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LESSONS FROM FUKUSHIMA

BY DICK FLANAGAN

Marvin Fertel, President and CEO
Nuclear Energy Institute

NEW YORK, NY - America's nuclear energy industry continues to operate safely and reliably, Marvin Fertel, president and CEO of the Nuclear Energy Institute, told financial analysts and the media at a press conference attended by *World-Gen* on July 26th.

"We certainly believe our existing facilities are safe," Fertel said. "That doesn't mean we can't take lessons learned and won't take lessons learned from Fukushima and actually enhance safety even better than it is right now. There are improvements that make a lot of sense to us."

The earthquake and tsunami in Japan on March 11th and the nuclear accident at TEPCO's Fukushima Daiichi nuclear power plant resulted in the worldwide intense interest in nuclear energy safety. The leadership of the US commercial nuclear industry, the Electric Power Research Institute (EPRI), the Institute of Nuclear Power Operations (INPO), and the Nuclear Energy Institute (NEI), with utility executives created a joint leadership model to integrate and coordinate the US

(continued page 18)

SOLAR ON THE CUSP

BY PAULA MINTS

Paula Mints, Director, Energy
Navigant (NYSE: NCI)

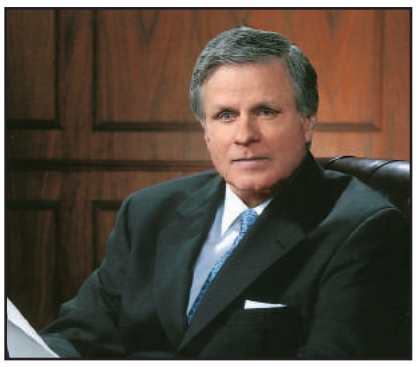
PALO ALTO, CA - The photovoltaic industry is at the beginning of a painful change in the way incentives (driving force for the grid-connected application) are designed and administrated. Instead of generous feed in tariffs, the future likely holds tradable certificates and tenders (auctions) to set power purchase agreement (PPA) rates that will then be referred to as FiTs. Auction based incentive rates are the trend leading to margin declines for entities along the solar value chain from manufacturing to projects.

Industries are made up of people reacting for market forces and pressures, and as such exhibit behaviors specific to these pressures. Reliance on incentives to drive demand has led to specific behaviors, including frantic buying when prices are low, and frantic installing into any available market. The industry continues to behave erratically, and can be difficult to size accurately. One reason for the sizing difficult are the different metrics that are available for measuring, and the lack of definition of what is being measured and how it is being measured. For

(continued page 21)

DEPARTMENTS

PUBLISHER'S LETTER



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American's nuclear energy industry is operating safely and reliably Marvin Fertel, CEO of NEI, told World-Gen and financial analysts at a press conference in New York. He outlined the actions being taken in the immediate aftermath of the Fukushima Daiichi accident. The leadership of the US commercial nuclear industry and industry stakeholders has developed seven building blocks noted on page 1.

Paula Mints, Director in Navigant's Energy Division, writes on page 1 that the industry now finds itself with price levels that cannot increase and incentive levels that will also not increase. This means that the industry will need to change to survive. It will need to develop price elastic customers that do not require incentives, it will need to adjust to power purchase agreement types of incentives where the price is set by bid, and it will, unfortunately, have to adjust to lower margins.

Solar's the new game in California, Lyn Corum tells us in "California News." Over 4,100 MW of utility-scale solar thermal projects already certified by the California Energy Commission have dominated the news but that's just the tip of the development tsunami. More than 10,000 MW of solar photovoltaic projects are being developed under the radar in six Southern California counties. The federal Bureau of Land Management is reviewing an additional 2,839 MW of solar PV projects. This huge growth in both solar PV and solar thermal projects is being driven by federal tax credits and California's Renewable Portfolio Standard. She outlines county by county where and what projects will be built on page 13.

Brian Seal at the Electric Power Research Institute writes on page 14 that an important part of the smart grid vision is enabling communication-connectedness with residential devices so that they can be informed of grid conditions, including energy price, critical peaks, and other curtailment events. Two years ago, EPRI began a research project to study this concept in depth. The project was designed to bring together end device manufacturers, communication system providers, and utilities in balanced representation. The group was provided with a blank slate, and the challenge to identify the characteristics and capabilities that a modular interface must have in order to satisfy the interests of each stakeholder group and to equally support the wide range of systems and devices from the simple to the complex. Participation was open, free of charge, and free of commitment. Over the course of the project, participation grew to over 150 individuals representing 65+ companies.

Wesley Symank and Hind Farag share on page 15 that growth in electricity demand during the next 10-15 years stemming from a massive wave of new hybrid and all-electric cars is becoming more of a dream and less of a real possibility. The range of perspectives has always been fairly diverse, with a wide range among prominent forecasts of electric vehicle sales. Although enthusiasm among many in the industry was widespread at first, the realization of several obstacles to transport electrification has since become more evident. Over the past year, Wood Mackenzie has been refining its view on the prospects of electric vehicles; and as ours has consistently been lower than other forecasts, we maintain that this estimate is still very achievable.

The gap between renewable generation and consumption cannot be bridged without energy storage. There are a number of energy storage alternatives, such as pure mechanical (flywheel), electrical, (batteries) underground stored compressed air or pumped water storage facilities. Dr. Justin Zachary concentrates on the heat storage as applicable to concentrated solar thermal (CSP) on page 16. Any large scale deployment of CSP will not be possible without thermal storage, which offers the capability to shift the power production closer to the peak demand. An additional benefit of thermal storage is to boost the plant utilization factor, a key element of any economic analysis. It should be emphasized that the use of any type of storage requires a larger solar field, where part of the heat generated is not used immediately to produce electricity but transferred to the storage device.

Building energy codes and appliance efficiency standards offer untapped potential for energy savings. Electric utilities, in working with their regulators, legislators, and construction trade allies, can integrate them within their energy efficiency portfolios. And in doing so, will create a payoff that will last for generation after generation, Dr. Lisa Wood, Executive Director for the Institute for Electric Efficiency explains on page 17. The IEE has issued two new white papers.

While roofs across the world sport photovoltaic solar panels to convert sunlight into electricity, a Duke University engineer believes a novel hybrid system can wring even more useful energy out of the sun's rays, Richard Merritt writes on page 18. The hybrid system achieved exergetic efficiencies of 28.5 percent in the summer and 18.5 percent in the winter.

Globally, grid-connected solar capacity increased at an average annual rate of 60 percent from 2004 to 2009, said author H. Sterling Burnett, an NCPA senior fellow on page 19. However, for solar energy to be truly successful, it must be competitive with other sources for electric power without subsidies. He concludes that, with major technological breakthroughs that significantly reduce the cost of

(continued page 12)

INDUSTRY NEWS

SIEMENS TEAMS

ORLANDO, FL - Black Hills Corporation has chosen Siemens Energy to integrate the eMeter EnergyIP® meter data management system into its information technology systems. Siemens will provide configuration, testing and integration services. Black Hills was awarded ARRA funding.

AE BENCHMARKS

FORT COLLINS, CO - Advanced Energy Industries announced that its 500kW Solaron®PV inverters have achieved a 98 percent efficiency rating from the California Energy Commission.

The CEC approved inverters for commercial use.

SOLARWORLD INKED

HILLSBORO, OR – SolarWorld was selected to power the North American headquarters of Vestas. The building's redevelopment will feature a 112-kilowatt photovoltaic system and will supply about 12 percent of the building's electricity needs when completed in 2012.

MTU, APR DEPLOY

MANKATO, MN - Tognum Group subsidiary MTU Onsite Energy provided 43 generator sets to Japan as part of a 203 MW emergency power contract between Tokyo Electric Power Company and APR Energy.

PV REPORT

DENVER, CO - CH2M HILL completed a new PV economic development report to help guide U.S. cities seeking to recruit and retain investment in the photovoltaic solar manufacturing industry. The report was part of the DOE's Solar America Communities program.

PARTNERS AWARDED

LOS ANGELES, CA - Alstom Power and Infosys were selected as finalists for the Microsoft Sustainability Partner of the Year Award. Alstom and Infosys were selected for OptiPlant, an application based on the latest Microsoft technologies helping power plant operators.

ENERNOC EXPANDS

BOSTON, MA - EnerNOC acquired Energy Response Pty Ltd, the largest demand response provider in Australia and New Zealand. "The electricity markets in Australia and New Zealand present tremendous opportunities for EnerNOC and Energy Response to join forces to provide a broad range of demand-side resources," said Tim Healy, CEO of EnerNOC and a member of *World-Gen's* Class of 2008.

NRG ACQUIRES

PRINCETON, NJ - NRG Energy completed its acquisition of the 290-megawatt Agua Caliente, the world's largest solar photovoltaic project from First Solar. The acquisition was contingent upon the financial closing of the project's loan guarantee from DOE.

SOLECTRIA SELECTED

LAKE MARY, FL - Solectria Renewables delivered four SGI 266's to BlueChip Energy to power the 1. 5 megawatt rooftop installation for the Rinehart Solar Farm. The 1.5MW system is the first stage of the 10MW Rinehart Farm.

This PV rooftop installation will be the largest in Florida.

ENXCO'S FIFTH

SOLANO COUNTY, CA - EnXco entered a 25-year renewable energy power purchase agreement with Pacific Gas and Electric Company for 100 MW of capacity from the Shiloh IV wind farm currently under development.

Shiloh IV will be enXco's fifth project in Solano County.

BECHTEL PARTNERS

SAN FRANCISCO, CA - Bechtel Corporation and Linde AG will work together to expand and build ethylene cracker plants in North America.

The alliance builds on the companies' previous work together at the Borouge petrochemicals complex in the United Arab Emirates.

"With the growth in shale gas production in North America, ethylene producers are planning new grass-roots projects and major expansions, and they need a world-class team to deliver them. The agreement between Bechtel and Linde creates that team," said Jack Futcher, president of Bechtel's Oil, Gas & Chemicals unit. Futcher is a member of *World-Gen's* Class of 2010.

Bechtel has built ethylene facilities in China, India, and the UAE in the last 10 years.

Linde is a leader in ethylene technology with the highest recent market share in ethane crackers, including the largest ethane cracker in the world.

MERCOM REPORTS

AUSTIN, TX - Mercom Capital Group released funding and merger and acquisition activity for the solar sector for the second quarter of 2011.

Venture capital funding in the solar sector dipped this quarter, coming in at $354 million, compared to $658 million in Q1 2011.

The number of deals remained steady with 26 deals funded in Q2 2011 compared to 25 deals in Q1.

Year-to-date funding in solar is approximately $1 billion. Photovoltaic technology companies attracted the most funding in Q2 with $107 million.

NAME CHANGE

ALPHARETTA, GA - Teton Industrial Construction is now called PCL Industrial Construction. The name change coincided with the opening of a new PCL office in Houston, TX.

VESTAS, E.ON SIGN

Vestas announced that E.On Climate & Renewables North America has purchased 112 turbines. The Vestas/E.On deal includes 202 MW worth of V-100 1.8-MW turbines, along with a five-year service and maintenance agreement, for completion in mid-2012.

EDF RANKS

SAN FRANCISCO, CA - The smart grid plans to modernize California's three largest public utilities have comprehensive visions and coherent strategies, but lack commitments to measure and verify progress on delivering benefits, according to Environmental Defense Fund.

GE INKED

SCHENECTADY, NY - GE and Wind Capital Group have inked deals for 228 wind turbines with operations and maintenance services for projects in Oklahoma and Kansas. GE will supply 94 wind turbines for the Osage project and 134 wind turbines for the Post Rock project.

INDUSTRY NEWS

URS TO EPC

SAN FRANCISCO, CA - URS Corporation has been awarded a contract by Hoosier Energy Rural Electric Cooperative, Inc. to provide engineering, procurement, and construction services to upgrade existing flue gas desulfurization systems at Merom Station.

SIEMENS SIGNED

SAN FRANCISCO, CA - Siemens Industry received an order from Interconnect Solar Development to supply solar technology for the 20MW Murphy Flats solar field located in Idaho. The technology will be manufactured at Siemens West Chicago plant.

IBM INKED

ARMONK, NY - IBM has been selected by UIL Holdings Corporation to help secure its Smart Meters and Advanced Metering Infrastructure. The United Illuminating Company is upgrading its electric energy grid with smart meters for its 324,000 electric customers.

IMPROVING STORAGE

CAMBRIDGE, MA - MIT researchers have found a way to improve the energy density of a type of battery known as lithium-air (or lithium-oxygen) batteries, producing a device that could potentially pack several times more energy per pound than the lithium-ion batteries that now dominate the market for rechargeable devices in everything from cell phones to cars.

In principle, lithium-air batteries have the potential to pack even more punch for a given weight than lithium-ion batteries because they replace one of the heavy solid electrodes with a porous carbon electrode that stores energy by capturing oxygen from air flowing through the system, combining it with lithium ions to form lithium oxides.

The gravimetric energy stored by these electrodes — the amount of power they can store for a given weight — is among the highest values reported to date, which shows that tuning the carbon structure is a promising route for increasing the energy density of lithium-air batteries. The result is an electrode that can store four times as much energy for its weight as present lithium-ion battery electrodes.

Because the electrodes take the form of orderly "carpets" of carbon fibers — unlike the randomly arranged carbon particles in other electrodes — it is relatively easy to use a scanning electron microscope to observe the behavior of the electrodes at intermediate states of charge. The researchers say this ability to observe the process, an advantage that they had not anticipated, is a critical step toward further improving battery performance. For example, it could help explain why existing systems degrade after many charge-discharge cycles.

MILBANK REPRESENTS

NEW YORK, NY - Milbank, Tweed, Hadley & McCloy represented Montgomery L'Energia Power Partners in the sale of L'Energia's 82-megawatt combined cycle plant to EDF Trading. Montgomery Energy Partners LP is a Houston-based energy development company.

SOLARWORLD INSTALLS

HILLSBORO, OR – The new largest solar installation in a U.S. national park features high-performance solar panels from SolarWorld. The park estimates the solar installation will supply about 12 percent of the Yosemite's total power consumption.

EMERSON ACQUIRES

ST. LOUIS, MO - Emerson Process Management acquired Net Safety Monitoring, Inc., a global leader in the design, development and manufacture of fixed toxic and combustible gas detectors with offices in Calgary, Houston, Abu Dhabi, Beijing and Singapore.

FEDEXFIELD DELIVERS

LANDOVER, MD -The Washington Redskins and NRG Energy will bring renewable energy to FedExField with solar power installations integrated into the stadium and in the parking lot, as part of the nine-year agreement.

STARWOOD SOLARS

GREENWICH, CT - Starwood SSM3 Canada closed on a 10 megawatt AC solar photovoltaic project in the City of Sault Ste. Marie, Ontario. Q-Cells will construct the project on a turn-key basis and provide operations and maintenance services post-completion.

WHITE AWARDED

CLINTON, IN - White Construction Inc. announced the award of an Engineering, Procurement, and Construction contract for the Pioneer Trail Wind Farm in Illinois. The Pioneer Trail 150 MW wind farm was developed and will be owned by E.ON Climate & Renewables.

OPT DEPLOYS

PENNINGTON, NJ - Ocean Power Technologies announced the latest deployment in its autonomous PowerBuoy®, under the LEAP program, OPT has integrated with Rutgers University and in partnership with CODAR Ocean Sensors.

The system provides power for sea-based radar and communications systems in all wave conditions, including zero-waves, and requires no maintenance for three years.

ANSI REPORTS

NEW YORK, NY - The American National Standards Institute (ANSI) submitted a report to DOE outlining priority areas to facilitate the safe, effective, and large-scale deployment of electric drive vehicles.

SOLTAS INVESTS

NEW YORK, NY - Soltas Energy Corporation has taken a majority position in Aegis Solar Energy of Branford, CT. Aegis Soltas Energy has also invested in Choice Solar Solutions, Inc., Nashville, TN and Sunergy America of Wall, NJ.

EPRI TEAMS

PALO ALTO, CA - The Electric Power Research Institute announced a 3-year agreement with Japan's Central Research Institute of Electric Power Industry to jointly research nuclear power plant issues related to plant performance and radiation safety.

VENTURE INVESTS

HOUSTON, TX - Energy Technology Ventures, a GE-NRG Energy-ConocoPhillips venture, has invested in Houston-based Glori Energy. Glori Energy's technology revives oil fields with depleting production volumes.

INDUSTRY NEWS

AEHI SIGNS

BOISE, ID - Alternate Energy Holdings signed a contract with Enercon Services to prepare the combined Construction and Operating License Application (COLA) for submittal to the US Nuclear Regulatory Commission for AEHI's Payette County, Idaho nuclear site.

GTI EXPANDS

DES PLAINES, IL - Gas Technology Institute opened the organization's newest office in Pittsburgh, PA. The new office represents GTI's local commitment to the natural gas industry in the Marcellus Shale fairway and the surrounding region.

SIEMENS TO SUPPLY

DES MOINES, IA - Siemens is supplying 193 of its SWT-2.3-101 wind turbines to the Rolling Hills wind project.

Mortenson Construction is installing the wind turbines, as well as constructing the balance of the project infrastructure.

NRG EXPANDS

PRINCETON, NJ - NRG Energy announced a definitive agreement to acquire Energy Plus Holdings, a Philadelphia-based retail electricity and natural gas provider for $190 million in cash.

"As we launch our retail expansion in the Northeast, Energy Plus adds a highly effective, absolutely unique and essentially non-replicable sales chain to our successful retail energy platform," said David Crane, NRG President and Chief Executive Officer. Crane is a member of *World-Gen's* Class of 2005.

POLAR CRANE TO CHINA

PITTSBURGH, PA - Westinghouse Electric Company announced that its NuCrane Manufacturing facility in Hutchinson, MN. has begun shipment of the first AP1000 polar crane destined for China National Nuclear Corporation's (CNNC) Sanmen 1 Nuclear Power Plant under construction.

NYISO UNVEILS

RENSSELAER, NY - New York Independent System Operator (NYISO) unveiled details of a $74 million smart grid initiative, which is being supported by a US Department of Energy Smart Grid Investment. NYISO started construction of its new $35.5 million primary power control center.

PATTERN PARTNERS

TORONTO, CN – Pattern Energy Group and Samsung Renewable Energy have signed four separate power purchase agreements with Ontario Power Authority to provide 870 megawatts from wind energy projects.

Pattern is scheduled to start construction on new projects totaling more than 1,000 MW over the next 12 months.

EMERSON AWARDED

MARSHALLTOWN, IA - Westinghouse Electric Company awarded Emerson Process Management more than $8 million in purchase orders for critical control valves to be used in two AP1000® pressurized water reactors at SCANA Corporation's Virgil C. Summer Nuclear Generating Station.

WHITE TO IEA

CLINTON, IN – Infrastructure and Energy Alternatives acquired White Construction. White Construction will remain in Clinton with CEO Buddy White joining the Board of IEA and continuing as President of White Construction. The GFI Energy Group along with IEA management will provide the equity capital.

Infrastructure and Energy Alternatives LLC is a newly formed venture chartered with building a diverse energy portfolio and is led by Paul M. Daily who previously served as CEO of the InfraSource unit of Quanta Services.

GFI Energy Group is a specialized investment team within Oaktree Capital Management, investing in more than seventy transactions with aggregate value of over $1.8 billion.

PROJECT "SOLAR STRONG"

LOS ANGELES, CA - US Renewables Group plan to provide $344 million in financing for a project led by SolarCity to install solar panels on military housing across the United States.

Project SolarStrong is a multi-year project valued at more than $1 billion under which SolarCity will install, own, and operate rooftop solar systems on up to 160,000 privatized military residences on as many as 124 military bases across 33 states.

"This will be the first time that long term debt has been successfully deployed to finance a residential distributed generation project at such a large scale," said Ed Feo, Managing Partner of US Renewable Finance. Feo is a member of *World-Gen's* Class of 2006.

SolarCity will seek to hire and train veterans and/or family members of active duty military service members to install and maintain the solar systems.

ELEKTRA ONE WINS

Erik Lindbergh, founder of LEAP and grandson of Charles Lindbergh, awarded its Lindbergh Prize for Electric Aircraft Vision Award to PC-Aero for its development of the Elektra One, the first solar-enabled airplane. The plane will be sold as a package featuring wing-borne SolarWorld photovoltaic cells to extend its range as well as a SolarWorld-powered hangar to house the plane and charge the aircraft's lithium battery pack.

Calin Gologan of Germany, principal of PC-Aero, accepted the award from LEAP (Lindbergh Electric Aircraft Prize).

NIPSCO SELECTS

CHARLOTTE, NC –Babcock & Wilcox Power Generation Group has been awarded a $54 million contract to design and supply two wet flue gas desulfurization units for NIPSCO's R.M. Schahfer Generating Station in Wheatfield, IN.

CALPINE, GE TEAM

HAYWARD, CA - Calpine Corporation and GE Energy Financial Services obtained an $844.5 million credit facility to finance construction of the 619-megawatt, Russell City Energy Center. PG & E signed a 10 year PPA and will supply natural gas.

DUPONT EXPANDS

WILMINGTON, DE - DuPont has acquired Innovalight, a company specializing in advanced silicon inks and process technologies that increase the efficiency of crystalline silicon solar cells. Innovalight is developing a pipeline of products.

INTERNATIONAL NEWS

AUSTRALIA

Wärtsilä has been contracted to supply engines, generators and associated auxiliary equipment for the Fortescue Metals Group, one of the world's leading producers of iron ore. The power plant is needed to supply electricity for its Solomon Hub mine in Western Australia.

AUSTRALIA

First Solar, Verve Energy and GE Energy Financial Services announced Australia's first utility-scale solar power project. First Solar has agreed to supply the project with over 150,000 of its advanced thin film photovoltaic (PV) modules and provide EPC services.

BRAZIL

Natural Power and Inova Energy have joined forces to develop asset management services in Brazil. Natural Power currently performs wind management services on 64 operational wind farm sites, totalling 1.2GW. Inova has worked on 94 projects in Brazil.

CHINA

Westinghouse Electric Company and its consortium team members announced that the first AP1000 nuclear reactor vessel successfully arrived at the Sanmen nuclear power plant in China's Zhejiang province, and will become operational in late 2013. The remaining units will come online in 2014 and 2015.

CHINA

Turbine Technology Services Corporation is delivering two TTS CMS-1000 portable combustion dynamics measurement system for customers in Jinjiang.

CHINA

Alcatel-Lucent and China's SGIT are teaming up to help utilities manage peak electricity demand, identify power savings and cut down on energy usage. The two companies will increase the intelligence in utilities' power distribution systems, or 'smart grids', allowing for continuous measurement, monitoring, control and adjustment of power distribution.

DENMARK

A wholly owned subsidiary of First Olsen Ltd., which is owned 50/50 by Bonheur ASA and Ganger Rolf ASA, has acquired 60% of Danish company Universal Foundation A/S, developers of an innovative 'Bucket Foundation' for offshore wind farm development. The remaining interests are held by the Danish utility company DONG Energy Power Holding A/S, Novasion ApS and Aalborg University, with whom the concept foundations have been developed and tested.

ESTONIA

GE wind is supplying 18 wind turbines for the Paldiski Wind Farm located in northwestern Estonia. In addition, the Paldiski wind farm will be supported by a 10-year full service agreement from GE.

FRANCE

Iberdrola Renewables and AREVA signed a memorandum of understanding to jointly develop offshore wind projects in France following the government's announcement of a plan to reach a 6 GW target by 2020. The partners will compete for two of the country's five offshore zones offered in a first phase of bidding. AREVA will be the sole supplier of the turbines.

GERMANY

At a ceremony in Arnstadt, the Bosch Group inaugurated its new photovoltaics center. The company has invested more than half a billion euros in this facility. In addition to the Solar Energy division's headquarters, this facility brings together research and development departments, the production of solar cells and modules, and a training center under one roof.

GERMANY

ABB won an order worth around $1 billion from the Dutch-German transmission grid operator TenneT to supply a power link connecting offshore North Sea wind farms to the German mainland grid. It will deploy the world's largest offshore HVDC system with a rating of over 900 megawatts.

HUNGARY

Paksi Atomer m Nuclear Power Plant has selected Emerson's CSI 6500 Machinery Health™ Monitor for real-time machinery protection and predictive monitoring of eight turbine-generator machine trains. The PAKS Nuclear Power Plant is the only operating nuclear power station in Hungary, producing approximately 40 percent of the electrical power generated in the country.

ISRAEL

Alstom signed a 20 year operation and maintenance €330 million contract with Dalia Power Energies for the 835 MW gas-fired Tzafit power plant. This service contract follows the agreement signed earlier in June 2011 between Alstom and Dalia Power Energies to construct two 417 MW gas-fired combined cycle units on an engineering, procurement and construction basis.

POLAND

Foster Wheeler has chosen Emerson Process Management's PlantWeb™ digital plant architecture with the Ovation™ expert control system and AMS Suite predictive maintenance software to control a new biomass boiler at the Polaniec Power Station in Poland.

ROMANIA

A 300-megawatt grid-connection agreement between Romania's grid operator Transelectrica, and a joint venture between GE and German wind farm developer Prowind GmbH, will play a major role in the expansion of Romania's wind power sector. Prowind will build four wind farms in northeastern Romania. GE will provide 120, 2.5-100 class wind turbines.

SAUDI ARABIA

Hanwa Engineering and Construction has awarded Alstom the contract to engineer, supply and supervise the commissioning of seawater flue gas desulphurization (SWFGD) systems* for phase 2 of the Marafiq power plant in the Yanbu Industrial Area, located on the Red Sea coast. Phase 2 includes three steam power plant blocks, each generating 276 MW. Alstom's technology uses only seawater and air, to remove 90% of sulphur dioxide from the plant. The first unit of Yanbu phase 2 is scheduled for completion in October 2013, with the entire project due to be completed by January 2014.

SOUTH AFRICA

Wärtsilä is to supply and construct a complete power plant in South Africa for Sasol New Energy Holdings. It will be powered by 18 Wärtsilä 20V34SG generating sets running on natural gas, with an output of 180 MW.

SWEDEN

ABB won an order from the Swedish utility Falbygdens Energi for a storage solution based on a new technology that uses a battery storage device to provide stability to the grid. The equipment will enable the storage of locally produced energy from wind turbines.

SWITZERLAND

ABB announced the acquisition of Epyon B.V., an early leader in electric vehicle charging infrastructure solutions focusing on direct current fast-charging stations and network charger software. Founded in 2005, Epyon is headquartered in Rijswijk, Netherlands, has an R&D center in Eindhoven and sales resources across Europe.

THAILAND

SCHOTT Solar will fill an order from Phoenix Solar Singapore for 67, 000 solar modules. The modules will be used in the two solar power plants that Phoenix Solar has been building just north of Bangkok. The two sites will achieve peak output of 9.7 and 6.2 megawatts.

THAILAND

PTT Utility Company signed a 13-year service agreement with GE valued at more than $40 million. The agreement includes power output efficiency, reliability and performance guarantees for eight GE Frame 6B gas turbines at PTT Utility's power generation plants at Map Ta Phut Industrial Estate in Rayong.

UNITED KINGDOM

The UK nuclear safety regulator lifted the "Regulatory Issue" connected with the design of the Westinghouse's AP1000® nuclear plant. This move clears a significant obstacle to Design Acceptance Confirmation by the Office for Nuclear Regulation (ONR). Westinghouse expects final approval for the AP1000 design in the UK later this year.

VIETNAM

GE has signed a contract with local developer Cong Ly Company Ltd. to provide 10 of its 1.6-82.5 wind turbines and operations and maintenance services for phase one of the Bac Lieu Wind Farm, totaling 16 megawatts of power generation capacity.

Cong Ly Company Ltd. also has plans for a second phase of the project, which would add up to 120 megawatts of power.

NEWSMAKERS

HEINTZELMAN LEADS


Dan Heintzelman

Dan Heintzelman, currently CEO of GE Energy Services, has been named CEO of GE Oil & Gas, succeeding Claudi Santiago. Dan is a member of the Class of 2010.

SNOW APPOINTED


Darlene Snow

Darlene Snow has been named the Executive Director of the Wind Energy Foundation, based in Washington, D.C.

NYISO NAMES

The New York Independent System Operator appointed Tariq N. Niazi as NYISO Consumer Interest Liaison. Mr. Niazi has served as the Director of the Utility Intervention Unit and as Chief Economist of the New York State Consumer Protection Board.

AETI APPOINTS

American Electric Technologies appointed Neal Dikeman to the company's board of directors. Dikeman is a founding partner of Jane Capital Partners,

ENERGATE NAMES TWO

Energate appointed Lisa V. Wood and John C. Fox to its board of directors. Ms. Wood is the executive director of the Institute for Electric Efficiency (IEE).

RIDGE APPOINTED


Tom Ridge

Pace Global Energy Services announced the appointment of Tom Ridge, the nation's first secretary of the U.S. Department of Homeland Security, to its company's board of advisors.

BROWN APPOINTED

First Solar announced that Jens Meyerhoff will be leaving the company effective Sept. 30, 2011, and James Brown, currently Senior Vice President of Utility Systems Business Sales, will succeed Meyerhoff.

SKANSKA HIRES


Rich Aquino

Skanska USA's civil business unit hired Rich Aquino as vice president of business development. Before joining Skanska, Rich spent over three years at URS Corporation.

ANDREWS JOINS NRG

Kirkland B. Andrews joins NRG Energy as Executive Vice President and Chief Financial Officer from Deutsche Bank Securities, where he served as Managing Director and Co-Head of Power and Utilities-Americas.

WESTINGHOUSE APPOINTS


Rick Gabbianelli

Westinghouse Electric Company announced the appointment of Rick Gabbianelli as senior vice president of its Strategy Organization.

SKADDEN ADDS


Chaka M. Patterson

Skadden, Arps, Slate, Meagher & Flom announced that Chaka M. Patterson has joined the firm's litigation practice in Chicago from Exelon Corporation.

WARD JOINS


Stephen Ward

VH Strategies welcomed Stephen Ward, former Chief of Staff to Senate Energy and Natural Resources Committee Chairman Jeff Bingaman (D-NM), to the firm.

EPRI ELECTS SIX

The Board of Directors of the Electric Power Research Institute announced that James Kerr II, John Bohn, Benjamin Fowke III, Jong-shin Kim, W. Terry Boston, and, James Lash were elected to 4 year terms on the Board.

DELOITTE NAMES


Sampat Prakash

Sampat Prakash has been named the National Managing Director for Energy & Resources at Deloitte Consulting.

LOPES NAMED


Carlos Silva Lopes

Dow Performance Materials named Carlos Silva Lopes as strategic marketing director for the ANGUS Chemical Company and Acima Specialty Chemicals.

SHAVER NAMED


Ron Shaver

Allied Power Group named Ron Shaver Vice President of Operations to oversee the company's expansion projects.

HOOK APPOINTED


Bob Hook

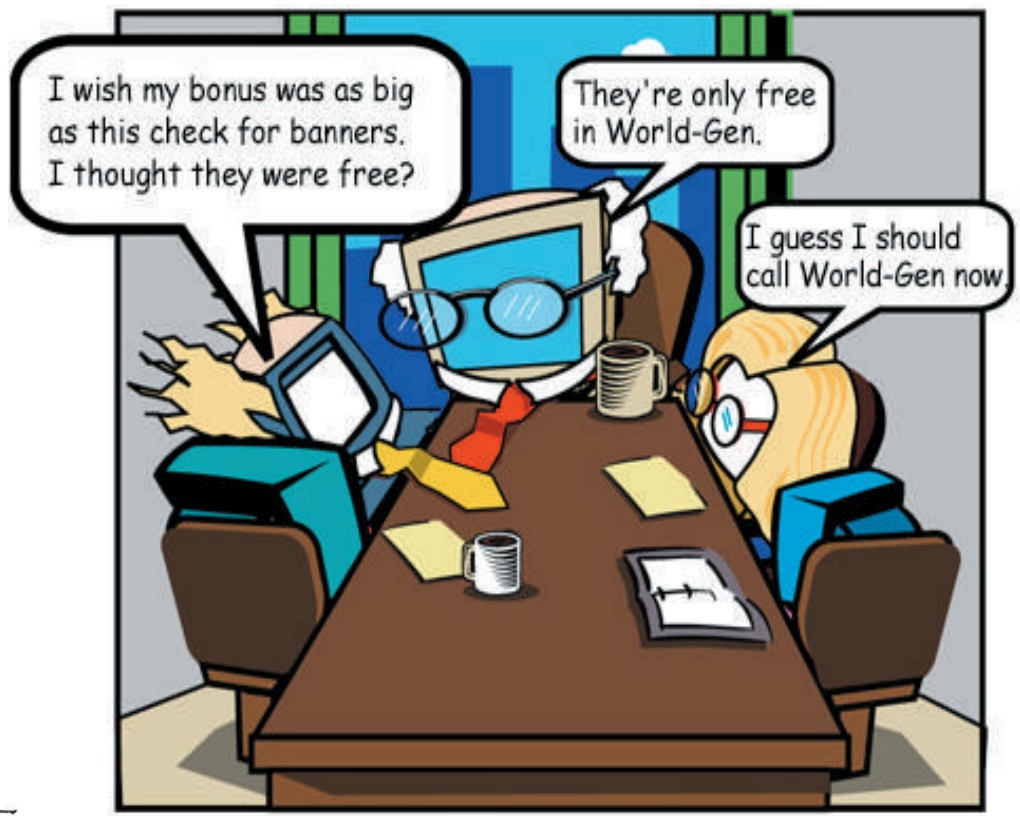
Westinghouse Electric Company appointed Bob Hook as controller for Westinghouse's Nuclear Fuel organization with responsibility for all finance and reporting activities for the company's Nuclear Fuel product line.

PUBLISHER'S LETTER

CONTINUED FROM PAGE 3

solar power production and the imposition of new environmental mandates that raise the price of electricity generated by other sources, solar could reach grid parity in some areas of the United States by the end of the decade.

Duke Energy's digital system is a 21st century end-to-end intelligent network that is able to collect, organize and analyze vast amounts of detailed and reliable information. This system will use communications nodes that can transmit data between multiple devices, such as transformers and smart meters, send information to workers with mobile devices, and route data back to a central location or to other nodes for more analysis and action. This flexibility enables utilities to better manage the system, resolve problems as they arise, and, in some cases, prevent outages before they occur, David Masters tells us on page 20. He quotes the EPRI study that estimates a cost of over half a trillion dollars to modernize the US Grid over the next 20 years but sees benefits of up to $2 trillion in greater energy efficiency, improved reliability and security and a small impact on the environment.



SOLAR — THE NEW GAME IN TOWN

BY LYN CORUM, CLASS OF 2003

It is a volatile time in Southern California for solar development, both utility-scale and smaller distributed generation projects. Over 4,100 MW of utility-scale solar thermal projects already certified by the California Energy Commission have dominated the news but that's just the tip of the development tsunami.

More than 10,000 MW of solar photovoltaic projects are being developed under the radar in six Southern California counties, in particular in the eastern side of the state in the high and low desert areas. The federal Bureau of Land Management is reviewing an additional 2,839 MW of solar PV projects.

This huge growth in both solar PV and solar thermal projects is being driven by federal tax credits and California's Renewable Portfolio Standard. And the huge number of projects is proving to be a challenge for the county planning departments which have to prepare environmental impact reports for the PV projects the CEC does not review. Even the solar thermal projects will have an impact on their fire and health services, the counties say.

Furthermore, environmental watchdog groups who otherwise favor renewable resources are up in arms over the potential loss of habitat for the Desert Kit Fox, Pronghorn Antelope, Giant Kangaroo Rat and other endangered species. Native American tribes have also filed lawsuits against five companies claiming their projects will negatively impact sacred sites, geoglyphs and the Giant Blythe Intaglios, monumental drawings of human and animal figures etched on the desert floor.

WHAT WILL GET BUILT?

The six counties, Kern, Riverside, Imperial, Los Angeles, San Luis Obispo and San Bernardino, are facing what for them is an unprecedented number of permit applications for solar PV projects. To help, the BLM reviews projects on federal lands. Most of these projects do not have contracts with utilities. So the question is, how many of these thousands of projects will eventually generate electricity?

ike Marelli, head of contract origination and analysis at Southern California Edison, said the utility has 4,200 MW of both solar thermal and PV projects under new contracts, not including utility-owned rooftop projects. He predicted a 60% to 70% success rate of projects under contract.

Marelli said, "We try and sort through the applications and pick the best projects, but not 100% will make it to the end." He said there are a wide variety of reasons why so many projects fail. Transmission is the number one barrier, he said. Permitting and access to capital are other reasons, although the latter is less of an issue now than it was two or three years ago.

Kern, Riverside, Imperial, Los Angeles and San Luis Obispo Counties have approved or are reviewing 9,647 MW of solar PV projects that range from 2 MW to over 600 MW. San Bernardino County would not release a list of the projects they are reviewing, but an additional 484 MW of PV projects are known to be active in the county from authorized and pending applications reviewed by the BLM and contracts signed by SCE. Five solar thermal projects totaling 2,750 MW are under review by the BLM or CEC.

PAYING FOR ROADS AND SERVICES

Each county is dealing with the impacts of these projects in different ways. Riverside County is concerned about the impacts the projects will have on emergency services, health and human services, and roads, some paved to minimal standards. George Johnson, Riverside County's director of the Transportation and Land Management Agency, said the county will experience a loss of open space, recreational activities and visual impacts in what is now largely undisturbed land in the eastern part of the county where 900 MW of solar thermal projects are approved for construction plus another 2,400 MW are on record as being in development. Another 1,500 MW of solar PV projects under development would be located throughout the county if they are eventually constructed.

To deal with these impacts, the Riverside County Board of Supervisors is considering imposing a franchise fee on large solar projects. They first proposed a 2% fee but First Solar objected saying it would cost their 550-MW Desert Sunlight PV project $3.4 million. It reached an agreement with the county to pay $600,000 a year instead. County staff is still evaluating a franchise fee for other projects.

Counties have been forced to innovate in order to process the large numbers of applications they are seeing. Craig Murphy, a planner in Kern County's Planning and Community Development Department said instead of hiring a consultant for each project they hired two under master contracts to streamline the process and speed up the review of the 12 projects they've already approved and the 25 now in review. Another 12 applications have been received and are waiting for review. The 49 projects represent 3,204 MW.

Murphy said mitigation fees to cover public impacts, such as injuries requiring medical intervention, vandalism, or fire protection services could not be calculated for solar projects as they are for other businesses because of the large land required for solar PV systems. Murphy said the department met with developers and developed a fee of $25.00 to $30.00/1,000 square feet/project.

Murphy said the economic impacts of solar and wind development in Kern County are unknown at this point, and noted state law has exempted solar panels from reassessment of property values, which reduces tax revenues the county will take in.

Armando Via, director of planning for Imperial County, a largely desert area located in the southeastern corner of the state, admitted the surge of solar PV permit applications is a new animal for his department. The planning department has 19 projects representing 3,659 MW currently under review. It reviews projects that are to be located on non-federal land.

There are economic impacts when setting aside large amounts of land for solar development that displace agriculture, Via said. The department has developed a model that determines how much economic value a solar project will have for the county and measures that against the agricultural benefits of, for example, growing 1,000 acres of alfalfa.

Via said doing the math on the first project the county approved showed it was a wash – there was almost no difference in the economic value of the two. He explained that because of the tax exemptions solar enjoys, only a portion of the equipment required in a project, such as inverters and transmission lines, is taxable, making $30 million to $40 million taxable at 1% to 3% on a $100,000,000 project. He explained that improvements on property being farmed will bring in the same 1% in taxes.

A DARING HYDROGEN PLANT

Hydrogen Energy California was first announced in 2007 and new ownership has taken over the very expensive project located in Kern County. SCS Energy is acquiring the project from BP Alternative Energy North America and Rio Tinto Hydrogen Energy which have already invested $110 million in the project. The US Department of Energy awarded the project $408 million in federal stimulus funding under the Clean Coal Power Initiative and it has already received $55 million.

The intent of the project was and is to produce hydrogen from gasified petroleum coke or coal which in turn would generate 380 MW in a combined cycle plant. The carbon dioxide produced in the combustion process would be captured, stored and used nearby for enhanced oil recovery. SCS Energy intends to change the design of the plant. Hydrogen would be used to produce urea in addition to or instead of electricity, depending on market demand for both. Urea is widely used in fertilizers for agriculture

SCE spent $30 million beginning in 2007 to study the feasibility of the project when the Southern California city of Carson was announced as the location. It was then moved to Kern County when Oxy Elk Hills expressed interest in the project. It has agreed to buy approximately 90% of the CO2 emitted by the plant's combustion cycle. Oxy would inject the CO2 into the Elk Hills Reservoir adjacent to the HECA site where it will be used for enhanced oil recovery.

HECA submitted an application for certification to the CEC in July 2008. After moving the project site to avoid endangered species habitat, HECA submitted a revised application in May 2009.

The CEC staff issued Part 1 of a preliminary staff assessment in August 2010 and promised that the remainder of the assessment would be released by the end of the year. However, it has not appeared and a CEC staff letter indicates there are many outstanding questions still to be answered by HECA relating to air quality, biological resources, land use, project description, among other items. It is also waiting for a description of the new design.

Jim Croyle, CEO of Concord, Massachusetts-based SCS Energy, would not comment on the size of the company's financial investment in the project. He said in May the company has just signed a purchase and sale agreement and would have more to say later.

Jonathan Briggs of HECA said in a statement, "Our major obstacle to moving forward has been attracting new investors that can provide a wider platform of interest and capital for the development of this pioneering project. We have benefited from strong support from local communities where the project would be built."

SCS Energy's job is to ensure the project will qualify for the remaining $354 million in DOE stimulus funding. According to a May 23 announcement, DOE is working with BP, Rio Tinto and SCS Energy to ensure HECA can access that remaining funding.

PERSPECTIVE

DESIGN THROUGH COLLABORATION

BY BRIAN SEAL, EPRI

An important part of the smart grid vision is enabling communication-connectedness with residential devices so that they can be informed of grid conditions, including energy price, critical peaks, and other curtailment events. Informed devices may respond by reducing consumption or delaying their operation until another time, according to the preferences and settings of owners. Communication to intelligent devices, rather than cutting their power off with a remotely managed switch, provides more flexibility for consumers and allows manufacturers to innovate, discovering creative ways to maximize energy savings while minimizing user inconvenience.

Many different communication architectures and technologies are presently being used and several new ones are being considered for integration of residential loads. Grid information may reach the home through diverse means (e.g. AMI system, cellular, FM radio, Internet, paging, powerline carrier, etc), each being optimal under different utility circumstances. At the home, these signals may be received directly by individual end devices, or may end at the meter or an energy management console that passes information along to local devices using a secondary communication system. Another possibility, particularly in the near term, is that consumers may prefer to stay on a flat rate and not to receive or respond to utility signals at all. These consumers would not require any demand response (DR) communication and may not be willing to pay more for products that have such capability.

The natural difficulty in providing products to serve such a diverse market is compounded by the fact that the end products may serve for 20, 30, or even 40 years whereas communication technologies are evolving much faster. In addition, consumers may relocate from one utility service territory to another, taking their products with them. When homes are bought and sold, some equipment is left behind, and new occupants may have very different interest in demand response programs than those who originally selected the equipment.

A practical way to address this problem is through the definition of a standard modular interface that enables products to be compatible with any demand response system through user-installable communication modules. If standardized and broadly adopted, this kind of socket interface would enable utilities to freely choose and evolve their communication systems, while maintaining compatibility with all end devices. Similarly, consumers would be free to select and employ the kinds of systems they prefer, or none at all, without having unnecessary or undesired costs passed their way.

DESIGN THROUGH COLLABORATION

Two years ago, EPRI began a research project to study this concept in depth. The project was designed to bring together end device manufacturers, communication system providers, and utilities in balanced representation. The group was provided with a blank slate, and the challenge to identify the characteristics and capabilities that a modular interface must have in order to satisfy the interests of each stakeholder group and to equally support the wide range of systems and devices from the simple to the complex. Participation was open, free of charge, and free of commitment. Over the course of the project, participation grew to over 150 individuals representing 65+ companies.

Throughout the project, coordination with related industry activity was carried out through presentations, interviews, and cross-participation in working meetings. Applicable bodies of work were studied by the project participants and beneficial elements were incorporated into the work. The final design was influenced by elements from the ClimateTalk Alliance, the ZigBee Smart Energy Profile, Cambridge Consultants' Universal Metering Interface, AS-4755, the MODBUS protocol, and the Serial Line Internet Protocol (SLIP).

The most significant point of coordination was with the USNAP Alliance, where a liaison agreement was put in place that allowed open information sharing between the two groups. The EPRI project and the USNAP Alliance were formed at about the same time, completely independent of one another, but with the same basic vision of a single universal standard for modular communication. The similarity of visions has made the exchange of information and design ideas beneficial to both groups over the course of the project.

PROTOTYPING AND INTEROPERABILITY TESTING

Once the participants in this initiative had completed the development of a specification, several volunteered to produce prototypes for testing and evaluation of the work. The prototypes included a range of end-device products including multiple thermostats and water heaters, an HVAC unit, a pool pump, load switches and a hub/gateway device. Communication modules were also diverse; including a wireless mesh AMI, a tower-based AMI, pager, FM, and others. These communication systems supported a range of demand response methods, including price-based and direct load control scenarios.

In May 2011, these prototypes were brought together at an interoperability workshop hosted by Southern Company at Alabama Power's Technology Applications Center. The workshop provided an opportunity for each communication module and associated demand response system to be evaluated with each end device, with the goal that every combination would work without requiring any modifications or reprogramming of the elements involved. This goal was achieved, with every pair demonstrated to work properly by the close of the workshop.

DEMONSTRATED ARCHITECTURAL FLEXIBILITY

A modular communication interface enables a wide range of communication architectures. For example, some consumers may want to employ an energy management console, while others may prefer that utility signals pass directly to the end-device. A modular interface allows a single end-device to be equally compatible with both architectures, unaffected by the consumer's preference or the associated diversity in communication technologies. Likewise, a modular interface allows the utility to be unconcerned with the architecture or communication technologies that customers may choose to employ inside their own homes. This concept was demonstrated in the recent interoperability workshop by a gateway device that received the range of communication modules and managed a group of downstream devices on a CliimateTalk network in response to the signals received from the utility.

Another example of how a modular interface provides flexibility was demonstrated by a plug-in module that monitored the local AC service voltage through the interface connection. When the voltage (or frequency) dropped by a predetermined amount, this module instantly sent load curtailment signals to the end device. This functionality, which could be incorporated into any communication module, enables a wide range of ancillary, grid-stabilizing functions. Because the thresholds and action are initiated by the communication module, optimal behaviors can vary regionally or be modified over time, without impacting the consumer's end-device. This ability is particularly important because the range of normal voltages and frequencies of the power system differ greatly from region to region and are anticipated to vary more going forward, with increased presence of intermittent generation, islanding, and conservation voltage reduction. It is impossible to build fixed dynamic behaviors into an appliance today that will be optimal in each locale, and over 30 years.

PATHWAY TO A UNIVERSAL OPEN STANDARD

In order to be of significant industry benefit, a modular interface specification must become a universal open standard. If such a standard were created and broadly adopted, an economy of interoperable devices would become increasingly viable. Toward this goal, the NIST Home to Grid Domain Expert Working Group (H2G DEWG) requested in early 2011 that EPRI and the USNAP Alliance merge their respective works into a single specification so that it can be contributed to a dejure Standards Development Organization (SDO). Both EPRI and the USNAP Alliance were receptive to the request and have since worked to produce a unified specification, drawing the best characteristics from each body of work. The activity progressed quickly, due to the similarity of the high level goals of the two groups of participants.

The merged work was completed in July 2011, and is presently being reviewed by the H2G DEWG. Once the review is complete, this work will be contributed to a NIST-selected SDO. The companies that have been participating in this research, prototyping and testing have expressed a willingness to remain involved in the standards process. Candidate SDOs have estimated processes in the 9 to 12 month timeframe from receipt of the initial contribution to release of a first version specification.

EPRI is currently launching a Phase 2 project, scheduled to coincide with the steps of the SDO process. This project will be centered on building and testing prototypes to continuously evaluate the specification as it progresses through the SDO process. Continued prototype development by independent sources is necessary to identify gaps and ambiguities in the standard as it is finalized and to guarantee interoperability of products. This Phase 2 project will contribute to the development of a general test harness to provide support for product developers and for device evaluation relative to the standard. In the long term, this test harness may be contributed to a users-group or vendor alliance, such as the USNAP Alliance, that could provide ongoing product testing and certification. Anyone interested in participating in this project, producing prototype communication modules or end-devices, is invited to do so. EPRI may be reached at askepri@epri.com.

PROSPECTS FOR ELECTRIC VEHICLES

BY WESLEY SYMANK AND HIND FARAG

Wesley Symank

Hind Farag

Growth in electricity demand during the next 10-15 years stemming from a massive wave of new hybrid and all-electric cars is becoming more of a dream and less of a real possibility. The range of perspectives has always been fairly diverse, with a wide range among prominent forecasts of electric vehicle sales. Although enthusiasm among many in the industry was widespread at first, the realization of several obstacles to transport electrification have since become more evident. Over the past year, Wood Mackenzie has been refining its view on the prospects of electric vehicles; and as ours has consistently been lower than other forecasts, we maintain that this estimate is still very achievable.

Perceptions are changing now that early experience with government subsidies is being reconsidered globally. China offered subsidies of up to $9,370 in five cities on a trial basis, but has had very little interest from buyers and that policy is now being questioned. The $7,500 tax credit offered in the US is comparable, yet is set to expire after the first 200,000 units sold by each manufacturer. President Obama's goal of one million electric vehicles on the road by 2015 might be very difficult to reach unless at least five manufacturers achieve a successful product launch within the next couple of years. Currently we can name only two in the running, Nissan and GM and the fate of these remains very tenuous.

An appraisal based on the trend in sales of the Volt and Leaf would be inconclusive at this early juncture. GM sold 2,870 Volts in the first seven months of this year, while Leaf sales in the US totaled 4,806. Nissan and GM both set sales goals for this year of 10,000 units. GM maintains that the 10,000 number is still achievable, even with just four months remaining. What draws more attention are manufacturer projections. For example, GM is ramping up production in anticipation of a big jump in sales next year to as many as 60,000 vehicles. This kind of acceleration outpaces even the historical pattern of growth for the Prius which grew at just a little over 30,000 per year for the first several years after initial release.

Regardless of near term acceleration in electric car sales, the U.S. government has invested $2.4 billion in research and development to improve EV batteries and another $300 million in grants, mostly to fund infrastructure projects at major cities to reduce oil consumption. These investments are more likely to pay off in the long term. Wood Mackenzie's integrated research across the energy sector, particularly the oil markets, applies significant consideration to the projection of aggregate sales. Our research contemplates ten million plug-in electric vehicles on the road in North America by 2030, with an associated increase in electricity demand of up to one half percent. The rate of sales, although highly influenced by changing consumer attitudes and preferences, which are decidedly unresolved at this point in time, will also be largely affected by the financial side of the equation which is expected to improve on a number of fronts for such a scenario to materialize. From declining battery cost combined with greater energy storage capability to the rising price of oil, the upfront premium paid for an electric vehicle is expected to become less of a detractor over time.

One of the more prominent government sponsored infrastructure projects is the EV Project managed by Ecotality. The focus of this project is to install charging infrastructure, more commonly referred to as electric vehicle supply equipment (EVSE), in 18 major cities and metropolitan areas in 6 states and the District of Columbia. By the winter of 2011, approximately 14,000 Level 2 (240 volt) chargers and approximately 400 DC Fast Charger ports will be installed.

The prospect of peak charging is a real concern for electricity providers. Although expected incremental energy demand from plug-in electric vehicles (PEVs) is a few percentage points at most, the timing and geographic concentration of demand could indeed affect reliability. Given the substantial investment required to roll out EVSE, it is reasonable to assume the vast predominance of public charging infrastructure will be limited to the top twenty or so major metropolitan areas. Such load centers, in many cases are already transmission constrained. Beyond the geographic location of future PEV charging, the key question is what will the daily and hourly charging profile look like.

Consumer charging patterns remain a key uncertainty. Originally the widely held belief was that a predominance of charging would occur during off-peak hours (evening and overnight) as commuters return home and plug-in their vehicles to recharge for the following morning commute. While this remains a central premise, the earlier presumption that charging would take 8-10 hours or more has been set aside.

Several important issues surrounding the characteristics of EVSE infrastructure and consumer charging behavior come to the fore as we recognize the potential for higher-intensity charging to achieve a full charge in much less time. In particular, Level 2 (240 volt) charging, which is four times as fast as the standard plug-in application, is expected to become more of the norm. In the public realm, it is foreseeable that even higher voltages and DC Fast Charging would eventually become more commonplace. The instantaneous electricity demand of these devices ranges from about 6.5 kW for the 240 volt charger to 65 kW or more for the fastest charging systems. Yet it is likely that only Level 2 charging would be available within the home setting. This means that even off-peak charging could come at a faster pace, drawing more instantaneous energy from the grid, which is why consumer behavior is so important to consider in predicting hourly demand.

The significance of electric vehicles in terms of incremental peak demand will largely be driven by the progression of managed charging. Several key issues pose as headwinds to optimized charge timing. One is the fact that in a future world where electric vehicles gain popularity, gas prices would necessarily be much higher than they are today. And in this setting, even more so than today, the variable cost advantage of consuming electricity for transportation is such that even discounted off-peak electricity would offer less motivation. The potential consequences of missing an opportunity to recharge would prove vastly more expensive for those who delay charging as they could find themselves consuming more gasoline. As a precaution, most drivers would prefer to keep their batteries in the highest reasonable state of charge. Consequently, we expect the timing of vehicle charging initially will be closely correlated with commuter arrival time at home in the evening, which roughly coincides with peak electricity demand. Managed charging programs will gain momentum over time, but will only reduce, not eliminate, the preference for more convenient on-demand charging.

Another interesting aspect of managed charging is the propensity of customers to self-select among the various rate schedules offered. We anticipate the aggregate hourly demand profile of vehicle charging will be dominated by a few primary charging habits. For instance, we envision an uncontrolled profile which would allow customers to charge immediately upon arrival at home, resulting in maximum charging between 5 and 9 in the evening. A simple controlled charging profile such as an off-peak, two-tier pricing program would motivate charging to commence at 9 pm resulting in a surge of demand that declines over subsequent hours. And with technological advances related to smart metering, an intelligent profile capable of responding to real-time prices would eventually emerge. Early versions might result in a demand surge sometime early in the morning as the onboard charging optimizer attempts to ramp up charging in advance of higher prices. Consumer adoption of this profile would probably increase as you go further out in time, but likely wouldn't be anywhere near 100 percent, even twenty years from now. The end result, after combining various rate schedule-related PEV demand profiles is that PEV demand would be a lot lumpier than any of the aggregate profiles that have been considered before. And by offering a variety of rate schedules, much of vehicle charging will be shifted away from the late afternoon and early evening, when electricity demand has traditionally reached its peak.

Even though there will only be a relatively small number of electric vehicles over much of the next decade, in Wood Mackenzie's view, more than 90 percent of daily maximum vehicle charging during these early years is expected to coincide with overall peak electricity demand. The picture will begin to change however as more electric vehicles begin to hit the road; yet even in 2020 more than 50 percent of maximum daily charging will coincide with peaks. However, by 2030 less than 20 percent of daily maximum vehicle charging will coincide with overall peak demand for electricity. Increasingly over time, these charging patterns are expected to flatten intra-day loads.

PERSPECTIVE

CHALLENGES IN SOLAR STORAGE

BY JUSTIN ZACHARY, PH.D

The main issue with deployment of renewable energy conversion systems is their intermittent nature. Wind, photovoltaic (PV), concentrated solar thermal (CSP) generate power only when the wind blows and the sun is shining. The electricity produced this way must be put on the grid and consumed immediately. On the other hand, the users expect any time they need electricity to turn it on and use it without any restriction. Unfortunately the peak of electricity production from wind ands solar does not coincide with either the industrial or residential peak demand.

This gap between generation and consumption can not be bridged without energy storage. There are a number of energy storage alternatives, such as pure mechanical (flywheel), electrical, (batteries) underground stored compressed air or pumped water storage facilities. However this paper will concentrate on the heat storage as applicable to CSP.

Any large scale deployment of CSP will not be possible without thermal storage, which offers the capability to shift the power production closer to the peak demand, to minimize fluctuations due to clouds and reduce the consumption of fossil fuel needed for startup. An additional benefit of thermal storage is to boost the plant utilization factor, a key element of any economic analysis.

It should be emphasized that the use of any type of storage requires a larger solar field, where part of the heat generated is not used immediately to produce electricity but transferred to the storage device.

EXISTING SOLAR THERMAL TECHNOLOGY CONCEPTS AND IMPACT ON STEAM PRODUCTION

CSP systems require several components to produce electricity: (1) concentrator, (2) receiver, (3) storage or transportation system, and (4) power conversion device. There are several concepts: trough, linear Fresnel and tower. The type of technology determines which are the most suitable storage systems. Figure 1 summarizes the types of CSP technology and their thermal output; short discussions of each technology follow.

TROUGH

The parabolic trough is considered the most proven CSP technology. It is basically a very large curved mirror designed to concentrate the solar energy and reflect it onto a linear focus. The mirror position follows the sun movement in the sky using a motorized device. A receiver tube is located at the focal point of the parabolic mirror. Flowing inside the tube is a conventional heat transfer fluid (HTF), which absorbs the energy from the concentrated sunlight and passes the heat to steam in a heat exchanger. (see Figure 2)

The main disadvantages of trough technology are related to (1) the maximum HTF temperature, which really dictates relative cycle efficiency, and (2) the complexity of having an additional heat exchanger between the steam and the fluid heated by the sun.

LINEAR FRESNEL

The linear Fresnel solar collector is a line focus system similar to the parabolic trough. Unlike troughs, however, it uses an array of nearly flat reflectors to concentrate sunlight. The receiver employs one or more tubes located above the mirrors at a determined height. Water or a mixture of water and steam flows within the tubes. At the end, the water and steam are separated and saturated steam is produced either for process heat or to generate electricity Figure 3 shows a linear Fresnel installation.

SOLAR TOWER

In this concept, a boiler on top of a tall tower receives concentrated solar radiation from a field of heliostats, two-axis tracking mirrors. The heat transfer media could be water or steam, molten salt, liquid sodium, or compressed air. In the more conventional arrangement, the working fluid is water. (see figure 4) The design requires accurate aiming and control capabilities for the solar field heliostats to maximize efficiency and avoid potential damage to the receiver on top of the tower.

THERMAL STORAGE OPTIONS

Let review the state of the art for existing and under development storage methods. They include a variety of technologies and materials, with specific characteristics, applications and performance. (see Figure 5). However irrespective of the storage technology, there are temperature differences between the charging and discharging modes of the storage medium and therefore the final steam temperature going to the turbine is lower, when the heat is coming from storage than directly from the solar field.

WATER AND STEAM

The use of water as the storage medium and working fluid eliminates the need for heat exchangers between the two different media. This type of storage has a small capacity but can provide a high output and very rapid response time. It is mostly used as buffer storage for transient events such as passing clouds over the solar field. The device is a pressurized tank containing water. During charging mode the process steam is fed inside the vessel and through condensation heats the water. In the discharging mode the tank is depressurized and the saturated steam generated is returned to the process. Constant-pressure operation of the system is not possible since the temperature of the water in the tank decreases continuously during the discharge mode. Any increase of the tank size and operating pressure could significantly affect its cost.

MOLTEN SALT

This is the most proven technology in troughs (SEGS I) and tower (Solar Two and Andasol 1). It uses as the storage material a mixture of sodium(60%) and potassium (40%) nitrate salts. There are two tanks: one hot and one cold. During the charging period the salt from the cold tank, at about 290C, is pumped through a heat exchanger where the heat from the trough heat transfer fluid (HTF) heats up the salt. The salt is then stored in hot tank at approximately 390C. During the dis-

(continued page 22)

Figure 1. Summary - CSP Solar Technologies

Technology Type	Working Fluid	Maximum Temperature (°C)
Trough	Synthetic Oil HTF	395
Linear Fresnel	Superheated Steam	310
Solar Tower	Superheated Steam	545

Figure 2. Solar Trough Technology

Source: Solel

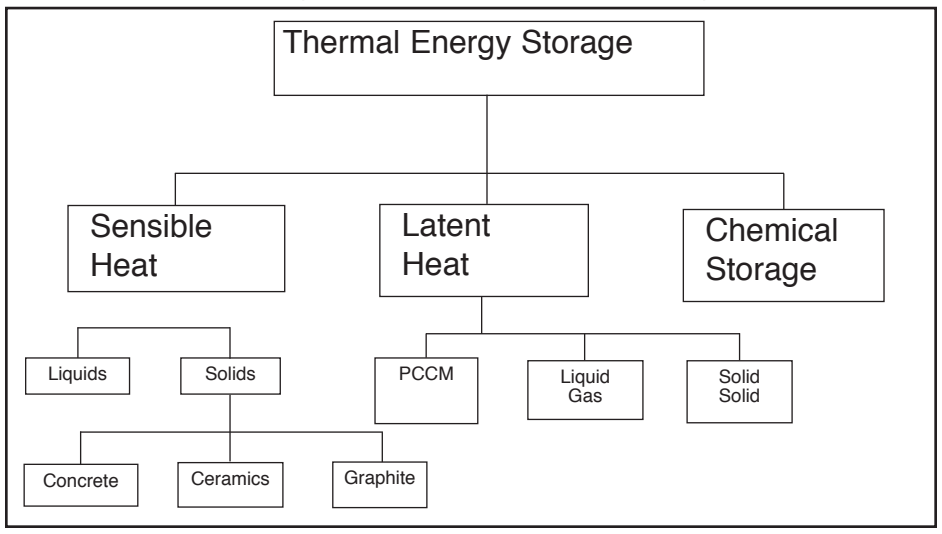
Figure 3. Linear Fresnel Technology

Source: Ausra

Figure 4. Solar Tower

Source: BrightSource

Figure 5 – Options for Thermal Storage



BUILDING ENERGY EFFICIENCY

BY LISA WOOD, PH.D.

Building codes and appliance standards are two policy mechanisms that provide the potential to create energy-saving opportunities for utilities and their customers.

In looking nationwide, a recent whitepaper by the Institute for Electric Efficiency, Assessment of Electricity Savings in the U.S. Achievable through New Appliance/Equipment Efficiency Standards and Building Efficiency Codes (2010-2025), found that tightening energy codes for new buildings and efficiency standards for appliances could potentially offset the country's future electricity use by between nine and 14 percent by 2025, relative to the Energy Information Administration's Annual Energy Outlook 2011 baseline forecast.

STRENGTHENING BUILDING CODES

Today, national standards organizations establish building energy codes, and state and municipal governments voluntarily adopt them. As a result, the opportunities for electric utilities to get involved in the energy code process will vary across states and regions. A new IEE white paper, Making Building Energy Codes and Appliance/Equipment Efficiency Standards Part of Utility Energy Efficiency Portfolios, outlines the different facets of the building code process and presents a range of engagement options for utilities. These are:

- Development—Once a state adopts a building energy code, utilities can help in the design of code language and cost effectiveness testing. Simplified code language is generally preferred as a simple code tends to be better enforced than a complex code.
- Adoption—If the current code lags readily available codes, utilities can actively support and promote the adoption of new building energy codes.
- Training—Utility training programs, such as role-based training, and the distribution of training materials to the building design and construction community are an effective way to educate and train key participants in designing and building structures to code.
- Compliance Enhancement—A primary issue with building codes is low compliance rates. There are a number of options for utilities to become engaged with building code compliance efforts. For instance, a utility can develop compliance enhancement programs, sponsor workshops to improve the training of code inspectors, help administer the programs, or offset the cost of third party administered inspections.
- Awareness—The potential for revisions in both the nation's model energy code and the state or region specific codes requires constant communication among various stakeholders including utilities, state energy offices, regulatory bodies, building professionals, and local code officials. Utilities can play a key role by monitoring changes, convening meetings, and providing up-to-date information to stakeholders.

AFFECTING APPLIANCE AND EQUIPMENT EFFICIENCY STANDARDS

Unlike building codes, the federal government sets national minimum efficiency requirements for a variety of appliances. For products with a standard, electric utilities can help to focus the market by offering incentives on the purchase of products that have a higher than minimum efficiency level.

In the instances when there is no set standard for a product, a utility can work with state regulators to negotiate a baseline efficiency level, and then run programs that support the purchase of products that exceed this baseline. The utility can then claim the incremental energy savings as measured against the baseline. Another, less common approach for a product that is not federally covered is for utilities to work with a state agency, such as a standard setting energy office, to develop a standard.

LEADING THE WAY

Some states and regions—Arizona, California, Massachusetts, Minnesota, and the Pacific Northwest—have already integrated codes and standards into utility energy efficiency program portfolios (or are moving in that direction). These offer potential approaches for getting involved.

APPROACH 1: CALIFORNIA, MASSACHUSETTS, MINNESOTA

CALIFORNIA: A key contribution from the California shareholder-owned electric utilities in advancing building energy codes and appliance/equipment standards are the Codes and Standards Enhancement (CASE) reports that the utilities develop and provide to the California Energy Commission (CEC). These CASE reports evaluate the costs and benefits of pursuing specific energy saving technology measures and help the CEC justify changes to California's Administrative Codes Title 20 (Appliance Codes) and Title 24 (Building Codes).

Once a technology/measure is identified for evaluation, the utility develops the CASE report and collaborates with the CEC throughout the process. Although this process can be lengthy, the utilities' efforts to develop and support increasingly stringent building energy codes and appliance/equipment standards have led to substantial cost-effective energy savings.

Electric utility-supported building codes and appliance standards helped customers to reduce overall electricity demand by 678 gigawatt-hours (GWh) between 2006 and 2009, and peak demand by 123 megawatts (MW). These savings accounted for about 9 percent of the state's total energy efficiency portfolio during that period. For the 2010-2012 program cycle, California is estimating that the codes and standards will generate 837 GWh in total energy savings and 136 MW in peak reductions.

Some states and utilities have begun taking portions of the California approach and tailoring models of engagement to fit the needs of their codes and standards community to meet their energy efficiency goals. Of note are the efforts underway in Massachusetts and Minnesota.

MASSACHUSETTS: The state's 2008 Green Communities Act allows for cities and towns to apply for "green community" status. These communities have adopted building codes that are 20 percent more energy efficient than the minimum statewide energy code. As of June 2011, 95 of 351 Massachusetts communities have adopted the reach codes.

A working group comprised of Massachusetts electric utilities, the Energy Efficiency Advisory Council and the Department of Public Utilities is developing a process that will recognize the role of utilities in supporting codes and standards and provide credit for such savings in meeting energy efficiency goals.

MINNESOTA: In Minnesota, the 2007 Next Generation Energy Act calls for energy savings of 1.5 percent of a utility's annual retail electricity sales starting in 2010. Energy savings from building codes and appliance standards can count towards the annual energy savings goals.

Through an effort funded by the state Department of Commerce and facilitated by the Minnesota Environmental Initiative, a group of stakeholders, including electric utilities, was brought together to fashion a set of recommendations on how codes and standards can contribute to the 1.5 percent goal. Suggestions for possible utility activities include:

- Early-retirement programs for inefficient appliances and equipment.
- Training, testing, and certifying inspectors and providing rebates for inspections.

APPROACH 2: ARIZONA

A second model for a utility to receive credit for its efforts in advancing codes and standards is emerging in Arizona where regulated electric utilities can receive a credit of up to one-third of the savings associated with codes programs.

In 2010, the Arizona Corporation Commission unanimously approved the Electric Energy Efficiency Standard, which requires regulated electric utilities to achieve cumulative energy savings equivalent to at least 20 percent of retail energy sales, plus up to a 2 percent credit for peak demand reductions from demand response programs, for a total of 22 percent by 2020.

In its recommendation, the Commission outlined an opportunity for utilities to count up to one-third of the energy savings resulting from the implementation of building energy codes towards these energy efficiency goals. Savings must be quantified and reported through a measurement and evaluation study undertaken by the affected utility.

APPROACH 3: PACIFIC NORTHWEST

In the Pacific Northwest, the region's electric utilities, the Northwest Energy Efficiency Alliance (NEEA), and the Northwest Power and Conservation Council (NPCC) coordinate efforts to realize energy savings in a four state area. Codes and standards programs are a cornerstone of their successes.

The groups actively participate in the code development process and lead contractor training workshops. Their strategy is to advance energy savings through commercial, industrial, and residential initiatives that are voluntary and are designed to train and inform building professionals on new technologies that can deliver energy savings.

This strategy has successfully developed trained building professionals that can explain the benefits of energy efficiency measures to their customers. As the voluntary approach spreads and benefits are realized the new technologies and practices by building professionals are then adopted by the state code. Of note, Washington and Oregon are two of three states to have ever documented a 90 percent energy code compliance rate across the entire state.

BUILDING FOR THE FUTURE

Energy codes and appliance efficiency standards offer untapped potential for energy savings. Electric utilities, in working with their regulators, legislators, and construction trade allies, can integrate them within their energy efficiency portfolios to create a payoff that will last for generation after generation.

HYBRID SOLAR SYSTEMS

BY RICHARD MERRITT, DUKE UNIVERSITY

DURHAM, N.C. – While roofs across the world sport photovoltaic solar panels to convert sunlight into electricity, a Duke University engineer believes a novel hybrid system can wring even more useful energy out of the sun's rays.

Instead of systems based on standard solar panels, Duke engineer Nico Hotz proposes a hybrid option in which sunlight heats a combination of water and methanol in a maze of glass tubes on a rooftop. After two catalytic reactions, the system produces hydrogen much more efficiently than current technology without significant impurities. The resulting hydrogen can be stored and used on demand in fuel cells.

For his analysis, Hotz compared the hybrid system to three different technologies in terms of their exergetic performance. Exergy is a way of describing how much of a given quantity of energy can theoretically be converted to useful work.

"The hybrid system achieved exergetic efficiencies of 28.5 percent in the summer and 18.5 percent in the winter, compared to 5 to 15 percent for the conventional systems in the summer, and 2.5 to 5 percent in the winter," said Hotz, assistant professor of mechanical engineering and materials science at Duke's Pratt School of Engineering.

The paper describing the results of Hotz's analysis was named the top paper during the ASME Energy Sustainability Fuel Cell 2011 conference in Washington, D.C. Hotz recently joined the Duke faculty after completing post-graduate work at the University of California-Berkeley, where he analyzed a model of the new system. He is currently constructing one of the systems at Duke to test whether or not the theoretical efficiencies are born out experimentally.

Hotz's comparisons took place during the months of July and February in order to measure each system's performance during summer and winter months.

Like other solar-based systems, the hybrid system begins with the collection of sunlight. Then things get different. While the hybrid device might look like a traditional solar collector from the distance, it is actually a series of copper tubes coated with a thin layer of aluminum and aluminum oxide and partly filled with catalytic nanoparticles. A combination of water and methanol flows through the tubes, which are sealed in a vacuum.

"This set-up allows up to 95 percent of the sunlight to be absorbed with very little being lost as heat to the surroundings," Hotz said. "This is crucial because it permits us to achieve temperatures of well over 200 degrees Celsius within the tubes. By comparison, a standard solar collector can only heat water between 60 and 70 degrees Celsius."

Once the evaporated liquid achieves these higher temperatures, tiny amounts of a catalyst are added, which produces hydrogen. This combination of high temperature and added catalysts produces hydrogen very efficiently, Hotz said. The resulting hydrogen can then be immediately directed to a fuel cell to provide electricity to a building during the day, or compressed and stored in a tank to provide power later.

The three systems examined in the analysis were the standard photovoltaic cell which converts sunlight directly into electricity to then split water electrolytically into hydrogen and oxygen; a photocatalytic system producing hydrogen similar to Hotz's system, but simpler and not mature yet; and a system in which photovoltaic cells turn sunlight into electricity which is then stored in different types of batteries (with lithium ion being the most efficient).

"We performed a cost analysis and found that the hybrid solar-methanol is the least expensive solution, considering the total installation costs of $7,900 if designed to fulfill the requirements in summer, although this is still much more expensive than a conventional fossil fuel-fed generator," Hotz said.

Costs and efficiencies of systems can vary widely depending on location – since the roof-mounted collectors that could provide all the building's needs in summer might not be enough for winter. A rooftop system large enough to supply all of a winter's electrical needs would produce more energy than needed in summer, so the owner could decide to shut down portions of the rooftop structure or, if possible, sell excess energy back to the grid.

"The installation costs per year including the fuel costs, and the price per amount of electricity produced, however showed that the (hybrid) solar scenarios can compete with the fossil fuel-based system to some degree," Hotz said. 'In summer, the first and third scenarios, as well as the hybrid system, are cheaper than a propane- or diesel-combusting generator."

This could be an important consideration, especially if a structure is to be located in a remote area where traditional forms of energy would be too difficult or expensive to obtain.

Hotz's research was supported by the Swiss National Science Fund. Joining him in the study were UC-Berkeley's Heng Pan and Costas Grigoropoulos, as well as Seung H. Ko of the Korea Advanced Institute of Science and Technology, Daejon.

FLANAGAN - LESSONS

CONTINUED FROM PAGE 1

nuclear industry's response to events at the Fukushima Daiichi nuclear energy facility. This ensures that lessons learned are identified and that response actions are effectively coordinated and implemented.

This is being accomplished while electric companies continue to ensure that the safe and reliable operation of commercial reactors is their highest priority. An integral aspect of the industry's response is the involvement of the industry's stakeholders: industry, vendors, architect-engineering companies, industry owners' groups and national consensus nuclear standards organizations.

Fertel provided recommendations made by the independent Nuclear Regulatory Commission's Fukushima Daiichi task force. The NRC 90 Day Task force reported that: US plants are safe; continued operation and continued licensing activities do not impose an imminent risk to public health and safety; no changes are required for used fuel storage; made no change in emergency planning zones; and issued 34 recommendations.

"Because what's happened at Fukushima is a broad issue, we've formed an industry leadership organization which is a coordinated effort to capture and apply lessons that emerge from Fukushima. That's an important effort for us to do and stay coordinated," Fertel added.

The seven building blocks along with the lead organization(s) are listed:

1. Maintain Focus on Excellence in Existing Plant Performance (INPO): focus on continued performance improvement of U.S. reactors.
2. Develop and Issue Lessons Learned from the Fukushima Events (INPO): focus on comprehensive analysis of the Fukushima event and that lessons learned are applied to the U.S. nuclear industry and shared with the World Association of Nuclear Operators (WANO).
3. Improve the Effectiveness of U.S. Industry Response Capability to Global Nuclear Events (INPO/NEI): focus on identified lessons learned from the U.S. industry response to the Fukushima event, allowing for more effective integrated response to future events.
4. Develop and Implement a Strategic Communications Plan (NEI): focus on managing the industry's strategic communications and outreach campaigns to recover policymaker and public support for nuclear energy.
5. Develop and Implement the Industry's Regulatory Response (NEI): focus on managing the industry's regulatory interactions and resolution of applicable industry regulatory issues from the incident.
6. Participate and Coordinate with International Organizations (INPO/EPRI): focus on ensuring the results from international investigations are captured and effectively used to inform actions with the other building blocks.
7. Provide Technical Support and R&D Coordination (EPRI/NSSS Owners' Groups): focus on existing technical solutions and research and development activities and deliverables necessary to address recommended actions of this plan.

Other issues require more substantial analysis than has been done—or has even been possible—to date, Fertel cautioned.

"Making sure we don't divert our staffs now from what they should be focused on is also critical. We need to make sure we stay focused on safety right now, not just changing things for the sake of changing things," he said.

The U.S. nuclear energy industry has continued to move ahead with various projects that require NRC oversight, Fertel noted. Since early March, power uprates that improve efficiency and increase a plant's electric generating capacity have been approved at two facilities, and operating license renewals have been approved for nine of the nation's 104 reactors. In addition, construction continues to progress in Tennessee, Georgia and South Carolina on new reactors that should begin operating between 2013 and 2019.

"Our estimate for the past three years has been that, between 2016 and 2020, we were going to add four to eight new reactors in this country. We believe, pre-Fukushima, that was realistic. We believe, post-Fukushima, that is very realistic. Then, as you move out toward the 2050 time frame, you add a lot more nuclear facilities as you replace power plants that retire and as you meet growing electricity demand," Fertel concluded.

PUBLIC OPINION BEGINS TO RECOVER

Public opinion is beginning to recover as shown in the Luntz Global Poll below:

- Slight increase in favorability of nuclear energy: 2009: 64%; April: 46%; July: 50% (66% among opinion leaders)
- 62% of the public favors industry expansion; 29% status quo
- 81% agree US should learn from Japan and license new plants rather than stopping progress entirely.

Marv Fertel is president and chief executive officer of the Nuclear Energy Institute. He has 35 years of experience consulting for electric utilities on issues related to designing, siting, licensing and managing both fossil and nuclear plants.

He has worked in executive positions with such organizations as Ebasco, Management Analysis Company and Tenera. In November 1990, he joined the U.S. Council for Energy Awareness as vice president of Technical Programs. With the formation of NEI in 1994, he became NEI's vice president of Nuclear Economics and Fuel Supply.

Mr. Fertel was named senior vice president and chief nuclear officer in 2003. In that role, he was responsible for leading NEI's programs related to ensuring an effective and safety-focused regulatory process. He directed industrywide efforts to ensure adequate security is provided at nuclear power plants and to address generic technical issues related to commercial nuclear facilities.

He also led NEI's activities related to the long-term management of used nuclear fuel, including achieving success in the U.S. government's program for the storage and ultimate disposal of used nuclear fuel.

SOLAR POWER PROSPECTS

BY H. STERLING BURNETT, PH.D.

DALLAS, TX - The production of electricity from renewable energy technologies is growing much faster than the electric power supply as a whole, and solar power is among the fastest growing segments of the renewable energy market. Indeed, globally, grid-connected solar capacity increased at an average annual rate of 60 percent from 2004 to 2009, faster than any other energy source. In the United States, solar electricity production grew 55 percent from 2004 to 2008, and 15.5 percent in 2009 alone.

Most, if not all of this growth, has been driven by public policies including favorable tax treatment, price supports and direct subsidies for renewable energy by both federal and state governments. In addition, some states have implemented mandates — called renewable portfolio standards — for production and/or use of electricity from renewables (and a number of states demand that a certain amount of the renewable energy produced is solar power). Tens of billions of dollars in public spending and renewable energy mandates have encouraged private investment in solar power. Public and private investment has encouraged innovation and increased production efficiency, reducing the cost of solar panels considerably.

However, even with significant subsidies, solar is still substantially more expensive than conventional power sources in most locations. Thus, it supplies only a small percentage of electric power. Solar power accounts for less than one-half of one percent of the world's electric power output. Analysts agree that if solar power is to become a significant source of electricity, it must compete with more conventional energy sources in markets without subsidies to any form of energy - barriers to the entry of new producers or discriminatory price regulations.

All other factors being equal, if solar is to become a significant power source, it must compete with other energy sources on price.

Currently, even with subsidies solar energy costs between $0.22 per kilowatt-hour and $0.30 per kilowatt-hour. By contrast, the average cost of electricity nationwide is expected to remain roughly $0.11 per kilowatt-hour through 2015.

And how big are the subsidies? Per unit of energy produced, solar is among the most highly subsidized power sources. According to the Energy Information Administration:

- Natural gas and petroleum subsidies amount to $0.25 per megawatt-hour of electricity produced.
- Coal subsidies amount to $0.44 per megawatt-hour.
- Nuclear power subsidies amount to $1.59 per megawatt-hour of electricity produced.
- Solar subsidies amount to $24.34 per megawatt-hour.

And this is before one takes account of state subsidies and the increasingly popular renewable portfolio standards.

Favorable tax treatments, price supports, direct subsidies and state renewable portfolio standards have encouraged private investment in solar power. As noted above, in the United States, solar electricity production grew 55 percent from 2004 to 2008, and 15.5 percent in 2009 alone. Public and private investment has encouraged innovation and increased production efficiency, reducing the cost of solar panels considerably. Thus, over the past 15 years, the cost of solar photovoltaic systems declined by an average of 4 percent per year, whereas the price of electric power has generally risen. In 2009 alone, prices for solar panels dropped approximately 40 percent, largely due to the tremendous growth in China's solar panel production, which resulted in a glut on the market. This shift in production of solar panels to China caused the cost per kilowatt-hour for solar cells to fall. Moreover, the efficiency of solar cells has improved.

As a result, a November 2010, Energy Information Administration report, "Updated Capital Cost Estimates for Electricity Generation Plants," showed that while the costs for natural gas plants remained largely unchanged since 2008 the capital costs for new coal-fired, nuclear and even wind power plants increased considerably — on average, 25 percent higher for coal-fired and nuclear power plants, and 21 percent higher for wind farms. By contrast, solar fell by 25 percent due to increasing economies of scale and falling component costs.

It should be noted that the price point at which solar power is competitive on price varies by location, due to such factors as the amount of sunlight an area receives, the orientation of the solar array, whether the solar arrays are fixed or track the sun, construction costs, rate structure and financing options. As a result, according to the National Renewable Energy Laboratory, breakeven costs vary by more than a factor of 10 in the United States.

The EIA's estimates considered a variety of factors including differences in labor costs and the likelihood of increased costs associated with inflation and policies to restrict greenhouse gas emissions.

Still, even with increased costs associated with coal, nuclear and wind power plants, and substantial declines in the cost of solar, the EIA finds that there is no location where solar's capital costs match or beat any competing electric generating technology, with the exception of nuclear power. For instance, the EIA's national base case projection was an average cost of natural gas of $978 per kilowatt (Kw), compared to $3,221 Kw for an integrated combined-cycle coal plant with carbon capture and $4,755 Kw for a solar photovoltaic plant.

Capital costs are only one factor in determining the viability of competing generating technologies. Solar photovoltaic has lower operating costs than competing generating technologies – though it only beats natural gas when the cost of fuel is figured in. However, solar is associated with much higher than average transmission costs since centralized arrays must usually be built many miles from where the power is in demand. In addition, solar power can only function as a part of a system that has on-demand stabilizing and fill-in power from other sources. Fossil fuel or nuclear-powered generating plants run as spinning reserve at less than peak efficiency in order to be brought on-line if the variable flow from a solar farm falls precipitously over a short period of time. Some portion of these plants' cost should be counted against the solar facility since they make it possible.

When all costs are factored in, arguably, the annualized cost of newly built electricity generating facilities is the most important measure of the viability of solar power.

Solar's annualized cost is significantly higher than almost every other generating technology, due primarily to three factors: a low capacity factor (the relatively small amount of energy it can be expected to deliver daily), higher than average transmission cost and a shorter useful life than comparable facilities. For instance, using EIA data, the Institute for Energy Research, estimates, the average annualized cost of an advanced combined cycle natural gas is $63.10 per megawatt-hour. The average annualized cost of an advanced nuclear plant is $113.90 per megawatt-hour. The average annualized cost of an advanced coal-fired power plant (with carbon capture technology) is $136.20 per megawatt-hour. The average annualized cost of a solar photovoltaic plant is $210.70 per megawatt-hour.

Even accounting for differences in geography, climate and labor costs, for solar power to competitive with conventional generating technologies in the near future would require continued substantial government support and, as importantly, the expectation that such support will continue in order to secure long-term financing and investment.

And there's the rub, under the economic conditions facing governments around the world, the current level of support for solar developments is unlikely to continue.

The United States House of Representatives substantially reduced funding for various renewable technologies in its proposed budget for the remainder of fiscal year 2011. Though all these cuts might not be enacted, less support in this and coming years seems likely from a Congress interested in reducing the budget deficit and national debt.

Support in Europe is already declining. The European Union has been the leader in installing solar. Indeed, from 2007 through 2010, EU countries accounted for more than 70 percent of solar energy demand.

For example, Germany's renewable energy act required utilities to pay generous prices, called feed in tariffs, for electricity produced by renewables. As a result, renewable power grew from 6 percent of generating capacity in 2000 to 16 percent in 2009. However, due to fiscal constraints as a result of the global economic recession, the German government has cut tariffs for large solar power facilities by 25 percent and for individual roof-top solar energy production by 15 percent.

Spain, the world's largest solar power producer, has spent more than €23 billion (about $32 billion) since 2002 supporting the industry. However, the government is reducing support for existing plants by more than 30 percent and for new plants by 45 percent.

France, the United Kingdom and Canada either have or are considering cutting their subsidies to solar power.

Even demand driven by renewable portfolio standards are under threat. Some state legislatures are considering transforming renewable portfolio standards into clean energy standards, which would allow natural gas, clean coal or nuclear generated electricity to count toward the overall energy goal. If this occurs, solar demand will further decline.

Thus, it seems unlikely that solar power costs will continue to decline at the historically high rates they have in the past couple of years. The decline in solar generated electricity prices will arguably return to its historic average of 4 percent per year. If it does, all else equal, it would not become cost competitive in most locations until after 2020.

AN INTELLIGENT POWER GRID

BY DAVID MASTERS, MANAGER, TECHNOLOGY DEPARTMENT, DUKE ENERGY CORP.

America's electrical grid is nothing short of an engineering marvel. This complex, interlinked highway of electrons – consisting of at least 9,200 power plants and 300,000 miles of transmission lines – delivers power to hundreds of millions of people in their homes and work places. But the grid, more than a century old, is now under tremendous strain as our energy use surges. In recent years, efforts have intensified to modernize the grid – that is, to make it "smarter." The goal is to create a more reliable, efficient and cleaner system, rather than just build more new, expensive power plants.

These ongoing efforts are significant, innovative and are being developed. But what if we took a bolder, more imaginative approach to dramatically transform how the grid generates, transmits and distributes electricity from coast to coast? The result might be the completely digital system that Duke Energy is exploring.

"IPHONES" ACROSS THE NETWORK

Duke Energy's digital system is a 21st century end-to-end intelligent network that is able to collect, organize and analyze vast amounts of detailed and reliable information. This system will use communications nodes – let's say, an iPhone of sorts for the modern grid – that can transmit data between multiple devices, such as transformers and smart meters, send information to workers with mobile devices, and route data back to a central location or to other nodes for more analysis and action. This flexibility enables utilities to better manage the system, resolve problems as they arise, and, in some cases, prevent outages before they occur. .

These nodes, based on open hardware and software architecture, would exchange data through various, secure wired and wireless networks, including cellular, Wi-Fi or powerline communications. The nodes would also have the storage and processing power to integrate new and emerging applications and technologies. Additionally, there would be one set of rules or standards to manage this data instead of creating several for individual or vendor data. This approach beefs up overall security of the network.

There are certain attractive advantages with nodes compared to current technology deployments. As the amount of data on the grid grows exponentially – and it will – these nodes will be able to collect and analyze information locally, reducing traffic across the entire system. The system would also have the elasticity to integrate new analytical capabilities as they become available. This will be important as the industry employs greater use of data analytics to help identify new data patterns and discover new uses that will benefit consumers.

NO SINGLE TECHNOLOGY

A key philosophy underpinning the foundation of the network is that no single technology can cover or meet the needs of all customers. Using different wired and wireless technologies to collect and stream data through wide area networks (WAN), local area networks (LAN) and node-to-node communications will help utilities better manage the grid and deliver more efficient services. The different technologies provide the flexibility to connect to various devices, fill in spotty coverage and ensure communications redundancy.

This intelligent network will rely primarily on 3G cellular networks through a WAN for several reasons. They are ubiquitous, provide state-of-the-art secure data transmission and are based on existing standards. Cellular technology uses Internet-based protocols as the transport layer, meaning high-speed, near real-time communication is possible. It also makes sense to leverage the technology since wireless operators are investing billions of dollars to continuously improve their network infrastructure and provide backwards compatibility.

Why should utilities spend billions themselves to build something from scratch when they can harness the existing expertise and capabilities of a proven technology at a fraction of the cost? Duke Energy is currently collaborating with a cellular company to develop an innovative pricing and operations and maintenance model to support grid requirements and reduce overall costs.

Our plan also envisions using other technologies, such as 802.11 Wi-Fi mesh, powerline and 900 MHz, through LANs. This will provide connectivity to end devices, such as meters, sensors, capacitor banks and in-home devices. Similarly, some of these technologies can also be used in a node-to-node, or N2N, environment that could reach more nodes within a small geographic area. These communication capabilities would allow nodes to collect and analyze data for all devices without having to go through a WAN and provide redundancy.

GAINS FROM THE GRID

The benefits from a digital network would be considerable. For example, we don't do an effective job of detecting and fixing problems as they occur. However, if we embed intelligence throughout the system by integrating advanced technologies as part of a larger digital communications platform, we could address problems as they arise. Or, better yet, prevent them before they do. Valuable data relayed across the system would better inform energy companies about the grid's condition. This means they could detect and mitigate overloads more quickly, assess and repair power outages and provide customers with more information and control to manage their energy use. . This could reduce overall costs and prolong the life of equipment.

Other examples of specific applications that could be developed over time include:

- More effective monitoring and forecasting demand for electricity, meaning utilities would be better able to adjust demand during peak times based on near real-time information.
- Better ability to detect and investigate potential theft and fraud in the grid that could improve efficiency and reduce costs.
- Voltage sensors in transformers and meters that can generate reports indicating voltage regulation problems.
- Transformer overload monitoring that can provide real-time alerts.
- Devices to measure currents, including identifying and locating faults.
- Remote configuration and control over capacitor banks and regulators to reach power factor and voltage objectives on the grid.
- Streetlight monitoring to ensure proper operations.
- Remote and real-time identification of where plug-in electric vehicles may be located and charging.

Again, utility companies would have a greater amount of information at their fingertips coming from various devices – such as smart meters, sensors and self-healing technologies – that would be managed by these nodes. The system also would be flexible enough to incorporate renewable forms of energy like wind and solar. It would also serve as a catalyst for greater use of electric vehicles and plug-in hybrid vehicles that could lessen the nation's dependence on foreign oil.

A MORE ENERGETIC FUTURE

Currently, there are hundreds of ongoing smart grid projects to install smart meters, sensors and communication technologies to help consumers use less energy and save more money. In fact, Duke Energy has been deploying this technology in Ohio for more than two years. But these steps are just smaller pieces of a much larger, more intricate and costlier puzzle.

The Electric Power Research Institute recently estimated that modernizing the U.S. electricity system could cost upwards of half a trillion dollars over the next 20 years. However, the nation could see benefits between $1.3 trillion to $2 trillion over that time in terms of greater energy efficiency, improved reliability and security and smaller impact to the environment, among others. The Obama administration recently outlined a strategy to spur the smart grid advancement and has provided billions of dollars of grants matched by the private industry to accelerate the upgrade. More than two dozen state governments also have adopted smart grid policies.

The challenge is daunting and energy companies must step up to meet the needs of their customers. The biggest hurdle is educating ourselves about what capabilities are out there and what's coming down the road. Rather than doing it on their own, utilities will need to collaborate with multiple vendors, including cellular companies, to leverage their existing expertise, proven technologies and infrastructure instead of building something from scratch. Our concept is a network infrastructure built upon using existing technologies that will be more cost-effective in the long run. But it will also be more adaptable to new and emerging technologies. Over the long haul, the transformation to a smart digital power grid will result in companies providing cleaner, cheaper and more reliable sustainable electricity.

David Masters is Duke Energy's manager for technology development. He recently authored a white paper, titled Developing the communications platform to enable a more intelligent electric grid, which is available for download at http://www.duke-energy.com/pdfs/OP-David-Masters-SmartGrid-Comm-Platform-02-01-11.pdf.

About the Author:

David Masters is manager, technology development for Duke Energy. He is responsible for the development and application of "Smart Grid" and telecommunications networks to assist the "Smart Grid" technologies in support of Duke Energy's strategic objectives. He was named to his current position in October 2006.

Previously, Masters served as director of business development and director of operations for DukeNet Communications, a Duke Energy communications subsidiary. Other roles include data communications supervisor and telecommunications engineer for Duke Power.

Prior to joining Duke Energy, he served five and a half years in the United States Air Force in the telecommunications field. Masters has been employed by Duke Energy for twenty-six (26) years, primarily in telecommunications roles.

MINTS - SOLAR ON THE CUSP

CONTINUED FROM PAGE 1

example, in some cases industry size is defined by announcements of projects, or by non-transparent state or country databases, or, by installations, manufacturer capacity or shipments to the first point of sale in the market.

In the 2005 through 2010 five-year period, shipments to the first point of sale in the market, increased by a compound annual growth rate (CAGR) of 65%. The first point of sale in the market can be an end user, a distributor, an installer or another manufacturer.

Installations tend to lag demand, however, in recent years with growing levels of inventory on the demand side, installations have in some cases exceeded annual demand levels. In general, the calendar year begins with some level of inventory from the previous year. This excess inventory is then absorbed, typically. In the 2005 through 2010 five-year period, installations (for all applications) increased by a compound annual rate of 73%.

In 2010 installations exceeded demand by 109.2-MWp, indicating that most of the inventory from 2009 was absorbed. During the end of 2010 there was significant buying, again leading to inventory, much of which was resold during the beginning of 2011.

On an annual basis, accelerated growth in the photovoltaic industry continued in 2010 at 120% over the previous year, from 7.9-GWp to 17.4-GWp. In 2011, despite a flat first half, growth is expected from 4% (conservative) to 27% for the accelerated forecast.

GRID CONNECTED DEMAND

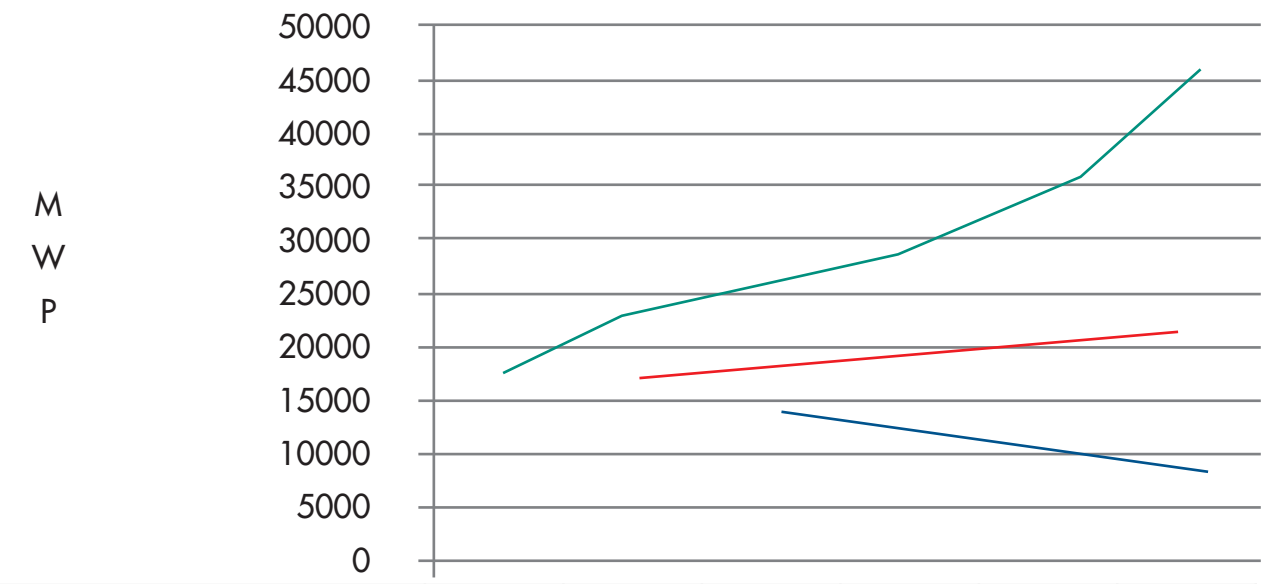
The grid-connected application, in the aggregate, grew by a compound annual rate of 71% during the 2005-2010 five-year period. This strong growth is entirely due to the feed in tariff incentive model. Now that this model is undergoing changes that a) make it a less profitable investment (lower IRR) and b) insert instability, strong growth going forward should not be assumed.

Nor can the solar industry be considered mature, at which slower growth is normal. The grid-connected application continues to require incentives in order to grow profitably. Without support, and likely even with it, prices will be artificially low, and there will be little incentive and costs will be cut in areas such as installation practices. Cutting costs in this regard will lead to substandard installations along with mind-share damage to a young industry that can ill afford it.

In addition, high levels of inventory will continue to obscure the true market picture as these data high levels of ship-

(continued page 22)

FIGURE 1
GRID-CONNECTED HISTORY AND FORECAST • 2010-2015



	2010	2011	2012	2013	2014	2015
Reduced Incentives			13300.1	10968.2	10137.9	8983.2
Conservative Grid Connected		17804.2	18694.4	19255.2	20025.4	21026.7
Accelerated Grid Connected/History	17119.4	21741.6	24785.4	28503.2	35629.1	46317.8

TABLE 1
REGIONAL DEMAND GROWTH 2005-2010

Region	2005	2006	2007	2008	2009	2010	CAGR 2005-2010	2010 Installations MWp	% Installations of Demand
Europe	676.1	1093.9	2178.7	4338.5	6568.0	13944.1	83%	14241.0	102%
% Total	48%	55%	71%	79%	83%	80%			
Asia	453.8	506.2	376.8	549.2	561.8	1219.9	22%	1640.9	135%
% Total	32%	26%	12%	10%	7%	7%			
North America	140.8	226.2	318.1	395.4	553.9	1566.2	62%	982.3	63%
% Total	10%	11%	10%	7%	7%	9%			
West Asia	49.3	67.5	76.8	87.9	79.1	52.2	1%	50.1	96%
% Total	4%	3%	2%	2%	1%	<1%			
Oceania	21.1	26.4	43.0	43.4	35.6	365.5	77%	358.5	98%
% Total	1%	1%	1%	1%	<1%	1%			
Southeast Asia	19.7	23.8	27.7	28.9	31.7	104.4	40%	93.0	89%
% Total	1%	1%	1%	1%	<1%	<1%			
Latin America	21.2	17.9	22.4	19.8	27.7	60.9	24%	48.6	80%
% Total	2%	1%	1%	<1%	<1%	<1%			
Central & Southern Africa	18.3	15.9	21.5	19.2	23.7	17.4	-1%	17.2	99%
% Total	1%	1%	1%	<1%	<1%	<1%			
Middle East	5.6	5.0	5.5	6.6	27.7	69.6	66%	68.3	98%
% Total	<1%	<1%	<1%	<1%	<1%	<1%			
North Africa	1.8	2.0	2.5	3.0	4.0	1.7	-1%	1.5	89%
% Total	<1%	<1%	<1%	<1%	<1%	<1%			
Total	1407.7	1984.6	3073.0	5491.8	7913.3	17402.7	65%	17501.6	101%
% Total	100%	100%	100%	100%	100%	100%			

MINTS - SOLAR ON THE CUSP

CONTINUED FROM PAGE 21

ments that are at odds with installation data.

Finally, as some held inventory is actually manufacture owned, the market picture is further obscured rendering planning difficult. Bluntly, it is difficult to plan for a volatile market with little transparency and much obfuscation.

Figure 1 (see page 21) provides a picture of grid-connected application growth through 2015, under the reduced incentives, conservative and accelerated growth scenarios. In mid-2011, demand remains slow in Germany (though it is expected to increase August, September, October and November), while demand in Italy remains strong. Mid-year, demand side inventory is between 3-GWp and 5-GWp, that is, there is at least 3-GWp of demand side inventory at mid-2011.

REGIONAL GROWTH

Table 1 (see page 21) provides an overview of regional growth and share of total demand from 2005 to 2010, along with the five-year compound annual growth rate for this period and installations for 2010. Demand for solar systems continues to be dominated by the photovoltaic technologies. For the several years, there has been significant inventory build-up on the demand side of the industry. Holding module inventory on the demand side is not new, however, the significant degree of held inventory is a recent phenomenon, and an unfortunate one.

AND FINALLY ...

The solar industry grew from megawatt level to multi-gigawatts of demand because of the feed in tariff incentive model.

Unfortunately, some versions of the FiT were overly generous and lacked sufficient controls leading to overheated markets. Overheated markets along with aggressive pricing for share led to the development of high levels (~36-GWp) of manufacturing capacity, artificially low prices, low margins for manufacturers and high levels of inventory.

Keeping these factors in mind, the industry now finds itself with price levels that cannot increase and incentive levels that will also not increase. This means that the industry will need to change to survive.

It will need to develop price elastic customers that do not require incentives, it will need to adjust to power purchase agreement types of incentives where the price is set by bid, and it will, unfortunately, have to adjust to lower margins.

About the Author:

Paula Mints is the Principal Analyst for the Solar Market Research Program, and a Director in Navigant's Energy Division, located at Navigant Consulting, Inc.'s Palo Alto, CA, office. Ms. Mints also serves as executive editor of the Solar Outlook Bimonthly Newsletter The PV Service Market Research program is a 37 year old, globally recognized market research practice. Ms. Mints began her work with this program in 1998.

Ms. Mints is widely recognized as an industry expert on photovoltaic (PV) technologies and markets. In 2011, she spoke at over 40 conferences and published over 30 times in industry journals, magazines and newsletters. She serves on several conference committees. Ms. Mints has a monthly column in the print and on-line *Photovoltaics World* magazine. Ms. Mints provides clients with objective, comprehensive PV industry analysis based on extensive primary research, including her forward-looking understanding of market and technology trends.

Professional Expertise

- Photovoltaic Value Chain Analysis, from raw material to end user
- Technology Sales (shipments) from Manufacturer to first point of sale in the market (the photovoltaic selling channel)
- Thin film and crystalline technology analysis
- Analysis of Photovoltaic Application Segments
- Photovoltaic Average Module and System Pricing over time and ten year ASP forecast
- Solar market trend analysis backed up by 37 years of hard data

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Professional Solar Industry History

- Navigant Consulting, Inc. 2005 - Present
- Strategies Unlimted
- 1998 - 2005 Education
- San Jose State, BS – Business Concentration
- San Jose State, MBA, Market Research Focus

ZACHARY - CHALLENGES IN SOLAR STORAGE

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charge period the reverse slat flow occurs from the hot to the cold tank. According to some studies, two tanks 30 feet tall and 80 feet in diameter could generate 100-MW electric for four hours. Some proposed systems could use directly the salt either in the tubes of the trough collector or in the boiler on top of a tower. The elimination of the HTF as the working fluid in the solar field allows operation at much higher temperatures (540C). However Integration of the molten salt storage directly with a steam cycle creates a mismatch in heat transfer properties between the salt with only sensible heat exchange and steam, which undergoes a latent heat transfer in both charging and discharging modes of operation

Beside its high capital cost, the concept has several disadvantages: It has a low thermal conductivity. Since molten salt freezes at quite high temperature, maintaining it in liquid form, when solar heat is not available, requires substantial external heat sources, thus increasing the plant parasitic losses. Large quantities of salt are needed and their market price becomes a significant factor in storage total cost. Molten salt is a corrosive material requiring special types of pumps and valves.

A lot of effort is been invested by the research community to identify salts with a much lower freezing temperature. Another improvement is the use of a single tank for storing the hot and cold salt instead of two tanks. The hot fluid is on top and the cold on the bottom of the tank. A low cost filler material is utilized to reduce the amount the salt. The stratification is achieved through thermal buoyancy. This option currently under development could offer significant savings.

PHASE CHANGING MATERIAL, (PCM)

An efficient substitute to sensible thermal storage such as molten salt, are phase changing materials with solid-liquid phase transformation. Exploiting the latent heat released or absorbed during a change of state of aggregation make more sense thermodynamically, since in this case there are very small temperature difference between the charging and discharging modes. PCM materials such nitrate salts offer also a higher energy density when compared with the conventional sensible heat systems, thus being compact and more economic.

Unfortunately PCMs exhibit a very low thermal conductivity and future commercial size storage systems will need to solve the heat transport problem. One option is to create heat exchangers with large heat transfer areas. The alternative is to enhance the heat conductivity of the storage materials using good heat transfer matter such graphite in the form of plates separating layers of the working substance. The technical feasibility of such systems was demonstrated but a substantial amount of development work is still required before these composite PCMs could be deployed commercially.

CONCRETE, GRAPHITE, CERAMIC MATERIALS

The search for alternative less expensive storage medium led to the use of solid materials such as concrete for parabolic trough applications. Pipes are embedded in a concrete block and the heat transfer fluid (HTF) used in the parabolic troughs is also circulated to move the heat in and out of the storage media. Experimental work has been done in Germany by the German Aerospace Center and at a site in Spain. Obviously the attraction is the relative low cost of the storage medium. It also fits well with single phase working fluid such HTF. However there are concerns about long term effects of thermal cycling on the contact between the concrete and the pipes. The type of concrete used for this application must sustain temperatures close to 400°C, (750°F) a condition where the conventional concrete looses its strength. It is expected that some commercial installations will appear in the near future.

While applications in the medium temperature range can be accommodated by more conventional means, the development of high temperature storage above 540°C (1100F) faces substantial technological challenges. Selecting a suitable operating medium and materials for the storage facility, capable to cope with the mechanical and thermal stress is a complex undertaking. Ceramic solid materials coupled with carbon dioxide as the working fluid are currently investigated as a potential contender for high temperature applications.

In this search for a solid medium, another promising candidate is graphite. Its thermal properties allow operation at very high temperature above 600°C (1100F) and its low coefficient of thermal expansion accommodates thermal cycling without excessive stress. As the temperature raises the graphite heat capacity increases.

In certain configurations, the graphite storage may be used to extend the storage capacity of low temperature solar thermal applications.

About the Author

Justin Zachary is currently Technology Manager in Bechtel Power Corporation.

He is an American Society of Mechanical Engineers (ASME) Fellow from 2005 and was elected Bechtel Fellow in 2009.