

Solar+Power MANAGEMENT

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Will our energy future be built on batteries?

THE solar and renewable energy market has once again demonstrated that it can surprise one and all. Amongst 2017's many surprises, who might have foreseen that batteries and energy storage could be just the technologies to bring together what many consider opposing forces: incumbent electricity utilities and solar-wind-hydro renewable energy advocates. A growing body of evidence points in just this direction.

According to the UK's Renewable Energy Association, storage is the 'Great White Hope' for robust growth in today's energy sector. REA spokesman James Court remarked that in meetings with UK Business, Energy and Industrial Strategy (BEIS) agents and the Office of Gas and Electricity Mobility (Ofgem), differences over energy storage were about when it was needed, not whether it is needed.

This is a huge.

In 2016 National Grid announced winners of its first Enhanced Frequency Response (EFR) tender for equipment to balance services at grid scale, and battery-based energy storage solutions won the day. After announcing tender winners, Cordi O'Hara, director of UK System Operator for National Grid said in part, "We are constantly looking to the future...these awards show that we can work with industry to bring forward new technology. I believe storage has much to contribute to the



flexible energy system of tomorrow...an exciting new chapter for the industry."

An exciting new chapter indeed. Fast-forward to 2017 and we see that the call made by UK-based Energy Storage Network for 2 GW in storage capacity by 2020 for grid-scale frequency balancing will likely be achieved by year's end, three years early.

Excitement over storage by both traditional and renewable energy programs may seem a revelation, but it has long been studied by research groups including IHS Markit. According to Julian Jansen, IHS Markit Senior Analyst for

Energy Storage, the sector is having its day because storage satisfies multiple requirements for both sides of the energy debate. Its most recent growth acceleration occurred because of evolving technology (better batteries and power management software / increased manufacturing capacity / more R&D investment,) that has enabled price decreases and performance gains since 2012.

This edition of Solar+Power Management explores the changing role of energy storage and ways that it is bringing together traditional and insurgent approaches to energy – And by the way, storage can also be a viable investment: IHS Markit projects double-digit growth through 2025.

Batteries anyone?

Editor / Publisher Jackie Cannon
T: +44 (0)1923 690205
E: jackie.cannon@angelbc.com

Technical Contributor: Mark Andrews
E: mark.andrews@amcsolutions.info

Sales & Marketing Manager Shehzad Munshi
T: +44 (0)1923 690215
E: shehzad.munshi@angelbc.com

USA Representatives:
Tom Brun, Tom Brun Media,
T: 724 539-2404, E: tbrun@brunmedia.com

Janice Jenkins, Tom Brun Media.
T: 724 929-3550, E: jjenkins@brunmedia.com

Design & Production Manager Mitch Gaynor
T: +44 (0)1923 690214
E: mitch.gaynor@angelbc.com

Director of Logistics Sharon Cowley
T: +44 (0)1923 690200
E: sharon.cowley@angelbc.com

Directors:
Bill Dunlop Uprichard – EC
Stephen Whitehurst – CEO
Jan Smoothy – CFO
Jackie Cannon, Scott Adams, Sharon Cowley,
Sukhi Bhadal, Jason Holloway

Circulation and Subscriptions
T: +44 (0)1923 690200 E: circ@angelbc.com

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12 COVER STORY

Power-Blox goes the distance for energy mobility

Swiss start-up Power-Blox has demonstrated that bringing the benefits of electricity to distant places needed a paradigm-changing look at how energy is stored, transmitted and shared.

16 Storage systems are key to the future of energy

The rapid growth and diversity of energy storage systems signals their emergence as linchpin components of fossil-fueled and renewable energy grids, ensuring double-digit growth through 2025, analysts say.

20 Battery sizing: oversize, augment, reduce or repower?

Does my battery look big in this? I posed this question in a blog 18 months ago, and nobody dared post a comment.

25 Solar & Power Awards 2017

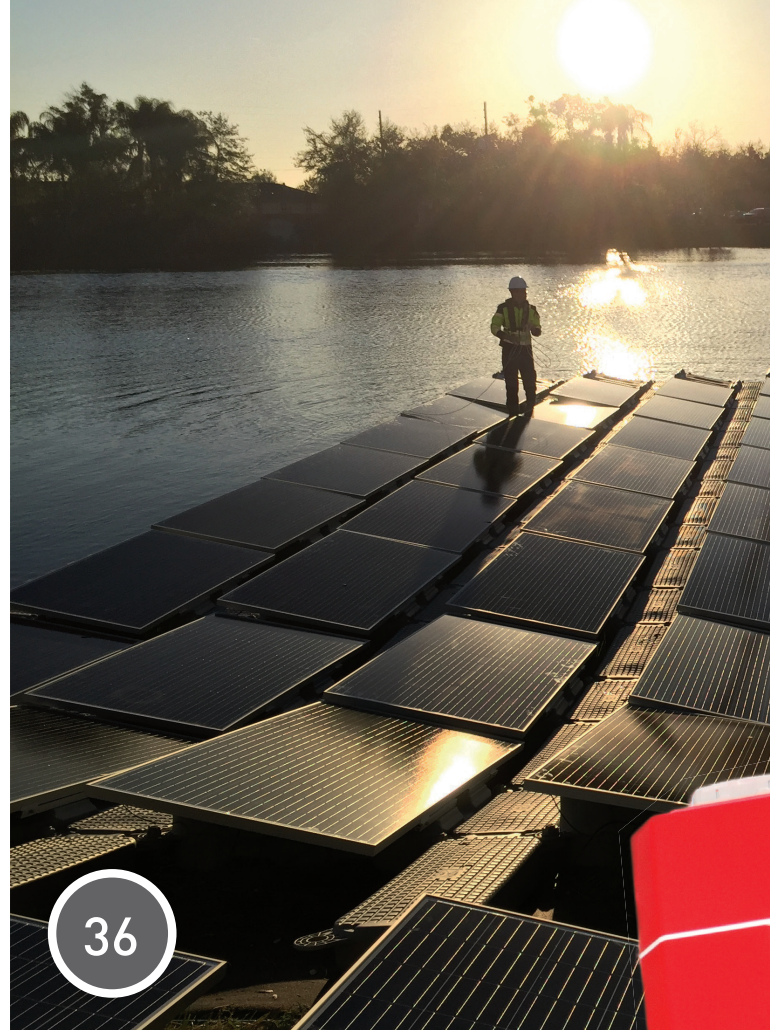
The industry decide their winners

36 C&T brings buoyancy to the PV equation

While falling equipment prices and rising efficiencies have fueled the rapid growth of photovoltaic (PV) technologies, Ciel & Terre has made a business of taking panels safely onto ponds, lakes and reservoirs as it creates a new solar market opportunity.



40



36

40 Time for batteries to shine in Ireland

Everoze Partner, Paul Reynolds sees an opportunity for batteries under the DS3 reforms of system services in Ireland. Here are his key takeaways – how the system works, and what a winning revenue strategy looks like.

44 PV module forecasts rise sharply thanks to chinese demand

Chinese demand for low-cost photovoltaic (PV) cells and modules is driving the global PV shipment forecast higher while creating spot shortages in some regions.



COVER STORY
12



44

industry news...

- 06 US \$12 million in first utility-scale Canadian storage project announced
- 07 BayWa R.e. commissions first PV plant with a battery system in Zambia
- 08 MicroLink to commercialise NREL solar technology
- 09 Leclanché welcomes the EU's plans on battery development
- 10 ABB delivers solar solutions in the Atacama Desert
- 11 Hanwha Q CELLS powers manufacturing plant in France



11

US \$12 million in first utility-scale Canadian storage project announced

EPAL, a joint venture between Indian state-owned Energy Efficiency Services Limited (EESL) and UK-based EnergyPro Limited (EP), is partnering with leading battery storage solutions provider Leclanché, starting with the investment of US \$12 million in a previously announced and nearly completed advanced battery storage project in Ontario, Canada, known as Basin 1 and 2[1]. The high-quality project, built and owned by Leclanché and development partner Deltro Energy, is the first utility scale energy storage facility designed to balance the Ontario power grid, with a total investment of approximately US \$25 million.



The battery storage project will provide services to the Independent Energy Systems Operator (IESO) that oversees and manages the power grid of the province of Ontario, and is interconnected to Toronto Hydro, the largest municipal electricity distribution company in Canada. The Ontario power supply has shifted heavily towards intermittent power sources over the past three years creating additional grid management challenges for the IESO. The lithium battery storage project will improve stability on Canada's largest transmission grid by managing unbalanced supply-demand situations.

The partnership has strategic importance from India's perspective as its government has set a target of achieving 175GW of renewable energy by the year 2022, equivalent to 40 per cent of the country's energy supply, up

from 12 per cent now. This was a part of India's commitment during COP21. To achieve this target, India's energy supply will be dependent on intermittent power sources and ancillary services will be required to stabilise the grid. Battery storage will help achieve stabilisation, supply power to charging stations and reduce the substantial Unscheduled Interchange (UI) charges payable by the country's utilities and states (around \$461.5 million annually).

Speaking on the occasion, Ambassador Mr. Dinesh K. Patnaik, Acting High Commissioner of India to UK, said, "This partnership marks the beginning of a significant development in the energy efficiency sector. With the ever-increasing energy consumption, technologies like battery storage will go hand in hand with efficiency to balance supply and demand. I am very hopeful that EPAL, with its excellent track record in driving the UJALA (UK Joins Affordable LEDs for All) initiative, will bring a revolution in the market with its advancement into battery storage projects."

Mr Saurabh Kumar, Managing Director, EESL, and Chairman of subsidiary EPAL, said, "We are delighted to partner with Leclanché. It has been our constant endeavor to make future-ready technology solutions accessible. With a focus on long, low-carbon initiatives globally, we have partnered with the world's leading battery storage solution provider. We are confident that this partnership will help bring a new era of clean energy solutions for the world." "Working together with EESL on this project has highlighted some unique synergies between the companies," said Anil Srivastava, Leclanché CEO. "We are exploring many additional ways to integrate Leclanché's advanced lithium battery solutions into stationary storage systems as well as new mobility applications such as EV charging stations, full-electric buses and urban transportation systems."

"At EnergyPro we are excited to be working with our JV partner EESL and

Leclanché on this significant utility scale energy storage project. We see it as a first step to deploying energy storage solutions at a range of scales, something that will be essential to the energy transition in all economies," said Steven Fawkes, Managing Partner at EnergyPro Limited.

The Indian government recently launched an ambitious investment programme in new energy, both domestically and overseas, of which the investment in the Leclanché and Deltro Project forms a part. The domestic plans are driven by the government's target of increasing the contribution of renewables to the country's energy supply. As part of this, the government has mandated that by 2030 all vehicles on its roads will be electric – the most aggressive such target in the world. Battery storage helps stabilise grids, which is a challenge as they become increasingly dependent on intermittent renewable energy sources. Storage also reduces the operational costs of grids and defers and reduces future infrastructure costs.

Integral to its global programme, in May 2017, the Indian government announced that it would invest £155 million in clean energy initiatives in the UK's public and private sectors through EPAL. To date, EPAL's UK initiatives include an affordable LED lighting scheme (UJALA), targeted at social housing associations in London, and the acquisition of two energy savings companies serving seven clients in education and leisure. The global energy storage markets continue to experience very high growth.

According to Navigant Research, in the four years to 2020 utility-scale generation and micro grids will experience a Combined Annual Growth Rate (CAGR) of 48 per cent; commercial and industrial battery systems, 58 per cent CAGR; and eTransport, 37 per cent CAGR.

Panitek Power AG, headquartered in Switzerland, was the investment adviser on the transaction.

BayWa R.e. commissions first PV plant with a battery system in Zambia

WITH THE initial commissioning of a combined photovoltaic plant and battery system in the Zambian province of Chisamba, BayWa r.e. has successfully completed the first pilot project in southern Africa. This makes the Agricultural Knowledge & Training Centre (AKTC) operated by the German and Zambian Ministry of Agriculture even more independent from the volatile power supply in Zambia.



The plant supplies the farm for up to thirteen hours per day with 450 kWh of renewable energy for the irrigation of the agricultural land in the area. This equals the consumption of 150 litres of diesel fuel per day and the emission of 145 tonnes of CO₂ per year.

“We are really happy to have successfully completed our first project in Africa,” comments Christof Thannbichler, Managing Director of BayWa r.e. Solar Projects GmbH. “Based on our years of experience in project planning in the PV sector, we see great potential in the entire region for the implementation of further weak and off-grid projects. We are going to significantly expand our activity on the African continent and already have further projects in development.”

The pilot plant on the premises of the AKTC farm consists of 260 solar modules erected in an east-west orientation with a total capacity of 86 kWp. They supply energy for the irrigation of a 90,000 m² grain field. If more energy is generated than can be consumed immediately, it is stored temporarily in a 160 kWh battery storage system. Thanks to an intelligent control system for precise pump control, the water reservoir also serves as additional storage. With the battery and water

storage the AKTC farm is supplied with PV power continuously from 7:00 am to 7:00 pm. During this time it operates independently of the public grid. The farm is only re-connected to the grid at nighttime.

“It is precisely in the tropical and subtropical regions of the globe where farmers are dependent on reliable and uninterrupted power supply for the irrigation of their fields,” explains Tobias Kriete, Regional Manager Africa at BayWa r.e. Solar Projects GmbH. “With intelligently designed weak grid solutions like our PV battery storage system, we can supply operations with reliably and sustainably produced energy, independent of their connection to the public grid. This not only increases the productivity of processes but also contributes to a significant improvement in their ecological assessment.”

As a general contractor, BayWa r.e. was responsible for the planning, financing, installation and turn-key hand-over of the PV plant in Zambia. In the future, the company will also assume technical operations management of the plant.

In addition to continuous monitoring of the systems remotely from Germany, BayWa r.e. also helps to train the farmers on location, so that they can take over the routine servicing of the plant together with local electricians in the future.

Heraeus introduce new front-side silver paste

HERAEUS PHOTOVOLTAICS, the worldwide supplier of metallization solutions to the PV industry, has announced the introduction of a new paste specifically designed for Diamond-Wire-Cut (DWC) multicrystalline solar cells at the PV Taiwan International Photovoltaic Exhibition.

The SOL9651D series front-side silver paste was developed by Heraeus in response to the growing industry adoption of DWC multicrystalline solar cells with a specially textured surface. Industry analysts expect DWC cells to have 80% market share by the end of 2018. Weiming Zhang, Senior Vice President and Chief Technology Officer of Heraeus Photovoltaics, noted that the development and production of the SOL9651D paste was accelerated to meet the cell's technical requirements and deliver superior performance.

He said, “When products like DWC quickly emerge to become the de-facto industry choice for cell manufacturers, it is critical that the right paste be ready and capable to deliver. Heraeus SOL9651D ensures manufacturers can avoid speed bumps on their innovation roadmap.” The launch of the SOL9651D paste series marks another milestone by Heraeus to help solar cell companies improve cell efficiency, address costs and stay ahead of rapid technology developments. For companies that are using DWC cells, SOL9651D is specifically designed to provide a wide range of capabilities and benefits. The availability of single, double printing and knotless screen packages The new glass chemistry was developed to provide excellent adhesion of SOL9651D, which allows customers to optimize their busbar design for better electrical performance and cost reduction, especially on DWC/ Black-silicon texturing.

MicroLink to commercialise NREL solar technology

MICROLINK DEVICES, based in Illinois, has entered into an exclusive license agreement with the US Department of Energy's (DOE) National Renewable Energy Laboratory (NREL) to commercialise inverted metamorphic multi-junction (IMM) solar cell technology. The IMM solar cell architecture enables the manufacture of solar cells with high efficiency as well as light weight, which are ideal for powering satellites and solar aircraft.

The IMM design is an innovative approach to improve solar cell efficiency by integrating an optimum combination of three or more compound semiconductor materials. IMM multi-junction solar cells are manufactured by depositing thin layers of semiconductor on a substrate such as GaAs.

A metamorphic buffer layer enables the growth of junction materials with ideal bandgaps for energy conversion such as InGaAs that are not lattice-matched to the GaAs substrate. MicroLink Devices has demonstrated an efficiency of 32.3 percent under 1-sun AM0 using an IMM design. IMM solar cells are a good match with MicroLink Devices' proprietary epitaxial lift-off (ELO) technology, which has been under development at MicroLink Devices for the past ten years.

Using the ELO process, MicroLink is able to peel off thin layers of active solar cell material that were deposited on the GaAs substrate. Removing the substrate enables the fabrication of solar

cells with exceptional light weight and specific powers greater than 3000 W/kg. The substrate can also be used multiple times to lower manufacturing costs. MicroLink's ELO technology was sponsored by numerous US agencies including NASA, DARPA, the Air Force Research Laboratory, the Office of Naval Research, NAVAIR, Army Research Office, Army REF, CERDEC, and the Department of Energy.

"We are excited to be manufacturing solar cells and arrays using NREL's IMM technology that have industry-leading performance as well as cost," said Noren Pan, president and CEO of MicroLink Devices. "We have been working for more than decade on the scale-up and manufacturing of this design, which enables us to provide very compelling solar solutions for powering high-altitude long-endurance (HALE) aircraft and space satellites."

MicroLink Devices has previously announced a production contract to provide ELO multi-junction solar sheets to Airbus Defence and Space for use on the Zephyr S HALE platform. The Zephyr is a new class of unmanned air vehicle that operates as a high-altitude pseudo-satellite (HAPS) enabling affordable, persistent, local satellite-like services.

The aircraft runs exclusively on solar power, and the Zephyr aircraft is at the forefront of the HAPS arena, holding world records with regards to absolute endurance (more than 14 days) and altitude (more than 70,000 feet).



Fraunhofer ISE to build new centre

THE FRAUNHOFER INSTITUTE for Solar Energy Systems ISE is constructing a new building with a clean room equipped to handle the latest technological challenges. The cornerstone of the 'Centre for High-Efficiency Solar Cells' was laid on October 4, 2017 in Freiburg, Germany.

Fraunhofer ISE has recently set several records for solar cell efficiencies: the world record for multicrystalline silicon solar cells at 22.3 percent efficiency, a 25.8 percent efficiency rate for a monocrystalline cell based on TOPCon technology, and – exceeding the limits of silicon as a material – 31.3 percent efficiency for a tandem solar cell comprising a III-V multi-junction solar cell on a silicon cell. With its III-V multi-junction concentrator solar cell, the institute also achieved the overall world record for photovoltaic efficiency at 46.1 percent. Fraunhofer ISE's new Cenyte will include infrastructure to replace the outdated clean room for solar cell development and is also perfectly equipped for the next generation of solar cells.

"We are delighted that in designing the new clean room facilities, we were able to adjust the infrastructure to meet the latest technological challenges," says institute director Andreas Bett, adding: "We are grateful to the Federal Ministry of Education and Research (BMBF) and the Federal State of Baden-Württemberg for financing the new laboratory building. With their contributions, they are recognising the importance of German research activities in the area of photovoltaics." Hans-Martin Henning, the other institute director under Fraunhofer ISE's new joint leadership system, stresses the prominent role that photovoltaics will play in a future sustainable energy system based on renewable energies: "When it comes to the cost-effective realisation of the energy transition, our energy system analyses make clear that PV and wind energy will be the pillars of our future energy supply."

Leclanché welcomes the EU's plans on battery development

Leclanché SA, one of the world's leading energy storage solution companies, welcomes the European Union's plans to make battery storage central to Europe's energy infrastructure. At the initiative of European Commission Vice-President Maroš Šefcovic, in charge of Energy Union, a meeting on Battery development and production in Europe took in Brussels. This meeting regrouped the leading actors from the EU industry and member states to discuss the establishment of a full value chain of batteries in Europe, importantly including large-scale Lithium ion battery cell production.

It was recognized that the large-scale manufacturing of Lithium ion cells with highest possible control of IP is crucial for EU economy and job creation for the future. There was a clear sense of urgency by all parties which included industrial leaders from automotive OEMs, Chemical companies, Energy companies and cell manufacturing companies. Anil Srivastava, CEO of Leclanché, and Pierre Blanc, the company's CTIO, were amongst the invited participants at the meeting in

Brussels yesterday. With its industrial scale manufacturing site in Germany, and its development centers in Switzerland and Belgium, Leclanché is one of the largest manufacturers of Lithium ion cells in Europe, and has one of the strongest industrial basis.

A clear conclusion of the meeting was to form work strands in order to prepare a concrete roadmap by February 2018, that could set the path to a strong European based consortium, in many ways inspired by what was achieved 50 years ago in the aerospace sector. Leclanché welcomes the initiative led by Vice-President Šefcovic, and is excited to be part of this process that should enable Europe to regain a strong position in the battery industry, which will be key in the ongoing transition to clean mobility and clean energy systems. Lithium ion cell production is central to the achievement of these goals and Leclanché is one of the very few players in Europe with industrial scale Lithium ion cell manufacturing experience. EU funding will be made available, possibly through IPCEI (Important Projects of Common European Interest), and the



group will develop an EU-wide action roadmap over the coming months. Work on this is to start immediately, with Industrial participants to take the lead. Anil Srivastava, CEO of Leclanché, said: "Battery technology is vital to the future security of Europe's energy supply and the initiative of Vice-President Šefcovic will help create the right momentum and sends a clear signal as to its importance.

Leclanché has been investing heavily over the past few years in building the required industrial foundations to be in a position to play an important role in this ambitious plan, and we are delighted to see such a strong and clear position taken by the European Commission.

GlassPoint Solar achieve 55% cost reduction in oilfield project

GLASSPOINT SOLAR and partner Petroleum Development Oman (PDO) say they have reduced costs by 55 per cent in the scale up of a massive desert solar project to produce steam used in thermal enhanced oil recovery (EOR). GlassPoint's enclosed trough technology features a unique solar thermal design that takes parabolic trough collectors, or large curved mirrors, and puts them inside an agricultural greenhouse.

The mirrors concentrate sunlight on a pipe filled with oilfield-grade water and boils the water directly into steam. The process is typically fuelled by burning natural gas. The technology is being scaled up from a seven-megawatt (MW) pilot to Miraah, a one-gigawatt solar thermal project under construction on the Oman oilfield. The savings resulted

from the use of improved designs, enhanced tooling and increased workforce productivity in deploying its enclosed trough technology.

"The greenhouse serves as protection, foundation and structure in one, enabling major cost and performance advantages compared to exposed solar designs. Most importantly, the zero-wind environment lets us reduce the amount of raw materials used throughout the entire system. Using less material reduces the weight and costs of the solar collectors, and makes the plant easier to install and easier to maintain," Pete von Behrens, GlassPoint's chief technology officer, said in a statement. The companies described the cost saving achievements in a technical paper presented at SolarPACES 2017. The paper, Deploying Enclosed Trough

for Thermal EOR at Commercial Scale, details many of the ways GlassPoint has been able to simplify its solar collectors, which are suspended from thin wires from the greenhouse roof. GlassPoint optimized the equipment and mirror manufacturing process, improving yield in the factory and mirror performance in the field. The mirror material was reduced by 18 percent to a little over one kilogram per square metre, reducing costs. They also deployed a new, lighter and stiffer mirror support structure. The new aluminum space frame design, assembled onsite, is five times stiffer than the previous design and cut aluminum usage by 30 per cent. GlassPoint is also deploying a new drive system, which is used to rotate the mirrors to track the sun, that uses one-third fewer motors, and reduces installation and maintenance costs.

ABB delivers solar solutions in the Atacama Desert

ABB has partnered with Spanish independent power producer ACCIONA to supply an all-in-one inverter solution for the 246 MWp El Romero Solar Plant in the Chilean desert. The solar plant is situated in the harsh environment of the Atacama Desert in Chile, 645 km north of the country's capital Santiago.

One of the driest places in the world, the Atacama spans 1,000 km and experiences extreme temperatures from 40 °C in the day to -5 °C and below at night.

Leading Spanish independent power producer ACCIONA, selected ABB to deliver an all-in-one inverter solution that provides clean energy to power the data center for a global, leading tech giant. Following more than 25 years of investment and research, ABB's solutions are designed to provide energy efficient solar power and withstand extreme weather conditions. The El Romero project included the installation of 60 ABB PVS800-IS inverter stations, each rated at 3.6MW.

Providing high conversion efficiency with low auxiliary power consumption, the PVS800-IS inverter station is a plug-and-play solution, designed for multi-megawatt PV power plants. To allow easy and rapid connection to a medium voltage (MV) transformer station, each inverter station, which houses two to three PVS800 central inverters, also features embedded auxiliary power, monitoring and air filtration systems.

The all-in-one solution also included 60 environmentally safe, dry type transformers of 3.6 MVA, which are designed to provide the best performance throughout the lifetime of the plant, ABB SafePlus CCV SF6 insulated compact switchgear and ABB Power Plant Controller for controlling and monitoring the solar plant.

The hardware delivery is supported with a comprehensive service offering that includes training, commissioning and local support for the future of the plant. The ability to deliver continuous power supply for a data center, from a



plant located in the desert, was critical to the installation. ABB'S UPS system, provides protection against all power failures, voltage regulation, power factor correction and harmonics. Covering 280 hectares, the El Romero solar plant, is now the largest photovoltaic plant of its kind in Latin America.

With a peak capacity of 246 MWp, the plant generates 493 GWh of clean energy per year, the electrical demand equivalent of 240,000 homes. Saving 473,000 metric tonnes of CO2 per year from coal-fired power stations, it is a flagship example for encouraging green energy on a global scale.

Commenting on the installation, ABB's Product Marketing Director for Solar in Spain, Alfredo Diez-Hochleitner, said: "The El Romero Solar Plant was a huge feat of engineering in hostile conditions, that saw ABB work closely with ACCIONA to install solar solutions that provide 100% of the data center's clean energy. We are proud of our ongoing investment in energy efficient solar technology that can operate in the most challenging environments, together with our ability to work closely with our partners to develop bespoke solutions, which has created an outstanding solar plant for the future."

Jose Ignacio Escobar, General Manager for ACCIONA Energia Chile added: "Renewable projects as ambitious as the El Romero Solar Plant contribute decisively, so that clean energy can

occupy the place it deserves in a sustainable energy model for Chile and the rest of the world."

JinkoSolar achieve new record in conversion efficiency
JinkoSolar has announced that its (245.83cm²) P-type multi-crystalline silicon solar cells reached a conversion efficiency of 22.04%. It is the second time that JinkoSolar has broken this world record since October 2016. JinkoSolar's record-breaking multi-crystalline silicon solar cell was manufactured on a high quality boron doped mc-Si substrate. Advanced texturing, passivation and anti-LID technologies were integrated into the passivated emitter rear contact (PERC) structure to achieve the new 22.04% world record. The new world record was independently confirmed by Fraunhofer ISE Germany and broke JinkoSolar's previous record of 21.63% one year ago. "This is the first time that conversion efficiency for P-type mc-Si PERC cells exceeded the 22% efficiency mark which I believe will serve as a guideline developing higher efficiency products," commented by Dr. Jin Hao, Vice President of JinkoSolar.

"The entire manufacturing chain is comprised of low-cost industrial processes and will be gradually transferred into mass production. Leveraging our high-efficiency solar cells, we will continue to develop advanced manufacturing techniques to reduce the cost of PV products."

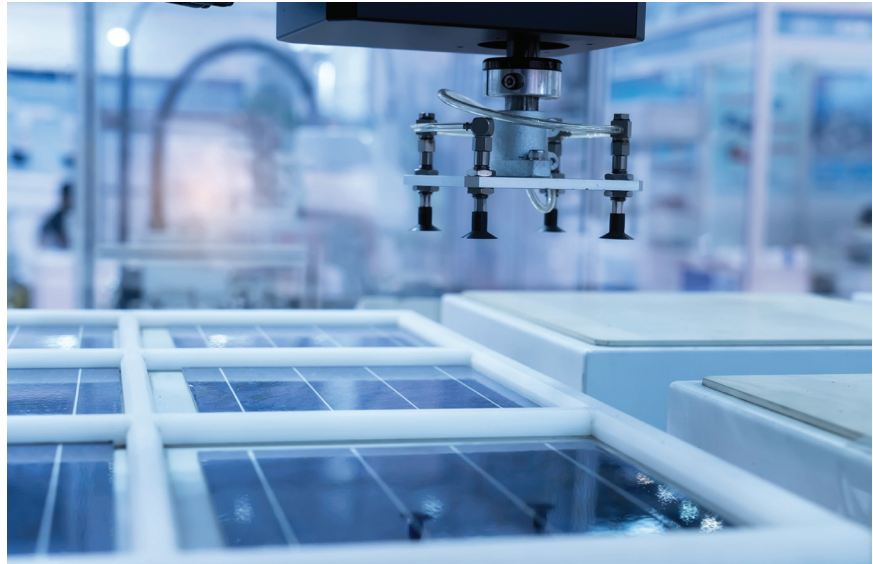
Hanwha Q CELLS powers manufacturing plant in France

A 84 kW Q.FLAT-G4.1 photovoltaic system powers the manufacturing plant of doming specialist CN Industries in France. Hanwha Q CELLS GmbH provided the complete flat roof solution Q.FLAT-G4.1 for the installation, which comprises of 280 Q.PEAK-G4.1 300 Wp modules as well as a tailor made mounting system.

The German subsidiary of the world's largest producer of high performance solar cells, Hanwha Q CELLS, first launched Q.FLAT-G4.1 at Intersolar Europe 2017.

The system has been designed to maximize system yields and lower LCOE (Levelized Cost of Electricity) on limited flat roof spaces regardless of the system orientation. In the case of CN Industries in the French Auvergne region, the 84 kW solar system has been installed in east-west orientation and is expected to produce around 116.280 kWh of clean electricity per year. This will enable the company to use around 70% of the self-produced solar electricity to power its doming production and save up to 5.218 kg of CO₂ per year.

Hanwha Q CELLS partner Systèmes Solaires, one of the most experienced installers in France, designed, and constructed the rooftop installation. The second installation phase will extend the system to a carport, where Q CELLS solar modules will increase the total system size to 112 kWp. Moreover, a large energy storage will help to reach



an energy autonomy rate of 72% for the plant. Clément Neyrial at CN Industries said:

“The self-consumption of solar energy through our new Q.FLAT-G4.1 rooftop installation helps us, both ecologically and economically. We'd like to thank our partners Systèmes Solaires and Hanwha Q CELLS for providing quality work and a high quality solar system solution.”

Rafael Soto, Sales Manager for Hanwha Q CELLS in France said: “In France and basically all over Europe, self-consumption of solar energy makes a lot of sense for companies in industry and commerce. Our Q.FLAT-G.4.1 flat roof system equipped with high efficiency

solar modules from Q CELLS is the ideal combination to maximize energy yields and returns on investment for the customer.” Q.FLAT-G.4.1- maximized yields and minimized LCOE, even from difficult flat roofs. The Q.FLAT-G4.1 flat-roof system is the central element of Hanwha Q CELLS system offering for flat roofs of commercial, industrial and public customers in Europe.

It is a lot more than just a support structure for flat roof systems.

Being perfectly adapted to Q CELLS' high efficiency solar modules, Q.FLAT-G4.1 offers a complete one-stop shop system solution, including planning, documentation, delivery and installation.

JinkoSolar achieve new record in conversion efficiency

JINKOSOLAR has announced that its (245.83cm²) P-type multi-crystalline silicon solar cells reached a conversion efficiency of 22.04%. It is the second time that JinkoSolar has broken this world record since October 2016.

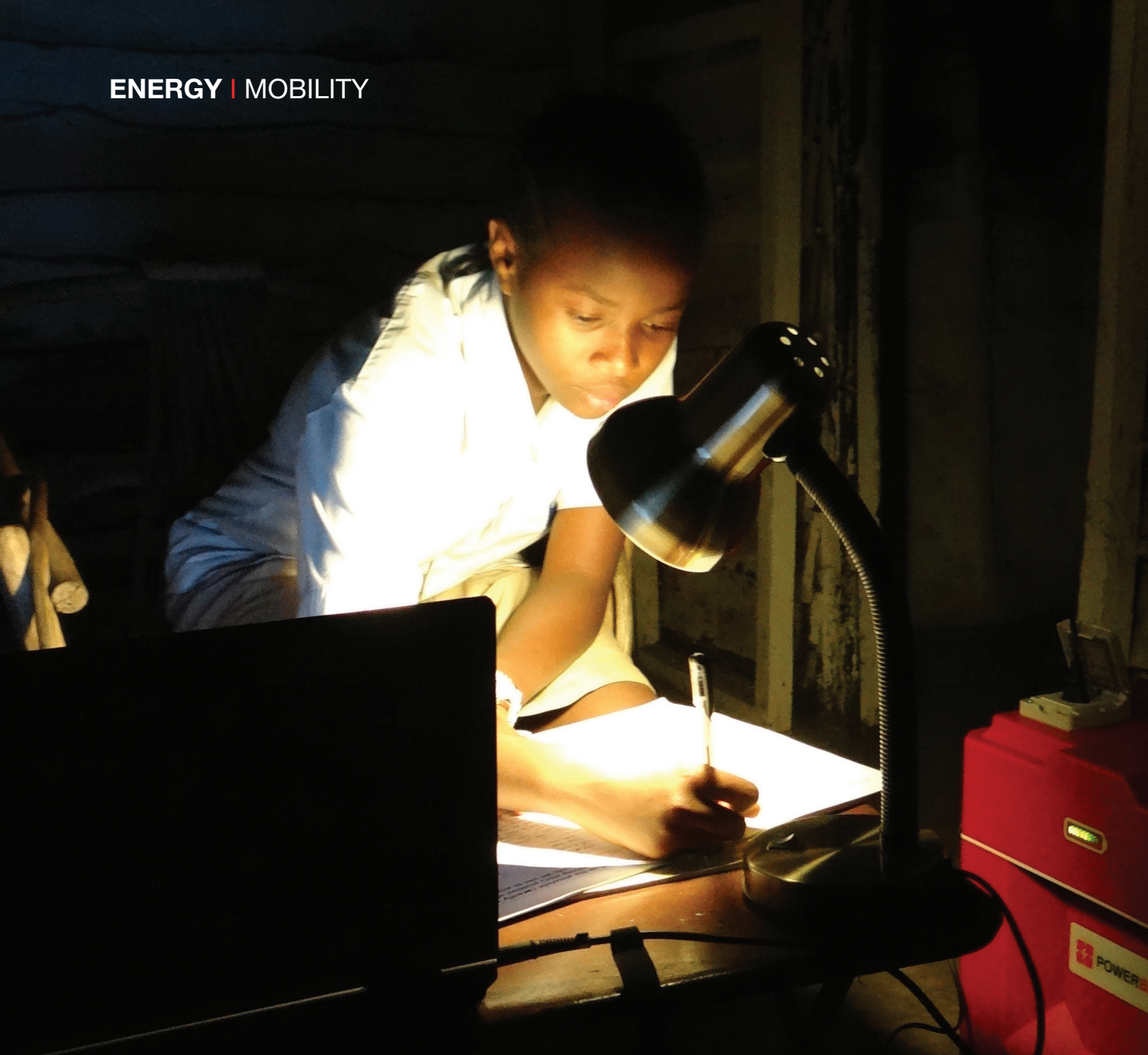
JinkoSolar's record-breaking multi-crystalline silicon solar cell was manufactured on a high quality boron doped mc-Si substrate. Advanced texturing, passivation and anti-LID

technologies were integrated into the passivated emitter rear contact (PERC) structure to achieve the new 22.04% world record. The new world record was independently confirmed by Fraunhofer ISE Germany and broke JinkoSolar's previous record of 21.63% one year ago.

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Goes the distance for
energy mobility

Swiss start-up Power-Blox has demonstrated that bringing the benefits of electricity to distant places needed a paradigm-changing look at how energy is stored, transmitted and shared.

TAKING ELECTRICAL ENERGY to where it's needed traditionally involves expensive infrastructure that works well in cities but becomes prohibitively expensive when consumers are few and far between such as the rural areas where much of the world's population resides. Enter Power-Blox and its novel approach to 'swarm' power that makes bringing energy to remote locals a lot like stacking LEGOs.

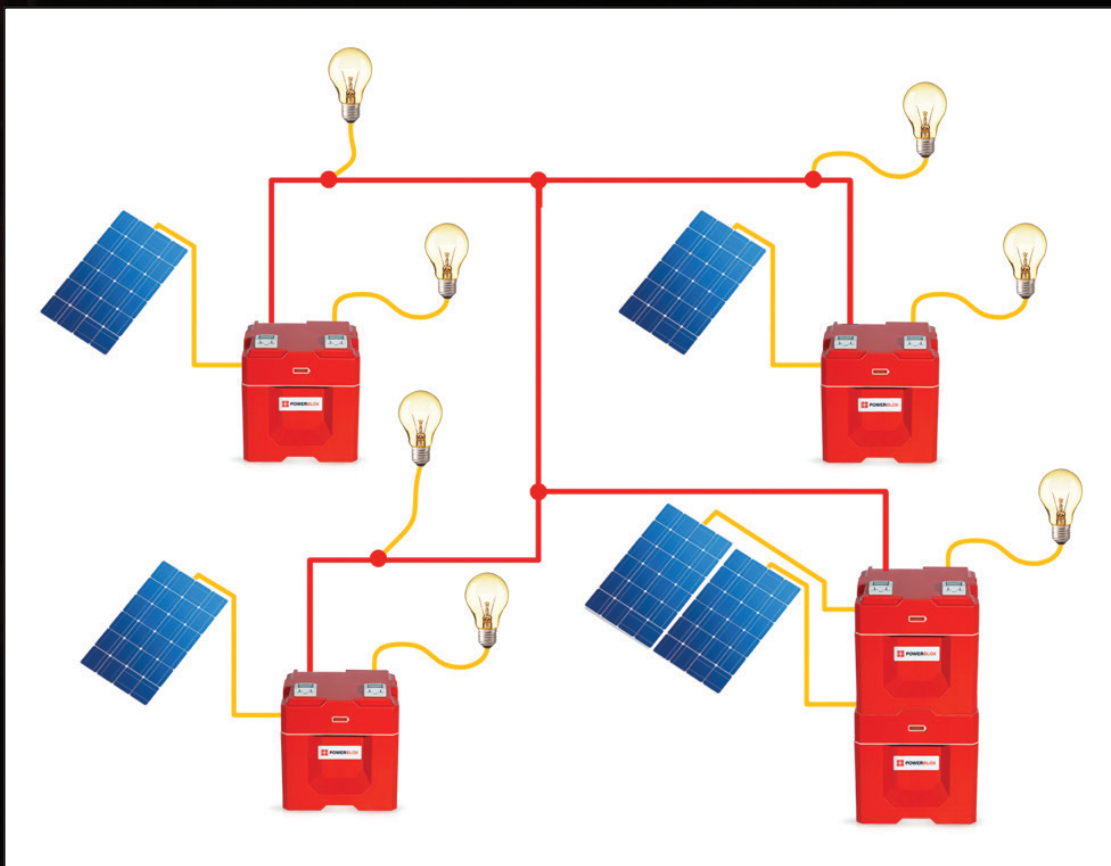
Power-Blox is the company co-founded by Alessandro Medici, CEO, and Armand Martin, board chairman, two Swiss engineers with a passion for bringing power to millions who lack convenient and affordable access to energy.

The Power-Blox concept and products have garnered a number of awards including recognition in 2017 with a Solar + Power Award for rural electrification from Solar+Power magazine. Medici explained in an interview with editor Mark Andrews that his experience with rural electrification changed his life when a friend with a ranch in rural Kenya called 'Segera' asked for Medici's help to modernize and electrify the facility in the heart of Laikipia, near a village called Nanyuki. "It was complicated," Medici said recently.

"And I was impressed by the fact that it took someone with my education and experience to configure and

plan a power system that met the ranch's needs, and that as those needs changed much of the system would need to be upgraded or changed, so even good things like more business would also mean greater expenses and time to do all this. If you have not built a power system in the middle of 'nowhere' the challenges cannot be fully appreciated." Medici said he discovered that the problem with most contemporary power systems (including most renewable energy plants) is that each is built from scratch, or requires a basic plan that is modified to fit particular needs—in essence, everything is 'custom' to a certain degree. As needs change, so must the power plan change along with its actual, physical components that provide the energy.

While the Power-Blox inventors appreciated that they needed a modular design with batteries for portability, the basic concept of systems before Power-Blox all utilized batteries in a similar fashion. Those systems are centralized, with a 'master' control unit that builds the voltage and maintains proper frequency across the entire structure. If the controller fails, the entire system goes down. If the system needs to be upgraded to supply more power, it needs more than additional batteries, the control hardware and software must also be upgraded. All of this typically requires specialized, skilled technicians that are in short supply in most rural areas across the



The flexible architecture of a swarm-based Mini Grid

globe. Enter Power-Blox. The Power-Blox approach is different, said Medici, in that it is based on ideas from nature that can instinctively control swarm behavior in fish, birds, insects and other large groups. In a swarm there is no central controller that 'tells' members of the group how to behave in order to travel together, fend off predators or accomplish other goals. A swarm governs activity by having each member maintain its location, distance and speed relative to other members; if one member falls out the overall structure is maintained. Members can come and go as needed, just as Power-Blox units can be added or subtracted to deliver the power that a community or an individual need.

The company's unique 'secret sauce' is found in the algorithms that specify behavior for members of the Power-Blox swarm (battery units in this case) that are added or subtracted. Swarm technology is

First power-Blox field project in Arusha, Tanzania



Flora demonstrates how to carry a Power-Blox unit



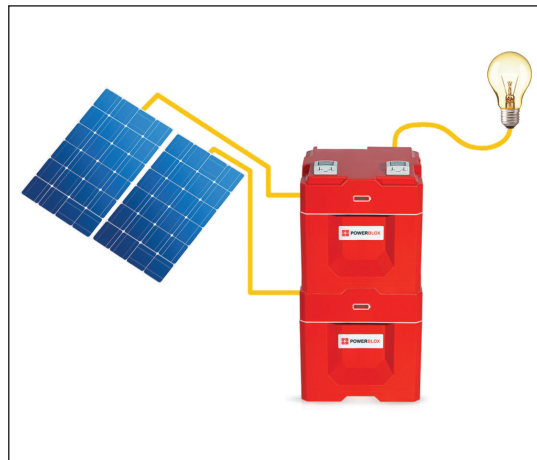
what makes Power-Blox different from any other battery system. At its simplest, a single Power-Blox 200 series cube and solar panel can function as an off-grid power supply. In this example the unit's 1.2 kWh battery and 230V AC / 200W inverter can provide enough electricity for a small refrigerator, a mobile phone charger, and up to three 7W LED lamps. A larger system with greater capacity can be created by adding multiple Power-Blox units by simply stacking them like LEGO blocks to create towers or walls of power with the units connected in parallel.

Power-Blox modularity is what allows users to quickly scale up a system to provide more power or more backup capacity, with 'no engineering, no calculations, no manual' required.

Individual Power-Blox cubes can be stacked together to provide a centralized power system if that is what is needed for security or other purposes, or the grid can be easily distributed out into the service area using what Medici called a 'snowflake topology' that places cubes at various locations that can be connected with industry standard 16mm cables.

"The system is intuitive, meaning that one does not need to be an engineer like me to figure it out," remarked Medici. "Once you explain how the system works to new Power-Blox owners, anyone can reconfigure their system as needed." Power-Blox was originally conceived as an off-grid electricity supply, which is already seeing use in Kenya, Tanzania and other locations, said Medici.

The system can be used to create a solar-powered micro-grid to power a village, a hospital or clinic, or to support disaster relief efforts by using either the centralized or decentralized (snowflake) approach. Power-Blox can also be put into place as a backup power system in locations where the public grid is unreliable, unstable or where a constant and stable supply



Stacking Power-Blox to easily increase power and battery capacity

of electricity is crucial. Power-Blox units already available are offered with either lead acid or Lithium-ion batteries, outputting energy at 230 V/50 Hertz.

The company plans to offer versions at 110 V and 60 Hertz, the electrical standard employed in North America and elsewhere. Choice of battery chemistry will be maintained so purchasers can select the battery type that fits their transportation plans. Versions of Power-Blox for various regions of the world are in development and Medici expects availability later in 2018. The company is also examining a simple means for consumers to use Power-Blox in racked micro-grid designs that would enable independent power systems for household or commercial needs in Europe, the Americas and elsewhere, supporting the creation of user-friendly power systems that could be expanded easily as power needs change over time.

"Power-Blox strength is its easiness, flexibility and scalability. Depending on the country regulation, you could think of a future in which you could buy a Power-Blox in the shop around the corner and just take it home and plug it into a standard wall socket. It will store energy during day when your own solar field on the roof is producing too much power and feed it back during the night." "If you need more storage capacity, just buy another one and stack it. You don't need any engineering or specialists to extend your system. This way you can start small and extend your system over time," Medici explained.

Power-Blox has been honored with recognition from international organizations including a 2017 Solar + Power Award in the rural electrification category; a United Nations National Energy Globe Award of Tanzania in 2015, and an Axpo Energy Award in 2014.

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Storage systems are key to the future of energy

The rapid growth and diversity of energy storage systems signals their emergence as linchpin components of fossil-fueled and renewable energy grids, ensuring double-digit growth through 2025, analysts say.

ENERGY STORAGE is fast becoming the technology around which both 'old school' electric power utilities and renewable energy advocates can agree: batteries are the future and that future is hot.

Energy storage has come a long ways in a short while. In 2016 the amount of utility-connected storage deployed totaled a bit over 1.3 GW, according to researchers at IHS Markit, who project that annual deployment of grid-connected storage will reach 8.8 GW by 2025, taking the cumulative installed base to 52 GW. Find complete details in their latest report, "IHS Markit Grid-connected Energy Storage Market Tracker."

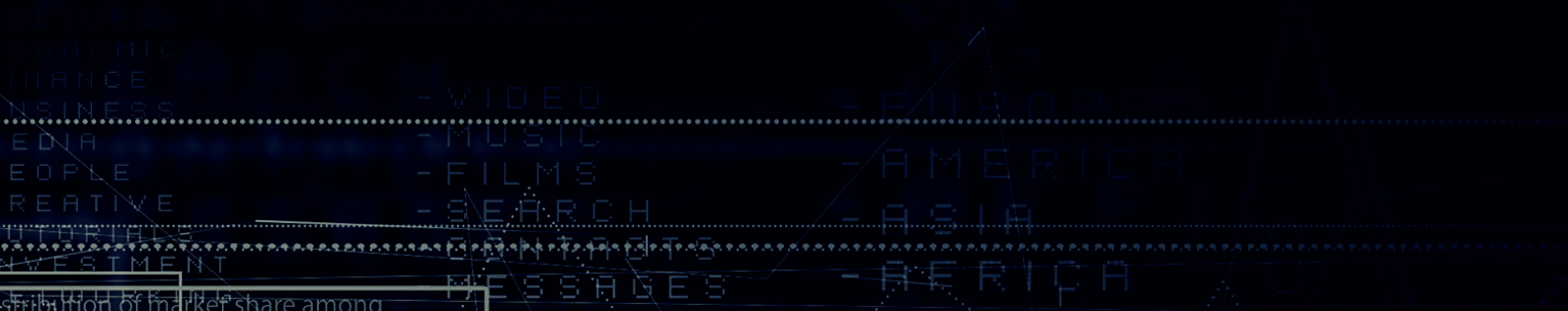
Part of the reason for the rapid ascent of energy storage is technological advancement paired with market forces driving down prices. Growth is also due to benefits that cross traditional, centralized energy generation territory and those of renewable, decentralized power generation platforms.

Consider the UK's Energy Storage Network and its call for 2 GW in storage capacity by 2020 to frequency balance power loads – that goal will likely be reached in 2017, almost three years early. Mainstream governmental agencies including the Business, Energy and Industrial Strategy (BEIS) agency and regulator Ofgem (Office of Gas and Electricity Markets) support storage as well, according to James Court of the Renewable

Energy Association (REA). Court said recently that the differences between policy makers mostly settle along two lines: one camp sees storage as a short-term necessity while the rest tend to view it as a future requirement, yet all agree that utility-scale storage is needed. According to IHS Markit Senior Analyst for Energy Storage, Julian Jansen, the emergence of storage as a distinct and important component of global energy markets has been building for some time. Jansen's group has monitored stationary storage as a distinct market since 2013, and as part of the renewable energy/traditional electric utility 'overlap' for years previously.

Jansen said the relatively rapid growth of energy storage in recent years came about for many reasons including the evolving nature of the technology (batteries, power management software, manufacturing capacity and so forth.) These factors enabled dramatic price decreases since 2012.

The tendency to link the growth of storage wholly to the success of intermittent renewables (wind power, photovoltaic (PV) energy, etc.) is a mistake, says Jansen, who notes that to fully appreciate the phenomena one needs to look at the overall picture of how energy generation and consumption is changing. For example, even in markets with relatively low PV penetration legacy utility companies appreciate that energy storage has benefits for them, whether it is frequency balancing and load leveling,



or reserve power for unexpectedly high demand periods.

“Energy storage can be seen as a key enabler for widespread penetration of intermittent renewables; however, explicitly linking energy storage only to renewables oversimplifies the picture. Especially as energy storage costs are coming down, the technology increasingly provides crucial balancing services and helps support constrained transmission and distribution networks,” Jansen remarked. “Another area of growth is microgrids, which have been a buzzword for years. It’s really now that battery energy storage has come down so much in cost that we can expect widespread adoption of microgrids for renewable integration, reduction of diesel consumption and the ability to island local electricity networks,” he stated.

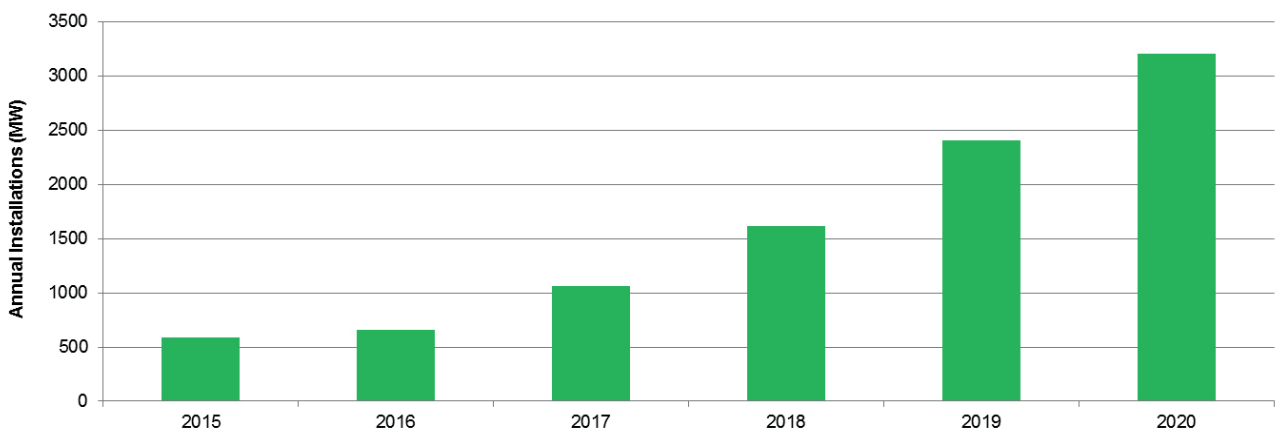
The expectation that storage will emerge as a significant component across global energy markets is creating economic opportunities; IHS Markit projects that storage spending will grow. Jansen’s group focuses on grid-connected storage options, noting that this segment alone will be valued at USD \$7 billion in eight years—a 16 percent compound annual growth rate. While many factors contribute to

the rise of storage in both traditional and renewable energy generation systems, falling battery prices and increases in quality, power density and reliability have been major factors, Jansen noted. One of the biggest changes has come in the way that lithium-ion (Li-ion) batteries have improved while costs fell 70 percent since 2012. Researchers predict Li-ion costs will fall below USD \$200/kWh by 2019.

“Really, it’s a range of factors, but by far the greatest is investment in Li-ion manufacturing capacity and R&D to improve performance, reduce cost, increase energy density, etc. This is particularly driven by investments to take advantage of the growing EV opportunity and the respective need for Li-ion batteries, which is the strongest driver in the future. We are also seeing heavy support and drive in countries such as South Korea and especially China into future battery manufacturing capacity,” Jansen remarked.

As storage emerges as a ‘next step’ in the evolution of power generation and consumption, some may wonder if growth projections can be realized without the subsidies that enabled the global renewable energy surge. While the discontinuance of subsidies did negatively affect residential solar/PV markets, at

Global annual grid-connected energy storage installations by segment (MW)



Source: IHS Markit Energy Storage Intelligence Service, Grid-connected Energy Storage Market Tracker H1 2017

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Making storage an important aspect of future energy generation and transmission is emerging as a key success metric for groups interested in renewable and traditional energy generation

the same time the quality increase of photovoltaic components over the same period, plus better grid-scale financing options, led to the growth of utility-scale PV plants. Market forces that drove down the cost of solar panels in a similar fashion affect batteries and power management systems. Since energy storage benefits both traditional and renewable energy consumers, the lack of subsidies does not appear to adversely affect the viability of storage as a market.

“The discontinuance of subsidies has been one major factor (in the decline in PV growth across Europe and elsewhere,) but by no means, not the only one. Other major factors are: (1 AD/CVD duties from late 2013 that reduced module availability and maintained higher prices in Europe than in other regions, making solar less competitive without subsidies. (2 Retroactivity measures for older installations (reducing project IRR) in several countries that generated widespread investor lack of trust on renewables, which moved investment to other areas, and finally (3 it takes time to move from a FIT scheme to a tender scheme. In addition, even in countries with very good solar irradiation and high electricity prices, that is, countries with good conditions for so-called grid parity, the legal framework did not allow for such tenders or for creating independent IPP; it has taken time to change laws to bring new opportunities for solar projects,” he remarked.

Making storage an important aspect of future energy generation and transmission is emerging as a key success metric for groups interested in renewable and traditional energy generation. The REA’s James Court called energy storage ‘The Great White Hope’ for restoring growth in the UK energy sector after many renewables segments, and in particular solar PV, have been hit by support cuts from the government coupled with the type of investor insecurity that cutbacks tend to foster. Storage systems – approved by renewables advocates as well as mainstream

power utilities, could turn that around, many believe. In markets not as penetrated by photovoltaic and other renewable systems like the United States, Jansen said even faster growth is expected.

“Fundamentally in many US states the drivers (for storage growth) are unrelated to renewable growth and are what enables the US to be the leading market for energy storage growth in the short-term future. Key factors include: Early growth in the PJM market driven by the ability of energy storage to provide frequency regulation; the creation of energy storage mandates or targets in states such as California or Massachusetts (with many states looking to follow-suit).”

“The very specific rate structures in the US and especially in California have enabled the C&I market to emerge. For future growth in the residential sector the revision of NEM policies / structures will be crucial; the needs for peaking capacity, which are more pronounced than in Europe (the Aliso Canyon gas leak is the best example here.) Finally, there is generally a greater risk appetite by investors in the US, as well as greater funding available for start-ups. This can often enable companies to put together business models and scale up more quickly,” he said. While focused on utility-scale storage requirements, Jansen also noted that the ability to store energy more efficiently and cheaply will impact residential markets as well.

“In the residential sector energy storage remains closely linked to solar PV -- the maximization of self-consumption and the customer taking control of their energy supply are the crucial drivers here. However, as companies such as Sonnen continue to build up VPPs and aggregating residential systems to provide demand response services a wealth of potential business models seems likely.”

“In the long-term I believe that in the residential sector it is not about selling hardware (i.e. boxes with batteries,) but about selling integrated energy solutions to customers supporting the transition towards a distributed, low-carbon and digital energy system. Customer empowerment is key for the residential sector,” he concluded.

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IHS Markit
Senior Analyst
for Energy
Storage,
Julian Jansen



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Battery sizing:

oversize, augment, reduce or repower?

Battery sizing: oversize, augment, reduce or repower? How big is too big? Fliss Jones and the Everoze storage team want to settle the matter, once and for all.

DOES my battery look big in this? I posed this question in a blog 18 months ago, and nobody dared post a comment.

There's no doubt that size is sensitive. Industry is split. On one side are those who prefer the voluptuous, substantially oversizing their battery assets upfront. Others argue for a 'lean and mean' approach, planning to augment and possibly even repower later on as needed.

But who is right? It's complex because sizing affects so many different aspects of storage project development and operation. So, we pulled together the Everoze storage team into one room – a team which has collectively conducted storage site inspections, simulations of battery usage, EPC contract support and Financial Model reviews. We also brought in colleagues who pioneered the Life Extension Assessment Framework (LEAF) for renewables. And we asked one simple question: what is the best approach to battery sizing: to oversize, augment, reduce and/or repower?

This feature summarises our agreed position.

1. What are the four strategies, exactly?

First off, let's make sure we're all talking about the same thing. Here are Everoze's definitions:

Oversize: Install more batteries upfront than is necessary to deliver the intended revenue stack at the beginning of life.

Augment: Supplement existing batteries with additional new ones.

Reduce: Reduce service offered from project in line with degrading energy capacity.

Repower: Replace all onsite batteries, and potentially balance of plant too.

These strategies are not mutually exclusive; in fact, two or more are often combined within a project's life.

2. What is the objective? Definitions sorted, the next step is to define the objective. In short, why is a developer interested in MWh capacity? There are two common objectives, often combined:

i. To anticipate degradation: Every project needs a plan for dealing with degradation. MWh capacity of batteries inevitably decrease with time and usage, so the costs of dealing with this must be considered in the project's base case.

ii. To enable a revenue stack reset: Many projects additionally seek to retain the option to increase the energy-to-power ratio of storage plant longer term, to facilitate a possible revenue stack reset. Unlike degradation compensation, this is not an essential objective. Instead, it's a futureproofing consideration, which might be either a base case or upside scenario. To frame this another way, when we talk about battery sizing, we need to be clear on what is the service to be delivered (current and future, base case and possible) and over what period of time? Oversizing is normally proposed as a solution for degradation only; it is less commonly proposed for revenue stack resets, because oversizing requires certain upfront capex, whereas the reset is a possibility rather than a certainty. By contrast, augmentation and repowering can be motivated by degradation anticipation or revenue stack resets, or both.

3. So – which strategy is best? Each strategy strikes a different balance in the trade-off between near-term cost and longer-term technical complexity.

Let's take augmentation as an example. The pros include deferred capex, and the ability to exploit anticipated cost reductions in batteries down the line. In addition, augmentation means that you only ever pay for the capacity you need, in case your revenue stack reset never happens. These are huge benefits. But getting augmentation right requires a hands-on owner. Old and new battery cells need to be on separate strings, and that has implications for inverters, cabling, layout and the Energy Management System. There may be planning risk if extra containers are needed. Outages should be anticipated and quantified. And what's less often appreciated is that 'lean and mean' systems experience faster degradation too, due to cycling and state of charge patterns. Our team concluded that there's no single 'right' strategy. But rather than fob you off with the classic 'it depends' cop-out, we've mapped out some pragmatic guidance. We identified the two key drivers of sizing strategy as

being (a) how confident an investor is in the flexibility market,

and (b) the investor's risk appetite; though we note that other parameters may also be influential. See our summary 2-by-2 matrix below:

4. Plan plan PLAN Although multiple approaches are viable, let's be clear: this isn't a case of 'anything goes'.

Far from it. Another clear outcome from our workshop was the absolute necessity for upfront preparations during project development. For example, spontaneous augmentation in Year 5 will cause a real headache if your original design didn't anticipate this in its layout, inverter configuration and cabling routes. Simply put, you need a plan that is both (a) technically credible and (b) consistent with the Financial Model. Is the degradation analysis robust? Has optionality been built into planning and land options? Does the EPC design reflect the intended approach? We could go on.

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		BATTERY SIZING GUIDANCE	
		INVESTOR'S CONFIDENCE IN MARKET	
		LOW	HIGH
INVESTOR'S RISK APPETITE	LOW	AVOID STORAGE!	OVERSIZE to ensure that revenue stack can be delivered in project's final year (as per business model)
	HIGH	OVERSIZE to deliver current contract, then AUGMENT	OVERSIZE to deliver current contract, then AUGMENT + REPOWER

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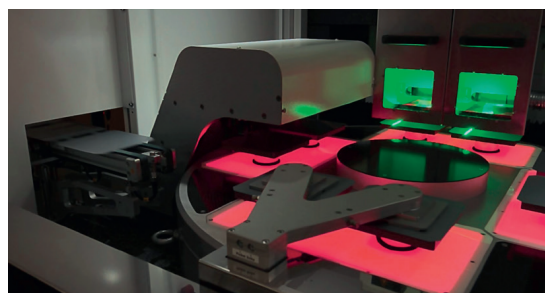
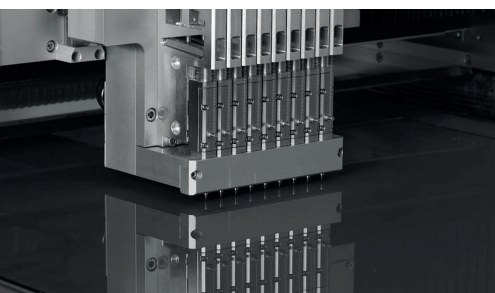




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R&D Award ECN+ UvA

Development of Green Solar Panels



Researchers from AMOLF, the University of Amsterdam (UvA) and ECN have developed a technology to create efficient bright green coloured solar panels. Arrays of silicon nanoparticles integrated in the front module glass of a silicon heterojunction solar cell scatter a narrow band of the solar spectrum and create a green appearance for a wide range of angles. The remainder of the solar spectrum is efficiently coupled into the solar cell. The current generated by the solar panel is only reduced by 10%. The realization of efficient colourful solar panels is an important step for the integration of solar panels into the built environment and landscape.



Solar PV Material Award SOL9641B Silver Paste

Heraeus SOL9641B series is based on the brand-new glass chemistry for ULDE (Ultra Lightly Doped Emitter), combined with the latest improvement in organic vehicle system for UFL (ultra-fine line) printing. Customers report that SOL9641B has excellent metallization contact on ULDE mono and multi crystalline solar cells. SOL9641B is a revolutionary design as a "Product Platform", not just a product family. Such unique paste chemistry has a wide firing window toward lower temperature side, which makes this series well-performed on PERC (Passivated Emitter Rear Contact) solar cells.



Solar PV Equipment Award A+A+A+ LED Solar Simulator

With the A+A+A+ sun simulator backend-solution MBJ Solutions GmbH offers a very compact solution for the inspection of solar modules at the end of the line. Besides an innovative TUV certified A+A+A+ LED solar simulator, the system includes an isolation test and an electroluminescence test on a very small footprint. The second-generation triple A+ LED solar simulator is prepared for the new standard Ed. 3. It includes the increased requirements for the spectral distribution and the option for an enlarged spectrum below 400 nm and above 1000 nm. The isolation and grounding test for framed modules can be integrated in the solar simulator. For unframed glass-glass modules the isolation test is moved into a separate station. The electroluminescence inspection is a separate unit following directly after the sun simulator. For the EL test MBJ relies on the proven technology of the EL-quickline series. By variation of the camera, setup a pixel resolution of 180 μm and cycle times of less than 20 sec can be realized.



Solar PV Process Award SENperc PV

SENperc PV is a system for quality control, which guarantees the efficiency and quality of PERC solar cell manufacturing. PERC cells consist of multiple layers, their properties and interdependences are generating more energy than conventional cells. For the quality control of PERC cells, it is necessary to precisely control the properties of the back side passivation layers by means of an optical, nondestructive measurement. The SENperc PV is the solution. The advantages of this innovative SENperc PV system are easy recipe based operation and statistical process control for quality control in industrial PERC cell manufacturing and the direct and long-term feedback to the operator for immediate intervention.



Silicon Module Award TwinPeak 2

REC has worked extremely hard to extend the module power output achievable with the multicrystalline silicon cell platform to levels thought impossible with this technology just a few years ago. The company has made an immense effort to evolve and introduce a number of innovations to both its 60-cell and 72-cell mc-Si solar modules, which when combined mean that its mc-Si solar modules can strongly compete on power with competitive monocrystalline products. By advancing mc-Si technology, REC is aiming to provide customers with high power products at very competitive prices, helping to reduce BOS costs and lower LCOE for investors in PV. With the TwinPeak 2 developments, REC has achieved this at the same time as delivering more power per m^2 - generating the same amount of power with fewer modules, or generating higher system yields from the same surface area.



Thin Film Module Award CIGS Technology

Flisom was a spin-off of the Laboratory of Solid State Physics of the Swiss Federal Institute of Technology Zurich (ETH Zurich). Flisom's solar modules are potentially a game-changer as they are beautifully-designed, flexible, rollable, and lightweight. Flisom modules have achieved conversion efficiency of 20.4% in a flexible CIGS solar cell - the highest efficiency and flexibility of any thin-film technology. Flisom has developed a line of proprietary manufacturing equipment and components that allows production from cell to solar module in one single factory. The system allows fewer and better materials across less manufacturing steps, as well as giving better process controls over the whole value chain. The process means they can now efficiently bring CIGS thin-film solar cells to market.



Solar PV BOS Award REFUcube

In commercial and utility scale plants, basically two inverter types can be used, both types have relevant advantages and disadvantages. The REFUcube - the first centralized string inverter solution in an ISO container - now combines the advantages of both inverter types while minimizing the respective risks. REFUcube is available in four power classes - 1, 1.6, 2 and 3 MVA and comes in a 20ft (for 1 MVA) or 40ft container (1.6-3MVA). It includes string inverters, MV/LV transformer, MV switchgear, LV switchboard, DC connection panel, auxiliary transfer and auxiliary switchboard as well as grid protection relay. All components are pre-wired (with DC, AC and data communication) and tested to ensure optimal compatibility and ease of installation.



Smart Energy Management Award FusionSolar Smart PV Solution

Huawei Technologies is a global information and ICT solutions. Huawei's smart PV solution incorporates digital information technology, Internet technology, and PV technology. Based on innovative concepts such as simple, full-digital, and automatic global O&M, Huawei aims to build smart solar plants supporting higher yields, smart O&M, and safety and reliable, helping customers maximize their ROI within the power plant life cycle. Huawei's smart PV solution has been widely applied around the world. FusionSolar Smart PV Solution is suitable for various scenarios including utility PV Plants, to help customers build smart PV plants that have continuous reliable operation, high energy yield, intelligent O&M with low initial investment.



Smart Energy Storage: RESIDENTIAL MyReserve Matrix Battery

MyReserve Matrix sets new standards for the battery storage market: the system is completely modular. The battery module and intelligence unit are each housed in solid, highly secure aluminum blocks, which means that no additional cladding is required. Each individual module is the size of a shoebox and weighs less than 25 kg. By combining these two basic components, any storage capacity from 2 kWh to 2 MWh can be configured. The SOLARWATT battery is as equally suited for private household use as commercial storage. MyReserve Matrix is also flexible in terms of performance: each connected battery module increases performance by 800 watts. The new battery storage system is suitable for all conceivable applications.



Smart Energy Storage: COMMERCIAL TrinaMega

TrinaMega is a modular plug-and-play containerized BESS solution, custom-made, to answer specific battery usage and functions from utilities and large energy users. TrinaMega provides one of the best battery densities on the market for utility-scale projects, up to 2.9 MWh per containerized BESS. TrinaMega is scalable, and includes the complete BESS system, UPS, SCADA unit, thermal management, fire suppressant, power supply and auxiliary systems. TrinaMega is designed, manufactured and tested in full compliance with the latest edition of IEC, EN and UL standards, and provides one of the most optimized safety, control and monitoring systems. TrinaMega has been successfully developed in the UK and Africa markets.



Rural Electrification Product Award The Power-Blox 200 Series

The Power-Blox 200 series is a revolutionary modular energy system producing AC power from 200W up to the Kilowatt range, which serves as a "portable socket" to off grid energy demands. Power-Blox created a solution for developing fully autonomous power grids that can scale up without the need for extensive configuration or a centralized control, thanks to "Swarm Power" technology. Power-Blox energy storage devices are designed to stack together into a bigger unit with a larger capacity, as well as joined together into a micro-grid that allows each of the connected units to have access to "the full power of all units."



Solar & Power Award Winners 2017



Rural Project Development Mobile Power Stations

Multicon AG & Co. KG has developed mobile solar power plants to ensure energy supply also in areas where there is no public electricity network. The mobile power stations are equipped with solar modules, inverters, storage batteries and an intelligent energy management. Because the systems work according to the "Plug & Play" principle, they are ready for use within a short time. Installed container or trailer based, our mobile power plants have an output from 5 to 86 kWp. As any number of mobile solar plants can be connected, they can cover electricity demands equating to several megawatts, which is enough energy to power hospitals, refugee camps or water desalination plants. The mobile solar plants are equipped with back up diesel generators.



Solar PV O&M Award ACTIS

Alectris has been developing the solar ERP system ACTIS since 2011. The software is a fully integrated platform for operational solar PV assets covering monitoring, service management, asset management, project management, cost management, billing and integrated reporting in one uniform platform. The software has been developed in-house with the assistance of the engineering team of Alectris based on real plants and out of real life experience. It combines everything that relates to managing operational PV assets in one uniform database and interface, allowing for standardization, streamlining of processes, aggregating all information and data (even from external software systems, like monitoring and accounting systems) in a uniform way allowing for in-depth insight of the operations and performance of individual plants. ACTIS can efficiently manage PV assets, streamline operations, decrease costs and increase performances in the most cost-effective way.



Green Investment Award Solar Lease Business Model

MEP was one of the first to launch a solar lease business model for German house owners offering private households the opportunity to participate in the energy transition without costly investments or planning effort. With 6,000 customers, MEP offers house owners a 20-year carefree solar lease package including everything from planning to assembly and insurance. To finance this business model on a long-term basis, MEP developed with its collaborating bank the first structured financing solution for the German solar lease market. In December 2016, MEP placed Europe's first Climate-Bond-certified green loan backed by small ticket solar lease contracts of the MEP solar lease business model- an important milestone for the industry and example for future investors and issuers of green long-term financing products. MEP complex financing structure allows institutional investors to invest on a long-term basis in the MEP solar lease business model and the private energy transition.



Company Excellence in Innovation Award Q.ANTUM

Q.ANTUM is the proprietary solar cell technology platform of Hanwha Q CELLS and the engine behind its complete portfolio of solar modules. While being based on the rear side passivation of the solar cell (PERC), Q.ANTUM offers many features that differentiate it from conventional PERC technologies. Q.ANTUM Technology's strength lies in controlling various degradation effects such as PID (potential induced degradation), LID (light induced degradation) and LeTID (light and elevated temperature induced degradation). Q.ANTUM Physics -The rear surfaces of Q.ANTUM solar cells are treated with a special nano coating that functions much like a typical household mirror. Rays of sunlight that would otherwise go to waste are reflected back through the cell to generate more electricity. Laser-fired contacts complement the nano coating to enhance the module's electrical properties, increasing its efficiency considerably.



Cost Management Tool Award Sunwire Calculator

Sunwire is Luvata's branded solar ribbon. The Sunwire Calculator enables module manufacturers to make informed decisions concerning their solar ribbon needs. Understanding solar ribbon is critically important to module efficiency and life cycle. With the Luvata Sunwire Calculator, module manufacturers can optimize the amount of Sunwire ribbon per spool to accommodate the speed of tabbing machines and shift changes. As manufacturers look to reduce usage of silver paste in the cell metallization process, this can increase the number of interconnecting ribbons on the cell. This offers lower costs, and improved the efficiency. Playing with the Sunwire Calculator to determine the solar ribbon weight based on the copper width, copper thickness or coating thickness or the length of Sunwire depending on the number of cells and busbars per cells will help PV module manufactures determine the optimal results.



AWARD: Cost Management Tool

ENTRY: Sunwire Calculator

LUVATA SPECIAL PRODUCTS manufactures photovoltaic ribbon branded Sunwire, used as both an interconnecting ribbon and a cross-connecting ribbon in solar panel manufacturing. Over the past few years as PV module manufacturers have begun to upgrade from two or three busbars to four or five; it has made their choice of PV ribbon far more important.

Raising the number of busbars puts less residual stress on the crystalline silicon cells, reducing the probability of micro-cracks which can lead to malfunctions and power degradation. Increasing the number of busbars also increases the number of ribbons while enabling shorter distances for electrons to travel along the grid lines. This requires narrower ribbon to reduce cell to module (CTM) power losses. This lowers module manufacturers' costs by reducing the use of expensive silver paste in the cell metallization process without sacrificing efficiency.

Over the past few years, Luvata Special Products' photovoltaic ribbon branded Sunwire has continued to evolve to meet this challenge and is today the flattest, straightest, softest and now narrowest PV ribbon available.

Without a doubt PV module manufacturers needs and requirements have changed, and as a PV ribbon manufacturer our products must keep pace. But our job doesn't stop there. We must also look for other opportunities to help PV module manufacturers. Working with customers to improve processes and end products is fundamental to Luvata Special Products as part of our "Partnerships beyond metals" philosophy.

We work with PV module manufacturers to help them improve their efficiency, and one way to do that is by optimizing the packaging of Sunwire PV ribbon per spool to accommodate the speed of their corresponding tabbing machines or shift changes. In response, Luvata Special Products developed the Sunwire Calculator to enable photovoltaic module manufacturers to make more informed decisions concerning their solar ribbon needs. In addition, it provides the opportunity to further refine module materials and Sunwire ribbon for improved module efficiency and reduce overall material costs.



Mr. Tero Horttana, Product Group Manager (left) and Mr. Janne Oksanen, Technical Manager

The Sunwire Calculator requires a few simple details to determine the solar ribbon weight, the ribbon length per spool and even the ribbon length per solar panel. Utilizing the Sunwire Calculator to determine the solar ribbon weight based on the copper width, copper thickness or coating thickness or the length of Sunwire depending on the number of cells and busbars per cells helps PV module manufacturers determine the optimal results. These tools are available to solar panel manufacturers 24 hours a day and 7 days a week via the company's website.

The pressure on manufacturers to improve product performance, manufacturing uptime and total cost of operation is never ending. At Luvata Special Products, we recognize that to be a world class manufacturer of solar ribbon for the PV industry we must go beyond simply providing the highest quality products. We also have the expertise and tools to help. Please see the Sunwire Calculator datasheet for additional information or visit our website to experience the Sunwire Calculator yourself.

www.mmluvata.com/en

Judge's remark:

Luvata's Sunwire Calculator helps manufacturers to optimize their use of silver paste and other expensive consumables to lower costs and improve overall efficiency.



AWARD: Rural Project Development Award ENTRY: Mobile Solar Plants

THE MULTICON GROUP (Germany) realizes innovative photovoltaic solutions by providing containerized and trailer-mounted photovoltaic (PV) and energy storage systems for a wide range of off-grid applications. The company has been active in the renewable energy field since 1993 and has installed more than 1,000 plants with a total energy output of more than 200 megawatts.

The company's focus has been on mobile solar systems since 2010. Multicon develops, produces, assembles and transports mobile PV power plants that are employed across the globe for commercial, defence, humanitarian and recreational programs. Each Multicon solar container has a capacity of up to 86 kWp and stores up to 150 kWh of solar power. They can generate single-phase or three-phase energy. Any number of containers can be coupled together to build multi-megawatt systems.

Multicon offers a wide variety of mobile off-grid solutions designed for economical transport; smaller systems can be moved by light truck or similar commercial vehicles; complete, 20-foot containerized Multicon energy solutions conform to international shipping regulations. Multicon offers a variety of energy generation packages based on the degree of portability required as well as energy output and power storage requirements.

The Multicon approach to mobile power generation is based on simple plug-and-play principles. Power is generated by using the latest PV modules along with all major balance of system (BoS) components including inverters/converters and distribution infrastructure that can be sized to fit any customer need. Multicon can add energy storage to most of its systems; mobile solar systems can be combined to create photovoltaic plants for any customer application.

Multicon systems can be used in any region that offers sufficient sunlight and are already serving in a wide range of climates across Europe, Africa, the Middle East, South America and Asia. Multicon systems are designed to perform well in extreme heat, cold, rain, and humidity. Solar power plants are free of pollutants; these systems offer fast, economical off-grid power and are far superior to



heavy and difficult-to-transport systems that utilize large diesel powered generators.

Fossil fuel-based power plants are complicated to install and maintain, requiring highly-trained personnel at every stage as well as the ongoing and considerable expense of fuel transport and on-site storage. When Multicon mobile solar systems arrive at their destinations they can be installed quickly thanks to their complete turnkey serviceability; maintenance is minimal; daily operation typically requires no specialized training after the initial installation phase.

Multicon solar systems often serve remote and rural areas, but are also ideal for urban locations since they operate quietly, making them perfect for service in crowded areas sensitive to noise and pollution, as well as in agriculture. On-site, the wired photovoltaic modules merely have to be pulled out of their container to be deployed. In the event of dangers such as sand storms, monsoons or theft/vandalism, the modules can be stored safely in their containers, with batteries providing power during nighttime, non-generating hours or during periods when panels cannot be deployed due to various other concerns. Electrical power where and when you need it with Multicon mobile solar power plants.

Judge's remark:

Restoring power after natural disasters or bringing power into remote areas for the first time is made easier thanks to mobile, all-in-one power stations like those of Multicon AG and Co. KG.

Solar+Power
award winner



AWARD: Smart Energy Management Award

ENTRY: FusionSolar®

FusionSolar® is Huawei's smart PV solution that incorporates its expertise in digital information, internet and PV technology. Based on innovative concepts such as simple, full-digital, and automatic global O&M, Huawei aims to build smart solar plants that deliver higher yields, while being both safe and reliable.

FusionSolar® Smart PV Solution combines smart hardware, from the inverter through to innovative power line communication, with digital information and internet technology. Incorporating these into a comprehensive, digitalised system, helps to optimise the overall performance of a solar power plant and to maintain grid stability. This enables automated PV system O&M through big data collection, high-speed communications and cloud computing.

At the heart of FusionSolar® are Huawei's SUN2000 string inverters which significantly improve power yields due to several innovative features, with a high EU efficiency of 98.8 percent, as well as a low failure rate. All SUN2000 string inverters feature Huawei-patented 5-level topology, use natural cooling technology with no external fans, no filters requiring cleaning or exchanging, and no DC fuses. This helps to improve reliability and minimise O&M costs. Inverter reliability is also enhanced by Huawei's focus on R&D. In order to ensure that they are able to withstand all the stresses and strains that PV scenarios demand, FusionSolar® inverters are put through over 1,400 tests during development to ensure that they are robust and reliable, helping Huawei to deliver inverter availability of 99.996%.

In addition to industry-leading hardware, FusionSolar® also enables plant owners and operators to utilise Huawei's unique Smart I-V Curve Diagnosis, which enables them to remotely monitor their assets using big data, cloud computing to analyse results in minute detail. Smart I-V Curve Diagnosis is perhaps one of the clearest examples of how digitalisation is enabling the solar industry to lower its LCOE. It aggregates the granular data about the array providing accurate information about the performance of the whole plant. Energy managers are able to monitor all PV strings and review the performance online with high precision, accurately identifying faults and the root cause of issues. This



remote, real-time monitoring enables pre-emptive maintenance and removes the need for expensive ad-hoc, laborious, on-site testing. This complete solution optimises plant uptime and increases energy yields. As a direct outcome, asset managers typically see much lower failure rates, thereby simultaneously increasing their return on investment and lowering operating costs. At Toggam Farm, Lakenheath, UK, a 12.8MW PV plant uses Huawei FusionSolar® enabling fully digitalised automated O&M. A balanced and flexible infrastructure comprised of multiple string inverters (rather than a few central inverters) ensures system reliability; one inverter failure simply cannot impact the whole array. As a result of Huawei's string inverters and smart PV controller equipment, the plant generates higher yields, safely and reliably, whilst reducing O&M costs.

Although the advantages in terms of energy yields and cost reductions are clear, FusionSolar® also offers broader benefits in terms of both grid stability and cyber-security. Huawei uses well-defined, advanced power electronics to provide enhanced grid support, stability, power quality and increased grid resilience.

Judge's remark:

Huawei's diverse product lines and best in class technology enable the company, through its FusionSolar Smart PV Solution, to offer commercial, grid scale solar plants with optimized yields, O&M, safety and reliability with the promise of first class results



AWARD: PV O&M Award ENTRY: ACTIS Solar ERP

ALECTRIS, a global solar asset care innovation firm, started the development of the world's first Solar ERP (Enterprise Resource Planning) platform called ACTIS in 2011 to serve its fleet of client PV assets.

ACTIS, (Asset Control Telemetry Information System), is the only fully integrated software platform for operational solar PV assets. ACTIS was developed completely in-house from high-level IT professionals with the assistance of the Alectris engineering experts based on active plants and field experience. The company is committed to the continued development of ACTIS based on daily business objectives along with client requirements and recommendations, set within a dynamic solar industry environment. ACTIS is used worldwide for dispersed solar asset management.

ACTIS integrates essential solar PV operations, maintenance and asset management activities into one system to take full control of the portfolio. It includes:

- Technical Reporting
- Service Management
- Monitoring
- Asset Management
- Financial Reporting

Constantinos Peonides, Director for Alectris, receives the Solar + Power Solar PV O&M Award on behalf of the company for its ACTIS, Solar ERP platform.

Alectris' internal analysis revealed tens of specific tasks for each individual plant managed either directly from the Asset Owner or in conjunction with Service Providers. The size of the solar PV portfolio increases the number of tasks to levels not sustainable in a cost-effective way, which increases management overhead and the risk of missing important regulatory or technical issues.

Even the most advanced organizations are using multiple systems (10 on average) to conduct their operations, maintenance and asset management activities. In this framework the need for a uniform, centralized system integrating all operational activities into one single database has become a necessity.

Along with the cost and regulatory challenges comes the need for standardization across multiple teams located in different regions and countries. The time needed to gather information and create consolidated reports with validated data has increased to the point that in many cases teams spend the biggest part of their work to gather and report information instead of conducting actual management activities.

This is exactly the need ACTIS addresses, developed out of real life experience with engineers who provide such services. ACTIS unifies all information and data into one single database, eliminating the challenge and risk of integrating separate and isolated systems.

In a world of rapid consolidation, ACTIS is a unique tool to efficiently manage solar PV assets, streamline operations, decrease costs and increase performance with the most cost-effective solution. This is the third award for ACTIS. In 2015, the platform won a Silver Facilities Management Award. This followed a Bronze in the same competition in 2014.



Judge's remark:

Streamlining solar plant operations and maintenance (O&M) activities is vital to achieving maximized return on investment, a process made easier with the ACTIS program from Alectris.

Solar+Power
award winner



Trinabess
Battery Energy Storage Systems

AWARD: Smart Energy Storage – Commercial ENTRY: TrinaMega

TrinaBESS designs, manufactures and delivers battery energy storage systems (BESS) for utilities, solar companies, project developers, installers and distributors for residential, commercial and utility markets. TrinaBESS, as part of the Trina Group, belongs to the fastest growing companies in the sector. We provide on / off-grid, handy power and micro-grid energy storage solutions from 0.4 kWh battery to 2 MWh battery and larger. From its foundation in 2010 TrinaBESS have set up branches and sales representatives in Germany, the UK, the US, Australia and Japan.

Network power quality issues have been growing as the deployment of renewable energy becomes a larger and larger percentage of the national energy mix and the unpredictable nature of renewables. This gives rise to the necessity to implement grid stabilisation techniques chiefly, battery storage for grid support. Growing populations, growing energy consumption in developing nations and rising energy prices also add to the need to provide sustainable energy solutions. TrinaBESS provides TrinaMega to solve these problems. A custom solution for all customer project needs tackling resource adequacy, store reserves, frequency regulation, peak shaving, sub-second demand response, non-export, power back up and many other problems. TrinaMega is a modular plug-and-play containerized BESS solution, entirely custom-made, in order to address specific battery usage and functions from commercial and utilities and large energy users. TrinaMega provides one of the best battery densities on the market for utility-scale projects, up to 2.9 MWh per containerized BESS. Each TrinaMega is scalable, and includes the complete BESS system, UPS, SCADA unit, thermal management, fire suppressant, power supply and auxiliary systems. TrinaMega is designed, manufactured and tested in full compliance with the latest in IEC, EN, VDE and UL standards, and provides one of the most optimized safety, control and monitoring systems out there. A successful implementation of a TrinaMega system relies on excellent engineering and project development skills. To make sure it can fit for every need for our customer, TrinaBESS is equipped with a strong R&D and engineer team, which is comprised of experienced battery energy storage engineers,



energy internet engineers, intelligent software monitoring engineers, electrical engineers, system simulation engineers, PV engineers and systems engineers. This core team has mastered the key technology concerning battery management systems, inverter technology, intelligent energy management technology, energy technology, energy storage large data processing technology and battery secondary utilization technology etc. These technologies keep TrinaBESS a pioneer in the battery energy storage industry. With this comprehensive and sophisticated technical team, we can offer a complete turnkey solution including consultancy services, solution design, component survey, procurement, system integration, construction, on-site training and commissioning, as well as operations and maintenance.

Most of these kinds of projects are located on islands and in remote areas, so that they require high standards, such as acid resistance, corrosion resistance and high IP rating. Especially for the island projects, the solutions not only require a high level of design and construction specification but also need to consider the environmental effect and natural disaster assessment and precaution.

Judge's remark:

Utility and commercial power companies can benefit from the TrinabESS / TrinaMega energy storage platform that provides a plug-and-play containerized solution featuring one of the utility market's best battery densities: 2.9 MWh for each containerized BESS.



AWARD: Award for Excellence – Innovation ENTRY: Q.ANTUM



HANWHA Q CELLS is the world's largest producer of 100 % in-house solar cells and modules, with a production capacity of 8.0 GW. Hanwha Q CELLS offers the full spectrum of photovoltaic products, applications and solutions, from modules to kits to systems to large-scale solar power plants. Through its growing global business network, the company provides services and long-term partnership to its customers in the utility, commercial, government and residential markets.

Q.ANTUM which is based on rear side passivation of the solar cell (PERC) is the proprietary solar cell technology platform of Hanwha Q CELLS. With more than 1 billion of produced Q.ANTUM solar cells, equaling 5 GW, Hanwha Q CELLS is the undisputed PERC-leader in the industry. But Q.ANTUM offers many additional features that differentiate it from conventional PERC technologies.

It combines PID (potential-induced degradation) resistance, Hot-Spot-Protection and Tra.QTM laser marking for 100 % traceability of any cells produced. All Q.ANTUM products comply with the strict Hanwha Q CELLS quality standards, including much harsher criteria than regular certification, frequent and repeated testing of samples from running production. One of the key differentiators of

Q.ANTUM technology is that it controls the degradation effects LID (light induced degradation) and LeTID (light and elevated temperature induced degradation), which can severely reduce the performance of conventional PERC solar modules. While LID mainly appears on monocrystalline solar cells, the LeTID effect was long believed to only appear on multicrystalline wafers.

However, Hanwha Q CELLS was the first to discover that LeTID can also significantly reduce the energy yield of monocrystalline PERC solar cells in early operation stages. The company not only understood the effect, but also implemented processes to control it effectively. This is reflected in the excellent performance warranties of all Q.ANTUM products. Q.PEAK DUO-G5 – monocrystalline power-house with half-cell technology. The latest product highlight in the Q.ANTUM Module range is the Q.PEAK DUO-G5, which convinces with extremely high power classes and high-end performance under real life conditions. The Q.PEAK DUO-G5 module series combines the companies most advanced technologies in one solar module.

Half-cell technology, six-bus-bars, decentralized junction box, round wires and of course the proprietary Q.ANTUM cell technology boost the module efficiency of Q.PEAK DUO-G5 close to 20 %. Thus, the series reaches power ratings of up to 330 Wp from 120 half-cells and even up to 395 Wp from 144 half-cells.

Besides the standard versions, it is also available as an all-black module with black back sheet and black frame. For customers, this high-end product not only offers impressive performance under real life conditions, but also best-in-class performance parameters of 98 % after the first year and 85 % after 25 years.

Judge's remark:

Hanwha Q CELLS is commended for its Q.ANTUM technology that enhances conventional PERC cell performance through nano coatings while also controlling degradation effects (PID, LID, and LeTID) for increased efficiency and quality.



AWARD: Rural Electrification Product Award ENTRY: The Power-Blox 200 series

THE POWER-BLOX 200 series is a revolutionary modular energy system producing AC power from 200W up to the Kilowatt range, which serves as a “portable socket” to off grid energy demands.

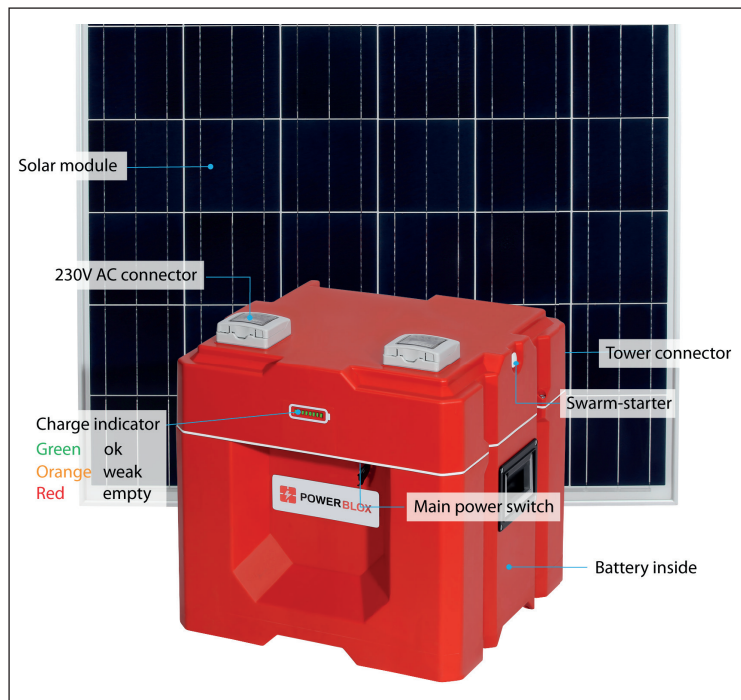
Swiss company Power-Blox has created a solution for developing fully autonomous power grids that can be scaled up easily without the need for extensive configuration or a centralized control, thanks to its “Swarm Power” technology.

The Power-Blox energy storage devices are designed to be able to stack together into a bigger unit with a larger capacity, as well as to be joined together into a micro-grid that allows each of the connected units to have access to “the full power of all units.”

At its simplest, a single Power-Blox 200 series cube and solar panel can function as an off-grid power supply, with the unit’s 1.2 kilowatt-hour battery and 230V AC / 200W inverter providing enough electricity for “one small fridge, a television, three LED lights (7W each)” and a mobile phone charger. A larger capacity system can be built by adding multiple units, simply by stacking them on top of each other like LEGO blocks to create towers or “Power-Walls.”

This modularity allows users to quickly scale up a system to provide more power or more backup capacity, with “no engineering, no calculations, no manual” required. However, a single Power-Blox cube or tower of cubes isn’t necessarily a major energy technology breakthrough all on its own, because the real secret sauce is the ability for multiple units to be joined together into a “Swarm Grid” that “mimics complex systems in nature” to create a completely autonomous intelligent grid system that can handle electricity inputs from a variety of sources.

This swarm technology enables a grid with a fully decentralized architecture that can manage fluctuating loads and inputs, with each component in the grid learning how to adapt to the current state of the grid. One key advantage of this swarm grid setup is that even if an individual component fails, the system still functions, as opposed to conventional mini-grids, which will go down if the “master” device (which is responsible for building the voltage and



frequency across the grid) fails. The Power-Blox system could be employed as an off-grid electricity supply, essentially creating a solar-powered micro-grid to power a village, a hospital or clinic, or disaster relief efforts, with either a centralized installation (cubes stacked in one location with current supplied to the point of use via conventional wiring) or a decentralized “Snowflake-Topology” swarm grid (cubes installed at various locations and joined together into a single system by 16mm cables).


The Power-Blox system can also be put into place as a backup power system in locations where the public grid is unreliable or unstable and a constant supply of electricity is crucial.

Judge’s remark:

The Power-Blox 200 represents a step towards the future of rural electrification and energy independence thanks to its nearly ‘fool-proof’ modularity and choice of battery chemistries ideal for residences and villages.

While falling equipment prices and rising efficiencies have fueled the rapid growth of photovoltaic (PV) technologies, Ciel & Terre has made a business of taking panels safely onto ponds, lakes and reservoirs as it creates a new solar market opportunity.

C&T brings buoyancy to the PV equation



They are common sights in most parts of the inhabited world: small ponds, lakes and reservoirs. But for independent power producer (IPP) Ciel & Terre, they are key ingredients for reaching a largely untapped renewable energy market that is being revealed by the advent of floating photovoltaic (PV) systems.

Ciel & Terre (C&T) entered the large-scale photovoltaic business as an IPP in 2006. Headquartered in France to serve Europe and with offices across Asia and the Americas, C&T brought their novel approach to PV as a means for leveraging untapped utility scale sites. It proved to be an important differentiator in what would become a crowded solar marketplace. Their patented Hydrelio floating PV platforms are an innovation that keeps solar modules safely generating electricity in places that might seem the very last that one would expect to see solar panels: floating in arrays across acres of open water.

Solar+Power magazine's Mark Andrews spoke recently with C&T International Sales Director and US representative Eva Pauly-Bowles about the challenges and advantages of floating PV systems. C&T has placed them on lakes, retention ponds, and even a massive Portuguese hydroelectric reservoir, demonstrating the flexibility and appeal of their system.

"Ciel & Terre uses our patented Hydrelio technology to allow standard PV modules to be installed on inland bodies of water. Compared to rooftop and ground based arrays, Hydrelio is made of HDPE so it's highly resistant to UV corrosion, as well as drinking water compliant. Our floating solar system also offers enormous environmental benefits including the ability to reduce evaporation and conserve valuable land surfaces by taking advantage of unused water spaces. It also enables high power production due to the natural cooling effects of water on panels and cables," she explained. The Hydrelio platforms are made of 100% recyclable materials that are highly UV resistant; placing them in water bodies comes with the added benefit of helping to reduce algae growth.

One of the most common misconceptions about a floating PV system concerns the installation process, which Pauly-Bowles described as actually being quite a bit more straightforward than land-based arrays.

“Installation for floating solar is faster than any other PV system. It’s relatively quick and simple, since land excavation and heavy tools are not required like those needed for ground and rooftop mounted systems. Typical installation time is 100 kW DC per day for a floating array. Assembly of the ‘floating island’ comes first and is done on shore. Once the floats are connected, the island is pushed out and anchored down,” she said.

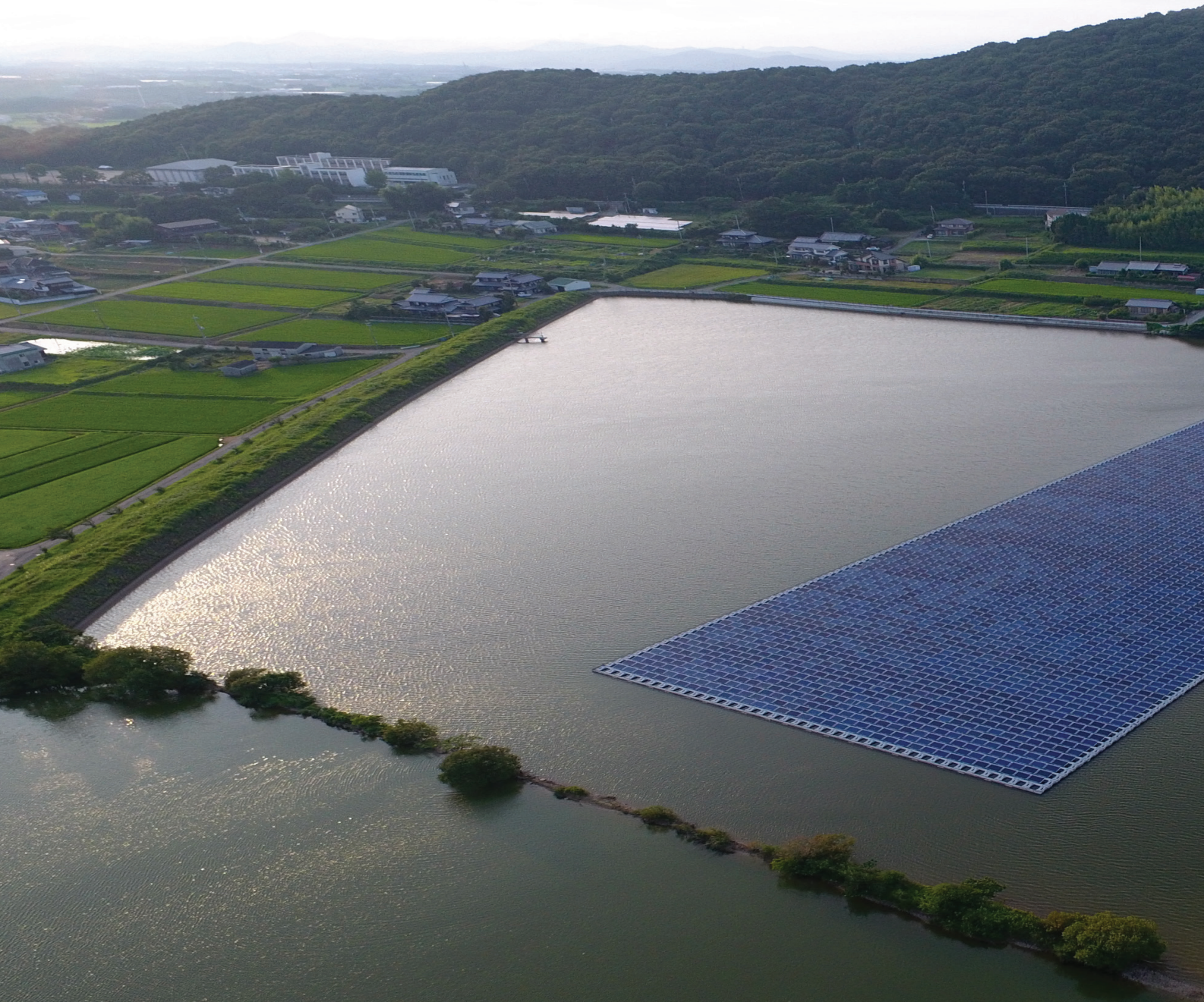
As soon as their buoyancy platforms are in place, PV panels can be connected along with other BoS components that are typical for any megawatt-scale PV project. The C&T systems do not require substantially different components compared to other PV systems beyond their floating platform.

The ‘solar island’ can be steered for to its optimal location for sun exposure; if an original anchor site falls from favour the entire platform can be relocated. C&T systems can also

accommodate up to 20 feet in water level fluctuations, and can be modified for areas with special needs such as those placed on active hydroelectric sites or drinking water reservoirs that exhibit more widely varying water levels.

A key attraction of a floating PV system is the fact it utilizes space that would otherwise go unused beyond its original purposes. C&T did for ponds and lakes what traditional rooftop PV did for private residences during the first phase of the solar revolution, which was to put unused roof space to work generating electricity.

The benefit for a new floating PV plant operator is gaining electric energy or rental income (or both) in a way previously not possible. This benefit is particularly well appreciated in densely populated areas such as the Japanese countryside where as many land resources as possible are dedicated to agriculture or other types of food production or



manufacturing. Those traditional uses can still take place, remarked Pauly-Bowles, with the added advantage of being able to generate power without using up precious fertile land. C&T officially entered the floating PV business in 2011.

Since then it has installed systems of varying sizes across three continents. It recently installed another 70 MW in China's Anhui province for the China Energy Conservation and Environmental Protection Group (CECEP), a state-owned energy conglomerate and a renewable energy project developer within the PRC.

Construction is expected to be completed by the end of 2017; when finalized the project will be C&T's largest, encompassing 13 floating arrays across multiple reservoirs; the plant will utilize more than 194,000 PV panels when complete. To date C&T has built more than 85 MWp in floating PV systems globally. "Ciel & Terre is naturally scaling up. After grid-

connecting over 85MWp around the world, this latest project in Anhui (China) perfectly illustrates our ambitions and leadership in the field of floating PV," Pauly-Bowles added. She also noted that the projects in China are part of that country's efforts to repurpose lands that were heavily mined for coal. Many floating PV platforms in China sit atop lakes that have formed as a result of gradual subsidence and rainfall in areas that have been mined-out.

Floating PV systems like those from C&T are another example of ways in which resources can be renewed and repurposed while reducing carbon footprints. These efforts are designed to meet the growing energy needs of a global community while supporting international efforts to reduce greenhouse gases and slow global warming.

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TIME FOR BATTERIES TO SHINE IN IRELAND



Everoze Partner, Paul Reynolds sees an opportunity for batteries under the DS3 reforms of system services in Ireland. Here are his key takeaways – how the system works, and what a winning revenue strategy looks like.

IRELAND IS GREAT. That goes without saying. Obviously, there are the people (especially my Irish wife!), but less well known, is perhaps that Ireland is a world leader when it comes to integrating renewable energy into the grid.

Over the past decade, the island has embarked on radical reforms to deliver a power system that can operate with a penetration of 75% of non-synchronous generation (wind, HVDC interconnectors and solar) at any one time. This metric is called SNSP – system non-synchronous penetration level. A key step in achieving 75% is

finalising the procurement approach for system (or ancillary) services, with major reforms recently consulted on. The result: a positive outlook for batteries. Let me explain...

System Services

For batteries, the focus is likely to be on Fast Frequency Response (FFR), Primary Operating Reserve (POR), Second Operating Reserve (SOR) and Tertiary Operating Reserve (TOR1 & TOR2). Although the plan is to eventually to move to competitive tendering, services are procured through a panel based procurement process whereby if

Service Name	Abbreviation	Unit of Payment	Short Description
Synchronous Inertial Response	SIR	MWs ² h	(Stored kinetic energy)*(SIR Factor – 15)
Fast Frequency Response	FFR	MWh	MW delivered between 2 and 10 seconds
Primary Operating Reserve	POR	MWh	MW delivered between 5 and 15 seconds
Secondary Operating Reserve	SOR	MWh	MW delivered between 15 to 90 seconds
Tertiary Operating Reserve 1	TOR1	MWh	MW delivered between 90 seconds to 5 minutes
Tertiary Operating Reserve 2	TOR2	MWh	MW delivered between 5 minutes to 20 minutes
Replacement Reserve – Synchronised	RRS	MWh	MW delivered between 20 minutes to 1 hour
Replacement Reserve – Desynchronised	RRD	MWh	MW delivered between 20 minutes to 1 hour
Ramping Margin 1	RM1	MWh	The increased MW output that can be delivered with a good degree of certainty for the given time horizon.
Ramping Margin 3	RM3	MWh	
Ramping Margin 8	RM8	MWh	
Fast Post Fault Active Power Recovery	FPFAPR	MWh	Active power (MW) >90% within 250 ms of voltage >90%
Steady State Reactive Power	SSRP	Mvarh	(Mvar capability)*(% of capacity that Mvar capability is achievable)
Dynamic Reactive Response	DRR	MWh	MVAR capability during large (>30%) voltage dips

Table 1: Summary of DS3 System Services

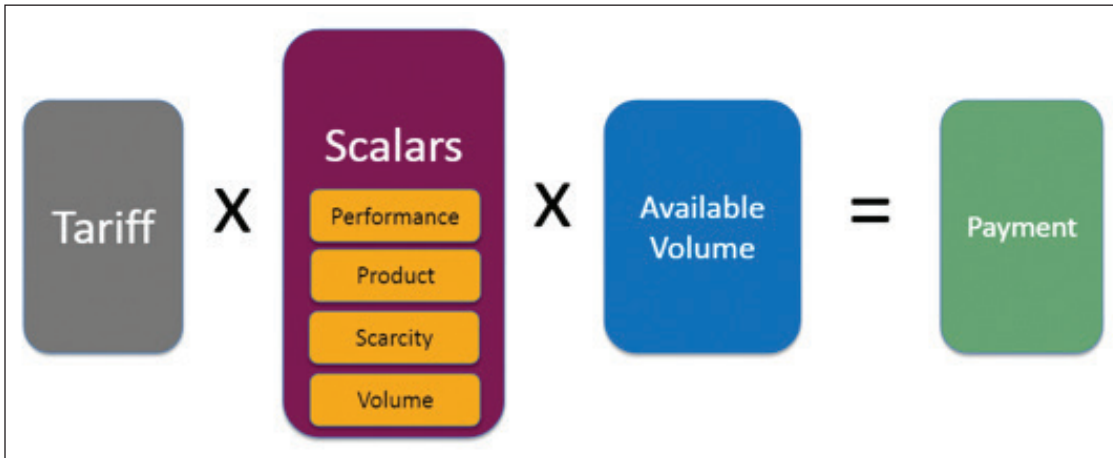


Figure 1: System services regulated tariffs, scalars and volume

providers can demonstrate technical compliance they are added to the panel. Providers are then paid when available according to the following formula.

Tariffs are set by the system operators Eirgrid and SONI, with the base tariff for FFR quite low. The volume is based on availability to provide the service (as opposed to utilised) and is calculated in MWh.

Scalars

The interesting part are the scalars. These give the system operators (SO)s flexibility to incentivise good behaviour or penalise bad behaviour, with different scalars applying to different revenue streams. If we focus on FFR, the most significant scalar is the scarcity scalar which is for FFR zero up to an SNSP level of 60%. 6.2 between 60-70% and 8.5 when the SNSP is above 70%.

In other words, FFR is paid well at high penetrations of wind/interconnectors; but only paid at high penetrations. As we will see this makes a big impact on revenue uncertainty.

A range of other scalars then seek to drive:

- Robust performance, with payments reduced substantially for any non-delivery;
- A fast response, with a scalar of 3 if a response is provided within (a very fast) 0.15 seconds (in time to deliver RoCoF reduction benefits);
- A dynamic response, with a scalar of 1 if a dynamic response is provided to a frequency sensitivity of +/- 0.015Hz (equivalent to the UK's Enhanced Frequency Response Service 2 specification); and,
- A longer duration response, with a scalar of 1.5 if the battery provides FFR, POR, SOR and TOR1.

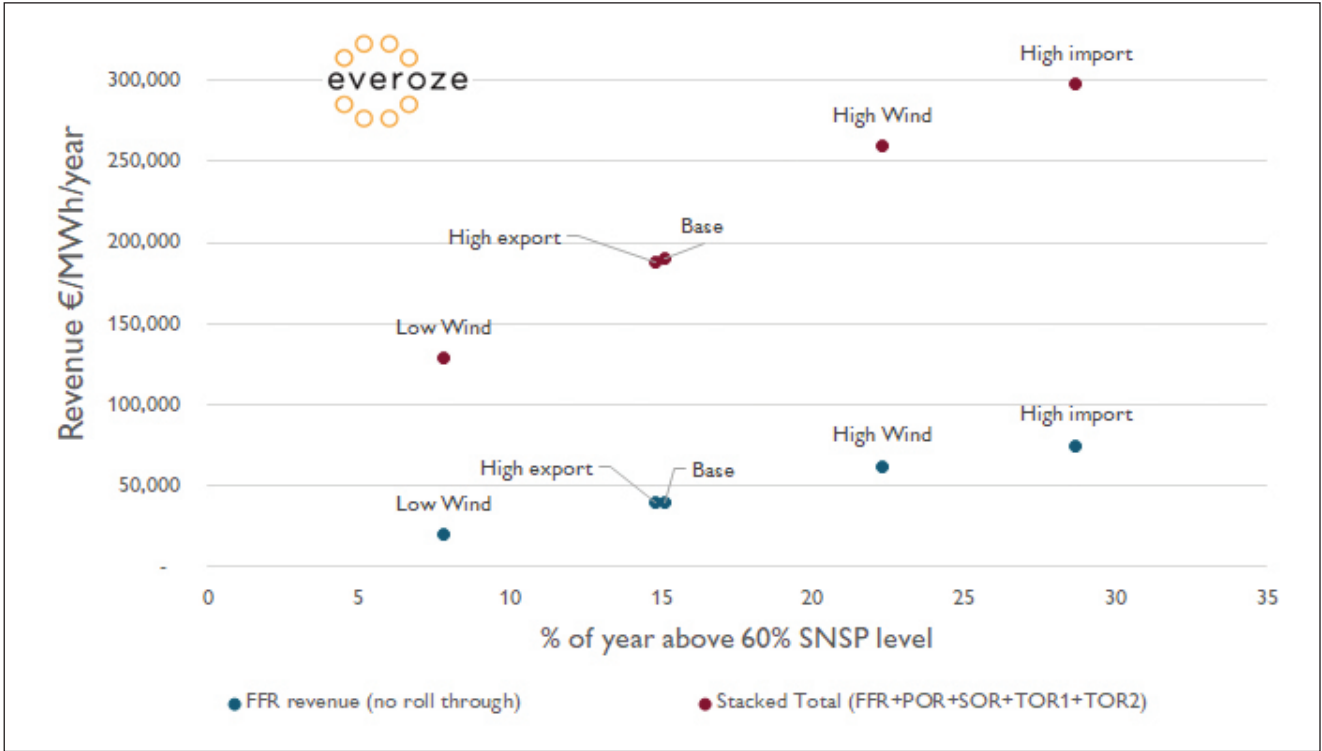
All this means, assuming no performance issues, a battery could earn ~28x the base tariff at periods of 60-70% SNSP and ~38x for SNSP levels above 70%.

SNSP levels

But there's a challenge. The time spent above this SNSP level will vary significantly from year to year. This is because SNSP level is a function of the generation mix, wind speeds, interconnector flows

Simulation Case	% Time above 60% SNSP	% Time above 70% SNSP
2019/20 Enhanced, Base	15.2	7.5
2019/20 Enhanced, Low Wind	7.9	3.0
2019/20 Enhanced, High Wind	22.2	14.6
2019/20 Enhanced, High Export	14.9	7.5
2019/20 Enhanced, High Import	29.0	12.7
2019/20 New Providers, Base	15.1	7.4
2019/20 New Providers, Low Wind	7.8	3.0
2019/20 New Providers, High Wind	22.3	14.5
2019/20 New Providers, High Export	14.8	7.4
2019/20 New Providers, High Import	28.7	12.5

Table 2: Percentage of time at high SNSP levels



Maximum annual battery project revenue under different SNSP levels

and demand levels in a given year. The table below shows system operator estimates for 2019/20 under two generation mix scenarios. As can be seen in a bad year you could be above 60% SNSP for 7.8% of the year. In a good year you are up at 29%. This is a huge variation, completely out of the control of battery developers.

Revenue estimates

Putting all this together and with the SNSP limit increased to 75% and the 'New providers' generation mix, at Everoze we estimate that for a battery with no performance issues, a dynamic response within 0.5 seconds to a 0.02Hz deviation in frequency (up or down) and provision of FFR, POR, SOR, TOR1 & TOR2 (20 min duration in total) then revenue could be ~€300k in a good year and ~€128k in a bad year. This excludes consideration of other revenue streams which might be stacked in with this (e.g. payments under the Capacity Remuneration Mechanism).

So what? Having worked as Technical Advisor to investors and developers for a number of GB battery

projects, Everoze notes three striking implications of DS3 design for batteries:

1. Revenues are attractive but variable: The base case revenues are likely sufficient to drive new investment, but investors will need to get comfortable with inter-annual variation and the level of regulatory certainty.
2. A probability-based approach is essential: In much the same way that we see wind projects use probability distributions to account for wind variability (with P50 and P90), battery storage projects will need to use probability distributions to account for the differences in revenue from year to year, albeit that SNSP is unlikely to have a normal distribution.
3. Wind forecasting will help: Wind forecasting will likely become a key input into battery control systems, with battery developers needing their systems to guarantee availability whenever wind speeds are high.

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PV module forecasts rise sharply thanks to chinese demand

Chinese demand for low-cost photovoltaic (PV) cells and modules is driving the global PV shipment forecast higher while creating spot shortages in some regions.

RENEWABLE ENERGY analysts are increasing their 2017 photovoltaic (PV) module installation forecasts led by a surge in Chinese capacity growth. IHS Markit now forecasts that China will install 45 GW of capacity this year while total global PV installations should reach 90 GW—a 14 percent increase over 2016.

The overcapacity, price instability and industry consolidation that characterized photovoltaic (PV) production in 2016 seems like a distant memory. While 2017 had been forecast to be somewhat more even than 2016, providing modest growth and less price instability, demand from the People's Republic of China surpassed even the most optimistic of last year's projections, paving the way for surprisingly strong demand in 2017.

In the IHS Markit "New Global Forecast for Solar Installations," researchers point to the heft that China brings to the global PV market. By the close of 2017 IHS expects China to have installed half of the 90 GW of PV capacity the world is expected to install this year. Based on an analysis of official Chinese connection statistics along with inverter and module shipments IHS Markit estimates that 26 GW of installations were

completed by China in the first half of 2017; another 12 GW is set to be installed by the official close of third quarter, leaving 7 GW to be installed before 31st December.

Researchers have observed that the boom in Chinese demand erased any surplus that carried over from 2016 and is consuming a large part of new global supply as it leaves factories across China and elsewhere. This is leading to increased prices and longer lead times, they noted, along with short-term and regional shortages in countries closest to China that tend to rely primarily upon Chinese modules for domestic PV requirements. The shortage of Chinese modules is not impacting United States supplies and installers as heavily as other regions. This is true largely because the rush to procure modules ahead of any potential trade action (arising from the Suniva and SolarWorld Americas petitions before the US International Trade Commission) focuses on securing tariff-free modules manufactured outside of Taiwan and China.

The surprising spike in demand for PV modules across China occurred for several reasons including moves to take advantage of lower prices and oversupply. PV appetites were also fueled by positive revisions to governmental policy



support aimed at meeting China's growing demand for power with PV instead of coal-fired plants; this helped lead to greater-than-expected first half installations. There was also no substantial second half installation fall-off as some had predicted, and the pace of installs early in fourth quarter appears sufficient to deliver the 45 GW of increase that analysts expect for the year.

IHS Senior Research Manager for Solar & Energy Storage, Sam Wilkinson, noted that in addition to the very strong PV growth in China, the world's residential markets are also undergoing substantial change that will create new and different opportunities than have existed up to this point. The discontinuance of Feed-in-Tariffs (FIT) in most countries, the dramatic drop in major PV system component prices during the last five years, continual increases in quality and a globalized manufacturing base have all had substantial impacts. See the details of how residential PV is changing in the complimentary IHS Markit report: "The Evolution of Residential PV: The biggest trends and most important developments in the smallest solar systems."

"The fact that it is now cheaper in most countries for people

to generate power from PV systems on their roofs than to buy electricity from the grid brings about some important changes to the market. This is the one of the fundamentals that is driving change in the electric power system," Wilkinson said.

Dramatic price decreases in PV generation (levelized cost of electricity/LCOE), has come at a time when new fossil-fueled power plants are not being built at the same pace as in previous years, showing the resilience of renewable energy and underscoring its potential to change the way people obtain power.

"In previous years, people installed residential PV systems as a simple investment, as they received guaranteed FIT income for as much as twenty years, offering an attractive return. With incentives now slimmed down to much less generous amounts or removed altogether, and the cost of PV systems fallen by incredible amounts over the last five years, people are now installing PV in order to reduce their electricity bills and increase their autonomy from the grid. This brings about important changes to the dynamics of the market, and is also one of the major factors behind a growing trend towards a more decentralized power system," he remarked.

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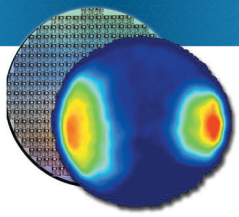
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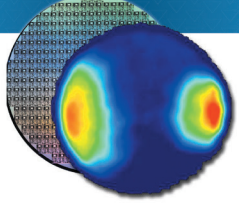
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