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Fall 2009

ENGINEER

Quarterly Publication of the Engineers' Society of Western Pennsylvania

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In this Issue

Extras

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA
Pittsburgh Engineers' Building
337 Fourth Avenue
Pittsburgh, PA 15222
Tel: 412-261-0710 • Fax: 412-261-1606
e-mail: eswp@eswp.com

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Guest EDITOR

Dennis Yablonsky

Chief Executive Officer

Allegheny Conference on Community Development and Affiliates

Dennis Yablonsky

The world community is increasingly recognizing that the important issues around energy production and consumption must be addressed. Excess is out and alternative is in—not as a passing fad, but rather as an essential and long-term approach to satisfying our energy demands while preserving our natural resources.

Discussions on a "new world energy order" were an important part of the G-8 summit in L'Aquila, Italy this past July. Underscoring their importance, these discussions included—for the first time ever, representatives of the world's leading corporations that operate in the energy industry, including oil and natural gas, renewable resources, nuclear energy and advanced systems and technologies for coal.

As you peruse this Fall 2009 issue of *Pittsburgh Engineer*, final preparations will be underway for the 2009 summit of G-20 leaders in Pittsburgh. Here, global leaders will again take up—among other critical concerns—a dialogue around energy that will likely build on the G-8's discussions in L'Aquila.

Pittsburgh's hosting of the 2009 G-20 summit is meaningful to our region for so many reasons, including, but not limited to, the beneficial impact it's expected to have on our economy and the opportunity it provides to tell thousands of global journalists and other influencers the story of a "new Pittsburgh."

But equally meaningful is Pittsburgh's recognized role as an energy innovator and green revolution leader. President Obama's selection of Pittsburgh as the site for the 2009 G-20 summit was deliberate. What better place is there to illustrate a winning economic transformation strategy – one which includes the marriage of historical manufacturing expertise and high tech savvy to allow the region to emerge as a creator of solutions for global energy needs? Couple that with the fact that the Pittsburgh region has historically been a steward and supplier of rich natural resources for energy – coal and natural gas, in particular – and you have a G-20 summit site that is uniquely illustrative of summit discussions and goals, particularly those around economic recovery and energy production and conservation.

The energy economy represents a tremendous opportunity for job growth and wealth creation in the Pittsburgh region. As a source for nuclear power, cleaner coal and carbon capture technology; domestic clean-burning natural gas; next generation wind, solar and other renewable energy devices and components; intelligent building materials; and systems created to efficiently deliver power and conserve global resources, Pittsburgh is unmatched. Southwestern Pennsylvania sits atop plentiful natural resources. We're additionally fortunate to be surrounded by world-class academic, corporate and government entities driving R&D and other innovation across traditional and alternative energy sectors. This leads to the creation of products and services for a global market with awareness that sustainability is no longer just nice, it's a necessity. Combined, the assets noted above distinguish the Pittsburgh region in the energy world.

The Pittsburgh region companies and institutions that help to define our diverse energy leadership include (but are not limited to) CONSOL Energy, Flabeg, MSE Power Systems, Inc., Range Resources, Solar Power Industries, Venture Engineering, Westinghouse Electric Company and Carnegie Mellon University. You can read more about these particular innovators and their solutions to sustainably energize the planet in this edition of *Pittsburgh Engineer* with its timely energy focus.

In addition to better informing readers within the region about why Pittsburgh is justifiably an integrated energy solutions provider to the world, it's my hope a copy of *Pittsburgh Engineer* will find its way into the hands of visiting G-20 delegates and journalists. Its company and organization profiles and stories provide a respectable introduction to our regional energy cachet—all in one convenient publication from a regarded professional association that has made its home in Pittsburgh for 129 years: The Engineers' Society of Western Pennsylvania. PE

Dennis Yablonksy was named Chief Executive Officer of the Allegheny Conference in March 2009. He may be reached by phone at 412-281-1890.

ESWP Annual Awards Program

FIRST CALL –
DEADLINE TO APPLY: DECEMBER 31, 2009

In conjunction with National Engineers Week, The Engineers' Society of Western Pennsylvnaia recognizes an exemplary engineer and outstanding projects from the Western Pennsylvania region. To that end, the ESWP Board of Directors is accepting nominations for the 2009 Engineer and Project of the Year Awards. The ESWP Awards will be presented in a ceremony at our 126th Annual Banquet on Wednesday, February 17, 2010 (Save the Date!) The attention that these awards will bring will highlight the important contributions engineers make to our society. It is the hope that these awards will represent a meaningful impetus in attracting the best minds to the field and encouraging those in the field to excel at their work.

Nominations for ESWP Engineer of the Year and Project of the Year can be submitted by any member of ESWP, or its affiliated technical societies or member companies. Selections are based upon the criteria as listed below. Nomination forms can be found on the ESWP web site at www.eswp.com. The Selection Committee seeks nominations that exhibit evidence of innovation and service to the engineering profession and society.

ESWP Engineer of the Year

Criteria:

- Technical and professional accomplishments
- Contributions to the engineering profession
- Civic and Community affairs

Eligibility:

- Member of ESWP, affiliated technical society or member company
- Bachelor's degree or advanced degree from Engineering School or 5 years work experience in a recognized engineering position
- Accomplishments should be within the last 5 years
- No members of the Engineer's Week Committee are eligible for this award

ESWP Project of the Year

Criteria:

- Technical innovation
- Commercial success
- Benefit to society

Eligibility:

- Company or organization who performed the project should be a member of ESWP, or have members who belong to ESWP, an affiliated technical society, or member company
- Projects may be located anywhere in the world
- Projects should have been completed within the last 5 years

Engineers Week Committee Members whose companies or organizations are nominated may not participate in the selection process. If you are interested in additional information, please contact the ESWP Offices at 412-261-0710. To submit an application for any of the above Awards, please visit the ESWP web site for an application at www.eswp.com/eswp/annual_awards.htm

Sincerely,
ESWP Engineers Week Committee

CARBON MANAGEMENT IN THE TRI-STATE AREA

CARBON SEQUESTRATION AND CAPTURE MOVES AHEAD

By Don Olmstead

Given our area's history of heavy industry, people usually do not associate Pittsburgh with air quality; however, Pittsburgh is a hub of several initiatives related to air quality, particularly management of carbon dioxide emissions. Much of the attention for CO_2 capture and sequestration in the tri-state area focuses on coal fired power plants.

Carbon dioxide capture and sequestration activities in the tri-state area include: basic research, field studies, and pilot or demonstration projects. Some areas of research address integrated gasification/combined cycle (IGCC) generation with CO_2 capture, post-combustion CO_2 capture, and oxygen combustion (oxy-combustion), which combusts coal using pure oxygen thus minimizing the volume of exhaust gas that requires processing.

Carbon Dioxide Generation

When carbon compounds are oxidized, whether by respiration or combustion, carbon dioxide (CO_2) gas is generated. According to the National Oceanic and Atmospheric Administration's (NOAA) Earth Systems Research Laboratory, global average CO_2 concentration has risen from a pre-industrial era level of 280 parts per million (ppm) to 386 ppm at the end of 2008.

NOAA attributes this increase to fossil fuel combustion.

Typically the source of oxygen for combustion processes is air, which is about 20% and 80% nitrogen. Exhaust gas composition after combustion varies with fuel type, but consider untreated flue gas from a power plant burning low sulfur eastern bituminous coal. Based on NETL data, the flue gas is typically 15-16& carbon dioxide, with 5-7% water, and 3-4% oxygen. The remainder, except for ppm quantities of other combustion products, is nitrogen gas at around 75%.

Accordingly, the handling and storage requirements can be reduced by a factor of about four when carbon dioxide is isolated from nitrogen. Nitrogen can be separated from oxygen before combustion, by cryogenics or other technology, which then has an impact on burners and operating temperatures of equipment. Nitrogen can also be separated after combustion, using different tools,

Table 1: Carbon Dioxide from Tri-State Area Power Plants

	Units	PA	OH	WV	Reference
Coal Consumption for Power Generation, 2007	1,000 Tons	55,712	59,452	38,056,	1
Carbon Dioxide Emissions for Power Generation, 2007	1,000 Tons	110,265	119,409	78,076	2,3,4
Coal Fired Generating Capacity, 2007	MW	18,581	22,074	14,715	5,6,7
Estimated Oil & Gas Reservoir Storage Resources	1,000 Tons	3,093,000	3,753,000	1,568,000	8

1 http://eia.doe.gov/cneaf/coal/page/acr/table26.html)
2 http://tonto.eia.doe.gov/state/state_energy_profiles.cfm?sid=PA
3 http://tonto.eia.doe.gov/state/state_energy_profiles.cfm?sid=OH
4 http://tonto.eia.doe.gov/state/state_energy_profiles.cfm?sid=WV
5 http://eia.doe.gov/cneaf/electricity/st_profiles/pennsylvania.html (Table 4)
6 http://eia.doe.gov/cneaf/electricity/st_profiles/ohio.html (Table 4)
7 http://eia.doe.gov/cneaf/electricity/st_profiles/west_virginia.html (Table 4)
8 http://netl.doe.gov/technologies/carbon_seq/refshelf/atlasII/2008%20ATLAS_MRCSP.pdf (pg 52)

which when properly done has minimal impact on upstream processes.

According to statistics published by the Department of Energy's Energy Information Administration, coal fired power plants are the source of most of the CO_2 generated in the tri-state area. Table 1 excerpts some of this data, and summaries of some CO_2 capture and sequestration activities in the tri-state area follow the Table.

National Energy Technology Laboratory

The center of this carbon dioxide capture and sequestration activity is the U.S. Department of Energy's National Energy Technology Laboratory (NETL). NETL's mission is to implement a research, development, and demonstration program to resolve the environmental, supply, and reliability constraints of producing and using fossil resources.

NETL's primary Carbon Sequestration research and development (R&D) objectives are to lower the cost and energy penalty associated with CO_2 capture from large point sources and improve the understanding of factors affecting CO_2 storage permanence, capacity, and safety in geologic formations and terrestrial ecosystems.

Two of NETL's five locations are in the tri-state area: Pittsburgh, PA, and Morgantown, WV. These two centers focus on coal and power systems and also capture and sequestration of carbon dioxide. At the Pittsburgh and Morgantown research sites, NETL has 607 federal employees and 680 site support contractors, for a total of 1,287 employees.

One result of NETL's activity in carbon dioxide management is the annual "Carbon Capture and Sequestration Conference," held in Pittsburgh, and sponsored by NETL and industry leaders. Over 700 people attended last year's conference. The next conference is scheduled for May 10-13, 2010.

NETL conducts research at its own laboratories, and sponsors or collaborates on research at area universities, through the Institute for Advanced Energy Studies (IAES), a virtual applied basic research entity within NETL's Office of Research and Development. These universities include: Carnegie Mellon, University of Pittsburgh, West Virginia University, and Pennsylvania State University.

NETL is also involved in geological and terrestrial demonstrations for storing carbon dioxide. As part of this initiative, NETL has formed regional partnerships of state agencies, universities, private companies and non-governmental organizations. The tri-state area is part of the Midwest Regional Carbon Sequestration Partnership (MRCSP), headquartered at Battelle in Columbus, OH. Activities in the tri-state area include: demonstrations of soil carbon sequestration techniques in Clearfield and

Figure 1: Truck mounted seismic energy source at work in Indiana County

Union Counties, and seven sites in neighboring Ohio, and geologic field demonstrations in association with carbon capture projects.

To date, NETL has focused on oil and gas reservoirs, unmineable coal seams, and deep saline formations for sequestration. Basalt formations and organic rich shales are also candidates for study. In the tri-state area, the focus is on oil and gas reservoirs and terrestrial sequestration (uptake of the carbon dioxide by soils and plants).

As an outcome of the American Recovery and Reinvestment Act of 2009, NETL has $3.4 billion of additional budget, including $1.52 billion for industrial carbon capture, energy efficiency and beneficial reuse of carbon dioxide, and $70 million related to geological sequestration. Accordingly, our local NETL offices should be busy for some time.

Academia

Area universities are focusing on energy, carbon capture and sequestration, and related environmental issues. Much activity is sponsored by NETL, through the IAES. A consortium initially comprised of West Virginia University in Morgantown, University of Pittsburgh, and Carnegie Mellon University has been expanded to include Pennsylvania State University (Penn State) and Virginia Polytechnic Institute and State University (Virginia Tech).

Area universities have responded to the demand for carbon management solutions through the establishment of various institutions. The University of Pittsburgh's Center for Energy has a mandate that includes carbon management, clean coal technology research, and related energy issues. Other examples include: Penn State's Energy Institute, WVU's National Research Center for Coal & Energy, and CMU's Climate Decision Making Center, funded by the National Science Foundation.

Related activity includes the Annual International Pittsburgh Coal Conference, hosted by the University of

Pittsburgh. This is the 26th year for the conference, which will be held September 20 – 23, 2009.

Pennsylvania Department of Conservation and Natural Resources

As Ohio and West Virginia pursue carbon sequestration sites in the vicinity of carbon dioxide emitters, Pennsylvania's Department of Conservation and Natural Resources (DCNR) is considering a centralized collection and storage system.

In the first phase of this activity, DCNR's Bureau of Topographic and Geologic Survey has awarded ARM Geophysics of Hershey, PA, a contract to conduct seismic surveys to evaluate the potential of geological formations for carbon dioxide storage.

On August 18, 2009, seismic survey work is to begin in Indiana and Westmoreland counties, move to Schuylkill County and then on to the Lancaster area. In Indiana County, the trucks will work along roads in Armstrong, Blacklick, Center, Conemaugh and Young townships, and in Derry and Loyalhanna townships in Westmoreland County.

The subsurface strata will be characterized with high resolution geophysical technologies including: mobile non-explosive seismic energy source(s) capable of generating up to 2 million lbs - force of energy, wireless and cabled geophones, and imaging software to produce cross sections depicting strata, fractures, discontinuities and other features to 10,000 to 30,000 feet.

DCNR is focusing on rock in the six thousand to 10 thousand foot range, below formations such as the Marcellus shale; the focus of recent drilling for natural gas. Depths below 10,000 feet are of interest in that there may be fractures or discontinuities that represent a path for escape.

The initial seismic work is to screen potential CO_2 sequestration sites. Promising areas will be investigated more thoroughly. To this end, DCNR is seeking Federal funding for deep drilling to begin in late 2010. DCNR is also looking closely at key legal questions such as ownership of pore space, risks and risk mitigation.

Pennsylvania's goal is to create a carbon dioxide transportation system with a single large carbon dioxide storage facility. This will involve multiple boreholes and compressors operating at high pressures to inject supercritical carbon dioxide underground. The Clinton Foundation is currently negotiating with potential business partners who would use the system.

Demonstration Projects

Carbon dioxide capture technology has been commercialized for well field acid gas, landfill gas, digester gas and other streams. These streams are generally characterized by lower volume, lower temperature, and have higher carbon dioxide content than flue gas from a coal fired power plant. Some issues to be dealt with include reduction of parasitic loads, commercial scale-up, and materials engineering. Laboratory study is ongoing, but pilot and demonstration scale projects are underway in various locations domestically and globally.

Within the tri-state area, along the Ohio River valley, we find three demonstration projects:

1. American Electric Power's (AEP's) Mountaineer Plant, New Haven, WV, southwest of Parkersburg, WV, AEP's 1300 MW Mountaineer Plant is the site of the nation's first major research project evaluating geologic disposal of carbon dioxide. Projects at this site include:

Figure 2: Powerspan Corp.'s ECO2®pilot test unit at FirstEnergy's R.E. Burger Plant in Shadyside, OH. The 1 MW carbon dioxide capture system is to the left. The pilot unit draws flue gas downstream of Powerspan's 50 MW ECO® multi-pollutant control unit, which is the shorter, wider column to the right.

- With Alstom, an equipment and services provider for the power industry, AEP has developed a 30 MW product validation plant to capture 110 thousand tons of carbon dioxide per year from flue gas using Alstom's chilled ammonia and thermal swing absorption technology. Operations are scheduled to begin in October. The Alstom technology involves chilling flue gas to 35 F, and capturing carbon dioxide through conversion of ammonium carbonate to ammonium bicarbonate with a variety of possible side reactions. These reactions are reversed with heating, releasing carbon

dioxide and moisture.

- In an associated effort, a carbon sequestration research project supported by the Battelle Memorial Institute and MRCSP will investigate storage of carbon dioxide emissions in underlying deep saline aquifers.

2. First Energy, RE Berger Plant, Berger, Oh. Located near Shadyside, Oh., FirstEnergy's R. E. Burger Plant produces 413 MW of electricity. Carbon management projects at this site include:

- A preliminary geologic characterization and sequestration field test, which highlighted some of the challenges of CO_2 sequestration.
- Powerspan, a provider of air pollution control technology for coal-fired power plants, has a 1 MW ECO2 pilot unit installed downstream of a 50 MW Powerspan ECO multi-pollutant control unit. The Powerspan carbon dioxide capture technology has similar chemistry to the Alsom process, involving heat-reversible conversion of ammonium carbonate to ammonium bicarbonate with a variety of possible side reactions. However, there are differences; for example, the Powerspan capture step operates at 120 F.

3. AEP Conesville, OH, located near Cambridge, OH, the AEP power plant has tested several options for CO_2 control on Unit 5 (463 MW) including:

- Coal combustion in air, followed by CO_2 separation with an amine based absorption/stripping process. In this process, amine carbamate or bicarbonates are formed, as well as side reactions, which are reversed by heating.
- Coal combustion in air with oxygen removal and CO_2 separation by amines.

Conclusion

The carbon capture and sequestration problem is an intriguing one. There are significant but surmountable problems to be resolved; in particular, reduction of parasitic loads, commercial scale-up and materials engineering issues. Information from the current projects will contribute to the process of generating safe, viable solutions. Subsurface sequestration may be challenging: with respect to verification, health and safety concerns, and emerging legal issues. Once the legal and regulatory issues have been resolved, it is just one more problem that engineers will solve. PE

Don Olmstead has 30 years of engineering experience. He has worked in equipment fabrication, environmental consulting, design and construction, holds a Bachelors engineering degree from the University of Guelph, Ontario, and a Masters degree from the University of Pittsburgh. He can be reached at (412)231-5890 x 302 or at dolmstead@ventureengr.com.

History of U.S. Windpower

By Mark Scher

Late 1970's — 1980's

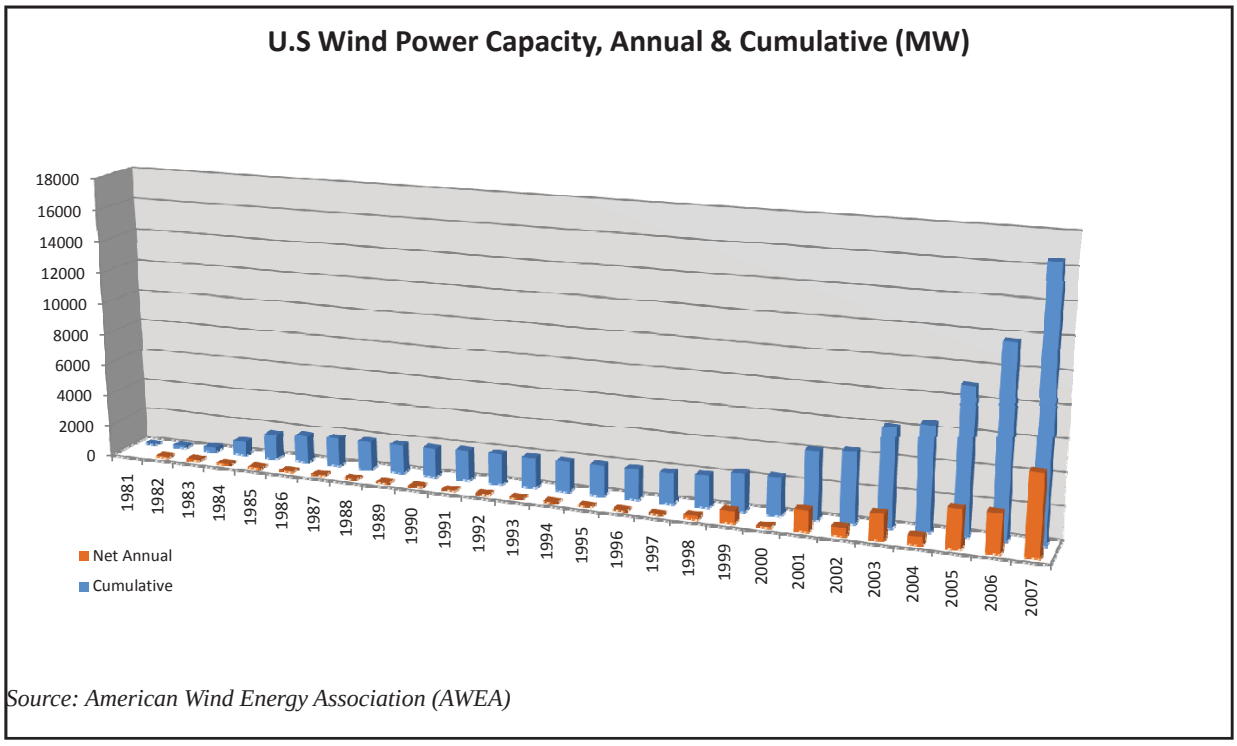
The first commercial development of windpower in the US began in California in the late 1970's. The typical turbine sizes at this time were 10 – 25 kW each. These were connected together in clusters of 1 – 2 MW and connected to local utility distribution circuits. By the mid - late 1980's, individual turbine sizes had grown to 100 – 250 kW. Turbines were connected together in clusters of 5 – 10 MW and connected to minor utility transmission circuits at 69 and 115 kV. Total installed wind capacity in the US was 10 MW in 1981 and 1400 MW in 1989. Cost of wind generation was approximately $ 0.25 / kWh (costs vary regionally). Heavy government subsidies were required for these projects to succeed.

1990's

The first 'utility scale' (40 – 50 MW) wind projects were installed in Southern California and the first projects were installed in Texas and Minnesota. Typical individual turbine size grew to 400 – 750 kW and total installed wind capacity in the country was 2511 MW in 1999. Cost of wind generation had decreased to approximately $ 0.12 / kWh. The US government changed the incentive strategy from subsidies to the current model of a production tax credit (PTC), which only rewarded projects that actually produced power and made the rewards proportional with the amount of power produced.

Current Decade

Wind development spread to many other states. MW class turbines are introduced (current turbine size is 1.5 – 3 MW). The development of large transmission connected projects becomes commonplace, 100 – 400 MW projects are not unusual. Total installed US capacity is 29,440 MW as of July 1, 2009. Cost of wind generation has decreased to approximately $ 0.05 / kWh. The US government changes tax incentive plant to allow project developers to chose between the PTC and a smaller investment tax credit (ITC), which they can take during the development of a project.



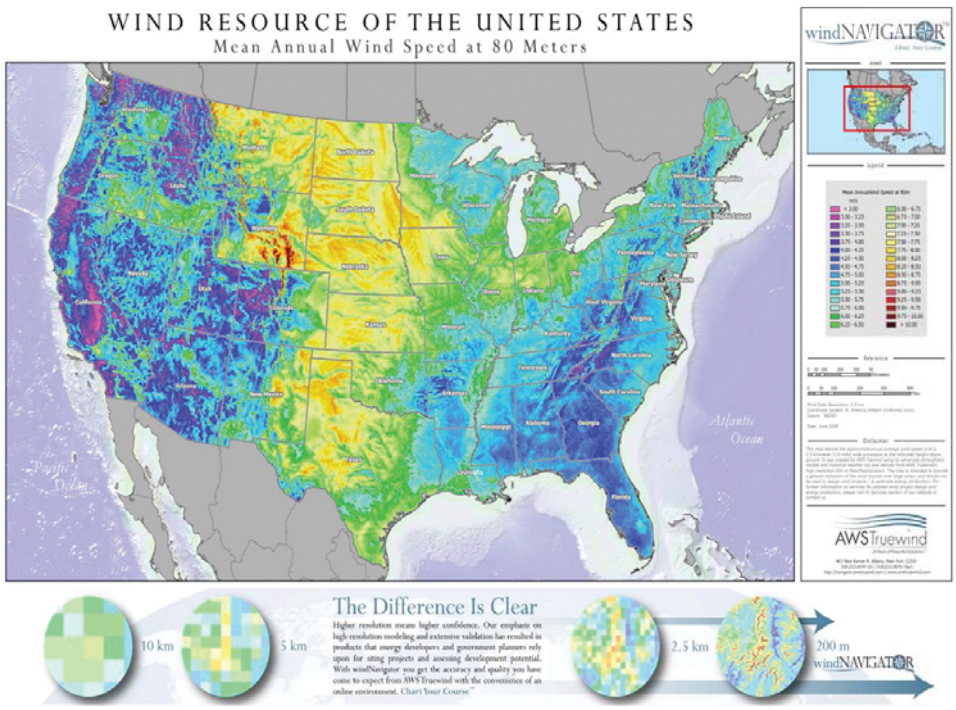
Source: American Wind Energy Association (AWEA)

Wind Integration: Why Isn't There More Windpower in the US Today?

This question has many answers, but there are three that seem to be the most prominent are primarily transmission related, they are:

- Wind is an intermittent resource
- Wind resources are not always located properly to utilize existing transmission
- Technical challenges wind creates for the transmission grid

U.S. Wind Resource Map



Source: AWS Truewind

Wind is an Intermittent Resource

As common sense would indicate, the wind doesn't blow 100% of the time, and when it does, it doesn't always blow at the same speed. Obviously, the amount of power that can be generated by a wind plant at any given time depends on the wind speed at that time. Windpower developers take great care in siting their projects in areas that maximize the power that can be generated by the wind resource. Despite this fact, wind generation currently installed in the US has an average annual "capacity factor" ranging from 20% to 50%. The average annual capacity factor of a wind plant is defined as the ratio of actual kWh produced over a year to the multiplied product of the plant size (in kW) times the number of hours in a year. For example, a 200 MW wind plant with a capacity factor of 30% will generate as many kWh as a fossil or nuclear plant rated 60 MW. In addition to this, it is important to understand the coincidence of the peak wind resource and the peak demand for electricity in the area. For example, in upstate NY the wind resource peaks at night during the winter months, yet electricity demand peaks in the afternoon during the summer months. However in the Palm Springs, California area, the wind resource peaks in the afternoon during summer months, which coincides exactly with peak demand for electricity. Despite the fact that these areas have similar capacity factors statistically, the wind power generated in Palm Springs better fits local consumption patterns, so wind generation can be a higher percentage of total generation in the area. The biggest problem with an intermittent resource is the capacity of the electrical transmission system in any given region. It is widely publicized that the US transmission system capacity is stretched thin due to lack of investment in expansion for several years. Transmission capacity is a valuable commodity to the utilities who own them and they are reluctant to dedicate large chunks of this capacity to a generating resource that will only use the lines part of the time.

In addition to the problem of line capacity utilization, grid operators need to assure that adequate generation resources are available to serve the demand at all times. Uncertainty of the amount of power that wind generators can produce at any given time in the future creates a need for the grid operators (such as PJM) to increase spinning generation reserve margins, which in turn increases the costs of providing power to customers. Most new wind plants collect meteorological data from the plant location and have the ability to transmit that data to the grid operator. Emerging software technologies allow grid operators to accurately forecast wind plant output in the day-ahead time frame once the software has collected enough data. The result of this is that grid operators will have enhanced capability to optimize transmission line usage and spinning reserve margins.

Wind Resources are Not Always Located Properly to Utilize Existing Transmission

Once the power is generated by a wind plant, it obviously needs to be transmitted to end users of electricity. Since wind plants require very large areas of land, and must be located within an adequate wind resource area, they tend not to be located adjacent to population centers. In fact, the areas where wind resources are often located in areas where the electrical transmission system is weak and has

little capacity. This is one of the most severe limitations to the amount of windpower that can be added to the US generation portfolio. There are technologies that can be applied to existing transmission systems to mitigate this problem, but the only way to overcome the problem is to add significant new transmission, a prospect that is costly and takes several years to realize. There are several new transmission projects in the planning process, but several more are needed to support the full potential penetration of US windpower.

Technical Challenges Wind Energy Creates for the Transmission Grid

In addition to the above mentioned issues, wind generation also causes additional concerns for transmission owners because of the nature of the generators themselves. Because of the frequent and wide ranging swings in wind speed, current wind generators are almost exclusively induction type machines as opposed to the synchronous machines employed for typical fossil or nuclear generation.

A detailed technical description of power transfer concepts is beyond the scope of this article. For the purpose of this article, let's say that power is made up of two components, real power, which is the power that actually does work (measured in watts) and reactive power (measured in vars), which is the component that supports the system voltage, thus allowing power to be transmitted along a line. Without adequate reactive power, the transmission system voltage will collapse and no power can be transmitted. Synchronous generators, by their nature produce reactive power that can be controlled independently of the real power output of the system. Induction generators have no inherent capability to produce reactive power in any way. Many newer wind generators have integral power electronics systems to provide reactive power support. Other manufacturers do not provide such support and leave it up to the wind plant designer to design a reactive power compensation system.

If the turbines have no compensation systems or do not provide adequate compensation then free-standing reactive power compensation systems are installed at the interconnect substation. These can range anywhere from simple switched capacitor banks to power electronic based dynamic compensation system depending on the needs of the grid operator at he project interconnect location.

Another major challenge for grid operators is the fact that since wind generation systems have now grown to be much larger, it is important for them to remain on the grid during grid disturbances, such as a short circuit on a transmission line not directly connected to the plant. In the early days of windpower, grid operators wanted wind generators to trip off line whenever there was a grid disturbance. Now that the wind plants are much larger, the grid operators need to be assured that the wind plants will stay on line during grid disturbances. This needed functionality is called "Low Voltage Ride Through" and is a feature integrated into most new wind turbines sold after January 1, 2008.

The Path Forward: How Much Windpower Can the U.S. Expect?

There has been an ongoing national debate about maximizing renewable energy utilization. Wind power currently accounts for approximately 1% of US electricity generation. The American Wind Energy Association believes that this number can be increased to 20% by the year 2030. This level of wind penetration will require a significant investment in transmission upgrades and additions. Given a more modest transmission investment scenario, a total of 10% appears to be a conservative estimate. Even in the more conservative case, this means that the installed base of wind generation will increase by tenfold over the next 20 years. This will make windpower easily the fastest growing market segment in power generation. PE

Mark Scher, P.E., is the Chief Executive Officer of MSE Power Systems, Inc., based in Albany, NY. He may be reached at 518-452-7718 x1104, or by e-Mail at: mscher@msepower.com. MSE is Member of the Crompton Greaves Family of Companies.

SOLAR POWER SHINING BRIGHT IN WESTERN PENNSYLVANIA

Flabeg Solar US Corporation, part of a worldwide specialty glass coating group, has developed a full product line of high performance mirrors for concentrating solar power (CSP) and other solar technologies, including parabolic trough, power tower, linear Fresnel and dish applications. Their parent company, Flabeg, is headquartered in Nuernberg, Germany and is comprised of three core competencies: automotive mirrors, technical glass and CSP mirrors. Flabeg Solar US Corporation will begin production in the greater Pittsburgh area of the number one-rated high performance solar thermal mirrors in the Fall of 2009. Flabeg is the only solar company that has a proven track record of over 30 years. Flabeg Solar US Corporation's facility will be approximately 230,000 square feet and the main operations will consist of precision bending, tempering, silvering, coating, and final assembly.

Flabeg Solar US Corporation chose western Pennsylvania as their business location for a number of reasons. Allegheny County is a leader in developing Green Economic businesses and has established a program to invest in the pre-development of "brown" and "green" sites for future businesses. In addition, Allegheny County has excellent infrastructure: the major interstate road system and an international airport. Allegheny County Executive, Dan Onorato, has worked tirelessly with his team to assist and promote new and existing businesses as follows: site search, grant application and low interest loans to facilitate expansion and green site projects. The Allegheny Conference adds incremental support to develop new businesses. The low cost of living is favorable compared to other major metro areas. In addition, Allegheny County has excellent University systems that partner with various industries and their technology center promotes cutting-edge businesses. Flabeg Solar US Corporation believes Allegheny County has an extremely skilled work force, which will be utilized in an effort to find employees for the 200 jobs Flabeg Solar US Corporation is creating at the Clinton Commerce Park.

The dependency on fossil fuels in the United States has brought forth the critical need for the development of renewable energy sources. Flabeg Solar US Corporation's technology helps to reduce the effects of climate change. Solar power is the most developed and the most widely available of renewable energy sources and almost any individual can use solar energy to reduce their means of traditional energy consumption. There are two main types of harvesting solar power, solar thermal and photovoltaic. Concentrating solar power systems produce heat and electricity using thousands of mirrors to concentrate the sun's rays. By concentrating solar energy it is possible to achieve higher temperatures resulting in better efficiency and reduced costs. The greatest advantage of solar power is that it has a massive renewable source, the sun. Concentrating solar power systems, typically located in areas with high solar radiation, can operate either by producing electricity immediately, storing heat, or in combination with other fossil fuels making power available at times when the sun is not shining.

According to the joint report done by the Greenpeace, European Solar Thermal Electricity Association and IEA SolarPACES, in the last five years, the concentrating solar

power industry has rapidly expanded and the newly-introduced technology has now become a mass-produced, mainstream energy generation to reduce carbon footprint. The joint report states that concentrating power system installations were providing 436 MW of the world's electricity at the end of 2008. Projects under construction in Spain will add at least another 1,000 MW by 2011 and in the USA, projects adding up to further 7,000 MW are under planning and development. The joint report projects that with advanced industry development and high efficiency levels, CSP could reach up to 7% of the world's power needs by 2030.

The cost of concentrated solar thermal electricity is decreasing rapidly and many developers say that it will be cost competitive with the thermal generation from mid-sized gas plants. The factors which affect the cost of CSP are: local solar radiation, technology improvements, mass production, economies of scale, grid connection, local infrastructure, and project development costs. Adding more CSP systems to the grid can help keep the costs of electricity stable as fuel scarcity and carbon costs take effect across the world's economy.

"The cost of concentrated solar thermal electricity is decreasing rapidly and...will be cost competitive"

The first commercial solar plants built in California in the 1980's are living proof of the high quality, efficiency, and durability of Flabeg's products. Since the introduction of SEGS 1 in the USA in 1982, Flabeg's mirrors have provided 1,394 MW (approx. 1,115,000 homes) to the world today. Highly reflective, silver-coated mirrors result in a reflector that concentrates the solar radiation onto a focal line. The parabolic mirrors are designed to track the sun along one axis and it is commercially proven, that they are the most mature of CSP technologies. Flabeg offers more than 30 years of experience in this process and has achieved a standard of excellence for the production of solar mirrors by a proprietary bending process, which results in the highest possible degree of precision. Modern bending techniques guarantee maximum precision and optical quality for the greatest energy output in concentrated solar power technology. Only three percent difference in optical performance result in a gain or loss of tens of millions of income over a 20 year operation period of a 50 MW solar power plant.

A power tower has the ability to convert the sun's rays into clean electricity for the world's electricity grids. This particular type of technology allows the thousands of sun-tracking mirrors (heliostats) to focus sunlight onto a receiver at the top of a tower. Water in

For PPG and Wind Energy – it's a (Glass) Material World

Pittsburgh-based PPG Industries is using its strength as a fiber glass manufacturer to foster growth in the wind energy industry. PPG is focused on not only on increasing the number of windmills installed, but also the size of the units, as doubling the diameter of the rotor produces a four-fold increase in the rotor's sweep — and the power it generates. As a result, the size of wind turbines has been increasing around the world. The average turbine was rated at 1.7 MW in the United States last year. Companies have built individual wind turbines as large as 6 MW, with rotors of 413 feet in diameter and blades measuring about 200 feet long. But building bigger blades increases the mass, which is proportional to the cube of its blade length, the maximum blade length is limited by the strength and stiffness of its material. To accommodate the industry's appetite for large, lightweight blades, PPG produces fiber glass, which is the main reinforcement in the large mega-watt class wind blades. The fiber glass gives the hollow blades necessary strength and stiffness while allowing them to remain lightweight. The fibers are held together with polymer resins to produce fiber reinforced composite. PPG has developed technology that delivers greater tensile strength (flexibility), compressive strength (stiffness), and fatigue strength (durability). Choosing the right type of glass fiber is important, but equally critical has been finding the right combination of chemicals with which to coat the fibers. To promote strong bonding, glass fibers 16 microns in diameter (about ½ the diameter of a human hair) are coated with 50 to 100 nanometers (200 times thinner than a human hair) of "sizing" that includes polymers, adhesion promoters and lubricants. PPG has introduced new products to the wind market that are strong, flexible and have outstanding durability. Designing new wind products requires a materials approach and takes time, since proving out the high durability requires mechanical testing a part more than a million load cycles to see meaningful results. This is PPG's strength as an engineered materials company; delivering solutions that enable energy.

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this receiver is used to produce steam, which is used in a conventional turbine-generator to produce electricity. Linear Fresnel systems focus sunlight in one dimension. They are used in concentrating solar thermal (CSP) and low concentration photovoltaic applications. Parabolic dish concentrators are individual units that have a motor-generator which is mounted at the focal point of the reflector. This generator can be based on a Stirling engine or a small gas turbine. Due to the size of the parabolic dishes, they are well-suited for decentralized power supply and stand-alone power systems.

Flabeg demonstrates superior flexibility by providing their customers with concentrating solar power technologies, such as: parabolic trough, power tower, linear Fresnel, and dish applications. Flabeg's market leadership is shown by a proven track record and they are committed to supplying their customers with innovative solar mirrors in order to provide concentrating solar power for the world. Flabeg Solar US Corporation will continue to invest in technologies to advance CSP applications for the world's future as demonstrated in its new facility in Clinton Commerce Park. PE

Lisa Metcalfe, is the Marketing Coordinator of Flabeg US Solar Corporation. She may be reached at 412-928-4984

ESWP Career Awareness News

The Career Awareness Committee of the Engineers' Society of Western Pennsylvania has been very active, introducing several new programs aimed towards "educating the next generation." In addition to the mainstay programs of the program, ACE Mentoring, Future Cities and Chain Reaction Contraption Competitions, ESWP has recently signed on to several new initiatives.

Pittsburgh Public Schools

In June of this year, ESWP entered into a Memorandum of Understanding (MOU) with the Pittsburgh Public Schools (PPS) Career and Technical Education Division. Under this agreement, ESWP will act as a resource for career and curriculum guidance in many of the programs that PPS provides. To date, ESWP members participated in the "Educator in the Workplace" program, whereby PPS teachers spend three days out of the classroom and in the workplace of a host. Although only the first time that PPS has offered such a program, a number of teachers participated in a variety of workplaces, including Miroslav Kuchta, Robotics teacher from Peabody High School who has been with the PPS for fourteen years. "Mike's" 3-day journey included visits to PennDOT, Siemens Environmental Services, CSD Engineers, and Loftus Engineers. By all accounts, the visit was very educational and informative for Mike, and will help with an understanding of the engineering workplace. (Thanks to ESWP members Daniel Cessna and Daniel Tis for accommodating this program in their workplaces.)

In addition to the Educator in the Workplace program, ESWP also serves on the PPS Occupational Advisory Committee, and represents the engineering profession among the group. This Committee assists the PPS in developing best practices curriculum that will enable students to prepare for a broad range of careers, including engineering, architecture and related professions. Dr. Deb Lange, ESWP 1st Vice-President is the ESWP delegate on the committee (several other ESWP members also serve on this Committee as representatives of their respective firms). Within the Committee is a group interested specifically in the engineering profession. The Engineering Advisory group held its summer meeting at Taylor Allderdice High School with ESWP members Glenn Avick, Tammi Halapin, Mike Roarty, Daniel Tis, and Charles Toran in attendance. The group meets directly with educators and academic counselors to comment on curriculum, and serve as a resource.

The Design Squad

ESWP has also agreed to be the prime sponsor of Design Squad™ program, in partnership with WQED Multimedia. Design Squad™ is an interactive, hands-on program designed to increase student's interest in engineering by showcasing real-life applications of engineering. This program is original content created by WGBH in Boston, and is the basis for the television show of the same name that airs locally on WQED. The content of the program is being introduced to the Pittsburgh region for the first time, for middle school students. In addition to financial sponsorship, ESWP will provide mentors to work with students.

Smart Futures

Only in the development stages, ESWP is working with Smart Futures e-mentoring program. This program allows ESWP mentors to mentor on-line with high school students to help with post-secondary and career choice decisions. Through a simple screening process, mentors are matched with students and provide guidance over the course of a school semester. A formal call for mentors will be posted soon, so please consider participating in this exciting program.

For more information on ways to contribute, please contact the ESWP offices.

CONSOL Energy:
A COMPANY PROFILE

Longwall mining systems are the safest and most productive method of underground coal mining. CONSOL Energy is the U.S. leader in the use of such systems.

Pennsylvania's coal industry has had a long and varied history since early settlers first starting harvesting the resource in 1760 along the banks of the Monongahela River near Pittsburgh.

Today, CONSOL Energy Inc. is Pennsylvania's largest coal producer, annually mining more than 20 million tons of coal from two of the largest underground coal mines in the world: Bailey and Enlow Fork, both located in Greene County, in the southwestern portion of the commonwealth.

In addition, CNX Gas Corporation, a CONSOL Energy company, is among the largest natural gas producers in Pennsylvania, and is the largest producer of natural gas in the Appalachian Basin, with 2,600 wells connected by more than 1,000 miles of pipeline. Each year, CNX Gas produces enough natural gas to heat more than 760,000 homes.

And they do it safely: employees of CNX Gas worked more than 3.5 million exposure hours without a lost-time incident, making it the safest operator in the gas exploration and production industry.

CNX Gas increased production by 32 percent in 2008, producing a daily net of 245 million cubic feet of pipeline-quality coalbed methane for commercial use.

CNX Gas's first horizontal Marcellus Shale well in Pennsylvania began producing at a rate of 6.5 million cubic feet (MMcf) per day in December of 2008. This is a daily production rate record for any well in company history.

Overall, CONSOL Energy has nearly 2,400 employees that live and work in Pennsylvania, accounting for more than $550 million in salaries and benefits and federal, state and local taxes paid, as well as $300 million annually in goods and services purchased and used.

CONSOL maintains a fleet of 25 towboats and 750 barges and is one of the largest commodity shippers along the inland waterways in the United States. In 2008, CONSOL Energy's river division shipped a record 23.6 million tons of coal and other products, and recently completed two million work hours without an injury over a two-year period.

In addition, CONSOL Energy operates the largest research and development facilities devoted exclusively to coal and energy production and utilization. Located in a suburb of Pittsburgh, CONSOL R&D also focuses on energy development programs. Among their projects are: improving energy efficiency, reducing greenhouse gases by capturing and selling methane-gas and storing carbon dioxide in unmineable coal seams, improving coal blends for steel making, reducing power plant emissions, producing electricity from by-products and researching various coal-to-liquids technologies.

Founded in 1860 when several western Maryland coal producers decided to "consolidate" their properties to form the Consolidation Coal Company, a predecessor company, CONSOL Energy is a high-Btu bituminous coal and natural gas company and is a member of the Standard & Poor's 500. CONSOL annually produces nearly 70 million tons of coal from 16 mining complexes in six states and reports proven and probable coal reserves of 4.5 billion tons. CNX Gas holds proved reserves of more than 1.4 trillion cubic feet.

"...Coal and natural gas account for about 70 percent of the electricity produced the United States"

Nationally, CONSOL Energy has nearly 8,200 employees throughout its coal mining and support operations, gas production facilities, industrial supply locations and land resources units.

Today, as back in the 18th Century, coal and gas users are seeking one thing: energy. Energy in the form of heat, either to generate electricity, help to forge steel or to heat

homes and to cook food. In fact, coal and natural gas account for about 70 percent of the electricity produced the United States, both of which are fuels which CONSOL Energy provides. Worldwide, demand for both resources is increasing.

"By many measures, 2008 was the strongest year in our 145 year history," said J. Brett Harvey, CONSOL Energy president and chief executive officer. "Our results represented a confluence of events, the most important of which was the globalization of demand for natural resources, including coal, which created, for the first time in many years, a market in which prices for coal in the U.S market were being set by prices for coal internationally.

"We truly were connected to the world. This was all the more significant because U.S. exports of coal constitute only about eight percent of total production."

Historically, CONSOL Energy ranks among the largest coal producers in the United States based upon total revenue, net income and operating cash flow. It is also one of the safest, with an annual safety performance nearly two times better than the industry average for underground coal mines.

CONSOL's production of approximately 65 million tons of coal in 2008 accounted for about 6 percent of the total tons produced in the United States and approximately 13 percent of the total tons produced east of the Mississippi River.

Using 2008 as an example, 90 percent of CONSOL Energy's production came from underground mines and 10 percent from surface mines. Where the geology is favorable and reserves are sufficient, CONSOL Energy employs longwall mining systems in its underground mines.

"Engineers have the first opportunity to ensure the safety of employees by designing safe operating systems, prudent mining plans and layouts and employing increased maintenance and control programs for mining equipment"

On an annual basis, 84 percent of CONSOL's coal production comes from mines equipped with longwall mining systems, which are the safest and most productive method of underground coal mining. CONSOL Energy has substantial reserves readily suitable to these types of operations, which are engineered to increase capacity at low incremental costs.

In terms of its safety programs, at CONSOL Energy,

"safety trumps everything" and the company is committed to eliminating all injuries from every one of its operations. CONSOL enhances its safety performance in several ways, including extensive training programs, increased emphasis on safety as a core value among employees and the engineering and structure of its operations.

To accomplish these safety goals, CONSOL Energy has conducted internal safety communications programs and advanced engineering techniques with a commitment to "engineered safety" within mine and gas operation planning. CONSOL engineers have the first opportunity to ensure the safety of employees by designing safe operating systems, prudent mining plans and layouts and employing increased maintenance and control programs for mining equipment at the producing face.

Coal is transported from CONSOL Energy's mining complexes to customers by means of railroad cars, river barges, trucks, conveyor belts or a combination of these means of transportation. CONSOL employs transportation specialists who negotiate freight and equipment agreements with various transportation suppliers, including railroads, barge lines, terminal operators, ocean vessel brokers and trucking companies for certain customers.

CONSOL Energy's coal export terminal at Baltimore celebrated its 25th anniversary in 2008, and has the capacity to handle 18 million tons of coal, annually. It is the only East Coast terminal served by two railroads: Norfolk Southern and CSX. CONSOL's Baltimore Terminal shipped a record 9.1 million tons of coal last year. Most of the coal, both CONSOL and third-party, was destined for the Atlantic market.

A technician checks gauges at a CNX Gas Processing Plant located in Southwestern Pennsylvania.

"we are concerned that although Carbon Capture and Storage (CCS) technologies may be commercially viable by 2020, they will not yet be deployed to a sufficient extent to avoid a serious impact on electricity prices and reliability."

CONSOL Energy has its own fleet of towboats and barges that move coal and other commodities along the inland waterways.

In view of the worldwide economic downturn, CONSOL Energy has taken several steps to weather this economic storm. First, CONSOL has closed or idled coal mines in order to ensure that we match production with sales, thereby avoiding a buildup of inventory. Second, CONSOL has postponed some of our gas drilling program in areas deemed to be of higher risk. Third, the company has reduced staffing at both the operations and staff level throughout the company. Finally, CONSOL has imposed strict cash management procedures, including the deferral of some capital projects.

As for the challenges facing the energy industry in general, it is estimated that fossil fuels, such as coal and natural gas, provide more than 80 percent of the world's energy. In particular, coal fuels almost 40 percent of electricity worldwide, and its use is expected to increase dramatically over the next few decades. But CONSOL believes it will take a dynamic stable of various energy resources, including nuclear and renewable fuels, to meet the world's voracious appetite for energy.

In order to meet this demand for coal and fossil fuels worldwide, CONSOL Energy remains committed to exploring new ways to utilize these vital coal and gas resources responsibly and while at the same time reasonably meeting the goals of environmental stewardship.

"While we recognize the desire of some to show progress on carbon reduction by the end of the next decade," said Steve Winberg, CONSOL Energy vice president – R&D during recent testimony before a U.S. Senate panel, "we are concerned that although Carbon Capture and Storage (CCS) technologies may be commercially viable by 2020, they will not yet be deployed to a sufficient extent to avoid a serious impact on electricity prices and reliability." Winberg called CCS technologies essential to both the U.S. and the world economies.

"Coal is our most abundant domestic energy resource and we need sustained investment in CCS technology and the time to develop, demonstrate and commercialize it," he said.

While CCS technologies will enable the U.S. to reduce carbon emissions, these technologies also can be exported to developing countries to help them reduce emissions as well, he said. He said that unilateral greenhouse gas reduc-

tions by the U.S. will have little to no impact on atmospheric concentrations of greenhouse gasses if carbon restrictions are not made elsewhere in the world.

Winberg said it is likely that the U.S. will find itself at a significant global disadvantage should Congress force significant reductions in US greenhouse gas emissions without providing sufficient resources and adequate time to develop the technologies to achieve them.

"Significant CO2 reductions will not be achieved by substituting renewable energy for fossil energy, or by relying heavily on conservation," he noted, saying fossil fuels will remain a significant part of the world's energy portfolio for years to come. "Regulating carbon will impact the food we grow, the fabrics in the clothes we wear and the shingles in the roof over our head."

On the economic front, which is the focus of the Pittsburgh Summit, the U.S. economy continued to contract in the second quarter driven by a decrease in industrial production in the manufacturing sector. This has led to a reduction in electricity generation, thereby negatively impacting demand and consumption of steam coal and natural gas. Milder weather this summer in most areas of the U.S. has further exacerbated the demand situation which has resulted in higher than normal coal stockpiles and gas storage levels across the country.

Many domestic coal companies have responded to the reduced coal demand by reducing production. Industry experts predict coal production will be reduced by at least 100 million tons in 2009.

"Currently, the outlook is improving in the steel industry and we are cautiously optimistic regarding a recovery in metallurgical coal demand and pricing,"

"CONSOL Energy has a long history of being a disciplined producer," Mr. Harvey noted. This year several other coal producers have also curtailed production due to market conditions. We believe that coal production cuts will continue into next year and that this should bode well for a sustained recovery in coal contract prices.

"In addition, natural gas producers have rapidly idled drilling rigs since the beginning of the economic downturn, with total active natural gas drilling rigs declining by more than 50 percent."

"Currently, the outlook is improving in the steel industry and we are cautiously optimistic regarding a recovery in metallurgical coal demand and pricing," said Mr. Harvey. "We are seeing increased interest from South American and European steel producers who are methodically restarting previously idled blast furnaces and coking operations."

Mr. Harvey concluded, "Although there is still much uncertainty in the economy, certain leading economic indicators have shown improvement. We believe that as the overall economy improves, coal production cuts will have a profound impact on contract prices. Furthermore, our low-cost position in coal and gas should enable us to outperform our peers during this bottoming process." PE

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Can Pennsylvania Become the Natural Gas Capital?

By Matt Pitzarella

By now, most have heard of the Marcellus Shale formation. Trapped inside the rock a mile below our surface could be the largest source of clean burning natural gas in the country, spanning five states including parts of West Virginia, Maryland, Ohio, and almost all of Pennsylvania. Unconventional gas reserves are now gaining interest across the globe as the rest of the world closely watches natural gas development in the United States.

According to reports from the Potential Gas Committee and the United States Department of Energy the United States now has a 120-year supply of natural gas, thanks largely to breakthroughs like the Marcellus. In fact, since 2006 reserves have increased more than 35% to 2,074 trillion cubic feet (Tcf), which is equivalent to roughly 350 billion barrels of oil, or about the same as Saudi Arabia's oil reserves.

A Washington County farm, notice the small footprint at the top of the hill.

While no one knows just how much natural gas is in the Marcellus, Professors of Geosciences Terry Engelder of Penn State University and Gary Lash of the University of New York-Fredonia have indicated that the Marcellus could contain as much as 516 Tcf of technically recoverable natural gas – more than 20 years of all U.S. demand. Since other sources of natural gas will always be in production and new discoveries will be made, Marcellus development is expected to last a century or perhaps much longer.

An Emerging Giant

In 2004 Range Resources pioneered the development of the Marcellus with the successful completion of the Renz #1 well in Washington County. In December of 2007 the company released production data from a series of wells, generating the interest of Wall Street and the industry. One month later, Engelder and Lash gave the world an idea of how large they believed the Marcellus to be. In 2008 the industry invested more than $3 billion in the Marcellus as natural gas prices neared record highs. Even with gas prices at a fraction of where they were, development in the Marcellus continues.

A recent study from economic and petroleum engineering professors at Penn State University indicated that by 2010 Marcellus development will create more than 100,000 new jobs in Pennsylvania, provide an $8 billion annual economic impact, and generate more than $900 million in state and local taxes. The report also indicates that the Marcellus is still in its infancy of development and that the industry will take several years to fully mature. By 2012, Pennsylvania is expected to reverse its position as one of the largest importing states for natural

gas and become a net exporter. These jobs offer opportunities spanning from those with high school education or less to highly advanced technical degrees.

Modern Technology

All of this activity didn't happen overnight. In fact, it took decades to perfect. In many ways the technology in modern natural gas development is second only to NASA and, in some instances, NASA has borrowed from the industry. While a number of factors and technological breakthroughs have contributed to the discovery and production of new reserves, it has been the marriage of two technologies that have played the largest role in what has been the biggest energy breakthrough of a generation –horizontal drilling and hydraulic fracture stimulation.

A piece of Marcellus Shale core used for research and testing. Notice the hydrocarbons literally bubble out of the rock.

Horizontal drilling has become increasingly popular in recent years, but the technology dates back to 1891, with the first true horizontal well being drilled in 1929. The technology has since been perfected in more than 57 countries. In many formations vertical wells are the most economical means of extracting oil or natural gas. But in unconventional reservoirs, horizontal drilling allows for the maximum amount of the wellbore to be exposed to the gas producing formation. In the Marcellus, a horizontal well can cost twice as much, but can produce more than four times the amount of gas and drastically reduce surface and environmental disturbances.

Hydraulic fracture stimulation has roots dating back to 1903, but was first commercially used in 1947. The technology has since been used in the completion of nearly one million oil and natural gas wells in the United States alone. Nearly three million pounds of steel and cement are used in each horizontal wellbore to protect fresh water aquifers and other formations. Fresh water and sand is pumped into the 8.5-inch wellbore to create a network of nearly microscopic fractures, roughly the width of a sheet of paper, in the formation. The sand serves as a proppant, which allows gas to flow through the wellbore.

Technologies will continue to improve and advance, and much of it will happen right here in Pennsylvania. The future looks bright, and the Marcellus could fuel our economy for generations and forever transform our nation's clean energy future. PE

Can the Marcellus Shale Fuel our Economy and Protect our Environment?

By Matt Pitzarella

In today's world it seems everyone must pick a side of every issue. Many believe that the Marcellus Shale and natural gas can be seen as a win-win for the economy and the environment. Natural gas is 10 times cleaner than coal and oil, and with landowners receiving lucrative leasing agreements and royalty checks, the Marcellus will help to preserve and conserve rural communities, family farms and Pennsylvania's countryside.

But can this be developed without sacrificing our environment for future generations?

As evidenced by several exhaustive reports from the United States Department of Energy, the National Energy Technology Laboratory, the Groundwater Protection Council, and the Interstate Oil and Gas Compact Commission, which represents more than 30 state regulatory agencies: natural gas development is very safe, environmentally sensitive with minimal impacts and very well regulated. In the 60-year history of hydraulic fracturing and nearly one million wells, there are zero confirmed cases of drinking water contamination.

According to the Pennsylvania Department of Environmental Protection in a letter to the Groundwater Protection Council, the industry has a proven record of

environmental excellence. Less than one tenth of one percent of the wells drilled in Pennsylvania result in any degree of water contamination. These rare instances are typically from an accident such as a surface spill, operator error, equipment failure, etc. In those unlikely cases, it's even more rare that the incident results in negative impacts on health or property. The industry and regulators work together to incorporate best management operating plans so if these unlikely incidents occur the impacts are minimized and safely corrected.

Many agree that Pennsylvania has among the most stringent environmental programs in the country. All aspects of natural gas development are closely regulated by the Pennsylvania Department of Environmental Protection. Other regulatory agencies have oversight depending on the circumstances including the Pennsylvania Fish and Boat Commission, the Susquehanna River Basin Commission, the Delaware River Basin Commission, the Pennsylvania Department of Conservation and Natural Resources, the Pennsylvania Historical and Museum Commission, and in some instances the United States Environmental Protection Agency.

A reclaimed site in Washington County. The footprint is smaller than a one-car garage.

Water and Water Resources

Virtually all aspects related to water are covered in a water management plan that is a part of the drilling permit, including where the water will come from, how the water will be used and how the water will be treated.

Each horizontal well requires about four million gallons of fresh water. While that sounds high, it's relatively low in relation to other water use. If Marcellus activity nearly tripled the expected peak drilling levels, the industry would still represent less than one percent of the state's daily water consumption of 10 billion gallons. At that dramatically increased rate, Marcellus development would be less than half of the water usage for recreational purposes like golf courses and ski resorts.

Water can be pumped from an approved body of water or can be purchased from a municipal water company. Water impoundments are strategically constructed within the development and water is transferred to drill sites through temporary pipes. This reduces truck traffic and allows companies to control water usage during periods of high or low flow when local bodies of water can be at risk from floods or droughts.

Once the water is injected, approximately 30% of the water immediately returns to the surface through a controlled series of pipes and storage units. The wastewater contains higher than usual levels of salts, mainly calcium chloride and some sodium chloride. Pennsylvania has ample treatment capacity for nearly a decade, but long term solutions must be developed. In 2008, the industry and DEP formed a wastewater taskforce to address these issues. Now nearly all of the water is recycled and reused. Other solutions include assimilation, underground disposal wells and evaporation and crystallization, and are all being further developed.

What About the Chemicals?

Many of the chemicals are organically based, and all of the chemicals are public information and can be found on the DEP's website. While there are a number of approved additives, most companies use about five to complete a well. Collectively these highly diluted additives make up anywhere from 0.05% - 0.5% of the injection – the remaining 99.95% is fresh water and some sand. The exact same chemicals are a part of our everyday lives and are often either consumed or applied directly to the skin in higher concentrations. Even still, they are tightly controlled and only injected through multiple layers of cemented steel casings to protect freshwater aquifers. Because the chemicals used have a very specific purpose – biocide, for instance, is used to eliminate bacteria from the wellbore and reduce water consumption – all of the chemicals are essentially spent during the process.

For more information, visit the websites for your state or federal regulators for accurate and unbiased information on modern natural gas development. PE

Matt Pitzarella is the Director of Public Affairs for Range Resources - Appalachia, LLC. Mr. Pitzarella can be reached at 724-873-3224 or by e-mail at mpitzarella@rangeresources.com

PATHS TO THE FUTURE:

Research on Energy and Sustainability at Carnegie Mellon's Department of Civil and Environmental Engineering

By James H. Garrett, Jr.

When considering how to provide for future power needs, there is no single answer. It will take a combination of approaches and technologies.

For the past 200 years or so, the developed world has been living off the earth's coal, oil and natural gas. But as we have learned, the earth's non-renewable resources are being permanently depleted and the process of doing so is also doing damage to our planet.

What's to be done? Where will we find enough clean, abundant energy to power the world for future generations? Where will we find enough skilled engineers to create a sustainable future?

In the labs and classrooms of Carnegie Mellon's Department of Civil and Environmental Engineering (CEE), researchers are studying everything from the think blue envelope of air that swaths our planet to the use of switchgrass to help curb U.S. dependence on fossil fuels. They are urging companies to embrace new methods for following the trail of carbon emissions linked to global warming. They have found that cap and trade emissions policies will not be sufficient enough to put the nation back on track to achieve a 50 percent to 80 percent reduction in greenhouse gas emissions of carbon dioxide by mid-century.

And they recommend skipping the imported steak and buying local. Fruits, vegetables, meat and milk produced closer to home racks up fewer petroleum miles and saves energy, according to research by CEE's H. Scott Matthews and Chris Weber.

In addition to work on life-cycle assessment tools, CEE professors are exploring opportunities for soon to be ubiquitous available sensors and radio frequency identification (RFID) tags.

Burcu Akinci, a CEE associate professor and winner of the prestigious Walter L. Huber Civil Engineering Research Prize from the American Society of Civil Engineers (ASCE), is creating novel building information models and a variety of sensors to streamline construction and facility management practices. Her work is designed to save time, money and energy costs for both the private and public sector facilities.

Developing and evaluating technologies to improve the built and natural environment, and thus our quality of life, is a major goal of many of the faculty members and students in our department.

Burcu Akinci

Through CenSCIR, researchers are studying and developing infrastructure-oriented sensor systems, data models and management strategies and intelligent decision support systems to help detect problematic conditions in complex and aging infrastructure networks allowing them to be addressed earlier and more cost effectively.

Americans spend more than 4 billion hours a year stuck in traffic at a cost of $78.2 billion or $710 per motorist, according to a 2009 Report Card for America's Infrastructure from the American Society of Civil Engineers. The report estimated that $2.2 trillion must be spent in the next five years to restore the nation's infrastructure to good condition.

The irony is that it takes more to rebuild crumbling infrastructure than to maintain it.

Another leading edge researcher working on this issue is Lucio Soibelman. He is developing spatial data mining and image reasoning approaches for use in understanding the spatial factors that affect water distribution and sewerage systems. And with those problems come issues with water and water pollution.

Jeanne M. VanBriesen, professor of CEE and director of WaterQUEST (Water Quality In Urban Environmental Systems), and her colleague CEE Professor Kelvin Gregory, are looking at how river water is impacted by bromides, which are associated with the current Marcellus shale gas produced water, and sulfate, which comes from abandoned coal mines. The huge southwestern Pennsylvania Marcellus shale formation is reported to contain more than 300 trillion cubic feet of natural gas.

VanBriesen also is leading a team of CEE students

in helping to restore a 100-year-old reservoir lake in the city's Panther Hollow section bordering Schenley Park, Phipps conservatory and several Oakland neighborhoods.

Jeanne VanBriesen,

Helping students become good stewards of both the built and natural environment and sustainable engineers is an ongoing mission for CEE. Going beyond the slogans of sustainability requires interdisciplinary analysis, innovative problem-solving, ethical and data-driven decision making. Courses addressing these different dimensions of sustainability are offered within CEE and nearly 40 environmentally-oriented courses are offered each semester in many different departments, including not only engineering, but architecture, design, chemistry and policy.

Not only are CEE students learning to challenge traditional notions about our built and natural environment the environment and the role that we play in promoting a sustainable future, but they are promoting sustainability on a global scale.

In CEE's International Collaborative Construction Management class, students work in international teams to collaborate from remote locations via the Internet taking maximum advantage of information technology using commercially available software.

The motivation for this particular course came from the realization that several American construction companies reported that some of their engineers and project managers were not prepared to deal with increasing requirements of the global marketplace. For the past three years, students have worked on virtual teams made up of students from Brazil, Turkey and Israel to address construction management challenges in these different countries.

Student teams are working right now to make the university campus the most energy-efficient and highly-sensed campus in the world with projects ranging from measuring the amount of energy used in campus buildings to helping facility managers inspect the life-saving fire sprinklers throughout the 144-acre campus using RFID tags.

Other CEE student projects have involved designing "green spaces'' throughout campus and developing community-based recycling projects for old computers and cellphones.

The department's Center for Sustainable Engineering, supported by the National Science Foundation and the U.S. Environmental Protection Agency, further supports the department's mission in sustainability and is designed to help future engineers better manage increased stress on the world's limited resources. The center is composed of a collaborative effort from Carnegie Mellon, the University of Texas at Austin and Arizona State University.

And the department's energy and sustainability work does not stop there. CEE's Amit Acharya, director of the new Center for Multi-Scale Modeling for Engineering Materials (CM-EM), along with colleagues Kaushik Dayal and Craig Maloney, are working to understand the atomistic and mesoscopic behavior of materials that remain very important for nuclear energy applications.

"We are working to understand how new and existing materials will perform and degrade under various settings,'' said Acharya. "Our work has significance for everything from turbine engines for jet planes and power generation, to alternative types of load-bearing materials that are used in every industry sector from aerospace to the steel and car industries.''

From sustainable energy to sustainable infrastructure, Carnegie Mellon's top-ranked CEE department continues to train tomorrow's engineering leaders to help make buildings and infrastructure more sustainable, evaluate the environmental and economic impacts of biofuels, better understand how materials degrade and make carbon offsets a reality.

Carnegie Mellon's CEE department has 21 faculty, 12 staff, 120 full-time graduate students and 35 undergraduate students per class. Research activities throughout the department are clustered into three areas including, advanced infrastructure systems, environmental engineering science and management, green design and mechanics, materials and computing.

For more department information, see http://www.ce.cmu.edu.about-us.index.html PE

James H. Garrett, Jr. is the head of the Department of Civil and Environmental Engineering at Carnegie Mellon University and co-director of the Center for Sensed Critical Infrastructure Research (CenSCIR).

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