

WORLD-GENERATION

WWW.WORLD-GEN.COM

FEBRUARY/MARCH 2017

CLASS OF 2017



Joe Mastrangelo
GE



Aymeric Sarrazin
SIEMENS



Gary Rackliffe
ABB



Sharelynn Moore
ITRON



Anil Srivastava
LECLANCHE



Michael Kotelec
VERIZON



Marlene Motyka
DELOITTE



Fai Lam
NOKIA



Jamie Resor
GROSOLAR



Abigail Hopper
SEIA



Maria Korsnick
NEI



Craig Evans
ESS



Phil Giudice
AMBRI



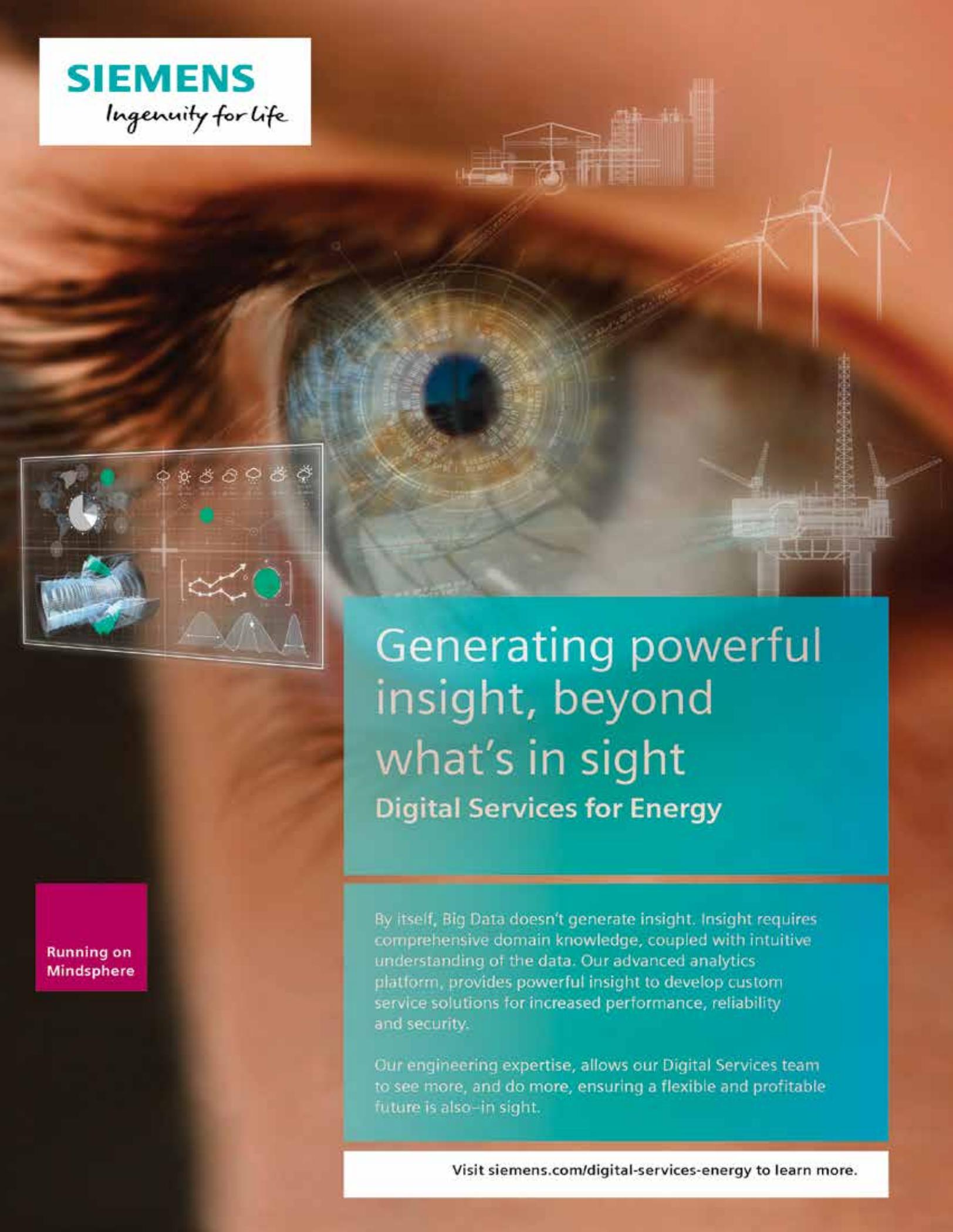
Gordon Murray
WPAC



Andre Borschberg
SOLAR IMPULSE



Bertrand Piccard
SOLAR IMPULSE



SIEMENS

Ingenuity for life



Generating powerful insight, beyond what's in sight

Digital Services for Energy

By itself, Big Data doesn't generate insight. Insight requires comprehensive domain knowledge, coupled with intuitive understanding of the data. Our advanced analytics platform, provides powerful insight to develop custom service solutions for increased performance, reliability and security.

Our engineering expertise, allows our Digital Services team to see more, and do more, ensuring a flexible and profitable future is also-in sight.

Running on
Mindsphere

Visit [siemens.com/digital-services-energy](https://www.siemens.com/digital-services-energy) to learn more.

TABLE OF CONTENTS

PUBLISHER'S LETTER	pg. 3
JOE MASTRANGELO, PRESIDENT & CEO	pg. 4
AYMERIC SARRAZIN, SENIOR VICE PRESIDENT	pg. 6
GARY RACKLIFFE, VICE PRESIDENT	pg. 8
SHARELYNN MOORE, VICE PRESIDENT	pg. 10
ANIL SRIVASTAVA, CEO	pg. 12
MICHAEL KOTELEC, GLOBAL PRACTICE LEADER	pg. 14
MARLENE MOTYKA, US ALTERNATIVE ENERGY LEADER	pg. 15
FAI LAM, DIRECTOR	pg. 16
JAMIE RESOR, CEO	pg. 17
ABIGAIL ROSS HOPPER, PRESIDENT AND CEO	pg. 18
MARIA KORSNICK, PRESIDENT AND CEO	pg. 19
CRAIG EVANS, CEO	pg. 20
PHIL GIUDICE, PRESIDENT & CEO	pg. 21
GORDON MURRAY, EXECUTIVE DIRECTOR	pg. 22
ANDRÉ BORSCHBERG, ENGINEER & PILOT	pg. 24
BERTRAND PICCARD, DOCTOR & PILOT	pg. 25



Dick Flanagan
flanagan@world-gen.com

It's fascinating how words are used in different countries to say the same thing. For example, in the US, we say "Watch your step," in the UK, they say "Mind the gap." We "take out" food; they "take away" food. We saw during a press trip to Imperial College that projects are "spin-outs," while in the US projects are "spin-offs."

The Class of 2017 features an MIT 'spin-off,' a flying laboratory, storage and grid solutions and much more. Please enjoy reading the 18th Class of the Millennium and let us know your thoughts.

Joe Mastrangelo of GE Power says on page 4 that GE is continuing to invest significantly to enable future record-setting efficiencies.

Aymeric Sarrazin shares on page 6 that digital services for energy leverage big data to help Siemens customers' performance.

Gary Rackliffe of ABB sees a big shift to the digital grid with the growing deployment of software on page 8.

Sharelynn Moore from Itron outlines the future of the IoT age with an active grid on page 10.

Anil Srivastava of Leclanché explains how the global electricity market is undergoing a major transformation on page 12.

Michael Kotelec of Verizon provides insights on more than 100,000 incidents from across 82 countries on the cyber battlefields on page 14.

Marlene Motyka of Deloitte highlights the increasing influence of the 80 million millennials behind the shift to cleaner energy on page 15.

Fai Lam of Nokia says the smart grid needs LTE or 4G wireless technology to meet new demands on page 16,

Jamie Resor of groSolar sees solar projects on brownfields as a growth area on page 17.

Abigail Ross Hopper of Solar Energy Industries Assn., shares her vision for the solar industry on page 18.

Maria Korsnick of the Nuclear Energy Institute says nuclear power is critical infrastructure on page 19.

Craig Evans asserts ESS has an all-iron flow battery used primarily for PV smoothing on page 20.

Ambri was founded in 2010 with the goal of commercializing a liquid, metal battery, and Phil Giudice was named CEO on page 21.

Under Gordon Murray's leadership, Canada's wood pellets are now a renewable source of generation internationally on page 22.

André Borschberg, an engineer, designed the Solar Impulse airplane on page 24 and piloted the longest leg.

Bertrand Piccard, a medical doctor, found funding to launch Solar Impulse and piloted the final leg on page 25.

Copyright 2017 by The Flanagan Group, Inc. All rights reserved. No part of this publication may be reproduced or transmitted in any form or by any means without written permission of the publisher.

Membership held in the National Press Club, Washington, DC

WORLD-GENERATION
521 FIFTH AVENUE • SUITE 1700
NEW YORK, NY 10175
212.292.5009 • FLANAGAN@WORLD-GEN.COM

JOE MASTRANGELO



*President and CEO
GE Gas Power Systems*

It may be a cliché, but it's not an exaggeration to say the sun never sets on a power generating facility outfitted with GE power systems. It's more of a sign of things to come to say that the sun is always rising somewhere around the world where state-of-the-art GE gas-fired power generation technology is being installed – so that 1.2 billion people still without access to electricity can flip a switch one day and enjoy the benefits of clean, economic energy generated from gas. And the rest of us can rely on high output, efficient, environmentally sustainable energy systems to meet the demands of a global economy with an anticipated GDP growth of 3.5 percent annually by 2020 and whose population is poised to increase by one billion.

Part of GE Power, its Gas Power Systems business has a history of stretching the envelope to advance the technology of its industry-leading gas and steam turbines, generators, heat recovery steam generators, condensers and other equipment and systems. In April 2016, GE's Gas Power Systems, in partnership with Electricite de France, SA, set a Guinness World Record for powering the world's most efficient combined-cycle power plant in Bouchain, France. Its innovative new 9HA turbine helped drive the plant to achieved a 62.22 percent efficiency rating. It was the first combined-cycle plant in history to top 62 percent, noted Joe Mastrangelo, President and CEO of GE's

Gas Power Systems and World-Generation's Class of 2017 inductee

"One of the accomplishments I'm proudest of from last year is the launch of our HA technology at the Bouchain plant," says Mastrangelo. "It was a game changer." But he expects 2017 could be just as productive as last year with HA class turbines coming online and changing the way power is delivered in the U.S., Pakistan, Japan and more.

Not content with the Guinness World Record, Mastrangelo says his team is on a path to achieve 65 percent combined-cycle efficiency with HA systems. GE's Gas Power Systems is already offering customers new HA technology that can deliver greater than 63 percent efficiency.

"This is an area where we are continuing to invest significantly with breakthroughs in advanced metals, coatings, fluid dynamics and additive-enabled cooling technologies," Mastrangelo says, "all of which will push higher operating temperatures and enable future record-setting efficiencies."

EXPANDING THE PORTFOLIO & THE GLOBE

The gas turbine has traditionally driven GE's Gas Power Systems business. The turbine is the heart of the power plant, notes Mastrangelo, who also points out that with the Alstom acquisition his GE unit now has on hand more than 200 years of combined engineering experience and expertise.

And following the acquisition, Gas Power Systems has expanded its capabilities across the entire plant. Its portfolio includes industry-leading gas and steam turbines, generators, heat recovery steam generators, condensers and other balance of plant equipment—making GE the largest OEM supplier in the gas turbine space. "We're able to provide an extended scope of products and solutions and fully execute and build the plant as well as improve overall performance and lower cycle times," Mastrangelo says. In addition, he adds, GE's power-installed base has increased, and GE now has a stronger presence in regions like India, Southeast Asia, and Africa. "In our services business, we now

offer our customers new solutions for upgrading both steam and gas fleets."

Recent wins that highlight GE's expanded portfolio of products and solutions include:

- **Alba:** The first use of HA technology at one of the world's largest aluminum smelter plant located in Bahrain.
- **Sergipe:** A more than \$900 million turnkey project that includes three HA gas turbines and other equipment for Latin America's largest gas power plant located in Brazil.
- **PSEG:** A combined-cycle plant expected to be one of the most efficient facilities in Connecticut.

LOWER MW PERFORMANCE GAINS

Mastrangelo's team at Gas Power Systems continues to invest in its lower MW range systems. "This segment remains strong," he says, pointing out that GE has installed more than 570 GW of capacity in the 30-200 MW space over the last 30 years.

"Our portfolio includes everything from the trailer-mounted TM2500, which is able to respond to emergency power needs anywhere on the globe in as little as 30 days, to the highest simple-efficiency gas turbine in the world, ideal for load balancing in areas with high variable renewable generation."

GE's F-class turbines (6F.01 and 6F.03) and LM6000 provide the right fit to respond to customer needs in simple-cycle, combined-cycle or CHP applications. Where reliability, durability, and flexibility are essential, the B and E-class machines continue to provide excellent solutions.

Mastrangelo describes this segment of the business as varied in terms of requirements and applications. The TM2500 fills the need for immediate and/or portable power, and along with the 6B.03 has been a staple of the small industrial co-generations space for decades. "These products are highly reliable and flexible to meet demands of industrial customers," he says.

(continued page 25)



Maximize the value of your renewable Enabling a stronger, smarter, greener grid

ABB microgrid solutions make it possible to maximize the penetration of renewable energy, minimizing fossil fuel consumption, optimizing and reducing spinning reserves, adding grid stability and lowering operating costs. Our turnkey solutions help defer infrastructure upgrades, reduce the total cost of ownership, and extend the life of generation assets. As the world's leading supplier of microgrid solutions, we have a wide array of relevant installations and references across the globe.

new.abb.com/power-generation/microgrids-solutions



AYMERIC SARRAZIN



Senior Vice President
Controls and Digitalization
Siemens Power Generation Services Division

Aymeric Sarrazin is Senior Vice President of Controls and Digitalization for Siemens Power Generation Services Division, a position he was appointed to in May 2016 after serving as the Division's Vice President of Strategy. He leads a team of more than 1,500 across 40 countries.

An MBA graduate from the Massachusetts Institute of Technology (MIT), Sarrazin served as the Director of the 2010 MIT Clean Energy Prize, the nation's oldest and largest clean energy entrepreneurship competition. He earned Master's degrees in electrical engineering from both Supelec in France and Georgia Institute of Technology in the U.S.

Sarrazin joined Siemens in 2011 as part of the company's CEO Leadership Program and has held positions within the Siemens energy business in the U.S., China, and Germany. Before his move to Siemens, he worked as a field engineer in the oil & gas upstream exploration business in China; an R&D manager in the U.S. focused on developing fracturing technology; and an infrastructure sales agent in West Africa.

IT'S NOT JUST A BUZZ WORD

"Digitalization is not just a buzz word; it is impacting and transforming all areas of our lives," Sarrazin said. "It's changing everything. We can get a ride from here to there by tapping our phone, and we have the ability to find the answer to just about

any question, or get needed information right at our fingertips."

That forward progress in digitalization is impacting the power generation industry too. That's why Siemens, building on more than 20 years of experience collecting and analyzing data as part of its diagnostic and monitoring services, is deploying projects and devoting significant resources to unlock the full potential of this transformation.

"Tapping this potential is not just about advanced sensors, big data, and powerful software," Sarrazin said. "To truly unlock the vast potential of digital service, those of us on both sides of the service contract — original equipment manufacturers and owners/operators — will have to evolve our thinking about what constitutes "service."

WHAT "SERVICE" LOOKS LIKE TODAY

Is there a difference than what was offered historically? Service still includes performing on-site maintenance, outages, or upgrades, but now, with digital services, Siemens is complementing this traditional approach with an advanced performance-focused service and maintenance model. By combining the technology with the depth of domain knowledge and experience of the Siemens team, power plant operators and energy generators are offered more options at less risk, with a flexible approach to managing their assets in a way that works best for them.

"Digital Services for Energy' leverage big data to help our customers optimize the performance of their energy assets, enabling them to lower operation and maintenance costs, reduce failure rate and operate plants that achieve the highest return on investment," Sarrazin said.

TAPPING THE FULL POTENTIAL

Real world outcomes with Siemens Digital Services for Energy are resulting from projects across the globe that are designed to support unique customer needs with innovative, data-supported service offerings.

For example, a Siemens customer in the U.S. wanted to increase their revenue

and reduce fuel consumption by optimizing turbine utilization. However, they faced several challenges such as fluctuating electricity, steam demand, and the fact that the plant configuration included equipment from three different OEMs. Their goals were to increase cash flow, reduce fuel costs, and maximize revenue by producing electricity at peak demand.

"By utilizing our Digital Services, we were able to provide this customer with comprehensive dashboards and plant-specific recommendations that enable them to make well-informed decisions to achieve their objectives," Sarrazin explained. "We're committed to helping each customer meet their unique needs through an individualized, flexible approach."

Additive manufacturing using 3D printing technology is another area where Siemens is out in front. The company extensively uses AM technology for rapid prototyping and has introduced serial production solutions for rapid manufacturing of small fuel mixers and for rapid repair of burner tips for mid-size gas turbines. Siemens started using AM technology in 2009 and opened a new, expanded state-of-the-art AM facility last year.

THE YEAR AHEAD

Sarrazin is looking forward to the coming year as the Siemens Controls & Digitalization business continues to leverage its expertise and innovate. On the controls side, the SPPA-T3000 Cue power plant controls system has set an industry benchmark with an intuitive, time-saving interface that gives plant operators the digital tools they need to succeed.

Cyber security will also continue as a critical aspect for digitalization in the energy industry. "We understand how important cyber security is to our customers," said Sarrazin. "We are committed to a cyber security-by-design approach that not only allows confidential data to be collected, transmitted and analyzed in a secure way but also means that cyber security is consistently integrated throughout all lifecycle phases. Cyber security is a critical business driver at Siemens and is thoroughly imple-

(continued page 8)

June 11-14, 2017 | Boston Marriott Copley Place | Boston, MA

Register Now to Take Advantage of Special Early Bird Rates

Come to Boston and meet the electric utility industry's top executives and major thought leaders, explore cutting-edge issues, and develop new insights and connections that will help you succeed.

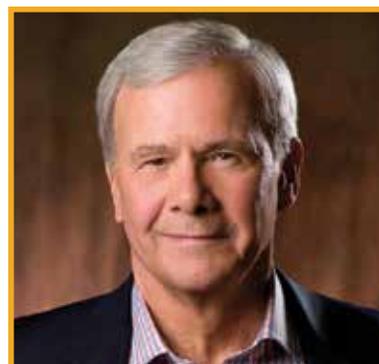
Key topics for Boston 2017 include:

- Energy Storage
- Environmental Policy
- Evolving Customer Needs
- Grid Resiliency/Cybersecurity
- Smart Cities
- Electrification

Don't Miss The Connection

A networking hub where you can unwind and interact directly with industry executives, vendors, and colleagues. Enjoy coffee, breakfast, lunch, and our networking happy hour. Plus, take advantage of additional amenities such as charging stations and a shoe shine.

KEYNOTE SPEAKER



Tom Brokaw

Join us on Tuesday, June 13 for an evening with Tom Brokaw, the legendary NBC newsman celebrating his 50th year of award-winning journalism. Stay tuned for more exciting speaker announcements.



Edison Electric
INSTITUTE

Register now at www.eei.org/2017

GARY RACKLIFFE



Vice President
ABB

THE BIG SHIFT TO THE DIGITAL GRID IS UNDERWAY

Electricity continues to be the most versatile and widely used form of energy, but fossil generation has also been a major contributor to carbon emissions. With growing awareness and global focus on mitigation, the challenge we face is to balance the demand for electricity with minimal environmental impact and optimized grid efficiency.

This challenge has led to an influx of renewables into the grid, and wind and solar resources will become a significant source for electrical power generation in the future. There are clear policy shifts and disruptive developments such as the dramatic price reductions in solar PV and battery technologies that are helping to drive the change. Recent utility-scale auctions have closed with wind and solar PV generation priced at 30 USD/MWH or less.

Wind generation and its often remote locations, a significant increase in solar PV distributed generation at the grid edge, and the variable nature of wind and solar have created new supply side challenges.

At the same time, we also see new demand loads like electric vehicles and data centers as well as smarter homes and buildings.

All these complexities require the evolving power system to be increasingly flexible and interconnected, as well as more reliable and intelligent.

ABB believes renewable energy will eventually become a dominant source for electrical power generation in the future. There are clear policy shifts and disruptive developments such as dramatic price reductions in solar and battery technologies that are helping to drive the change.

GRID INVESTMENTS

While the power industry has an increasingly strong focus on renewables, there are also initiatives around transmission grids, the digital grid, energy storage, and evolving business models as part of the future. These opportunities are driving the development of transmission grid investments, including HVDC and FACTS technologies. Grid investments also include more eco-efficient and resilient products, power quality and local grid stabilization technologies, service and asset health management solutions, as well as emerging innovations like advanced energy storage and strategically located microgrids.

The key to managing this shift in power is the increasing digitalization and automation of the grid, the growing deployment of software and the convergence of information and operational technologies.

As part of grid modernization, the electric utility industry is now implementing the energy internet of things to optimize the grid of the future through operational control and data acquisition from grid sensors and monitoring.

Utilities are upgrading distribution management systems to include SCADA, outage management, automated dynamic switching for improved reliability, and voltage optimization control to support grid efficiency. Distributed energy resource management systems are helping to integrate distributed energy resources such as solar PV, battery energy storage, demand response, and electric vehicle charging infrastructure. Utility analytics are emerging as strategic enterprise systems to leverage the available data for asset health management, grid performance analytics, and system planning.

GENERATION MIX

As the generation mix continues to evolve and the industry invests in the digital grid of the future, customers will diversify and suppliers will differentiate to meet new needs. The evolutionary power market shifts are now underway, and utility customers will be capitalizing on the revolutionary bursts driven by dramatic technological advancements along the evolutionary path.

ABOUT GARY RACKLIFFE

Gary Rackliffe is VP for Smart Grids, North America, leading ABB's smart grid and grid modernization initiatives in North America and directing the Smart Grid Center of Excellence in Raleigh, North Carolina. Gary is past chair of NEMA's Smart Grid Council and a member of the NEMA Grid Modernization Leadership Council. Gary holds BS and ME degrees in Power Engineering from Rensselaer Polytechnic Institute and a MBA from Carnegie Mellon University.

AYMERIC SARRAZIN

CONTINUED FROM PAGE 6

mented into the architecture of MindSphere, our company-wide, cloud-based digital platform."

Sarrazin says the company's vast "Digital Services for Energy" portfolio is expanding its data-driven capabilities and impacting the energy industry in ways that really matter. Using the data generated from energy assets and integrating it with other data sources such as weather data, fleet data, outage reports, Siemens is able to gain powerful insights that are used to develop customized service solutions designed specifically to meet customer needs... whether it is increased efficiency, reliability, flexibility, availability or all of the above.



CREATING A MORE RESOURCEFUL WORLD

At Itron, we connect people, devices and information through technology and services—and in the process, we build more insightful utilities, stronger communities and smarter cities.

Welcome to a more **resourceful world**.

itron.com

SHARELYNN MOORE



*Vice President
Global Marketing & Public Affairs
ITRON*

Fifteen years ago, many in the utility industry were confident that the most sophisticated technology they would need would be technology to drive by meters and collect meter reads. That was it.

Today, the utility industry is in the midst of unprecedented change, being buffeted by a disruptive mix of technical, business and customer service challenges.

THE INTERNET OF THINGS

The Internet of Things (IoT) is fundamentally changing technology decisions and network thinking. The power of computing is being applied to utility technologies, enabling applications never dream of before. The increasing adoption of solar and other distributed energy resources is driving significant investment in grid modernization to provide greater awareness, control and flexibility. Meanwhile, spurred by their experience in other industries, customers are demanding greater value and a more personalized experience from their energy provider.

This is all driving utilities to rethink their business models, innovate and create new value streams to meet the challenges ahead and become the utility of the future.

The utility of the future will have an electric grid – the grid isn't going away and will continue to play an important role in deliver-

ing safe, reliable and resilient power. However, this asset base and infrastructure will need to be managed more efficiently and effectively than ever before, while also meeting new technical challenges posed by microgrids, local power pools, distributed energy resources, electric vehicles and more.

The active grid will need to become more dynamic and interactive. It will need to be active. Known as the Active Grid, this grid features intelligent devices that communicate and collaborate directly with each other and make decisions in real time, instead collecting and transporting data for analysis after the fact. This Active Grid is open, secure, robust and interoperable. It can connect everything from utility smart meters, distribution sensors and control devices to urban infrastructure, such as streetlight controls, traffic sensors, EV charging stations and solar installations.

The Active Grid brings four key technology building blocks that, applied together, redefine what is possible for smart distribution of water, electricity and gas, and smart city infrastructure.

First, the Active Grid is built on a unified, scalable, multi-purpose network infrastructure for smart utilities and cities. Once the network is deployed, it is easy to add new devices and applications to the network allowing for scalability.

Next, the Active Grid utilizes assured connectivity and network reliability, with multiple adaptive communication technologies—radio frequency, Power Line Carrier or WiFi and cellular—on the same chipset and in the same edge devices. The devices on the Active Grid intelligently select the most appropriate path, ensuring performance and reliability.

The Active Grid supports an open application ecosystem that encourages development of innovative new distribution system applications, driving new capabilities as new challenges arise.

With the Active Grid, smart meters are more than metering devices. They are advanced grid sensors with metering being one of multiple applications. By embedding the equivalent computing power of a smart phone in every device, meters are able to conduct real-time analysis of data at the edge. This distributed computing platform also provides the ability to run multiple “apps” on

meters and other edge devices, delivering true distributed intelligence.

This allows the devices to solve problems at the edge of the network as conditions change—a smart meter can communicate directly to a distribution automation control device or to an inverter on a solar panel, or a remote valve control on a gas or water pipeline.

With this type of access to real-time data flow using dynamic analytical engines operating throughout the network, utilities and cities can accelerate and improve decision-making while shortening the time it takes to react to changing grid conditions.

By harnessing the power of IoT—which spans distributed intelligence, machine-to-machine communications, multi-application network architecture, cloud computing, data analytics and a new generation of battery-powered edge devices and sensors—utilities can access the information that allows them to interpret consumption patterns, quickly identify problems and solutions, and more efficiently allocate resources from the beginning.

UTILITY OF THE FUTURE

In this capacity, the utility of the future can reach a new level of productivity and efficiency unparalleled since the transition from manual to automated meter reading, enabling it to meet challenges today and tomorrow. By applying the right technology to approach problems in new ways in the IoT age, the utility of the future will be more efficient and reliable.

ABOUT SHARELYNN MOORE

Sharelynn Moore has more than 20 years of experience in the energy and technology sectors.

In 2013, she was named vice president of global marketing and public affairs.

In this role, Moore is responsible for all global marketing and public affairs activities for Itron, including development of strategic marketing objectives, oversight of internal and external communications and management of external affairs including community investment and government relations.

UTILITY SCALE ENERGY STORAGE

Grid Ancillary Services
Renewables Integration
Island Micro-grid Solutions

UNDER CONSTRUCTION

50MW/ 22MWh GRID ANCILLARY SERVICES
CANADA AND USA

2MW/ 3MWh GRID ANCILLARY SERVICES
GERMANY

6MW/ 3.2MWh MICRO-GRID
PORTUGAL

4.2MWh ELECTRIC FERRY
DENMARK

ORDERS ON HAND

41MWh GRID ANCILLARY SERVICES
CANADA

20MW/ 30MWh GRID ANCILLARY SERVICES
GERMANY

1MWh FREQUENCY REGULATION
NETHERLANDS



eTRANSPORT



**UTILITY-SCALE
& MICRO-GRIDS**



COMMERCIAL & INDUSTRIAL

Mark Albert, VP Business Development
Leclanché North America
(214) 891-5530

SalesLNA@leclanche.com

www.leclanche.com

ANIL SRIVASTAVA



CEO
LECLANCHÉ

In technology markets, five years can seem a lifetime; 10-years an icon; and 50-years a revered milestone. Founded in 1906, Leclanché SA is just hitting its stride. Headquartered in Yverdon Les Bains, Switzerland and publicly listed on the Six Swiss Exchange, the technology innovator is transforming itself into one of the world's leading, vertically integrated energy storage solutions providers.

Leclanché offers a rich portfolio of Battery-based Energy Storage Systems (BESS) comprised of bespoke battery systems from industry leading lithium-ion solutions. Leclanché designs, develops and manufactures customized energy storage solutions for electricity generation and transmission, mass transportation and other critical infrastructure markets. The company is pioneering a wide range of turnkey energy storage solutions (ESS) for the smart grid, virtual power plants and hybridization for mass transport systems – markets not yet invented at the turn of the 20th century. Not bad for a 111-year old.

In 2014, Anil Srivastava took the reins of Leclanché as CEO, bringing a strong track record of building global businesses. His arrival coincided with a seismic change taking place in the global energy market as battery storage systems were emerging as economically viable and a preferred means for harnessing wind, solar and excess electrical energy as well as a cost-effective alternative to fossil fuels for bus fleets and ferries.

DISTRIBUTED ENERGY — UPENDING THE MARKETPLACE

Srivastava saw the global electricity market undergoing a major transformation shifting from a centralized generation and conventional grid-based distribution model toward an increasingly decentralized smart grid making use of distributed energy resources. An example of this is in the transportation market which is progressively switching to hybrid and/or fully electric vehicles (think electric cars, busses and marine vehicles). He envisions a “smart ultrafast charging infrastructure” will become the convergence platform between e-mobility and the grid. Every instant a vehicle stops, it can receive a burst of power from the smart grid. Underpinning this revolution are several key factors including the increasing share of renewables in the energy mix and an evolution in the regulatory environment for reduction of greenhouse gas emissions specifically in large population centers.

The redefinition of the role of utilities has led to the demand for a new business model which can facilitate the shift to smart, cloud-based and decentralized energy markets. Srivastava sees storage as the “missing glue or enabler” allowing distributed energy generation and consumption in a similar vein to how IP networking encouraged distributed and mobile computing.

Understanding these trends, Srivastava is transforming Leclanché, through in-house investments and acquisitions, from a provider of battery energy systems to becoming a fully functional, vertically integrated organization to competitively deliver cutting-edge energy storage solutions including battery systems, power conversion systems and energy management software.

GAINING TRACTION IN NORTH AMERICA

Srivastava believes that the North American electricity market, particularly the U.S., has the greatest potential for utilizing distributed energy resources due to the huge infrastructure cost facing the sector. It's why he established a North American subsidiary in Dallas in 2016.

In January 2016, Leclanché announced a \$28.9 million contract to deliver one of the world's largest stationary storage systems to Independent Electricity System Operator (IESO) in Ontario, Canada. This contract covers the battery storage system and power conversion equipment for the project and is part of an overall \$45 million project construction which will be managed by Leclanché. The first phases of the project, a 120MW/ 53MWh ESS, are now under construction in Toronto and are due to be operational by the third quarter of 2017.

In November of 2016, Leclanché announced its first U.S. battery storage project in which the company is the engineering, procurement and construction contractor and BESS supplier for the Marengo project in the PJM Regulation Market.

The Marengo 20 MW / 10 MWh grid-scale energy storage project is among the largest, fully commercial battery storage projects in North America. The Chicago-area project is being developed for PJM Interconnection, the regional market transmission operator. The plant will be interconnected to the local Commonwealth Edison Company electric grid and will provide real-time frequency regulation service to PJM. The storage plant will respond almost instantly to the continually changing needs of the grid, providing real-time frequency regulation and allowing PJM to deliver higher quality reliable electrical service at a lower cost to its end-users in 13 states and the District of Columbia. It will also help PJM reduce the MW needed to correct frequency deviations, helping to stabilize the grid.

INDUSTRY INVESTMENT OPPORTUNITIES ABOUND

Leclanché's IESO and PJM projects have proven that the technology is mature and able to meet and even exceed performance requirements for short duration power-focused applications and long duration energy-focused grid applications, both on the utility side of the consumer's electricity meter and behind the consumer's meter. Consequently, the market rules are evolving,

(continued on page 26)



POWER-GEN[®]
EUROPE

**RENEWABLE
ENERGY
WORLD**
CONFERENCE & EXPO
EUROPE

25 ANNI[®]VERSARY
YEARS

CONFERENCE & EXHIBITION
27-29 JUNE 2017
KOELNMESSE, COLOGNE, GERMANY



Image courtesy of GE

DIGITALIZATION TRANSFORMING THE POWER LANDSCAPE

- A digital revolution is hitting the power sector and all operators of generating assets need to be fully informed as to what this means for them
- POWER-GEN & Renewable Energy World Europe is dedicating a whole conference track to this digital revolution
- The prestigious Plenary Panel on the opening afternoon will see top level executives from leading utilities and technology suppliers debate what exactly this digital revolution means to the sector
- Anyone operating assets needs to hear this information and meet these global players
POWER-GEN & Renewable Energy World Europe is the place.

Register now at www.powergeneurope.com/register, and save on conference delegate rates at the power industry's most prestigious conference and exhibition.

For exhibiting and brand awareness enquiries, please contact:

Leon Stone | T: +44 (0) 1992 656 671 | E: leons@pennwell.com



MAKING SENSE OF POWER

WWW.POWERGENEUROPE.COM
[#POWEREUROPE](https://twitter.com/POWEREUROPE)

Owned and Produced by: PennWell[®]



MICHAEL KOTELEC



Global Practice Leader
Verizon

With global cyberthreats that continue to increase in frequency and scale, the need for cybersecurity and resiliency is one of the most serious issues facing energy and utilities organizations and their boards of directors today. Protecting confidential customer information and corporate assets is critical to building a trusting relationship with customers, upholding a company's brand, and for the energy & utilities industry in particular, protecting national security.

SECURING THE SMART GRID MUST GO BEYOND BRAND REPUTATION TO ISSUES OF PUBLIC SAFETY

As grid modernization projects are adopted, the importance of incorporating a strong cybersecurity program from the inception cannot be overstated. The energy and utilities sector handles vast amounts of proprietary customer data such as bank account details and credit card numbers. This data, when combined with the critical mandate to protect national infrastructure from external threats, underscores the imperative for organizations to double down on security measures.

Vulnerability to cyberthreats grows as an increase in systems results in more potential entry routes to customer data.

This is especially true as energy and utilities companies roll out web-based solutions such as online billing and Internet of Things (IoT) devices like smart meters to deliver efficiencies and enhance the customer experience. Therefore, managing risk while disrupting traditional business models must go hand in hand.

Organizations must understand the security risks and implement plans and systems to safeguard all devices, sensors and things connected to their networks. The goal is to help maintain a safe environment for customer information while also helping protect public safety.

So, what are some of the big cybersecurity issues keeping CIOs and CSOs up at night? In this article, I'll share a snapshot of the cybersecurity landscape with in the backdrop of Verizon's annual Data Breach Investigations Report, and will also explain what this means for businesses today, including the critical need for strong cybersecurity strategies and plans. In addition, I'll offer recommendations on steps that organizations can take to strengthen security to better serve their customers, including today's highly digital and mobile consumer population.

DBIR

A recent picture of the cybersecurity landscape will help to set the stage for discussing the major threats to the energy & utilities industry. Verizon's Data Breach Investigations Report (DBIR), now in its ninth year of publication, reflects incident data from contributing organizations across the globe to expose what's happening on the cyber battlefields. The 2016 DBIR provides insights based on more than 100,000 incidents, including 2,260 analyzed breaches, from across 82 countries.

The major plot line of this year's story involves cybercriminals exploiting common errors and human weakness in pursuit of financial gain. Consider the following DBIR statistics:

- 89% of confirmed breaches had a financial or espionage motive;
- 63% of confirmed breaches involved leveraging weak, default or stolen pass-

words; and 30% of phishing messages were opened in 2015, and 12% of targets clicked on the malicious attachment or link.

In addition, the DBIR found that most attacks exploit known vulnerabilities that have never been patched despite patches being available for months, or even years. In fact, the top 10 known vulnerabilities accounted for 85% of successful exploits. Essentially, basic defenses continue to be sorely lacking in many organizations.

How does this all apply to the energy and utility sector specifically? According to Verizon's research, the vast majority of security incidents across the energy & utilities industry involved cyber espionage (38%) in which state-affiliated actors breach an organization to target intellectual property; crimeware (19%) which is any use of malware to compromise systems, and is typically opportunistic and motivated by financial gain; and, Denial-of-service (12%) which is the use of botnets to overwhelm an organization with malicious traffic and bring operations to a halt.

RECOMMENDATIONS

What can you do to better avoid falling victim to a damaging and often costly cyberattack? Consider these recommendations for the most common types of attacks on the energy & utilities industry:

Cyber espionage intrusions:

- Patch promptly.
- Track and monitor all inputs: Keep good logs and review consistently to help identify malicious activity.
- Train your staff: Developing security awareness within your organization is critical especially with the rise in phishing attacks.

Crimeware attacks:

- Patch anti-virus and browsers.
- Capture data on attacks.
- Implement configuration change monitoring.
- Monitor user behavior. Put processes in place to track daily system usage, particularly for anyone with access to financial account details or personally

(continued on page 26)

MARLENE MOTYKA



US Alternative Energy Leader
Deloitte

OVERVIEW

· The renewables industry faced strong headwinds in 2014 – from uncertain tax policy to lackluster electricity demand growth and competition from natural gas.

· Instead of idling, renewable M&A activity revved up, with 37% more capacity changing hands than the prior year, in 115 deals.

· This was largely due to financing innovations, rapidly declining costs, and pending tax credit deadlines, as well as increasing investor confidence in wind and solar technologies.

· Overall, wind and solar accounted for approximately 5 percent of U.S. electric generation in 2014.

· Looking ahead, M&A activity is poised for continued growth, as investor interest flourishes and renewables move further into the mainstream.

DEAL-MAKING & BUYER TRENDS

· There is a broader trend of increasing investor interest in the renewable energy sector, with M&A activity generally moving upward over the last five years (2010-2014).

· Independent Power Producers (IPPs) voraciously added renewable capacity, overtaking utilities as the lead buyers in the renewables space.

· IPPs acquired more than 101. GW of capacity, a stunning 147% increase from 2013.

MARKET CONDITIONS

· Nearly every type of investor has become more comfortable with renewables as an asset class.

· After two consecutive years of decline, U.S. clean energy investment rose nearly 20% in 2014.

FINANCIAL INNOVATIONS

· YieldCos doubled from 3 to 6 in 2014 and increased investment to \$3.2 billion. A YieldCo is a publicly traded company formed to own operating assets that produce cash flows. YieldCos are typically designed to have minimal taxable income to limit their cash tax requirements, much like MLPs.

· Capital raised through “Green bonds,” corporate bonds with proceeds ring-fenced for clean energy investments, more than doubled, to \$32.9 billion in 2014, compared with \$500 million in 2013.

· Crowdfunding has helped the growth of the rooftop solar industry. Non-profit crowdfunds, are putting solar photovoltaic projects within reach of churches, schools, and other organizations.

TRADITIONAL FINANCING

· Asset financing – investors poured more than \$12 billion into wind and solar projects.

· Venture capital investment in renewable companies rose 105% to more than \$1 billion, 75% in solar.

· Public markets – Investment in solar and wind companies jumped 68% to \$5.13 billion.

SOLAR

· The US residential solar market added 1.2 GW – more than 50 percent growth for the third consecutive year.

· For the first time ever, more than half a gigawatt of resident solar installations came online without any state incentive in 2014.

· Utility-scale development is also breaking records: in Q4 of 2014, 1.5 GW of utility-scale PV projects came online – the largest quarterly total for any market segment.

WIND

· Approximately 4.9 GW of wind power came online in 2014, and 12.7 GW are under construction.

· Texas presently accounts for the majority of wind construction activity, though New Mexico, Kansas, Iowa and North Dakota are also very active.

· The cost of wind power is competitive with other sources of generation, and is likely to be driven lower with increasing technological innovations.

POLICY DEVELOPMENTS

· The Production Tax Credit (PTC) came too late to stimulate large wind developments in 2014 and had little effect on new wind development or deal-making activity.

· The Investment Tax Credit (ITC) did not change in 2014, given its extension to 2016. The ITC continues to provide a strong incentive for solar development, especially ahead of the end of 2016 deadline.

· Renewable development will likely have more support in regulatory developments.

· Many states are experimenting with policies and tax credits favorable to renewable investments and developments.

OUTLOOK/CHALLENGES

· Grid Integration & Stability

How flexible do grids need to be to use the maximum amount of renewable energy?

Should there be a ceiling on renewables development to help with regulating frequency and distribution?

· Electricity Demand

Utilities often operate on the premise of increasing electric demand – is this still an acceptable premise, given the small 1% increase in demand for electricity each year until 2020?

· Utility’s role in balancing first two challenges

Who will pay for shared infrastructure changes as renewable power use increases?

Are costs being unfairly shifted on non-renewable customers?

(continued on page 17)

FAI LAM



*Director
Network Business
Nokia*

Power utilities are in the midst of a significant transformation as they gear up to meet tomorrow's challenges. New approaches and technologies, including distributed energy resources such as renewables, storage and microgrids, are putting new demands on the electrical distribution system. Shifting loads and fluctuating generation from renewables will require real-time adjustment without operator intervention.

Automation of the distribution network will be critical to this transformation. This will require the collection and analysis of data, modeling of the distribution operations for automated decision-making, and the relaying of decisions to utility control centers. None of this is possible without a robust wireless communications network in the last mile or field area network (FAN). The mission critical nature of these operations means that the FAN cannot be subject to interference from other wireless devices or line-of-sight issues. It should be able to handle high bandwidth communications, provide redundant paths and be built on open industry standards.

The good news is that unlike some other technologies critical to our energy future, such as storage solutions, networking technology has already evolved sufficiently to meet the needs of the energy

industry. 4G wireless technology, or LTE, has already been adopted worldwide by telecom operators to meet the needs of literally billions of mobile customers. The technology is extremely robust, reliable and scalable.

There are many types of communications systems used by power utilities in the FAN today. In the wireless space, these are typically either some kind of wireless mesh using unlicensed spectrum and subject to interference, or point-to-point microwave subject to line-of-sight issues. The interference issue will only increase as the number of Internet of Things (IoT) devices proliferates. These technologies also tend to be non-redundant and short range. Many are also proprietary, single vendor solutions that lock the utility in, limiting its ability to choose the best options and embrace new applications as they develop.

Currently, most FANs use a mix of these older communications technologies to cover different applications and their associated field devices such as metering infrastructure, quality monitoring or protection. Many of them are based on centralized management systems such as SCADA. Some distribution automation applications, in contrast, will require control and processing to be distributed. More frequent monitoring to handle rapid variances in load and generation will also demand higher bandwidths for data and control traffic. In other words, automating distribution and converging all traffic on a single network demands higher bandwidth and a more reliable network than these technologies can provide.

LTE is well suited to meet this need. It can operate in numerous frequency bands, accommodates different channel sizes and can adapt to different spectrum allocation regimes. While it has been largely deployed in public networks, private LTE networks are possible, either through the use of dedicated utility spectrum (e.g. 450 MHz in Austria and Hungary), or by partnering with mobile providers that can provide dedicated spectrum (e.g. AT&T in the US). The highly regulated nature of LTE spectrum ensures that interference is not an issue. LTE also provides sufficient bandwidth, even for video applications. It is highly scalable and redundant, and avoids

any line-of-sight issues common with other technologies.

Some distributed automation applications adopt a decentralized approach to processing and control, referred to as distributed computing. A local computing device or server, for instance, might acquire line data from voltage/current sensors to control and operate local switches. The response times have to be very short, sometimes even in tens of milliseconds, which is uniquely supported by LTE. Atop LTE, IP/MPLS provides the necessary quality of service and security for connectivity to both distributed and centralized processing resources. IP/MPLS provides high resiliency, security and the versatility to control network performance levels per application.

Beyond distribution automation, private LTE networks will allow the consolidation and convergence of many disparate communication systems now in use, including mobile field operations. With its high bandwidth capacity, LTE will enable seamless integration between back office and mobile workforces, even using video for collaboration between on-site and back office personnel.

Society's pressing need to address climate change is creating new regulatory and market conditions, as well as leading to exciting new innovations in energy technology.

ABOUT FAI LAM

Fai Lam is responsible for promoting Nokia's IP/Optical Networks portfolio to enterprises and governments. A seasoned professional in networking and communications technology, Fai has been helping industries such as power utilities with their transformation projects. He has held positions in product development, product line management, business development and marketing. His marketing campaigns have resulted in major market penetration and product awards. Fai holds a B.Eng. in Electrical Engineering from the University of Victoria in British Columbia, an MBA from the University of Ottawa, and is a Registered Professional Engineer in Ontario, Canada.

JAMIE RESOR



CEO
groSolar

WORLD-GEN: Where and when was groSolar formed and please explain its mission.

Jamie Resor: groSolar was founded in 1998 in Vermont and began as a residential-focused solar company.

Today, we have grown into a leading North American developer and EPC firm and operator of commercial and utility solar projects. Our mission is to provide creative, industry leading, and cost-effective solar energy and storage solutions to utility, commercial and government markets.

We strive for excellence in development, design and construction with an emphasis on respect, team work, and safe work practices.

WORLD-GEN: Please elaborate on groSolar both as a development and EPC firm?

Jamie Resor: groSolar prides itself on being able to offer a multi-disciplinary capability to take a project from concept thru all the steps of development, feasibility and financing thru final design and construction and ongoing operation of solar facilities.

This capability allows us to offer our clients with a single source for their project needs.

We believe this makes us both a better developer and better EPC and strong partner with our clients.

WORLD-GEN: Explain how groSolar

will continue landfill and brownfield activities?

Jamie Resor: groSolar has a long resume in successfully developing and constructing solar projects on landfills and brownfields, having completed such projects in numerous states. We continue to see this as a growth area as solar can be an ideal usage of such sites that offer little other development potential and are often in areas of substantial electricity demand.

WORLD-GEN: Where do you see the growth of groSolar and will it be in utility and storage?

Jamie Resor: We offer both storage and solar solutions and anticipate continued growth with utilities, corporate and institutional customers. Last year's acquisition of groSolar by EDF-RE is also giving us additional access to solar plus storage opportunities throughout the U.S.

WORLD-GEN: In what ways has the EDF-RE acquisition benefitted groSolar and where do you see future directions for the company?

Jamie Resor: As part of EDF-RE and the broader EDF family in North America, groSolar benefits from the depth of EDF-RE's technical expertise in areas like storage and commodity market presence thru EDF-Energy Services. These capabilities help groSolar offer a more comprehensive energy solution to a wide range of customers in the distributed energy marketplace.

ABOUT JAMIE RESOR

Mr. Resor joined groSolar in 2008 and was CFO and COO before becoming CEO in 2012. Mr. Resor has led groSolar's growth as a leading solar developer and engineering, procurement, and construction (EPC) firm in the U.S.

The company has developed and/or constructed many award-winning projects over the past five years.

Prior to joining groSolar, Mr. Resor had 20 years of experience across many corporate and board roles in large organizations, start-up companies, and nonprofit organizations.

Mr. Resor's early career included a range of opportunities from working on the Thai/Cambodian border for the

International Rescue Committee to banking and management consulting with Fortune 1000 clients.

Later, Mr. Resor developed and directed the pioneering conservation finance program for World Wildlife Fund, the world's largest environmental organization.

In this capacity, he raised more than \$150 million for environmental conservation projects through debt-for-nature swaps and other cross-border financing transactions in Africa, Asia, and Latin America.

Mr. Resor also assisted in the establishment of the Bhutan Trust Fund for Environmental Conservation and served on its advisory board for ten years. Throughout his career, Mr. Resor has brought creativity and leadership to managing successful businesses and environmental stewardship.

Mr. Resor received his undergraduate degree from Dartmouth College and MBA from Stanford University Graduate School of Business.

MARLENE MOTYKA

CONTINUED FROM PAGE 15

OPPORTUNITIES

Electricity storage is already being used across the grid, as one of several options to smooth the effects of variable resources like wind and solar.

Storage technologies like batteries are gaining traction quickly, as performance improves and costs decline.

Energy storage growth is projected to explode from 0.34 GW in 2012-2013 to 6 GW by 2017 and over 40 GW by 2022.

Clean Power Plan – If approved, states will be required to cut CO₂, and would have to use renewable sources of power.

Other Clean Air Act rules, such as CSAPR and MATS, depending on court rulings.

US-China Climate Accord – US pledged to cut CO₂ more than 25% by 2025, with incentives for wind and solar development.

ABIGAIL ROSS HOPPER



*President and CEO
Solar Energy Industries Assn.*

Abigail Ross Hopper joined SEIA just as the solar industry was basking in its highest ever growth period, where installations increased 97% in 2016 over the previous year. She was appointed president and CEO of SEIA in early January and started the job on January 17, soon after she left the Department of Interior's Bureau of Ocean Energy Management where she served as Director.

Hopper came from Maryland's Governor's office where she spent five years working as energy advisor to Governor Martin O'Malley. Starting in 2013, she served first as acting director then director of the Maryland Energy Administration all the while advising O'Malley. She moved to BOEM in 2015.

Her achievements in the MEA included ensuring the passage of the Maryland Offshore Wind Energy Act of 2013, negotiating the Exelon/Constellation merger on behalf of the state and the FirstEnergy/Allegheny Energy merger.

Before moving to the MEA Hopper spent over two years as Deputy General Counsel with the Maryland Public Service Commission. After graduating Cum Laude from the University of Maryland School of Law she spent nine years in private practice.

At SEIA, Hopper oversees government affairs, research, communications and industry leadership. She steps into the shoes of Rhone Resch who left SEIA at the

end of May 2016 after 13 years of visionary leadership. Tom Kimbis served as interim president for the intervening eight months and will continue as executive vice president and general counsel.

Hopper's vision for the solar industry includes ensuring the investment tax credit at the federal level remains intact to guarantee that the market will continue to grow. SEIA will continue to strengthen and maintain strong state policies.

For example in early February, SEIA announced the formation of the Midwest State Committee in an effort to expand education and advocacy efforts in Illinois, Indiana, Iowa, Michigan, Minnesota, Ohio and Wisconsin. "Over the next few years, the Midwest has the potential to become a hotbed of solar growth, which will result in a host of economic and environmental benefits for local communities," Hopper said in a February 9 press release.

She does not see the solar market becoming saturated. As long as our population continues to grow, so will the solar business, Hopper says.

Third, Hopper will work to see that the solar industry reflects the diversity of the country's population, on both the employment and customer sides and across all economic classes.

The investment tax credit is an important part of the solar financing mix according to Hopper, and it certainly propelled the large market growth in 2016 following the extension of the investment tax credit. "We are actively working to make sure the ITC stays intact, as it is currently drafted." She is cautiously optimistic that Congress and the current administration will not change it. A bipartisan agreement reached at the end of 2015 intends to keep it in place and SEIA is talking with congressional representatives to maintain it, she says.

The ITC currently provides a 30% tax credit until December 2019 and steps down to 26% in 2020, then 22% in 2021. It then drops to zero in 2022 for residences and 10% for commercial and utility tax credits after 2023.

Hopper expects solar's growth rate to continue to increase as the price of solar continues to fall. Prices have declined over 50% over the past five years, and 16% in the

past year alone. She declined to quote market prices since they vary across competitive solar businesses and markets.

Solar photovoltaic installations increased 95% in 2016, topping out at 14,626 MW over 2015 installations which broke records then at 7,493 MW, according to GTM Research, working in collaboration with SEIA. The industry's PV installations now have a cumulative capacity of over 40 gigawatts according to the February 14 announcement. GTM Research and SEIA released the complete US Solar Market Insight 2016 Year in Review on March 9.

The utility scale solar segment was responsible for 71.5%, representing a growth rate of 145% over 2015 installations. On the commercial side, Target led in 2016, installing 147.5 MW in 300 locations, overcoming Walmart's 145 MW at 364 locations. Walmart had taken the top spot in each of the last four reports. Prologis came in in third place with 108 MW at 49 locations.

The residential segment represented 17.7% in sales and commercial and industrials' 9.4%. Community solar is the new segment representing 1.5%. It is growing, says Hopper, and SEIA will continue to support its development.

NEXT ISSUE

May/June 2017
Closing May 1, 2017

**INTERSOLAR
SOLAR POWER INTERNATIONAL
(SPI)
EDISON ELECTRIC INSTITUTE (EEI)
REFF WALL STREET
POWER-GEN EUROPE**

Bonus Circulation
at above Conventions.

MARIA KORSNICK



President and CEO
Nuclear Energy Institute

I firmly believe that the U.S. is the global leader in nuclear energy today and that it must continue to embrace this leadership role. The US has the largest fleet of nuclear power plants, and the Nuclear Regulatory Commission is viewed as the global leader for ensuring safety. This leadership is predicated on having a strong nuclear industry that is building for the future. I would like to lay out a vision for nuclear energy and provide an assessment of key issues facing the industry.

NUCLEAR POWER'S VITAL ROLE

The US nuclear fleet supports over 475,000 jobs and produces over \$12 billion annually in federal and state tax revenues. Over its entire lifetime, a single two-unit plant creates the equivalent of 1,000 jobs for 60 years! Nuclear plants provide a unique combination of large capacity, dispatchable generation, and enormous clean air compliance value. Nuclear plants do not emit pollutants such as carbon, sulfur or nitrous oxides. Independent studies estimate the value to society of avoiding these emissions at roughly \$33 billion per year.

Due to uranium's extraordinarily high energy content and stable prices, nuclear electricity has very little price volatility, making it a valuable part of a portfolio. Collectively, the nuclear industry contributes about \$60 billion every year to the U.S. economy.

Nuclear power is critical to the national energy infrastructure. It provides sustained economic benefits to the entire economy. It plays a key role in assuring grid reliability. It is by far the largest source of clean energy. Let me ask you to think 25 to 30 years ahead. I know that seems like a long time, but it's the blink of an eye when we're thinking about planning for our electric infrastructure.

We want fuel diversity for energy security and to prevent price swings. And we want to make sure that this is done while protecting clean air and clean water for all. Doing all of this right requires thinking decades ahead, in terms of both policy and technology development. Nuclear power will play a vital role in meeting these needs. Within 25 to 30 years, the U.S. electric grid will include a range of reactor types that will expand the roles for nuclear energy in the economy.

THE GRID OF THE FUTURE

The nuclear reactors of the future will accommodate that reality. Some will make electricity around the clock. Others will produce electricity when it's needed, then produce other products when it is not. Some will supply the transportation market.

Nuclear electricity will charge batteries and nuclear process heat will make alternative fuels. Some reactors will make fresh water. Some will drive industrial production. Some reactors might even produce energy from today's used fuel, reducing the disposal burden. The runway to that future is a continuum of development and innovation. The journey starts with preserving America's existing nuclear power plants. Almost all of the reactors in the U.S. have received a renewed license to operate for 60 years. The industry is working to enable additional license renewals that will allow them to safely operate even longer.

WE SEE THIS NOW

We have four reactors under construction in Georgia and South Carolina. These designs use passive safety approaches to advance the state of the art in nuclear technology.

This approach was informed by decades of operational experience and innovation.

Beyond the four being built, nuclear plant owners have already received construction-operating licenses for seven additional reactors and three more are being evaluated at the Nuclear Regulatory Commission. These licenses provide valuable options as companies look to the future. Small modular reactors – SMRs – will be ready in the early to mid-2020s. These are designs that use their smaller size to maximize safety and rethink how nuclear plants could be configured. They will offer flexibility in deployment and operation.

Industry and government must play the short game and the long game with equal energy and commitment. Allowing existing nuclear plants to close prematurely will compromise America's ability to develop a sustainable electric sector. Premature closures will cause significant economic damage. The loss of expertise, and erosion of the commercial infrastructure will severely limit the ability to develop the grid of the future. A promising future creates a compelling rationale for tackling challenges in the present.

NUCLEAR PLANTS ARE CRITICAL INFRASTRUCTURE

While it is difficult to make predictions about the Trump Administration in these early days, it seems clear that his priorities include improving our infrastructure and creating jobs. Nuclear energy will serve these priorities well.

We do need to address infrastructure. Every year, the World Economic Forum publishes a Global Competitiveness Report, ranking the world's 138 economies. In the 2016 report, the United States ranked third overall. But measured by its infrastructure, the United States — the world's largest economy and most powerful nation — ranked 11th. Even worse, the quality of electricity supply in the United States was ranked 17th. The American Society of Civil Engineers' most recent report card gives

(continued on page 26)

CRAIG EVANS



CEO
ESS, Inc

PORTLAND, OR - With the growth trajectory that solar is experiencing, more solar is being installed due to dramatically lower installation costs, and considering that net metering certainly appears to be going away, batteries are becoming an asset and in some locations a requirement for further solar integration. One of the big emerging use cases for integrating batteries with solar, is long-duration storage – and the beneficial impacts that 4+ hours of storage will have on the market in terms of how the value of solar and other renewable installations are measured. For example, having the flexibility to engage both power and energy applications utilizing stored solar power is an incredible use case for this resource. With long-duration storage you have the ability to store excess solar production and time shift that energy to when it has higher economic value. The storage allows you to smooth out solar intermittencies throughout the day, address expensive demand charges for C&I customers, and shift that solar power out into the later afternoon and early evening where it is far more valuable to the asset owner and to the grid operator. Certainly the integration of longer duration storage will allow us to deploy even more solar and other renewables.

A 10-kilowatt, 60-kilowatt hour all-iron flow battery from ESS Inc. installed at the Stone Edge Farms Advanced Micro Grid in Sonoma County, CA is primarily for PV smoothing as well as shifting stored solar

energy to the evening to power irrigation pumps and a hydrogen electrolyzer. The ESS battery system is coupled with a D.C. System micro grid controller that controls the battery using Sun Spec protocols over a Modbus interface. DC Systems optimizes the use of the battery system, locally, on a daily basis. ESS is also able to monitor and control the system back at its headquarters.

The ESS system is an environmentally safe chemistry. It's iron, salt, and water. These abundant and low cost materials are also non-corrosive, so low cost plastic-type materials can be used in the battery modules, which keep capital costs extremely low. The benign ingredients are also non-flammable which completely eliminates a costly fire suppression system.

The system is very easy to install. The IFB ships in a dry state, is hydrated on site and because it is a complete integrated and turnkey system, once the system is grid connected our team can have it fully operational in about a day and a half. Field certified through Intertek. The IFB has a durable and a long operating life in excess of 20,000 cycles, or > 25 years.

The company has done extensive testing of the IFB, cycling it in two different depth of discharge modes.

The first one is operating at very high states of charge, doing very shallow depth of discharge cycles, so between 80 and 90 percent of state of charge (SOC). The second one is deep discharge cycles, going from 95 percent down to 20 percent state of charge. This simulates doing one full cycle a day on the battery. This rigorous testing has validated no capacity loss and very little efficiency loss over its operating life.

When you're doing large-scale PPA's that last 20-25 years, the life of the solar system, you want to couple that with a battery that's going to last just as long, so you don't have to replace the battery multiple times, impacting your levelized cost of storage (LCOS). That's very counterintuitive to a lithium ion battery or a lead acid type battery, which are actually going to fade over time and have to be replaced.

Some of the reasons why ESS is able to achieve these no capacity fade cycles and long-duration capacities are primarily

due to the type of battery chemistry used. It's a flow battery. And in a flow battery basically all of the reactions occur in the liquid form. Basically you're stripping the electrons on and off of Iron ions. In our case, on the positive side of the battery, you are changing the oxidation state of iron – Fe^{2+} to Fe^{3+} , as you charge. And when you discharge the battery, the positive side goes from Fe^{3+} to Fe^{2+} . So you're basically going from ferrous to ferric states. On the negative side of the battery, we go from ferrous chloride, which is Fe^{2+} , to plate iron on the electrode surface. And on discharge, the reverse happens.

One of the other reasons, besides operating in the liquid form, is that we have very high capacity, operating with the same electrolyte on both sides of the battery. So, there's no ability to cross-contaminate the battery. In some types of flow batteries, you have different elements on both sides of the battery – iron chrome, zinc iron, vanadium iron. Over time, no membrane is perfect and will result in diffusion. Eventually, the elements from either side of the battery are going to cross over, which is going to contaminate the electrolyte and degrade the performance of a flow battery. Then you have two choices. One, you can either replace the electrolyte entirely, which can be costly and a lot of O&M. Or you can live with that efficiency and capacity loss. The ESS IFB does not have this limitation.

In terms of how we keep our efficiency high over all these cycles – that lends itself to the positive electrode where typically you would see a lot of carbon corrosion.

ABOUT CRAIG EVANS

Craig Evans started ESS from his garage in 2011. He led the company to the commercialization of the Iron Flow Battery system in 2016. Prior to ESS, Mr. Evans was the Director of Design & Product Development at ClearEdge Power Inc. His team designed the ClearEdge5, a 5kW combine-heat-and-power fuel cell system, which was successfully commercialized in 2010. This product received both CSA International certification in North America and KNREC certification in Asia. Mr. Evans

(continued on page 21)

PHIL GIUDICE



*President and CEO
Ambri*

WORLD-GEN: How did Ambri get started?

Phil Giudice: Ambri was founded in 2010 with the goal of commercializing the Liquid Metal Battery (LMB) grid-scale electricity storage technology, which was invented at the Massachusetts Institute of Technology (MIT) in the lab of Professor Donald Sadoway and his graduate student (and now Ambri's Chief Technology Officer), Dr. David Bradwell. Research on the LMB at MIT started in 2005 and was funded by grants from the U.S.

Department of Energy's ARPA-E program, the energy company Total and other sources. The academic research team made tremendous progress and in a very short period of time solved major scientific challenges. Ambri was founded in 2010 to scale the technology to a commercial product.

WORLD-GEN: What funding has Ambri received to date and from whom?

Phil Giudice: Ambri has raised over \$50 million in equity financing to date, from five (5) investors: Bill and Melinda Gates, Total, Khosla Ventures, KLP Enterprises and GVB. All of our investors are strong supporters of Ambri.

WORLD-GEN: How is Ambri's battery technology different?

Phil Giudice: Ambri's LMB technology is unique from any storage technology currently available or in development today. Most fundamentally, it is projected to have a lower upfront capital cost than

alternatives and a much longer lifespan. The battery is able to cycle for tens of thousands of times to 100% full depth of discharge with no degradation in capacity, making it particularly well suited to be integrated into electric infrastructure. The battery is also very flexible – it can respond in milliseconds to grid signals. And, it's safe. The robust design offers inherent safety features. Simply put, the failure mechanisms that can be catastrophic in other technologies aren't present for the LMB.

WORLD-GEN: Where are Ambri batteries manufactured?

Phil Giudice: Ambri has a small prototype manufacturing facility in Marlborough, Massachusetts, where we have developed manufacturing processes and equipment to produce the LMB at high volume. The extensive manufacturing capability we have developed provides great confidence for our scale-up and commercialization plans. We anticipate building our first full scale commercial factory within the next few years.

WORLD-GEN: Please share your current sales and forecast future sales to utilities, IPP's, transmission operators and end-users.

Phil Giudice: I'm am humbled and encouraged by the substantial commercial interest in Ambri's energy storage systems from a very diverse group of customers worldwide, including utilities, independent power producers, major renewable developers and end user customers. Ambri's batteries are targeted to be low cost and flexible, and the battery will be able to provide value in a variety of ways. One application I'm particularly enthusiastic about is pairing Ambri systems with solar and wind energy, to transform electric grids to be predominately powered by renewable energy. These projects of "solar/wind plus Ambri storage" will provide dispatchable, firm, 24-hour per day power at a price point that is less than current fossil power. These projects will not need any government subsidies; they will be cost effective from the get-go. I also think that storage is poised to play an increasingly important role within utility transmission and distribution infrastructure, offsetting and avoiding the need for traditional poles and

wires. With Ambri storage at every substation, system load factors will increase and system costs will decrease, providing more cost effective electricity for all.

ABOUT PHIL GIUDICE

Phil Giudice has 40 years of experience in the energy industry as a geologist, consultant, executive, and state official. Phil serves on the boards of the New England Clean Energy Counsel and FirstFuel and he is an advisory board member for Fraunhofer Center for Sustainable Energy Systems and the Union of Concerned Scientists.

Prior to Ambri, Phil served the Commonwealth of Massachusetts as Undersecretary of Energy and as Commissioner of the Department of Energy Resources.

Phil was senior vice president and board member at EnerNOC. He was also a senior partner and leader of Mercer Management Consulting's global energy utilities practice for 20 years. He started his career as a geologist with Freeport-McMoRan and with Chevron.

Phil received a B.S. from the University of New Hampshire, an M.S. from the University of Arizona and an M.B.A. from the Tuck School at Dartmouth College.

CRAIG EVANS
CONTINUED FROM PAGE 20

began his career at United Technologies Corporation (UTC) where he held technical leadership positions in their Fuel Cell business and, prior to that, as a project engineer in the Pratt & Whitney aircraft engine business. In 2006, Mr. Evans was awarded the distinguished George Mead Award, the highest honor for individual engineering achievement at UTC.

Mr. Evans has authored over 15 patents and patent applications. He holds a BS in Aerospace Engineering and a MS in Mechanical Engineering from Clarkson University, a MS in Finance from Rensselaer Polytechnic Institute and a M.B.A from Carnegie Mellon University.

GORDON MURRAY



*Executive Director
Wood Pellet Association, Canada*

The World Generation Class of 2017 is joined by a gentleman who could aptly be called “Mr. Wood Pellet” in Canada, Gordon Murray. Gordon cannot take the credit for creating the wood pellet industry in Canada, but since he has been the Association’s Executive Director he has played a key role along with the membership in guiding the Canadian wood pellet to its present position in the global forest products industry. Gordon’s impact has not only included significant advancements in the use of Canadian wood pellets in off-shore markets, but the development of the association’s message to the power generation industry throughout the world. He can be singled out as one of the members of the Canadian power generation industry who has successfully guided the multi-faceted wood pellet industry. Canada has become one of the world’s leading manufacturer and exporter of wood pellets.

Gordon joined the Wood Pellet Association of Canada in 2008. He had previously spent 26 years working in the forest industry. His expertise extends to a variety of wood products in the Canadian industry’s sectors including lumber, plywood, value-added manufacturing and logging. Gordon graduated from the University of British Columbia in 1982 with a Bachelor of Science degree in forestry

and is a registered professional forester. He is also a chartered professional accountant.

Gordon’s main trust, the Wood Pellet Association of Canada, is tasked with the development and growth of the Wood Pellet industry in Canada. Since joining as the Executive Director, Gordon has guided the Association through steady growth over nine years and has seen the development of the multiple facets of the commodity. Canada’s wood pellet industry has emerged as the leader not only in Canada but throughout the world.

Today the WPAC’s primary membership includes pellet producers, traders, Canadian seaports, stevedores, commodity inspection groups, equipment providers, and consulting firms. As Gordon indicates, “The Association welcomes all firms who wish to participate in the prosperity of the growing wood pellet industry.”

Under Gordon’s leadership, and the active support of the Wood Pellet Association’s membership, the manufacturing and shipping of Canadian wood pellets have risen from a concept as an inexpensive fuel - an alternative source of heat for individual homes in Canada - to a major source of industrial power generation on an international scale.

Numerous countries throughout the world have recognized the viability of the wood pellet as a low cost, cleaner, renewable replacement for heating oil and electricity, generating more than adequate heating and power source for homes as well as boilers for institutional and commercial heating at industrial complexes. As example, the United Kingdom, having recently converted a number of its power generation plants, has been the world’s leading importer of wood pellets from Canada. Italy, Japan and Korea, as well as Scandinavia, and other countries in the Far East are also well established as significant wood pellet customers.

Canada’s power utility industry is resisting the phase out coal power, however, it is the goal of the provinces and the federal government to eliminate coal power by the year 2030. At the WPAC’s annual conference in 2014 one of the major presentations pointed out that Canada was the largest producer of wood pellets in the

world and countries such as England, Italy, Denmark, Sweden, France, Japan and Korea appeared to be the areas where the annual volumes of wood pellet consumption continued to increase. The report also indicated that the estimated annual market for wood pellets would rise from 23 million tons per year in 2014 to 50 million tons per year in 2024. The report in 2014 indicated that Italy, as example, favored bagged Canadian wood pellets. The Italian market, it was estimated, included over 1.9 million wood pellet stoves and two hundred thousand residential boilers that used wood pellets. At that time, the favored mode of shipping to the Italian market, as example, was both bulk vessels and bagged pellets loaded into 40 foot shipping containers. The estimated weight of the loaded container was 26.2 MT per container. Wood Pellets arriving in bulk vessels are discharged, screened, bagged and distributed to retailers.

In addition to the Italian market, the demand for wood pellets was expected to increase annually in England - the largest importer - Denmark, Sweden, France and Korea and Japan. In Italy and Korea, however, the report indicated that there has been a downturn in the importation of Canadian wood pellets. Italy’s volumes decreased to 3% over 2015 and 2016 and Korea’s was 2%, over the same period. Both Italian and South Korean demand for wood pellets was expected to increase to over this period.

The United Kingdom, however, has received the largest share of Canada’s output since 2014. As the world’s largest importer of wood pellets, the UK received 1,664,145 tons in 2016, an increase of approximately 701,336 tons from 2014 to 2016. Significant annual percentage increases between 2014 and 2016 included Japan, receiving 61,807 tons in 2014 and 272,376 tons in 2016. In addition, Belgium with 306 tons in 2014 has increased its importation of Canadian wood pellets to 144,000 tons in 2016. World statistics indicated that United States imports from Canada have been reducing over the past three years from 218,903 tons in 2014 to 169,930 in 2016.

It's the most cost-effective networking
event for the California solar market:

CALIFORNIA
SOLARPOWER
EXPO

- ✓ Earn NAPCEP credits.
- ✓ Get hands-on, comprehensive training from leading solutions providers and exhibitors.
- ✓ Access technical training from experts such as Bill Brooks Principal, Brooks Engineering and Dr. Sean White, Professor, IREC Trainer of the Year IREC Certified Master Trainer, Diablo Valley College & White House Solar.
- ✓ **It's free for those attendees who act early. Register with code MKPNACECOMP and receive complimentary registration.**

Register today at www.events.solar/expo

MAY 1-2, 2017

SAN DIEGO CONVENTION CENTER | SAN DIEGO, CA

POWERED BY



ANDRE BORSCHBERG



Pilot
Solar Impulse

Solar Impulse, the Swiss solar aircraft, has completed the first-ever round-the-world flight by a solar plane. The record-breaking flight covered more than 40,000km without a single drop of jet fuel.

The Solar Impulse is a completely solar-powered plane. Unveiled in 2009, it made history as the first solar aircraft to fly through the night in 2010. That was also the plane that flew across the continental United States in 2013. Engineers back at the base in Payerne, Switzerland, then fine-tuned the aircraft.

HOW BIG IS THE PLANE, AND HOW MANY PEOPLE CAN IT CARRY?

With a wingspan of 72 metres, it's a bit wider than a Boeing 747 Jumbo Jet. But instead of carrying 400 passengers, the Si2 only has room for a single pilot in its 3.8 m³ cockpit. It weighs 2,300 kilograms, about as much as an SUV.

Two pilots took turns flying this plane, just as they did with the prototype. Initiator Bertrand Piccard, who comes from a family of explorers and scientists, is known for making the first round-the-world balloon flight. CEO André Borschberg is an engineer, a former Swiss Air Force pilot and graduate of the Massachusetts Institute of Technology. There was also a test pilot, Markus Scherdel, who helped make sure the Si2 was airworthy.

HOW DOES IT WORK?

The wings are covered in 17,248 solar cells, which feed the plane's lithium polymer batteries. These in turn help the Si2 to generate and store enough energy to power its motors to fly for longer periods. Extremely lightweight materials also contribute to the aircraft's energy efficiency. However, it can only fly in fair weather – and is sensitive to high winds. Meteorologists help the Solar Impulse team to find the best weather windows. Departures can be delayed for days if there's rain, which was the case in India in mid-March 2015.

CAN IT REALLY FLY IN THE DARK?

Thanks to the batteries, yes. During the day, it climbs to its maximum cruising altitude of 8,500 metres to capture the most rays. To conserve energy, it works its way down to 1,500 metres in the evening, and stays there overnight. The maximum speed is 90km/hour. The flight from Abu Dhabi to Muscat, for example, took 13 hours – something a normal plane could do in about 90 minutes.

HOW LONG CAN THE SI2 FLY?

In theory, and under the right weather conditions, the Si2 could remain in perpetual flight, but that would be a bit much for the pilots and crew. The longest flight was the leg from Japan to Hawaii, covering 8,924km over a period of four days, 21 hours and 52 minutes – a world record for a solar plane with a pilot.

Because the temperature can range from -40°C to 40°C, the pilots have several layers of clothing. They also carry a week's supply of water and specially-prepared food, plus oxygen for use at the higher elevations. In an emergency, they can bail via parachute and float away on a life raft.

HOW DO THE PILOTS SLEEP OR GO TO THE BATHROOM?

Autopilot and a special seat make both activities possible. The pilot can recline and move around somewhat to keep his circula-

tion going. If nature calls, he can convert the seat into a lofty portable potty. Except for 20-minute power naps, they'll hardly get more than two or three hours of sleep per 24-hour period. Piccard, who is also a psychiatrist, uses self-hypnosis techniques to cope with that. Borschberg meditates and does yoga. Physicians as well as a yoga guru will be monitoring them from the ground.

HOW MANY OTHER PEOPLE ARE INVOLVED?

More than 100 people are part of the Solar Impulse team – including dozens of engineers. The folks at mission control, located in Monaco, are in constant contact with the pilot and the plane. Data, including hundreds of technical parameters, is transmitted via satellite. For every destination, a ground crew shows up in advance to prepare for the arrival as well as the next departure.

WHO'S PAYING FOR ALL THIS?

This "idea born in Switzerland" has an overall budget of CHF170million (\$177million). Because of the delay, that's CHF20million more than originally planned – but the project managed to raise it within a few months of stopping in Hawaii. Solar Impulse's many partners include the Swiss government, which granted Solar Impulse the use of two airbases. The mission control centre is funded by Prince Albert of Monaco's environmental protection foundation. In addition, numerous companies and institutions have contributed their expertise and high-tech materials. The names of the Si2's main and official partners are written on the plane. ABB is a major partner.

The plane's role as a laboratory and platform for clean technology was one of the reasons for the Solar Impulse adventure. Solar Impulse is an extraordinary basis for the development of future technologies.

The technology that powered Si2 has many applications. For example, Solar Impulse inspired Swiss lift and escalator manufacturer Schindler to create a solar-powered elevator. And Solar Impulse engi-

(continued on page 25)

BERTRAND PICCARD



Pilot
Solar Impulse

neers have been looking into the feasibility of solar drones.

It was designed to fly 2,000 hours but it only has 700 on the clock. It's still new and can be used for testing and the development of clean energy. The first plane is on display at the Paris Science Museum.

(*World-Gen* received reprint permission from Susan Misicka and Rita Emch at Swissinfo headquarters in Bern.)

JOE MASTRANGELO

CONTINUED FROM PAGE 4

The 6F.01, 6F.03 and LM6000 are installed primarily for small-block power generation applications, which range from 100-250 MW. The LMS100 supplies high-efficiency, fast-start capabilities where rapid response is essential in fluctuating grid level conditions or situation.

"The 7E, 9E and GT13E2 are the primary offerings where customers need the reliability of our 6B, but desire the larger block sizes," Mastrangelo explains. "They are used in the larger industrial space like refineries, LNG and metal processing where the electrical demands are high and down-time is extremely expensive."

DIGITAL DEVELOPMENT

GE Power signed the first enterprise-wide software license with Exelon, which

will deploy GE software across the entire Exelon 32GW generation fleet – including nuclear, wind, solar, hydro and natural gas – to improve the reliability and performance of Exelon's fleet. Exelon will deploy the Predix platform and consume all of GE Power's applications, including GE Power's Asset Performance Management (APM), Operations Optimization, and Business Optimization. In addition, the deal included a co-innovation agreement in which Exelon and GE Power will work together to build apps on the Predix platform for delivery back into the market.

"We're using Predix to run our own business, so we see firsthand why this platform makes so much sense for our customers," says Mastrangelo. "We can take a 3D model from engineering, put it right out on the factory floor – no paper and faster cycle time. We're also using Predix today in our test stands, where we push our technology to its limits." GE engineers and technicians can analyze more than 500 terabytes of data that are collected from the 6,000 sensors across the turbine test stand.

GE describes the Digital Power Plant solution as customized for individual needs and built on a control and software platform that expands plant capabilities and delivers enhanced controllability as well as improved project execution through integrated models and simulation. It serves a plant's full life cycle, from project planning to start-up, to servicing.

"Our system combines the physical strengths of our gas power technology with our industry-leading digital technology," Mastrangelo notes, "and helps customers achieve even better performance, greater efficiencies and improved reliability at the lowest emissions possible."

COAL ENHANCEMENTS

GE's Steam Power team is installing hardware and software upgrade solutions to increase the efficiency of the world's existing fleet of coal-fired power plants. Upgrades to existing plants can be done relatively quickly and cost effectively, and GE says their focus is on delivering solutions that help the world's coal fired power

producers achieve their goals, while protecting the environment and communities they serve.

GE has a suite of ultra-super critical (USC) technology, upgrades/retrofits, digital solutions, as well as emission management technologies such as Sox, NOx and particulates. These solutions make coal plants more efficient, reduce emissions and enable more flexibility to help compensate for fluctuating power production often inherent with renewable energies.

In addition GE recently introduced the creation of GE's Powering Efficiency COE, which combines expertise and technologies from across our businesses to innovate and deliver total lifecycle solutions for coal-fired operations.

ABOUT JOE MASTRANGELO

As the President & CEO of Gas Power Systems, GE Power, Mastrangelo leads GE Power's Gas Power Systems (GPS), a global business of more than 15,000 employees in more than 60 countries that works to power the world by combining the most advanced gas-fired technologies with digital innovation.

As CEO, Joe has assembled a team that is reimagining the design and capabilities of today's power plant. GPS now offers a more comprehensive range of products than ever before, from component equipment to full plant solutions – each with a digital infrastructure to optimize performance. In 2016, the team set a world record for powering the most efficient combined-cycle power plant with its formidable HA gas turbine in Bouchain, France. And today, GPS has the largest delivered fleet of gas turbines in the world, and continues to grow—with more than 7,400 turbines operating in 112 countries, plus a manufacturing footprint in the Americas, Europe and Asia.

As a GE officer, Joe has spent the majority of his career in the energy industry including as vice president of Turbomachinery for Oil & Gas and as CEO of GE's Power Conversion business. Joe has been in his current position since September 2015.

ANIL SRIVATAVA CONTINUED FROM PAGE 12

enabling BESS to provide unique grid and load management services as well as helping to reduce and defer the very large investment needed to upgrade the aging distribution and transmission infrastructure.

Srivastava envisages smart deployment of ESSs in a 'clustered clouds' architecture which will be designed and engineered to deliver blended energy and power, encompassing both stationary and mobile systems.

Srivastava sees a parallel between what happened during the birth of distributed solar to new business models that are now being driven by the emergence of predictable revenue flows to energy storage project asset owners. Infrastructure financiers need to adjust their views for participating in this new "storage asset-class."

These are not usual large ticket investments where revenue is backed by power purchase agreements. A portfolio approach to the investment size and risk-adjusted returns is needed.

ABOUT ANIL SRIVASTAVA

India-born and a naturalized French citizen, Srivastava joined Leclanché in June 2014 as chief executive officer and member of the company's board of directors.

He is an experienced executive with a strong track record in building global businesses.

Prior to joining Leclanché, he was the chief executive of Areva Renewables, a large offshore wind business in Germany. Srivastava also was a member of the Areva Group's executive committee from January 2009 to December 2011.

Previously, Srivastava has held senior executive positions in companies such as TomTom group and Alcatel-Lucent.

He obtained a master's degree from the National Institute of Technology in India and graduated with an Executive MBA from the Wharton School of Business in the U.S.A.

MICHAEL KOTELEC CONTINUED FROM PAGE 14

identifiable information.

- Denial-of-service (DOS) attacks:
- Segregate key servers: separate critical systems onto different network circuits.
- Have a mitigation plan: Know the details of your DoS mitigation service. Brief key operations staff on the best course of action should an incident occur.
- Test for gaps: Test and update your plan regularly as your infrastructure and processes change, and as new DoS techniques emerge.
- Also, given that many attacks come through vendors, seek out partners that also use strong authentication.

ABOUT MICHAEL KOTELEC

Michael Kotelec serves as Global Practice Leader for Verizon Enterprise Solution's Energy & Utilities and Manufacturing vertical practice where he advises customers on smart grid solutions, cybersecurity, global manufacturing value chains, business models and processes in addition to operational technology.

Prior to joining Verizon, Mr. Kotelec held senior executive positions in general management, commercial, supply chain, and operations with Allied Signal, Honeywell, Sabanci Holdings and Kennametal. Much of his corporate career was spent as an expatriate in Europe and Asia Pacific where he focused on developing international expansion through strategic alliances, organic growth, acquisitions and customer partnerships.

Mr. Kotelec is a graduate of Hamden-Sydney College with a Bachelor of Arts in Government and Foreign Affairs. He holds a Master in Business Administration in International Marketing from the College of William and Mary.

MARIA KORSNICK CONTINUED FROM PAGE 19

the U.S. energy infrastructure a D+ grade.

Capital investment has increased steadily over the last 15 years, but most of this has gone to transmission, distribution, natural gas, and renewables.

The part of America's electricity infrastructure in urgent need of attention is the baseload plants that form the backbone of America's electric grid.

They play a key role in grid stability and stabilize electricity prices, acting as an essential hedge against price volatility and supply interruptions. By 2040, half of the nation's nuclear fleet will have turned 60.

ABOUT MARIA KORSNICK

Before joining NEI in 2015, Maria was senior vice president of Northeast Operations for Exelon, overseeing operations of Calvert Cliffs 1 and 2, R.E. Ginna and Nine Mile Point 1 and 2 power plants.

Before Exelon, she was acting chief executive officer at Constellation Energy's Nuclear Group.

Maria holds a bachelor's degree in nuclear engineering from the University of Maryland.

She replaces Marv Fertel who retired at the end of last year.

ADVERTISER'S INDEX

- ABB - p.5
- EEI - p.7
- INTERSOLAR
- MIDDLE EAST - p.27
- INTERSOLAR
- NORTH AMERICA - p. 28
- ITRON - p.9
- LECLANCHÉ - p.11
- POWER-GEN EUROPE - p.13
- SIEMENS - p.2
- SOLAR POWER EXPO - p.23

inter
solar

connecting solar business

| MIDDLE EAST

The Most Powerful Solar Conference in the MENA Region, Conrad Dubai, UAE

- MENA's top conference for project developers, investors, researchers, and visionary CEOs
- Network with 500+ like-minded people from all over the world
- Join the most outstanding solar conference in the Middle East

SEPT
26-27
2017

www.intersolar.ae



Get more
information!

inter solar

connecting solar business

| NORTH AMERICA

North America's Most-Attended Solar Event Moscone Center, San Francisco

- Hear it here first! Be part of the first major U.S. solar event of the year
- 18,000 visitors connect with 550 international exhibitors
- The perfect match! Intersolar is co-located with ees (electrical energy storage)

JULY 11-13 2017

www.intersolar.us



co-located with



**SEMICON
WEST**



Exhibit now!