

FT4000[®] INTRODUCED



Chuck Levey

GLASTONBURY, CT - PW Power Systems, a group company of Mitsubishi Heavy Industries, Ltd., announced the successful completion of the initial verification tests for its latest aero-derivative power solution, the FT4000[®] gas turbine. *World-Gen* spoke by



Dave Maher

phone to Chuck Levey and Dave Maher upon completion of the initial phase of validation testing conducted on its first FT4000[®] engine on the Pratt & Whitney engine test facility in Florida.

"The final integration of both the high pressure

(continued on page 17)

J920 LAUNCHED



Lorraine Bolsinger

DENVER, CO - GE invited *World-Gen* to the official launch of its new, 10 megawatt Jenbacher J920 FleXtra gas engine designed for the 60 Hz North American market. The launch was announced by Lorraine Bolsinger, president and CEO for GE's Distributed Power at a press conference held during the American Public Power Association (APPA) 2014 conference and expo in Denver. She also announced a memorandum of understanding with Sky Global Partners to supply the IPP with six of its natural gas-fueled J920 FleXtra gas engines.

"Our Jenbacher J920 FleXtra gas engines offer best in class electrical efficiency of 49 percent for 60Hz adding up to big savings in fuel over the life cycle of any plant. For example, over 15 years, a US facility could realize fuel savings of as much as \$15 million for a 100-MW J920 FleXtra power plant," Bolsinger said. Featuring a five-minute start up, the J920 FleXtra is scalable for any plant size.

"The installed capacity of non-dispatchable resources such as wind and solar has doubled since 2010 and is expected to increase further in the coming decade. They must be supported by complementary generation to maintain a stable grid," added Bolsinger. "The J920 FleXtra can be activated during periods of low renewable power supply or during tariff spikes. Conversely, the J920 FleXtra can be quickly curtailed during spells of high feed in of renewable energy or low energy prices." The J920 FleXtra enables the integration of renewables onto the grid and is well suited for regions with water constraints due to its lower water consumption, and was developed as a modular system with a small footprint.

The complete J920 engine's turbocharger module consists of four turbo-chargers, a two-stage turbocharging system, intercoolers, gas train, oil and water heat exchangers, blow-by system, and an electrical cabinet. This enables excellent lean-burn combustion, higher efficiency and lower emissions. J920 FleXtra engine efficiency remains high even in tropical regions and high altitudes.

Two-stage turbocharging enables more than 90 percent total efficiency when the J920 FleXtra engine is used in a combined heat and power (CHP) plant application that produces hot water. Using the J920 FleXtra engine's exhaust heat, a hot water temperature of up to 130°C

(continued on page 19)

THE NETHERLANDS GREENOVATES



Maeslant Gate — The surge barrier is the last part of Delta Works, a series of dams and dikes commissioned after the North Sea flood of 1953.

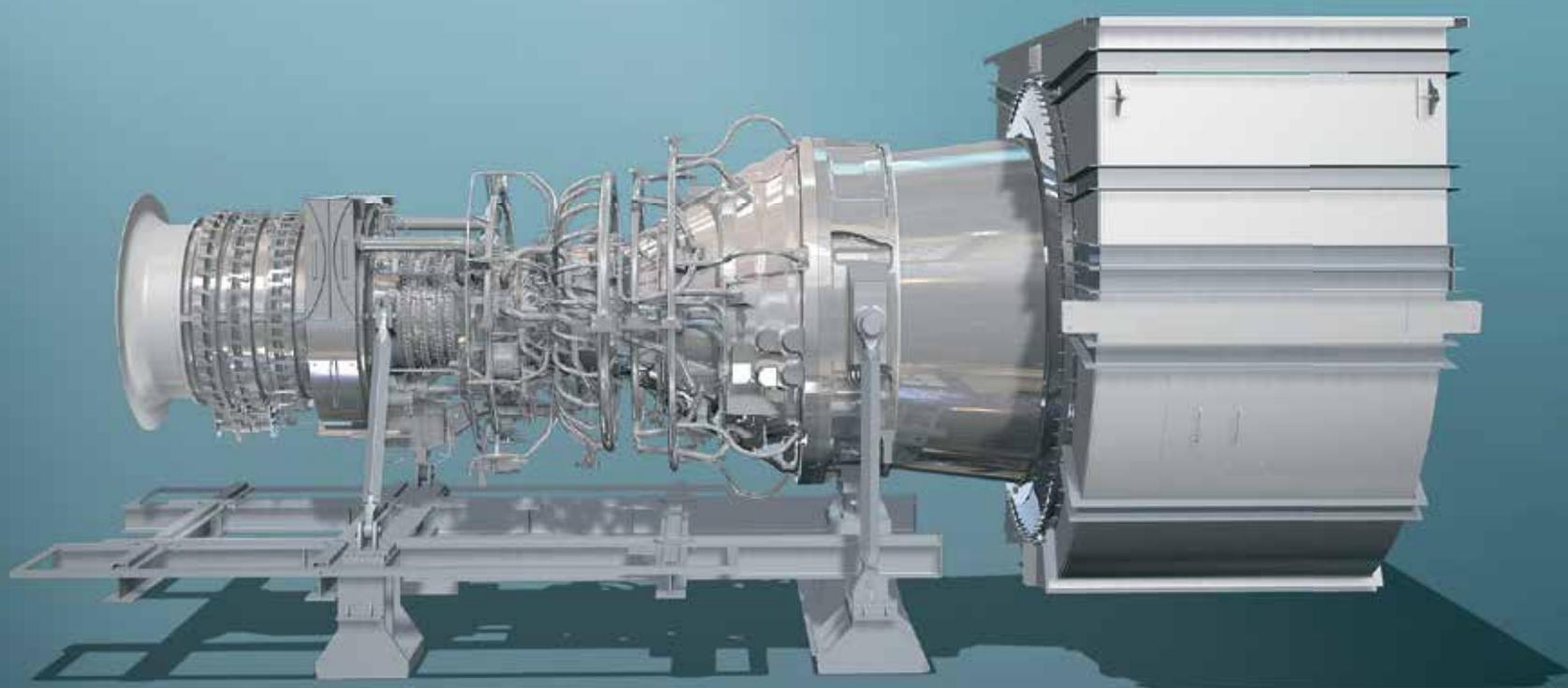
AMSTERDAM, NE - The Netherlands Ministry of Foreign Affairs invited *World-Gen* to a five day press tour hosted by Dr. Peter Stoel that started in Amsterdam. Renee Jones-Bos, Secretary General of the Ministry said that, "The Netherlands is often referred to as Holland." The recent tour consisted of a series of site visits to seven of twelve Netherland provinces where public-private partnerships, innovations, incubators and university spinoffs were showcased as the country transitions to sustainable energy.

PAN EUROPEAN DCA

The capital city of Amsterdam is joining London, Paris and Frankfurt to be a green data center as a member of PEDCA. PEDCA is the first research and development FP7 grant of euro 1.7 million for 18 months ending December, 2014 to address the data center sector. Forty-one private companies are participating in this "Green IT Initiative," Maikel Bouricins, Project Manager, told *World-Gen*. The Geysler project is to design, implement and validate a fully innovative

(continued on page 18)

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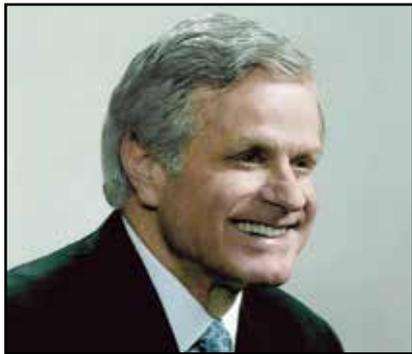
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Dick Flanagan

PW Power Systems, a group company of Mitsubishi Heavy Industries, Ltd., announced the successful completion of the initial verification tests for its latest aero-derivative power solution, the FT4000™ gas turbine. World-Gen spoke by phone to Chuck Levey and Dave Maher on the eve of the release of the first FT4000 assembly heading to Exelon from new assembly and testing facilities in Palm Beach, FL. Maher took us back in time to the design objective of the FT4000 and Levey highlighted its evolution to the oil and gas industry. Begins on page 1.

The Netherlands Ministry of Foreign Affairs invited World-Gen to a five day press tour hosted by Dr. Peter Stoel that started in Amsterdam. The recent tour consisted of a series of site visits to seven of twelve Netherland provinces where public-private partnerships, innovations, incubators and university spinoffs were showcased as the country transitions to sustainable energy, starts on page 1.

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Microgrids have become a hot topic in industry news describing installations popping up across the country, particularly at universities and on military bases. The Solar Electric Power Association held a webinar on July 31 profiling two microgrids in San Diego Gas & Electric's service territory, Lyn Corum reports on page 11.

The Renewable Fuel Standard was designed to increase production and use of domestic biofuels as a way to reduce U.S. reliance on foreign oil. It is also intended to mitigate the environmental impact of transportation fuel use. The program promotes competition within the U.S. transportation fuel market, ensuring that consumers benefit, Paul Winters explains on page 12.

The Massachusetts Port of New Bedford, the Nation's number one fishing port is soon to become the Nation's number one port for the first offshore wind farm of 468 megawatts. Jim Gordon, President of Cape Wind, announced that he has entered into a two year lease agreement with the Massachusetts Clean Energy Center (MassCEC). This feature is on page 13.

James Cater answers this question: Does solar really save costs for society as a whole? Or does it simply shift the costs from solar customers to utilities, and in turn to other electricity customers who don't use solar? Can utilities set rates that are fair to all? Read what he has to say on page 14.

Panda Power Funds, Siemens Energy and Bechtel Power dedicated the Panda Temple 1 Power Project located at the Synergy Industrial Park on September 25th, 2014. The plant has been strategically located to meet electricity demand in the "Texas Triangle", an area bordered by Dallas, Austin, San Antonio and Houston, four of the fastest growing metropolitan areas in the United States. See page 15 for the details.

AES launched its energy storage business six years ago with the commercial operation of AES Los Andes ES, a 24MW, lithium-ion based energy storage system located in the Atacama desert in northern Chile. AES has developed and operates over 200MW of lithium-ion battery based energy storage resources and continues to develop and offer energy storage solutions to utilities globally, Brett Galura says on page 16.

Our job as journalists is to report the news and now World-Gen is making news. We are going digital in 2015. We have been enhancing our site, world-gen.com with 24/7 news coverage from Business Wire and PR News, the only publication offering these two news feeds. You'll be seeing more videos on the site too.

World-Gen has 250,000 visits a year tracked daily on the site. This September had the most site visits to date.

World-Gen also publishes online Energy Technology Review from MIT, DOE Spotlight and The Bueche Directory of Developers.

World-Gen is a media sponsor at nine conventions throughout the year and we will continue publishing show issues for bonus distribution. The magazine will be resized from tab to magazine size. Display advertisers will receive discounted rates and can also advertise online with banner flash ads. You'll be hearing more and let us hear from you.

Look forward to seeing you at SPI and PGI.

Dick Flanagan

DUPONT SOLARS #13

CERNAY, FR - DuPont celebrated the completion of its largest solar power installation to date by inaugurating a 4.5 megawatt solar power plant at its 15 acre facility in Cernay. This is one of 13 solar installations worldwide on DuPont land. The project was developed by Hanau Energies, and has a 20-year power purchase agreement with energy provider Électricité Réseau Distribution France (ERDF).

B&W ACQUIRES

CHARLOTTE, NC - Babcock & Wilcox Power Generation Group has completed the acquisition of MEGTEC, a De Pere, WI-headquartered industrial processes solutions provider, based on an enterprise value of \$155 million. B&W MEGTEC employs approximately 600 people and designs, engineers, manufactures and services air pollution control systems and coating and drying equipment for the industrial sector.

WESTINGHOUSE INKS

PITTSBURGH, PA - Westinghouse Electric Company announced its intent to purchase 100 percent ownership of Mangiarotti S.p.A., an Italy-based manufacturer of components for the nuclear, oil and gas industries. Mangiarotti has engineered, designed and manufactured a comprehensive line of products during its more than 80-year history. Westinghouse is expanding into the oil and gas market.

EDF EXPANDS

SAN DIEGO, CA; AMARILLO, TX - EDF Renewable Energy announced that the 161-megawatt Spinning Spur II Wind Project in Texas has reached commercial operation (COD). The company further announced the close of structured equity financing from GE Energy Financial Services and MUFG Union Bank, NA. The completion of construction and COD milestone allows the closing of the sale of 50 percent of EDF Renewable Energy's equity interest in the project to UBS International Infrastructure Fund.

"The announcement exemplifies EDF Renewable Energy's strategy to develop renewable energy projects with strong local community support, and first tier equipment suppliers and contractors, and then invite the investment from longstanding financial partners," commented Tristan Grimbert, President and CEO of EDF Renewable Energy. "EDF RE will retain substantial ownership in the facility and bring our expertise in operations and maintenance through EDF Renewable Services to optimize long-term investment profitability." With the Spinning Spur II project in operation, the Group's installed capacity since entering the Texas market in 2012 reaches 472 MW with another 700 MW in late-stage development.

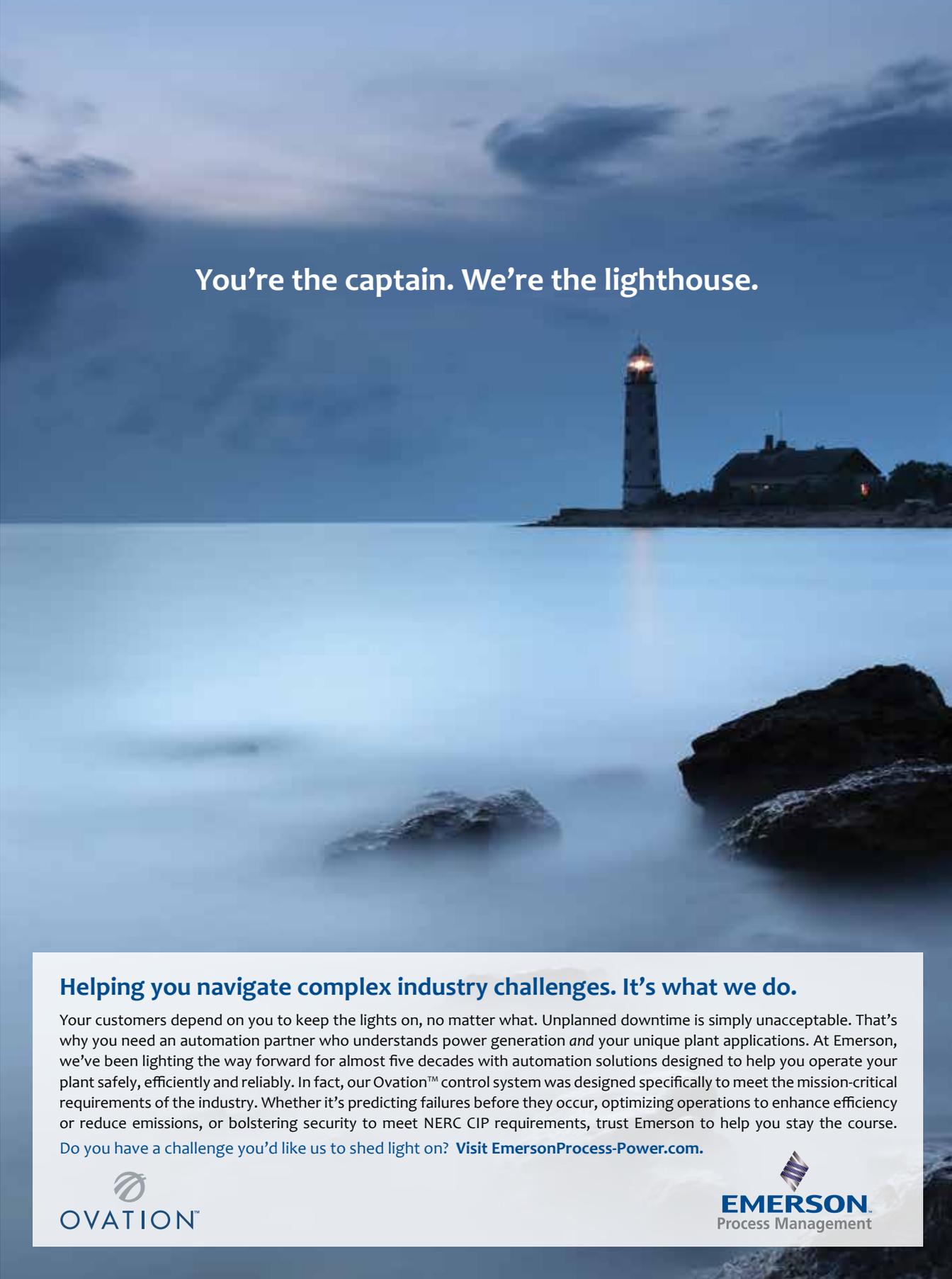
AREVA IN US

PARIS, FR - Six U.S. nuclear utilities have established a technical advisory board for the deployment of GAIA, AREVA's next generation pressurized water reactor fuel assembly design. The utilities - including Dominion, Duke Energy, Exelon and PSEG - share a common interest in ensuring the technical advancement and demonstration of this fuel for the U.S. market.

The innovative GAIA fuel design provides utilities cost-savings through its high mechanical fretting resistance, better thermal performance and increased tolerance to earthquakes. The design also features advanced cladding that meets anticipated changes in U.S. regulatory requirements.

NRG INNOVATES

SANTA CLARA, CA - NRG Energy, the Santa Clara Stadium Authority and the San Francisco 49ers celebrated the completion of the NRG Solar Terrace as well as the photovoltaic (PV) solar systems for the three NRG Energy Bridges at Levi's® Stadium, making it the first stadium in the United States that is home to a professional football team with LEED certification standards incorporated into the original design and architecture. Among the installations are solar panels expected to generate enough energy annually to offset the power consumed at the stadium during 49ers regular season home games, with the goal to achieve a "net zero" energy use.



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SOLECTRIA SOLD

LAWRENCE, MA - Yaskawa Electric will acquire Solectria Renewables through its U.S. subsidiary, Yaskawa America Inc. Solectria Renewables will continue to operate as a wholly owned subsidiary. Solectria employees over 170 people throughout the U.S.

Yaskawa Electric is a \$3.6 billion global leader in factory automation solutions, and has a leadership position in the low power PV inverter market in Japan.

Yaskawa America's President Mike Knappek said, "We are very excited to bring Solectria into the Yaskawa family to provide world leading Inverter solutions."

S&L AWARDED

CHICAGO, IL - Sargent & Lundy LLC has been awarded a contract by Petra Nova to continue providing engineering services for the completion of the Petra Nova Carbon Capture Project.

Sargent & Lundy has been supporting NRG/Petra Nova throughout their development retrofitting an existing coal-fired power plant with commercial-scale carbon capture.

The captured CO₂ will be transported by pipeline to a mature oilfield and used to increase oil production with enhanced oil recovery technology.

The Petra Nova Carbon Capture Project is expected to be operational by the end of 2016.

URS, MOBOTEC TEAM

AUSTIN, TX - URS Corporation will collaborate with Mobotec to expand the use of the ROFA™ and Rotamix™ NO_x control technologies within the U.S. coal-fired power industry.

URS has become the exclusive partner for Mobotec's Rotating Opposed Fire Air (ROFA) and advanced selective non-catalytic reduction (Rotamix) systems for the North American power market.

Mobotec's ROFA technology offers the advantage of decreased NO_x formation, increased thermal efficiency, fuel flexibility and, in many cases, reduced operating costs. Mobotec solutions are customized to fit each client's plant configuration.

AREVA AWARDED

PARIS, FR - AREVA Federal Services has been selected to provide the engineering, construction, and commissioning of a remote-handled low-level waste disposal facility at the Idaho National Laboratory (INL).

AREVA was awarded this contract worth more than \$30 million from Battelle Energy Alliance, which manages the INL on behalf of the U.S. Department of Energy.

SCHNEIDER'S NEW HUB

ANDOVER, MA - Schneider Electric announced the grand opening of its North American research and development center in Andover. The Boston One Campus will serve as the company's North American headquarters and is built to house 750 employees. Laurent Vernerey, President and CEO of Schneider Electric's North America Operations, will relocate to the new headquarters.

DUPONT ADDS

RESEARCH TRIANGLE PARK, NC - DuPont Microcircuit Materials has added two new products to its lineup of frontside silver metallization pastes for crystalline silicon solar cells. "The DuPont™ Solamet® PV18x series offers more efficiency with less material required," said Peter Brenner, global photovoltaic marketing manager, DuPont Microcircuit Materials.

GE INKED

WEXFORD, PA - GE's Distributed Power business announced that it will provide its Jenbacher gas engine technology to IMG Midstream for two, 20-megawatt projects serving the PJM Interconnection energy, capacity and ancillary services segments. These projects will use natural gas and electric infrastructure and will produce electricity for 26,000 homes.

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GTI ACQUIRES

DES PLAINES, IL - GTI International, a subsidiary of Gas Technology Institute, announced it has acquired CDH Energy Corp., a professional services firm specializing in monitoring and evaluating energy technologies related to building efficiency, combined heat and power, fuel cell, and solar power performance.

SOLECTRIA POWERS

LAWRENCE, MA - Solectria Renewables, LLC will supply 69 SGI 500XTM's to Entropy Solar Integrators for seven projects in North Carolina.

The seven projects are slated to be commissioned by the end of 2014, and are anticipated to generate 1.1 billion kWh, enough to power up to 130,000 homes.

IBERDROLA TO SUPPLY

PORTLAND, OR - Iberdrola Renewables announced a 10 year contract to supply Roseville Electric, the municipal electric utility of Roseville, CA, with a package of renewable energy products. The deal will deliver renewable energy over time to help Roseville fulfill California's renewable portfolio standard (RPS) obligation through 2024.

BLACK & VEATCH FORECASTS

WASHINGTON, DC - Black & Veatch's 8th annual Strategic Directions: U.S. Electric Industry report shows that many retiring nuclear and coal power plants may not need to be replaced on a megawatt-to-megawatt basis. New technologies and distributed generation, coupled with soft energy demand growth, enable utilities to replace retiring plants with ones that produce less energy.

Half of the respondents stated their company is planning to replace retiring coal and nuclear power plants with gas generation. Natural gas will also be used as backup power for renewable generation.

"This year's Strategic Directions: U.S. Electric Industry report finds many utilities at a crossroads," said Dean Oskvig, president of B&W's energy business. "The influx of new technologies, new energy sources and new generation approaches, create immense challenges and opportunities for utilities. What has not and will not change, however, is the mandate to deliver the 'always on' reliable electric service the industry has provided for more than 100 years."

The Black & Veatch report found that the rise of DG in particular creates unique challenges for utilities. DG requires rapid changes to the power grid in order to integrate new assets and resources.

Utilities must also be able to ramp up capacity to account for varying renewable energy output. Where DG reduces demand, utilities will have to revisit their current revenue structure in order to ensure continued reliable service. DG has a current market share of five percent.

"Every kilowatt that is now being produced by a third party or a consumer is a kilowatt not being sold by the utility," said John Chevrette, president of Black & Veatch's management consulting

business. "At the same time, utilities still carry the burden of building, maintaining and operating the bulk of the power delivery system. Given the high cost of maintaining these assets, we expect to see more utilities making the case with regulators to adjust their business models."

The report also found that concern for cyber and physical security is growing and is among the top five industry issues, as ranked by survey participants.

Additionally, nearly 60 percent of utilities are updating emergency response plans to improve resiliency to weather and unanticipated events.

Black & Veatch conducted its eighth annual U.S. electric industry study from 7 May - 27 May 2014. 576 qualified electric industry participants provided responses. Chevrette and Oskvig presented key findings from this year's report during a briefing at the U.S. Energy Association.

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GE, EDF TEAM

COLOGNE, GERMANY – At Power-Gen Europe, General Electric and EDF held a joint press briefing on the launch of the first GE9HA01 scheduled for the EDF Bouchain plant in France. The plant is located on a former brown field coal-fired site that is being phased out and shut down.

Umberto Dotta, Executive Vice President at EDF said, “The agreement we made is based on our 40 year partnership between us and GE. We run over 100 engines from GE.”

John Lammas, Vice President of Thermal Engineering at GE shared the testing of the 9HA01 in the Greenville, SC facility: “We can map it to look at the responses over a whole operating range, more than any gas turbine would ever see.”

The FlexEfficiency 50 Combined Cycle Plant will produce 600 megawatts and is scheduled to begin commercial operation in 2016.

WESTINGHOUSE'S MOU

PITTSBURGH, PA - Westinghouse Electric Company and Blue Castle Holdings announced the signing of a memorandum of understanding to pursue the development of a two-unit AP1000® nuclear power plant at the Green River site in Utah.

Under the agreement, the companies will work together to develop a scope of activities for enabling the Blue Castle Project under a definitive agreement, including marketing, nuclear safety licensing, permitting, design, engineering, procurement, construction, installation, commissioning, startup, testing, nuclear fuel, refueling, operation and maintenance of the two-unit plant.

EDF TO SELL

SAN DIEGO, CA – EDF Renewable Energy announced that Dominion will acquire two solar projects - Cottonwood Solar (32.6 MWp) and Catalina Solar 2 (24.3 MWp). Cottonwood Solar consists of three sites, two of which are ground-mount facilities located on private land in the central California counties of Kern and Kings totaling 31.6 MWp / 23 MWac of capacity. The third site is a 1 MWp / 1 MWac carport structure to be built in Marin County. The project has secured a 25-year Power Purchase Agreement (PPA).

Catalina Solar 2, located on 270 acres in the Mojave Desert of Kern County, is designed as a 24.3 MWp / 18 MWac solar photovoltaic horizontal single axis tracker project and has secured a 20-year PPA. Construction on both projects is anticipated to commence in Q4 2014 with commercial operation expected in Q2 of 2015.

3M INVESTS

ST. PAUL, MN - 3M New Ventures announced an equity stake in Toronto-based Smart Energy Instruments to accelerate SEI's efforts in developing electronic chipsets for smart grids. According to Navigant Research, cumulative worldwide electric utility spending on asset management and condition monitoring systems will total close to \$50 billion from 2014 to 2023.

ABENGOA TO DEVELOP

WASHINGTON, DC - Abengoa, the National Renewable Energy Laboratory and the Colorado School of Mines, have been selected by the US Department of Energy to develop a new solar storage technology for thermo-electric plants. The program will last for two years and will require an investment of €1.3 million by the US Department of Energy. This project is part of the SunShot Initiative carried out by the DOE.

XCEL SOLARS

AMARILLO, TX – Xcel Energy's Southwestern Public Service Company is seeking proposals for additional solar energy resources as a component of its resource planning process. SPS is requesting proposals for up to 200 megawatts of solar photovoltaic generation resources that could begin delivery to SPS on or before Dec. 31, 2016, contracted through a power purchase agreement.



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ABU DHABI

Siemens and its consortium partner Daewoo Engineering & Construction Co. handed over into commercial operation the Shuweihat S3 combined cycle power plant in Abu Dhabi. The owner is Shuweihat Asia Power Company which is a consortium comprising of Sumitomo Corporation of Japan, the Korea Electric Power Corporation and ADWEA.

BELGIUM

Siemens Energy has secured its first Belgium wind power contract for the first phase of the Wind aan de Stroom project in Antwerp harbor, consisting of 11 direct-drive wind turbines of the Siemens D3-platform. The project can be extended to 17 wind turbines and the contract includes a service and maintenance agreement for a period of 15 years.

BRAZIL

Alstom has signed a €320 million contract with Renova Energia to deliver, erect and commission 127 wind turbines in the Umburanas complex, located in Bahia State.

The wind turbines, composed of ECO 122, ECO 110 and ECO 100 models, will be delivered between January 2017 and January 2018. The Umburanas wind complex will generate 355.5 MWs.

BRAZIL

ABB has successfully commissioned the HVDC converter stations to the Rio Madeira High Voltage Direct Current (HVDC) link in Brazil and delivered the project to Abengoa.

The approximately 1,500 mile, 3,150 megawatt power connection is the longest transmission link in the world, and will bring electricity from two hydropower plants in the northwest of the country to São Paulo.

FRANCE

AREVA signed a contract with the agency "Fusion for Energy" which gathers the European partners of the ITER fusion project, to manufacture a "first wall" panel prototype.

The "first wall" panels are one of the covering components that wrap the internal surface of the ITER reactor vacuum vessel and protect it during the nuclear fusion reaction.

Please visit world-gen.com for "Magnetic Fusion" feature.

INDIA

GE Energy Financial Services has invested equity in three Atria Power wind projects under construction in India. The wind farms will have a combined capacity of 126 megawatts and will support the Indian Ministry of New and Renewable Energy's program to generate competitively priced grid-interactive wind power through feed-in tariffs.

INDIA

Siemens Energy is supplying high-efficiency steam turbine-generator sets with associated instrumentation & control components to power plant projects in India. The machines are destined for the coal-fired units of the North Karanpura Super Thermal Power Project located in the eastern Indian state of Jharkhand, and for IB Thermal Power Station Banharpalli in the neighboring state of

Odisha. These turbine generators deliver a combined installed electrical generating capacity of over 3,300 megawatts. The customer is the Indian company Bharat Heavy Electricals Ltd. (BHEL), Siemens' licensed partner in India.

MALAYSIA

Siemens in a consortium with MMC Engineering Services Sdn Bhd has received an order from PETRONAS, for

the turnkey construction of the Pengerang Co-generation Plant. The order requires Siemens to undertake the turnkey construction of the PCP, which comprises four co-generation units along with a long-term maintenance and services contract. Each unit comes with an H class gas turbine, a waste-heat recovery steam generator, a steam turbine, associated mechanical and electrical systems and the instrumentation and control system.

PLATTS 2014 GLOBAL ENERGY AWARDS



Congratulations to the 2014 Platts Global Energy Awards Finalists!

The Platts Global Energy Awards indicate the direction in which the industry is headed. Winners will be announced at a black-tie celebration on December 11, 2014 at the Waldorf Astoria in New York City. Don't miss the opportunity to be involved with this highly recognized and rewarding event.

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MEXICO

SolarWorld supplied a complete 1.16-MW system for Plantronics' Tijuana factory. The 1.16-megawatt system features solar panels, racking and system engineering from SolarWorld.

MEXICO

Alstom has been awarded a €335 million contract to supply a power island for Iberdrola's Monterrey III combined-cycle

power plant in Pesqueria, Nuevo Leon. The contracts also include a Long Term Service Agreement (LTSA) for new unit 5 and for the existing 4 units. The commissioning is scheduled in 2016. The unit consists of one GT24 gas turbine, a steam turbine and Heat Recovery Steam Generator.

PHILIPPINES

GE announced its jet engine-based aeroderivative gas turbines have been chosen to power First Generation

Corporation's Avion 97-megawatt power plant in the Philippines. GE's LM6000-PC Sprint gas turbines will be the first of their kind in the country.

POLAND

Alstom signed an €80 million contract with PGE Energia Odnawialna SA for the supply of 30 ECO 110 wind turbines for the "Lotnisko 90MW" wind farm. With a total output of 90MW and scheduled for commissioning at the end of 2015, Lotnisko is one

of the largest projects in the Polish wind power industry, and the first wind power project implemented by Alstom in Poland.

POLAND

Emerson will install its Ovation™ control system at a 1,075-MW, ultra-supercritical, coal-fired power generating unit under construction at the Kozenice Power Station. The Ovation™ technology will be used to unify control of boiler, turbine and major plant equipment at the new unit, which is part of the second-largest power generating facility in Poland.

SAUDI ARABIA

Wärtsilä has received an order to supply a turnkey power plant from Umm Al-Qura Cement Company. The 47 MW captive power plant will be located in the mountain desert close to Taif city. The power plant consists of five 20-cylinder Wärtsilä 32TS engines, a new 2-stage turbocharged version of the market-leading Wärtsilä 32 series.

SAUDI ARABIA

Shanahan Engineering has been awarded a multi-million dollar Commissioning Services Contract by Hanwha Engineering & Construction for the start-up of YANBU Phase II power project. Yanbu Phase 2 MED Expansion Power & Desalination Project located at Yanbu Industrial City, 300km north of Jeddah, consists of three power generation units, with a combined output of 690MWs and a multiple-effect distillation (MED) desalination unit capable of producing 15 million imperial gallons per day (MIGD).

SCOTLAND

ABB has been awarded a contract by Atlantis Resources Limited to provide the onshore grid connection for Phase I of the MeyGen tidal stream project in Scotland's Pentland Firth. The first 6 megawatt demonstration phase of the UK's first large-scale tidal array scheme will see four submerged turbines installed in the Inner Pentland Firth just north of Caithness, with first power expected to be delivered by 2016.

SOUTH KOREA

Siemens will deliver the power island for Dangjin 4 combined cycle power plant for South Korean construction company GS Engineering & Construction Corporation. The natural gas-fired 902-megawatts power plant is scheduled to come on line in the summer of 2017. Order volume for Siemens including a long-term service contract is EUR 360 million.

SWEDEN

Westinghouse Electric Company has been selected by OKG AB in Sweden to provide replacement nuclear fuel deliveries for all of their three reactors, Oskarshamn Units 1, 2 and 3. The contract includes yearly deliveries of fuel for their reactors during the five-year period of 2016 to 2020.

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NEWSMAKERS

BECHTEL NAMES

Bechtel announced that Brendan Bechtel will become president and chief operating officer and a member of the board of directors of Bechtel Group, Inc. Bechtel is the fifth generation of the Bechtel family to become president of the 116-year-old firm.



Brendan Bechtel

EPRI APPOINTS

The Electric Power Research Institute (EPRI) announced that Steve Lennon, at Eskom of South Africa, Lisa D. Goodman, of Goodiman, of Seminole Electric Cooperative, Inc., and David C. Coen, a former commissioner on the Vermont Public Service Board, have been appointed to the Board of Directors.



Steve Lennon



Lisa D. Goodman



David C. Coen

DUKE PROMOTES

Duke Energy announced that Lloyd Yates was named executive vp of marketing solutions and president, Carolinas Region. Keith Trent was named executive vp of grid solutions and president, Midwest and Florida Regions.



Lloyd Yates

HINMAN NAMED CHAIRMAN

CH2M HILL announced that the Board of Directors has unanimously appointed President and CEO Jacqueline Hinman to Chairman of the Board of CH2M HILL effective September 18, 2014. From 2012 to 2014, Ms. Hinman was president of CH2M HILL's International Division.



Jacqueline Hinman

WÄRTSILÄ APPOINTS

Rakesh Sarin has been appointed President of Power Plants, Executive Vice President and member of the Board of Management of Wärtsilä Corporation, effective 1 September 2014.



Rakesh Sarin

ESD PROMOTES

ESD (Environmental Systems Design, Inc.) has promoted Paul Barter, Zackery House, Keith Seier, and Michael Thomas to Senior Vice President.



Paul Barter



Zackery House



Keith Seier



Michael Thomas

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MICROGRIDS ARE THE NEW GREEN

BY LYN CORUM, CLASS OF 2002



Microgrids have become a hot topic in industry news describing installations popping up across the country, particularly at universities and on military bases. The Solar Electric Power Association, whose mission is to support utility integration of solar, held a webinar on July 31 profiling two microgrids in San Diego Gas & Electric's service territory. One is the microgrid at Borrego Springs built by the utility. The other has been built by the University of San Diego on its campus.

UCSD GENERATES ITS POWER

Beginning in 2000, Byron Washom, director of strategic energy initiatives at UC San Diego, and his colleagues built a 40-MW microgrid system that now provides power for 90% of the campus. Peak demand is 42 MW on the 1,200 acre campus that hosts a daily population of 45,000 students, faculty and researchers.

Washom described the various components of the microgrid: Two Solar combined-cycle gas-fired turbines produce 25 MW and 3 MW of Dresser Rand steam turbines produce 120,000 lbs./hour of steam for heat recovery. The waste heat flows into the district heating system to provide 95% of the campus's heating and cooling. There are three steam-driven chillers and eight electric-driven chillers.

Two megawatts of photovoltaic solar systems include a Soitec concentrating PV solar system which is 27% efficient, Washom said, and a Kyosera system rated at 14% efficiency. Moreover, the campus has invested \$4 million in solar forecasting. A fish eye camera scans the sky and takes pictures every 30 seconds, allowing staff to forecast solar power availability. He said the ground-based system is more accurate, since a satellite-based system is less accurate due to the slow delivery of data.

A 3.8-million gallon thermal storage system, installed in 2000, creates ice at night and cools the campus during the daylight hours.

A 2.8-MW fuel cell system, manufactured by FuelCell Energy, began operating

in January 2012. It burns biogas generated at the Pt. Loma waste water treatment plant 17 miles away. "We purify the methane to inject it into SDG&E's gas lines" he said, and UCSD receives renewable credits.

Washom said the fuel cell plant is working well and supplies 10% of the campus electrical base load. The campus is installing an absorption chiller to use the fuel cell's waste heat.

A 2.5-MW energy storage system is scheduled to be installed by December 2014. Washom emphasized this is not a demonstration. "It is an early commercial system and we want to illustrate the flexibility of different solar electricity strategies," he said. A 1.3 MW/2.6 MWh PV integrated storage system was installed in 2012.

Washom said Power Analytics monitors and manages the high volume of data generated by the microgrid control systems – 90,000 data points/second, he said. The microgrid is tied into SDG&E's grid and the California Independent System Operator has the ability to observe its operational system. "We think this will increase incorporation and development of microgrids in the wider transmission system, he said.

Washom said they are also looking at PMUs, or phasor measurement units, which use GPS systems to monitor the phases of all the voltages and currents throughout a grid in real time. "If we had PMUs at the time of the September 2011 regional blackout in Southern California we would have detected the problem ten minutes ahead of time" and islanded our system. "We didn't and the microgrid collapsed with the grid. We had to black-start the system," he said. The physical plant has 75 diesel generators for just such an emergency.

UTILITY MICROGRID

San Diego Gas & Electric created a microgrid in the desert community of Borrego Springs with \$10.8 million in funding from the US Department of Energy and the California Energy Commission. The community, with 2,500 customers of whom 300 are commercial, is located in the middle of a state park in the southeastern corner of the state. Borrego Spring is surrounded by mountains and is beset with flash floods during monsoon season. Since it is at the end of a 69-kV transmission line the flooding often cuts off electricity service for hours at a time.

Tom Bialek, SDG&E's chief engineer, said during the SEPA webcast, the community is progressive-minded and there is a high concentration of roof-top solar. Advanced metering is fully deployed in the town. Therefore, residents and businesses can reconfigure their energy management

systems to island their homes or business space during emergencies.

SDG&E installed two .1.8-MW diesel generators with selective catalytic reduction units and one 500-kW/1,500 kWh battery. A community energy storage system consists of three 25 kW/50 kWh lithium ion batteries.

In a September 2013 flood the microgrid supplied power to 1,056 customers for up to 20 hours, in essence islanding the community from SDG&E's grid. Bialek said it took 25 hours to restore power because of the devastation to distribution line poles. Customers with solar panels on their roofs did not see the outage. In an earlier wind storm in April 2013, the microgrid was able to provide power to 1,225 customers for six hours.

SDG&E is continuing to upgrade the technologies, and is planning to charge the energy storage batteries with solar power.

Bialek said all power electronics are housed below ground. The batteries are warranted for 40 degrees centigrade but temperatures in the area can reach as high as 50 degrees, so air-conditioning is needed in the buildings housing the electronics.

SONGS REPLACEMENT POWER

Recall that in March of this year, the California Public Utilities Commission authorized SDG&E and Southern California Edison to procure additional local power resources to make up for the June 2013 retirement of the San Onofre Nuclear Generating Station? (If not, see my column in the May/June issue.)

SDG&E is to procure between 500 and 800 MW in San Diego's "local reliability area." It is quietly moving forward with contracts to fulfill this requirements and submitted an application to the CPUC on July 21 requesting approval for a power purchase tolling agreement with NRG Energy to purchase the 600 MW of capacity from the Carlsbad Energy Center in Carlsbad, California. The CPUC will decide on SDG&E's application perhaps as late as the end of the year.

NRG has been developing the Carlsbad Energy Center since 2007 when it applied for certification at the California Energy Commission. It didn't receive a permit to construct until 2012, due largely to city and community resistance, but without a power purchase agreement the development was stalled. SDG&E expressed no interest in a contract with the plant until SONGS shut down.

In May, 2014, NRG asked the CEC to amend its certification and allow it to install fast start, simple cycle peaking generation instead of the combined cycle units it originally intended to install. The CEC has not

published a schedule for its review but it may take as long as a year. NRG is likely hoping the review will be much shorter.

The new facility will consist of six generating units utilizing GE LMS100 turbine technology. The plant's flexibility will give it the capability to start and stop multiple times per day. This will allow SDG&E to accommodate the variable and intermittent solar and wind projects being added to its system, and hence the utility's new interest in signing a contract with NRG.

Bringing the Carlsbad plant online by November 2017, as currently scheduled, will allow the old Encina power plant next door to be razed and its once-through cooling system to be removed by the December 31, 2017 deadline as ordered by the State Water Resources Control Board.

The new Carlsbad power plant has finally won the support of the City of Carlsbad which put up a vociferous (and losing) fight over the original development. The agreement with the city includes turning over land currently occupied by the Encina plant to the city for recreational development. The new plant will also have a lower profile.

In a second request filed in May 2014, SDG&E sought approval at the CPUC for an amendment of a contract with a qualifying facility, Oceanside Refrigeration, Inc., owned by Goal Line, L.P. The 49.9-MW cogeneration facility in Escondido has been selling firm power to SDG&E since February 1995. The original standard offer contract, as well as the amendment, will expire in February 2025.

The amendment will convert Oceanside Refrigeration to a prescheduled facility, allowing SDG&E to schedule the plant rather than being required to accept firm power, even at times it isn't needed, according to SDG&E.

The facility is federally certified as a qualifying cogeneration facility but will operate as an exempt wholesale generator once this amendment is approved by the CPUC. SDG&E will be the scheduling coordinator and will supply the fuel required to run the cogeneration plant.

SCE also got into the act. It announced on August 1 it signed contracts with solar and geothermal energy producers representing more than 1,500 megawatts of clean, renewable power. Signed contracts include the purchase of more than 1,300 megawatts of new solar power and the re-contracting of 225 MW with Calpine subsidiary, Geysers Power Company. The contracts need to be approved by the CPUC and resulted from a solicitation for renewable power last year.

THE FUTURE OF THE RENEWABLE FUEL STANDARD

BY PAUL WINTERS, DIRECTOR, COMMUNICATIONS
BIOTECHNOLOGY INDUSTRY ORGANIZATION (BIO)



The U.S. Environmental Protection Agency has created considerable uncertainty in administering the federal Renewable Fuel Standard (RFS) rules for 2014, and the future of this program is an open question. A panel of experts explored facets of that topic during the final day of BIO's World Congress on Industrial Biotechnology, which ran from May 12 to May 15 at the Pennsylvania Convention Center in Philadelphia. The panelists included a Washington-based investment analyst, two environmental policy experts, and myself as an advocate for biofuel producers.

The RFS was designed to increase production and use of domestic biofuels as a way to reduce U.S. reliance on foreign oil. It is also intended to mitigate the environmental impact of transportation fuel use by displacing petroleum with biofuels, emphasizing advanced and cellulosic biofuels that achieve greater reductions in carbon emissions. The program promotes competition within the U.S. transportation fuel market, ensuring that consumers benefit from new renewable fuel technologies.

CONGRESS ACTS

When expanding the program in 2007, Congress set a schedule through 2022 of annual increases in the minimum amount to be produced and used of four different categories of renewable fuel. But Congress also recognized that the U.S. fuel market could change in unforeseen ways, so it authorized EPA to make changes to the annual requirement after analyzing the industry's ability to produce biofuels. For instance, cellulosic biofuel has not been commercialized as rapidly as projected by Congress, so EPA has reduced the requirement each year to match expected production.

EPA is required to issue an annual rule each November, setting the volume obligations for the following year. For 2013, EPA did not establish the rule by

November 2012 as required; the rule was not finalized until August 2013, when the compliance year was nearly two-thirds complete. Then in November 2013, EPA proposed volumes for 2014 that were well below the statutory schedule and even below the required volumes for 2013.

MARWOOD GROUP

Tommy Barletta, vice president at the Marwood Group, a Washington-based financial analysis consultancy, started the panel discussion with a review of the development of this 2014 proposal from EPA. Barletta worked for Rep. Cal Dooley (D-Calif.) at the time the original RFS was written in 2005. He noted that Congress' expectation of continual growth in the U.S. transportation fuel market proved untrue. In fact, U.S. transportation fuel use has declined dramatically since 2007, due in part to the economic recession of 2008. U.S. drivers have cut their use of gasoline, driving less and buying more fuel efficient cars. Automakers are building more diesel fueled cars in response to federal Corporate Average Fuel Economy (CAFE) standards. With a shrinking gasoline market, oil refiners are resisting obligations to use increasing volumes of renewable fuels.

Barletta told World Congress attendees that he expects EPA in the final rule to increase the required volumes for 2014 from the levels proposed back in November. Gasoline and diesel use are expected to increase slightly in 2014 as the U.S. economy recovers, providing more market space for all stakeholders. And from all indications, the biofuel industry produced a surplus in 2013, and the oil industry was able to use those volumes without problems.

Still, Barletta foresees EPA relying on a novel interpretation of its general waiver authority as it cuts the 2014 volumes from the congressionally established schedule. That is likely to inspire litigation and Congressional scrutiny of EPA's administration of the program, Barletta said.

ANNUAL RFS RULES

Ryan Fitzpatrick, a senior policy advisor for Third Way's Clean Energy Program, next informed World Congress attendees about the process and various government entities involved in formulating the annual RFS rules. While EPA administers the program, it does so in consultation with the Departments of Energy (DOE) and Agriculture (USDA). The White House Office of Management and Budget (OMB) coordinates the inter-

agency discussions and negotiations. And that interagency review process is where most of the delay in promulgating the annual rules has occurred.

Fitzpatrick noted that petroleum refiners and oil companies have formed alliances with animal processors and fast food restaurants to lobby Congress against the RFS. So, if Congress does decide to review the RFS program in the near future, lawmakers have already staked out positions on whether to reduce, remove or repeal the RFS. Disagreement over how to change the program has so far stymied Congressional action on the RFS. Those who want to reduce the required volumes or remove some of the provisions do not agree that the program should be fully repealed. For the most part, Congress has held off on legislating changes while EPA continues work on the 2014 rule.

BIO PUBLISHED

I was the third presenter on the panel, outlining for World Congress attendees the results of a study that I and colleagues at BIO published on the environmental impact of EPA's proposed 2014 RFS rule. While EPA is proposing to reduce the use of biofuel in 2014 compared to 2013, transportation fuel use – both gasoline and diesel – is projected to increase. Use of petroleum would increase substantially under the proposed rule and release more carbon and other pollutants. In fact, EPA's proposal could have the same environmental impact as putting 5.9 million additional cars on the road, when compared with maintaining the statutory RFS volumes.

BIO's paper – published in the April edition of *Industrial Biotechnology Journal* – also warned that EPA's proposed reduction in the RFS could derail the emergence of cellulosic and other advanced biofuels. EPA intends to reduce future annual RFS volumes along the same lines it proposed for 2014. If the market for biofuels shrinks or the program becomes unstable, then investment in advanced biofuels could dry up. And since advanced biofuels achieve the greatest reduction in carbon emissions compared to petroleum, the United States would forego a significant opportunity for future carbon reductions. The foregone emissions reductions would compound year over year as the United States continued to rely on petroleum.

CLEAN VEHICLES PROGRAM

Jeremy Martin, senior scientist with the Union of Concerned Scientists' Clean Vehicles Program, gave the final

presentation in the discussion. Martin said that the RFS is facing two major challenges – the shortfall in cellulosic biofuel production and the “blend wall,” which is a regulatory requirement that limits ethanol blending in gasoline. Because cellulosic biofuel technology has been slow to emerge the annual increase in production and use envisioned by Congress back in 2007 can't be achieved. Martin made clear that the volumes in the RFS have to be reduced accordingly, and EPA should map out a new trajectory for the required volumes through 2022 in order to support investment and provide advanced biofuel producers certainty.

The blend wall, Martin told the audience, is more like a speed bump. Additional investment in biofuel distribution and flex fuel vehicle technology or in drop-in biofuels can overcome the challenge. In fact, there are sufficient existing E85 stations and flex-fuel cars to utilize the statutory volumes in the RFS for 2014. But Martin warned that the industry must be careful to develop biofuels that provably vitiate the environmental impacts of transportation fuel use. Martin told the audience that the United States can cut projected oil use in half by 2035, through energy efficiency and innovation, with biomass-based biofuels playing a significant part.

EPA TO DECIDE

All stakeholders in the RFS continue to wait for the EPA to make a decision about the program. As of writing, EPA has not issued a final rule for 2014. And there is a great deal at stake for both biofuel producers and oil companies. For oil refiners, the rule will tell them how much of a competing product they will be required to use in place of their primary product in 2014. And for biofuel producers, the rule will tell them how much of the U.S. transportation market will be open to them this year.

ABOUT THE AUTHOR

Paul Winters is presently the Director of Communications at the Biotechnology Industry Organization. BIO produces BIOtechNOW, an online portal and monthly newsletter chronicling innovations.

Paul previously worked at C-SPAN in Washington and in the publishing industry. Paul earned a Master of Arts degree from the University of California-Davis.

CAPE WIND ANCHORS

BY DICK FLANAGAN AND MARTY PILSCH

BOSTON, MA – The Massachusetts Port of New Bedford, the Nation's number one fishing port is soon to become the Nation's number one port for the first offshore wind farm of 468 megawatts. Jim Gordon, President of Cape Wind, announced that he has entered into an anchor lease agreement with the Massachusetts Clean Energy Center (MassCEC) to stage its historic, First-in-the-Nation offshore wind project out of the South Coast Marine Commerce Terminal located on New Bedford harbor.

The two-year lease agreement calls for Cape Wind to pay MassCEC \$4.5 million in rent for use of its 28-acre facility. The terminal is the first facility of its kind in North America, and has been specifically designed to handle the heavy loads associated with the staging of offshore wind projects.

The terms of the lease include an option for two one-year extensions.

Edward Anthes-Washburn, Deputy Director at the Port of New Bedford told *World-Gen* that the name "South East Marine Commerce Terminal" is being reviewed for a change to "New Bedford Marine Commerce Terminal." Construction of the terminal is 80 percent complete and is scheduled to be completed in December, 2014.

The initial project will begin with the arrival of components by special vessels owned by Hansa Lines, (HY-Lift).

AUCTION

There are more than 742,000 acres in federal waters off the shore of Massachusetts – the largest offshore wind planning area along the East Coast. The U.S. Department of Energy's National Renewable Energy Lab estimates that the area has the potential to generate between 4,000 and 5,000 megawatts of clean energy, enough to power more than half of the homes in Massachusetts.

The federal government will be conducting an auction to lease this area for commercial wind energy development in December, 2014. DOE estimates that 43,000 new jobs will be created in the offshore wind industry by 2030. Mass CEC CEO Alicia Barton said, "The clean energy industry already employs 80,000 workers."

STRATEGIC INVESTMENTS

Governor Patrick's Administration made strategic investments to position the Commonwealth as the national hub for emerging offshore wind industry. Along with the construction of the Terminal, the Commonwealth has constructed the Wind Technology Testing Center in Boston; invested in workforce training programs;

commenced a supply chain analysis to survey and connect Massachusetts companies to offshore wind developers and contractors; conducted marine wildlife surveys in the region's offshore wind planning area and began a transmission study to assess the most cost effective routes and interconnection locations.

SIEMENS SIGNED

Siemens and Cape Wind have signed a major contract in which Siemens will supply Cape Wind 130 of its 3.6 megawatt offshore wind turbines, an offshore Electric Service Platform (ESP) and a service agreement for the first 15 years of commercial operations. Siemens is subcontracting the manufacturing of the ESP to Cianbro to be fabricated in its facility in Brewer, ME. The ESP was designed for Cianbro by Moffatt and Nichol Engineers of Norfolk, VA. The turbines will be floated to the wind farm by specially constructed Jones Act barges with American crews, constructed and owned by East Coast companies, Weeks Marine and Cashman.

Cape Wind has sold 77 ½% of its power output in long term Power Purchase Agreements to National Grid and NSTAR, the two largest electric utilities in Massachusetts, Cape Wind's Mark Rodgers told *World-Gen* during a visit to his Boston office.

Seaports in North America have been active in the handling of energy generating products for centuries. Beginning with the era of the great sailing ships, including the New England whaling fleets, to the present day bulk carriers now serving global markets. Ports such as New Bedford, Boston and Portland, Maine were the hubs from which whale oil flowed to the inland populations. Today, the goals of the ports in the U.S. are similar to those in New England during the early days, however, the challenges to meet those goals have changed dramatically.

The nation's ports began handling wooden kegs of whale oil with rope and tackle ships gear. Over a three hundred year period, the development of energy related cargo handling methods have included new technologies, larger capacity storage facilities at or near dockside, higher speed unloading and expanded receiving and storing sites.

As cargo volumes continued to place greater demands, seaports, railroads and road conveyance also responded. Increased demands and the development of multi-modal carriers have brought new challenges to the ports.

The movement of increasing quantities of dry bulk energy products such as



Courtesy – Siemens

coal and wood pellets, have brought not only increases in deep water outlets but also improved land access along the US coast lines.

As America's population grew, coast line expansion continued and additional ports were created to support the new centers. In addition, seaports were developed based upon their proximity to demand, created by development of export cargoes nearby and necessary import cargo to support the growth. Eventually, ports along the US South Atlantic, Gulf of Mexico, the Pacific Coast, the Great Lakes and rivers such as the Mississippi began handling much needed products. New territories such as Alaska and Hawaii were opened and seaport development followed.

Along with expansion, a certain amount of redundancy occurred and many of the busiest ports in the early days began to fade away.

PORT OF NEW BEDFORD

With the opening of new territories, new ports were created to not only support the burgeoning populations but also new commerce developing around them. Port development continues today in response to the availability of both import and export commodities, especially those that are energy related.

As these commodities evolve, the search for increased volumes and cleaner, more affordable products have moved our energy related efforts toward new sources. In this search, Seaports such as New Bedford again have become the hub of the logistics chain, playing a key role in what and where the tools used to develop wind power are concentrated.

According to a Presidential initiative

in 2007, areas with good wind resources could provide up to 20% of the electrical supply in the USA. The potential to harness wind power, immediately became a hot topic. A number of years ago, members of the energy, logistics, equipment, consulting, manufacturing and port industries gathered to discuss the challenges and opportunities presented by the creation and handling of wind farms and the feasibility of wind power generation at the levels that were eagerly anticipated. Wind energy as a dynamic commodity, promised immense benefits to the American economy including reduced costs of power, creation of new jobs in domestic production and new found prosperity to the logistics community.

WIND POWERING AMERICA

In a Wind Powering America Program Overview, the U.S. Department of Energy indicated that the anticipated results of the development of wind projects would be a direct spin-off of over \$400 billion in economic development and 180,000 jobs. While the potential of wind power to develop these results is possible, private involvement in segments of the projects has remained in the manufacturing sector.

The significance of this project is two-fold. First, it has helped transform a port whose significance in the development of the seafaring history of the United States has all but been forgotten, and two, it provides a demonstration of the ability of public and private sectors and foreign and domestic commercial entities to work together to provide the capability of U.S. populations to improve their stake in affordable electric power generation.

WHO'S REALLY PAYING FOR SOLAR POWER?

BY JAMES CATER, DIRECTOR OF ECONOMIC AND FINANCIAL POLICY, APPA



As an electricity consumer, I seem to be getting more mail every day that tries to persuade me to install solar panels on my roof and save on my electricity bills. In fact, I'm told, I can even profit from selling excess solar power that I don't use back to my utility. "Net metering" is the buzzword. Well, who can resist "making hay while the sun shines?"

But in the long term, does solar really save costs for society as a whole? Or does it simply shift the costs from solar customers to utilities, and in turn to other electricity customers who don't use solar? Can utilities set rates that are fair to all? These are some of the questions I will discuss in to help decision makers like utility managers and public officials assess the benefits and costs, and manage the trade-offs inherent in the use of solar PV.

ECONOMICS OF SOLAR PV

The economics of solar PV can be viewed from at least three broad perspectives — of solar customers, non-solar customers, and society as a whole. Then let's do some math and derive a simple benefit-cost (B/C) ratio in which the cost of electricity produced with a solar PV system is compared to the value of its output.

$B/C \text{ Ratio} = \text{Net present value of project benefit} / \text{Net present value of project costs}$

The cost-effectiveness of projects can be assessed by comparing their benefit-cost ratios — the higher the B/C ratio, the greater the bang for the buck. B/C ratios are significantly impacted by various subsidies and tax credits available for solar projects. This is especially true for net metering systems, which causes costs to shift to those who are not incurring them.

Let's stop for a minute and understand what net metering is. According to the Solar Energy Industries Association, net metering is a billing mechanism that credits solar energy system owners for the electricity they add to the grid. For example, if a residential customer has a PV sys-

tem on the home's rooftop, it may generate more electricity than the home uses during daylight hours. If the home is net metered, the electricity meter will run backwards to provide a credit against what electricity is consumed at night or other periods where the home's electricity use exceeds the system's output. Customers are only billed for their "net" energy use. Exported solar electricity serves nearby customers' loads.

Over a period of time, the electric output from a solar PV system will be less than, equal to, or greater than the host customer's electricity usage. If the output exceeds the customer's usage, he or she can "sell" the excess power to the utility. Rather than actual sales transactions, this typically involves the utility crediting the customer for power production from one period against power usage in another period. The utility is, in effect, purchasing the net output of the project. The incremental costs of this purchase will be offset to some degree because the utility avoids the costs of procuring the output from a different source. However, if the utility's payments to customers exceed its avoided costs, the utility's total costs go up and it may have to charge higher electric rates for all customers — so in effect, the non-solar customers end up subsidizing the project.

NET METERING PROGRAMS

Solar customers with net metering continue to rely on their utility's distribution system to meet their needs when the solar panels are not producing, when usage exceeds output, and when selling excess power to the grid. So, for the most part, distribution costs are not avoided and solar customers are simply not carrying their corresponding share of distribution and other embedded costs when they avoid, or are paid, rates designed to recover those costs.

In my paper, I discuss how net metering programs can affect rates paid by non-solar customers, and demonstrate how this cost shifting can be avoided through thoughtful rate design by utilities.

We must remember that along with the effects of cost shifting, other key variables — direct project costs, cash flows associated with wholesale market products, societal subsidies, and external factors — can cause the economics of solar PV to vary across stakeholder groups. For example, projects that qualify for a federal investment tax credit can yield cash flow benefits to the stakeholder group that invests, but not to society or other stakeholders. Global environmental benefits might appear as positive cash flows for society but not for utility customers —

at least not the full amount — because customers will garner only a negligible fraction of the societal benefit. The value of renewable energy credits flows to the stakeholder groups that hold the rights, but not to groups that don't.

UTILITY-SCALE SOLAR

The paper discusses how cost shifting can be avoided through larger solar PV projects undertaken by utilities rather than by individual customers installing panels on their rooftops. Larger utility-scale solar PV projects have lower unitized, all-in costs. Although under many circumstances average utility rates will increase with utility projects, as they do with net metered projects, the magnitude will be less and the cost shifting between customers is eliminated. The overall increase will be less, other things equal, because utility sales do not decline. Thus fixed costs are spread over more billing units. The tension between solar and non-solar customers is eliminated because all customers will be solar customers.

Conventional rate design mechanisms provide familiar tools for utilities to manage cost shifting and rate impacts. For example, a utility can minimize cost shifting by setting the volumetric charges as close as possible to its actual variable costs, while relying more on customer charges and less on usage-sensitive demand charges to recover fixed costs.

In addition to managing cost shifting, proper rate design can also help to prevent ill-informed public perceptions about a utility's attitude toward renewable resources and energy efficiency. Solar proponents have assailed utilities for attempting to mitigate cost shifting by imposing surcharges on net metering production. However, these surcharges actually make good economic sense when a significant portion of a utility's fixed costs — costs not avoided by net metering programs or energy efficiency measures — are recovered through the utility's volumetric charges. In such circumstances, a properly designed surcharge would be fair, and economically efficient.

Solar PV has been growing rapidly in recent years, but the rapid growth does not, by itself, demonstrate the economic viability of solar PV as a power resource. It is clear that the penetration of solar PV has been aided by direct subsidies, and indirect subsidization in the form of higher utility rates and cost shifting to non-solar customers.

Decision makers, both public authorities and utility managers, will have to balance different constituent interests when setting and pursuing renewable goals.

ABOUT THE AUTHOR

Before joining APPA, James Cater was manager of power and market analytics at Green Mountain Power Corp. in VT. He has a Bachelor's Degree in Economics from Western Connecticut State University and a Master's in Economics from American University and is a candidate for his Ph.D in Economics.

ABOUT THE APPA

The American Public Power Association (APPA), is based in Washington DC, serves the nation's more than 2,000 community-owned electric utilities. Created in 1940 as a nonprofit, non-partisan organization, APPA advances public policy interests and provides member services. The APPA website address is www.PublicPower.org.

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TEMPLE 1 COMMISSIONED

BY DICK FLANAGAN



L to R: Lee Peterson (Temple EDF), Troy Fraser (Texas Senate), Todd Carter (Panda), Janice Carter (Panda), Robert W. Carter (Panda); Drayton McLane, Jr. (McLane); Mary McLaughlin (Bechtel); Danny Dunn (Mayor, Temple), Barry Nicholls (Siemens).

TEMPLE, TX – Panda Power Funds, Siemens Energy and Bechtel Power dedicated the Panda Temple 1 Power Project located at the Synergy Industrial Park on September 25th, 2014. The project on a 250 acre greenfield site started by excavating 80,000 cubic yards of dirt; pouring 24,000 cubic yards of concrete and installing 1,086 tons of steel, 24 miles of pipe and 284 miles of electrical cable. *World-Gen* and other media were invited to this first Flex-Plant in commercial operation in Texas. The plant has been strategically located to meet electricity demand in the “Texas Triangle”, an area bordered by Dallas, Austin, San Antonio and Houston, four of the fastest growing metropolitan areas in the United States.

Siemens Energy supplied the natural-gas-fired Combined Cycle Power Plant in consortium with its partner, Bechtel. The multi-shaft plant is a Siemens Flex-Plant configuration, with a gross installed electrical capacity of 758 megawatts. Innovative design features are incorporated to enable fast start, and fast ramping up and down across a large operating window from low plant turn-down to high plant output with Carbon Monoxide (CO) emissions less than 10 parts-per-million (ppm), and Nitrogen Oxide (NOx) emissions less than 2.0 ppm.

Siemens also delivered two SGT6-5000F gas turbines, one SST6-5000 steam turbine, two SGen6-1000A generators, one SGen6-2000H generator, the SPPA-T3000 instrumentation and control system as well as two Benson heavy duct-fired heat recovery steam generators manufactured by NEM USA Corp and other key cycle components. A long-term service agreement is also in place for the main generation

components. Bechtel was responsible for the balance of the plant engineering, overall plant construction, procurement, and led the commissioning of the facility. The gas turbines for this project are equipped with Shaping Power™, a feature which enables higher power output on higher temperature days.

“Siemens fast and efficient Flex-Plant technology is a perfect fit in balancing intermittent renewable resources and providing low cost electricity,” said Martin Tartibi, Senior Executive Vice President at Siemens Energy Solutions Americas. “The Panda Temple plant is the third Flex-Plant in commercial operation in the United States and it will be

considered one of the cleanest fossil-fueled plants in the nation.”

“Temple was our very first project working with Siemens, and we made the right choice,” said Todd Carter, President of Panda Power Funds and a member of *World-Gen*’s Class of 2013. “We are impressed with their state of the art technological power plant solutions and service.”

“Panda Temple I represents a tremendous team effort, including our consortium partner Siemens and Panda Power Funds, both of which worked seamlessly to bring the plant online early, which was important for our customer and the community,” said Mary McLaughlin, president of Bechtel’s thermal power business line. “We are pleased to have delivered a quality plant safely. As a result of a strong safety culture, the team worked the duration of the project without a single lost-time accident.”

About 70 percent of the project’s subcontractors and 80 percent of Bechtel’s craft workers were from Texas.

Bechtel introduced a pilot program, Military Relations Strategic Initiative, at Temple I to hire separated military veterans at Ft. Hood to fill 15 positions during construction. The Bechtel initiative is planning to fill a total of 600 positions with returning veterans company-wide.

Bechtel and Siemens also are working as a consortium to deliver the Panda Temple II Generating Station, adjacent to Panda Temple I; the Panda

Sherman Power Project in Sherman, Texas; and the Panda Stonewall Power Project in Leesburg, Virginia. The projects are similar in size to Panda Temple I and, when completed, will collectively generate enough electricity to power almost 3 million homes.

Panda Power Funds is a private equity firm headquartered in Dallas that has the ability to develop, acquire, construct, finance and operate utility-scale, natural gas-fueled power generation facilities. Panda has two 758 megawatt combined-cycle power plants in operation in Temple and Sherman, Texas and three combined-cycle power plants currently under construction in Texas and Pennsylvania with a total capacity of more than 2,400 megawatts. Panda Power Funds also has two power projects in advanced development: a 778 megawatt combined-cycle power plant in Northern Virginia and an 859 megawatt power facility in Southern Maryland. The fund built a 20 megawatt solar farm in Southwest New Jersey that is one of the largest solar facilities in the Northeast United States.

Panda has a 59 person, full service professional team. Employees average more than 20 years of industry experience and 7 years tenure at Panda Funds, and the fund has financed approximately \$4 billion of generating capacity during a two year period.



Courtesy – Panda

AES'S 4TH GENERATION ADVANCION

BY BRETT GALURA, VICE PRESIDENT, SOLUTION DEVELOPMENT
AES ENERGY STORAGE



AES launched its energy storage business six years ago with the commercial operation of AES Los Andes ES, a 24MW, lithium-ion based energy storage system located in the Atacama desert in northern Chile. Acting as flexible capacity, the spinning reserve function it performs is a common one. To many, it seemed like a technological leap yet the primary technology employed was far from new, lithium-ion batteries and IGBT based power conversion systems, both developed in the 1970's, began broad commercial adoption in the early 1990's.

Utilities that need new sources of reliability and flexibility today have a valuable "new" resource to turn to in energy storage. With open and competitive bids where flexible capacity is needed, storage can win competitively based on its merits. But today's challenge isn't limited to providing reliable electricity cost-effectively, but to do so sustainably. California, Hawaii, New York, and others are showcases for recognition of this need, each acknowledging the value of energy storage in their recent capacity requests.

This more recent mandate of sustainability adds tough criteria to an already restrictive set of filters. The underlying technologies must be proven ones and companies supplying those solutions must have financeable balance sheets that banks and insurers are comfortable with. Utilities seek to deploy resilient systems that can handle circumstances planners may not be able to model or anticipate. This will translate to robust networks that are ready to absorb renewables at any level and to withstand unanticipated disruptions.

As an owner and operator of eight utility companies and over 30GW of generation in 20 countries, AES has served utilities and grid operators reliably and dependably for over 30 years. AES has a

proven record of developing and financing power projects, matching appropriate technology to meet customer needs.

Consistent with this experience, AES has developed and operates over 200MW of lithium-ion battery based energy storage resources and, as the leader in utility scale commercial energy storage, continues to develop and offer energy storage solutions to utilities globally.

STORAGE IS THE ENABLER

According to the US Energy Information Administration (EIA), in the next 10 years the US electric sector will spend over \$25 billion on new resources to meet needs for reliability and increased needs for flexibility. Most of these capacity additions will come in the form of natural gas fueled simple-cycle combustion turbines which typically operate for fewer than 7% of all hours in a year due to their relatively high operating costs.

Energy storage—as a cost competitive provider of flexible capacity—can be dispatched immediately, has no emissions when operating, has no standby costs, can be located to strengthen natural weak points, and can be operated to manage and balance supply and demand since it is a source of both generation and load. No other resources in any combination can accomplish these critical tasks as quickly, reliably, and cost effectively.

When located strategically, utility scale energy storage systems can dramatically increase grid reliability and eliminate the possibility of large, and potentially, cascading blackouts caused by transmission faults and generator trips. AES Los Andes ES provides evidence of this. Since beginning operations, the 24MW facility has helped to eliminate an entire layer of load shedding in SING, the northern grid of Chile.

Today, lithium-ion battery based energy storage solutions exist, built on mature, technology with costs under \$1000/kW—on par or better than a prior generation of solutions—due largely to the scale and maturity of their manufacturing.

Energy storage is not new, pumped-hydro gained adoption in the 1970's, paralleling the adoption of nuclear power. While technologically sound, it is difficult to site, has a long development cycle and has significant development and construction costs. Because pumped-hydro also has significant geological requirements it is nearly impossible to site based on need. While there may be some cases for its development and use, it is a blunt instru-

ment, unable to target precise needs and is impractical to rely on as a widely available option for capacity planning or grid resiliency.

CAES fundamentals are similarly not in favor of widespread adoption, illuminated by the fact that only 3 commercial plants have been built in the last 30 years. While there are a few new projects underway, the geological requirements severely limit its placement and effectiveness. While there may be some engineering successes, it is not a market solution widely available for adoption and is a difficult technology to progress past the idea stage of development.

Batteries differ significantly. Battery based energy storage systems are free from the constraints of peculiar geologies and pre-existing conditions and can be located exactly where they are needed to support grid stability. They can be scaled to any size needed, quickly, or over time to match changing needs. Built in factories for decades, batteries are not new, but are emerging as the star of commercial energy storage.

OTHER BATTERIES MAY FIND NICHES

Within the world of battery solutions there might seem to be a variety of choices. At AES we track the development of over 100 new technology energy storage startups and universities. Some of these new technologies may eventually find their way to commercial viability and widespread use but it is impossible to choose a new-technology winner at this stage.

While new technology development must continue, much of it does so against an ocean of R&D in the lithium-ion industry which already has massive revenue from consumer electronics and transportation and several decades head start in scale and practical experience.

Prudent, progressive, and smart utilities are choosing lithium-ion based energy storage solutions because, as a technology, lithium-ion has nearly 25 years of commercial use and is approaching nearly a half-century of research and development. It is estimated that between 2 and 3 billion dollars per year are spent on lithium-ion R&D which is likely to increase over the next decade thanks to the combined interests of consumer electronics, automotive, and power industries. Lithium-ion is established, yet its research is broad, with academia and the private sector both contributing significantly. No other power technology is available which shares its development

costs with similarly massive global industries.

Of the choices among battery based energy storage, only lithium-ion is mature, cost competitive, produced at scale, and financeable.

COMPREHENSIVE SOLUTIONS REQUIRED.

While lithium-ion technology is mature, solutions from experienced power industry companies are needed. Solutions must be integrated with existing utility operations, not only technically, but in a manner consistent with existing operational practices.

This need is why AES has developed Advancion™, a scalable, advanced battery array available for purchase or under contract to utilities globally. Advancion™ is AES' 4th generation energy storage array and combines key components—battery modules and power conversion—from leading suppliers with an aggregation and control system designed by AES based on years of operational experience with a focus on reliability and safety.

When a technology so highly evolved as lithium-ion is offered and delivered by experienced electric industry participants like AES, the utilities are able to select the most mature, robust and suitable solutions to meet our needs for clean, cost effective and sustainable power. No other battery technology has the maturity and cost effectiveness of lithium-ion and no storage technology other than batteries brings all the smart benefits of grid stability and resiliency quickly, cost effectively, and sustainably.

In the next ten years the US will spend \$25 billion on flexible capacity resources. Energy storage is the right choice to meet much of that need.

ABOUT THE AUTHOR

Brett Galura is the Vice President of Solution Development for AES Energy Storage. In his 21 years at AES he has architected and managed the deployment of multiple, global, information technology projects, overseen commercial operations development in an AES retail electricity business, co-founded an AES telecom business and directed AES' IT operations expansion in Asia and the Middle East. In his current role with AES Energy Storage he is responsible for technology selection, solution architecture, controls development and market & system modeling.

FT4000[®] INTRODUCED

CONTINUED FROM PAGE 1

core from Middletown, CT and the low pressure compressor and turbine, which are being assembled in Florida, will be accomplished at a newly reconfigured facility for the sole support of the FT4000[®] engine assembly and test,” Chuck Levey says. “This dedicated FT4000[®] facility is located on the Pratt & Whitney assembly and test facility located in West Palm Beach, Florida.”

Maher took us back in time discussing the design objectives of the FT4000[®] engine. “One of our primary objectives was to fully leverage the PW4000[™] flight engine core, applying its more than 34 million hours of demonstrated fleet reliability to our industrial gas turbine. In addition we desired a new low pressure spool, featuring both technology to assure performance, and lower cost construction to help assure desired economics. The FT4000[®] low pressure spool features higher speed aerodynamics consistent with Pratt & Whitney technologies from its current aero products while also incorporating materials and manufacturing processes aligned with industrial gas turbine applications and requirements.

Maher continued highlighting that the new low spool design, in particular its performance and operability characteristics, was a significant deliverable for the program with measured results well aligned with pre-test predictions. Over the past two months, the engine successfully completed close to 150 operating hours at the Palm Beach facility, validating the engine’s ability to support customer requirements such as quick start and response capability. “We have been able to demonstrate less than 10 minute start capability on the engine through numerous starts and stops throughout the test program,” Maher confirmed. The engine also demonstrated compliance with targeted emissions requirements at intended water-to-fuel ratios. “We are pleased with the engine’s ability to meet expectations thus far and are now positioned to complete our next phase of testing planned at a customer installation early next year.”

“We’ve taken a proven hybrid approach,” Levey said. “The FT4000[®] turbine provides the operability and flexibility of an aero derivative engine, and the ruggedness of industrial component designs, all of which are fundamental to the FT4000[®] package.” Levey added that the engine is designed for power augmentation. The 120 megawatt twin pack configuration under standard ISO conditions can produce approximately 138 megawatts of power generation with wet compression, adding flexibility to the overall design and operability characteristics of the engine itself.

Maher explained the evolution of the FT8[®] engine to the FT4000[®] engine. “We’ve got extensive experience and success with both our FT8[®] SWIFTPAC[®] and MOBILEPAC[®] gas turbine package

and have applied this experience to our continued evolution of the FT4000[®]. Obviously, with the larger and heavier FT4000[®] design, some integration adjustments are necessary, and are based upon effective application of our years of integration expertise. For example the fuel and hydraulic systems are fully integrated within the enclosures prior to delivery, and while lubrication and water injection skids are not integrated within the enclosures, they are unitized and are factory checked and flushed before site delivery. The gas turbine enclosure is fully fabricated and assembled and has a separate roof assembly. This is an evolution of the FT8[®] design, and is fully integrated with key components and fit-checked for proper assembly prior to site delivery. Quick disconnect cabling has been a key feature of our FT8[®] package designs, and is carried over to FT4000[®] package, reducing on-site labor once the equipment is delivered. Also, significant care was taken to provide proper access and ease of engine removal and installation to reduce desired maintenance turn-time when necessary.

Levey said the FT4000[®] program will evolve to address the oil and gas industry as well. “We have a wider focus with adjacent markets such as oil and gas, leveraging the synergies we now have with our Mitsubishi compressors.” He added, “Mitsubishi has been able to add value to the overall business with their engineering

and industry experience, enabling a healthy working relationship between engineers as we’ve brought the FT4000[®] package through development.”

ABOUT PW POWER SYSTEMS, INC.

PW Power Systems, Inc. (PWPS), headquartered in Glastonbury, CT, is a world leader in the supply of energy solutions for the power generation industry. PWPS provides an array of products and services, including gas turbine packages, industrial gas turbine aftermarket services, and engineering, procurement and construction services. PWPS is a group company of Mitsubishi Heavy Industries, Ltd. (MHI). MHI, headquartered in Tokyo, Japan, is one of the world’s leading heavy machinery manufacturers, with consolidated net sales of approximately \$32.5 billion for the fiscal year ending March 31, 2014. MHI’s diverse lineup of products and services encompasses shipbuilding, power plants including distributed power, chemical plants, environmental equipment, steel structures, industrial and general machinery, aircraft, space systems and air-conditioning systems. To learn more about PWPS, visit www.pwps.com.

ABOUT CHARLES E. LEVEY

Chuck Levey is Vice President of PW Power Systems, with responsibilities that include worldwide sales and marketing of all PWPS’ products and services, directing

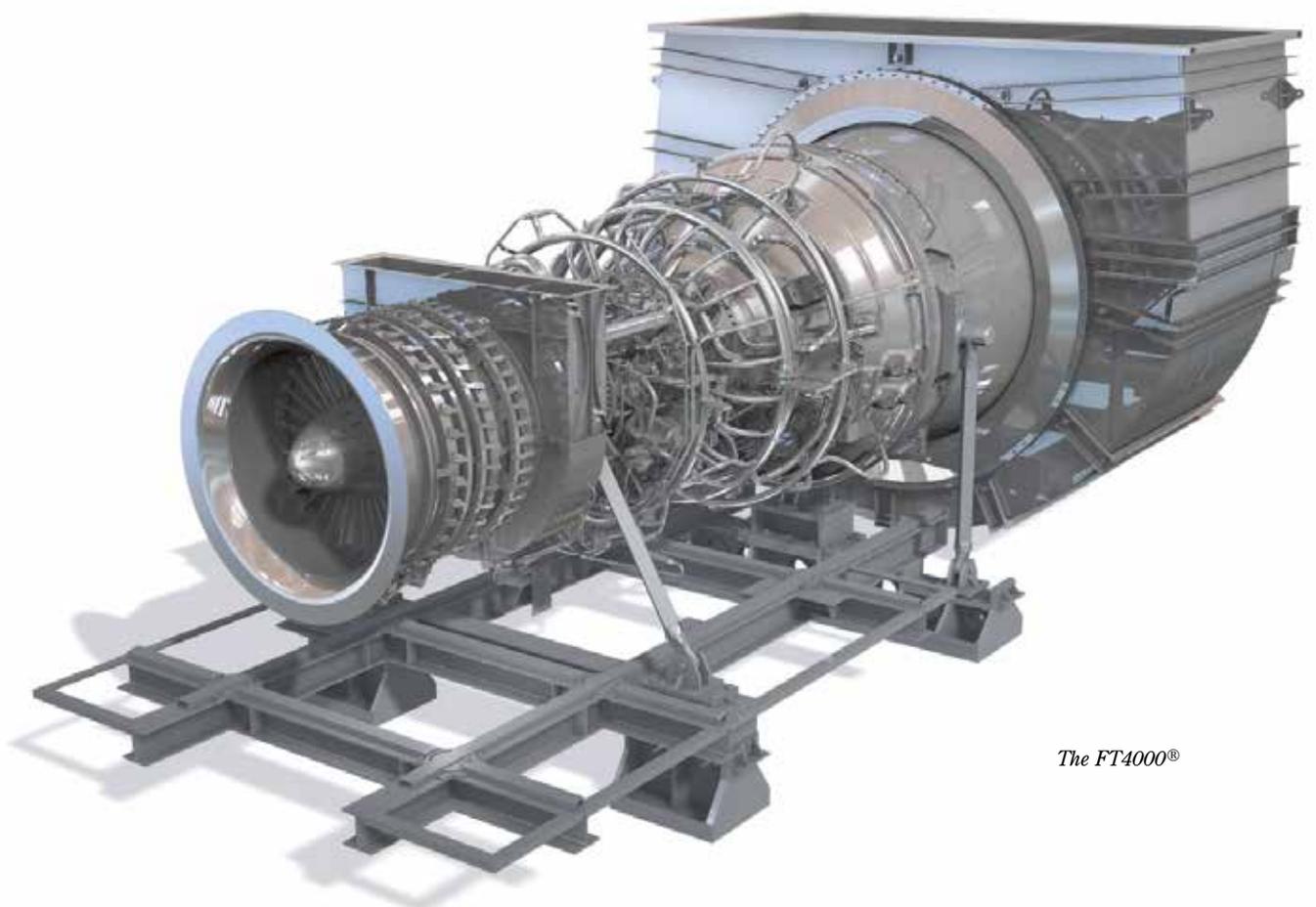
product and market expansion and business development activities. He also serves on corporate executive committees for emerging markets, investment strategy and the identification and development of new product and service offerings.

Chuck obtained his MBA from the University of Connecticut and graduated the State University of New York, Maritime College with a Bachelor of Engineering degree in Mechanical Engineering.

ABOUT DAVID MAHER

David Maher has been with PW Power Systems since 2000, serving most recently as Vice-President, FT4000[®] Program. David has program management responsibility for the design, development and successful introduction of the FT4000[®]. Prior to 2010, David had responsibility for its current aero-derivative business, the FT8[®], where he oversaw the successful development and introduction of the FT8-3[®] in 2005 as well as the operations ramp-up and overall project execution. Prior to joining PW Power Systems, David held a variety of management positions within Pratt & Whitney’s commercial aerospace businesses.

David holds a Bachelor of Science in Mechanical Engineering from Clarkson University.



The FT4000[®]

THE NETHERLANDS GREENOVATES

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concept for green energy-sustainable Data Centers acting as Energy Prosumers within a Smart City/Smart Grid paradigm, in which the Data Center will be the key transformation nodes.

SMART CITY

Amsterdam Smart City (ASC) is a six year program to transform Amsterdam's Metropolitan area into a smart city with 120 partners. The EC K P7 Smart City program is partly funding the project through 2015.

SMART GRID

In Amsterdam Nieuw-West, the first intelligent grid has been implemented providing energy for 10,000 households. Computers and sensors have been placed at interconnecting nodes meaning the middle voltage grid can be operated remotely. The current grid has been improved with two-way communications.

ELECTRIC VEHICLES

One learns to look in both directions, to the right for cars and to the left for bicycles before crossing Dutch streets. (While we're on this subject, let me add that Utrecht is building a garage - not for cars - but to park 18,000 bicycles.) The Netherlands has over 35,000 electric vehicles. Nine out of ten cars travel under 40 miles a day. One site visit was to meet Mark Schreurs who heads up "Mr. Green," a fast charging EV network. The existing stations can charge in 10 minutes and plans are to add 25 new EV highway locations in 2015.

ECN

Professor Wion Sinke, Manager of Program Development at the Energy Research Center of the Netherlands (ECN), Chairman of the European PV technology platform and director of Top consortium Solar Energy, told *World-Gen* that ECN is an international leader in energy innovation. It does research in solar power, wind energy, biomass, waste, energy efficiency, the environment and sustainable energy systems. ECN also advises on policy and strategic matters as an independent third party. ECN's research focuses on finding innovative solutions to promote the use of sustainable energy and energy conservation. Almost sixty percent of all solar panels across the globe utilize ECN technology.

INNOVATIONS

Target Holding was launched in 2009 and has 50 employees to achieve optimal value from innovative analysis and search methods. The amount of information is exploding generated by complex sensor networks. Target offers an ICT infrastructure with a storage capacity of 10 Petabytes, DR. G.J.W Van Dijk shared.

INRG has developed an energy management system called "I-CE" which is

connected to a smart meter. It provides information into the amount of power and gas consumption, energy costs and the energy produced from solar panels. The I-CE system will be deployed as a third generation product in 2014 with a two year warranty and a ten year guarantee. The site visit was conducted by Lusanne Van Benthem at the Energy Transition Center (EnTranCe) where products are tested and sustainable partnerships established with universities, governments and private companies.

Enexis launched two pilot projects on smart grids in 2012, Rund van.de.Meeberg said. The results of the projects will guide the development of future local energy systems in The Netherlands. Residents produce their own energy using photovoltaic panels, possess a smart meter, energy computer and a smart washing machine which communicates with the energy computer. These smart appliances allow participants to make decisions based on actual energy use, increasing efficiency and reducing costs. Residents will also receive a 24 hour forecast of energy prices per hour. Enexis installs and maintains the distribution networks in northern, eastern and southern Netherlands and has 2.6 million customers.

Brake energy released from trains stopping at the Apeldoorn Station can be used to charge an EV for a 350 KM drive, Auke Huisman explained. The Wheel is a unique in-wheel motor driving device in e-mobility. The main patent was granted in 2001. Today, e-Traction employs 36 employees. In 2012, the majority of the shares of e-Traction were acquired by private investor De Hoge Dennen Capital.

Windcat Workboats was founded in 2002 in the Netherlands and is Europe's leading provider of crew transfer vessels to the offshore wind power industry. They have 35 vessels in operation staffed by 120 offshore and 25 onshore and have had one million transfers with safety as their highest priority and are developing new safety platforms as passengers disembark, Rob Van Rijke told *World-Gen*.

Stedin has two million customers with revenues of euro 1, 106 million and a net profit of euro 259. It has 70 municipal stakeholders and invests euro 500 million in their networks. In Rotterdam, Stedin is taking the lead with a self-healing grid in the event of a power outage, the part of the network where the fault has occurred is automatically isolated by means of ICT/electro technology. The unaffected part will continue to be operational or will be quickly reconnected, Harald Hanmaaijer said.

Paul Stoelinga of DEERS gave *World-Gen* a tour of the system that collects seawater at the entrance of the harbor and a heat exchanger transfers the heat to a distribution network for district heating to 800 homes in Duindorp. The heat exchanger is made of aluminum, not titanium by Alfa-Laval resulting in substantial cost savings.

Dr. Monique Hoogwijk told *World-Gen*

that Utrecht has a 200,000 euro fund for loans up to 10-15 years at 2 percent for insulation and solar panels on homes. It's a one time loan with a maximum of 15,000 euros per home. There's also a six and a half million euro budget for businesses. Dr. Hoogwijk gave the example of SOLEASE that started in November, 2013 after receiving a 100,000 euro loan for their solar panel business.

THE RENEWABLE ENERGY FOUNDATION

"The Renewable Energy Foundation aims to promote and encourage the use of renewable energy in the Netherlands. The purpose of the foundation is to influence and lobby on politics and policy in favor of renewable energy," said M. Van Eijkelenburg. Participating trade associations represent several hundred companies and institutions.

(continued on page 19)

THE DARCY LAB

By Dr. Ir. Huiniak

AMBITION & AIM

The ambition is to realize a stable and affordable compact thermal battery for loss-free heat storage. TCM's (Thermo Chemical Materials) seem to be the most promising route for realization of such a battery. The concept of most TCM is based on (de)hydration or oxidation/reduction reaction of inorganic crystals. A typical example is the hydration of MgSO₄. The aim is to boost the development of appropriate TCM materials for compact seasonal heat storage or low temperature waste heat.

DRIVERS OF THE INITIATIVE

Driver 1: Built environment - In 2020, 48% of the energy consumption will be thermal energy. There is an unbalance between heat production, (not needed in the summer) and heat consumption (needed in the winter). A heat battery could solve this problem. It enables local solutions for heat production and consumption and reduces the need for transportation.

Driver 2: Low temperature waste heat - A large amount of the industrial heat production is emitted to the environment. A stable and compact heat battery could facilitate storage, transport and trade of thermal heat.

CHALLENGES WITH TCM'S

Improving the energy density of TCM materials: Compact storage demands small volumes and high energy densities. The most promising materials have intrinsic energy densities around

1-3 GJ/m³. The effective energy densities are generally lower, because optimal heat and mass transfer demand specific reactor geometries.

Improving the lifetime of systems with TCM materials: The most promising class of TCM materials for the built environment are salt hydrates. Hydration/dehydration reactions involve volume changes that destabilize the material. Stabilization of TCM's is a key issue.

Tuning Power: Depending on the application there are different specifications regarding the rates of (dis)charge. To tune the kinetics the interplay between the solid-solid reactions in a TCM and heat/mass transfer has to be known. The heat conductivity of the TCM materials itself and the TCM-conductor interfaces have to be improved.

Safe Operation Window: As the aim is to develop a battery for a dwelling, the operations have to be done not far from the ambient pressure and at moderate temperatures. A key to the success of TCM's will be the ability to tune phase behavior into the appropriate window.

CONSORTIUM

A Dutch multidisciplinary consortium is now initiating research activities to tackle the challenges above. Within this consortium the Eindhoven University of Technology plays a coordinating role. Included are the energy technologists and transport physicists of the Eindhoven University of Technology, solid-state and theoretical chemists of the Radboud University (Nijmegen).

ABOUT DR. HUININK

Dr Huinink is an Assistant Professor at Eindhoven University of Technology in the Dept of Applied Physics/group Transport in Permeable Media (TMP). His research expertise is the transport of molecules through (porous) materials/imaging with NMR and modeling. He is active in cooperation with several universities to develop a "heat battery" for the built environment (seasonal heat storage).

THE NETHERLANDS GREENOVATES

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UNIVERSITIES

Forty percent of Utrecht's population is academic, attending Utrecht University founded in 1636. The University invests heavily in four strategic themes: Life Sciences, Sustainability, Institutions and Youth & Identity. Utrecht University is the only faculty of Veterinary Medicine in the Netherlands. According to the Shanghai Ranking, Utrecht University is the number one research university in the Netherlands, ranks 13th in Europe and occupies a shared 52nd position worldwide. University Medical Center Utrecht is one of the top-ranked medical centers in Europe. The European Union named Utrecht as Europe's most competitive region for the second time.

The tour included a visit to Technische Univestest Eindhoven (TUE) to view laboratory research on three products.

SPINID

Dr. Ivo Jongsma shared his research on Spinid. Spinid designs and engineers chemical reactors and separators based on patented "Spinning Disc Technology", enabling higher resource and energy efficiency, improving product quality and allowing process window extension. Unprecedented process controllability combined with high throughput makes this platform technology unique.

CYCLOX

Dr. Michael Boot provided a smell test of the result of CYCLOX using flavors from plants. CYCLOX is a new diesel fuel invented by the Combustion Technology Department at Eindhoven University of Technology. CYCLOX is a 'double-green' fuel because it prevents the emission of nitrogen oxides and soot and can eventually be produced from plant waste. One will be able to "fuel-up" with a fuel smelling something like a rose instead of benzene with its carcinogenic potential.

DARCY LAB

Dr. Ir Huinink heads up the Darcy Lab at TUE and demonstrated the battery storage under development. The focus of the Darcy Lab is the development of better materials for energy storage. The development of a thermal battery based on saline hydration is the ultimate goal of the Lab. The man-made crystal, MgSO₄ is a promising material for compact long term heat storage.

KERINGHUIS

The last visit was to see the Maeslant storm surge barrier, the world's largest moveable water barrier located on the Scheur River. It consists of two massive steel doors; each door is equal to the height of the Eiffel Tower. The storm surge barrier took six years to build and was completed in 1997 and is the last part of Delta Works, a series of dams and dikes commissioned after the North Sea flood of 1953.

J920 LAUNCHED IN US

CONTINUED FROM PAGE 1

(266°F) can feed a district heating system and maintain a water return temperature of up to 70°C (158°F).

The J920 FleXtra engine has three major sections, the turbocharger auxiliary module (TCS), the generator and the one-ton power engine. No separation is required during maintenance; major parts can be serviced from the top. The main engine comprises the cylinder head, piston, cylinder liner, conrod and other significant components. Its compact design and individually mountable main assembly reduces onsite labor time during routine maintenance.

GE's online monitoring and diagnostic tool provides online access to plant and J920 FleXtra equipment. In addition, myPlant technology enables GE to monitor and control global fleets of Jenbacher gas engines. The myPlant technology transmits sensor data back to GE enterprise servers to calculate the plant's operation state, predicts faults and analyses any issues. All maintenance work on J920 FleXtra gas engine systems-including upgrade, repair and overhauls-is performed at the plant, saving time while updating the engine to the latest technology.

J920 IN EUROPE

GE's 50-Hz version of the J920 FleXtra along with a large-scale pilot program was started at the Stadtwerke Rosenheim municipal cogeneration plant in the city of Rosenheim, Germany in April, 2013. The plant generates 40 percent of Rosenheim's electricity and 20 percent of its heating requirements. The Rosenheim CHP plant stores heat in hot water tanks. As wind and solar energy kick in, the facility can switch to these power sources. During summertime, when district heating is no longer necessary, the J920 FleXtra gas engine supplies peaking and balancing power to

the municipality's electricity distribution network. Residents of Rosenheim have installed rooftop solar panels, adding 10 megawatts to the local grid. Sudden weather changes cause fast spikes in solar power. The city must compensate for those spikes with its own assets in order to maintain the power balance and stabilize the grid.

GE also announced that E.ON Hanse Wärme GmbH is planning to build northern Germany's largest gas engine combined heat and power plant with a 6.8 million euro investment, which will include the 50-Hz J920 FleXtra. Construction of the plant started in March, 2014.

The J920 FleXtra for combined heat and power has extensive operational and environmental benefits. When compared with other gas engines in the same output range, GE's J920 FleXtra can prevent the equivalent of about 1,500 tons of carbon dioxide emissions annually, and fuel savings of more than 6.4 million kilowatt hours of natural gas can be achieved per year.

J920 IN ASIA

GE will provide project developer Navigat Energy Pte Ltd with 100 new Jenbacher gas engines that will generate a total of 330 megawatts at a number of independent power production sites in Indonesia and Thailand.

GE will provide four Waukesha 12V275GL+ gas engines and two VGF48GL units to help upgrade Pertamina's Lembak gas compression increasing the gas transmission pressure to the customer's liquid stripping plant and fertilizing plant.

GE and Green& Smart Sdn Bhd (GNS) will provide a proven solution for waste-to-power using GNS' patented technology in anaerobic digestors and GE's Jenbacher gas engine technology to produce power and supply to the

Malaysian electricity grid.

GE Oil & Gas and GE's Distributed Power businesses signed a memorandum of understanding with PLN Enjiniring to develop an integrated virtual pipeline power generation pilot project in remote islands of Indonesia.

CAPACITY TO GROW

GE estimates that distributed power capacity additions will grow from 142 GW per year in 2012 to 200 GW per year in 2020. Investment in distributed power technologies will jump from \$150 billion to \$205 billion. It is important to note that distributed power's continued rise will probably not follow a steady path on an annual basis. Instead, distributed power will rise like a tide-ebbing and flowing as the underlying drivers strengthen and weaken over time, GE warned.

GE's Distributed Power business unit combines three product lines-aeroderivative gas turbines, Jenbacher gas engines and Waukesha gas engines. Distributed Power is focused on power generation at or near the point of use, on or off the grid.

Distributed power generation plays a vital role in providing reliable and long-term power solutions. Developed regions have a growing need for decentralized power to stabilize the grid, as the number of renewable installations continues to rise. At the other end of the spectrum, remote communities and facilities can receive distributed power without having to wait for a transmission and distribution network to be established.

Distributed Power is one of GE Power and Water's six business units. It is located in Cincinnati, OH and employs 5,000 globally.





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