its universities and businesses are active in many sectors of the Clean Energy Business Economy. Some of the sectors and technologies are more advanced than others, and there are some in which Delaware plays more of a leading role nationally and internationally. Following the comprehensive recommendations, the sectors will be presented in an order based on "Categories of Emphasis." These include:

[1] http://www.dnrec.delaware.gov/Admin/Pages/SupportingCleanEnergyBusinessWorkgroup.aspx

"Lead" – those sectors in which Delaware is poised to be a leader and thus warrant significant resource allocations and aggressive activities to support and further develop the sector. The Lead sectors are: Wind, Solar, Vehicle-to –Grid, and Hydrogen/Fuel Cell.

"Contribute" – those sectors where Delaware is not yet positioned as a leader, but where there is potential to play a significant role in the overall development of the sector, perhaps contributing to other Regional or National initiatives that can be tailored for Delaware's needs. These sectors would warrant medium resource allocation. The Contribute sectors are: Biofuels and Energy Storage.

"Participate" – those sectors where Delaware companies and universities are involved and the sector has potential for growth, but Delaware is not a leader either because the sector and its technologies are more fully developed or because Delaware is a center for research in the technologies rather than also an implementer. These sectors also warrant investment and institutional support. The Participate Sectors are: Conservation and Efficiency, Clean Coal, and Recycling.

Within each sector, the recommendations are presented in basic order of priority, with the highest priority recommendations presented first.

OVERARCHING RECOMMENDATIONS

1. *Delaware should develop and implement a comprehensive Clean Energy Business Development Initiative*.

   This is the primary recommendation of the work group. All the rest of the recommendations are either in support of or specific implementation pieces of this recommendation. To implement this, the Economic Development Office (DEDO) will need to establish the Clean Energy Business Cluster strategy as a high-level, high-priority strategy with appropriate leadership and resources. To be attractive both nationally and on a global basis, DEDO should conduct a review of programs being offered by other states and countries as part of their energy initiative, including: R&D support, grants for capital investment, tax relief, etc. Many states and countries have established programs and although incentives will not be the only deciding factor for business location decisions, they can heavily influence where R&D is completed, along with pilot scale facilities and major commercial supply manufacturing. The strategy should include metrics with regular monitoring and measurement to assess progress as the strategy is implemented.

   a. Provide grants and other forms of assistance to strengthen and support clean energy businesses currently located in Delaware.
   b. Develop opportunities and a suite of incentives to recruit clean energy business manufacturing operations to Delaware. In light of the recent success of bringing the wind industry to Delaware, initial focus should be on attracting a turbine or blade manufacturer and other ancillary businesses to locate in Delaware.
   c. Provide seed money for clean energy business start-ups to drive new business development. New ideas will likely come from research at local academic centers, so

university and state policies that encourage technology spin-off companies should be instituted.

d. Identify private/public demonstration projects of alternative energy and conservation concepts to position DE as a national model.
e. Strengthen and expand the Delaware Green Industries Program. The Green Industries Program, created in the mid-1990's, was designed to encourage use of recycled products and source reduction. The program provides financial incentives, in the form of tax credits and tax reductions, and technical assistance. The program has been underutilized. A review of the financial incentives should be conducted to improve the effectiveness of the program. In addition, the program should be reviewed for potential expansion to include clean energy businesses and businesses incorporating clean energy technologies.

2. *Support clean energy research at Delaware's universities.*

Strong research programs will attract outstanding researchers to locate in Delaware, and will serve as a draw for clean energy businesses to locate in Delaware as well as the opportunity to grow new businesses based on the research (see rec. 1.b). The State should build on the existing relationship with Delaware State University and the emerging UD Energy Institute and its related research centers. The Energy Institute will provide an excellent opportunity to coordinate necessary research efforts and to train workforce in many aspects of alternative energy. In order to function well and to be competitive with similar institutes in other states, it needs a very strong immediate commitment from the State of Delaware to make the State one of the leaders in this rapidly growing field.

This includes helping the universities to obtain Federal funding for clean energy related research projects through provision of matching funds or supporting projects with the federal delegation.

3. *Implement a comprehensive energy workforce training strategy.*

A trained workforce is a critical component for a new clean energy business economy. The most immediate needs are for energy conservation and renewable energy installations and the assembly, installation, and maintenance of an offshore wind park. Distributed renewable energy technologies and energy efficiency investments in residential and commercial establishments throughout Delaware will require a trained small business workforce to deploy across the state. In addition, Delaware Technical and Community College (DTCC) is establishing an Energy Management program which will include operation and maintenance of wind turbines. There is a need, nationally, for additional wind technicians, and Delaware has the opportunity to become the premier training center serving regional and national training needs in addition to those in Delaware. The current "Facility Energy Management" certificate program offers an introduction to wind turbines and other renewable energy sources. Additional continuing education training in Green Building design and techniques, energy auditing and other sustainability-related professional and trades skills are being developed. DTCC is well suited to offer the programs that prepare the technicians who will produce, install and maintain new energy related technology, and undertake the massive job of retrofitting existing buildings and systems. State investments combined with grant awards will be necessary to fund the resources required to fully implement these vital learning programs.

There is a need for graduate level electrical and mechanical engineers for R&D efforts and technically capable undergrads for lab technician and program support.

The strategy should include a workforce continuum, from programs in the vocational/technical schools to DTCC to the University of Delaware and Delaware State University.

Fundamental to the strategy is the need to considerably strengthen the math and science programs in elementary and secondary schools throughout the state. This is critical both for a successful workforce training program and to attract quality employers and workforce to locate in Delaware and should be prioritized in ongoing school reform efforts.

4. *Implement an aggressive public awareness program.*

Improve public awareness of the role the clean energy technologies can play in the life of Delawareans and in meeting the state's energy and climate change needs. A full scale Marketing Plan should be recommended to drive communications and execution of our plan. This plan should specifically include both local education on how to utilize the clean technologies and external marketing of "Why Delaware". The effort should target all stakeholders (public, state and federal government, targeted industries and companies, and academia).

"LEAD" SECTOR RECOMMENDATIONS

Wind

Overview of Industry in Delaware

Delaware has an opportunity to develop a significant wind energy industry. The state has jumpstarted the US industry with its historic power purchase agreement (PPA) between Bluewater Wind and Delmarva Power, garnering national and international attention and stimulating other states to solicit projects. This happened because the state took an active role in requiring a new, in-state power plant with a long-term contract for stable-priced power. As a result, Delaware has already been emulated by New Jersey and Rhode Island, with others, including Maryland, considering RFPs for offshore wind.

Delaware is well positioned to take advantage of this growing industry given its first mover status, its large wind resource (almost all offshore), a long coastline with protected ports, one deepwater port, an underutilized manufacturing base, strong public support, and the nation's leading academic research group on offshore wind power (UD). The power sector is also well positioned for wind expansion. Currently 100% of our in-state generation is derived from fossil fuels, and we are currently importing a third of our electricity due to the high costs of those fuels. The expansion of wind generation makes sense for the electricity sector to stabilize prices and reduce our high carbon risk profile.

Existing Businesses

Bluewater Wind (Newark): During the project development phase, two permanent DE employees, approximately 50 consultants, analysts, public relations, etc and about $10M spent, to develop project and contract. During construction, 400 – 500 skilled and technical jobs ramping up over a three-year period during engineering and construction, then dropping to approximately 80 permanent employees for operations & maintenance of the facility over its 25 year project life.

Port of Wilmington (Wilmington): Offloading imported components from deepwater ships, loading onto barges to carry to assembly site.

Claymont steel (Claymont): Potential for manufacturing sub-surface piles. Would require equipment for bending steel plate into 15' diameter tube. Not currently contracted with Bluewater. Unknown employment impact.

Philadelphia Gear (New Castle): A manufacturer of large, high precision gearboxes such as those for wind turbines. The company has a new 44,000 sq.ft. facility with enhanced 1500 horsepower test stand capability and 25 ton crane capacity.

DelStar Technologies (Middletown): Produces a high performance fabric used in the manufacturing of wind turbine blades.

Automobile manufacturing (Chrysler and GM): Trained manufacturing workforce with skills that could transfer to wind turbine assembly.

Research Activity

University of Delaware (UD): With its newly created Center for Carbon-free Power Integration, UD is the lead university research group in the US on offshore wind. Areas include planning, policy, and grid integration. The University currently employs eight people conducting research, analysis, and teaching on offshore wind. UD's Center for Composite Materials is also considered world class in conducting research on materials and design of advanced wind turbine blades.

Ongoing Pilot Project

The current Bluewater Wind project is the size of a large power plant with 230 MW initially contracted, and the potential additions of other contracts could increase this to as much as 450 MW, with a maximum project size of 600 MW. Nevertheless, as potentially the first US facility to be built, it could be considered a pilot project. After this project is underway, it will be easier to design and plan the next offshore wind farms.

Potential for Industry Growth in Delaware over the Next 20-30 Years

The current installed power generation capacity in Delaware is 3400 MW and the state's total load is 11,600,000 MWh with about a third of the load required for Delaware generated from outside the state.

The offshore wind power potential for Delaware is over 19,000 MW of capacity or 65,000,000 MWh/year output. Delaware could become totally energy sufficient and meet the 2% annual growth in electric demand by adding 2,100 MW of offshore wind capacity over a 10 year period. That is the equivalent of 5 Bluewater wind sized projects (current economic assumptions are based on one 450 MW project). Correspondingly this would dramatically increase the job creation and sustainability of the work force.

In addition, White Pine Energy suggests that the use of new technology high efficiency flywheel storage devices could enhance the available capacity from wind and help stabilize the variability of wind systems.

The proposed Mid-Atlantic Power Pathway (MAPP) will strengthen the reliability of the Mid-Atlantic region's electricity grid by complementing other ongoing transmission upgrades. It also would increase the region's power import capabilities. MAPP will provide the region with greater access to affordable electricity generation sources and provide a pathway for electricity from clean, nuclear and wind generation.

http://www.powerpathway.com

Beyond the next 10 years additional offshore wind capacity could be added for the purpose of exporting power to neighboring inland states. This consideration would require the MAPP project to be designed to include options for transmission interconnection and storage devices to accommodate the variability of wind power production.

Delaware has the potential to become the staging area for regional deployment of wind power infrastructure to coastal neighbors greatly increasing the size and duration of the workforce to be created by the Bluewater project.

Recommendations

1. *Business Development*
   The Delaware Economic Development Office should be funded and tasked with the development of a favorable climate in Delaware for new primary wind industry and ancillary support businesses for the wind industry.

2. *Transmission*
   The State should facilitate the construction of adequate transmission capacity to accommodate the development of 2,000 MW of wind generation during years 1 – 10, and an additional 4,000 MW of wind generation during years 11-20. This would accommodate offshore transmission of all the developed wind projects making landfall in Delaware, and facilitate Delaware becoming the economic hub for the development, construction and the transmission of the most significant wind power potential on the East Coast.

3. *Center of Excellence in Offshore Wind*
   The State should work with its Federal Delegation to support graduate training and a Center of Excellence in offshore wind at UD's Center for Carbon-free Power Integration. Designation as a Center of Excellence or national center would lead to an approximate $1M/year budget. Federal or federal/state funding could be utilized for stipends for students and postdoctoral scholars, and a base funding level for the R&D program.

4. *Renewable Portfolio Standards Modifications – (LEGISLATION)*
   The State should evaluate its Renewable Portfolio Standards legislation to provide increasing incentives for Delaware electricity users and load-serving entities to purchase an increasing number of blocks of wind power, incremented every two years with the stated goal of meeting all growth and replacing imports. The 2007 changes to the Renewable Portfolio Standards made Delaware's legislation one of the most aggressive in the country.

5. *Power Sector Planning*
   The State should adopt policies that better adapt power sector planning to fuel-free generation

Solar

Overview of the Industry in Delaware

Sunlight can be used for generating electricity, heating and cooling of buildings, domestic and process water heating, and pool heating. These approaches have been aggressively implemented in Europe over the past decade and, in many ways, the US is still a developing country with respect to solar energy. Delaware is in an excellent position to benefit from the expected growth in the solar energy field. It has several key players in research, manufacturing, and education, such as GE Energy, DuPont, the University of Delaware, and Delaware State University. In addition, the creation of the Sustainable Energy Utility (SEU) has the potential to significantly increase the deployment of solar technologies as distributed energy sources throughout Delaware.

Prior to 2007, little photovoltaic (PV) was installed in the State. During 2007 approximately 0.5 MW_{peak} was installed and 2008 estimates may be 50% to 100% higher. In total, Delaware has approximately 2.0 MW_{peak} installed. Each MW_{peak} of PV generates an average of 1300MWhr of energy per year. Today approximately 0.02% of the state's energy consumption is being met by solar.

Existing Businesses

Today approximately 300 people are employed in the solar industry in the state of Delaware. This is dominated by the 200 employees of GE Energy's manufacturing plant in Pencader Industrial Park in Glasgow. The only other large employer is DuPont, with an estimated 40 employees. The remaining 60 jobs are in the area of solar installation, of which there are approximately 11 different installer groups operating in the state. All of the above jobs are in the area of PV solar, the direct conversion of sunlight to electricity. There is little activity in solar thermal for water or space heating, or solar pool heating which are both big opportunities for growth in Delaware.

Research Activity

At UD, the following Research Centers and Programs are directly involved in solar energy conversion research: Energy Institute, Institute of Energy Conversion (IEC), and the Center for Catalytic Science & Technology. The IEC is a nationally recognized center of excellence. On the educational side, a new energy minor for engineering undergraduate students was just created in the College of Engineering. The Solar Hydrogen Integrative Graduate Education and Research Traineeship Program (IGERT), funded by the National Science Foundation, is located at the University of Delaware and provides a path for graduate level education in solar cell technology research. A National Science Foundation funded Research Experience for Undergraduate program also currently brings in 10 domestic students every summer to UD.

Green Energy Fund

The Green Energy Fund offers a 50% rebate of the installed system cost. Currently, the 2008 funds are exhausted, and reservations for rebates are extending out to January 2011 for residential systems (27 months of proposed installations).

The Green Energy Fund grows at approximately $2.6MM per year, and is funded by a fee of 0.36 $/MWhr of usage for Delmarva (0.18 $/Mwhr for Munis and Coops). This can be compared to the fund operated by New Jersey, which collects 0.86 $/MWhr. Germany funds its Green Energy Fund with a charge of 5.40 Euros/Mwhr, and further commits to payments for a 20 year period. This aggressive policy covers all renewables and has made Germany the center of the PV manufacturing world, with over 225,000 jobs and 3% of its overall energy demand met by solar. Delaware is far sunnier than Germany, with 50% more electricity generated on the same PV equipment.

Owners of PV are presently compensated by a combination of avoided electrical charges (demand and usage) and by selling Solar Renewable Energy Credits (SRECs). There is an open market in SRECs with New Jersey. These SRECs are purchased by power producers in New Jersey to meet the New Jersey RPS requirements. In August, 2008 SRECs sold for 552-170 $/MWhr, or 0.52-0.17$/kWhr.

Figure 1. Example of solar installation located on Route 7 in New Castle County

Potential for Industry Growth in Delaware over the Next 20-30 Years?

The manufacturing base established by GE Energy and DuPont is likely to continue, as the industry has been growing at >40% per year for the past 8 years. Most recently, the industry is undergoing some difficult times as ramifications of the financial crisis are being felt, and prices are generally falling for PV equipment. Although this is good news for the consumers and installers, it may cause some consolidation of the manufacturing industry in the short term.

Growth of Delaware's installation businesses will depend largely on the Green Energy Fund and perhaps even more on the effectiveness of the SEU and its ability to incentivize solar installations.

Present policy will fund the installation of 1.0 MW_{peak} of new PV each year; slightly more as PV equipment prices fall. An installed Base of 1,100 MW_{peak} is needed to meet the solar portion of the State's Renewable Portfolio Standard (RPS) requirement. The Green Energy Fund, as presently designed, will support only 14 MW_{peak} over that time frame, thus will not provide sufficient financial incentive to achieve the requirement.

Recommendations

1. *The immediate step is that the State needs to conduct a financial analysis of options for the Green Energy Fund in how it will interact with the SEU and federal incentives to achieve or exceed the 2% solar carve-out required in the RPS law.*
   This analysis is necessary since the Fund as currently configured will not incent sufficient solar installations to meet the carve-out and the backlog for rebates is increasing. A key question is what type of program will be best to achieve the State's goals.

One option to consider in the analysis is to provide payments to solar electricity producers based on the energy generated. These payments could serve as an incentive, guaranteed for the 20-year life of the system. The rate of payment could be indexed down overtime as PV equipment prices drop, with the index being designed to maintain a modest return for solar electricity producers. This change could work in conjunction with the SEU, which could design its policies to assist with upfront equipment costs.

This recommendation could result in legislation amending the Green Energy Program.

2. *Eliminate Deed Restrictions – (LEGISLATION)*

Presently, deed restrictions exist in many communities that do not allow solar hot water or solar electricity systems, creating a substantial roadblock to new business opportunities in solar energy conversion. In the last General Assembly a bill was introduced to amend title 29 of the Delaware code relating to solar photovoltaic systems, banning the use of covenants or other restrictions to prohibit the installation of solar photovoltaic systems in Delaware. The legislation passed the Senate but remained in House Committee at the end of the session. Similar legislation should be introduced, but should also include solar hot water systems, which could in principle still be prohibited by deed restrictions.

Vehicle-to-Grid

Overview of the Industry in Delaware

Vehicle-to-grid (V2G) interconnects the automotive industry and the electric industry. The batteries in plug-in cars, whether all-electric or plug-in hybrid, are used for services of value to the electric system. These include balancing fluctuations in power (called "regulation") for the large grid operators - in our region, PJM Interconnect. As solar and wind power increase on the grid, electrical storage in batteries will also become valuable to smooth out mismatches between renewable power output and the need for electricity ('load'). The V2G technology was developed at UD, and UD is widely considered the leading R&D group developing it. UD has 16 researchers engaged in software development, prototype vehicle modifications, federal policy initiatives, marketing research, and policy and rate research, toward enabling V2G businesses. This is organized within UD's new Center for Carbon-free Power Integration. Additional information on the research can be found at www.udel.edu/V2G.

Related Entities and Operations

The Mid-Atlantic Grid-Interactive Cars Consortium (MAGICC) is an industrial consortium furthering the preconditions for the business model for V2G. Delaware-related entities participating in the consortium include UD, Pepco Holdings, and PJM Interconnect.

Pepco Holdings, Inc. Parent company of Delmarva Power, has invested $250,000 in V2G research and development at UD. They could plausibly play a role in V2G businesses, although they have not committed to do so.

AutoPort (New Castle) has the capability to process 250,000 "light conversions" per year, or several thousand of the more extensive conversion of gasoline to electric vehicles.

Pilot Projects Underway

One pilot project at UD operates an electric car and the UD fuel cell bus as power plants, controlled by a signal from PJM. This pilot has garnered national attention within the electrical industry.

A second project, underway and funded, will place about 6 vehicles in local fleets, all controlled by a server to respond to the PJM signal as a group.

Negotiations are underway for an assembly facility in Delaware to refit gasoline cars to be fully electric cars with built-in V2G capability. This would satisfy back orders for about 10 electric cars and would provide in-state capability to produce electric cars for experiments and niche markets—up to 1,000 per year. Due to low volumes, cost of the package would be $70,000. In volume OEM production, with suppliers also in volume production, the cost would be approximately a $5,000 premium over the comparable gasoline car.

Potential for Industry Growth in Delaware over the Next 20-30 Years?

It is plausible that over next 20 years up to 50% of the automobiles in the state would be either fully electric or plug-in hybrid, and 70% of those, or 35% of the automobiles in the state on V2G contract. Implications of this include a thriving V2G business with gross revenues of $1,000 per car providing regulation (100,000 cars * $1,000=$100M) plus $500 per car providing other V2G services (180,000*$500=$90M). Total gross revenue for V2G of $190M. If Delaware maintains its current lead on this technology, there could be additional licensing, training, franchising businesses outside Delaware.

Short-term business in years 1 – 10 could include production at rates of 100 to 5,000 vehicles per year that are customized for V2G. As cars become more electrified but still lack V2G capability, this could be accomplished at higher volumes and lower cost. Low volume capability also enables conversion of custom vehicles (e.g. mail trucks, bucket trucks) even after OEMs pick up plug-in cars.

Possible production in Delaware of OEM electric vehicles in existing plants. The two major auto assembly plants in DE employ over 2,000 people (1,100 people at Chrysler Newark Assembly (to be shut at the end of 2008), and 920 employees at General Motor's (GM) Boxwood Road Assembly. These plants are less economic because their supply chain is long, with many parts coming from the Midwest. However, electric cars would have different suppliers, some starting anew. The Chrysler plant has high-volume but inflexible equipment, less suitable for a new model starting up. The GM plant is more flexible, with ability to run four or more models at the same time, which means production of 10,000/year can be economical. GM is currently running at less than ½ capacity.

Opportunities to develop suppliers to V2G assembly plants:

- There are a few manufacturers of auto parts in Delaware providing parts for our assembly plants, including plastics. There are many smaller shops providing smaller volumes to automobile refitters.
- There are plausible suppliers of power electronics for electric cars at low to medium volumes. However, at higher volumes we currently have nothing that could compete with high-volume power electronics suppliers such as Delphi.
- Companies like DuPont and W.L.Gore could become suppliers for large-scale battery production. However, a V2G business in Delaware, or electric-car manufacturing in Delaware, does not guarantee battery production locally.

Each car is the equivalent of adding about 400 W_a continuous to load. With V2G, there is the additional ability to charge or discharge about 10 kW when the grid needs it[2]. Thus 50% of the state's cars electric at 400W_a implies 160 MW_a additional load (1,402,000 MWh/year), approximately $224 M in electric sales revenue per year to Delaware utilities, with about 2/3 of that passed through to generators.

Adding V2G, and assuming 35% of state automobiles under V2G contract, provides the ability to produce or absorb 2,800 MW on command (280,000 * 10 kW).

For each privately-owned vehicle, a plug at home and one at work ($1,200 total installation cost). Additionally, plugs at stopover points of > 15 minutes (rest stops, restaurants, tour destinations, business meetings) for opportunistic "top off" charge (15kW recharge adds a mile a minute).

Due to the above V2G control ability, a large-scale deployment of intermittent renewables (wind and solar) would be much easier to integrate into the power system.

Recommendations

1. *Establish the infrastructure, incentives and rules to facilitate V2G development and implementation*. Specific approaches could include, but are not limited to:
   A. *Provide incentives for businesses to facilitate startup of refit vehicles with V2G.*
      This may involve financial incentives, training support, and/or other forms of market priming.

   B. *Subsidize initial hand-assembled electric vehicles with V2G to get 100s of vehicles out and running V2G.*
      Three possible mechanisms:
      i. A state "freedom from oil" gasoline tax adder of 2¢/gallon would raise approximately $6.4 million. This could provide an initial subsidy of $30,000/vehicle to about 200 vehicles/year, which would bring early customer vehicle costs down to an expensive but affordable $35,000. 200 vehicles/year would make a viable fleet for V2G power in just a couple of years. As vehicle costs come down, the per-vehicle subsidy would decline and # of vehicles/year would increase. (LEGISLATION)
      ii. Use of RGGI or other funds also as a per-vehicle subsidy, similar to above.
      iii. Provide state income tax credits for purchase of plug in hybrids capable of V2G at 10kW or more.

   C. *The PSC and Energy Office should review existing rules and legislation statewide to identify needed changes to enable V2G service provision*. (LEGISLATION)

   D. *Public Service Commission should allow DP&L infrastructure costs (for "docking stations" at work/employment centers) to be recoverable in rate base and should investigate and evaluate the benefits and costs of purchase by electric utilities of V2G-capable fleet vehicles.*
      Because V2G can have distribution system benefits and enable larger renewable fractions, it should be considered as part of the rate base, with cost-recovery and return on investment.

[2] The vehicle we are now working with can produce or absorb 19 kW. To compensate for building power limitation in some locations, and to adjust for cars not plugged in when power is needed, we use 10 kW here.

E. *Provide prime parking places with plugs at major stopover points in Delaware*.
This should be pursued through public/private partnerships at locations where people would stop for at least ½ to one hour. Locations along major roadways, such as I-95, would include places where vehicles can be charged (such as the rest area). Locations where people spend longer periods, such as malls, may be suited for both charging and discharging plugs.

F. Conduct a pilot project with state government or other large fleets to prove the economics of selling back to the grid.
This is another opportunity for public/private partnerships.

Hydrogen/Fuel Cells

Overview of the Industry in Delaware

The fuel cell and hydrogen industry in Delaware is vibrant and active. Two major industry suppliers of fuel cell components, W. L. Gore and Associates, Inc. and E. I. Du Pont de Nemours, Inc. are headquartered in Delaware. These two companies together account for the majority of the membrane electrode assemblies (the heart of the polymer electrolyte fuel cell) provided for fuel cell systems made today. Additionally, Ion Power is a local small business that supplies materials for fuel cells. In the hydrogen production/distribution arena, Air Liquide houses its North American research facility in Newark and has a hydrogen facility filling station at their site.

Delaware also has a good regional location, with numerous major fuel cell industrial suppliers within ~100 miles: Air Products, Inc in Allentown, PA, (hydrogen), BASF in Iselin, NJ, (catalyst materials), and Johnson Matthey, Inc. in West Chester, PA. (catalysts and MEAs), Arkema, Inc. in Philadelphia, PA, (membrane materials), and Millennium Cell, Inc. in Eatontown, NJ (fuel cell systems). The total employment in fuel cell related businesses within these companies is currently many hundreds, with the potential to grow to many thousands within 10-15 years.

The academic expertise in fuel cells and hydrogen is equally rich and varied. At University of Delaware (UD) approximately25 faculty are engaged in fuel cell research, and Delaware State University (DSU) is active in research on hydrogen storage materials. In 2008, a Center for Fuel Cell Research (CFCR) was founded at UD. The CFCR conducts fundamental research on fuel cell and hydrogen infrastructure science and technology to improve performance and durability of fuel cells using novel materials, architectures, and operating strategies, while enabling commercialization with technology transfer to industry. The Center will also conduct public outreach to educate the community about the benefits of fuel cells. Local industry has a history of partnering with the universities to fund research efforts.

Ongoing Pilot Project

Currently, the most visible project in the state is the UD Fuel Cell Bus Program. The first bus (22-ft) has been in operation on UD campus since April 2007. A second bus (22-ft) will be added in Spring 2009. Two additional, 30-ft buses will be added in 2010. One hydrogen refueling station is in operation at Air Liquide, and two more stations are planned for Wilmington and Dover. By 2010, we expect Delaware to have a fleet of at least four transit buses and a network of three hydrogen refueling stations. The project has $10million in federal funding and has received $400,000 in funding

from DNREC and some smaller grants from DEDO, funding sufficient for the increased buses and fueling stations.

Potential for Industry Growth in Delaware Over the Next 20-30 Years?

Delaware has an excellent base of companies (e.g., DuPont, WL Gore, Ion Power, Air Liquide, and Air Products) and a superb university research environment at UD and DSU to support it. The region is already a hub for production of fuel cell components, and if properly leveraged, could become "the silicon valley of fuel cells". By mid-century, the fuel cell industry will likely be a multi-billion dollar industry with products in automobiles, portable electronic products like laptops and cell phones, and stationary applications like backup generators and/or home power stations. With proper stewardship, Delaware could be the home to tens of thousands of high paying, manufacturing and fuel cell related jobs in the next 20-30 years.

Recommendations

1. *In order to turn the dream of "the silicon valley of fuel cells" into reality, the state government, local industry and the Delaware universities will have to have a coordinated, strong approach to fuel cells.*
   Specific aspects of the approach should include:

   A. *Invest in a high visibility, high impact project.*
      Proposed project: Create a public/private partnership to fund a fast fill hydrogen station at the I-95 rest area. This station would leverage the state's network of hydrogen refueling stations and location on the New York to Washington DC "hydrogen highway". The project could help to attract a major automotive company to set up a fuel cell vehicle lease program here for cold-weather fuel cell vehicle testing. Cost for the fast fill station: ~$1million.

   B. *Implement a State fuel cell vehicle fleet pilot project.*
      The pilot project would help to create a functioning system of fuel pumps and vehicles located near where the research is being conducted. This will be useful in attracting new fuel cell businesses to the state. The project can also be used as a national educational tool for increasing public awareness and acceptance of fuel cell vehicles.

   C. *Institute fuel cell automotive and stationary fuel cell tax credits that mirror (or lead) federal tax credits for investments in automotive or stationary fuel cell systems in the state.*

"CONTRIBUTE" SECTOR RECOMMENDATIONS

Biofuels

Overview of Industry in Delaware

DuPont is a global leader in developing the value chain from agricultural carbohydrates to biofuels and biomaterials. A number of significant partnerships have been established to accomplish

this with others anticipated in the future. Some of the current partners are Genencor, Tennessee, Iowa and BP.

It is unlikely Delaware will be the home for large production of agricultural feedstocks as their collection and conversion to sugar/alcohol and finally refined and blended into biofuels. The critical research and business development leadership is located in Delaware and is a major factor in the corporate strategy of DuPont. Smaller companies such as AthenaBio and Fraunhofer CMB and research at UD and DSU can contribute specific improvements to steps in the value chain such as enhanced seeds and feedstock candidates, high temperature, continuous ethanol and biobutanol production with hyperthermophilic bacteria, and new enzymes for bioprocessing. There is a modest facility for soy diesel in Delaware.

Potential for Industry Growth in Delaware over the Next 20-30 Years?

The current fuel additive, ethanol derived from the edible part of corn, is not a sustainable answer to the oil supply and cost issue. More attractive solutions under development and demonstration are bioprocessing of the stover from the corn plant or use of non food source replenishable plants such as switch grass. One of the most promising fuel additives is biobutanol instead of ethanol. Biobutanol is less corrosive and has much more energy/environmental value than ethanol. This is the goal of DuPont and its partners over the next 20 years.

The potential world market for biofuels exceeds $100 billion with an annual growth of 20%/yr. The Innovation Center at DuPont's Experimental Station in Wilmington is the hub for the biofuel leadership. It received a $6 million grant from the State as a commitment of its support. Currently there are about 100 DuPont employees working to build one of the largest businesses in DuPont history.

Recommendations

1. *Expanded Research*
   Work in close alignment with Delaware-based companies and universities to encourage expanded research and business leadership in the State, including the attraction of partners.

2. *Demonstration Projects (LEGISLATION)*
   When improved additives beyond ethanol are commercialized, consider State legislation to support its demonstration and adoption.

3. *Incorporation into Refinery Operations*
   If appropriate, assist Valero and DuPont to partner for use of improved additives in the Delaware refinery.

Energy Storage

Overview of the Industry in Delaware

Many of the sources of alternative energy have the common issue of variable power delivery (such as the sun or wind for electricity) or a limited power life without recharge (such as electric or hybrid vehicles or electronic devices).

There are many regional companies active in the development of materials or components in the energy storage market. These products are electrolytes, separators, electrode binders, electrodes and flywheels. These comprise the system of battery and capacitor devices. The current companies in Delaware engaged in storage technology are DuPont, W.L. Gore, Air Products and small start-ups.

There are several key research projects on energy storage being conducted at UD. Research on energy storage in nanostructure carbon and other nano materials is aimed at developing new energy storage devices, i.e. electrochemical supercapacitor, a new type of electrochemical energy storage system that utilizes the capacitance associated with charging and discharging of electrons in double-layer format. Development of high energy and high power devices has been one of the areas of top most importance in recent years; the rechargeable batteries/capacitors and/or fuel cells are anticipated to be the primary sources of power for the future.

For the past nineteen years, the Magnetics Lab at the University of Delaware has been involved in the study and development of materials for high performance permanent magnets. These materials are currently being widely used in a vast number of commercial and military applications. These applications include advanced motors, generation and distribution of electrical power (windmills, hydroelectric turbines, etc), the automotive and aviation industry (hybrid electric vehicles, MagLev trains, more electric aircraft, etc.), the information storage industry, medical surgical and diagnostics equipment, bioengineering, and numerous military weapons, guidance and communications systems. The high strength of these magnets will allow lighter, more compact, lower cost and more energy efficient devices to be developed which will help us to reduce our dependency on fossil fuels and enable "more electric" product commercialization.

Pilot Projects, in place or under consideration, include separator development and R&D; electrolyte R&D; electrode materials development: and battery pack development and assembly.

Potential for Industry Growth in Delaware over the Next 20-30 Years?

The current world market is about $60 billion/yr. and is expected to grow to over $300 billion/yr. as alternative energy and longer life electronic devices are commercialized and adopted. Also the level of federal funding will continue to escalate from over $100 million. Energy storage is a common denominator for many very large markets such as transportation, consumer electronics and electricity power back-up which can involve many companies.

Delaware, by having two major multi-national suppliers that are active in the market, along with many companies that could enter this market, and university support of alternative energy production methods, could become a leader in R&D of Energy Storage Materials (battery and capacitor). The newly formed UD Energy Institute and similar efforts at Delaware State could become the cornerstone to development and directed R&D in areas of interest to Delaware based companies. This could feed the potential growth to establish technology development programs and encourage suppliers to locate R&D and scale up activities in Delaware. These suppliers, with state support, could establish and grow

pilot production and commercial facilities supporting materials supply to these developing and growing applications.

Most of the industry research programs for energy storage are staffed with 8-10 researchers; pilot production capability for energy storage could add another 15-20 highly skill workers and production facilities can add significantly higher numbers. Delaware could potentially establish 10 different programs in Energy Storage in the next 20-30 years.
Continued growth from the existing Delaware base could be greatly expanded by attraction of new companies into the State.

Recommendations

Links to alternative energy developers and support for the smart grid will drive many changes and opportunities in energy storage research and materials production.

1. *Overall, to achieve this potential, Delaware should establish a governmental support effort in funded R&D, incentives for suppliers to locate in Delaware and efforts to raise awareness of energy storage.*
   This would include:

   A. Encouragement and possible match of federal grant research funding for both academic and private sector efforts.
   New breakthroughs in materials and components are required to meet the environmental and electric capacity demands of consumers whether for transportation or digital devices. This research support is particularly important for research at the universities that is relevant to the needs, or in partnership with, local companies.

   B. New Business Development
   New companies in energy storage, particularly energy storage materials suppliers, should be incentivized by DEDO to locate near Delaware's material and component research base. Partnership demonstration projects discussed elsewhere such as vehicle to grid, wind and solar would also help.

   C. As systems with improved storage capacity are commercialized the Sustainable Energy Utility will be important in driving adoption.
   Early adoption programs such as this can interplay with company research and assist in attracting pilot plants and programs.

"PARTICIPATE" SECTOR RECOMMENDATIONS

Conservation and Energy Efficiency

Overview of the Industry in Delaware

In 2007, SS1 for SB18, created the Sustainable Energy Utility (SEU). The SEU was established for the purpose of (1) promoting and providing energy efficiency services and (2) increasing the

deployment of distributed renewable generation facilities. The SEU was created as a non-profit tax exempt organization with $30 million in bond authority, $20 million from carbon auction proceeds, and $5-10 million from the sale of renewable energy certificates.
The legislation set some specific goals and targets for the SEU:

- Reduce conventional energy consumption by 30% for participants by 2020 (assumed 2020 participation rate of 33%)
- Invest in 300-40 MW of renewables installed onsite (by 2020)
- Double the yearly Low- & Moderate Income Weatherization rate by 2012 under the SEU's Affordable Energy Program
- Create Green Communities Program to assist school districts, local governments and public university and health care facilities to 'go green' (annual investments might total $2-4 million)

Energy conservation and efficiency audits and installation of renewable energy equipment are conducted by businesses that include heating and cooling companies, electrical contractors, well drillers, specialized energy service companies, etc. There are currently 14 solar installation businesses in Delaware (increased from 6 prior to enactment of the new RPS law in 2007), 1 solar hot water installation company, 35 geothermal installation contractors, and 2 wind turbine installers.

Potential for Industry Growth in Delaware over the Next 20-30 Years?

With the significantly increased demand for energy conservation and efficiency services and renewable installations that is anticipated to be generated by the SEU, there will be a substantial need for additional workers and businesses to provide those services. Estimates of the average number of jobs created per million dollars invested are:

ENERGY EFFICIENCY & CONSERVATION	5.4 jobs/$million invested
Residential Buildings	8.2
Commercial Buildings	6.3
Transportation	4.6
Appliances & Equipment	4.0
RENEWABLE ENERGY	5.3
Wind	5.7
Solar PV	5.65
Geothermal	4.7

As a comparison, coal plants are estimated to create 4.0 jobs per million dollars invested.[3]

Recommendations

Key to the success of this sector in creating jobs in Delaware will be the success of the SEU. The SEU will be the main driving force for the demand for companies in the energy efficiency and conservation field.

[3] Sources:Erhardt-Laitner, *The Market*. Fehrs, *The Energy*. ErhardtMartinez & Laitner *The Size of the U.S. Energy Efficiency Market*ACEEE, 2008. Singh & Fehrs *The Work that Goes into Renewable Energy*. REPP, 2001.

The main recommendation for this sector is enhanced workforce development. The details of the recommendation are included in Overarching Recommendation #3: *Implement a comprehensive energy workforce training strategy*.

Clean Coal Technologies

Overview of the Industry in Delaware

More than fifty percent of U.S. electricity supply comes from coal. The Federal government recognizes the importance of finding new ways of producing power from coal, while simultaneously expanding environmental protection and confronting the issue of global climate change. About two pounds of carbon dioxide (CO_2) are emitted for every kilowatt hour of electricity produced; a modern 1000MW coal plant emits more than 20,000 metric tons of CO_2 daily.

The leading technological option for reducing CO_2 emissions from coal into the atmosphere is sequestration: This involves capturing the gas produced by coal combustion and burying it in deep geological reservoirs such as aquifers. Air Liquide, with research operations in Newark, is active in the development and evaluation of one of the technological approaches to carbon sequestration, oxygen-fired (Ultra) supercritical pulverized coal combustion. The "oxy-fired" plant is designed for coal combustion in oxygen to generate flue gas rich in CO_2 and the CO_2 is captured for sequestration but after combustion. One key advantage of oxycombustion is that it can be applied to both new and retrofit plants where as IGCC is only possible for new plant applications.

In addition, Compact Membranes (Newport) develops membrane products for coal fired transportation (trains) that enrich the oxygen feed for cleaner and more efficient combustion.

Potential for Clean Coal Development in Delaware

The continuous development of clean coal technologies could include 100+ technology jobs in the state. The types of skills needed would include chemical engineering, mechanical engineering, environmental engineering, process control, combustion engineering, metallurgy and inorganic chemistry.

Public, energy and environmental policy will greatly impact our ability to make clean coal technologies commercially viable, we need to continue to expand our understanding of geo-political issues, financial and environmental impact of our energy needs. The UD Energy Institute will play a key role in this area.

Recommendations

1. *Reduce regulatory uncertainty*
   Push the Federal government for a regulatory regime that reduces uncertainty for large scale carbon capture and sequestration (CCS) technologies and addresses long term liabilities. In absence of federal regulations, reduce state regulatory uncertainty regarding CO_2 capture and sequestration costs.

2. *Expanded Research*
   Support research on large-scale demonstration projects for CCS, because it offers a practical option for continuing to burn coal competitively in a carbon-constrained world.

Recycling

Overview of the Industry in Delaware

Recycling is a nascent industry in Delaware which has finally established a secure foothold. More so than most industries reviewed by this workgroup, the recycling industry in Delaware is strongly influenced by and, in some sectors, tied to government policy. Recycling saves energy and as such is a relevant topic for this workgroup and the energy planning effort.

'Recycling' typically includes recycling and reuse activities including, but not limited to: post-consumer recycling of residential and commercial cans, paper, cardboard, plastic, etc.; pre-consumer, industrial waste and byproduct recycling (such as wood shavings or chemical solvents); the collection, processing and remanufacture of these materials; and the reuse of materials such as tire re-treading and timber for building construction.

Due to the diversity of activities included in 'recycling' and different definitions of recycling; the data on many recycling activities is difficult to develop. Data on most industrial recycling activities are not reported or available, however some available useful data is presented below.4

According to a recent draft report by the Northeast Recycling Council on recycling activities in Delaware in 20065, using a broad definition of 'recycling':

- 142 businesses were engaged in recycling activities
- 1,555 jobs were directly involved in "recycling related economic activity"
- $47 million were spent on annual payroll for "recycling related economic activity"
- $250 million in estimated gross receipts were generated by "recycling related economic activity"

The major contributors to this economic activity were:

- Iron and steel mills
- Re-used merchandise sales
- Recycled material wholesalers
- Compost and organic producers
- Residential and commercial recycling collection

Potential for Industry Growth in Delaware over the Next 20-30 years?

There are a number of trends that support the growth of recycling in Delaware. The most notable trends include: increasing energy costs, increasing virgin material costs (wood fibers, metals, plastics), increasing transportation costs, increasing integration of recycled materials into manufacturing processes, and a trend towards local self sufficiency. Given these trends, the global growth of the industry, and the current size and state of this industry in Delaware, Delaware is in a good position to benefit from this growth.

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[4] It should be noted that the data is from different sources, generated by different methods, and some caution should be exercised when combining and comparing the data.

[5] DSM Environmental Services Report for the Northeast Recycling Council. (2008) *2006 Recycling Economic Information Study - Draft Report*. (This report is not publicly available at this time, but should be published and available on this website by the end of 2008: http://www.nerc.org/documents/index.html)

A recent report by the Recycling Public Advisory Council on Municipal Solid Waste recycling (a limited subset of recycling activities) in Delaware found that, in 20066, employing the very limited EPA definition of 'recycling':

- 1.1 million tons of MSW were disposed of in Delaware
- 250,000 tons (23%) of this waste were recycled

Another recent report on resource management in Delaware produced by the Institute for Local Self Reliance reached the following conclusions7, using a broad definition of 'recycling':

- 75% or more of Delaware's Municipal Solid waste could be recycled;
- The estimated value this 75% in 2006 was $60 million;
- If the 75% of the MSW was recycled in 2006, 2,360 direct jobs would be generated, plus 1,000's of additional indirect jobs;
- On a per-ton basis, sorting and processing recyclables alone sustain 11 times more jobs than land filling or incineration.

Based upon the reports above and information from the EPA[8], it is estimated that at a MSW recycling rate of 75%, nearly 14 Billion BTU's of energy would be saved and 386,000 metric tons of carbon equivalent green house gasses would be avoided annually.

Recommendations

1. *Enact legislation supporting recycling initiatives in Delaware. (LEGISLATION)*
   The State's lack of commitment to recycling has created an uncertain business environment and discouraged businesses from investing in recycling activities in the state. Specifically legislation should include:
   A. A mandate that all state agencies recycle. (This is commonly the first step taken and helps to seed the industry, support the market, and create a supportive business environment.)
   B. Creation of a statewide recycling plan requiring that all households have the option to recycle with no penalty charge for doing so. (Currently many DE households have the option of recycling, but are penalized for doing so by paying $6 more/month than those who elect not to recycle. Since recycling is less costly for the state than land filling in the long run, this disincentive must be removed.)
   C. Revision and clarification of the role of the Delaware Solid Waste Authority in recycling activities, ideally including, (as the DSWA has publicly requested) the phasing out of their recycling responsibilities. (The current situation forces the DSWA to do some recycling involuntarily, while undermining private sector initiatives.)
   D. Creation of a larger grant fund or expansion of the existing $50,000 municipalities recycling grant fund to at least $250,000.
   E. Measures necessary to support the creation of the MRF appropriate to the path chosen – Public or Private.

[6] Recycling Public Advisory Council. (2008) *Addendum to the Recycling Public Advisory Council 2007 Annual Report.* *http://www.awm.delaware.gov/Info/Documents/Measurement%20and%20Methodology%20Report%20FINAL%20COMPILED%20MASTER%20-%20V20.pdf*

[7] Institute for Local Self Reliance. (2007) *A Scenario for Resource Management for the State of Delaware.* http://www.awm.delaware.gov/SiteCollectionDocuments/AWM%20Gallery/AWM-DelawareILSR060407.pdf

[8] "Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks" (EPA530-R-06-004).

2. *Create a Materials Recovery Facility in New Castle County – either public or regulated private.*
   Delaware currently exports the majority of our raw recycled materials to nearby states for initial processing. The approximate cost for transportation of these materials is $12 per ton or 25% of the market value of these materials ($48/ton). A public MRF in Delaware would create 30-40 direct jobs, support a variety of local recycling programs, and provide less expensive material feedstock to existing and future manufactures.

3. *Task Force*
   Once a MRF is operational in Delaware, create a task force to review Delaware's waste streams: residential, commercial, and industrial; and Delaware industries which currently use or could use elements of this waste stream, and target specific industry growth and economic development opportunities.

APPENDIX A
Members – Clean Energy Business Community Work Group

Chair – Mike Bowman, Delaware Technology Park
Phil Cherry, DNREC
John deruyter', DuPont
Will Johnson, W L Gore
Willett Kempton, University of Delaware College of Marine & Earth Studies
Konrad Kmetz, University of Delaware, Office of Economic and Innovation Partnerships
Jochen Lauterbach, University of Delaware
Patrick McCullar, Delaware Municipal Electric Corporation
Stanley Merritt, DuPont Photovoltaic Solutions
John Pierce, DuPont
Ajay Prasad, University of Delaware Fuel Cell Bus Program
Jerry Quinn, AthenaBio
Jim Rand, GE Solar
Shekar Shetty, Air Liquide
Jim Smith, Delmarva Power
Jeff Stone, Delaware Economic Development Office
Ross Tyler, Delaware Economic Development Office
BJ Vinton, Sustainable Delaware
Layton Wheeler, Delaware Electric Cooperative
Darrell Wilson, Chesapeake Utilities
Brian Yerger, Jessup & Lamont
Non-Member Regular Attendee – Paul Sample, Technical Advisory Office, Legislative Council
Consultant – Andrea Kreiner, AKreiner Company
Staff – Shannon Clark, Delaware Economic Development Office