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In This Issue...

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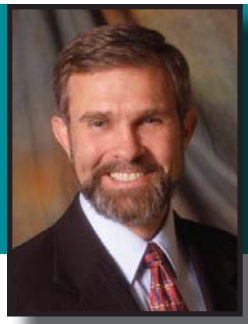
Guest Editor

Carl O. Bauer
Director
National Energy Technology Laboratory



Carl O. Bauer

The invitation to serve as guest editor of this energy issue of Pittsburgh Engineer magazine came at an ideal time. Energy is in the forefront of our national consciousness today perhaps more than it ever has been, thanks to escalating oil prices, concerns about carbon dioxide emissions, a focus on renewable sources of energy, and concerns about future availability of sufficient and affordable energy. As director of the National Energy Technology Laboratory (NETL), which we like to call "the ENERGY lab" – one of the Department of Energy's 17 national labs – addressing these energy issues is what my job is all about. Engineers play a big role in helping me do my job. We have 218 federal engineer positions at NETL and more than 150 additional engineer positions among our onsite research contractors. We maintain close working relationships with the regional universities – especially the University of Pittsburgh, Carnegie Mellon University, and West Virginia University – so we can attract top engineering graduates to work in our important R&D programs.

"increased competition for global supplies is leading to constrained resources and sharp escalations in energy prices"

America's economic prosperity has been built on its energy bounty. In today's global economy, increased competition for global supplies is leading to constrained resources and sharp escalations in energy prices—particularly in oil and natural gas. This presents a formidable challenge to our nation. Secure, reliable energy supplies at sustainable prices are essential to U.S. stability and growth.

Affordable, reliable energy is absolutely essential to maintaining quality of life. You may not associate energy and food, but take time to consider how much energy is required to produce the food that the world's population relies on. Energy is needed to run the farm machinery, to power the irrigation systems, to harvest the crops, to deliver the food to markets, to check out at the grocery store, to get the food from the store to home, and to cook the food before we eat it. Energy gets us from home to our job and back to home at the end of the work day. Energy cools and heats our home, makes it possible for us to watch CSI on TV, and to call someone on the telephone.

Energy affordability and supply security make up two of the three overarching issues characterizing today's energy situation in the United States. The third is environmental quality. As a nation, we strive to act responsibly by reducing the impact of energy production and use on our nation's air, land, and waterways.

Many energy strategists regard these arenas as disparate challenges, one of which takes precedence over the other two. This produces a competitive tension that pulls the spheres in opposing directions. Significant improvements may be realized in the chosen area, but the others are left stagnant, or even severely damaged.

An effective approach to meeting our nation's energy needs depends on our giving equal attention to all three requirements, seeing them as a single issue that demands our immediate attention.

Since its inception in 1977, the Department of Energy has consistently incorporated these areas into its strategic plans for public energy research and development. In support of the Department's efforts, NETL and its predecessor organizations have pursued science and engineering solutions that drive the circles closer together, with the ultimate goal of finding tools and processes that hit the center mark by addressing all three areas concurrently. NETL is a center where the energy challenges converge and energy solutions emerge.

Our planet is facing a worldwide increase in energy demand, concerns about the environment, and a need for more energy-producing plants that might exceed our ability to keep up. Our security, our economy and our standard of living require that we focus on the broad energy mix needed for an affordable, sustainable energy future.

"Where will our energy come from?"

Where will our energy come from? U.S. and world energy use is expected to increase significantly in the next two decades. Even though fossil energy will provide a slightly smaller percentage of the energy mix, the actual amount of fossil energy that will be needed will increase. The percentage of our energy mix provided by fossil fuels will stay at about 82 to 85 percent. The use of renewables is likely to increase from 6 to 9 percentage points of the total. Nuclear is slated to remain constant at 8 percent.

Even though energy conservation and increased energy efficiency will slow the rate of increase of energy demand, we still require more plants to be built to meet our needs. Managing electricity use could become a reality. This could mean limiting use during peak times or setting allowances. How much are we willing to sweat or shiver? How much are we going to allow

someone to manage our own use through a meter on our house to control the flow of electricity and shut us down if demand goes too high?

Whether our efforts are geared toward carbon management, enhanced oil and natural gas recovery, advanced materials, energy efficiency, or methane hydrate, our scientists and engineers at NETL are finding economical solutions to environmental challenges, the means to expand our domestic energy sources without driving up costs, and methods for extracting resources with minimal impact to the environment.

> ***"America's energy challenges are formidable, but they are also surmountable"***

America's energy challenges are formidable, but they are also surmountable.

We have invited an impressive group of energy experts to contribute articles for this special issue of Pittsburgh Engineer. These articles cover the energy spectrum from coal resources deep within the earth, to the energy that resides in atoms, to conservation, and even renewables that come from space in the form of solar energy. One article even explains the necessity of having a modern delivery grid to transmit electricity.

Nathaniel Doyno, co-founder and executive director of Steel City Biofuels, which is now a program of the Pennsylvania State University, writes about aggressive new federal and state legislation that's helping to position Pennsylvania bioenergy companies to expect substantial growth in 2009.

Alan Singleton, CEO of Energy Technology Partners, LLC, and In Situ Energy, LLC, of the University of Pittsburgh, discusses how coal that we can't mine today because it lies at great depths or in very steep formations can be converted in place to a synthetic gaseous fuel with promising commercial prospects.

John Greenwald, president of MOC, Inc., of Pittsburgh, introduces us to the intriguing concept of "negawatts" and how the production of these "negawatts" – a term that measures conserved energy – offers many opportunities for professional engineers and engineering firms.

Dr. Kathryn McCarthy and Carol Ann Cole of Idaho National Laboratory, which, like NETL, is one of DOE's national labs, tell us that the growth in energy demand and the concern over rising global carbon levels have prompted renewed interest in nuclear energy. Nuclear and coal are important sources of baseload power.

James M. Ferguson of NETL notes that renewables are not likely to compete with the market share of traditional energy sources for quite a while, but projections anticipate that renewable-generated energy will account for 12.6 percent of total U.S. generation in 2030.

D. Anthony White, of planetwatch.org, writing about transportation describes a car you can plug into your electric outlet when the charge runs low. Fully electric or plug-in hybrid cars are closer to reality and it may be that you won't have to sacrifice speed or power to use them.

Steve Pullins, president of Horizon Energy Group, and Steve Bossart, a senior manager at NETL, discuss delivery of power. With our aging electricity infrastructure, the U.S. is becoming increasingly vulnerable to natural disasters, acts of terrorism, loss of jobs, higher costs and blackouts and brownouts. NETL has launched a Modern Grid Strategy project to assist the nation in modernizing the electricity grid.

This impressive collection of articles by energy experts focuses on a range of energy issues and possible solutions, and together they constitute an information resource that you should consider saving as a reference.

Carl Bauer is Director of the National Energy Technology Laboratory (NETL), a national laboratory owned and operated by the U.S. Department of Energy, that serves as the lead field laboratory for the Department's Office of Fossil Energy.

Mr. Bauer has more than 30 years experience in technical and business management in both the public and private sectors. He was appointed NETL Director in August 2005, following six months as Acting Director. He has also served as NETL Deputy Director, Director of NETL's Office of Coal and Environmental Systems, and Director of NETL's Office of Product Management for Environmental Management.

Mr. Bauer received an M.S. in nuclear power engineering from the Naval Nuclear Power Postgraduate Program in 1972 and a B.S. in marine engineering/oceanography from the U.S. Naval Academy in 1971. He was recognized as a 2006 Director of the Year by the Federal Laboratory Consortium for Technology Transfer.

NETL has research campuses in Morgantown, West Virginia; Pittsburgh, Pennsylvania; and Albany, Oregon. In total, these sites include 81 buildings and 14 major research facilities on nearly 200 acres. More than 1,100 employees work at NETL; roughly half are federal employees and half are onsite contractors.

We invite you to learn more about NETL at our website: www.netl.doe.gov

By Nathaniel Doyno
Steel City Biofuels

It is boom time for bioenergy in Pennsylvania. Against a stark backdrop of rising fuel and energy costs, energy security and environmental concerns and fueled by aggressive new Federal and State legislation, Pennsylvania bioenergy companies and initiatives are positioned for substantial growth in 2009.

Last December President Bush signed the Energy Independence and National Security of 2007 into law. (http://www.whitehouse.gov/news/releases/2007/12/20071219-1.html & http://www1.eere.energy.gov/biomass/federal_biomass.html). This legislation provides strong support Nationally for the biofuel and bioenergy industries by creating a more aggressive Renewable Fuel Standard (Section 202) with specific requirements for advanced biofuels, establishing a $500 million grant program (Section 207) for research on advanced biofuels that reduce lifecycle greenhouse gas emissions by a minimum of 80% compared to conventional petroleum fuels, authorizing $25 million for research, development, demonstration, and commercial application of biofuel production technologies specifically in States with low rates of ethanol production (Section 223), and authorizing and additional $25M for a competitive grant program for institutions of higher education (Section 234).

This July, Pennsylvania Governor Edward G. Rendell signed two bills into law that will provide a significant boost for the Commonwealth's biofuel and bioenergy industries. Special Senate Bill 22 is the most direct, providing a $0.75 per gallon tax credit for biodiesel produced in Pennsylvania. House Bill 1202's support is broader, providing $40 million to the Ben Franklin Technology Development Authority to support early stage activities for renewable energy companies (such as incubator support services, translational and early stage research), $165 million for loans and grants to spur the development of alternative and renewable energy projects (excluding solar) among businesses and local governments, and $50 million in tax credits of up to $1 million a year per project for developing and building alternative energy project.

More locally, in July the City of Pittsburgh Green Government Task Force released its final report for the Pittsburgh Climate Protection Initiative. This initiative funded by local foundations and jointly chaired by State Senator Jim Ferlo, Mayor Luke Ravenstahl, and City Councilman Bill Peduto includes multiple recommendations supporting the increased production and use of biofuels and biomass.

This spring the Pittsburgh Technology Council launched an exciting new addition to its suite of networks with a focus on biofuels and bioenergy. The Green Tech Network will support existing and emerging biofuel and bioenergy companies by providing knowledge of market trends and best practices through educational events and publications, coordinating personal introductions and roundtables to facilitate collaboration and interaction, providing increased access to funding sources and investor exposure, advocating as a unified voice for the industry, and leveraging strategic plans to position the region as an energy hub.

Another exciting addition the Pennsylvania bioenergy landscape is the opening of a Western Regional Office for the Pennsylvania State University's Biomass Energy Center. In August, Penn State hired Robert Wallace as the new Associate Director for the Biomass Energy Center. Originally from Pittsburgh, Wallace was formerly a senior engineer at the National Renewable Energy Laboratory with a focus on advanced biofuels. In conjunction with this hire, Penn State also absorbed Steel City Biofuels, a local non-profit organization created to develop the awareness, technology, policy and infrastructure necessary for the sustainable production and use of biofuels in Pennsylvania. The Western Regional Office for the Biomass Energy Center will be based out of Steel City Biofuels offices in Pittsburgh, PA.

In October all of these exciting programs and initiatives will be featured at the 2nd Annual International Energy from Biomass & Waste Convention and Exposition (EBW), which will be held October 14-16, 2008 in Exhibit Hall A of the David L. Lawrence Convention Center. The EBW is an outgrowth of a formal partnership signed in 2006 between the Commonwealth of Pennsylvania and the German State of North Rhine Westphalia to support renewable energy technology transfer and business development opportunities. The EBW is a hybrid event that combines a traditional trade show featuring leading domestic and international companies with an informational conference featuring leading academics, researchers, and industry professionals. In addition, this year the EBW will also feature annual meetings of the State sponsored Pennsylvania Biomass Working Group and the Pennsylvania Fuels for Schools Initiative.

Nathaniel Doyno is the Co-Founder and Executive Director of Steel City Biofuels, now a program of the Pennsylvania State University. He is a member of the Advisory Committee for the Pittsburgh Technology Council's Green Technology Network, the City of Pittsburgh Green Government Task Force, and Sustainable Pittsburgh's "Champions for Sustainability". He also serves on the Board of Directors for GTECH Strategies, a new social venture that is growing bioenergy crops on brownfields, and Pittsburgh Region Clean Cities, a non-profit organization designated by U.S. Department of Energy to support the deployment of alternative fuel vehicles and infrastructure.

NUCLEAR POWER:

Meeting Future Energy Demand and Safeguarding the Environment

By Dr. Kathryn McCarthy and Carol Ann Cole
Idaho National Laboratory

Expanding populations and rising standards of living, nationally and internationally, are creating unprecedented pressures on both world energy supplies and the overall health of our planet. By 2050, U.S. population will approach 400 million and global population is estimated to grow from 6.6 billion to near 9 billion.[1,2] The Energy Information Administration, which provides national and international statistics and analyses for all energy resources, forecasts that total U.S. electricity consumption will grow from 3,814 billion kilowatt-hours in 2006 to 4,972 billion kilowatt-hours in 2030, increasing at an average annual rate of 1.1 percent (reference case).[3] Globally, EIA projects that world net electricity generation will nearly double from about 17.3 trillion kilowatt-hours in 2005 to x 33.3 trillion kilowatt-hours in 2030.[4]

Most of the growth in energy demand will occur in the expanding economies of developing countries; their total energy demand is projected to increase by 85 percent, compared with an increase of 19 percent in developed countries. By the year 2030, oil demand is projected to reach 116 million barrels/day, with the majority of supply controlled by Saudi Arabia, Iran, Iraq, Kuwait, and Russia.

Without corrective action to avoid or capture carbon emissions, however, rising energy consumption will increase global atmospheric carbon dioxide levels, with China, India, and the U.S. dominating both consumption and emissions. In the U.S. alone, carbon dioxide emissions could grow by more than one third over present levels if no mitigating measures are taken.

The convergence of these two issues—energy and rising global carbon levels—has prompted renewed interest in nuclear energy. Nuclear, like coal, is an important source of base-load power and is the only currently available technology capable of delivering large amounts of power without producing air emissions.

"Nuclear energy... will continue to be an important energy source for the next century and beyond"

Nuclear plants have no emissions during operations, and no energy technology has a smaller carbon footprint. Nuclear energy today serves an essential role in reducing greenhouse gas emissions and will continue to be an important energy source for the next century and beyond.

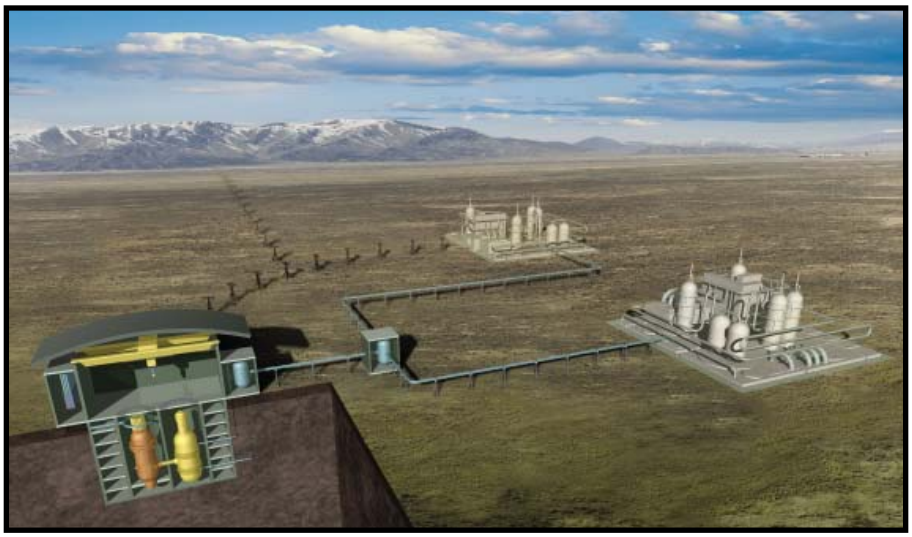
Stabilizing atmospheric carbon levels while supplying the energy necessary to sustain and grow our economies will require a major paradigm shift in world energy production. Experts in organizations ranging from private companies to the United Nations are urging rapid change as well as efforts to make the most of all our energy resources and consider new policies that move more alternative energies to the transportation and industrial sectors, promote greater energy efficiency, and value carbon avoidance.[5] The Intergovernmental Panel on Climate Change has identified nuclear power and advanced nuclear power as two key technologies needed to mitigate global greenhouse gases over the coming decades.[6]

Low fuel costs, a strong safety record, and outstanding operational performance enable nuclear energy to provide 20 percent of total electricity in the U.S. currently. On a global level, 439 plants in 30 countries generate 16.5 percent of electricity worldwide, and at least 15 countries rely on nuclear power for 25 percent or more of their electricity.[7] Expanding economies, principally in Asia, are aggressively pursuing nuclear energy programs to meet their rapidly growing energy needs; these

include China, India, Vietnam, Turkey, Thailand, Indonesia, Yemen, Israel, Syria, Libya, Algeria, and Morocco.

The International Atomic Energy Agency reports that there are 35 plants currently under construction in 11 countries, with about 60 new plants in the planning stage. The U.S., too, is planning to build more than 30 new light water reactors, so called Generation III plants, over the next decade.

Overall, global electricity generation from nuclear power is projected to increase from about 2.6 to 3.8 trillion kilowatt-hours from 2005 to 2030 in response to concerns about rising fossil fuel prices, energy security, and greenhouse gas emissions. Many existing nuclear facilities in the U.S. and abroad are reporting higher utilization rates, and most countries are granting extensions to the operating lives of their older plants. Yet challenges remain that continue to raise public concerns in many countries and, if unresolved, may hinder the development of new nuclear power reactors: (1) how to use sensitive nuclear fuel cycle technologies responsibly and in ways that do not threaten global security and (2) how to manage used fuel beyond safe storage at power plant sites today.



The Advanced Test Reactor is located 45 miles west of Idaho Falls at the Advanced Test Reactor Complex

France, Japan, and a few other countries are already addressing these issues by recycling the plutonium contained in used fuel to recover remaining value and reduce waste – a reuse approach that is part of a closed fuel cycle. The U.S. currently stores used fuel pending final disposal underground in a geologic repository – an approach referred to as an open or once through fuel cycle – but is currently considering domestic alternatives to this approach. Over the longer term, the global expansion of nuclear will require more widespread nuclear fuel recycling to maximize and extend energy resources to reduce wastes. Eventually, a sustainable nuclear fuel cycle would incorporate beneficial uses for all but a very small fraction of used fuel.

The U.S. Department Energy, Office of Nuclear Energy recognizes both the key role of nuclear power in the national and global mix of energy technologies and the challenges to be resolved. It is supporting domestic and international programs to develop new reactor types and nuclear fuel technologies. These include the Generation IV International Forum consisting of 11 nations actively collaborating on development of advanced reactor concepts to enhance the economics, sustainability, proliferation resistance of nuclear power while reducing waste intensity. Collectively, these countries invest more than $100 million each year on advanced research, developing and pursuing high-temperature reactors, fast spectrum reactors, and other novel concepts that could be available for commercial deployment in the year 2030 or beyond.

New plant designs promise to produce power even more safely and economically than first-generation facilities. For example, the Nuclear Regulatory Commission has certified three new light-water reactor designs that incorporate enhanced safety concepts and use significantly fewer pumps, pipes, valves, and cables than first-generation facilities.

Nuclear power is also growing with respect to public acceptance. A 2007 poll of 1,152 people living near U.S. power reactors showed that 82 percent supported nuclear power, and 71 percent said that construction of a new unit near them would be acceptable if needed to supply electricity.[8] Some former environmentalists, including Greenpeace co-founder Dr. Patrick Moore, are today supporting nuclear power and other renewable energy sources such as hydroelectric, geothermal, biomass, and wind. Dr. Moore now argues that any realistic plan to reduce reliance on fossil fuels and the emission of greenhouse

gases should include increased use of nuclear energy because wind, solar, hydroelectric, and geothermal sources alone cannot meet global demand.[9]

Beyond generation of electricity, nuclear power has the potential to supplement or even supplant fossil fuels by providing electricity for electric powered vehicles, or generate hydrogen for synthetic fuels and eventually for vehicles that use hydrogen fuel cells. Combined with coal to liquids and coal to gas plants, advanced gas cooled reactors could enable the use of coal to produce feedstock for refineries and chemical plants with essentially no carbon emissions. The U.S. is collaborating with other countries, including France, Japan, and South Africa, to develop advanced gas cooled reactors for electricity production as well as nontraditional applications.

In addition, the international community has formed an alliance called the Global Nuclear Energy Partnership that seeks the safe and secure expansion of nuclear through advanced safeguards technologies; mechanisms for reliable fuel supply, including used fuel disposition; use of advanced recycling technologies; and support to nations seeking nuclear energy to address associated infrastructure requirements. The initiative seeks to provide the framework and technologies that will enable countries to pursue nuclear power without having to invest in a complete fuel cycle and related sensitive technologies. For example, France and Russia have provided fuel services, including reprocessing or fuel take-back for other countries for some time.

"Meeting growing global energy demand while safeguarding our environment will require all sources of energy"

Meeting growing global energy demand while safeguarding our environment will require all sources of energy as well as international cooperation to develop new technologies, encourage conservation, and enact policies that reward carbon avoidance. While nuclear energy is not the only solution to a growing demand for clean energy, it must be part of the solution for maintaining our economy and our way of life while protecting the global environment.

Endnotes:

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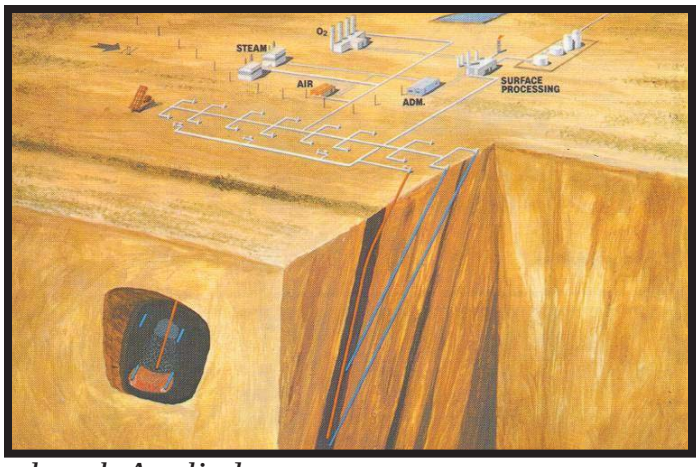
Underground Coal Gasification:

Expanding Fuel Production in the USA



Conceptual View of a Commercial UGC Facility

By Energy Technology Partners, LLC and In Situ Energy, LLC and The University of Pittsburgh Applied Research Center

The United States has extremely large deposits of coal, much of it sub-bituminous coal in the western states. Wyoming alone has over 500 billion tons of coal according to the US Geological Survey. About 95% of this coal cannot be produced by present-day mining because it exists at great depths, or in steeply dipping strata.

Conversion of such coal, while it remains underground, to a synthetic gaseous fuel (which is a mixture of carbon monoxide and hydrogen, called "syngas") was demonstrated in commercial-sized operations in the 1980's and 90's in Wyoming and New Zealand by several US corporations and the US government's energy program. In such underground coal gasification (UCG), oxygen-steam injection wells and syngas production wells are drilled into the coal seam, oxygen and steam are injected in controlled amounts, and syngas is produced, as is shown schematically on Figure 1. While this figure portrays UCG in a steeply dipping resource, the principals and the concept is similar to that which would be employed in a flat lying resource.

The cost of the syngas produced is about $4 per million BTUs, which at the time of the Wyoming demonstration in the 1990's was not competitive with US natural gas. Today natural gas costs $10-12 per million BTU's at the wellhead in the US. As a result, underground coal gasification (UCG) is being planned here and on every major continent-Europe, Africa, Asia, Australia, and in the USA. The great potential of syngas as a source of energy for the USA has been discussed elsewhere recently.[1]

The current prospects for the commercial use of UCG are sufficiently promising that, for the last three years, a leading European financial institution, ABN-AMRO, has sponsored annual UCG seminars at their offices in London for interested parties. This group, now called The UCG Partnership, has numerous industrial, governmental, and financial members. Figure 2 lists the current members of the group. Energy Technology Partners (ETP) and its associate in UCG, Raven Ridge Resources (RRR), were invited to join The UCG Partnership at its inception. To capitalize on the imminent commercialization of UCG, ETP and Raven Ridge pooled their UCG experience, data, and expertise in a new corporation called In Situ Energy, LLC (ISE), which firm is an active member of The UCG Partnership.

Recently the leadership of the London-based UCG Partnership asked Energy Technology Partners to organize and lead a US-based branch of the Partnership, seeking to expand the membership and spread the knowledge of UCG and its current potential.

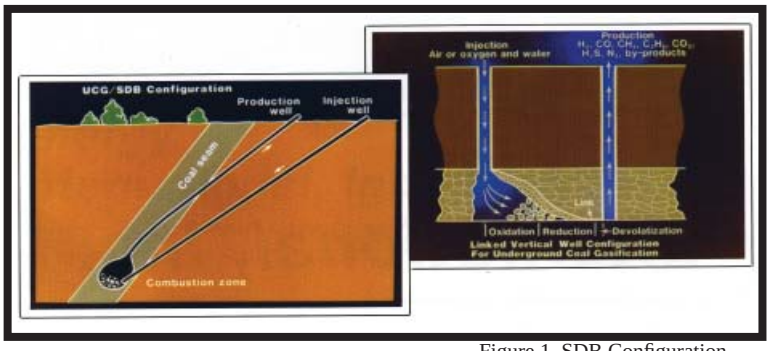


Figure 1 SDB Configuration

UCG can deliver 85% of the energy in the coal to the surface as syngas, an energy recovery comparable to the amount of the coal's energy that is recovered today from coal, net of mining and delivery energy. Syngas from UCG is useful directly as a fuel in the production of electric power or as a raw material that can be converted to gasoline, diesel fuel, or jet fuel. Conversion to such liquid fuels of syngas produced from mined coal in surface gasification apparatus has been practiced commercially on a very large scale by Sasol in South Africa for more than 50 years. The conversion of natural gas to syngas for the production of liquid fuels is also being used commercially in the Middle East and Southeast Asia currently, locations where the cost of the natural gas is very low. Accordingly, both UCG and syngas conversion to liquid fuels are processes available for commercial application today.

The UCG projects carried out as demonstrations have produced extensive environmental data and yielded planning and operating procedures needed to obtain environmentally acceptable results. Inherent factors impacting the environmental success of UCG on any coal include unfaulted overburden, the thickness of overburden, isolating hydrologic barriers, coal type, coal seam thickness and continuity. All of these criteria can be met by much of the deep Wyoming coal resource.

UCG operations must be so-planned as to prevent: the excursion of gases to the surface or to ground waters, contamination of aquifers in spent reaction zones, and subsidence, to name a few factors. Resource characterization that is necessary to avoid such occurrences include: drilling,

coring, geophysical logging, hydrological testing and monitoring, high-resolution seismic testing, and integrated geological and hydrological modeling.

A principal UCG demonstration site in Wyoming has been monitored for the 15 years since that demonstration, with environmental results indicating that properly planned UCG can be carried out safely and cleanly for air, water, and the surface. To accomplish environmentally acceptable results, geotechnical and hydrological conditions must be studied in planning and locating the site for UCG operations. Surface processing facilities clean the syngas as it is produced. The result is an environmentally clean production process for gaseous and liquid fuels from otherwise unproductive coal deposits.

An aerial view of a UCG demonstration near Rawlins, Wyoming is shown in Figure 3, while Figure 4 shows the surface facilities at the New Zealand (Huntly) UCG demonstration, with the exhaust stacks of the Huntly Power Plant which will use the syngas as a fuel being visible in the distance.

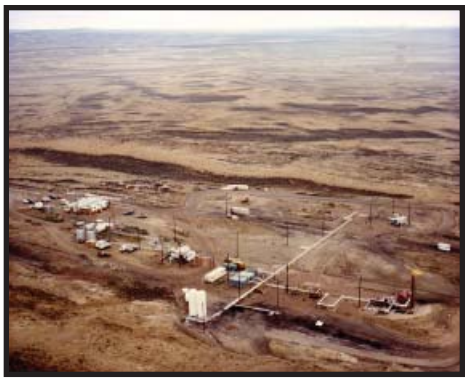


Figure 3 Rawlins UGC Plant

Figure 4 Huntly UCG Site

Energy Technology Partners, LLC and its associated geotechnical firm, Raven Ridge Resources Corporation (operating together as In Situ Energy, or ISE), with their environmental support team, plan a commercial UCG project on a Wyoming site similar to that used by the same team to carry out the 1990's demonstration project. In their project planning, the partners have available the extensive geotechnical, environmental, engineering, and on-site processing information produced during the earlier projects.

Figure 5 ETP F-T Facility

ISE's plan for its Wyoming Project will combine UCG production of syngas with ETP's proprietary syngas-to-liquids process (called SFBP) to produce top-quality diesel fuel, high octane naphtha, and LPG as the primary products. ETP's SFBP technology has operated for extended periods in a full-scale demonstration plant (Figure 5) at ETP's location in Pittsburgh, PA. It is noteworthy that UCG operation in the ISE Wyoming Project will produce as a by-product sufficient electric power for its own needs, for the power required by an on-site air-separation plant, and still have excess power available for export from the Project.

This ISE commercial UCG facility will produce 20 billion BTU's of syngas daily from several production wells installed on the first Section of land. The syngas will be converted to 2700 barrels per day of the liquid fuels mentioned above in an ETP SFBP plant. An engineering estimate of total capital cost to build and start-up the UCG and SFBP facilities is $150 million. With petroleum at or above $100 per barrel, this small initial plant will return its investment in three years (or less as petroleum exceeds $100 per barrel).

The amount of coal resource available to this Wyoming UCG-SFBP project is very large, with geotechnical data in hand for many adjacent land Sections having the same coal strata. Hence, expansion of syngas production within the initial Section and further expansion to adjacent Sections can ultimately lead to liquid fuel production capacities of hundreds of thousands of barrels of liquid fuels daily.

The potential of this undertaking is to obtain a major new source of liquid fuels for the USA using otherwise unproductive deep western coal. Importantly, this new source of liquid fuels is within the United States and is sufficiently abundant that it can have a positive effect upon our energy supplies for a long time. And, it can be done now, because the technologies have been demonstrated.

Energy Technology Partners, LLC is a descendant from the Gulf Oil Corporation, where the Partners of ETP managed the programs that resulted in the UCG and gas-to-liquids (SFBP) processes discussed in this article. Since the passing of Gulf, these partners have pursued these and other synfuel technologies in new ventures they formed, sold to third parties, and formed again to pursue their continuing goals of new fuel production methods. Included in the synthetic fuels experiences of the key ETP partners are many programs done in cooperation and with the support of US-DOE.

Raven Ridge Resources Corporation (www.ravenridge.com) is a geological and engineering firm located in Grand Junction, Colorado with extensive worldwide experience in oil, gas, and coal and with a particular strength and current activity in Coalbed Methane and Coal Mine Methane. RRR led the geotechnical work of the UCG demonstration projects discussed above.

The authors of this article and the principals of ISE are: Alan H. Singleton, Ph.D., Richard A. Flinn, Ph.D., and Raymond C. Pilcher.

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Renewable Energy: An Overview

By James M. Ferguson, NETL

Renewable energy resources are virtually inexhaustible in duration but limited in the amount of energy that is available per unit of time. Renewable energy resources include solar, wind, biomass, geothermal, hydropower, and wave/tidal energy.

Renewable energy benefits the United States by: enhancing our national security; reducing the country's dependence on imported energy sources; improving environmental quality by reducing harmful emissions, including greenhouse gases; and stimulating the economy and creating American jobs by investing in domestic resources.

Renewable energy consumption in the United States increased 7% between 2005 and 2006, contributing about 7% of the nation's total energy demand and 9.5% of total U.S. electricity generation in 2006.[1]

The Energy Information Administration (EIA) projects that renewable-generated electricity will account for 12.6% of total U.S. electricity generation in 2030.[2] This growth (from 9.5% in 2006 to 12.6% in 2030) is fueled by the rapid expansion of non-hydro renewable generation technologies that qualify to meet State mandates for renewable energy production.

Pennsylvania and 25 other states, plus the District of Columbia, are using renewable portfolio standards (RPS) and renewable energy mandates to increase renewable energy generation. Other incentives include the federal Renewable Electricity Production Tax Credit, and state Renewable Energy Certificates/Credits (RECs), which are usually included in the state RPS and which allow electricity providers to sell the RECs and use the proceeds to support renewable energy projects. For more information on federal and state incentives for clean energy, please visit the Database of State Incentives for Renewables & Efficiency, at www.dsireusa.org

> ***"Renewable energy... will likely not compete with...traditional energy sources for some time"***

Renewable energy will play an increasing role in providing the nation's power, but will likely not compete with the market share of traditional energy sources for some time. It is clear that the United States will need a mix of sources to provide energy, and that fossil fuels, nuclear and renewables may all have a role in that mix.

Below are short summaries of the four major renewable energy sources:

Solar Energy

In 2006, President George W. Bush launched the Solar America Initiative (SAI) to support the development of solar energy technologies. Solar energy is a clean, widespread and renewable energy source that can be used to increase electricity generating capacity. Electricity produced from solar energy will not only reduce demand for natural gas – which is increasingly imported – but will also reduce the greenhouse gas emissions from traditional combustion-driven electricity generation. Various technologies can capture solar energy and convert it into other useful forms of energy, such as electricity and heat.

The U.S. Department of Energy (DOE) has robust activities to support the development of solar energy technologies, including applied research in the Office of Energy Efficiency and Renewable Energy (EERE) and important exploratory research in the Office of Science. The Solar America Initiative is a bold effort to spur widespread commercialization, acceptance and adoption of clean solar technologies across the United States by the year 2015.

DOE has developed a coordinated strategy for accomplishing the goals of the Solar America Initiative, which will include:

- Conducting accelerated research and development to improve the materials performance and reduce the cost of advanced photovoltaic systems;
- Developing new manufacturing technology to lower process costs and increase throughput for enabling expanded U.S. manufacturing capability;
- Providing technical expertise and building stakeholder consensus to resolve regulatory, institutional, infrastructure, and education-related barriers to technology acceptance;
- Accelerating deployment of new solar technologies through promoting demonstrations and early adopter activities consistent with the Energy Policy Act of 2005 and the Energy

Independence and Security Act of 2007; and

- Supporting the demonstration and deployment of energy technologies through collaborative efforts with the private sector and public sector entities.

Displacing a significant amount of conventional electricity production with new energy technologies is a major challenge. The U.S. electric generation system is enormous, with roughly 1,000 GW of generating capacity currently in place. [3] In contrast, in 2005, the total U.S. installed PV capacity was 0.44 GW [4], i.e., less than 0.1% of total U.S. generating capacity. Yet solar energy is available in all regions of the country and can provide significant amounts of energy in places like Pennsylvania, not just places like Texas and California. In fact, according to National Renewable Energy Laboratory projections, if every single-family home in America has a 3 kilowatt (kW) photovoltaic (PV) system on its roof, these combined homes could generate more than 420 billion kilowatt-hours of electricity – more than 35% of the entire residential energy demand for the United States.[5]

The City of Pittsburgh was competitively selected by DOE as one of the Solar America Cities in 2007, and is one of 25 cities nationwide that are working to build a sustainable solar infrastructure, streamline city-level regulations, and promote the adoption of mainstream solar technology among residents and businesses. DOE is providing financial and technical assistance of $4.9 million to the cities, which have all demonstrated a high level of commitment to promote solar power throughout their city, involving local government officials, utilities, private partners, and other stakeholder organizations.

For more information, please visit the DOE Office of Energy Efficiency and Renewable Energy website for Solar Energy Technologies, at http://www1.eere.energy.gov/solar/

Wind Energy

In May 2008, the U.S. Department of Energy (DOE) released a first-of-its kind report that examines the technical feasibility of harnessing wind power to provide up to 20 percent of the nation's total electricity needs by 2030. Entitled "20 Percent Wind Energy by 2030", the report identifies requirements to achieve this goal including reducing the cost of wind technologies, siting new transmission infrastructure, and enhancing domestic manufacturing capability. Most notably, the report identifies opportunities for 7.6 cumulative gigatons of CO_2 to be avoided by 2030, saving 825 million metric tons in 2030 and every year thereafter if wind energy achieves 20 percent of the nation's electricity mix.

The report was prepared by DOE and a broad cross-section of stakeholders across industry, government, and three of DOE's national laboratories – the National Renewable Energy Laboratory, Lawrence Berkeley National Laboratory, and Sandia National Laboratory, the report presents an in-depth analysis of the potential for wind in the U.S. and outlines a potential scenario to boost wind electric generation from its current production of 16.8 gigawatts (GW) to 304 GW by 2030. For its technical report, DOE also drew upon the expertise of the American Wind Energy Association and Black and Veatch engineering consultants, and the report reflects input from more than fifty energy organizations and corporations.

"Meeting these goals will require significant and rapid advances in... technologies"

The analysis concludes that reaching 20 percent wind energy will require enhanced transmission infrastructure, streamlined siting and permitting regimes, improved reliability and operability of wind systems, and increased U.S. wind manufacturing capacity. Highlight of the report include:

- Annual installations need to increase more than threefold, from approximately 2000 in 2006 to almost 7000 in 2017.
- Costs of integrating intermittent wind power into the grid are modest -- 20 percent wind can be reliably integrated into the grid for less than 0.5 cents per kWh.
- No material constraints currently exist for raw materials such as fiberglass, copper, or other raw materials.
- Transmission challenges need to be addressed, including issues related to siting and cost allocation of new transmission lines.

With the U.S. leading the world in new wind installations and having the potential to be the world leader in total wind capacity by 2010, DOE's report comes at an important time in wind development. In 2007, U.S. cumulative wind energy capacity reached 16,818 megawatts (MW) – with more than 5,000 MW of wind installed in 2007. Wind contributed to more than 30 percent of the new U.S. generation capacity in 2007, making it the second largest source of new power generation in the nation – surpassed only by natural gas. The U.S. wind energy industry invested approximately $9 billion in new generating capacity in 2007, and has experienced a 30 percent annual growth rate in the last five years.

According to the American Wind Energy Association, there are over 293 megawatts of wind energy projects in Pennsylvania, and another 272 megawatts of wind energy projects under construction. Pennsylvania currently ranks 16th among states nationwide in wind energy capacity.

For more information, please visit the

DOE Office of Energy Efficiency and Renewable Energy website for Wind and Hydropower Technologies, at http://www1.eere.energy.gov/windandhydro/

Biomass

Biomass includes agricultural and forestry residues, perennial grasses, woody energy crops, and wastes (municipal solid waste, urban wood waste, and food waste). It is unique among renewable energy resources in that it can be converted to carbon-based fuels and chemicals, in addition to electric power.

Growing concerns over climate change and national energy security signal a new urgency for the development of clean biofuels from abundant, domestic biomass. In 2005, President Bush laid out aggressive goals for moving biofuels into the marketplace to reduce the nation's dependence on foreign sources of energy and reduce greenhouse emissions from the transportation sector. Specifically, the President's goals are to achieve the following:

- Foster breakthrough technologies needed to make cellulosic ethanol cost-competitive with corn-based ethanol by 2012 6
- Increase the supply of renewable fuels to 36 billion gallons by 20227

Meeting these goals will require significant and rapid advances in biomass feedstock and conversion technologies; availability of large volumes of sustainable biomass feedstock; demonstration and deployment of large-scale, integrated biofuels production facilities; and development of an adequate biofuels infrastructure. In addition, the existing agricultural, forestry, waste management, and automotive industries will need to invest in biomass systems based on economic viability, food security, environmental sustainability, and the needs of the marketplace. These investments will help to shift land use, build capital-intensive biorefineries, and establish the infrastructure and public vehicle fleet required for biofuels distribution and end use.

For more information, please visit the DOE Office of Energy Efficiency and Renewable Energy website for Biomass, at http://www1.eere.energy.gov/biomass

Geothermal Energy

The United States contains reservoirs of steam and hot water that provide electricity and heat for thousands of homes and businesses. This heat from the earth, often referred to as geothermal energy, is clean, reliable and sustainable; geothermal power plants are among the cleanest sources of energy available.

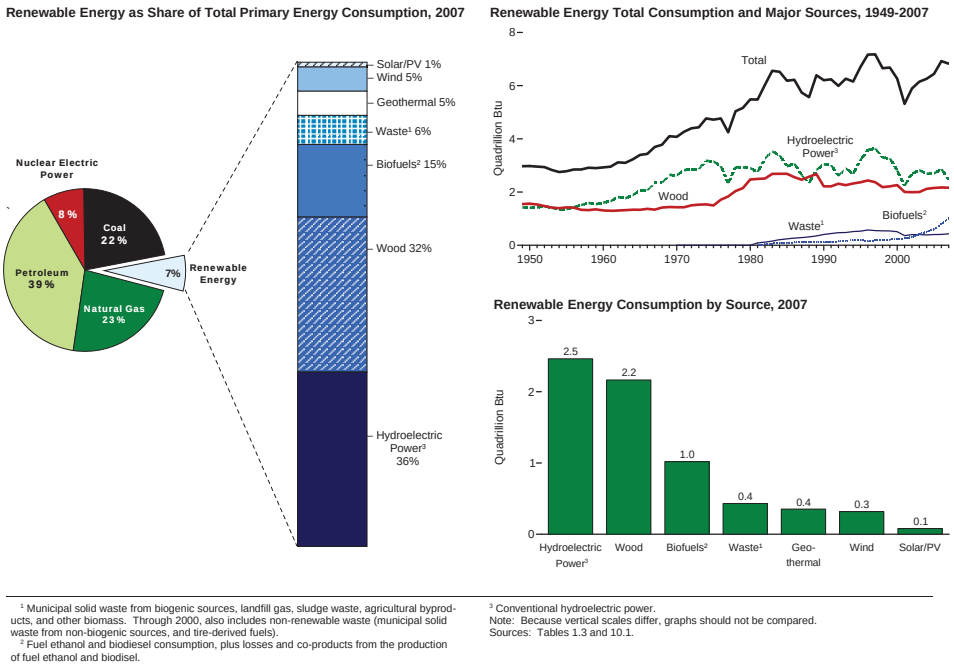
The U.S. Department of Energy (DOE) works in partnership with industry to establish geothermal energy as an economically competitive contributor to the nation's energy supply. Goals of the Geothermal Technologies Program include:

- Reducing the levelized cost of geothermal electricity to less than 5 cents per kilowatt-hour.
- Expand the economically viable resources to 40,000 megawatts.

The Geothermal Technologies Program conducts focused research that will: (1) enhance the performance of geothermal systems through the application of advanced technologies; (2) reduce risk and cost through improved reservoir engineering, drilling and conversion techniques; (3) expand the resource base with improvements in methods for finding new resources and cost-shared exploration with industry.

According to the Geothermal Energy Association, the U.S. trade association, the U.S. installed capacity is over 2800 megawatts electric. Geothermal energy also provides about 600 megawatts thermal of heating capacity for schools, homes and businesses in the United States. Geothermal is presently a $1.3 billion per year business. The U.S. government receives more than $40 million annually in royalty and lease payments from geothermal energy production.

For more information, please visit the DOE Office of Energy Efficiency and Renewable Energy website for Geothermal Technologies, at http://www1.eere.energy.gov/geothermal/



¹ Municipal solid waste from biogenic sources, landfill gas, sludge waste, agricultural byproducts, and other biomass. Through 2000, also includes non-renewable waste (municipal solid waste from non-biogenic sources, and tire-derived fuels).
² Fuel ethanol and biodiesel consumption, plus losses and co-products from the production of fuel ethanol and biodisel.
³ Conventional hydroelectric power.
Note: Because vertical scales differ, graphs should not be compared.
Sources: Tables 1.3 and 10.1.

Endnotes:

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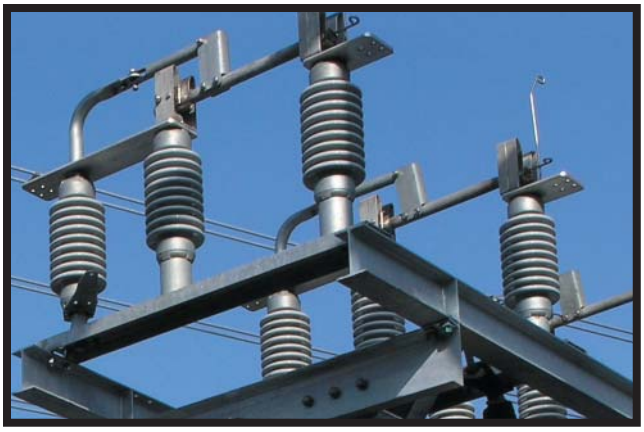

The Importance of Smart Grid to Our Nation's Energy Future

By Steve Pullins
Horizon Energy Group
and **Steve Bossart**
National Energy Technology Laboratory

Today's U.S. electricity grid is an aging infrastructure based largely on designs of the 1950s before the era of the microprocessor and it was mostly constructed in the 1960s and 1970s. Since the 1970s, the U.S. grid has been expanded as needed to meet load growth using the same vintage technologies. The U.S. Department of Energy estimates that 70% of the transmission lines and transformers are over 25 years old and 60% of the circuit breakers are over 30 years old [1]. The nation's electricity grid is under increasing stress and is being asked to perform functions that it was not designed to perform. This has resulted in some disturbing trends:

- Transmission Loading Relief actions have increased dramatically to relieve transmission congestion (i.e., 10-fold since 1997).
- U.S. businesses have experienced financial losses up to $150 million per year due to outages and power quality events.
- The frequency and duration of power outages have risen 4% per year and 3% per year, respectively.
- Cost of electricity is rising due to increases in fuel and plant construction costs and inefficiency of grid operation (e.g. the cost of new baseload generation has doubled since 2003).
- Asset utilization has decreased 8% over the last decade as reflected by widening gap between the amount of electrical generation capacity and the amount of electricity delivered.
- Customers are disconnecting from the traditional grid at a rate increasing by 33% every year. Most of these customers have their own source of electricity generation that is not connected to the grid At this rate, half the electric consumers in the US could be off-grid by 2026.

"Europe, the Middle East, China, and India have upgraded...their electircal grids to meet the demands of the 21st century global economy...The U.S. is lagging these other parts of the world"

Without a strong and resilient electricity grid, we become increasingly vulnerable to natural disasters, acts of terrorism, losing jobs to foreign competition, escalating costs, and widespread and frequent blackouts and brownouts.

Much of Europe, the Middle East, China, and India have upgraded or are upgrading their electrical grids to meet the demands of the 21st century global economy and its customers. The U.S. is lagging these other parts of the world since the last major buildout and upgrade to the U.S. electricity grid was 40 to 50 years ago.

In the U.S., we are just beginning to see the cusp of upgrading our electric grid with some major investments in Advanced Metering Infrastructure, distributed generation, wind turbine farms, and a few Demand Response programs.

Value of the Electricity Grid

The electric grid plays an important part in maintaining our nation's economic prosperity, lifestyle, and security. An affordable and reliable electric grid is critical for U.S. businesses to compete in the global marketplace. For some businesses, it is the cost of not having electricity that drives business decisions as much as the cost of electricity indicating that electricity reliability is critical to their operations. Business executives have shared stories about momentary disruptions to their electric service that have shutdown sensitive digital automation equipment causing production lines to go idle for three weeks while the equipment is repaired and the product is jack-hammered out of the production line. An increase in our nation's consumption of electricity is directly related to an increase in our gross national product.[2]

The electricity load in our society is becoming more digital with industry transforming to more automation and more computers, televisions, and digital devices in homes. The digital load requires a higher level of power quality and is projected to increase from 20% in 2005 to 60% by 2015. The electric grid can also transform the transportation sector through the use of plug-in hybrid electric vehicles (PHEV) and all-electric vehicles largely powered from electricity produced from coal and nuclear plants and renewable resources, thus reducing foreign imports of crude oil for transportation fuels by over 50%.[3]

NETL Modern Grid Strategy Project

In support of the DOE Office of Electricity Delivery and Energy Reliability, the National Energy Technology Laboratory launched a Modern Grid Strategy (MGS) project in 2005 to assist the nation in modernizing the electricity grid by confronting the barriers that slow progress. Some of the key initiatives of the MGS team are to:

1. Align the power industry and its stakeholders in reaching a consensus on the values, functional characteristics, key technology areas, and metrics of a Smart Grid.
2. Participate in large-scale field demonstrations of integrated suites of Smart Grid technologies to validate the business

case of moving to a Smart Grid considering benefits to utilities, consumers, and society.

3. Assist state regulators as requested to enable them to implement the regulatory and policy changes that are absolutely necessary to move to a Smart Grid.
4. Assist all stakeholder groups (e.g., utilities, consumers, researchers, vendors, government) by sharing information on Smart Grid.
5. Share successes of Smart Grid implementation to encourage further deployment.

The MGS team has engaged the stakeholders of the electric power industry through many workshops and other correspondence. For a national Smart Grid to be achieved, all stakeholders need to have a common understanding of the values, functional characteristics, and technologies that comprise a "Smart Grid." In addition, stakeholders need to have a consistent approach to achieve the Smart Grid and to be able to measure progress in achieving it. Primary stakeholders include Federal, state, and local regulators and government; utilities; residential, commercial and industrial consumers; electric power industry vendors and service providers; and various advocacy groups such as environmental groups and electricity consumer groups. As a result of MGS engaging electric power industry stakeholders, there is a growing general consensus on Smart Grid values, functionality, and key technologies (see Figure 1).

The Smart Grid "values" are the goals to be realized through acheivement of a national Smart Grid. These goals include:

- •Increase in reliability through reductions in the number, duration, and extent of blackouts and brownouts
- •Reductions in failure to meet the high power quality criteria demanded by some customers.
- •Improved security and resiliency from cyber attacks, physical attacks, and natural disasters.
- •Delivery of electricity to customers at an affordable price.
- •Efficient generation and delivery of electricity
- •Reductions in losses associated with transporting electricity through transmission and distribution substations and interconnecting lines.
- •Reductions in environmental impact impact through electricity generation from green, renewable sources (e.g,. solar, wind) and through improved efficiencies.
- •Enhanced safety to workers and the public due to reductions in routine field maintenance and emergency work by utility crews, and public safety issues during electrical outages (e.g., traffic signals, climate control)

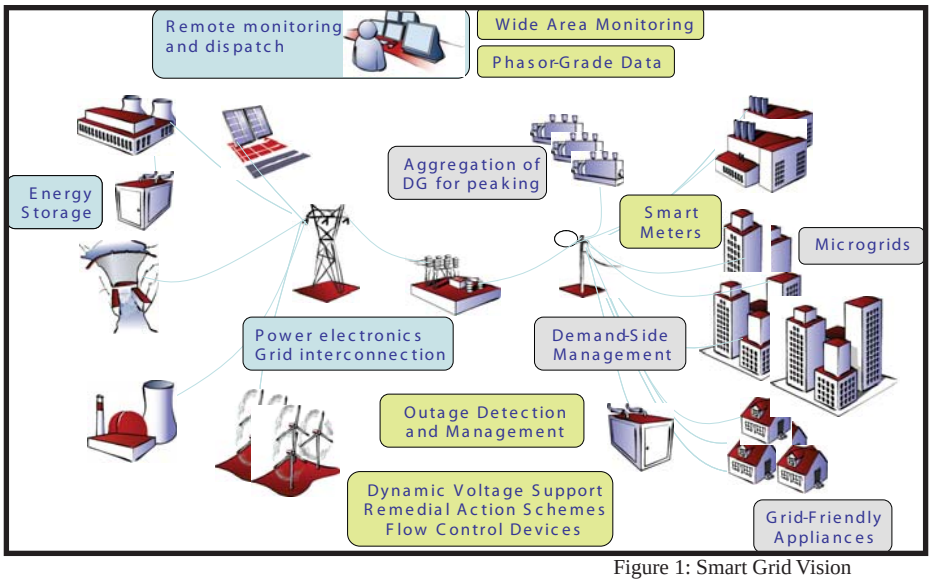

Figure 1: Smart Grid Vision

The seven functional characteristics of the Smart Grid that enable the values to be achieved include:

- •Motivates and includes the consumer by enabling the consumer to beneficially participate in grid operations through consumer-owned generation and demand response programs
- •Accommodates all generation and storage options including large central generating stations and smaller distributed generation
- •Enables new products, services, and markets including real-time prices for electricity
- •Provides power quality needed by 21st century customers with pricing options at various power quality needs
- •Optimizes grids assets and operates efficiently by increasing load factors, reducing losses in transmission and distribution systems, improving planning, and adopting condition-based maintenance programs
- •Self-heals by continually assessing the condition of the grid; anticipating problems before they occur; and automating responses to avoid problems or quickly correct them.
- •Operates resiliently despite adverse physical and cyber events including natural disasters

The key technology areas (Figure 2) of the Smart Grid are Integrated Communications, Sensing and Measurement, Advanced Control Methods, Improved Interfaces and Decision Support, and Advanced Components. The Integrated Communications provides the high-speed, integrated, two-way communication backbone that enables the condition of the grid to be monitored and grid technologies to be controlled and interact with each other. Sensing and Measurement provides the real-time data to assess the condition of the grid and support real-time pricing markets for electricity. Advanced Control Methods makes use of the data from Sensing and Measurements to implement an appropriate response to any event. Advanced Components enables improvements to efficiency, reliability, and power quality and includes devices such as superconductors, energy storage, and power electronics. Improved Interfaces and Decision Support provides an array of tools to operators to assist in their decision making including advanced visualization and simulation methods to enable operators to quickly assess viable responses to events.

Smart Grid Role in National Priorities

The Smart Grid plays an important role in our nation's current priorities namely affordable and secure energy supplies and climate change. The MGS team has become increasingly aware of the importance of energy independence for the nation, as this

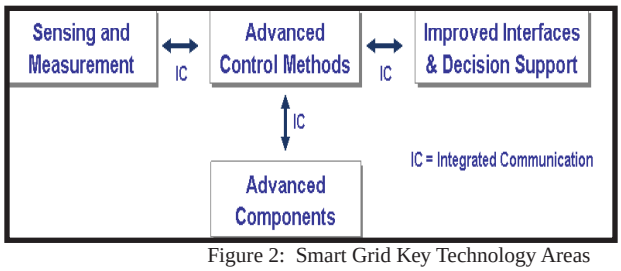

Figure 2: Smart Grid Key Technology Areas

affects economic strength, global competitiveness, and geopolitical risk as can be seen in Eastern Europe. While the news today is centered on gasoline prices and oil independence, the MGS team sees the same issues in the electric and natural gas industry. While the issues are developing slower in the electric and natural gas industry, it has the potential to be even more devastating than the current oil independency issue.

Affordability

The Smart Grid accommodates all sources of electricity generation and storage options including domestic resources such as coal, natural gas, biofuels, wind, hydro, solar, and geothermal. Each state and region of the country possesses or has access to unique resources for its electricity supply. The Smart Grid enables each state and region to use the optimal mix of generation resources considering cost, environmental impact, reliability, consumer preference, and other factors.

Security

The Smart Grid enables more domestic resources to be used to generate electricity which reduces our nation's dependency on foreign sources of fuels such as liquefied natural gas (LNG). In addition, the Smart Grid operates more efficiently which reduces consumption of fuels for generation of electricity. Demand side programs such as Demand Response programs, Dispatchable Distributed Generation, and Energy Efficiency programs also reduce the need for foreign sources of fuels.

Reliability

The Smart Grid can improve resiliency from natural disasters and man-made events due to improved communications, connectivity, and controls and increase number of generation sources, particularly local generation sources, providing more options for recovery. The self-healing nature of the Smart Grid makes it resistant to long and widespread outages and most problems can be detected and corrected without interruption of service.

Climate Change. Coal will continue to be a domestic base load resource for electricity generation by employing clean coal technologies with carbon capture and sequestration. In addition, renewable resources such as wind, hydropower, biopower, geothermal and solar will be vital in regions where they are available. The improved efficiency offered by the Smart Grid, Demand Response and Energy Efficiency programs reduces environmental emissions by reducing the generation of electricity to meet peak demand.

Value Proposition of Smart Grid

In 2004, the Electric Power Research Institute released a report on the benefit and costs of implementing a national Smart Grid. The report concludes that the cost over 20 years is about $165 billion and the benefits to utilities, consumers, and society ranges from $638 to $802 billion indicating that the benefits of Smart Grid outweigh its costs by a 4:1 to 5:1.

The current investment in maintaining and expanding the nation's electricity transmission and distribution grid using conventional technologies is about $18 billion per year.

This investment is necessary to replace existing aging electrical infrastructure and to meet the growing demand for electricity. Implementation of a national Smart Grid over 20 years would require an additional investment of about $8.3 billion per year, but would accrue far more benefits than continuing to install conventional T&D technologies. For example, the MGS team studies have shown the possibility that transitioning to the Smart Grid may cost less over the next 20 years than the currently planned building of more central, traditional generation and its associated transmission lines.

"As a nation, it is critical that we overcome these barriers and implement a Smart Grid as part of the solution to our nation's energy issues"

Conclusion

There is great benefit to implementation of a Smart Grid nationwide since it beneficially addresses key energy issues of our nation, namely energy independency, climate change, electricity reliability, and how we use our assets. The Smart Grid will provide benefit to the electric power industry and the transportation industry through the introduction of electric-powered vehicles and associated infrastructure. However, there are some major change management, regulatory and policy, and to a lesser extent, technical barriers that must be overcome for the Smart Grid to become a reality. As a nation, it is critical that we overcome these barriers and implement a Smart Grid as part of the solution to our nation's energy issues.

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Hybrid Cars

All-Electric and Plug-in Hybrid Cars Are Happening ...Sooner Than You Probably Expected

Thanks to recent corporate decisions and technological breakthroughs, the prospect of actually owning and driving a fully-electric or plug-in hybrid car is closer to reality. And, if some of the latest models are any indication, you won't have to sacrifice speed or power or worry about the price of gasoline. While some of the major automobile companies are leading the way, other, smaller startup companies or organizations, especially in the San Francisco Bay Area, have also made their mark.

After announcing the iQ car, Toyota President Katsuaki Watanabe announced that Toyota would also be selling a plug-in hybrid with a lithium-ion battery by 2010, at the latest. Because the crucial technology for plug-in hybrids or purely electrical vehicles is an adequate power storage capacity, Toyota's engineers still have to design a more efficient lithium-ion battery that can be mass produced and be cost effective.

General Motors and Daimler AG also revealed plans at Geneva to develop lithium-ion hybrids in which an electric motor assists combustion but does not propel the car. Spurred by tougher European fleet standards by 2012, Daimler plans to make a hybrid version of its Mercedes-Benz top-of-the-line model available by 2009. Though it will not match the emissions performance of smaller, more efficient cars, it will be the most efficient luxury car available.

General Motors' version is a Saab concept car which releases very low carbon emissions running on gasoline, and slightly less on ethanol. Unlike the GM's Volt, in which an electric motor powers the wheels and the gasoline motor recharges the battery, the Saab uses a smaller battery which assists the internal combustion engine. While GM plans to have a market-ready model by 2010, both GM and Daimler AG will have to perfect batteries that do not overheat, and at a reasonable cost.

Rumors were also circulating that Toyota is working on another concept car that will combine plug-in hybrid and flex-fuel technologies, weigh one third of the Prius, and go 140 miles on a gallon of gas.

> ***"Silicon Valley is also leading the way in developing new car technology"***

A New Detroit in the Bay Area

Better known for its breakthroughs in electronics and personal computers, Silicon Valley is also leading the way in developing new car technology. In the last few years, venture capitalists have invested several hundred million dollars in startup companies developing electrical vehicles in the South Bay.

Using the lessons from designing a solar-powered car for the American Solar Challenge, a team of former Stanford students formed Tesla Motors five years ago and designed a two-seater electrically-powered sports car. The prototype runs on a large lithium-ion storage battery that weighs 1,000 pounds; nevertheless, it can reach 60 miles per hour in 4 seconds, go 120 miles per hour and travel 200 miles on a single charge.

Because of its fast acceleration, without noise or exhaust, the engineers had to develop a new transmission, and it is hoped that new battery technology will not only reduce the size of the battery and its cost, but also make it lighter and more efficient. While the electric power unit is adequate for most daily trips, an on-board generator would be available for longer trips.

Although a number of celebrities have made deposits for cars that will be delivered this spring, including Governor Schwarzenegger, Tesla Motors' future may not be in competing with the large car manufacturers, but in selling its power train technology to them. Like CalCars in Palo Alto, this startup company has helped to convince major car manufacturers to develop more fuel-efficient and less polluting cars. Tesla may have its $50,000 White Star sedan in showrooms in 2010, when GM plans to sell its sporty Volt.

Also using lithium-ion batteries, Santa Rosa's Thunderstruck Motors in the North Bay has produced an electric powered motorcycle which recently set two records at Infineon racetrack. It is silent and emits no exhaust. A small company, it provides electric kits to convert gasoline motorcycles or scooters to electricity.

Using the schematics developed by CalCars and made available free, Plug-in Supply in Petaluma, California, sells kits to convert a Toyota Prius Hybrid into a plug-in hybrid vehicle which can go up to 40 miles on a single charge from a household circuit. For faster speeds or longer distances, the gasoline motor kicks in, but the conversion kit increases mileage from 45 to 100 miles per gallon. Though the

cost of conversion (as much as $12,000) outweighs the savings, and currently invalidates the Prius warranty, buyers feel good about protecting the environment and Toyota plans to market its own plug-in hybrid next year. As the technology improves and more kits are produced, the costs will also come down, while the price of gasoline continues to rise.

One of the question marks about electric vehicles is how the electricity is produced to power the car. Since a much greater amount of the electricity generated in California is from renewable sources -- solar, wind, hydroelectric and geothermal -- electric cars effectively run cleaner than they would in the Midwest, where much of the power is generated by coal-burning power plants. In fact, because of the heightened interest and already extensive use of electric vehicles in the Bay Area, Project Better Place in Palo Alto raised $200 million of new capital in 2007 to develop fuel stations for electric vehicles.

Plug-In Hybrids

As CalCars and others have demonstrated, the technology for plug-in hybrid (PHEV) vehicles already exists, and this non-profit seizes every opportunity to present the plug-in Prius hybrids which it introduced in 2004. Unlike ethanol, other biofuels or hydrogen, the infrastructure for plug-in hybrids is already in place: an electric grid, a 120-volt household socket and an extension cord. By adding a larger battery and some electronic connections, you can convert a Prius to a PHEV which can go up to 40 miles on an electric charge without kicking in the gasoline engine. This will greatly reduce the cost of driving, produce fewer emissions even when taken off the national grid (50% coal), and reduce costly imports of oil.

Technological Revolution

Clearly, the automobile industry is capable of gearing up and developing more fuel-efficient and cleaner vehicles. Encouraged by higher government emissions standards, public awareness and increasing costs of fossil fuels, we may be on the brink of a revolutionary breakthrough in automobile propulsion. Thanks to more renewable sources of energy, new fuels and energy technology, not only private transportation, but all forms of transport, power generation, lighting, heating and air conditioning, as well as manufacturing, are likely to be transformed.

New Ways to Power Our Cars

Compressed-Air Powers a Small European Car Up to 70 mph

In Europe, a persistent inventor has developed an emissions-free small passenger car. Located in Luxembourg, Moteur plans to market its MiniCATs in France. Using lightweight composite materials, these passenger cars employ electric pumps to compress air that powers the pistons to achieve speeds of 70 mph, traveling 50 miles or more at lower speeds.

The pumps can be recharged at home by plugging into an electric socket for four hours, costing only $2.50 at French electricity rates. The only exhaust from air-powered MiniCATS is cold air. More expensive hybrid versions could run on a combination of compressed air and gasoline, or on bio-fuels.

Like other vehicles using electricity as the major source of power, operating costs, efficiency and emissions are ultimately determined by how the electric power is generated.

D. Anthony White and Stephen Wilson, from the website link: www.planetwatch.org

ESWP Annual Banquet

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Negawatts

...and How to Produce Them

By John Greenwald, MOC, Inc.

Given the increasing public concern about the energy shortage and the impact of industrial and commercial activity on the ailing environment, many have pointed to alternative energy as a solution to the problem. A big (and inexpensive) part of the solution may be immediately available through an oft-ignored form of "alternative energy": the "negawatt." The "negawatt" is a term coined by Amory Lovins, founder of the Rocky Mountain Institute.

> ***"A negawatt is a... megawatt that a power plant never has to generate"***

A negawatt is a unit of conserved energy, a megawatt that a power plant never has to generate because the demand for it has been eliminated through efficiency and conservation. The cheapest and cleanest megawatt of electricity is one that was never produced. Every negawatt produced is another megawatt made available to the grid and to new businesses without the corresponding need to increase capacity at the power plant.

The National Action Plan for Energy Efficiency has stated that energy efficiency programs could do the following:

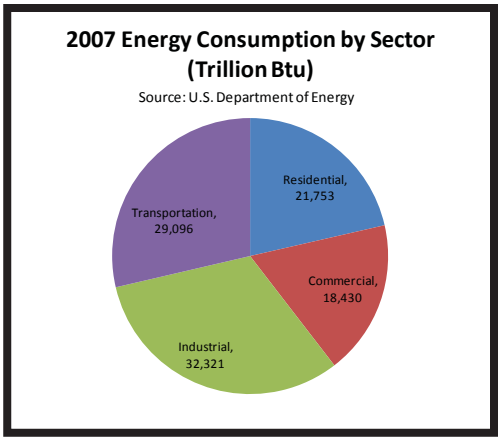
•Realize a 20% reduction in total electrical demand nationally by 2025.

•Create $20 billion/year in energy bill savings.

•Defer the need for 20 gigawatts of power (40 new 500 megawatt power plants).

•Reduce emissions from energy production by more than 200 million tons of carbon dioxide, 50,000 tons of sulfur dioxide, and 40,000 tons of nitrous oxide annually.

Negawatts do not sound as innovative or as exciting as other clean resources such as wind, solar, or biofuels; however, the above facts show that the former has a more immediate and dramatic impact, and should be drawing the attention of the best and brightest professional engineers. Many opportunities for professional engineers and engineering firms lie in the production of negawatts in the commercial and industrial sector. Commercial and industrial facilities use 50% of the nation's energy resources. Reducing energy consumption by 20% in this sector would have the same effect as increasing the contribution of wind and solar power to ten times its present level.



The keys to producing negawatts in these industries are a comprehensive energy management program, an effective O&M program (Operations and Maintenance), and a detailed performance measuring system such as the EPA's Energy Star Program.

Energy Management Programs

An Energy Management Program is a systematic approach to controlling a facility's energy consumption. It reduces energy waste to the absolute minimum necessary to sustain the businesses' core functions while taking into account the climate where the building is located and the physical characteristics of the building itself. As Albert Thumann, P.E., C.E.M relates, "In short, an effective Energy Management Program establishes and maintains efficient balance between a business's functional energy requirements and its actual energy consumption - no more, no less."

In order for any management program to be successful, it requires a defined method for gathering and interpreting information, as well as mechanisms to ensure its continued existence and effectiveness. Thumann describes a very effective seven-step program in his Energy Conservation in Existing Buildings Deskbook. The following outline describes the seven steps that will pull together all the aspects of energy management into a logical progression for implementation. Professional mechanical and electrical engineers should play an important part in each step. The methodology is as follows:

Step 1: Form an Energy Management Team

Step 2: Survey the Business or Facility

Step 3: Tabulate Present Energy Usage

Step 4: Identify Energy Conservation Opportunities

Step 5: Analyze Costs and Benefits

Step 6: Set Goals

Step 7: Implement and Monitor the Impact of the Program

In order for an Energy Management Program to be successful, this Seven-Step process must be initiated and directed by a competent management team. The Energy

Management Team should consist of individuals who are aware of energy use in their respective areas of daily responsibility and who can keep the program focused on its goals. The energy management team should meet on a monthly basis, preferably in the middle of the month. This allows time for bills to arrive and be entered into the energy management reporting program. The makeup of the team should include the overall business manager, key operating personnel, a professional engineering consultant, the accountant responsible for energy-related accounts payable, and, periodically, expert guests (e.g., architects, vendors, manufacturers, etc.). The idea behind the makeup of this team is to bring together persons of various disciplines that have first-hand experience with the mechanical and electrical requirements of the business and the facility that houses it.

"Unfortunately, the professional engineer is frequently underutilized in these areas"

The professional engineer would play a major role by interpreting the information and Energy Conservation Opportunities provided by the other participants. Many energy management teams fail to get off the ground because they do not have a solid understanding of where their power is going, and cannot accurately define the return on investment of their Energy Conservation Opportunities. The complex interrelationships of lighting, heating, cooling, and industry-specific systems necessitate professional engineers to help managers discern whether a specific conservation initiative will be successful - or whether it will produce a situation that will actually end up using more energy.

Operations and Maintenance Programs (O&M)

Another key element in achieving optimum energy efficiency, reliability, and safety in a business or facility is the development of a comprehensive O&M (Operation and Maintenance) program. It has been estimated that O&M programs targeting energy efficiency can save 5% to 20% on energy bills without significant capital investment. An effective O&M program also aids in compliance with federal laws such as the Clean Air Act and the Clean Water Act. O&M encompasses Operational Procedures, Reactive Maintenance, Preventive Maintenance, Predictive Maintenance, and Reliability-Centered Maintenance. Unfortunately, the professional engineer is frequently underutilized in these areas. Businesses that build facilities spend countless hours working with their engineering teams through the design, construction, and commissioning phases. Too often, the relationship is put on hiatus until the business expands or changes, and at which time a professional engineer is engaged again. There is a great benefit to businesses, as well as a great opportunity for professional engineers, in the continuity of their relationship through the operation and maintenance phase of the business life cycle. Newer and more sophisticated technologies require an approach to their operations and maintenance that equals the professionalism involved in their design and installation.

Energy Star

If you can't measure it, you can't manage it. How can facilities measure their energy efficiency improvements, and how can they benchmark the efficiency of their operations against others? For professionals working in the commercial building sector, the EPA's Energy Star Program for professional buildings can provide the answer to both of these questions. Once a commercial building's energy profile is assessed, the results are sent to the EPA, and the energy data is entered through the EPA's Portfolio Manager.

The Portfolio Manager is an online, interactive software tool that makes benchmarking energy performance easy and accessible. Portfolio Manager is based on statistical models gathered by the EPA that correlate energy data to operational characteristics, identifying key energy drivers in the facility. Based on the facility's physical and operational characteristics, such as location, size, number of workers, hours of operation per week, number of PCs, etc., the rating system evaluates a given facility, and then compares its energy performance to others with similar characteristics in the U.S. Those that score within the top 25% or earn an Energy Star score of 75+/100 are eligible to apply for an Energy Star Rating.

"The Professional Engineer is essential in the Energy Star certification process"

The Professional Engineer is essential in the Energy Star certification process. The EPA requires that the Statement of Energy Performance section of the Portfolio Manager be verified by a PE. Once validated, the Statement of Energy Performance becomes an official document that is used to apply for the Energy Star rating. Professionals wanting to learn more about their role in the program should consult "The 2007 Professional Engineer's Guide to The Energy Star Label for Commercial Buildings".

Negawatts as an Energy Resource

Energy efficiency and conservation obviously play an important role in the solution to our nation's energy problems. They reduce electrical demand, reduce the need for more fossil fuel plants (thus reducing pollution and greenhouse gas emissions), and can help minimize the occurrence of brownouts and blackouts. Negawatts should be regarded as a significant energy resource, and the role of those producing negawatts should not be ignored nor underestimated in the quest for energy independence.

John Greenwald is President and Owner of Mechanical Operations and Consulting Inc. MOC Inc. is a Pittsburgh-based firm providing M.E.P. operations, maintenance, and consulting services to the commercial property industry.

Pittsburgh Based Engineers are Expanding Their Borders of Work

By Emma Baillargeon, Marta Beltran-Perez, and Joshua Jedlicka

In a time of demand for engineers around the world, a group of Pittsburgh based engineers are offering their skills and time to global humanitarian causes. The Pittsburgh Professional Chapter (EWB-PPC) and University of Pittsburgh Chapter (EWB-PITT) of Engineers Without Borders, are bringing to the Pittsburgh region the mission and goals of Engineers Without Borders-USA, a non-profit humanitarian organization of engineering students and professionals dedicated to improving the quality of life in developing communities worldwide.

EWB-PITT was established in the Spring of 2006 and has since collaborated with the emerging EWB-PPC, formed in the Fall of 2007-, to apply the experience of their members toward the assessment and design of international projects. EWB members have volunteered time outside their work and school schedules to plan strategies for providing the greatest assistance to targeted communities, carry out site assessment trips and finally design and implement sustainable solutions to recognized problems. In addition, each chapter is responsible for raising all necessary funds to support project implementation. Meetings are held regularly to go over aspects of chapter organization and project progress, and as the chapters expand, the enthusiasm of EWB members continues to build.

EWB-PPC truly embodies the idea of delivering sustainable engineering solutions to the global community, as its members represent a diverse cultural spectrum and expertise in varying disciplines of engineering. Success in finding solutions to quality of life issues in remote areas of the world is only attained through the combined knowledge and life experiences of every member. The commitment to bettering the lives of others holds paramount in the efforts of the group, and has allowed EWB-PPC and EWB-PITT to grow to over 75 members and take on projects in Makili, Mali (Africa) and Tingo Pucara, Ecuador (South America).

In Mali, the community of Makili lacks consistent access to proper nutrition, compounded with limited fresh water storage during the annual dry season. With support of the village chief, the community came to EWB in the hopes of designing a fish farm to not only supplement the community's protein deficient diet, but also diversify the farming goods produced within their region. EWB-PITT took up this project in October of 2007, and has since received support from EWB-PPC as they move forward in planning and design. This past May, a group of 4 students and 2 professional engineers embarked on a site assessment trip to Makili in order to complete the first phase of this project and receive input from the community. The site assessment team forged valuable relationships with Makili villagers in addition to gathering health and geographical data about the community. EWB-PITT is currently working to analyze the data acquired on this trip, and hopes to return to Africa to begin project implementation in December of 2008. The pictures, stories and lessons learned from the first phase of this project have undoubtedly encouraged every group member to work harder toward the overall goal of improving the quality of life for the villagers of Makili.

In Ecuador, EWB-PPC members are working towards finding a method of bringing potable water to the village of Tingo Pucara set high in the Andes Mountains. Villagers currently have to travel hours to gather clean water, which becomes contaminated during storage because of lack of sanitary conditions. EWB-PPC is working with a local contact at the University of San Francisco de Quito toward finding a solution to bring clean water to the community, which would reduce the travel while benefiting the health and education of the community members. A group of 5 professionals will travel to Tingo Pucara in early September for a site assessment and data acquisition, after which the design phase for a sustainable clean water supply will begin.

Additionally, EWB-PPC's collaboration with the University of Pittsburgh Student Chapter has proven to be an invaluable resource for members of both chapters. Involvement in EWB exposes Pitt students to complex international engineering projects, testing their limits of thinking outside the classroom. The experience also allows them the opportunity for individual interaction with practicing professional engineers. This fall, EWB-PPC and EWB-PITT will help students at Carnegie-Mellon University foster their own chapter and add to the exciting student-professional interaction that has been a motivation and education to all.

Both EWB-PPC and EWB-PITT continue to expand and welcome the participation of anyone interested, regardless of technical background or experience. For information specific to the Pittsburgh chapters or to contact the EWB-PPC professional chapter, please visit http://ewb-pitt.org. The EWB-PITT student chapter can be contacted through email at ewb.usa.pitt@gmail.com. For more information on the mission of the organization at the national level, please visit www.ewb-usa.org.

Emma Baillargeon is the president of EWB-PITT, and is a Senior in Bioengineering at the University of Pittsburgh. Emma was a participant in the Mali site assessment trip.

Marta Beltran-Perez , is the Project Coordinator for the Ecuador project. Marta.is an Environmental Engineer with N.A. Water Systems L.L.C. in Moon Township, PA..

Joshua Jedlicka, is the Fundraising Chair for EWB-PPC. Joshua is an Environmental Engineer with CDM in Pittsburgh.