THE CIP REPORT

CENTER FOR INFRASTRUCTURE PROTECTION AND HOMELAND SECURITY
VOLUME 10 NUMBER 7

JANUARY 2012

ALTERNATIVE ENERGY

EDITORIAL STAFF

EDITORS
Devon Hardy
Olivia Pacheco

STAFF WRITERS
M. Hasan Aijaz
Shahin Saloom

JMU COORDINATORS
Ken Newbold
John Noftsinger

PUBLISHER
Liz Hale-Salice

Contact: dhardy1@gmu.edu
703.993.8591

Click here to subscribe. Visit us online for this and other issues at http://cip.gmu.edu.

GEORGE MASON UNIVERSITY
School of Law
CENTER for INFRASTRUCTURE PROTECTION and HOMELAND SECURITY

This month's issue of *The CIP Report* highlights alternative sources of energy, including education programs that focus on energy, and critical infrastructure.

First, two Associate Professors in James Madison University's (JMU) Department of Integrated Science and Technology analyze the energy options and challenges facing the Transportation Sector. The Associate Director of Research Development with the Institute for Infrastructure and Information Assurance (IIIA) at JMU then evaluates the potential role of Distributed Energy Resources (DER) in the Energy Sector. Next, the Senior Vice President at Fluor Corporation assesses changed program management requirements in unconventional gas programs. Finally, an Assistant Professor at Iowa Lakes Community College discusses the Wind Energy and Turbine Technology education program at the college.

This month's *Legal Insights* examines the legal and technical challenges involved with securely integrating renewable power.

We would like to take this opportunity to thank the contributors of this month's issue. We truly appreciate your valuable insight.

We hope you enjoy this issue of *The CIP Report* and find it useful and informative. Thank you for your support and feedback.

Mick Kicklighter
Director, CIP/HS
George Mason University, School of Law

No Silver Bullet: Options and Challenges in Energy for Transportation

by Dr. Jeffrey Tang and Dr. Christopher Bachmann

Of the challenges facing the United States and the world in the next few decades, few are as significant as securing adequate energy supply and distribution. Environmental and resource-limitation concerns have understandably driven much of the debate in the energy sphere, which has focused largely on securing sustainable, renewable energy. Yet the majority of renewable energy options are best suited to electricity generation, which for the United States is the least pressing in terms of resource depletion. A far more challenging — and perhaps more strategically and economically important — problem is in energy for transportation systems, particularly in the United States.[1] Not only does the United States depend heavily on vehicles with petroleum-fueled engines, the United States also imports the majority of the oil that it consumes.[2] This dependence on foreign oil, much lamented by commentators, consumers, and presidents, has become stronger during recent decades. Although the concept of "peak oil" is a highly debated one, there is little question that oil supplies will crest in the future, and most experts agree that the time frame is measured in decades (or even years), not centuries.[3]

This dependence on a non-renewable fossil fuel resource that is not abundant domestically is a key strategic vulnerability when one considers how dependent the United States economy is on oil. Long-term trends in inflation, for example, tend to mirror the relative price of oil. In recent decades, spikes in oil prices often resulted in economic slowdowns or recessions in the United States (see Figure 1 on Page 3).[4] Given that virtually all of the goods and services that Americans consume depend at least in part upon transportation, and because transportation in the United States is so overwhelmingly powered by oil-based fuels, it is no big stretch to say that oil is an essential lubricant for the U.S. economy. For example, it is estimated that the average meal in the United States has traveled about 1,300 miles before it reaches the dinner plate.[5] In fact, the increase in corn prices during the late 2000s, which many observers blamed on increased ethanol production, primarily resulted from an increase in the price of oil.[6] In terms of vulnerability, it is probably fair to say that the U.S. economy is more vulnerable to a price spike in oil markets more than to anything else.

The United States has a powerful and compelling interest to diversify its transportation technology to become less dependent on oil-based fuels, but any changeover will be difficult, costly, and lengthy. There are no quick fixes. There are no silver bullets. Any substantial shift towards public transportation would take decades to approve, build, and implement. Changing over to most alternative-fueled vehicles would take almost as long due to the need to develop appropriate infrastructure and change over the stock of vehicles. The latter challenge is a particularly significant

(Continued on Page 3)

1. This is particularly true of the United States, which is what this paper will focus on, given our relatively underdeveloped public transportation infrastructure.

2. U.S. Energy Information Administration, *Monthly Energy Review,* (November 2011), Accessed December 2, 2011, http://www.eia.gov/totalenergy/data/monthly/pdf/sec3_3.pdf.

3. The debates about peak oil are extensive. One good overview is, *Crude Oil: Uncertainty about Future Oil Supply Makes It Important to Develop a Strategy for Addressing a Peak and Decline in Oil Production*, GAO Report to Congressional Requesters, GAO-07-283, (February 2007), Accessed December 5, 2011, http://www.gao.gov/new.items/d07283.pdf.

4. U.S. Energy Information Administration, Accessed December 2, 2011, http://www.eia.gov/oiaf/economy/energy_price.html.

5. Leo Horrigan, et al., "How Sustainable Agriculture Can Address the Environmental and Human Health Harms of Industrial Agriculture," http://www2.grist.org/gristmill/images/user/2988/Sustainable_Ag_Horrigan.pdf.

6. Congressional Budget Office, "The Impact of Ethanol Use on Food Prices and Greenhouse-Gas Emissions," (April 2009), http://www.cbo.gov/ftpdocs/100xx/doc10057/04-08-Ethanol.pdf.

Energy Transportation *(Cont. from 2)*

one, though it is commonly overlooked. The Hirsch Report, which approached peak oil from a risk management perspective, noted that under normal conditions, turning over half of the overall fleet of automobiles takes between 10 and 15 years; for light trucks, the range is 9 to 14 years.[7] Even far more optimistic assumptions yield an obvious conclusion: shifting from petroleum-powered internal combustion engine vehicles to anything else requires action well in advance of acute shortages of oil if serious economic damage is to be avoided.

Options for Short- and Long-Term Solutions

We have several options to reduce this dangerous dependence on oil. The easiest option is to improve the efficiency of our vehicles. In the shorter term, using drop-in fuels are the only viable option. In the longer term, two other options emerge: next-generation alternative fuels and significant changes in lifestyle and transportation patterns.

Increasing the fuel efficiency of traditional vehicles is probably the quickest, easiest, and cheapest technological means of decreasing oil consumption in the short term.[8] The fuel efficiency of internal combustion engines (ICEs) has increased steadily in recent decades, but because the size and weight of our vehicles have also increased, the overall fuel economy of vehicles has enjoyed far more modest gains. Much of this lag has been due to regulatory stagnation, as Corporate Average Fuel Economy (CAFE) standards increased very slowly from 1986 through 2006 and more consumers shifted to light trucks.[9] President Obama recently announced a substantial hike in CAFE standards, which will increase from an average of a little over 35 miles per gallon (mpg) to nearly 55 mpg equivalence by 2025.[10] Much of this increase is expected to come from hybrid, plug-in hybrid, and fully electric vehicles (EVs), whose fuel economy tends to be much higher than traditional ICEs. EVs face a number of obstacles, however, including limited range, limited battery life, high cost, and lack of charging and repair infrastructure. Although battery technology has improved dramatically in recent years, it still remains the most significant obstacle to widespread EV adoption.

The ideal alternative fuel for the near future is a high-energy, hydrophobic liquid that blends easily with conventional gasoline and diesel fuels. Several available alternative-fuel options can be integrated into the existing transportation infrastructure with varying degrees of success. These

(Continued on Page 4)

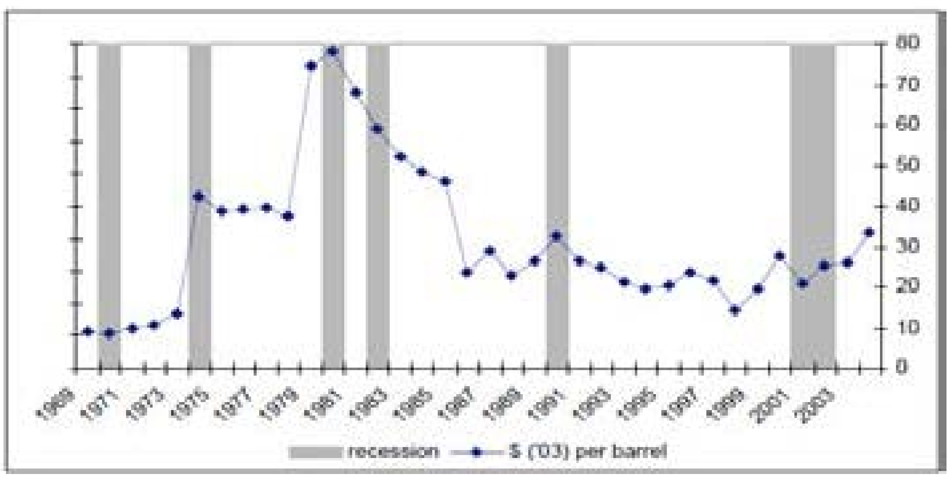


Figure 1: Oil Prices and U.S. Recessions: 1960-2003. *Source: Hirsch Report, 2005.*

[7] Robert L. Hirsch, et al., *Peaking of World Oil Production: Impacts, Mitigation, & Risk Management,* Accessed December 2, 2011, http://www.netl.doe.gov/publications/others/pdf/Oil_Peaking_NETL.pdf.

[8] Significantly higher gasoline and diesel taxes would be a more economically efficient way of reducing fuel consumption, but that is not politically viable.

[9] *History of Fuel Economy: One Decade of Innovation, Two Decades of Inaction*, The Pew Charitable Trusts, Accessed December 2, 2011, http://www.pewenvironment.org/uploadedFiles/PEG/Publications/Fact_Sheet/History of Fuel Economy.pdf.

[10] *President Obama Announces Historic 54.5 mpg Fuel Efficiency Standard*, White House Office of the Press Secretary, (July 29, 2011), Accessed December 2, 2011, http://www.whitehouse.gov/the-press-office/2011/07/29/president-obama-announces-historic-545-mpg-fuel-efficiency-standard. An, Feng and Amanda Sauer, *Comparison Of Passenger Vehicle Fuel Economy And GHG Emission Standards Around The World*., Pew Center on Global Climate Change, (December 2004), http://www.pewclimate.org/docUploads/Fuel Economy and GHG Standards_010605_110719.pdf. Accessed 12-2-11.

Energy Transportation *(Cont. from 3)*

include cleaner, renewable fuels like ethanol and biodiesel, as well as the expanding xTL family of synthetic fuels, including coal-to-liquids (CTL), gas-to-liquids (GTL), and biomass-to-liquid (BTL) technologies. Drop-in fuels would ideally work with existing pipelines, delivery trucks, and fueling stations and perform well in existing internal combustion engines under a diverse mix of climate conditions.

Ethanol is the mostly widely used alternative fuel because of its proven effectiveness. Corn-based ethanol cannot be scaled up enough to displace our oil consumption, has limited compatibility with the pipeline infrastructure, has lower fuel economy, and can cause engine damage in specific applications. Despite public skepticism about ethanol's net energy, numerous scientific studies have demonstrated ethanol's higher energy yields and environmental benefits.[11] Though the compatibility issues can be overcome, the base-feedstock for ethanol production needs to be changed to alleviate the food vs. food concern of corn-based ethanol. Also, because the ratio of diesel to gasoline processed from crude oil can be adjusted only within a certain range, ethanol implementation is effectively limited by our ability to mass-produce a diesel substitute. Biodiesel alternatives to petroleum diesel have a long history, though modern diesel engines require natural oils to be modified before use and can suffer from a variety of problems, including gelling in cold temperatures and microbial overgrowth in fuel tanks. Biodiesel has a favorable energy balance and positive environmental effects, but its feedstocks typically compete with food.

The xTL fuels involve the gasification of energy-rich substrates (coal, natural gas, biomass, etc.) and subsequent re-forming of synthesis gases into liquids nearly identical to conventional gasoline and diesel. Their near-perfect compatibility with all aspects of the transportation infrastructure (pipelines, storage, dispensation, and engine combustion) makes the xTLs a very appealing short-term fuel option. At present, the main limitation is that the production of these fuels is more energy intensive, and therefore more expensive than oil refining. Over the longer term, with rising oil prices and more installed production capacity, and availability of suitable feedstocks, xTL synthetic fuels could become cost-competitive. The potentially detrimental environmental impacts might then be the biggest limiting factor.

Few long-term solutions for the transportation sector appear able to fulfill the vision of systems that allow transportation of population, goods, and services with little or no effort. The xTL fuels may enjoy long-term success because liquid fuels have extremely high energy density, easy distribution, and effective end-use. Large deposits of gas hydrates could theoretically provide enough energy to power transportation for thousands of years with methane being converted to methanol and then refined into a GTL gasoline equivalent.[12] The main challenge with gas hydrates is the harvesting and liberation of the desired gas molecules, and a potential danger is the rapid, uncontrolled release of methane into the atmosphere.

Cellulosic ethanol has much potential but has not achieved wide-spread commercialization, largely because of technical challenges and high costs. If these obstacles can be overcome, cellulosic ethanol could have a significant future. Offshore algae-based biofuels are particularly promising, as algae function almost like large-scale solar collectors that convert solar energy into sugars and oils (see Figure 2 on Page 18). If results from the laboratory can be replicated off-shore, a small fraction of appropriate unused ocean space could power the world's transportation network indefinitely. Recent investments from public-private partnerships, including U.S. Navy, Solazyme, and Chevron, on algae biofuels using emerging tools in biotechnology, present the most promise for moving towards a clean, renewable energy future.

By far the most effective long-term solution is simply a change in lifestyle and transportation choices. The U.S. population is far less

(Continued on Page 18)

---

11. Hosein Shapouri, et al., *The Energy Balance of Corn Ethanol: An Update*, USDA Agricultural Economic Report Number 813, Accessed December 5, 2011, http://www.transportation.anl.gov/pdfs/AF/265.pdf.

12. E. Dendy Sloan, "Fundamental Principles and Applications of Natural Gas Hydrates," *Nature*, 426, (November 2003), 353-359.

Distributed Energy Resources (DER) to Mitigate Energy Sector Vulnerabilities

by Benjamin T. Delp, Associate Director of Research Development, and
Nathan H. Miller II, Research Assistant
Institute for Infrastructure and Information Assurance, James Madison University

Long recognized by public policy and security experts as an impediment to a robust national security strategy, the inherent vulnerability of concentrated critical infrastructure was presented to U.S. policymakers through a Congressional Research Service Report for Congress in September 2008. Author Paul Parfomak, research specialist in energy and infrastructure, explains in his introduction that, "[w]hen infrastructure is physically concentrated in a limited geographic area it may be particularly vulnerable to geographic hazards such as natural disasters, epidemics, and certain kinds of terrorist attacks."[1] For example, more than 40 percent of oil refining capacity is found along the coastlines of Texas and Louisiana, leaving that region particularly at risk to any number of disastrous events.[2] Drilling even deeper into the energy/electricity critical infrastructure sector, plans are currently underway to integrate smart-grid technology into the electric grid. Interconnected electrical networks enable access (malicious or other) to the Internet through a single point source — a computer. (It should be noted that the authors recognize the many benefits of the smart-grid, but security considerations must be a large component of any smart-grid implementation, especially when taking into account past cyber attacks against the U.S. electric grid by both Russia and China.)[3]

If geographic concentration and single point access of critical infrastructure are security vulnerabilities, then perhaps efforts to decentralize infrastructure can decrease certain threats toward critical infrastructure sectors while increasing redundancy. For example, what role could Distributed Energy Resources (DER), which are small, decentralized energy systems, play in enhancing the security of the Energy Sector? According to the U.S. Department of Energy's (DOE) Federal Emergency Management Program (FEMP), "DER systems can also enhance energy security at a site by helping diversify the energy supply and by providing prime power to mission-critical loads."[4] Below are descriptions and examples of three types of DER that are lessening different industries' reliance on a vulnerable, centralized electric grid: microhydroelectric, photovoltaic arrays, and combined heat and power.

Microhydroelectric Power

As is the case with all hydroelectric power projects, micro-hydro relies on the energy produced by the speed of water flowing over turbine blades to produce electricity. As the name would suggest, micro-hydro is on a much smaller scale than large-scale hydro, and the use of a dam to control the amount of water needed is not always necessary. Micro-hydro projects typically use run-of-the-river systems, which do not utilize large reservoirs.

In a run-of-the-river scheme (see Figure 1 on Page 6), part of a stream or river's flow is diverted through either a channel or pipeline known as a penstock from an intake opening at a higher elevation upstream, which delivers the water to a turbine room or powerhouse downstream at a lower elevation. The higher the elevation of fall between the intake and the turbine

(Continued on Page 6)

---

1. Paul Parformak, *Vulnerability of Concentrated Critical Infrastructure: Background and Policy Options*, CRS Report for Congress, (September 12, 2010), 1.
2. Ibid., 5.
3. Siobhan Gorman, "Electricity Grid in U.S. Penetrated by Spies," *The Wall Street Journal*, (April 8, 2009), Accessed July 22, 2011, http://online.wsj.com/article/SB123914805204099085.html.
4. Federal Energy Management Program, "Distributed Energy Resource Basics," U.S. Department of Energy, (2011), Accessed November 8, 2011, http://www1.eere.energy.gov/femp/technologies/derchp_derbasics.html.

Distributed Energy *(Cont. from 5)*

area plus the amount of water being channeled will determine the amount of electricity produced via how fast and frequent the turbine blades spin. The turbine does not necessarily have to produce electricity alone; it can also pump water for services such as irrigation.[5]

The Dodarak Afghanistan Microhydroelectric Project

In the mountains of Afghanistan, a stream with a powerful current runs through the village of Dodarak in Nangarhar's Dare Noor district. This stream now flows through a turbine that creates electricity for the town's homes and shops. On April 6, 2009, members of Dare Noor District Development Assembly, elders of Dodarak village, and representatives from the U.S. Agency for International Development-funded Alternative Development Program — Eastern Region (ADP/E), gathered to open a 60-kilowatt microhydropower plant driven by the stream (see Photo 1). The energy created from the stream supplies electricity for 150 households in the villages of Dodarak, Dodailak, and Gorkhal. The plant also powers six shops that sell food, cold drinks, and other items. The goal of ADP/E's micro-hydro programs is the creation of well-designed projects that support broader community and economic growth. This was, exemplified during the development of the Dodarak plant by the organized labor efforts of local residents who invested a personal stake in the project. They learned the required maintenance skills while earning money to stimulate the local economy.[6]

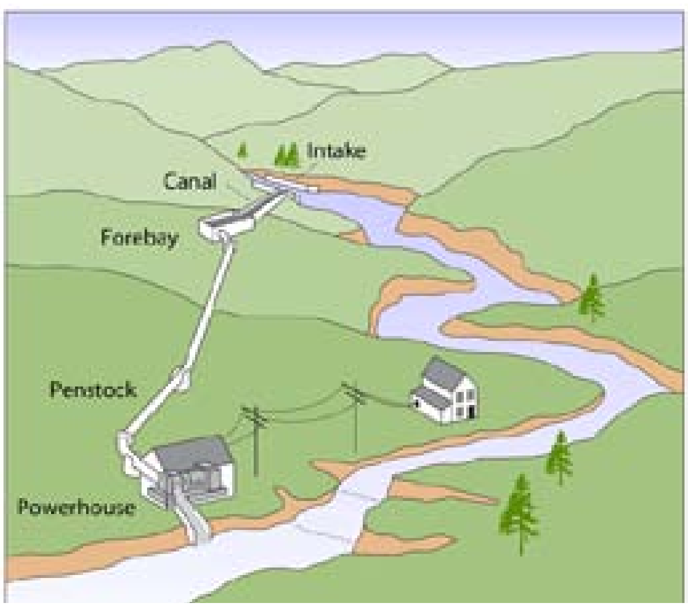


Figure 1. In this microhydropower system, water is diverted into the pen-stock. Some generators can be placed directly into the stream. *Courtesy of the U.S. Department of Energy.*

The Dodarak micro-hydro plant cost about US $107,000, including $17,000 for local labor to engineer and build. It should be noted that if designed appropriately, such "run-of-the-river" plants have no adverse impacts on water resources, aquatic life, or the environment. Additional micro-hydro plants can be placed up or downstream, harnessing the power of the same water many times over. The overall life of the plant is estimated at 40 years. The Community Development Council (CDC) of Dodarak village has promulgated a transparent system for managing electricity accounts. Each of the families pay three Afghanis, and each business five Afghanis, for one kilowatt-hour of electricity. The CDC obtains the money, which is used to pay the power plant technicians and maintain the plant. If revenue exceeds regular expenses, the CDC can allocate funds for other development projects in the village.[7]

Photo 1. *Courtesy of ADP/E.*

Photovoltaic Arrays

A photovoltaic array (or solar array) is a linked collection of solar panels. The power that one panel can produce is usually not enough

(Continued on Page 7)

5. Energy Efficiency and Renewable Energy Office, "How a Microhydropower System Works," U.S. Department of Energy, (2011), Accessed November 14, 2011, http://www.energysavers.gov/your_home/electricity/index.cfm/mytopic=11060.
6. DAI, "Afghan Villages Bolstered by Micro-hydro Power Plant," (2009), Accessed November 14, 2011, http://www.dai.com/pdf/1241103378_Afghanistan_Micro-Hydro_plant.pdf.
7. Ibid.

Distributed Energy *(Cont. from 6)*

to meet the needs of a home or a business, so the panels are connected together to form an array. Typically PV arrays use an inverter to change the DC power produced by the modules into alternating current that can power lights, motors, and other loads. The modules in a PV array are usually first connected in series to obtain the desired voltage; the individual strings are then connected in parallel to allow the system to produce more current. Solar arrays are typically measured under STC (standard test conditions) or PTC (PVUSA test conditions), in watts, kilowatts, or even megawatts.[8]

Isthmus Engineering & Manufacturing Solar PV Array Installation

The engineering and manufacturing firm Isthmus made contact with the MadiSUN Solar Energy Program to explore the possibility of siting a solar array on their facility.[9] MadiSUN receives funds through the DOE's Solar America Cities program, and provides solar assessments and renewable energy consulting for business or residential property owners located within the city of Madison, Wisconsin.[10]

It was discovered that the Isthmus Engineering building actually had a perfect solar window, with no exterior objects creating shadows. Next, the parking lot was evaluated for the possible location of pole-mounted panels and the south-facing façade of the manufacturing wing was analyzed as a good location for an awning-style mounting system. After reviewing a report summarizing both the solar potential of the building and the estimated costs and paybacks of the system, Isthmus decided to install a 10-kilowatt solar electric system (see Photo 2), the largest size that meets the criteria for Madison Gas and Electric's (MG&E) solar buyback program. The system produces about 12,500 kilowatt-hours of electricity each year, worth over $3,100 in buy-back payments, and eradicates over 13 tons of CO2 emissions each year. This program speeds up the payback of a solar electric system by paying the owner 25 cents per kilowatt-hour for the first 10 years of ownership. That is almost double the MG&E rate for residential customers and more than double the rate for most commercial customers.[11]

Photo 2. *Courtesy of MadiSUN Solar Energy Program.*

Combined Heat and Power (Cogeneration)

Cogeneration (or Combined Heat and Power, CHP) is the use of a heat engine or a power station to concurrently generate both electricity and useful heat. The world's first commercial power plant, the Pearl Street Station built by Thomas Edison in 1882, was in fact a cogeneration plant. All thermal power plants emit heat to some degree during electricity generation. This heat is discharged into the environment through cooling towers, flue gas, or by other means. CHP captures some or all of the by-product heat for heating purposes, either very close to the plant, or as hot water for district heating. By capturing the excess heat, CHP can potentially reach an efficiency of up to 80 percent at a

(Continued on Page 19)

8. Research Institute for Sustainable Energy, "Small Photovoltaic Arrays," Murdoch University, (2008), Accessed November 14, 2011, http://www.eepe.murdoch.edu.au/resources/info/Applic/Array/index.html.

9. MadiSUN Solar Energy Program, "Madison Solar PV Case Study: Manufacturing Facility," City of Madison, (n.d.), Accessed on November 14, 2011, http://www.cityofmadison.com/sustainability/City/madiSUN/documents/CaseStudy-IsthmusEnginv1.pdf.

10. City of Madison, "Sustainability," (2011), Accessed on November 14, 2011, http://www.cityofmadison.com/sustainability/.

11. MadiSUN Solar Energy Program, "Madison Solar PV Case Study: Manufacturing Facility," City of Madison, (n.d.), Accessed on November 14, 2011, http://www.cityofmadison.com/sustainability/City/madiSUN/documents/CaseStudy-IsthmusEnginv1.pdf.

Changed Program Management Requirements in Unconventional Gas Programs

by Bob Prieto*
Senior Vice President, Fluor Corporation

This article was originally published in the November 2011 issue of PM World Today.

Unconventional gas represents an emerging energy option for a world which increasingly appears to have no clear and easy energy supply winners. This race to develop unconventional gas resources is in many ways being driven by prospects in the United States, but early involvement of large global players sends a clear signal that this technology will be exploited more broadly. These new unconventional gas programs employ evolving technologies, building on 60 years of experience, but more importantly are witnessing the need to evolve program delivery models from those employed on more traditional oil and gas projects. In this paper, the focus will be limited to the United States unconventional gas market and observations are shared on how program delivery may need to evolve to meet the unique aspects of this market.

What is the Unconventional Gas Opportunity in the United States?

Unconventional gas, or shale gas, developed by use of hydraulic fracturing or fracking has transformed the United States from a situation where gas production was declining to one where it is once again growing. Shale gas discoveries and the ability to exploit those discoveries through both vertical and horizontal drilling with fracking have extended U.S. gas supplies to a 100 year horizon. The year ahead should see over $7 billion of new investment in unconventional gas for well investment, new gas plants, new natural gas liquids fractionation plants, new and retrofit pipeline plans, and well hook ups. This annual level is expected to grow… if concerns are addressed and more efficient program delivery strategies are employed.

Shale gas offsets declines in other U.S. supply to meet consumption growth and lower import need.

What are Some of the Concerns?

Unlike conventional oil and gas developments, where a smaller number of higher volume wells are drilled and where fracking has been more limited in scope, unconventional gas development requires a much more extensive drilling program and the use of much larger quantities of water. The logistics and environmental issues associated with this changed delivery give rise to a set of concerns which include:

- Potential groundwater contamination;
- Traffic, safety, damage to roads and bridges, and other unconventional gas construction activity over a broader area;
- Potential for increased accidents and surface spills associated with frac chemical handling;
- Waste disposal related to frac return water, dissolved solids, and radioactive isotopes from the wells;

(Continued on Page 9)

Unconventional Gas *(Cont. from 8)*

- Air quality; and
- Water use.

To put some dimension on the differences between conventional and unconventional gas development, consider the following.

New Program Delivery Challenges

Unconventional gas development programs are not our father's gas development programs nor are the fracking operations of today comparable to those used in conventional wells. In many ways the large, single location well and associated plant of the past is being replaced by a new distributed plant with many smaller scale activities. These smaller scale activities, however, have associated with them logistical and infrastructure demands that dwarf those encountered in extracting comparable volumes of conventional gas.

In many ways, these new unconventional gas programs sit at the intersection of:

- Traditional oil and gas project skills;

- Infrastructure stakeholder, permitting, environmental, traffic and associated design and construction skills; and

- Multi-plant operations, maintenance and small CAPEX delivery skills.

This new program paradigm creates new challenges that include:

- Evolving regulatory and permitting environments at the local, State, Federal and multi-state commission levels;

- Major stakeholder engagement programs;

- Utilization of significant quantities of water for fracking, drawn from basins that in many instances have had limited industrial usage;

- Generation, tracking, and treatment of large quantities of frac water;

- Pre- and post-environmental monitoring and reporting both as a risk mitigation strategy as well as to meet regulatory requirements;

- New temporary and permanent civil infrastructure, across wide areas of geography, spanning multiple jurisdictions;

- Logistical challenges that will continue to evolve as unconventional gas resources are built out;

- Fleet management challenges, including safety, training, logistics, dispatch;

- New gathering lines;

- Ability to access Federal aid to highway facilities for longitudinal transport of gas;

- Development of new intrastate and interstate transmission capacity;

- Potential liquefaction facilities;

- Waste water treatment strategies and facilities; and

- Public private partnerships.

With awareness of these new challenges, current program delivery strategies can be assessed and some conclusions about a path forward suggested.

	Conventional Gas	Unconventional Gas
CAPEX	$ 1 billion	$ 1 billion
Number of Wells	5-6	400 - 600
Water Required per Well	Nil	3 – 5 million gallons
Sand per Well	Nil	700 – 1500 tons
Chemical Additives per Well	Nil	6000 gallons
Gas Production	2x	1x

Table 1.

Observations on Unconventional Gas Program Requirements

The following observations are drawn from a review of the conventional gas market and suggest that a more comprehensive, life-cycle oriented program management

(Continued on Page 10)

Unconventional Gas *(Cont. from 9)*

approach may provide improved risk mitigation, safety regime, and cost benefits. We believe this more comprehensive and integrated approach will become more important as the market scales up and as the associated technologies are deployed on a global scale (See Table 2 on Page 11).

Implications for Program Delivery

These new challenges must be addressed in new ways, recognizing the distributed nature of this asset base and life cycle characteristics different from many existing production platforms. We believe an integrated program management approach that reflects the unique intersection of three traditional program delivery markets is required. Specifically, we believe the needs of the unconventional gas market can be best met through an approach that integrates:

- Infrastructure focused strategic program management capabilities that include:
  - Early involvement in project definition, selection and siting;
  - Strong, early and ongoing stakeholder management programs and dashboards tailored to public concerns;
  - Regulatory, permitting, and agency engagement;
  - Transportation modeling;
  - Civil engineering oriented design and construction;
  - Environmental mitigation; and
  - Public private partnerships including use of unique structures that may open new right of way options.
- Energy and chemicals focused PMC and PMC+ capabilities that include:
  - Strong baseline centric driven program management;
  - Resilient risk assessment and management;
  - Offsites and utilities engineering and construction;
  - Pipeline and compressor design and construction;
  - Water and wastewater treatment and recycling;
  - Solid waste handling and disposal;
  - Chemical tracking and storage;
  - Industry leading safety program; and
  - Regulatory and permit reporting.
- Operations, maintenance, and logistics capabilities that include:
  - Infrastructure and treatment plant operating and maintenance services;
  - Material management services, including strategic procurement, logistics, warehousing, and free issue;
  - Small cap project implementation; and
  - Asset management and improvement.

Like all good program management, successful delivery of unconventional gas programs will require:

- Strong and decisive leadership by senior management;
- Early, consistent, and direct involvement of frontline staff;
- Engagement and ongoing involvement by each stakeholder population both within the owner's organization as well as externally;
- Acceptance and projected confidence in the implementation of new strategies and solutions at an early program stage;
- Use of experienced, neutral, and external facilitators to
  - Drive organizational change management and alignment processes,
  - Identification of latent conflicts for resolution,
  - Facilitation of building the required multidisciplinary team focused on undertaking the program management "journey;"
- Clear recognition that many parts of the project delivery system need to be restructured simultaneously for effective program delivery;
- Collective determination of key performance indicators and their application;
- Comprehensive data analysis by experienced staff with a programmatic and systemic focus and timely reporting of Key Performance Indicators (KPIs);
- Recognition and reward for success emphasized over penalty for failure; and
- Appropriate resourcing of program management role with sufficient flexibility to migrate the organization structure and skills

(Continued on Page 20)

Unconventional Gas *(Cont. from 9)*

Ten Observations on the Current State of Unconventional Gas Program Delivery

Observation #1 – Program Management Not Being Effectively Deployed as a Delivery Strategy: Many current efforts in unconventional gas are being approached on a project or multiproject basis with opportunities associated with a programmatic approach not being fully realized. Such opportunities relate to broader stakeholder management; environmental, health & safety (EH&S); risk management including liability management; supply chain and logistics; and longer term asset management

Observation #2 – Specialized Resources are Being Deployed to Lower Value Activities: Unconventional gas players are deploying large numbers of their limited, specialized development and production resources in the management of local suppliers and contractors. Demands are exacerbated by the distributed nature of the "plant" and the presence of new issues associated with the deployment of fracking technology (water supply, waste water collection and treatment or disposal, water quality monitoring, water transport, and reporting). Diversion of these resources from exploration, development, and production sub-optimizes the owner's returns.

Observation #3 – A New Risk Focus is Required Reflecting the Intersection of Multiple Program Environments: Unconventional gas development represents the combination of a set of risk drivers traditionally not found in oil and gas projects. For Fluor, this set of risk drivers are collectively what we experience in a number of our business lines and include:

- Energy and Chemicals: drilling, pipeline, gas treatment risks; energy regulators
- Infrastructure: Distributed "plant;" multiple often competing stakeholder interests; higher public and press visibility; programs comprised of a multiplicity of projects that are geographically dispersed; multiple, often overlapping, permitting authorities and regulatory bodies; local procurement and capacity building pressures; increased 3rd party liability exposure (risk is proportional to the length of the fence it would take to enclose the impacted area
- Global Services: Multiplicity of small CAPEX projects for a single owner; asset management focus on minimizing spares; distributed maintenance operation

We have spent considerable time in thinking through how to get the right risk focus.

Observation #4 – Regulatory Risks are Both Beyond Traditional Gas Player Areas of Expertise and Evolving at Multiple Government Levels: The regulatory environment is evolving and the rate of evolution is likely to accelerate before it slows down. Unconventional gas needs better pre-existing condition data, real-time monitoring of both construction impacts and any operations phase anomalies. The infrastructure project type nature of unconventional gas development opens new doors for regulatory and permitting mischief. A litigation framed risk mitigation strategy similar to that employed on many infrastructure projects may be appropriate.

Observation #5 – Brand Risk is Growing as the Number of Multiple Points of "Failure" Grows: Brand risk will be high because of the multiplicity of failure modes so pre-emptive brand protection strategies related to environmental, health and safety will become increasingly important. Brand risk will also exist to the extent that local corruption with respect to permitting activities is present.

(Continued on Page 12)

Unconventional Gas *(Cont. from 11)*

Ten Observations on the Current State of Unconventional Gas Program Delivery (Continued)

Observation #6 – New Supply Chains and New Supply Chain Strategies are Required: Supply chain is not the traditional many sources to one (or a few) points. It is many sources to many points. Client furnished material percentages (CFM %) appears to be low compared to broader industry practice representing a cost savings opportunity. Logistics chains are becoming overwhelmed and conditions on certain aspects are degrading.

Observation #7 – Stakeholder Engagement and Management Models Will Not be Drawn from the Conventional Oil and Gas Industry Practices: Stakeholder engagement programs will increasingly be required to look like those undertaken for large infrastructure programs with high touch and recognition that there are a multiplicity of communities that will need to be engaged.

Observation #8 – Latent Safety Risks Exist Today and Are Growing: Safety risks are elevated during construction because of a large untrained and distributed workforce. Class action type labor risks can be mitigated through proven safety training programs such as the driver safety training program deployed by Fluor on the South Carolina Construction and Resource Manager (CRM) program.

Observation #9 – A More Robust Contracting Community with Requisite Skills and Improving Practices is Required: Like all infrastructure projects, there will be growing pressure to mobilize local contractors and labor force. This requires a programmatic approach to ensure sufficient qualified contractors with increasing scale capable of reproducing quality results. Best practices will need to be captured and leveraged and systemic craft and contractor training programs similar to what Fluor has implemented on other large programs may be considered.

Observation #10 – The Opportunities of Leverage that Strategic Program Management can Bring Still Lie Ahead: Consistency across multiple unconventional gas plays will promote efficiencies. This leveraging effect is applicable across all phases (planning, permitting, design, construction, operations, and maintenance).

(Continued on Page 20)

Establishment and Growth of a Wind Energy Training Program at Iowa Lakes Community College

by Craig Evert, Assistant Professor
Wind Energy Turbine & Technology, KS

Iowa Lakes Community College, a public, rural, multi-campus institution, serves a five- county district with a population of 70,000 residents. In 2003, the college was in the process of installing a 1.65 MW wind turbine to offset electrical costs and the need for training qualified technicians was immediately recognized as a simultaneous goal. Later that year, the Iowa Department of Education approved a two-year Associate in Applied Science degree through the Wind Energy and Turbine Technology program. The program was the first educational wind energy curriculum offered in the State of Iowa and the first in the Nation to utilize and operate a utility sized wind turbine as a laboratory. Three expansions in facilities have been necessary since the initial class of 15 enrolled in 2004. Iowa Lakes currently admits more than 80 students per incoming freshman class.

The academically rigorous program requires a summer-term employment for these motivated students. Typically, demand exceeds the number of program graduates, and several Iowa Lakes wind students have as many as three employment offers in a variety of entry-level positions.

Industry support for the program has been substantial, resulting in numerous donations of specialized equipment, scholarships, and financial support for facility expansion. Industry partners travel from across the Nation to attend semi-annual meetings at the campus and their companies also provide professional development opportunities for faculty. Edison-Mission, Iberdrola, Vestas, Siemens, and General Electric have been particularly generous with their resources. The Wind Energy and Turbine Technology program faculty have embraced diversifying employment opportunities by expanding the program advisory committee to include emerging companies

Iowa Lakes Community College operates a Vestas 1.65 MW turbine near the Estherville Iowa Campus.

An Iowa Lakes Wind Energy program advisory committee continues to shape program curriculum and student work experiences. The program has matured in step with the modern utility scale wind industry. The representation of industry from the conceptual phase has insured that students receive the most realistic training possible. Iowa Lakes wind students have the opportunity to learn on a 1.65 megawatt Vestas V82 turbine, a Vestas V82 hub and blades, a Vestas V90 nacelle prototype, a Gamesa G87 nacelle, and numerous simulators. Additionally, program curriculum incorporates high voltage, process control, and field operations training identical to those utilized in complementary alternative energy industries.

Iowa Lakes' wind curriculum allows students to explore specialized industry opportunities. The Wind Energy program director and six instructors bring unique perspectives, ranging from electric

(Continued on Page 21)

Legal Insights

Integrating Renewable Power, Securely

by Donna M. Attanasio, Partner, Energy, Infrastructure,
Project & Asset Finance ("EIPAF") Group, White & Case LLP*

Background

The concept of protecting electric system critical infrastructure is long-standing and deeply ingrained in the industry. Almost any utility worker will tell you that her or his primary duty is "keeping the lights on." Threats to electric infrastructure include severe weather, physical and cyber attacks, electromagnetic pulses, geomagnetic disturbances, interdependence with other critical infrastructure, such as telecommunications, fuel and water, pandemics,[1] human error, and uncontrolled (cascading) operational failures on neighboring systems.

Given the lack of storage, the speed of transmission, and the interconnectedness of the system, there are few other types of infrastructure, telecommunications being perhaps the only exception, where the impact of a failure is felt so widely, so quickly. For example, on August 14, 2003, the contact between a tree and a wire in Ohio at 2:02 p.m. set off two hours of increasing instability of the grid in the Cleveland-Akron area, which by 4:05 p.m., could no longer be controlled, resulting in a cascading blackout affecting approximately 50 million people in the northeastern United States and Canada ("the 2003 Northeast Blackout").[2]

The 2003 Northeast Blackout, like the massive blackout that affected the Northeast in 1965, became a turning point. The 1965 blackout spurred the growth of power pools and increased cooperation among utilities. The 2003 Northeast Blackout resulted in legislation that set the framework to transform the North American Electric Reliability Council, an industry-run organization that relied primarily on voluntary cooperation among utilities, into the North American Electric Reliability Corporation (NERC), an independently funded reliability organization tasked with developing and administering mandatory reliability standards (Reliability Standards), subject to oversight and enforcement, including civil penalty assessments, by the Federal Energy Regulatory Commission (FERC).

In the area of critical infrastructure protection (narrowly defined), the Reliability Standards include measures for perimeter control of critical assets and reporting of threats; other Reliability Standards specify operational safeguards ranging from training requirements to relay settings.[3] In September 2011, FERC proposed to adopt revised cybersecurity standards that, among other things, would impose "bright line" criteria for identifying critical assets.[4] Notwithstanding these efforts, grid security is an elusive prey. As recently as September 8, 2011, a blackout originating in Arizona caused a loss of power to southern California, parts of Arizona, and Mexico's Baja peninsula, including every customer of San Diego Gas &

(Continued on Page 15)

[1] National Infrastructure Advisory Council, *A Framework for Establishing Critical Infrastructure Resilience Goals,* ("NIAC Framework Report"), (October 2010),48, available at http://www.dhs.gov/xlibrary/assets/niac/niac-a-framework-for-establishing-critical-infrastructure-resilience-goals-2010-10-19.pdf.

[2] U.S.-Canada Power System Outage Task Force, *Final Report on the August 14, 2003 Blackout in the United States and Canada: Causes and Recommendations,* (September 2004), 1, and 45-72, available at https://reports.energy.gov/BlackoutFinal-Web.pdf.

[3] Reliability Standards, Accessed on December 7, 2011, available at http://www.nerc.com/page.php?cid=2|20.

[4] *Version 4 Critical Infrastructure Protection Reliability Standards,* Notice of Proposed Rulemaking, 136 FERC ¶ 61,184 (2011).

Legal Insights *(Cont. from 14)*

Electric Company.[5] Ultimately, protection must include both efforts to prevent problems from occurring, and enhancing the grid's ability to withstand and recover from those stresses that cannot be avoided.

Renewable Power

Against this backdrop — an industry committed to reliability and infrastructure protection, but facing a Herculean task — comes a new factor: renewable generation. Renewable generation encompasses intermittent or variable energy resources (VERs), such as wind and solar, as well as resources that may be more controllable, such as biomass, hydro, landfill gas and geothermal, but which for commercial or other operational reasons are often not fully dispatchable.

Many renewable generation facilities are smaller than their fossil-fuel counterparts, and the sector includes a rapidly growing amount of distributed generation which may be interconnected directly to the distribution system or may serve load behind the meter (such as rooftop solar). For example, the California Public Utilities Commission released a report last summer stating that 194 MW of distributed solar generation capacity was installed in 2010, a 47 percent increase over 2009.[6] But, the 924 MW of installed solar capacity in California is spread over 94,891 sites,[7] which averages to less than 10 kW per site. In New Jersey, which rivals California in solar capacity growth, over 400 MW of solar capacity is generated from over 10,000 facilities.[8]

Renewable power has some inherent infrastructure protection benefits as well as the environmental benefits for which it is more generally sought. Wind and solar power are not dependent on fuel distribution infrastructures, and certain other renewable fuels are sourced locally (e.g., landfill gas and some biomass). Thus, failures of infrastructure in other sectors, such as rail transport (used for coal) or natural gas pipelines are less likely to impact such generation.[9] The "fuel" is domestic and, thus, not subject to national security concerns. Further, renewable power is often delivered through distributed generation sources, close to load, diversifying the risk posed by large central power stations, where terrorist activity or natural disasters can disable a large amount of capacity at once. While renewable resources are not immune from disruption, the U.S. pursuit of greener energy resources is adding more resilience to the grid through diversification.[10] But, renewables also add new challenges and opportunities.

(Continued on Page 16)

5. For an interesting mathematical perspective on the intractability of grid failures, see Peter Fairley, *The Unruly Power Grid*, IEEE Spectrum, (August 2004), available at http://spectrum.ieee.org/energy/the-smarter-grid/the-unruly-power-grid/0.

6. Press Release, California Public Utilities Commission, *CPUC Report Shows Record Growth in Rooftop Solar Installs*, (July 5, 2011), available at http://docs.cpuc.ca.gov/published/News_release/138482.htm.

7. Ibid.

8. Nathanial Gronewold, "Solar Industry's Boom in N.J. Casts Shadow Over Program That Spurred It," *N.Y. Times*, (August 25, 2011), available at http://www.nytimes.com/gwire/2011/08/25/25greenwire-solar-industrys-boom-in-nj-casts-shadow-over-p-52495.html?pagewanted=all.

9. In contrast, coal-fired generation can be adversely impacted by issues with rail infrastructure, such as the 2005 rail line maintenance that disrupted coal deliveries from the Powder River Basin, affecting units as far away as Michigan and Louisiana and costing an estimated $228 million. See Stan Mark Kaplan, *Rail Transportation of Coal to Power Plants: Reliability Issues*, at CRS-7, (September 26, 2007), (identifying Powder River Basin as "the nation's largest single source of any fuel for electricity"), available at http://cnie.org/NLE/CRSreports/07Oct/RL34186.pdf. Curtailments of gas supply added to the problems created by unusually cold weather in February 2011 in the southwest United States. The cold snap had an "unprecedented" effect on gas supply, and region-wide, 1.2 million MWhs of electric generation were lost, of which 12 percent was due to issues with gas supply or attempted switching from gas to alternative fuels. See Report on Outages and Curtailments During the Southwest Cold Weather Event of February 1-5, 2011, Item No. A-4, (September 15, 2011). Texas was particularly hard hit, losing 225 units representing 14,855 MW of which 4 percent was due to gas curtailments. See Texas Reliability Entity Event Analysis, February 2, 2011, EEA-3 Event, Public Report, (August 15, 2011), 19-20, 28 (TRE Event Analysis), available at http://www.texasre.org/CPDL/2011-02-02%20EEA3%20Event%20Analysis-public_final.pdf.

10. Renewable generation can be subject to disruptions, but differently than fossil-fuel generation. For example, the Texas cold snap in February 2011 caused numerous wind turbines to shut down due to low temperatures. See TRE Event Analysis, 25. The 1991 eruption of Mt. Pinatubo allegedly resulted in a reduction in solar radiation for solar power generation in southern California of 26-27%. See Kramer Junction Co., 64 FERC ¶ 61,025 (1993).

Legal Insights *(Cont. from 15)*

In general, the NERC Reliability Standards for physical infrastructure and cyber protection of generation sources do not draw a distinction based on fuel source. However, unless a generator is specifically found to be critical to the reliability of the bulk power system or needed for black start or system restoration, NERC has exempted individual generating units. This includes units with a gross nameplate rating of 20 MVA or less or a plant with a gross nameplate rating of 75 MVA or less from inclusion in its compliance registry, because, generally, they are not deemed critical.[11] Accordingly, many renewable power generation sources are not directly subject to Reliability Standards. Instead, they are subject to compliance with their interconnection agreements, which generally provide the grid operator the right to disconnect a unit if it creates a disturbance or threatens the system. This approach puts security control in the grid operator's hands, without unduly burdening small projects with costs and requirements they cannot handle.

However, a recent decision by NERC, which has been upheld by FERC, threatens to expand the regulatory burden on larger renewable generation projects by imposing on them transmission owner and operator obligations. The issue centers on the interconnection facilities or "gen-ties," by which all units connecting at a transmission voltage interface with the grid. Typically, the owners and operators of non-exempt generation and the associated gen-ties register with NERC, and are regulated under the Reliability Standards solely as, "Generator Owners" and "Generator Operators." However, in at least three instances, NERC has determined that a gen-tie is integral to the bulk power system and required the owner and operator of each such gen-tie to also register with NERC as a "Transmission Owner" or "Transmission Operator" (as applicable). In the first of these cases, the facility at issue was a 1,092 MW gas-fired unit that shared a bus with a nuclear plant.[12] But this year, the new requirements were extended to two wind facilities, the larger of which was only 300 MW.[13] The affected companies and others opposed the imposition of this additional cost and burden, arguing that the interconnected plants were not themselves integral to grid reliability and the loss of the associated gen-tie would affect only the interconnected plant. Notwithstanding these protests, FERC has determined that these wind generation owners and operators will be required to register as, and comply with, at least some of the reliability standards applicable to transmission owners and operators.

Often, renewable resources, including wind, solar, and geothermal resources, are found in locations far from load centers and existing transmission corridors. As a result, the gen-ties needed to connect capacity located in these renewable-rich areas with the grid often include long transmission lines that are owned, and controlled at least in part, by the generation owner. Particularly where these lines traverse long distances and remote territory, they may be vulnerable to the elements, sabotage, or other disruptions and loss of the line strands the interconnected generator. The gen-ties for the two affected wind facilities were each over 70 miles long, but the decision did not rest on that fact; rather NERC found that operation of the line could affect other parts of the grid. However, critics argue that the decisions affecting these two wind facilities cannot be distinguished from other plants with transmission-voltage interconnections, and therefore this regulatory burden potentially looms over a number of units. The two cases are fact-specific and NERC continues to evaluate this issue, but if it continues down this path, many generator owners and operators, including those of renewable power, could be required to take on some of the responsibilities of transmission owners and operators.

(Continued on Page 17)

11. *NERC, Statement of Compliance Registry Criteria (Revision 5.0), (October 16, 2008), 8-9, available at http://www.nerc.com/files/Statement_Compliance_Registry_Criteria-V5-0.pdf.*

12. New Harquahala Generating Co., 123 FERC ¶ 61,173, order on clarification, 123 FERC ¶ 61,311 (2008).

13. *Cedar Creek Wind Energy, LLC; Milford Wind Corridor Phase I, LLC,* 135 FERC ¶ 61,241, *order denying reh'g and clarifying,* 137 FERC ¶ 61,141 (2011).

Legal Insights *(Cont. from 16)*

Decentralizing this responsibility among generators seems to be a step backward in advancing reliability.

The growth in the renewable sector, including the proliferation of small, new units and the location of large units remote from the existing grid, undoubtedly poses new security challenges. These include, for example, the potential for opening new portals for a potential cyber attack.[14] But devoting resources to making the grid more flexible and resilient so that problem areas can be quickly isolated and losses or fluctuations in load and generation can be absorbed, rather than seeking to stringently control each new portal, would benefit all users without discouraging smaller renewable projects and the benefits they bring to the grid.

Better integrating VERs into the grid requires understanding how they differ from more traditional resources. For example, at present, grid operators rely on a mix of direct controls and economic incentives to keep generation and load in balance. Low prices during periods of low load, or on parts of the system that are congested, discourage generation; and high prices, such as on summer afternoons, make participation feasible even for high-cost units. In nodal systems, the price may also be negative from time to time in certain locations — that is, requiring a generator to pay to generate. Grid operators also rely on units that can be ramped up or down to follow load through "automatic generation control" or "AGC." Thus, price signals and direct control feature heavily in assuring the appropriate balance of generation for grid stability.

However, VERs and certain other renewables have operating characteristics that are markedly different from fossil generation. Wind and solar energy are particularly vulnerable to climatic changes; when the wind dies down or cloud cover moves in, generation declines. For wind, the inertia of the blades will to some degree smooth changes in output, but for solar, the change is very abrupt and difficult to forecast. Thus, one impact of an increase in renewables is that the grid operator needs detailed forecasting tools and faster, flexible resources in order to respond.

Further, economic signals do not always work. For obvious reasons, wind and solar cannot ramp up if the units are already utilizing all their available "fuel," regardless of the price of power. Perhaps less obvious, although wind and solar can be curtailed if needed for reliability, commercial forces tend to skew renewable resources' responses to economic signals. First, renewable generation is typically eligible to receive a "renewable energy credit" or REC for each megawatthour of production and that REC has a market value. Second, some facilities, in particular wind, biomass, and geothermal facilities, may receive a "production tax credit" or PTC which, again, is based on production. Thus, unlike a fossil unit whose owner operates it (or not) based on the market price of power relative to the unit's variable operating cost (which is typically driven by fuel), a renewable facility's owner may not have an economic incentive to stop producing until the price of power is not only negative, but so negative that it offsets the value of any RECs and/or PTCs associated with that additional generation.

On top of this, renewable energy is frequently sold under bilateral contracts which include only a volumetric price — if the project does not generate, it is not paid — and give the buyer only limited rights to curtail. Such generators may schedule themselves to operate. Such provisions further insulate the generator from market prices and encourage maximum production whenever possible, regardless of load, congestion, or the preferred mix of generation for grid stability.

The addition of large quantities of generation that cannot be controlled by the grid operator either physically, such as with AGC, or by price signal creates an operational risk that increases the vulnerability of the grid. For example, California utilities are under a mandate to generate (or purchase) 33 percent of the power they sell at retail from renewables by 2020, which has required the California Independent System Operator Corporation (CAISO) to closely examine the potential impact on the grid. In a 2010 study assuming only a 20 percent

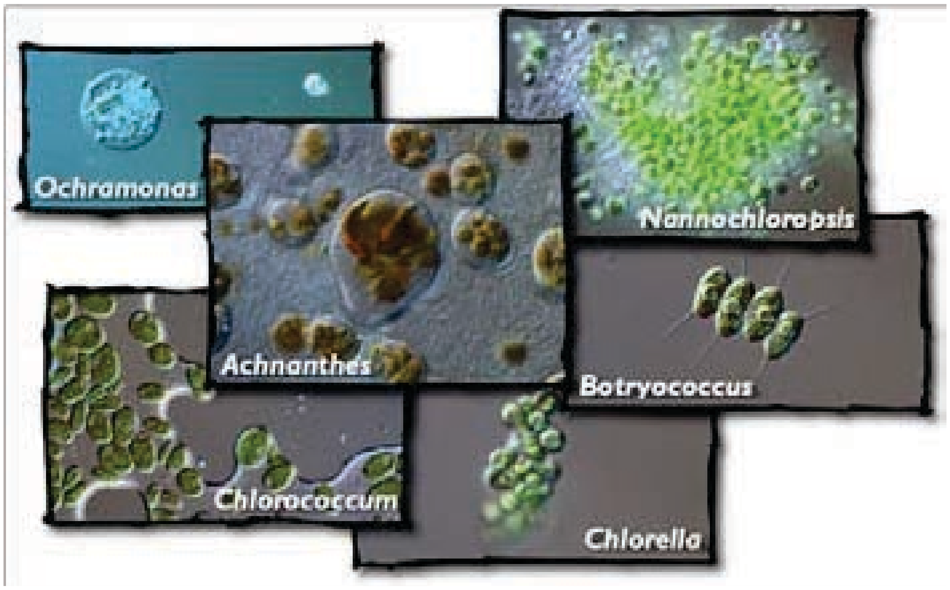
(Continued on Page 22)

14. *See* NIAC Framework Report, 48, (pointing to new digital control equipment as creating openings for potential cyber attacks).

Energy Transportation *(Cont. from 4)*

centralized than Europe, for example, and efforts to de-suburbanize could dramatically decrease our oil consumption. It would also help to adjust our economic and business models to emphasize local economic activity and discourage long-distance trade and to focus on seasonal and regionally appropriate food and other consumables. Changing our culture and our personal transportation habits to prioritize short-distance travel, bicycling or walking, and carpooling could slash fuel consumption. None of these options seems socially, culturally, or politically viable, however, without some painful price shock to spur change. Simply put, we are too comfortable with our existing modes of living to change in an effort to avoid some potential future calamity.

Figure 2: Photosynthetic micro-algae represent one of the most promising long-term biofuel energy strategies because numerous species exhibit rapid growth and high oil yields (compared to conventional biofuel crops). They do not compete for land-space that could be used for food production and are capable of growing in a wide range of climates. Scientific breakthroughs are still needed to tap their potential and make cost-effective, abundant algae-based biofuels a reality.



Implications

There is little reason to expect the sort of aggressive changes that are needed to reduce U.S. vulnerability to oil supply shocks, absent some significant policy shift. Market forces will certainly help in directing consumers towards more fuel efficient vehicles, but the major infrastructure, price, and technical challenges to alternative fuel vehicles require some governmental intervention. That intervention will likely need to take a very direct form in short-term interventions, such as subsidies, rebates, or mandates. Long-term change will pose an even greater political challenge, as significant work will need to be done either in basic and applied research on new technologies or on likely unpopular measures to compel behavioral change among consumers/citizens. Although the latter approach would undoubtedly have a larger impact and more substantially decrease U.S. vulnerability, our general unwillingness to compromise the "American way of life" likely precludes this option.

On the technology front, we do not see a "silver bullet" solution emerging in the field of transportation. It seems likely that our transportation future will be dominated by a variety of different technologies adapted to particular applications. Since the social, political, and economic challenges are so significant, these technical solutions will need to be informed by and developed in concert with a broader awareness of these issues. Renewed emphasis on STEM (science, technology, engineering, mathematics) education is undoubtedly a critical requirement of the needed development, but we will need well-rounded, pragmatic-yet-creative problem solvers to tackle the challenge of sustainable transportation for a safer and more prosperous future. ❖

Distributed Energy *(Cont. from 7)*

conventional plant.[12]

The viability of CHP (sometimes termed utilization factor), especially in smaller CHP installations, depends on a good baseload of operation, both in terms of an on-site (or near site) electrical demand and heat demand. In practice, an exact match between the heat and electricity needs rarely exists. A CHP plant can either meet the need for heat (heat driven operation) or be run as a power plant with some use of its waste heat, the latter being less advantageous in terms of its utilization factor and thus its overall efficiency. The viability can be greatly increased where opportunities for trigeneration exist. In such cases, the heat from the CHP plant is also used as a primary energy source to deliver cooling by means of an absorption chiller.[13] CHP is most efficient when heat can be used on-site or very close to it.

DOE has an aggressive goal of increasing CHP to comprise 20 percent of U.S. generation capacity by the year 2030. Germany reported that at present, over 50 percent of the country's total electricity demand could be provided through cogeneration. One study states that cogeneration plants in the United States have been proliferating and could soon be producing about 8 percent of all energy in the United States.[14]

The Magic Valley Foods Cogeneration Plant Rupert, Idaho

The 10-megawatt Magic Valley Foods Cogeneration Plant in Rupert, Idaho was built in response to the 1978 Public Utility Regulatory Policies Act (PURPA) to provide steam and electricity to Magic Valley Foods' potato processing facility in an environmentally sound and economical manner. A third party who sells steam to Magic Valley Foods and electrical energy to Idaho Power operates the plant. The plant is located close to an existing natural gas pipeline that runs through the area and is approximately a half mile from an existing electrical substation. The plant burns natural gas in a combustion turbine and uses the high-temperature waste heat to produce steam needed during the processing of potatoes. Prior to the plant's construction, Magic Valley Foods used coal-fired boilers to create steam.

Idaho Power is mandated to purchase power from the Magic Valley Foods cogeneration facility. Generally this cost is much higher than the cost from Idaho Power's own generation facilities and the regional prices for purchased power. The utility's regulating agency permits the utility to pass through the cost of this power to the ratepayers so that there is no net cost to the utility. However, during the period when power prices in the western United States were $250/MWh and higher, the power from PURPA Qualifying Facilities was a bargain.[15]

Conclusion

While Distributed Energy Resources possess their own unique challenges, perhaps research and development investment in DER can help mitigate the potential impact of the vulnerabilities associated with geographically concentrated critical infrastructure and an interconnected electrical network. The application potential of DER toward off-grid and remote locations, along with DER's utilization of renewable energy and efficient use of resources, warrants further study on and expansion of the technologies available. Additionally, DER could provide solutions for long-term planning, forecasting 25, 50, even 100 years into the future, regarding national policy toward the strategic powering of U.S critical infrastructure. ❖

---

12. Oak Ridge National Laboratory, "Combined Heat and Power: Effective Energy Solutions for a Sustainable Future," U.S. Department of Energy, (December 1, 2008), Accessed November 14, 2011, http://www1.eere.energy.gov/industry/distributedenergy/pdfs/chp_report_12-08.pdf.

13. Clarke Energy, "Trigeneration – Combined Heat, Power and Cooling (CHPC)," (n.d.), Accessed November 14, 2011, http://www.clarke-energy.com/gas-engines/trigeneration/.

14. World Alliance for Decentralized Energy, "World Survey of Decentralized Energy," (2006), Accessed on November 16, 2011, http://www.localpower.org/documents/report_worldsurvey06.pdf.

15. W.P. Poore, T.K. Stovall, B.J. Kirby, D.T. Rizy, J.D. Kueck, and J.P. Stovall, "Connecting Distributed Energy Resources to the Grid: Their Benefits to the DER Owner/Customer, Other Customers, the Utility, and Society," Oak Ridge National Laboratory, (2001), Accessed on November 14, 2011, http://www.ornl.gov/~webworks/cppr/y2002/rpt/112701.pdf.

Unconventional Gas *(Cont. from 10)*

mix as the program evolves

In order to be a viable energy supply competitor, the unconventional gas program must have a life cycle focus. The linkage between operating revenues and program quality, as measured by total system availability, will be a key performance metric. It will also require a flexible, lean, and cost effective EPC capability, potentially coupled with innovative financing approaches for non process infrastructure to lower capital costs.

As operators, we understand that what is designed and built is linked to the productivity, labor, materials, and energy costs experienced in operation. Common equipment types and broader asset management strategies must be deployed to reduce inventory requirements

Unconventional gas will drive new infrastructure networks and the reconfiguration of many that currently exist. Stakeholder communities will go well beyond the immediate vicinities of individual projects. A focus on sustainability that begins at the very outset of the program, influencing project selection, water extraction strategies, treatment options, and traffic management is essential.

Summary

Unconventional gas is a key element in meeting the energy supply needs of the United States and the world in the years ahead. It is a market with a set of challenges different than those experienced in the conventional oil and gas markets driven by both its "distributed plant," high infrastructure impacts, and its position squarely at the intersection of the world's energy and water challenges in the decades ahead.

New challenges require new models or the adaptation of those that have served us well in the past. The author sees the new management model sitting at the intersection of three markets which currently employ variants on program management. Blending these approaches to obtain the right program management model for the unconventional gas market will be a key factor in its long term success. ❖

Bob Prieto is a Senior Vice President of Fluor Corporation, one of America's largest engineering, construction and project management firms, where he is responsible for strategy in support of the firm's Industrial & Infrastructure Group and its key clients. He focuses on the development, delivery, and oversight of large, complex projects worldwide. Prior to joining Fluor, Bob served as chairman of Parsons Brinckerhoff Inc. He served as a member of the executive committee of the National Center for Asia-Pacific Economic Cooperation, a member of the Industry Leaders' Council of the American Society of Civil Engineers (ASCE), and co-founder of the Disaster Resource Network. He currently serves on a number of committees looking at issues related to infrastructure delivery and resiliency and disaster response and rebuilding and is a member of the National Academy of Construction. Until 2006 he served as one of three U.S. presidential appointees to the Asia Pacific Economic Cooperation (APEC) Business Advisory Council (ABAC) and previously served as chairman of the Engineering and Construction Governors of The World Economic Forum and co-chair of the infrastructure task force formed after September 11th by the New York City Chamber of Commerce. He recently completed ten year tenure as a member of the board of trustees of Polytechnic University of New York culminating in its merger with New York University. Bob is the author of "Strategic Program Management" published by the Construction Management Association of America (CMAA) and more recently a companion work entitled "Topics in Strategic Program Management." He is a member of the National Academy of Construction.

Wind Energy Program *(Cont. from 13)*

power generation and transmission, mechanical and structural maintenance, digital communications, utility management, and business operations. Program faculty annually attend American Wind Energy Association (AWEA) national conferences to further refine program curriculum and ensure the broadest possible industry perspective will be represented in the classroom.

As safety is the main point of emphasis for all power generation facilities, Iowa Lakes Community College addresses it in the program by creating a specific Job Hazard Analysis (JHA) before each unique operation. The hazard documentation is based on standard industry procedures and safety issues are recognized and addressed before each class leaves the building for training or simulation. Concerns addressed on this documentation include: job planning, personnel support, tooling, equipment safety, traffic, weather conditions, and utility coordination.

Iowa Lakes' Wind Energy and Turbine Technology program was one of the first programs in the Nation to receive the American Wind Energy Association's Seal of Approval for the academic relevance of its curriculum.

Site operation and security are also recognized in Iowa Lakes wind curriculum. Wind farms have expanded into extremely remote areas of many rural states. Isolated locations have created many challenges for utility-sized wind operators in such areas as: emergency response, basic infrastructure, hazard mitigation, border management, communications, and logistical support.

In providing realistic training for Iowa Lake wind students, the faculty takes an honest approach to the threat of industrial sabotage. The localized nature of wind turbine placement occasionally creates zoning and environmental issues which are sometimes controversial to the affected citizens. Iowa Lakes' graduates complete a course in wind turbine site location which helps define the nature and scope of individual wind projects. Graduates are expected to understand that while not all are supportive of wind energy, operations companies are expected to be stewards of the geographic locations they maintain. Providing reliable, clean electricity is the goal of wind power and it is the same goal for nearly all suppliers to the power grid.

Since its inception, the program's innovative fusion of industry partners, rigorous hands-on training, and skills development have prepared highly-trained technicians to meet a growing national demand. The program prepares highly-employable students and brings them into contact with potential employers. The entire curriculum and requests for other information may be accessed at http://www.iowalakes.edu/academic_programs/programs_of_study/industrial_technology/wind_energy__turbine_technology/. ❖

Iowa Lakes wind students also receive training in: First Aid/CPR, Working-at-Heights Rescue, and OSHA 10 Hour Safety training.

For more information, please contact Craig Evert at: cevert@iowalakes.edu.

Legal Insights *(Cont. from 17)*

mandate, it found that under certain production simulations, the prevalence of non-dispatchable generation (primarily nuclear and renewables) in low load hours, could potentially leave the grid operator with insufficient downward load-following capability.[15] Recommendations for improvement included better economic incentives to reduce self-scheduling and encourage operational flexibility.

Over a year ago, FERC initiated a rulemaking procedure to better integrate VERs into the grid. It proposed intra-hour transmission scheduling (15-minute intervals) to improve the correlation between real-time generation and schedules, mandates for VERs to provide meteorological and operational data to grid operators who are developing or deploying VER power production forecasting tools, and proposals to allow grid operators to recover the cost of regulation service needed to integrate variable resources.[16] The proposed rules are still under evaluation. In October 2011, FERC directed operators of the organized markets to restructure the payments offered for regulation service to include a performance factor in order to attract and reward resources that can respond with the greatest speed and flexibility and, thus, improve the ability of the operator to maintain a balanced system. Additional resilience could come through technological change, such as the development of additional storage resources, better forecasting tools, and smart grid technologies. All of these elements would contribute to a more robust grid, better able to sustain itself from multiple impacts, as well as better handle an influx of VERs.

Imposing protection measures has a cost and therefore should be carefully weighed against the benefits gained. But, infrastructure protection regulation that promotes, rather than burdens, a diverse generation pool that includes renewable power, and simultaneously focuses on building a more resilient grid, is an approach that can benefit all users of the electric grid. ❖

The author would like to thank Daniel A. Hagan, Partner, EIPAF, White & Case LLP for his assistance and suggestions.

---

[15] CAISO, *Integration of Renewable Resources, Operational Requirements and Generation Fleet Capability at 20% RPS*, (August 31, 2010), 92-93, available at http://www.caiso.com/Documents/Integration-RenewableResources-OperationalRequirementsandGenerationFleetCapabilityAt20PercRPS.pdf.

[16] *Integration of Variable Energy Resources*, Notice of Proposed Rulemaking, 133 FERC ¶ 61,149 (2010).