06 | 2021 | 78538

pv magazine

PHOTOVOLTAIC MARKETS & TECHNOLOGY



European solar's new dawn

PV's new inflection point forms, as corporate, government and investor interests align

Surface tension

How floating PV deployment is being bolstered by new standards and best practices

TOPCon under pressure

New cell manufacturing processes promise to narrow the price gap for n-type

ALL-IN-ONE SMART ENERGY STORAGE AND EV CHARGING SYSTEM



The 4th Generation Energy Storage System from SolaX

X-ESS G4

SMARTER DESIGN

SMARTER ENERGY



600W+ More Reliable, Powered by Innovation

Advanced
210mm modules
and ultra-high power
tracker systems

Vertex | TrinaTracker



Vertex Series Module

- Power output to 600W+, catering to different market segments
- Lower BOS cost and optimized customer value
- MBB and high density interconnection technology

TrinaTracker

- High reliability
- More yield gain
- Low O&M costs
- United contact window

www.trinasolar.com

Trinasolar

FIMER

Find your flex

The new PVS-10/33-TL gives you complete flexibility.
Forget constraints. Choose it for new and existing installations. DC-side specifications work for any plant design and advanced communication ensures it's easy to add new technology, while keeping costs low.

Available now in six power sizes.

Stronger. Better. FIMER
fimer.com



GROWATT

FUTURE-PROOF PV SYSTEM FOR YOUR HOME

SMART, SAFE, SCALABLE AND POWERFUL

- 2 X POWER BATTERY READY*
- HIGH POWER BACKUP UP TO 6KW
- EASY EXTENSION TO SMART HOME SYSTEM
- VPP INTERFACE READY FOR ENERGY TRADING
- WHOLE SYSTEM SERVICE



MIN 2500-6000TL-XH + ARK XH Battery Storage System

*A MIN 5KTL-XH INVERTER PROVIDES 5KW POWER TO THE AC OUTPUT PLUS 5KW POWER TO CHARGE THE BATTERY

Growatt New Energy

SHENZHEN GROWATT NEW ENERGY CO.,LTD

www.ginverter.com info@ginverter.com

service@ginverter.com

imprint

Publisher
Eckhart K. Gouras
pv magazine group GmbH & Co. KG
Kurfürstendamm 64, 10707 Berlin, Germany

Editors pv magazine group
Becky Beetz – Head of Content – beetz@pv-magazine.com
Jonathan Gifford – Editor in Chief – gifford@pv-magazine.com
Mark Hutchins – mark.hutchins@pv-magazine.com
Emiliano Bellini – emiliano.bellini@pv-magazine.com
Blake Matich – bkmatich@pv-magazine.com
Tristan Rayner – tristan.rayner@pv-magazine.com
Michael Fuhs, Editor in Chief pv magazine Deutschland fuhs@pv-magazine.com
Sandra Enkhardt – enkhardt@pv-magazine.com
Marian Willuhn – marian.willuhn@pv-magazine.com
David Wagman – david.wagman@pv-magazine.com
Authors: Molly Cox, Gwénaelle DeBoutte, Amy Fang, Siobhàn Green, Rolf Heynen, Felicia Jackson, Joseph Johnson, Radek Kubala, Claire Miller, Ian Morse, Piotr Mrowiec, Josef Patočka, Jesse Pichel, Pilar Sánchez Molina, Martin Schachinger, Vincent Shaw, George Touloupas, Ilias Tsagas, Aditya Vardhan, Susanne von Aichberger, Andreas Walstad, Steven Xuereb
Proofreader: Brian Publicover
Translators: Tim Hanes, EasyTranslate Ltd.
Photo editor: Tom Baerwald
Graphics: Harald Schütt
Cover: Image courtesy of Shutterstock

Sales
Andrea Jeremias, CSO
Tel.: +49-30-213 00 50 23 | jeremias@pv-magazine.com
Julia Wolters
Tel.: +49 -30-213 00 50 28 | julia.wolters@pv-magazine.com
Rachel Sorenson
Tel.:+49 -30-213 00 50 39 | rachel.sorenson@pv-magazine.com
Greater China & Korea, Hong Kong Office, Calvin Chong
Tel.: +852-9732 8266 | calvin@pv-magazine.com
North America, Matt Gallinger
Tel.: +1-518-560-0179 | matt@pv-magazine.com
Italy, Francesco Tedesco
Tel.: +39 -328-939 24 50 | fr.tedesco@pv-magazine.com
Japan, Noriko Ishii
Tel.: +49 -30-213 00 50 24 | japan@pv-magazine.com

Marketing
Marina Ramain – Head of Marketing
Tel: +49-30-213 00 50 29 | marina.ramain@pv-magazine.com
Adélaïde Cadioux – Junior Marketing Manager
Tel: +49-152-06472031 | adelaide.cadioux@pv-magazine.com

Event Management
Frederike Egerer – Head of Events
Tel: +49-30-213 00 50 32
frederike.egerer@pv-magazine.com
Beatriz Santos – Manager Webinar Program & Strategy
beatriz.santos@pv-magazine.com
Lucie Demeillier – Event Manager
lucie.demeillier@pv-magazine.com

Advertising Administration
Anika Wedemeyer
Tel.: +49-30-213 00 50 22 | media@pv-magazine.com

Subscriptions/individual issues
Contact support@pv-magazine.com or visit the pv magazine web shop at **https://shop.pv-magazine.com** to buy a subscription or purchase single issues.
Number of issues Twelve per year
Purchase prices
Annual subscription for 12 issues: €199 print/€89 digital, including shipping and VAT, where appropriate. Single issue: €19 print/€9.50 digital, including shipping and VAT where appropriate. Purchase prices are applicable at the time an order is received.
Terms
Orders can be made in our online shop (shop.pv-magazine.com), with our reader service or in bookshops in Germany and abroad. Should it not be possible to ship the magazine for reasons that lie outside the responsibility of the publisher, the subscriber has no right to claim subsequent shipments, replacement issues, or a refund. Full terms & conditions: http://shop.pv-magazine.com/terms-and-conditions/. The venue for the settlement of all disputes with full merchants is Berlin, which is also the venue for all disputes pertaining to payment reminders.
Layout & typesetting
Alexx Schulz | mADVICE Berlin
Printer
Humburg Media group,
Am Hilgeskampf 51-57, D-28325 Bremen

Copyright
The magazine and all of the texts and images contained therein are protected by copyright. When a manuscript is approved for publication, the right to publish, translate, reprint, electronically store in databases, print special editions, photocopies, and microcopies is transferred to the publisher. The publisher requires the author to be the holder of copyrights and commercialization rights for all submissions. Any commercial use outside the limits specified by copyright is inadmissible without the publisher's consent.

ISSN 1865-3138
pv magazine was founded in 2008 by
Solarpraxis AG, Karl-Heinz Remmers.

Europe's back in business

Spain, the Czech Republic, Italy, and then Germany: the PV markets of Europe were instrumental in delivering the demand required to build a solar industry of any scale and to set the industrial wheels in motion toward dramatic cost reductions. And today, as European markets set a course for substantial and sustained growth, solar modules cost just 5% of what they did some 12 years ago.

With the cost hurdle largely overcome, now comes a fresh set of challenges. Grid capacity constraints, wholesale market barriers (pp. 104-106), solar's electricity price cannibalization and achieving deep decarbonization of the economy are all non-trivial. But as with the technical challenges, incremental improvements and the overwhelming momentum of scale, this new set of obstacles to ongoing deployment too can be overcome.

In this June edition of **pv magazine**, we take a close look at European solar and storage markets (pp. 21-25) – both emerging and established – and find a vibrant and sophisticated landscape, where opportunities abound and a robust outlook for expansion is evident.

Things that may have seemed a distant dream back in the early days of Europe's modern PV industry, like mass-produced BIPV (pp. 76-78) and floating PV (pp.42-47), are today taking shape as promising segments for the future.

June also means Roundtables at **pv magazine** (pp. 32-35), and the 2021 program is impressive both for its breadth and the depth of discussion to be had. On June 9 and 10, not only will the main stages tackle the biggest issues facing solar and energy storage today – large-format modules (pp. 36-38), modern O&M (pp. 50-51), green hydrogen (pp. 98-99), and sustainability (pp. 84-87) – but a plethora of additional opportunities await attendees.

For the first time, while the discussions on the Roundtables main stage will take place in English, breakout sessions in German, French and Spanish will allow attendees to engage in ongoing discussions and build networks among the European solar community. And if you missed it, stay in touch with pv-magazine.com for the video recordings of the event.

Jonathan Gifford, Editor in Chief



Photo: pv magazine

"Greece seems to be in a period of frantic policy reform, aiming to attract investments in all clean energy sectors"

Greek investments soar

Page 26

"Even if all capacity is fully utilized, there is almost 90 GW more module production than polysilicon"

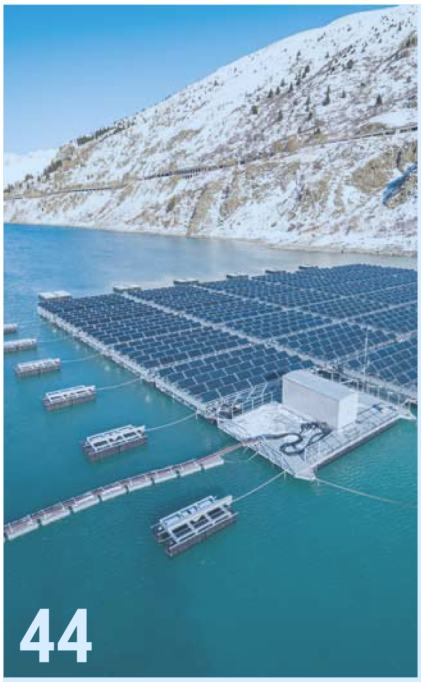
Firm foundations on shifting sands

Page 72



22

European solar's new dawn
The biggest trends shaping European PV's comeback in 2021.



44

Floating up to standard:
Standards must catch up with FPV for market growth to continue.



64

China struggles with solar supply
With rising prices for PV, China's investors may soon favor wind projects.



100

Return of the sun tax
Australia mulls a policy shift that would see rooftop PV owners charged for grid export.

advertisement overview ▸

Aiko Solar Energy Technology Co., Ltd. . . . 21
Aiswei New Energy Technology (Jiangsu) Co., Ltd. . . . 17
Ampner Oy . . . 47
Bisol Group d.o.o. . . . 71
Changzhou EGing Photovoltaic Technology Co., Ltd. . . . 59
Fimer S.p.A. . . . thick paper front
Growatt New Energy Co., Ltd. . . . thick paper back
h.a.l.m. elektronik GmbH . . . 11
Hangzhou First Applied Material Co., Ltd. . . . 87
Huawei Technologies Co., Ltd. . . . back cover inside
Intersolar Global . . . 107
Jinko Solar Co., Ltd. . . . back cover outside
K2 Systems GmbH . . . 29
Mersen Electrical Power . . . 67
meteocontrol GmbH . . . 39
Pfeiffer Vacuum GmbH . . . 79
PVHardware . . . 13
Risen Energy Co., Ltd. . . . 61
S-5! Attachment Solutions . . . 55
Shenzhen Kstar Science&Technology Co., Ltd. . . . 9
SMA Solar Technology AG . . . 3
SNEC . . . 111
SofarSolar . . . 49
SolaX Power Network Technology (Zhejiang) Co., Ltd. . . . cover wrap
Stäubli Electrical Connectors AG . . . 15
Trina Solar . . . front cover inside
von Ardenne GmbH . . . 75
Wuppermann Austria GmbH . . . 43


40
YEARS
POWERFUL
PERSPECTIVES
SMA
40 years of SMA.
Pioneering Spirit.
Passion for a Sustainable Future.
What began in 1981 with the bold vision to power the world with decentralized renewable energy has evolved into a forerunner in clean energy access. Driven by a pioneering spirit, passion and innovation.
Products and solutions from SMA have been sustainably shaping the global energy transition for 40 years. Time to celebrate and look forward to what is yet to come.
Discover Powerful Perspectives of Renewable Energies.
www.40yrs.SMA.de/en

6 News

markets & trends ▸

8 **Shipping and steel:** With prices up across the board, solar stocks slipped in May.

10 **Nuclear, no thanks:** Martin Schachinger argues against a return to nuclear power in Germany.

12 **Baltic breakdown:** Susanne von Aichberger of IHS Markit lifts the lid on PV in Estonia, Latvia and Lithuania.

14 **n-type development:** New cell technologies are set to falter in 2021, but TOPCon and HJT remain on the roadmap for most.

16 **Politicians tend to overpromise:** … except when it comes to solar. Rolf Heynen examines the consistent underestimation of solar PV's true potential.

18 **Rapid growth the new normal:** Felicia Jackson reports on the financial models backing PV growth.

22 **European solar's new dawn:** The biggest trends shaping European PV in 2021.

26 **Greek investments soar:** As public utility PPC brings forward its plan to abandon coal, Greece is set for big investments in solar and storage.

30 **Poland's policy overhaul:** New regulations are in place to clear the way for solar.

applications & installations ▸

32 **Roundtables Europe:** A look ahead at our event covering four cornerstones of the energy transition.

36 **Making sense of new sizes:** PI Berlin's Steven Xuereb on the implications of new module formats.

40 **Unplugged:** A discontinued connector spells trouble in this quality case study from northern Germany.

42 **FPV's important role:** Though challenges remain, floating PV has a job to do, argues Molly Cox of WoodMackenzie.

44 **Floating up to standard:** Quality standards must catch up for floating solar growth to continue.

48 **Your solar+storage business plan:** Siobhán Green of Everoze talks best practice for PV+battery projects.

50 **A PV band-aid:** DuPont's Stéphan Padlewski introduces the company's latest innovation – tape to repair failing backsheets in the field.

industry & suppliers ▸

52 **pv magazine Award:** A first look at entries received in the BOS and Inverters categories.

62 **Module finalists:** Our pv magazine Award jurors have narrowed down the selection in modules.

64 **China struggles with solar supply:** With rising prices for PV, China's state-owned investors may soon favor wind projects.

68 **TOPCon under pressure:** A tale of two sides in the latest cell deposition techniques.

72 **Firm foundations on shifting sands:** Rapid technology changes and supply chain imbalances pose a threat to quality, says CEA.

76 **Custom standardization:** Meeting the needs of architects and energy to build a BIPV market.

80 **Rethinking degradation:** Talking long-term performance with Bisol's Uroš Merc.

82 **SEIA seeks supply-chain transparency:** A look at the impacts of the association's traceability protocol on solar in the United States.

85 **Corporates critical role:** Our UP initiative will shift focus to green energy supply in the next quarter.

88 **pv magazine test:** The latest results from the rooftop array in Xi'an.

storage & smart grids ▸

90 **Dial manganese for stability:** Manganese could be the key to more sustainable cathode production.

94 **New support for green transition:** EU policy proposals promise a boost for renewables and hydrogen.

98 **Solar hydrogen in Europe:** Smart-energy's Christian Pho Duc talks electrolyzers and EU regulation.

financial & legal ▸

100 **Return of the sun tax:** Australia mulls a policy to charge rooftop PV owners for grid export.

104 **Probes confront market barriers:** An EU investigation is underway into anti-competitive practice on cross-border interconnections. Andreas Walstad reports.

108 **Insurers derail EU decarbonization:** Insurance providers find loopholes to keep covering Czech coal plants.

details ▸

110 **pv magazine events**
112 **Final thought**

Contributors

Steven Xuereb



Steven (pp. 36-38) is director of sales and project delivery at PI Berlin. He is a renewable energy professional who has 20 years of experience in the wind and solar industries, developing projects and procuring equipment. At PI Berlin he is responsible for the sales and delivery of technical consulting services for PV power plants and equipment, from the development phase through operation. "There is a lot of uncertainty in the module market at the moment, with new technologies, shortages of supply and rising prices," says Xuereb. "Developers are under a lot of pressure to find the optimal solution for their projects, but there isn't always a clear answer."



Siobhán Green

Siobhán (pp. 48-49) is a partner at Everoze, a technical and commercial energy consultancy. She has focused on storage since the ancillary services market started opening to battery projects in France in 2018. Since then she has been providing market-entry support, due diligence, and owners engineering for utility-scale battery projects in France, Belgium, the United Kingdom, and Ireland. "So many companies come to Everoze with a desire to get into the storage market and that's great, because storage will be a pillar of tomorrow's electricity system. But when it comes to drawing up a concrete business plan for co-located renewables plus storage, there are missasumptions about the benefits and limitations. Clarifying these is an important first step."

Advertisement

pv magazine
PHOTOVOLTAIC MARKETS & TECHNOLOGY

Subscribe to pv magazine now and support great journalism!



shop.pv-magazine.com

*yearly subscription, 12 issues

European agrivoltaic activity buzzing

A number of agrivoltaic projects were announced in May. French state-owned utility EDF and U.K. renewable energy developer Cero Generation each acquired 45% stakes in France-based agrivoltaic specialist Green Lighthouse Development (GLHD) for an undisclosed sum. EDF said the transaction was made through a private share placement and that GLHD's founders will maintain a 10% share in the company, which currently owns an agrivoltaic project portfolio in France of around 2.4 GW. Also in France, Engie Green has joined forces with the associations France Nature Environnement and Apicluster to implement a beekeeping project at several of its solar parks located in southeastern France.

The project is called "HappySolaire" and is aimed at utilizing the vast, calm, and secure areas offered by the empty spaces of the solar parks, which Engie Green defined as perfectly suitable to the development of bee colonies. In Spain, Iberdrola has built an apiary at its Andévalo PV plant in Spain's Andalucia region, and another one in the country's Extremadura region. The first solar park hosts 165 beehives and more than 8 million bees. The second set of 105 beehives hosts another 5 million bees. The projects are designed to demonstrate how the location of pollinators in renewable facilities can improve the stability of ecosystems and enhance the yield of crops from surrounding agricultural land. Finally, the Portuguese Ministry of Agriculture has launched a €10 million call to select innovative agrivoltaic developers. The ministry said chosen developers can secure funds to cover up to 70% of a project's upfront costs and that it will give priority to vulnerable territories and disadvantaged mountainous areas. Rebates will range from €700 ($855) to €35,000.



Photo: Engie

Photo: Vally_Photography



India's ReNew Power to build 2 GW mono PERC factory

Indian PV developer ReNew Power will build its new solar cell and module manufacturing facility in the state of Gujarat. The greenfield facility will manufacture 2 GW of solar cells and modules per year using monocrystalline PERC and large wafer technologies. The factory will also sell components to other renewable energy companies in India, in addition to serving ReNew Power's own requirements for its utility-scale power generation business. It is expected to generate 2,500 jobs in the state. The developer has secured 100 acres of land for the project from the state government, which leaves room for future capacity expansion. The vertically integrated plant is expected to start production in fiscal year 2022-23.

Photo: RUMSL



IEA: Annual solar PV build to reach 630 GW by 2030

The world has a viable pathway to building a global energy sector with net-zero emissions in 2050, but it is narrow and requires an "unprecedented transformation" of how energy is produced, transported, and used globally. Those are the key findings in a report from the International Energy Agency (IEA), "Net Zero by 2050: A Roadmap for the Global Energy Sector". The findings call for annual additions of solar PV to reach 630 GW by 2030, and those of wind power to reach 390 GW. The report said this combined capacity is four times what was installed in 2020, a record year. For solar PV, it is equivalent to installing the world's current largest solar parks – around 1,000 MW – roughly every day. "The scale and speed of the efforts demanded by this critical and formidable goal … make this perhaps the greatest challenge humankind has ever faced," said Fatih Birol, IEA executive director. pv

Maxeon announces 1 GW module deal

U.S.-based Maxeon Solar Technologies will supply 1 GW of its bifacial Performance 5 UPP solar panels for the $1 billion Gemini solar+storage power plant project near Las Vegas, Nevada. Primergy Solar will build, own and operate the project.

"The agreement calls for nearly 1.8 million modules to be supplied over a four-quarter period"

The agreement calls for nearly 1.8 million modules to be supplied over a four-quarter period starting in the second quarter of 2022. Project completion is planned by the end of 2023. The Gemini Project is a 690 MW solar PV array and 380 MW/1,400 MWh battery energy storage installation. It will be one of the largest operational solar arrays in the United States once it is completed. pv

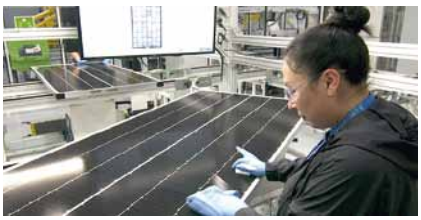


Photo: Maxeon

Photo: DEWA



Dubai's first green hydrogen project comes online

Dubai's first green hydrogen project has come into operation two and a half years after work on the facility began. The hydrogen plant is owned and operated by the Dubai Water and Electricity Authority (DEWA) and is linked to the 5 GW Mohammed bin Rashid Al Maktoum Solar Park. It was built by Siemens Energy Middle East, a unit of Germany-based Siemens Energy, and is the first solar-powered green hydrogen facility in the Middle East and North Africa region.

"This is a system that allows for buffering renewable energy production, both for fast response applications, as well as for long-term storage," said DEWA CEO Saeed Mohammed Al Tayer. "The plant has been built to accommodate future applications and test platforms for the different uses of hydrogen, including potential mobility and industrial uses." pv

Large floating PV projects completed

Dutch solar project developer Groenleven, a unit of German renewable energy company BayWa re, has completed construction of what has been described as Europe's largest floating PV project. The 27.3 MWac plant is located on a former sand extraction lake in Zwolle, in the Dutch province of Overijssel. The Bomhofsplas solar park comprises 72,000 solar modules provided by an unnamed manufacturer. Meanwhile, in India, French floating PV specialist Ciel & Terre's India arm has completed construction on a 14.7 MWp floating solar plant in the Indian state of Tamil Nadu. The project was developed for Southern Petrochemical Industries Corp. (SPIC) Limited on a water surface located in its Thoothukudi plant. The floating solar PV array relies on Ciel & Terre's proprietary Hydrelio Equato floating platforms, which were manufactured locally. The plant was built with 37,632 solar panels with power output of 390 W each on a surface of 15.6 hectares. pv

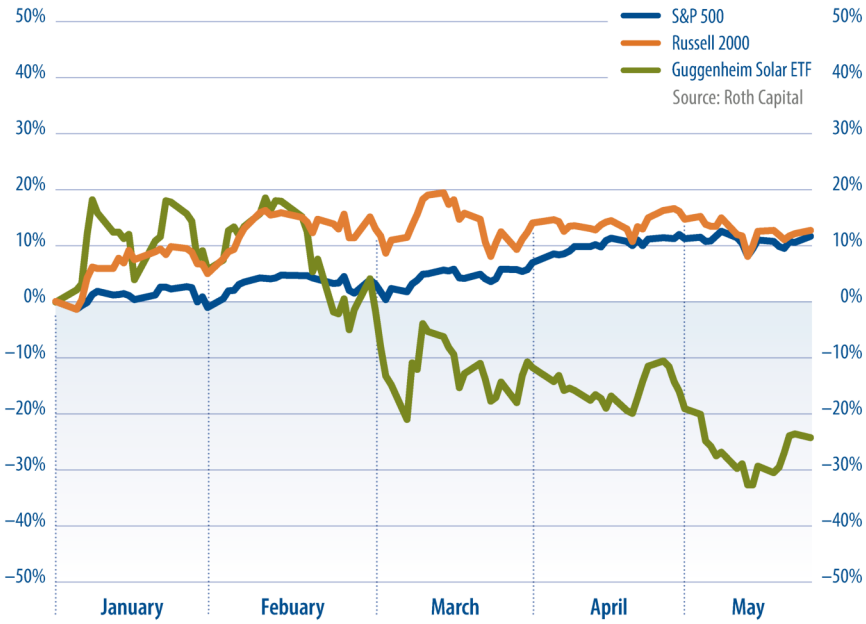
Photo: BayWa re



Shipping and steel

In May, cost increases across the supply chain left solar stocks underperforming in the market, writes Jesse Pichel of ROTH Capital Partners. For the U.S., higher prices for shipping and steel have hit particularly hard.

Guggenheim Solar ETF – TAN Holdings



Company	Ticker	Close price May 24, 2021	% change May 01–24, 2021	% change year to date
Tianjin Zhonghuan Semiconductor Co., Ltd.	SZSE:002129	27.22 CNY	– 1.5%	+ 6.7%
REC Silicon ASA	OB:RECsi	15.96 NOK	– 12.8%	– 0.9%
centrotherm international AG	DB:CTNK	3.04 EUR	– 14.6%	+ 10.1%
Manz AG	XTRA:M5Z	53.20 EUR	– 2.7%	+ 56.5%
Wacker Chemie AG	XTRA:WCH	135.30 EUR	+ 7.8%	+ 15.9%
Risen Energy Co.,Ltd.	SZSE:300118	12.98 CNY	+ 2.5%	– 55.0%
Shenzhen S.C New Energy Technology Corp.	SZSE:300724	97.18 CNY	– 12.0%	– 33.3%
Atlantica Sustainable Infrastructure plc	NasdaqGS:AY	36.97 USD	– 4.1%	– 2.7%
SMA Solar Technology AG	XTRA:S92	45.16 EUR	– 4.9%	– 19.3%
China Shuifa Singyes Energy Hold. Ltd.	SEHK:750	1.02 HKD	– 10.5%	+ 27.5%
Generac Hold. Inc.	NYSE:GNRC	310.64 USD	– 4.1%	+ 36.6%
Hannon Armstrong, Inc.	NYSE:HASI	48.72 USD	– 7.0%	– 23.2%
First Solar, Inc.	NasdaqGS:FSLR	75.38 USD	– 1.5%	– 23.8%
Applied Materials, Inc.	NasdaqGS:AMAT	134.58 USD	+ 1.4%	+ 55.9%
Azure Power Global Ltd.	NYSE:AZRE	20.77 USD	– 10.8%	– 49.1%
Beijing Jingyuntong Technology Co., Ltd.	SHSE:601908	7.86 CNY	– 2.4%	– 23.6%
PVA TePla AG	XTRA:TPE	23.00 EUR	– 6.9%	+ 17.3%
Meyer Burger Technology AG	SWX:MBTN	0.44 CHF	+ 2.2%	+ 29.2%
TBEA Co., Ltd.	SHSE:600089	11.75 CNY	– 4.7%	+ 15.8%
Daqo New Energy Corp.	NYSE:DQ	72.59 USD	– 9.8%	+ 26.6%
Array Technologies, Inc.	nasdaqgm:arry	15.56 USD	– 44.7%	– 63.9%
Canadian Solar Inc.	NasdaqGS:CSIQ	38.41 USD	– 6.9%	– 25.0%
Shunfeng International Clean Energy Ltd.	SEHK:1165	0.18 HKD	– 2.7%	– 23.5%
Jolywood (Suzhou) Sunwatt Co., Ltd.	SZSE:300393	9.33 CNY	+ 17.4%	– 28.2%
JinkoSolar Holding Co., Ltd.	NYSE:JKS	33.27 USD	– 10.0%	– 46.2%

Information upon which this material is based has been compiled by **pv magazine**. Information was obtained from sources believed to be reliable, but it has not been verified. Additional information is available upon request.

Up to May 25, the Invesco Solar ETF – an exchange-traded fund that tracks the MAC Global Solar Energy Index – underperformed relative to the S&P 500 and Dow Jones Industrial. The Invesco Solar ETF (TAN) decreased 6.4%, while the S&P 500 and DJIA increased 0.4% and 1.5%, respectively.

The five solar stocks in the U.S. market that predominantly recorded losses include Applied Materials (1.4%), Enphase Energy (1.2%), SolarEdge Technologies (-3.3%), Atlantica Sustainable Infrastructure (4.1%), and Generac Holdings (-4.1%). The most pressing challenge for the solar PV industry is without a doubt the cost increases throughout the supply chain, but none are highlighted more than the increase in commodities costs, in particular steel and freight costs.

U.S. steel prices are expected to remain high through the first two quarters of 2022. U.S. manufacturers do not appear in a rush to increase production. Factors that contribute to the price increases include the consolidation of U.S. steel mills and tariffs on steel imports. Steel imports have driven the rise in U.S. steel mill utilization (now reported at 85%), and with a decline in suppliers due to consolidation, producers are able to maintain their "stranglehold" on supply and sustain high prices until the first half of 2022. Overall, price increases and a higher cost of capital have added $0.05/W of incremental costs.

Input costs

Solar tracker manufacturers such as Array (ARRY) and FTC Solar (FTCI) witnessed major hits to their stock prices (down ~50% and ~40% on May 12, respectively) during earnings season in the week of May 10. Again, this was directly attributed to cost inflation. For reference, U.S. utility-scale PV module pricing six months ago for the third quarter of 2020 was $0.25/W, compared to $0.28/W today. With mid-teen IRRs for utility-scale projects, these companies do not have much room to absorb this rapidly increasing cost inflation.

Jesse Pichel

New Technology For Home

New Generation Residential PV Inverter & ESS

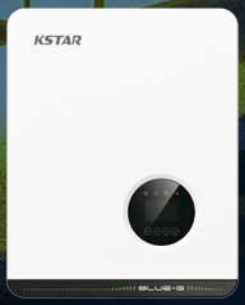
Powered by CATL

All In One Energy Storage System

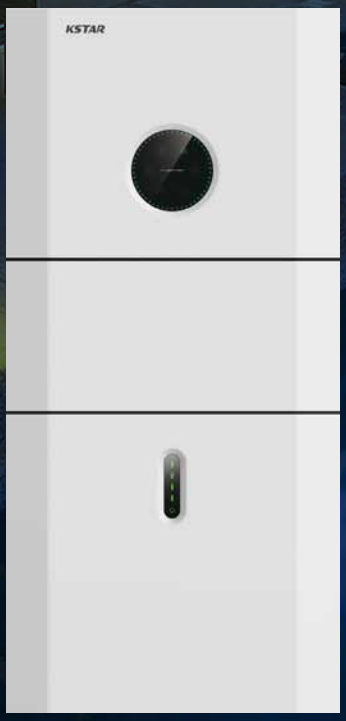
- Safety
- Simple
- Interconnection



BluE-G Single Phase Series



BluE-G Three Phase Series



BluE Residential ESS



BluE Residential ESS

KSTAR

Shenzhen Kstar Science and Technology Co.,Ltd

E-mail: ess@kstar.com

www.kstar.com

Nuclear – no thanks!

The somewhat timeworn slogan from Germany in the 1970s and 1980s, "Atomkraft – Nein Danke," is well known, even outside the country. But you hardly ever see or hear it anymore – least of all after the German government decided to phase out nuclear power in 2012, in the wake of the Fukushima disaster. This incident brought the global expansion of nuclear power to a virtual standstill, writes Martin Schachinger of pvXchange. Yet, despite all the latest developments and talk about climate protection in Germany and abroad, there is reason to be concerned that the use of nuclear power as a low-carbon energy source may not be over yet.

A constitutional complaint against Germany's short-sighted climate protection effort has forced policymakers to improve their plans in recent weeks. But there is a fear that in the years ahead, politicians in Germany and elsewhere will lack the creativity to present anything other than nuclear energy as the best, or only, solution that can be implemented in enough time to make a difference.

Solar is demonstrably the most economical form of energy generation.Unfortunately, we are still struggling with a shortage of materials across the board, starting with polysilicon for cell production, and precious metals, glass, and aluminum for module production. Added to this is a shortage of components for inverters, steel for substructures, and copper for cables. Freight rates from China are also rising on an almost daily basis. These factors are causing module prices and the overall cost of PV systems to skyrocket. However, a turnaround by the spring of 2022 at the latest is a realistic possibility.

German goals

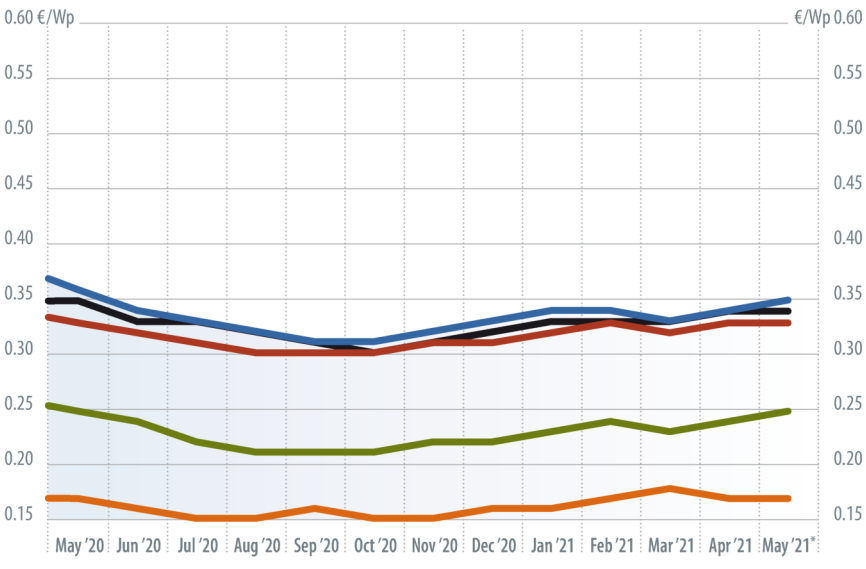
Following a constitutional complaint by climate activists, including those from the Fridays For Future movement, the Federal Constitutional Court declared parts of the Climate Protection Act unconstitutional due to failure to provide sufficient emissions reductions from 2031 onwards.

According to the court ruling, future generations must not be left with a situation that restricts their freedoms and fundamental rights. The response was swift, probably with a view to the upcoming election. Instead of achieving climate neutrality by 2050, Germany is now set to be climate-neutral by 2045, and the target for greenhouse gas reduction by 2030 has been bumped up from 55% to 65%. Climate experts warn that the targets are still not enough to limit global warming to 1.5 C, yet some are already saying that all this will be far too expensive and will deal a mortal blow to Germany as a commercial location – same old story.

With the gradual decommissioning of Germany's nuclear fleet, there has been more talk of an expected "electricity gap" that cannot be filled with renewables, only with natural gas. In any case, all reduction scenarios include some mention of greenhouse gas sequestration and storage; that is, technical or natural processes to remove CO_2 from the atmosphere and permanently store it. After all, the climate law uses the misleading term "climate neutrality" and not "zero emissions" or "100% renewable energy generation." But we are being led to believe that there are offsetting options which on closer inspection prove unrealistic. And the technical removal of carbon from the air with subsequent storage in underground reservoirs, so-called CO_2 sequestration, is neither safe nor energetically feasible.

The success of the German activist legal action will probably inspire imitators around the world to file similar lawsuits. This is good, but in my opinion there is a danger that nuclear will be presented as a stopgap solution. Thankfully, a constitutional appeal would also be filed if nuclear expansion plans revive, since the radioactive waste also represents a burden imposed on future generations.

EU spot market module prices by technology



Crystalline modules (mono-/poly-Si) average net prices (€/Wp)

- **High efficiency:** Crystalline modules **335 Wp** and above with Cello, PERC, HIT-, n-type – or back-contact cells or combinations thereof
- **Mainstream:** Modules with usually 60 cells, standard aluminum frames, white backing and **275 Wp to 330 Wp** – the majority of modules on the market
- **Bifacial:** Modules with bifacial cells, transparent backsheet or glass-glass, framed and unframed
- **All black:** Module types with black backsheets, black frames and rated outputs of between **290 Wp and 390 Wp**
- **Low cost:** Reduced-capacity modules, factory seconds, insolvency goods, used modules (crystalline), products with limited or no guarantee

* Data as of May 17, 2021
More information: www.pvXchange.com

Nuclear renaissance

Even today, the reactors at Chernobyl and Fukushima are a threat. From Chernobyl, worrying incidents occur in the bowels of the containment structure created around the plant. And in Fukushima, the release of huge quantities of contaminated cooling water into the sea threatens to unleash another environmental catastrophe.

Meanwhile, sun and wind have been used to generate energy for over 30 years without major incident. When these plants are decommissioned, only valuable raw materials remain, which can be recycled increasingly well. There are some protests from those who feel inconvenienced by the close proximity of wind farms. But compared to nuclear, these are new technologies, and refinement can only make them more efficient and inconspicuous.

To take the wind out of the sails of nuclear power, we must accelerate the expansion of renewables at least twice the current speed. This means removing obstacles to onshore wind farms, and creating new incentives for private expansion. This need not, however, increase feed-in tariffs, which would only justify higher turbine prices and allow some manufacturers to maximize profits. Rather, implement more intelligent support measures such as tax breaks, scraping levies for operators, and genuine industry support for the establishment of local manufacturers. After all, if materials don't have to be transported around the world, a lot of CO_2 can be saved – and the products can be offered more cheaply to boot. pv

Martin Schachinger, pvXchange.com

Overview of price points broken down by technology in April 2021, including changes over the previous month (as of May 17):

Module class	€/Wp	Trend since April 2021	Trend since Jan. 2021	Description
Crystalline modules				
Bifacial	0.35	+2.9%	+2.9%	Modules with bifacial cells, transparent backsheets, or glass-glass, framed and unframed
High efficiency	0.33	0.0%	+3.1%	Crystalline panels at 335 Wp and above, with PERC, HJT, n-type, or back-contact cells, or combinations thereof
All black	0.34	0.0%	+3.0%	Module types with black backsheets, black frames, and rated power between 290 Wp and 390 Wp
Mainstream	0.25	+4.2%	+8.7%	Modules typically featuring 60 cells, standard aluminum frames, white backsheets, and 275 Wp to 330 Wp.
Low cost	0.17	0.0%	+6.3%	Factory seconds, insolvency goods, used or low-output modules, and products with limited or no warranty

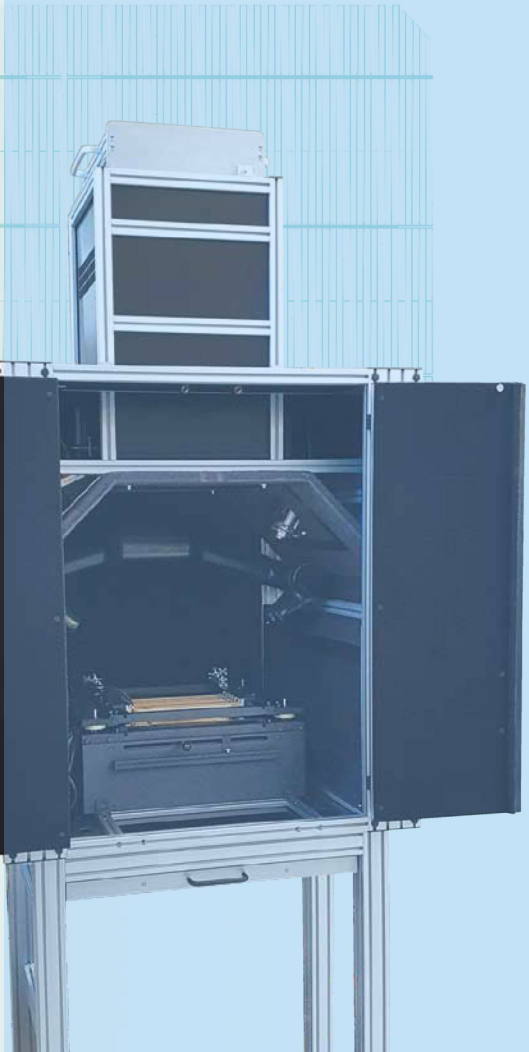
Notes: *Only tax-free prices for PV modules are shown, with stated prices reflecting average prices on the European spot market (customs cleared)*
Source: *pvXchange.com*



About the author

Martin Schachinger *has been active in renewable energy for more than 20 years. In 2004, he founded the online trading platform pvXchange.com, where wholesalers, installers, and service companies can purchase standard components, solar modules, and inverters that are no longer manufactured.but are still urgently needed to repair defective PV systems.*

Advertisement



.h.a.l.m.

cetisPV-Celltest4

High precision Class A+AA+ laboratory system for PV cells

- user-optimised contact station for up to 220 mm x 220 mm solar cells
- true bifacial measurement possible
- additional measurement options available: integrated electroluminescence, hot-spot, grid resistance
- thermo-control for automated temperature-dependent measurements available
- applicable for all cell technologies, e. g. PERC, heterojunction, TOPCon, busbarless, bifacial cells

www.halm.de

Baltic breakdown

Estonia, Latvia and Lithuania have seen uneven development in PV installations to date, and the three Baltic states are still highly dependent on imports from Russia. Estonia needs to replace aging energy infrastructure, and so far it has led the region in PV deployments. Latvia, meanwhile, has a high level of hydro in its energy mix, and less incentive to build PV. IHS Markit analyst Susanne von Aichberger examines the latest policy developments in the Baltic states.

At the end of 2020, the three Baltic states had a cumulative installed PV capacity of 800 MW. More than three-quarters of this has been installed in Estonia. Lithuania accounts for around one-fifth, while installations in Latvia are negligible.

The need to replace conventional power plants that were recently closed or are to be phased out partly explains the higher motivation for Estonia and Lithuania to expand the use of solar energy. As one of the EU member states with the highest per capita CO_2 emissions, Estonia is being urged by the European Union to reduce its use of shale oil – the largest power generation source in the country. The planned closure of old shale oil facilities is incentivizing increased use of renewables.

Lithuania has been highly dependent on electricity imports since the closing of its last reactor at the Ignalina nuclear power plant in 2009. The plant was a bone of contention for Lithuania's independence movement, Sąjūdis, in the late 1980s. Plans for a new nuclear power plant were shattered after Lithuanians voted against the resumption of the technology in a 2012 referendum. With a high share of hydropower, Latvia's need for the build-out of further renewable capacities is less urgent.

Estonian market

Estonia's PV market was driven by a feed-in premium scheme until the end of 2020. This scheme was discontinued for new installations outside of tenders from 51 kW to 1 MW at the end of 2018, and for systems smaller than 50 kW at the end of 2020. The phasing-out of the incentive created a rush of installations in 2020. As clusters of systems below 50 kW were permitted, a large part of Estonia's installed capacity was made up of larger systems. The high volume of grid-connection requests for PV systems of close to 500 MW overwhelmed the grid companies, meaning nearly all plants built in 2020 will be connected to the grid in 2021 or in 2022. New installations instead have fallen drastically in 2021.

Net-metering in Lithuania

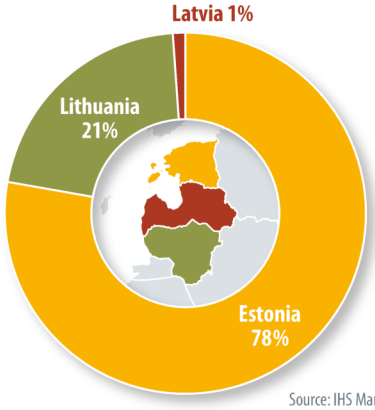
Since its introduction in 2015, Lithuania's net-metering scheme has been amended several times. The most important changes came in October 2019. The upper size limit for commercial PV installations to run under net-metering was increased from 100 kW to 500 kW, and the upper limit for a simplified permitting process of microgeneration systems was raised from 10 kW to 30 kW. Another change to the net-metering scheme is the option to consume the electricity at a different location to the place of generation.

The latter has opened a whole new business model that enables customers who do not have their own roof space to buy or rent part of a solar park, and to run their part of the installation under the national net-metering scheme. It also helps developers to attract small investors. To bring together developers and investors, state-controlled utility Ignitis founded the first remote solar park platform in October 2019. Other companies offering participation in remote solar parks include Sun Investment group, Latvian utility Latvenergo, Egrupė and Saulės Grąža, and Solet Technics. The first remote solar parks to operate under this scheme were realized in 2020.

In addition to the net-metering scheme, Lithuania subsidizes on- and off-grid systems of up to 10 kW per installation, financed by the EU structural fund. Another subsidy for commercial systems in 2020 is also expected to be reissued in 2021. Latvia's net-billing scheme was first introduced in 2014 and is much less attractive than the Lithuanian net-metering program. In Latvia, the electricity fed into the grid from the PV producer is not fully compensated. Improvements for microgeneration systems, effective from April 1, 2020, have only slightly increased the scheme's attractiveness. Systems below 11.1 kW no longer need a permit from the Ministry of Economics, and net-metering systems are now exempt from the variable part of the mandatory procurement component (MPC) fee for electricity fed into the grid and taken back.

While the Latvian government is reportedly contemplating the opening of the net-billing scheme to larger systems and commercial installations, there are no known plans to improve the level of remuneration for the injected electricity.

Baltic states – Cumulative installed PV capacity at the end of 2020



Source: IHS Markit

Technology neutral tenders

To reach their renewable energy targets, Estonia and Lithuania have launched technology-neutral auctions, exposing PV projects to strong competition from wind power plants.

Lithuania's auctions have not yet resulted in any awarded PV capacity. A pilot awarded all available capacity to a wind project, while the first regular round launched in May 2020 was cancelled due to low participation. A round planned for April 2021 has also been cancelled. According to the government, if all permitted renewable energy projects (mainly wind) are taken into account, the planned 5 TWh annually from renewables by 2025 should be reached without the need for further incentives. However, new auction rounds are not out of the question.

Estonia's auctions have been more successful for solar. A total of 7.2 MW of PV projects below 1 MW was awarded in the first two pilot rounds in 2020. Each for an annual production of 5 GWh, for a feed-in premium on top of the wholesale price, to be paid for 12 years. After a third pilot round in July 2021, two large rounds are planned for late 2021 and for 2024 or 2025, with annual generation of 450 GWh and 650 GWh, respectively. However, there are concerns the entire first large tender could go to one wind power project.

Little progress

Utility-scale projects have emerged that could potentially be built outside of state auctions. In 2018, Estonian company Estiko Energia won a tender for a land plot near Tartu to be used for the construction of a 140-hectare solar park. But delays in clearing the site of thousands of tires were extensive. The project, with a planned capacity of up to 75 MW, has now missed the opportunity to benefit from the FIP scheme outside of government auctions, and the current status or plan is unclear.

A floating PV project of between 200 MW and 250 MW was planned for the reservoir of the Lithuanian Kruonis hydroelectric plant. However, during the installation of a 60 kW pilot system, the available technical solutions turned out to be unsuitable, and in 2020 the decision was made to postpone the project indefinitely. pv

Susanne von Aichberger

> *"Estonia's auctions have been more successful for solar"*



About the author

***Susanne von Aichberger** is a senior analyst on the clean energy technology team at IHS Markit. She performs market analysis of trends and strategies in the downstream part of the PV market. Her focus areas include solar PV markets in Europe and in parts of the Asia-Pacific region.*

Advertisement



At GRS we are celebrating our 15th anniversary building PV projects for the main international IPPs.

We have built 107 photovoltaic plants around the globe, making us a leading EPC builder worldwide.

GRS is part of Gransolar, a vertically integrated group that covers all the needs of utility-scale PV projects, from engineering to energy storage. This integration gives us great control over every stage of the project, including commissioning and connection, and gives us the ability to offer better lead times and competitive prices than if we relied on third parties.

With over 2.4 GW of power in operation and 800 MW more in ongoing projects, GRS is the safe and reliable partner for the construction of your PV projects.

(+34) 917 364 248
contact@gransolar.com
www.grs.energy

GRS is part of GRANSOLAR GROUP

N-type development

This year, PV cell manufacturers will face the challenge of transformation. Apart from adjusting the ratio of production for different-sized cells, some manufacturers are turning to next-generation opportunities, shifting investment from p-PERC to n-type technology. PV InfoLink Analyst Amy Fang discusses the issues facing n-type cell development this year.

It is estimated that by the end of 2021 there will be around 400 GW of mono PERC capacity, doubling the 2020 volume. There will be at least 280 GW of cell capacity, calculating 182 mm and 210 mm cells only. Amid the serious capacity surplus, Tier-1 cell manufacturers could only keep slim profits in the first quarter, with only 1-3% of profit left for mono PERC cells.

Demand growth

PV manufacturers have not changed their target markets. Chinese n-type TOPCon manufacturers mainly target utility-scale projects, but the power output of modules assembled with large p-PERC cells has reached beyond 500 W, outshining n-type, despite its efficiency advantage. Silver prices remain high, hindering the development of HJT cells with higher silver paste consumption. This means slower demand for n-type products.

Non-China n-type module manufacturers, on the other hand, focus on residential and C&I rooftop projects. Outside China, Panasonic withdrew from solar and Maxeon announced PERC cell capacity expansion plans. In a competitive cell market, foreign manufacturers also began to develop strategies for the future. Mature markets including Europe, the U.S., and Japan, where demand is rather stable, will remain the major overseas markets.

The large-scale capacity expansion and economies of scale of p-PERC makes it difficult for n-type to compete. With the rising cost of raw materials and sluggish demand, n-type cell production declines to around 6 GW, and market share slips from 5% in 2020 to 4% this year.

N-type capacity

Orders for n-type products remain low. Manufacturers mainly gear up for n-type technology this year, with capacity significantly higher than production. Having expanded, mono PERC now sees signs of decrease in profitability. Several manufacturers revealed that they will stop adding PERC capacity, as it's already in surplus. Projects for the second half of the year are mostly n-type technology roadmaps or high-end technology research. It will take a while for n-type technology to reach large-scale commercial production.

Progress by larger manufacturers in 2021 will determine whether n-type can achieve mass production. The industry is watching whether Longi's TOPCon and Tongwei's 1 GW HJT capacity expansion projects materialize by early 2022, bringing costs down. Eyes are also on the yield rate of TOPCon and the selection of equipment for these processes.

Equipment capex for TOPCon dropped in 2020 to a level slightly higher than PERC. Taking into account equipment compatibility and the ability to increase cell efficiencies after switching from PERC to TOPCon, many new PERC production lines have been earmarked for upgrade to TOPCon. If TOPCon process can help increase efficiencies of existing cells and stabilize yield rate, real TOPCon capacity and production will exceed HJT. Technically, manufacturers are still choosing between LPCVD and PECVD, and the issue of wraparound polysilicon layer remains to be solved.

HJT processing is simpler and has advantages on yield rate and efficien-

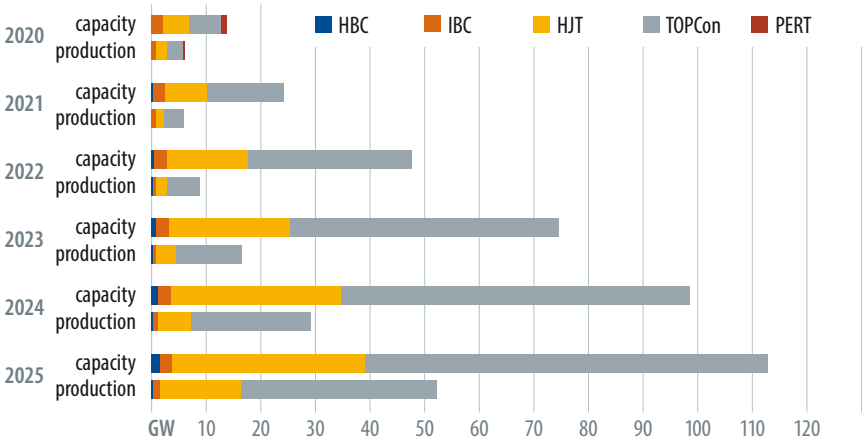
Comparison of current technologies

	P-type PERC Module	N-type TOPCon Module	N-type HJT Module
Capex ($/1 GW)	CNY 160-220 million ($22 million-30 million)/1 GW	CNY 250-300 million ($34-41 million)/1 GW	CNY 450 million ($61 million)/1 GW
Cell Efficiency	22.4%-22.8%+	23,50%	24%
Mainstream Module Power Output (72 pcs)	440-445 W(166 mm)	415-420 W (158.75 mm)	420-425 W (158.75 mm)
	535-540 W (182 mm)	450-455 W (166 mm)	465-470 W (166 mm)
Module Price	$0.22-0.24/W	$0.23-0.245/W	$0.25-0.26/W

Source: PV InfoLink

N-type module: capacity and shipment (2020–2025)

Source: PV InfoLink



cies. After introducing light-soaking last year, overall cell efficiencies increased to more than 24%. However, cost reduction remains a bottleneck. With the emergence of Chinese HJT equipment suppliers and their continued optimization, the capex for a 1 GW HJT cell production line has declined to CNY 450 million ($61 million)/GW. In addition to cost reduction through decreased equipment capex, adopting multi-busbars or smart wire interconnection can drive efficiencies up and silver paste consumption down. Meanwhile, R&D in silver pastes continues, hoping for a technical breakthrough with different materials.

High costs put most manufacturers in wait-and-see mode. Except for Tongwei and HuaSun, most capacity expansion projects this year are at pilot scale. Future development depends on whether HJT expansion in the second half can bring down the cost per watt. The depreciation of equipment brings limited cost reduction, after equipment costs declined from an annual CNY 800 million/1 GW last year to this year's CNY 450 million/ 1 GW. Further cost reduction can only depend on the advancement of silver paste technology, as well as economies of scale. For HJT capacity and production to grow in the long term, HJT must narrow the gap of costs with p-type.

Continuous progress

TOPCon and HJT both see continuous progress in cost control and efficiencies. The two are projected to see expansion in capacity and production in the next one to three years. However, TOPCon has advantages over HJT in order volume and capacity expansion, as it is easier to be upgraded from PERC. As a result, TOPCon will outpace HJT in terms of capacity and production in the short term. If costs for equipment and silver paste can decrease continuously while production volume increases, HJT will have more room for cost reduction for each high-cost material. Moreover, as HJT cell efficiencies continue to improve, its capacity and production will grow long term.

TOPCon and HJT face challenges in the large wafer transition. While 182 mm and 210 mm will become the mainstream format for p-type in the second half of the year, it remains a barrier for n-type to overcome stability issues using large wafers. If n-type cells made with large wafers can go into mass production in the next two years, costs will fall immediately.

Mono PERC is showing signs of decline after large-scale expansion, so it becomes increasingly important to prepare for next-generation technologies. But as it will take time for n-type to reach commercial production, large manufacturers' materialization of capacity expansion projects, the degree of cost reduction, mass production efficiency, as well as yield rate control, 2021 and 2022 will be a key period for the evaluation of manufacturers. PV *Amy Fang*



About the author

Amy Fang *focuses on research and analysis of the solar cell segment of the supply chain. She supports PV InfoLink in producing market trend analysis and works across price forecast and production capacity data services. Fang continues to contribute to solar cell technology research efforts, analysis of market trends, and timely market information.*

Advertisement



RENEWABLE ENERGY

Looking for a partner with outstanding experience in the industry? We have.

FAST MOVING TECHNOLOGY

STÄUBLI

For real added value

At Stäubli Renewable Energy, we take care to develop our products and services not just for today, but for the future. Our many years of experience in implementing complex solutions around the world help us add long-term value. As a company with Swiss roots, you can rely on us.

Stäubli – Connections for sustainable change

www.staubli-renewable-energy.com

Politicians tend to overpromise, except when it comes to solar

The speed of all transitions is inherently underestimated, and solar PV is no exception. The EU has grossly underestimated its coming of age, as its forecasts for 2020 were off by 67% for the Netherlands and 74% for Germany, writes Rolf Heynen, CEO of Dutch New Energy Research.

As with many industrial transitions, the emergence of solar PV was aided by government investment. This occurred first through R&D, and then the creation of a stable investment climate, as Germany did with the creation of the Energiewende (energy transition) over the last 15 years.

This gave manufacturers the chance to create scale, which is crucial for decreasing costs and increasing global accessibility and growth. When the engine of scale starts to run, a point of no return is created as acceptance and adoption grows.

Transitions are often exponential, both in price drops and in growth and acceptance. Remember the transition from horse and carriage to combustion engines, from landline phones to mobiles, from LP records to cassettes to CDs to online streaming, and so on.

From that perspective, it is fascinating to see how the International Energy Agency (IEA) has predicted, for over 10 years, a flat line of solar PV year after year. And although it has since updated its models, it still underestimates growth.

The Netherlands is one of many countries where the speed of PV development has been consistently underestimated. According to DNE's Rolf Heynen, this underestimation continues, as PV growth in Europe is already beginning to surpass the EU's 2030 forecast.



Photo: Naga Solar

350 GW in 2030?

Last year, the EU presented goals for all member states and a forecast for installed PV capacity to 2030. EU countries were asked to share their expectations and ambitions for the growth of PV (and other renewable energy sources). When these expectations are met, the European solar market will triple. One year down the road, political goals are already underperforming when compared to the market.

The political ambitions and the policies in place per country are presented in the Dutch New Energy Research 2021 EU White Paper, which includes a foreword by Diederik Samsom, head of cabinet for European Commissioner Frans Timmermans, who leads the EU Green Deal.

"The Green Deal in December 2019 represents our vision for a just and sustainable future for everyone. Not just another environmental policy, but an overarching comprehensive investment plan to decarbonize our economy and become fully climate neutral in 2050," said Samsom. "It is clear that solar PV will play a huge role in this transition. The commission's own assessment shows an installed capacity of approximately 350 GW in 2030 and more than 1,000 GW in 2050. And I do not exclude the possibility that, yet again, reality will beat predictions."

I fear, but mostly cheer, that Samsom is right about the possibility that reality will beat predictions. The EU predictions start in 2020, and for many countries we can already validate the political underestimation.

Underestimated growth

The Netherlands has been performing exceptionally well for a small country, showing annual double-digit growth

numbers for a decade, except for 2014. The Netherlands has a successful residential, C&I, and utility market of more than 10 GW. In the Dutch government's national climate and energy plan, the market was estimated to grow by 1.8 GW per year over the next decade. However, closer to 3 GW of new capacity was already installed in 2020, off by 67%. This shows the difficulty in assessing the enormous potential of the PV market, and not just in the Netherlands.

Other countries are struggling to value PV development for its true potential as well. For example, this has been the case in two other large markets in the EU, where ambitions for 2020 were outpaced by actual developments: Germany and Spain.

In Spain, the national tally was almost 4 GW installed in 2019, and then 3.2 GW in 2020. The market, in reality, shrunk by 19% compared to the year before. Yet the government estimated a decrease of the market by 47%, making the miss smaller than what was realized.

Similarly, Germany installed 4.88 GW in 2020, a growth rate of 24% compared to 2019, when 3.9 GW was installed. Meanwhile, the German federal government forecast a conservative 2.7 GW, which would have been a decrease of 29% from the previous year. In total, German estimates were off by 74%.

Fearless PV predictions

As shown by these three countries, market statistics and forecasts based on climate ambitions by governments remain a challenge. Especially in the midst of a tremendous energy transition, when markets are still, for the short term, influenced by changing policies. Having governments speak out for a stable long-term investment climate is crucial. A highly ambitious Green Deal on one side and unrealistic conservative estimates on the other lay bare the poor connection of politics with the market. And this unnecessarily undermines the transition.

Within two years of submission, the 10-year EU estimates have already proven to be outdated. Underestimation is central in transitions. Even with the urgency of the energy transition, seeing such estimates this far off remains astounding.

The EU projected a threefold increase for the PV market over the next 10 years. Taking both the context of Covid-19 and the historical gross underestimation of transitions, I predict tenfold growth of the EU PV market to be more realistic. pv

Rolf Heynen

The German government's 2020 forecast underestimated PV installations in the country by:

74%



About the author

***Rolf Heynen** is the CEO of Dutch New Energy Research and the CTO of Solar Solutions International. The figures in this article were derived from DNE Research's EU white paper and its upcoming European Solar Quarterly report, which contains quarterly installed capacity, distribution data, and forecasts per country. Heynen holds university degrees in electrical engineering and political science.*

Advertisement

For the future of our planet

Dr. Janusz Kabata, is updating the 100+ year-old former forester's lodge in Kętrzyn, Poland to the requirements of modern life: eco-friendly and sustainable.



solplanet.net

"After a very careful analysis, we chose one of Solplanet's reliable inverters for our newly designed solar installation"

Solplanet

Rapid growth becomes new normal

Despite the impact of the pandemic and associated economic crisis, 2020 saw unprecedented growth in the solar market. With the International Energy Agency stating that high rates of capacity additions are the new normal, has the energy and investment environment fundamentally changed? Felicia Jackson in London explores these issues.

In 2021, the place of solar in the energy market has been transformed. The International Energy Agency (IEA) has crowned it the "king of electricity," and says its 2020 global capacity growth rate of 45% (to nearly 280 GW) is the new normal. This year will see the return of international climate negotiations, as the U.S. has returned to the Paris Agreement and the EU is driving forward with its Green Deal, with $21 billion approved for the green transition. Meanwhile, economies around the world, including China, are committing to net zero targets.

Georgios Gkiaouris – acting director, head of Energy Europe at the European Bank for Reconstruction and Development (EBRD) – said that both the climate change context and the EU's green agenda are increasingly important market drivers. Of course, the rising cost of carbon emissions is also playing a significant role, with emissions credits recently passing €50 ($61)/ton. At a basis of €40 or above, the cost of solar is lower than the



Corporate PPAs in Europe tripled last year, including the signing of several by developer Iberdrola with multiple offtakers for its projects in the Extremadura region of Spain.

Photo: Iberdrola

cost of the emissions, and this changes the economics of coal.

Alessandro Boschi, head of renewables at the European Investment Bank (EIB), believes that the EU's Sustainable Taxonomy will be key to ensuring that investment goes toward truly green investment options like renewable energy. The Taxonomy is going to affect companies far beyond European borders in an increasingly globalized economic environment. The EIB is fully aligned with new definitions in sustainable finance and Boschi agrees that we are seeing a structural shift in the market.

Merce Labordena, senior policy adviser at SolarPower Europe, said that solar growth will continue to be driven by falling costs of the technology, by scalability, modularity on rooftops, carports, water surfaces, and innovative applications.

Structural shift

Investor concerns about risk are driving interest in understanding externalities, while the rising cost of emissions is driving corporate action on emissions. This has driven growth in demand for climate and sustainability risk reporting and is behind the huge boom in ESG investing. According to 2021 research by Bloomberg, global ESG assets are expected to reach more than $53 trillion by the middle of the decade – over one-third of total assets under management (AUM) of $140.5 trillion. At the same time, new analysis of Bloomberg data has shown that more than $1.3 trillion of green bonds and loans have been issued to relevant projects since 2015.



Boschi confirmed that any talk of a bubble doesn't relate to investment in clean energy assets, but may be in relation to the market value of some related companies.

For Gkiaouris, it is the combination of ESG with increasing climate-reporting demands, like the Task Force on Climate-related Financial Disclosures (TCFD), that are driving change. Greek utility PPC, a lignite owner, recently announced a coal phase-out accelerated to 2025.

"We have worked with PPC on that journey, from the provision of a working capital facility to developing an action plan to implement the TCFD," Gkiaouris said. The collaboration even expanded to the launch of its first sustainability-linked bond in March, where the EBRD was the anchor investor.

Corporate appetite is also growing for renewable energy assets like power purchase agreements (PPAs), which nearly tripled in 2020. For the EBRD, the world of PPAs is fairly new, and the bank is supporting development predominantly through auctions, FITs and other forms of revenue stabilization.

"We know corporates see solar as a lower cost energy which, combined with increased sensitivity on sustainability and their emissions profile will continue to act as a driver," said Gkiaouris.

For the EIB, the landscape is more familiar. In Spain, for example, many of the projects it has financed have been based on PPAs where the LCOE of solar is lower than the current level of power prices. That creates an investment opportunity for some private investors, even in the absence of subsidies and in the face of the pandemic. On average, the EIB has financed around €1 billion a year in loans to solar over the last four years, and Boschi expects this to continue.

Funding solar

A challenge for the oil majors moving on the energy transition is historical returns.

Photo: EBRD



"We know corporates see solar as a lower-cost energy"

Georgios Gkiaouris

Photo: Government of the United Kingdom



"The market needs to … stop thinking about reasonably profitable and start thinking about reasonable, profitable but reliable returns"

Zula Luvsandorj

With previous project returns starting at 14%, solar returns are averaging closer to 7%. Gkiaouris points out, "There's a lot of competition, especially for auction supported plants, so their IRR is getting low – we're seeing it go below 10%."

"There can be reasonably profitable returns of 5% to 6%, but the market needs to understand that shift, stop thinking about reasonably profitable, and start thinking about reasonable, profitable but reliable returns," said Zula Luvsandorj, project finance adviser to the UK government's Infrastructure and Projects Authority at the Cabinet Office.

Paul Glendinning, head of power networks and renewables at WSP, believes that one of the issues the solar sector should grapple with is the shift in mindset needed as it moves from subsidy support to the mainstream. He points to a 75 MW, subsidy-free solar plant in Wales as an example of what can be done. Glendinning believes that while the system may need inertia and backup, we're potentially only five years away from net zero in a number of markets. "It's all about increasing yield. It's about the lowest cost of power and then improvements in site performance," he said.

Technologies and costs

While solar's success has been driven by cost decreases of 90% in a decade, Boschi still sees margins for improvement. "There are still margins on the cost side in PV modules," he said. "The International Renewable Energy Agency (IRENA) has estimated cost reductions of 20% every time capacity is doubled."

The big challenge is capex and efficiency. Boschi says the EIB expects to continue to see technology efficiency improvements, as well as in bifacial and non-silicon materials, plus research, development and innovation (RDI) in building-integrated and asset-integrated PV.

One issue, especially in Europe and Asia, will be land availability. With much already developed, limitations on new solar farm developments emerge. Opportunities exist in cross-sectoral approaches such as floating and agrivoltaics.

Where Glendinning expects to see technical innovation is in the grid, which he described as being at the forefront of innovation. He said there are many opportunities to change the way in which energy is managed, not least of which is the use of DC transmission. In the U.K., National Grid has launched its Stability Pathfinder project to explore how more flexible capacity and devices on the grid can support system strength. The intent is to be able to operate the grid safely and securely without carbon.

Storage is also now becoming more cost-competitive for the variable nature of wind and solar. Glendinning accordingly believes that we should no longer be using the term "intermittent generation," but rather than we should start looking at electricity as predictable and schedulable.

Regulatory concerns

One problem that arises from continually falling power prices (due to the increasing penetration of renewables) is how to maintain investment return over time. "In order to reach projected capacity we will need regulatory support such as auctions and CFD for revenue support or stabilization to regulate income," Boschi said.

Permitting is also seen by the industry as a major bottleneck for growth.

"In some places, the growth of the industry is outpacing the capacity of the economy and the country to cope," Gkiaouris explained.

The investor demand is there, but the networks still struggle to remove bottlenecks, and that is what the regulators need to consider.

Meeting increasingly high renewable energy targets will need stronger legislative provisions to overcome existing administrative and regulatory barriers in the power sector, along with building heating, cooling, and transportation, as Labordena pointed out.

"The key objective today is decarbonizing electricity through renewable energy. By 2030 we need to get 60% to 80% of our electricity from renewable sources," Boschi said. The technology exists today to create a low-carbon future, without unnecessary offsets. Effectively decarbonizing the grid within the decade means that renewable energy with flexible generation and storage will be the only affordable option.

That means that politicians, fossil fuel companies, and energy companies are going to have get comfortable with the fact that solar is no longer an alternative energy source, but a key route to the green electrification required for a sustainable low-carbon future. pv

Felicia Jackson

Aiko CELLS
made from the heart

Aikosolar



DARK CELLS

Art and Technology

Driving toward the

An inflection point for European solar is beginning to take shape as the industry finds itself in a period of acceleration and transformation. pv magazine's European editors – Emiliano Bellini, Sandra Enkhardt, Gwénaelle DeBoutte, and Pilar Sánchez Molina, along with Jonathan Gifford – look at four trends shaping the market.

1: Big PV is back

While markets outside of Europe have hogged the limelight when it comes to size and record low tenders for the last five years or more, this decade has already been notable for the return of very large utility-scale projects on the continent. And very large means 100 MW and up.

IHS Markit is tracking a pipeline of some 80 GW of utility-scale solar projects 100 MW+. Athough Josefin Berg, a research and analysis manager of clean energy technology for the company, acknowledges that they "are in very early stages and many are not going to happen."

But there are 100 MW+ projects going ahead in Europe, with the transition away from FITs to auctions and eventually merchant PV enabling big projects to get off the ground.



Southern and southwestern European markets provide many notable 100 MW+ examples. Solaria Energía was set to begin work on the 626 MW Trillo project in Spain this May, while Iberdrola reports that work is underway on its Francisco Pizarro Spanish project, for which it has signed a PPA with pharmaceutical giant Bayer. In France, Neoen and Engie have announced their intention to develop the vast, multifaceted Horizeo project, with a proposed capacity of 1 GW. And Greece is back with gigawatt-scale ambitions as a part of its lignite exit (pp. 26-29).

"There are so many ways to find remuneration now, making it possible to get to that scale, and you need it [scale] to get your prices to the right level be to become competitive in the power market," explains Berg.

Analysts note that grid capacity is likely to be a limiting factor for these vast projects, with developers responding by racing to lock in available capacity. This dynamic informed Portugal's second solar auction, which stunned the PV market with a record low strike price of €0.0114/kWh at a scale of 670 MW.

"The thing that is worth a lot of money in Europe, and all developers want access to, is grid connection," says Jenny Chase, the head of BloombergNEF's Solar Insight team. "In Portugal, the developers aim to sell at a loss for 15 years to get access to a grid connection for as long as they want – and that is where they are hoping to make their money."

The development of big solar in Europe is not limited to the sunny south. Having completed a 187 MW solar project in Germany in December 2020, utility EnBW announced its intention to develop two

inflection point

150 MW projects in the country's north. The projects are developed outside of the country's renewable energy system, the EEG, and will operate on a merchant basis – likely a combination of wholesale and PPAs.

Even further north in Denmark, where wind power and cloudy skies are more prevalent than solar, local developer Better Energy has begun construction on its 200 MW unsubsidized PV power plant in the municipality of Holstebro. The project will be owned by a subsidiary of Danish clothing company Bestseller, and will supply its electricity to the fashion company, along with Danish retail chains Normal and Nemlig.

"Solar holds a major cost advantage in many markets, including over offshore wind, and the market for PPAs is really picking up," says Brian Gaylord, a principal analyst covering southern Europe and Latin America for Wood Mackenzie. "There is a definite acceleration [in large scale PV in Europe] even without looking at the 2030 targets."

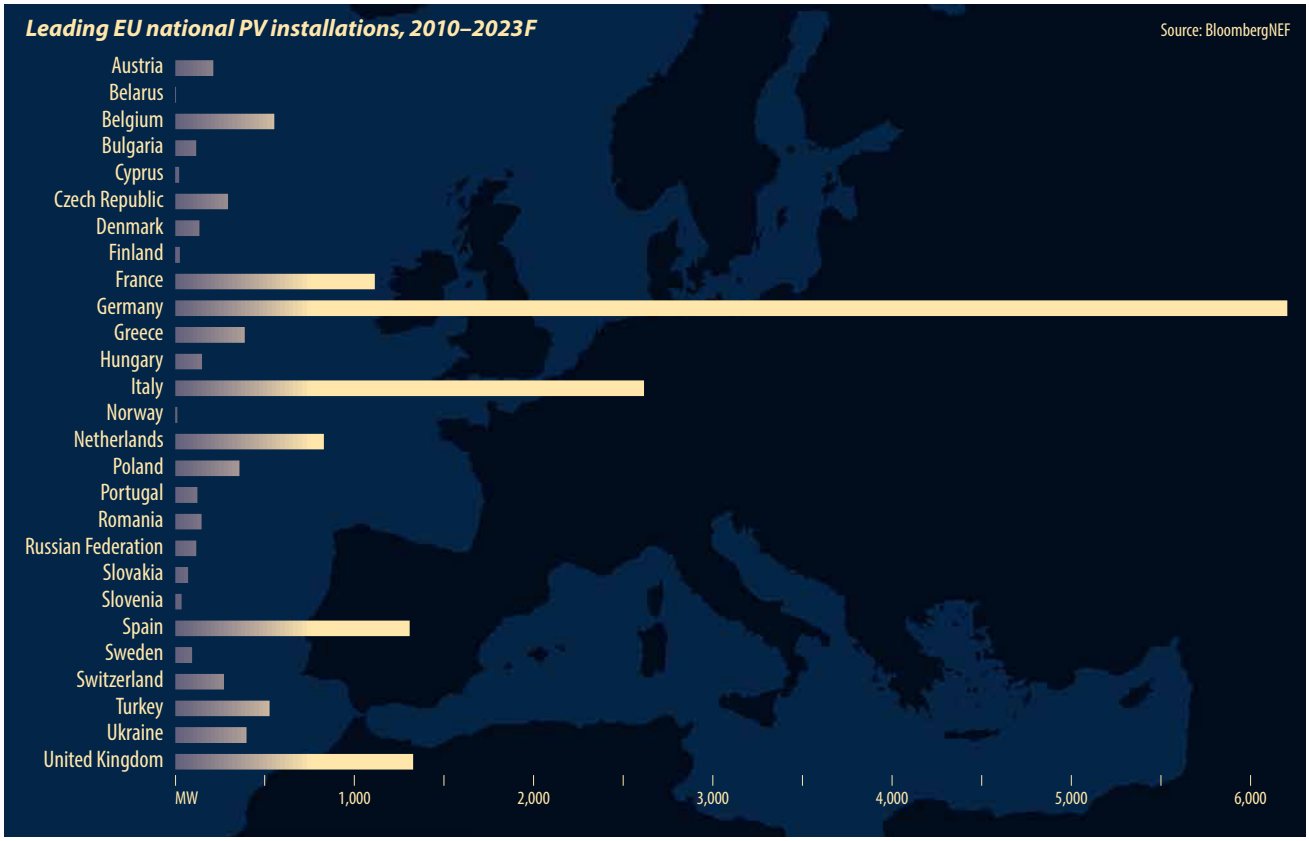
2: Ways around grid constraints

While developers of large projects scramble to acquire land close to the grid and connection rights, PV is demonstrating its versatility and set to deliver ongoing demand. The Dutch government has set a hugely ambitious 27 GW solar ambition by 2030. However, the densely populated nation lacks the wide open spaces for big PV. In response, developers are showing remarkable creativity, getting close to 3 GW installed in 2020.

"I think there will be way more floating PV than many people think," says Prashant Khorana, a director of consulting at Wood Mackenzie. "There are abundant lakes with shallow water, and floating

670 MW

at €0.0114/kWh – the value of grid access in Portugal auction



145 MW

of agrivoltaics auctioned for €0.0815/kWh in France

PV is pretty simple – particularly when you compare it to the complexity in offshore wind. I mean, the biggest problem is bird droppings."

"The Dutch are sticking solar on everything at the moment," observes Jenny Chase. "It's a pretty healthy way to install solar in your grid."

Dutch grid operator Tennet produced a study finding that between 500 MW and 1 GW of flexible grid demand can be created by coupling solar with heat pumps.

In terms of larger projects, IHS Markit's Berg describes the situation of developers "taking control of the situation rather than having curtailment imposed," and points to projects adding storage, coupling with heat pumps or even green hydrogen production (in the longer term), as ways in which PV production and demand can be brought closer into alignment.

"Simply overbuilding your plant so that you have more modules than inverters, and clip off some production midday but higher production in the mornings and evenings is all about taking control." These innovations, the analyst notes, can be limited by costs. "Every company wants to innovate, but it still has to be within your budget."

3: Policy innovation shines

Innovation is also occurring in Europe's solar tenders, auctions or support programs, and a move toward a zero-emissions technology neutral basis is a commonality between countries. Italian lawmakers have dedicated more than €3 billion in funding toward agrivoltaic installations and "energy communities." The programs anticipate seeing up to 4 GW of solar capacity installed.

France is also backing agrivoltaics, though large projects like the Engie-Neoen array mentioned earlier are meeting some local opposition. CRE, France's energy regulator, announced the results of its second tender for innovative technology, a yield of around 145 MW of projects at an average strike price of €0.0815/kWh.

The 500 MW Nuñez de Balboa project was connected to Spain's grid in April 2020.



Photo: Iberdrola

Germany has announced plans to ramp up its solar tender ambitions, with as much as 6 GW in 2022 expected in plans agreed to by its ruling coalition parties. There are signs that these tenders could include 150 MW of floating and/or agrivoltaics.

In April, Germany's "innovation" tender results were announced for combined solar+storage facilites, with some 258 MW of projects successful. Strike prices ranged between €0.0333 – €0.0429/kWh.

"Solar+storage is where we are going," says WoodMac's Khorana. "And I think the discussion will move away from wind versus solar and move to technology neutral. Governments are going to say, we want big, firm generation – 16/9 or 24/7." And, indeed, Germany will hold another 250 MW innovation tender in August.

"We are going to be focused more on when electricity is delivered and less on how much [electricity]," says Jenny Chase. "Tenders that move things in this direction are a good thing, but they probably won't go perfectly the first time."

4: Make it in Europe

Module prices in Europe, and elsewhere, are on the up and there is significantly enhanced scrutiny on both the sustainability and labor practices across the PV cell and module supply chain. Combined with a significant uptick in demand, the stage could be set for an expansion of Europe's PV manufacturing base – even further up the supply chain to polysilicon, wafers and cells.

€0.0333 – €0.0488/kWh is the strike price range for

258 MW

of "innovation auction" projects in Germany



Former tool maker Meyer Burger is making much fanfare of its module series launch, with its in-house HJT cell production. And a host of pure-play module makers in Europe have been investing in equipment for larger cell and module formats – taking the opportunity to expand production capacities at the same time.

"For 'Made in Europe' to happen, you need to have a local market," says Berg, from IHS Markit. "You need to make sure there is demand for what you produce in Europe and stability in that demand for five, 10 or hopefully 20 years. Without that kind of visibility, investments will hardly take place." And, indeed, demand expectations in Europe are more robust, however competition from Asia in terms of price, quality and technology remains strong.

"I think the ship has sailed on that one. But maybe there is some space for some innovative products," says Khorana.

BloombergNEF's Chase is equally subdued in her expectations. "It is good if people can choose to buy 'Made in Europe' modules, but there is also nothing wrong with Chinese modules. If we had always relied on European solar production, solar would still be a cottage industry. But I do like what Meyer Burger are doing and I wish them well." pv

"Combined with a significant uptick in demand, the stage could be set for an expansion of Europe's PV manufacturing base"

Greek investment soars

An array of new investment plans were announced in Greece in May, ranging from mega PV projects to battery and electric vehicle production, as well as a move to smart green islands. pv magazine explores the state of these investments and links them to the country's general policy frameworks – most notably, Greece's master plan to boost green investments in former lignite regions and establish a new type of economy.

There is no doubt that Greece's flagship project in the post-lignite era is the development of 3 GW of solar PV capacity in former coal mines from state-owned Public Power Corp. (PPC). Of this, a massive 2 GW solar farm is expected to be built in Ptolemaida, northern Greece, and a 1 GW installation will be developed on the Peloponnese Peninsula in southern Greece.

"A massive 2 GW solar farm is expected to be built in Ptolemaida … and a 1 GW installation will be developed on the Peloponnese Peninsula"

Both projects are split into several smaller chunks that the utility aims to develop alone or in partnership with other investors. Germany's RWE is one of those investors. A spokesperson for RWE told **pv magazine** that initially, PPC and RWE signed a memorandum of understanding aiming to "pursue potential collaboration in order to exchange know-how in decarbonization, as well as in the development and implementation of renewable energy projects in Greece." However, added RWE, the two parties have now signed a letter of intent "to strengthen the collaboration and focus initially on the development of solar projects and onshore wind in the Greek market, with a total capacity of at least 2 GW."

RWE chose not to provide further information regarding the timeline and the policy mechanisms supporting this investment. It is widely expected that the two will participate in Greece's future renewable energy tenders aiming to win contracts for projects supported by premium tariffs.

The RWE spokesperson was happy to reveal that although the company's "first strategic focus is on the development and implementation of solar farms … we always have an eye on developments for energy storage facilities and hybrid projects across all European markets wherever it makes economic sense, including Greece." RWE added that it is currently focusing on a number of solar projects together with PPC within the boundaries of a former open pit lignite mine. However, the two companies may broaden their geographical scope later on.

RWE also recently won a contract to build a combined 14.4 MW photovoltaic farm with a 9.6 MWh storage facility in Germany's Tagebau Inden open-cast mine and it is very much interested in transferring its experience to Greece, said the RWE spokesperson. The case, though is that Greece, will help RWE to diversify its business and make it fit for the 21st century. Based on figures provided by RWE, by the end of last year, the company had a global solar portfolio of just 229 MW in operation, including PV projects in Europe in the order of 56 MW.

EVs, batteries

RWE is not the only German investor eyeing Greece with clean technology plans. The country's state investment and trade promotion agency, Enterprise Greece, recently signed an initial agreement with Germany's Next.e.GO Mobile SE, an electric vehicle manufacturer, to establish a production facility in Greece.

The agreement refers to an "in principle collaboration," which sees the two parties form a working group to detail the framework and conditions for the implementation of the full-scale manufacturing facility of the German company in Greece. Should this collaboration come to fruition, Greece will acquire its first local manufacturing base for electric vehicles. Next.e.GO Mobile SE also intends to establish a Technology and Innovation Campus (TIC) in Greece.

Photo: Mvlaxou/Wikimedia



Coal mining in Ptolemaida, northern Greece. State-owned utility PPC has plans to build 3 GW of solar on former lignite mining sites in the region.

Another recent development currently being implemented is a move by Athens-based Sunlight to expand its local R&D and battery manufacturing bases.

Specifically, the European Commission's Directorate-General for Competition (DG COMP) approved state aid a few months ago for a Sunlight research project on energy storage. Thus, Sunlight will receive €49.9 million from Greece's government toward the development of an R&D center in Athens, aiming for the development of innovative lithium battery technologies.

The state aid funds will comprise part of Greece's National Strategic Reference Framework (NSRF), which in turn is mainly funded via the European Union and backed by Greek government funding. Sunlight will cover the remaining €55.26 million of the project costs with own funds, amounting to a total €105 million investment.

The new R&D center in Athens will complement the research work developed by Sunlight's R&D center in Xanthi, northern Greece, which is already in operation. Sunlight said the new investment will focus on the development of battery solutions for automated guided vehicles (AGVs), electric city buses and the shipping industry, as well as smart storage systems for renewable energy sources."

The company currently operates two manufacturing plants in northern Greece: one battery manufacturing plant in Xanthi and a recycling plant for used batteries in Komotini. It also operates a bat-

tery assembly unit in Italy. Sunlight's new investment, following the approval of Greek state aid, will boost its R&D program and the industrial deployment of its battery solutions. It aims for a production capacity of up to 1.1 GWh of lithium-ion cells, 1.1 GWh of batteries, and the development of green battery cells for heavy-duty applications.

"Volkswagen … to turn the Greek island of Astypalaia into a global model for smart and emission-free mobility"

Sunlight's investment is expected to create 800 to 1,500 direct and indirect jobs, in Greece as well as in Sunlight's subsidiaries in Italy, Germany and the United States, which demonstrates the joint nature of the EU policy and business.

Car manufacturing giant Volkswagen has also set on a route to turn the Greek island of Astypalaia into a global model for smart and emissions-free mobility, using the island as a testbed for its e-mobility and smart mobility business model. Initially, public vehicles will be replaced by EVs, then inhabitants will be incentivized to replace their private cars with electric ones. New car sharing services will also be put forward. Energy will primarily be generated from local green power sources, said Volkswagen, and the project will initially run for six years.

Volkswagen plans to conduct a six-year test of its e-mobility business model on Astypalaia. The Greek island will replace public vehicles with electric ones and incentivize EV purchases from the public.



Photo: ER Bauer

High-value production

All previous projects, but most importantly, the Sunlight and Next.e.GO Mobile SE's investments in Greece, are vital for the country to make the shift toward high-value production. Modern economies do not seek to attract any type of investment, but aim predominantly to develop production with high-value output that can add to a country's growth rapidly. This is definitely the case for Greece, which seeks to leave years of financial turmoil behind, investing in a high-value future. Manufacturing in energy storage and EVs offers such an opportunity, as does developing home-grown R&D knowledge.

A widespread problem that occurs with this type of investment is that it requires locations and states with developed infrastructure (e.g., roads and ports) in place, as well as robust laws and a highly skilled employment base. This is why only rich and developed nations are capable of reaping the benefits of the technological revolution. And from this point of view, Greece's latest moves are impressive. Of course, Greece's membership in the European Union also helps, providing the country with frictionless access to the continent's single market.

Business-minded government

The role of Greece's government to attract investments is pivotal. Alexandra Sdoukou, secretary general for energy and mineral resources at Greece's ministry of the environment and energy (Ypen), told **pv magazine** that its task is to make the best policies and set up the fittest regulatory frameworks to provide investors with confidence to invest their capital in Greece. Sdoukou argues that the overarching policy that shows Greece's travel of energy direction is phasing out coal from its energy system.

Greece had initially set 2028 as the latest date for phasing out its lignite power fleet, but PPC, which owns the country's coal plants, recently said it would be able to close down or convert to gas its last lignite power station by 2025.

"Phasing out coal is an ambitious, complex and demanding project that will affect the economy of the coal regions and the livelihood of the local communi-

ties. So the government is working to establish a new economic model for Greece's two coal regions, aiming for a just transition that facilitates new jobs and retraining workers to acquire new skills," said Sdoukou.

This is why the task of phasing out coal does not concern an institution or a ministry alone, but the whole of the government and its institutions, added Greece's secretary general for energy. With this in mind, Sdoukou explained that Greece set up a phase-out coal committee that is chaired by the energy minister, but comprises several other ministers and government figures. Moreover, the government has established a management team, which is responsible for the daily management of Greece's coal phase out effort.

In fact, last year Greece published a post-lignite master plan, focusing on new economic activities in the mining regions in the following five pillars: renewable energy, commerce, industry, smart agriculture, and eco-tourism, along with technology and education.

It's the reforms, stupid

Yet, investments do not come out of the blue, argued Sdoukou. "Investors need to see clear policy frameworks that allow them to work in a speedy and transparent manner. This is why my team reformed Greece's renewable energy licensing last year, establishing a new digital licensing process that reduces the time required for the issuance of the first license of a power plant down to just 30 days. The second wave of the reform is now under way, which upon completion in the summer will allow investors to undertake the complete licensing of their project in maximum two years, down from seven years time that is needed today." The upcoming reform will gather all necessary licenses and issuing institutions under the same online roof, the so-called 'one-stop shop.'

Sdoukou also referred to Greece's energy storage policy framework, which is now under way with the goal to make it a law in the third quarter of this year. Similarly, Greece acquired its first ever eco-mobility policy framework last year, with the government devoting a €100 million subsidy package towards the purchase of electric vehicles.

Greece seems to be in a period of frantic policy reform activity aiming to attract investments in all clean energy sectors, while making the best use of its chunk of the EU's post-Covid recovery fund. But Sdoukou said that Greece needs a clear mandate from its prime minister to attract foreign investment, and should do so by establishing robust policy frameworks and using the EU's recovery funds. He noted that the Greek Covid recovery plan comprises about €54.5 billion. The aim is to steer private capital toward the Greek energy transition effort.

For example, the energy ministry was able to allocate €450 million from Greece's recovery fund to support specific storage projects. The projects will be announced following the publication of an energy storage framework. Similarly, the country has secured another €450 million of the recovery fund toward electric mobility, with €80 million to be spent on the development of a charging network in Greece.

The RWE spokesperson told **pv magazine**: "We see Greece as a promising market for our further growth in renewable energy. Greece offers good conditions – especially for solar – and is clearly committed to renewable energy to facilitate the transformation of the country's power market." pv

Ilias Tsagas

Advertisement

We support PV systems

K2 systems



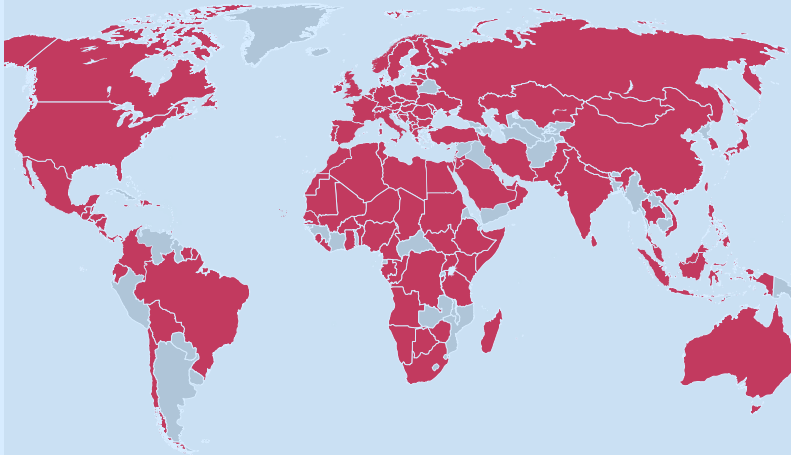
Your global partner for
PV mounting systems

How to start with K2?

We have an **easy, fast and safe** planning solution called K2 Base. The user interface is easy to use. The software architecture in the background ensures fast calculations.

More information:
k2-systems.com/base

/ **Mounting systems** since 2004
/ **More than 16 GW** installed worldwide
/ **9 locations around the world**
/ **120 distributors** worldwide
/ **400 t material** delivered per day
/ **Approx 60.000 PV projects** each month with K2



k2-systems.com

Poland's policy overhaul

The first half of 2021 promises significant changes for the renewable energy industry in Poland. Lawmakers are working on a major overhaul of key legislation for the renewable energy sector – the Energy Act and the Renewable Energy Sources Act. These latest amendments make sense and, truth be told, some of them should have been made a long time ago, writes Piotr Mrowiec of law firm Rödl & Partner.

The renewables-friendly bill amending Poland's earlier RES Act was submitted to the lower chamber of the Polish parliament (Sejm) in April. Luckily, there is no major disagreement within the ruling coalition parties, or between the coalition and the opposition, as to the proposed changes.

Here we'll focus on four of the most significant changes. The first is the extension of the reasonably well-functioning RES support system. The proposal is to keep organizing the energy auctions in Poland until the end of 2027.

"Since there is no dispute over the need for the overhaul, its signing into law by the Polish president seems to be only a matter of time"

The second is the long-awaited deregulation of business activity for plants of up to 1 MW. At present, plants with power of 500 kWp or more must go through a complicated procedure to obtain a license for electricity production, which is required to start selling electricity (leaving aside the sale during the commissioning) and for plants that have won an energy auction – a prerequisite to receive the auction support. According to the bill, PV plants up to 1 MW will be exempt from the licensing obligation and instead will be entered in the register of small plants (except micro-installations of up to 50 kWp), which is incomparably easier.

The third is about the obligation to refund a positive balance by the energy producer who wins an auction. Under the current legislation, if the market price of electricity is higher than the price offered by the producer in the auction-winning bid, the producer must refund the positive difference between the auction price and the average sales price of the electricity after the support period – that is, after 15 years. Following the legislative amendment, the positive difference will be refunded in three-year intervals. This is a far-reaching revision. On the one hand, producers may currently deal in the surplus until the end of the support period and lawmakers do not require any payment security. On the other, given that most RES plants are financed by banks – which require the difference between the auction price and the market price to be deposited to a special account – this change may be for the better. Producers will be able to write off the loss arising from the refund of the surplus after each three-year interval for tax purposes.

The fourth is the amendment of zoning regulations. The size of plants which need to be included in a local spatial development plan (location area and protection zone) will be increased from 100 kW to 500 kW. On low-class land (class V or higher), such areas will only have to be designated for plants of 1 MW or more. A crucial thing for rooftop photovoltaic installations is that no location area and protection zone will have to be designated for them, no matter the installation size.

Energy Act

The amendments to the Energy Act are even more far-reaching. The major amending act was passed without parliamentary quarrel in April and was at the legislative stage in the Polish senate at the time of writing. Since there is no dispute over the need for the overhaul, its signing into law by the Polish president seems to be only a matter of time.

The amended law is designed to embrace so-called smart grids, and more specifically – to oblige the power market players to implement smart metering technologies. According to the legislative

proposals, the distribution system operators (DSOs) will be obliged to replace traditional power meters with smart meters, which read the actual use or production of electricity from a single source with 15-minute accuracy. The new laws will bring a new body to the market; namely, an energy market information operator who will be responsible for the management and administration of the central energy market information system and for processing the data gathered in that system for the energy market processes. The DSOs will be obliged to replace 80% of conventional power meters with remote devices by the end of 2028. Smart metering aims to better manage the power grid and react faster to any overloads, which may improve the grid's "traffic capacity" and allow the connection of more RES plants.

One of the most important updates deals with energy storage. The explanatory notes to the bill say that it introduces comprehensive solutions for the functioning and development of power storage systems. The lawmakers have clearly emphasized the need to develop storage technologies, saying that "the wide-scale power storage will be key to improve the power generation system, especially by allowing absorption of greater power output from renewable energy sources and improving security of electricity supply."

Above all, the distribution and transmission fees have been sorted out. At present, whenever a storage system takes electricity from the grid and later feeds it to the grid, the system owner pays the distribution fee twice. Following the amendments, the fee will be payable for the balance.

The licensing of the energy storage business activity will be regulated as follows:

1. Energy storage systems of up to 50 kW will not need to be registered at all;
2. Energy storage systems from 50 kW up to 10 MW will have to go through a relatively easy registration procedure with the power storage databank;
3. Energy storage systems of more than 10 MW will need a license for commercial operation.

Lawmakers have also proposed reducing the fee for connecting energy storage to the distribution/transmission system to half the actual costs of connection, as is the case with RES plants. The processing of the application for connection will, however, require an advance toward the connection fee, which will amount to PLN 30 ($8) for every kilowatt of connection power. This system has been used for the connection of RES plants for years. Furthermore, the amending bill introduces a definition of energy storage as a system that allows storing and feeding electricity to the grid.

It is also noteworthy that the bill is supposed to regulate the power recovery and reuse area by introducing a simple and effective system of accounting for electricity based on the difference between the amount of electricity taken from and returned to the grid. The bill also regulates the legal aspects of the so-called "closed distribution systems" – that is, electricity distribution within certain areas such as large manufacturing plants, special economic zones, shopping and office centers, by waiving some of the obligations which would otherwise apply as if they were standard DSOs.

PV auctions

Last but not least, I would like to mention that two auction rounds dedicated to electricity from photovoltaic plants will be held as soon as this June. Photovoltaic projects larger than 1 MW will compete with wind farms for auction support on 8 June. PV plants of up to 1 MWp will bid, mainly against each other, for support three days later. Hints from government circles suggest that some additional auction rounds for photovoltaic and wind projects may be held at the end of the year. pv

Piotr Mrowiec

Photo: IBC Solar



A solar installation on an apartment building in Poznan, Poland. The Polish authorities will likely introduce new regulations for renewable energy in the coming months. The new rules will simplify the process of commissioning solar PV plants smaller than 1 MW.



About the author

Piotr Mrowiec *is an associate partner at Rödl & Partner and the head of the Gdansk office and its renewable energy team. As a specialist in renewable energy sector regulations, he advises numerous clients and conducts legal due diligence for wind and PV projects. Mrowiec has been involved in studies for dozens of wind and solar projects, with a total capacity of several hundred megawatts.*



ROUNDTABLES EUROPE 2021

Cornerstones for the solar energy revolution

JUNE 9 - 10, 2021

Join us for two days of high-quality content and networking opportunities with top industry players

With the deployment of solar in the markets of Europe hitting an inflection point, now is the time to ensure that the industry is built on sound foundations. pv magazine's 2021 Roundtables Europe program addresses the cornerstones that will define the industry as it cements itself as a key pillar of the continent's energy transition.

The program reflects both the importance and multifaceted nature of this, addressing four themes relevant to how solar can reach its potential and deliver on its promise over the next decade. These cornerstones comprise the streams of the Roundtables conference program: Quality, Asset Management, Sustainability and Made in Europe, and Innovation hub: hydrogen, battery storage and EV.

MEET YOUR TALENTED PV MAGAZINE MODERATORS AND PROGRAM CURATORS!



Michael Fuhs
Head of Editorial



Jonathan Gifford
Editor in Chief



Marian Willuhn
Editor

Day 1 – June 9, 2021

10 am – 12 pm (CEST) | Berlin

Cornerstone 1 | Maintaining quality alongside rapid technological development

We will look inside large-format modules to get a better understanding of the technology risks they pose. You will hear from leading solar experts as they share real-world testing data to learn what faults can occur. During the session, attendees will also hear about efforts being taken to reduce these technology risks, and how this risk can be managed. Looking beyond components, this Roundtable session also takes a holistic approach to quality. Much of the anticipated solar boom in Europe will be driven by decarbonization and post-pandemic reconstruction efforts – pursuing the goal of "building back better." Tune in to inform yourself as to the risks and opportunities posed by high powered modules, and an update of all developments relating to solar component and project quality in 2021.

2 pm – 4 pm (CEST) | Berlin

Cornerstone 2 | Due diligence: Financial, technical, and contractual perspectives of an evolving industry

Preparing for new sustainability rules, handling old assets, and de-risking new ones. This year's asset management cornerstone of our Roundtables Europe takes due diligence processes into focus.
At the EU level, a new directive on sustainable finance, the ESG taxonomy, has caught the attention of project developers, asking themselves whether PV assets automatically qualify as a sustainable asset class. Moving from financial to technical due diligence, we also look at the documentation and checks required before final commissioning. And with an eye on Europe's aging solar fleet, we will discuss whether revamping or continuing with the old modules is the right choice. Apart from modules, there are also many inverters that need replacing. When, why, and how remain contentious questions in the industry, which we will discuss.

Day 2 – June 10, 2021

10 am – 12 pm (CEST) | Berlin

Cornerstone 3 | Sustainability & Made in Europe PV: Pros, cons and opportunities

Take part to learn about the future for solar manufacturing in Europe and whether a competitive supply chain can be fostered on the continent. The traceability of solar components fair work practices has emerged as a "hot button" issue within the PV industry in 2021. Can calls for greater transparency and sustainability in PV production enhance the value proposition presented by European PV manufacturers? Technology, as always, is likely to play a role in the evolution of the European solar production landscape, as too will finance. Which technologies could provide opportunities for solar manufacturers in Europe and how can the new capacities be financed and supported by policy measures? Join the experts from the solar analyst community, PV manufacturers, equipment and materials suppliers, and the EPCs and developers who are looking to install homegrown solar products.

2 pm – 4 pm (CEST) | Berlin

Cornerstone 4 | Innovation hub: hydrogen, battery storage and electromobility raise new opportunities for solar companies

In the past year, we've seen a series of game-changers in technologies and markets which are closely entangled with the deployment of solar. These include real hydrogen projects coupled with solar in Europe, some evolution in European battery storage markets, and the integration of electric vehicles into the grid. In this session, we showcase the frontrunners of these developments and discuss short and mid-term market opportunities and risks. We'll look at some co-located solar and hydrogen projects in the Netherlands and in Portugal, how they deal with the regulatory environment, and how this is expected to change. Looking at battery storage, we've invited leading industry experts, analysts, and scientists to discuss which amount of battery storage will be necessary and possible in which segments during the energy transition, and what the booming US storage market can teach Europe.

MORE DETAILS ON THE EXPERT LINE-UP ON OUR EVENT WEBSITE

pv magazine roundtables

NETWORK ACROSS THE CONTINENT!

Registration for our Roundtables is already booming with more than 1,800 registrations from over 100 countries. Our program might be focused on Europe, but we are looking forward to welcoming people from Germany to Qatar, from Spain to the USA, from Sweden to Sri Lanka, from France to Zimbabwe.

REGISTRATION FOR OUR VIRTUAL ROUNDTABLES IS FREE OF CHARGE

Alongside the curated main stage program with live Q&As, our global attendees have the chance to meet the expert speakers, as well as representatives from across the solar and energy storage industries, in targeted networking sessions.

Our Global team of veteran editors is looking forward to discussing the burning topics of the European PV industry with you in designated English, German, French, and Spanish networking rooms:

6 English Networking sessions

June 9 - 10
at 8 am –10 am, 12 pm – 1 pm & 4 pm – 5 pm*

Moderated by pv magazine editors Becky Beetz, Mark Hutchins, and David Wagman

4 German Networking sessions

June 9 - 10
at 8 am –10 am & 4 pm – 5 pm*

Moderated by pv magazine Germany editors Cornelia Lichner and Sandra Enkhardt

2 Spanish Networking sessions

June 9 - 10
at 12:00-1:00 pm*

Moderated by pv magazine Spain editors Pilar Sanchéz Molina and Emiliano Bellini

2 French Networking sessions

June 9 - 10
at 12 pm – 1 pm*

Moderated by pv magazine France editors Gwenaëlle Deboutte and Joël Spaes

*All times are shown in CEST, Berlin

PV MAGAZINE ROUNDTABLES IN A NUTSHELL:

- Two-day high-quality program, fully digital
- 1,800+ registrants
- 50+ speakers
- Solar heavyweights
- Targeted networking
- The burning topics that are lighting up the industry

PARTNER INTERVIEWS

Catch up with key speakers ahead of our Roundtables inside this very edition: On p. 50, DuPont Photovoltaic Solutions' Stéphan Padlewski introduces the company's latest innovation – a repair tape for damaged backsheets. And on page 98, Christian Pho Duc, CTO and managing director of H2 projects at Smartenergy, offers an update on green hydrogen production in Europe.

pv magazine roundtables

OUR PARTNERS IN 2021

Networking Partner

FIMER

Platinum Sponsors

DUPONT

GOODWE YOUR SOLAR ENGINE

GROWATT

JinKO Solar Building Your Trust in Solar

SMARTENERGY

Gold Sponsors

Ariel Re

BayWa r.e.

BELECTRIC

COOLBACK

coveme THE VALUE OF INNOVATION

Enapter

LONGi

maxeon

meteo control

MEYER BURGER

nextracker A Flex Company

RECOM TECHNOLOGIES

shoals

STÄUBLI

STS Beyond Inspection

VON ARDENNE

Silver Sponsors

ampere.cloud

BERLIN PI Trusted Solar Advisors

SENS STEAG Solar Energy Solutions

solaredge

Making sense of new sizes

The era of large modules has arrived, but it shouldn't be assumed that this will immediately make projects more profitable, argues Steven Xuereb of engineering service provider PI Berlin, as he compares different module size options for a current development project.

Last year's SNEC trade show saw the unveiling of large PV modules from most module suppliers under the headline "Bigger and better."

Modules based on the 182 mm and 210 mm wafers were introduced and brought into production by the seven top suppliers. They already made up 28% of the manufacturing capacity in China by the end of 2020.

Wafer size directly correlates to module size, as panel suppliers are using the same number of cells or half cells as the previous generation. Based on the current modules on the market, by using these larger wafers, the modules increase in the range of 11% to 81% in area, and by 15% to 84% in power output.

Many articles, webinars and presentations have since been dominated by claims from module suppliers that large modules will lower balance of system (BOS) and land costs and as a result, improve on the levelized cost of electricity (LCOE) for PV plants. So where are we today? What are the factors that developers, investors, and EPC contractors are considering about projects with large modules?

The first quarter of 2021 has seen an upward trend of module prices and shortages in supply – something not seen by developers in years. Some solar developers have been forced to delay their projects as long as possible in the hope that module prices will come back down by the end of the year.

As of March 31, 2021, larger modules made up 36% of production and the forecast is that they will reach more than 60% by year end. Projects that have shifted into the fourth quarter or 2022 will likely be presented with large modules as the best price and availability option.

Design parameters

PI Berlin was recently contracted to conduct a preliminary design for a large utility-scale PV plant, such that the developer was able to go out to tender to EPC contractors. The objective was to find the optimum design to produce the lowest LCOE within the project boundaries, such as land and grid constraints.

One of the first decisions to be made in such an exercise is the selection of the solar module type and format, as this affects all the next steps, such as the string configuration, table arrangement, and inverter sizing.

Since the project is planning to go into construction at the end of 2021, it was agreed with the customer to consider large modules as an option. The next steps involved the design optimization process, where the risks and benefits of this decision, based on our previous experience with earlier generations of PV modules, were assessed.

> *"Projects that have shifted into the fourth quarter of 2021 or 2022 will likely be presented with large modules as the best price and availability option"*

The results of this assessment were then presented according to the key parameters that influence the LCOE optimization process.

Land use

One of the main selling features of large modules from suppliers is the potential to have higher power density in a PV plant – meaning that more power is installed on the same or smaller area.

In fact, since the cell efficiency improvement with large modules is relatively insignificant at this time, the dimensions of modules have only increased proportionally with the increase in power. Whether there will be actual land savings depends greatly on the module arrangement and mounting structure design.

Another aspect to consider is the building permit, which may have restrictions in total height. This may also include environmental constraints that limit flexibility in one direction or another.

In this case, developers are also the landowners and have very minimal restrictions on the land. Therefore, the application of large modules is possible, but there will be no significant positive impact on the LCOE in terms of land-cost savings.

Electrical configuration

The increase in power of the large modules comes at either an increase in the V_{oc} open circuit voltage) or the I_{sc} (short circuit current).

"In the first case with higher voltage, the number of serial modules per string is reduced, which increases the costs for wiring, combiner boxes, inverters and other small components. Ultimately, the BOS costs increase," said Asier Ukar, a senior consultant at PI Berlin. "The second case with higher current makes it possible to connect more modules in series and reduce BOS costs – just the opposite of the previous case."

This is more noticeable in the case in which string inverters are used.

Photo: Longi Solar



Installers working an an array in the Netherlands featuring modules based on 166 mm cells. With the rapid switch to even larger wafer formats than this, EPCs will need time to adapt components and processes in order to offer the best prices.

"The higher current also has a negative side, however, due to increased risk of fire, increases in temperature in the junction box and connectors, which also leads to efficiency losses," said Ukar.

Another key consideration is the selection of the inverter type and their compatibility with the string electrical characteristics. By the end of 2020, suppliers of both central and string inverters made public announcements of new models suitable for the large modules.

In this particular design case, the decision was made to use string inverters due to the topography complexity. Assessing some of the string inverters on the market indicated that higher currents of the large modules limited the number of strings that could connect to the MPPT.

In the end, there was no significant improvement on the reduction of strings by using the large solar modules with higher current.

Mechanical arrangement

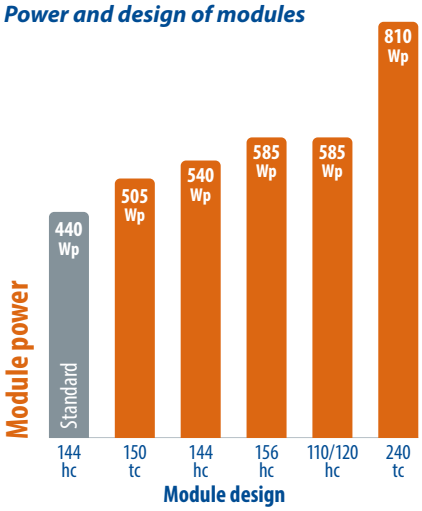
Early in the process, the decision was made to use a bifacial fixed mounting structure due to the land terrain and the irradiation profile. Determining the optimum module arrangement of a fixed

pv magazine roundtables

Steven Xuereb from PI Berlin is speaking at the Roundtables Europe virtual event on June 9. Sign up free at pv-magazine.com

"The remaining question is whether or not, and when, the promised cost benefits of this strategy will be realized"

Power and design of modules



mounting structure is dictated by a number of factors, such as pitch and tilt angle, but the larger module dimensions bring another aspect to consider.

Discussions with mounting structure and tracker suppliers certainly confirmed that products are available on the market to account for the new module dimensions. That said, due to the form and weight of the various types on the market, there are different loading and installation considerations to look at.

To get feedback from the market, German EPC contractor Bejulo was approached. Bejulo is currently building plants in the Netherlands and Germany.

"We have been able to use 182 mm wafer modules with our standard 3p [three modules in portrait] structure with just different clamps," said purchasing manager Sven Klosse. "The 210 mm wafer modules however would require us to move to 2p and may need changes to the structural design, because of potentially being subject to constraints in the building permit."

For the particular project in question, when looking at some of the larger and wider module types, wider strings were required, meaning more posts and leading to higher costs.

EPCs need time

The final main aspect to consider was the overall impact on the EPC pricing due to factors associated with large modules, such as installation costs. EPC installation teams have years of experience handling and installing modules in the field, making the process extremely efficient and cost effective.

The new generation of large modules present challenges due to their weight: One person can no longer unpack a module by themselves due to health and safety restrictions and limitations regarding how much weight one person can carry. The heavier loads also slow down the installation process.

"We expect some time for installation teams to gain the required experience with these new modules before we see any cost reduction in the installation," said Bejulo Managing Director Marin Görner. "We are also hoping for some standardization regarding the size and weight of the modules to maintain the flexibility we need to offer the best pricing."

Best options

In the end, on this project the customer had two design options for them to go to tender for the EPC contract. One has a 166 mm wafer PV module with a fixed 3p design and the other a 182 mm wafer with a 2p design.

The LCOE calculation assumed slightly higher installation costs, together with a reduction in BOS and module costs for the 182 mm wafer and 2p design – these assumptions led to slightly better LCOE results. However, the resultant lower LCOE is strongly dependent on the EPC contractor's costs related to the BOS and installation.

A set of technical requirements to be included in the EPC tender process was provided, and subsequently, for the EPC contractor. These focused on the extra diligence needed to be considered with the large modules in terms of safety, reliability, and performance.

And the end result? The question is not whether large modules will take over the market. They have arrived, and if a developer wants the cheapest module as quickly as possible, most likely they will be offered such a module by the end of the year. However, the remaining question is whether or not, and when, the promised cost benefits of this strategy will be realized.

For this, it appears to be a case of wait and see, as the BOS suppliers and EPC contractors catch up on the learning curve to optimize their components and processes. pv

Steven Xuereb



About the author

Steven Xuereb *is director of sales and project delivery at PI Berlin. He is a renewable energy professional who has 20 years of experience in the wind and solar industries, developing projects and procuring equipment. At PI Berlin he is responsible for the sales and delivery of technical consulting services for PV power plants and equipment, from the development phase through operation. PI Berlin's focus is on independent quality assurance and risk management for its clients.*

meteo control

YOUR **SOLAR POWER MONITORING** SYSTEM CHALLENGES **SOLVED.**



Get ready for the global rise of photovoltaics with our independent cloud solution: professional monitoring, digitalized service management and reliable hosting of your data – enhanced by machine learning and AI algorithms.

Profit as an **O&M manager**, **investor** or **asset manager** from our wealth of experience and the systematic enhancement of our cloud solution. With our monthly releases, we optimize PV plant operation and secure yields while carefully serving the needs of our customers and the world market.

Unplugged

An O&M provider to a project in northern Germany has been left scrambling to acquire replacement connectors after a series of failures. pv magazine investigates the case and finds that it all could come down to a simple click (or was it two?).

When it comes to quality, it's often the little things that make a big difference. This has been the experience of independent solar engineering and O&M service provider Solartechnik Bayern and its proprietor, Christian Bieber.

Since 2017, Solartechnik Bayern has overseen the O&M at a 4.3 MW project in the German state of Mecklenburg-Vorpommern, approximately 250 km north of Berlin. The plant had been installed the previous year, and uses 250-270 Wp multicrystalline modules from a European supplier, utilizing six-inch cells, with three busbars and three bypass diodes.

The modules are equipped with one 4mm² male cable coupler and one 4 mm² female coupler – rather than a 1-1.5 meter cable on both sides of the junction box (JB), which is more commonplace. And while Solartechnik Bayern has experienced no issues with the modules themselves, it has encountered a problem that may seem minor, but has left the engineers scrambling for a solution.

"The [cable-connector] system is completely different to other systems," says Bieber. "I don't see a benefit and the bad thing is that if you don't have the specific connector for the JB, it is a major problem."

The reason Bieber and his team required the specific cable-connector product, is that over its years in operation, the park has seen multiple connector failures – primarily the result of them becoming



While power losses due to faulty connections may cause frustration, the potential for fire is a very serious issue.

unplugged or being insufficiently mated. The reason why these connector failures keep occurring is disputed. Solartechnik Bayern argues that for these connectors, an audible "double click" must be heard for both mounting clips to be in place. Usually, both mechanical connections click in the same moment – two clicks, but only one is audible because they are close together. Installation conditions also play a role here. In the case of this installation, the modules are just 50 cm above ground, limiting access for the technicians and, increasing the chance of problems.

The clicks should occur after a slotted torque wrench is used to tighten the cable screw nut, inserting the contact with a crimped connection. If, during installation, there was not a "double click," argues Solartechnik Bayern, then, the connectors are not mated – leading to water ingress and corrosion. "The mechanical connection is not done well with one click," says Bieber, "and if it opens a little, that is enough to make a gap inside and the JB can burn in this moment."

Responding to this claim, the cable manufacturer says the connectors in question are its "first generation" product, with over 50 million having been supplied for well over a decade. It disputes that a "double click" is needed in installation, although it acknowledges that two latches should be flush against the connector – something that is noted in the installation specification documents. It should, however, be observed that the documentation does not say whether latches should make an audible click.

The supplier's response to **pv magazine** reads: "This [double click] is unfamiliar to us. Our application specification indicates that a clear audible [single] click will indicate that the connectors are correctly mated." The first-generation connectors were replaced by the supplier in production a small number of years after this 4.3 MW plant in question was installed.

Ongoing service

Clicks aside, the cable and connector supplier also notes that no claim has been made by the module manufacturer in question with regard to such failures. It also says that the "few claims" it has received over the years, were "fully investigated with customers and determined to be due to improper handling or installation of the product."

This is of little use to Solartechnik Bayern, which did not do the installation and is now left working out how to provide ongoing O&M. And Bieber reports that he is running out of replacements.

Bieber claims that around 100 to 150 cables are needed each year for ongoing maintenance. Until 2021, he reports, the module maker provided replacement cables, for purchase, but that it no longer supplies them.

"There was an order of cable for an older type of junction box (without a complaint) some time ago," the module maker responds in a statement. "We could not satisfy the customer and supplied only part of the order; we wanted a safe remainder of stock for other customers." The module company has apologized if any complaint has been "overlooked" and says it is willing to work with Solartechnik Bayern on a resolution – through the filing of a comprehensive claim.

Having been briefed on this case, quality assurance provider STS notes that this type of "catastrophic failure" could have been avoided by "carefully" checking either, or indeed any, of the three elements that comprise a PV product: design, materials and process.

"It appears that somehow the procedure was not fully transferred to the installation team, and therefore not followed," says Frédéric Dross, the VP for strategic development at STS. "The objective of construction monitoring is to ensure that standard operating procedures for installation are carefully followed, by a qualified crew using the right equipment. This mistake in installation would have been captured during verification of the process of installation, if performed appropriately."

Dross continues, that by checking the STS database of millions of solar modules, it would have become clear that such a cabling solution was not prevalent in the market, and carried a higher risk requiring additional oversight such as construction monitoring. "An exotic component such as these cables, would have been flagged," says Dross.

Jonathan Gifford

Photos: Solartechnik Bayern



Christian Bieber of Solartechnik Bayern

pv magazine roundtables

This case study will be discussed at the Roundtables Europe virtual event on June 9. The objective is not to "name and shame" suppliers, hence individual component suppliers or manufacturers are not indentified. Rather, the aim is to spark discussion and to provide takeaways for event participants, readers and the PV community. Register for the Roundtables free at: pv-magazine.com

FPV's important role

Molly Cox details Wood Mackenzie's research showing that floating PV installations will continue to grow as the niche industry finds its large-scale fit with utility companies, large communities, companies, and municipalities – wherever the right waters are to be found.

The global floating solar (FPV) market has seen remarkable growth over the last few years, and it shows no signs of slowing. According to Wood Mackenzie's Global Solar Markets Service data, the global market is estimated to reach 1.6 GW in 2021, which is more than double the total installed capacity in 2020.

Although FPV will likely represent just 1% of global solar PV demand in 2021 – a drop in the bucket for global solar installations of 149 GW – the market is a promising one. FPV has an important role to play in the energy transition, as it presents an opportunity for solar markets facing challenges with traditional PV applications. As more countries commit to competitive solar and overall renewable energy targets, FPV will be key to meeting these goals.

China leads

China will dominate FPV installations over the next five years, with India and South Korea trailing close behind. Country-level targets, such as China's carbon-neutrality goal, South Korea's 9th Basic Plan, and India's 2022 solar installation target, will all contribute to growth in these countries.

Although Japan currently has the largest number of completed FPV projects of any country globally and will see high growth of FPV, projects are typically smaller, and therefore cumulative capacity is less than that of other countries in Asia. This is a trend that we expect to continue. Other parts of Asia – including Taiwan, Malaysia, Indonesia, Thailand, and Vietnam – will see FPV become huge growth markets this decade.

Outside Asia, the Netherlands will continue to lead the European FPV market through 2026, with other countries, such as France and Spain, expected to maintain a significant share of the European market by the same year.

While Asia and Europe are expected to hold most of the global FPV capacity through 2026, other markets will emerge over the coming years. For example, Israel had a record year in 2020 in terms of FPV installations and is likely to continue to be a strong FPV market participant in the Middle East.

FPV benefits

FPV installations won't work for just anyone. Most FPV systems are large-scale and provide solar power for utility companies, large communities, companies, or municipalities.

One of the biggest advantages of FPV is that installations don't need the large amount of land required by ground-based solar PV systems. Most of these installations can take unused space on bodies of water, therefore minimizing the impact on land that could serve another purpose in the future.

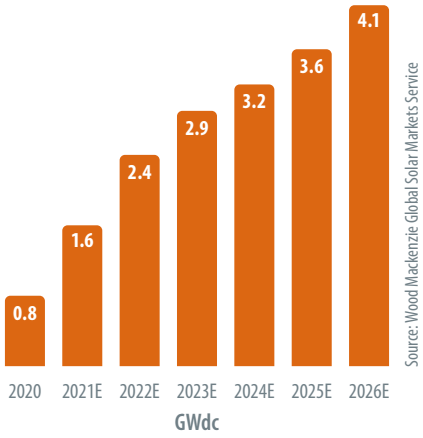
The bodies of water that host FPV systems help the array to cool down. This increases the efficiency of the solar modules in hot climates, which presents multiple opportunities around the globe.

Key challenges

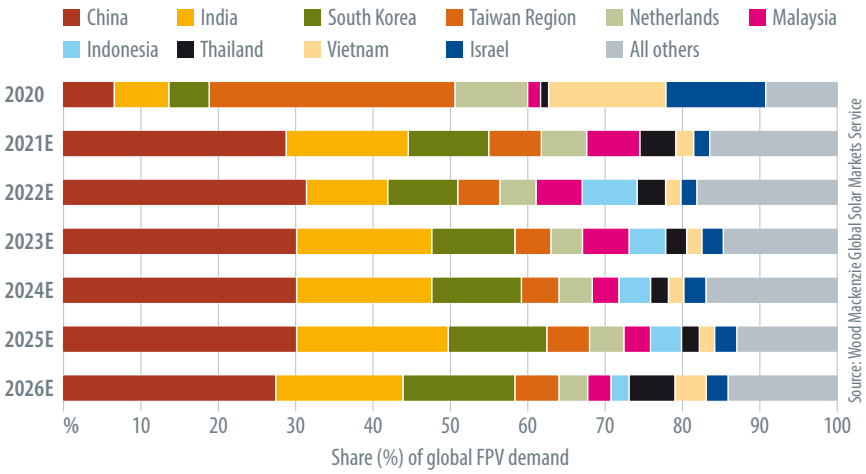
All-in costs for FPV applications are typically more expensive than ground-mount technologies of a similar size and location. This is typically because of high soft costs and the structural balance of system costs.

FPV system costs are highly variable by country and site. Japan continues to be the highest-cost market with average system costs of $2.68/W in 2021, while India currently has the lowest system costs of $0.78/W. While there are multiple factors that cause system costs to be high or low within countries, larger projects can typically take advantage of economies of scale for both component and labor costs.

Annual global floating solar installations (GWdc)



Global FPV demand by top 10 markets, 2020–2026E



Float maintenance

The ongoing maintenance of FPV is a key consideration for developers. Module failure rates may be lower due to water cooling on or near bodies of water, but maintenance costs for repairs and fixes may be higher due to a lack of access and longer periods when the plant is offline. Other decisive factors may play their part, too, as evidence of reduced water evaporation could be a significant benefit in water-scarce areas.

Although FPV systems are typically more expensive than their ground-mount peers, increased development and installation experience will contribute to reduced costs in the future. Average FPV project costs in South Korea, India, and the Netherlands are inching closer to ground-mount applications of a similar size. And in the Netherlands, average FPV costs are approximately 25% higher than ground-mount projects in 2021 – down from more than 50% in 2019.

Photo: Ciel & Terre



France's Ciel et Terre was one of the early leaders in providing FPV mounting structures.

With system costs coming in at

$0.78/W

India has achieved the lowest cost for floating PV so far

Floating future

As costs continue to fall, solar's share of power supply will continue to rise and begin to displace other forms of generation, according to recent Wood Mackenzie research. And this will only benefit the FPV market.

The confluence of land scarcity, country-level carbon-neutrality targets, and falling prices will all contribute to the growth of this niche industry. Given the higher cost of floating applications compared to ground-mount systems, financial incentives and government support are still crucial in most markets for floating solar to survive and thrive. pv

Molly Cox



About the author

***Molly Cox** is solar PV technology systems and operations analyst at Wood Mackenzie. Before joining Wood Mackenzie, she was an account manager at CivicSolar, helping solar PV installers design their systems and selling them equipment. Cox holds a bachelor's degree in global studies from Colby College, with a concentration in environmental studies.*

Advertisement





This 448 kWp FPV installation in Switzerland shows how solar developers can make the most of all available flat surfaces.

Floating up to standard

Floating PV is a growing market, especially in Asian countries with land pressures. However, like many promising niches, it is growing faster than the standards surrounding it. With installed floating PV capacity set to double in 2021, a raft of various and sometimes competing standards are being floated, but the question remains – what is truly the best way forward?

On the surface (literally), floating PV (FPV) is a great way of generating clean energy without taking up land. But that's only if the entire plant, from cells to cables, stays afloat.

Yet there are currently no specific standards for FPV, with existing projects constructed to terrestrial standards. The prevailing attitude, beyond the existing standards for terrestrial PV, seems to be "whatever floats your boat." But "whatever" isn't good enough when it comes to a nascent technology growing at the rate FPV is forecast to in the years ahead.

So, what should an FPV project be judged on? According to Michele Tagliapietra, a consultant at DNV and a project manager for the joint industry project behind the recent Recommended Practice (DNVGL-RP-0584) for FPV, "the top three components that should be handled with particular care … would be cables, mooring lines and the material of the floats themselves – with specific focus on the interconnection between the floats."

Power and water

Cable standards in water start the concerns. FPV in Southeast Asia has two primary concerns – water (from both below and above) and humidity. According to Jan Mastny, head of global sales for Studer Cables, "what is very important to say is that today's cable standards … do not consider any exposure to water or humidity." This means that cables do not have to be tested for their water and humidity resistance prior to installation. Mastny, an International Electrotechnical Commission (IEC) member, says that part of the problem is that the range of standards currently applicable to solar PV were made as long as 10 years ago, when FPV was little more than a curiosity.


Photo: Romande Energie

Lokesh Vinayagam, a research associate with the Solar Energy Research Institute of Singapore (SERIS) – where he is the O&M lead of the world's largest FPV test bed – told **pv magazine** that FPV currently follows the same DC cable standards used for terrestrial applications.

"For systems on water, the DC cable should be highly water resistant, and for certain installations (e.g. near-shore/offshore floating PV), even marine grade," he said. "Any unnoticed and continuous immersion in water for extended periods of time will lead to accelerated degradations and possible damages … this could cause the system to shut down."

Of course, whether it be a lower energy yield from degradation, or downtimes and replacements, the opex of inadequate components only increases.

"At minimum, cables for FPV applications should be highly water resistant," Lokesh said. This might seem pretty straightforward, but marine cables are often too expensive for FPV business models. "According to existing standards, PV cables need to be halogen-free," Mastny explained. However, "in order to replace the halogen with other additives" for FPV, he said, "compounds are being used that are highly hydroscopic" – which is to say, absorbent.

"The cable is actually behaving like a sponge," Mastny continued. "And it is only a question of time before the moisture gets to the conductor … and one of the first things the water does is increase the resistance in the cable, so if the conductor is exposed to moisture, it creates more resistance and the resistance is reducing the performance of the installation."

Leaving humidity aside, the cable material shouldn't matter if the cables are kept out of the water. Yet keeping cables out of the water isn't easy. "The standards today are actually contradicting each other," said Mastny. "For example, in the standard today, it is clearly written that the string cable must be flexible. But if you want to make a water-resistant cable you need a metallic layer as a protection, and if you add this layer, obviously the cable is no longer flexible."

Of course, when it comes to near-shore and offshore saltwater FPV (which are not covered in the current version of the DNV Recommended Practice, because wider commercial viability is still thought to be five to 10 years away), the demands are only intensified.

"The important difference," said Børge Bjørneklett, founder and CEO of Ocean Sun, a Norway-based offshore FPV outfit, "is the saltwater and the corrosive atmosphere, which put extra requirements on the power electronics." Therefore, "the challenge is to create a protective environment for the panels and the power electronics," and this requires the floating structure to be constructed with marine grade materials. "We use cable conduits in UV-resistant polyamide and have not had any problems," said Bjørneklett.

Staying anchored

For anchoring and mooring, FPV projects are very dependent on underground and underwater conditions. Taking the SERIS testbed in Singapore as an example, the water is, according to Lokesh, "relatively calm and doesn't induce much stress on the anchoring and mooring system."

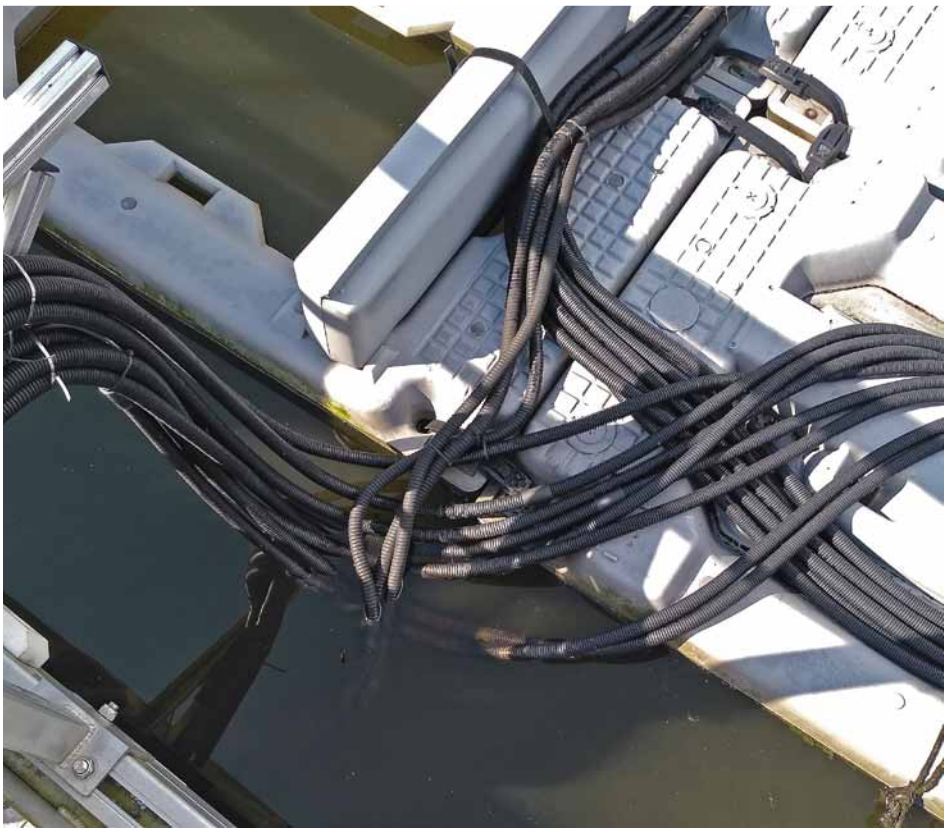
"Cables do not have to be tested for their water and humidity resistance prior to installation"

Photos: SERIS









Cables at the SERIS FPV testbed in Singapore demonstrate the occurrence of drooping and the impacts of the resultant degradation.

However, no FPV plant is motionless. Even in the relative calm of the SERIS Singapore testbed – as opposed to the much greater stresses of near-shore and offshore FPV – Lokesh said that all anchoring and mooring components receive regular checks for "corrosion, tension, and slackness." He added that "certified divers or underwater drones might need to be employed to carry out periodic inspections over the lifetime of the system."

Thankfully, when it comes to anchoring and mooring, there are other industries that have been doing it a lot longer than PV. And that knowledge can and is being transferred across.

"We need … a clarified and harmonious way of testing the float components and the connection between floats, because these are items that can cause problems in the long term," said Tagliapietra. The lack of specific standards, and the tangle of various local and national standards, is one of the reasons DNV produced its Recommended Practice.

"If every manufacturer will push internally to have a structure that complies to all its [the Recommended Practice] requirements, being stable, having enough space for walkways, being resistant to cyclic load, being fireproof, being resistant to UV … if they all comply then we believe FPV would be safer and more reliable in the medium and long term," said Tagliapietra.

Extraordinary environs

Putting a solar power plant on water is an extraordinary situation, and as such it deserves extraordinary standards. What needs to be done first is to acknowledge the problem.

The problems for FPV are twofold. Firstly, solar power plants are not naturally buoyant or at home in water. Only compromises can be made to get around this. And secondly, as mentioned, the standards which currently apply to FPV are terrestrially minded and therefore at least partly inadequate.

The ideal solution would be to redesign floating PV from the ground up, or rather,

from the waterline up. But as Mastny noted, the best we can do is to compromise. "We are converting PV plants, not building submarines," he said. As far as cables are concerned, Lokesh and Mastny agree that the best course of action is long-duration testing of water-resistance, cable management, and good O&M practices, so as to minimize faults and costs.

Of course, standards always move slower than the technologies to which they apply, and FPV is a young market in rapid development. But there is already movement on this front. While work on an international floating PV standard is underway in the IEC (driven in part by SERIS), Lokesh said there is no need to reinvent the wheel.

"The approach is to focus on topics that are different for floating PV as compared to ground-mounted installations. Also, we are looking at adjacent standards, such as marine electrical standards which we can apply to FPV," he said.

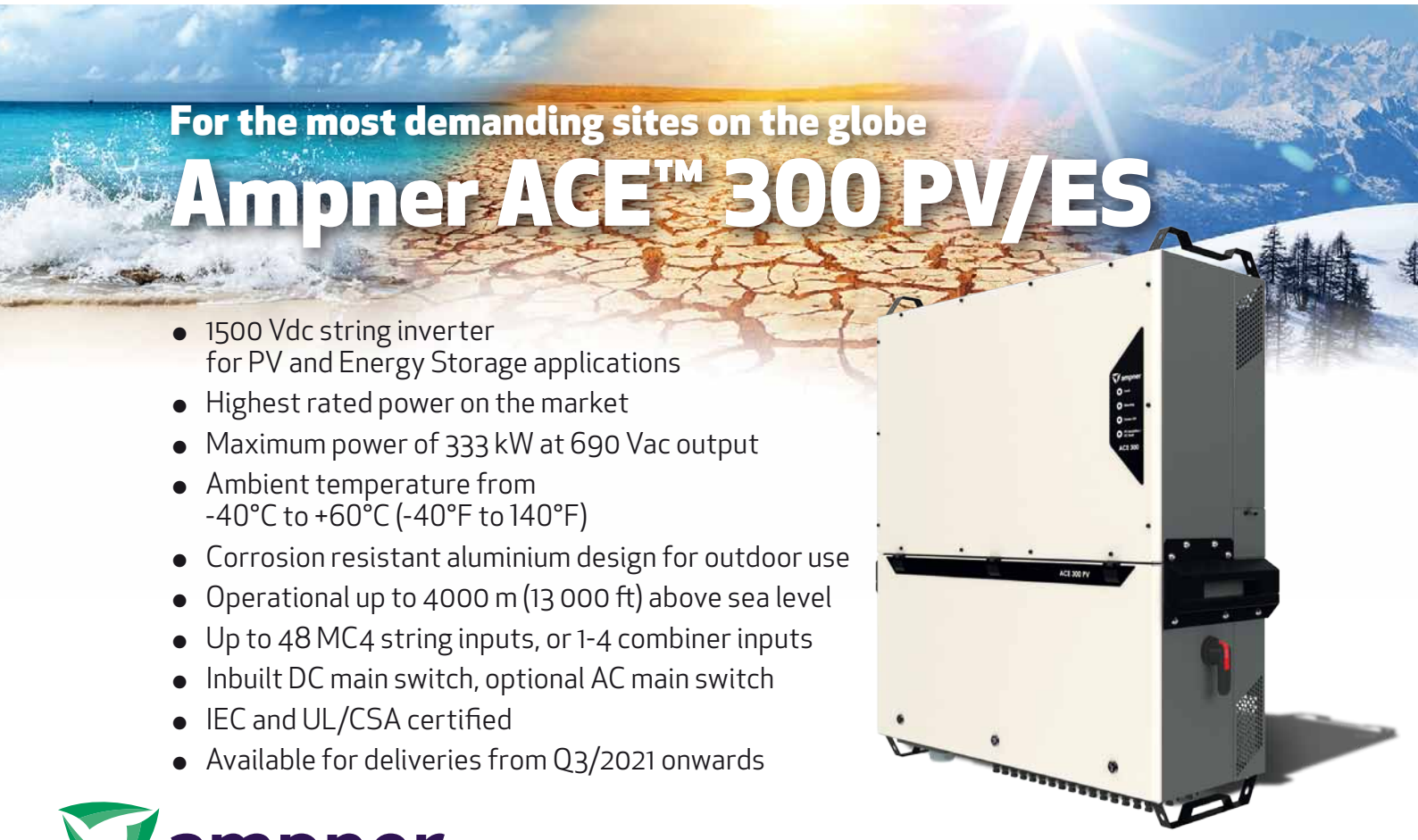
Bjørneklett looks at FPV standards in a similar way to Lokesh and DNV, and also with relation to maritime standards. "Traditionally, the insurance companies and financiers will turn to the classification societies, certification bureaus, etc., and ask them for third-party advice. This is how it's done in other maritime industries and works well for all parties. The classification societies have long experience in calculating the risks based on sound engineering analysis."

> *"Standards always move slower than the technologies to which they apply, and FPV is a young market in rapid development"*

Mastny, on the other hand, looks to the big EPCs as drivers of change. "The EPCs are those who can directly influence the specification of the product – nobody else has the power," he said. "Sometimes I have the impression that EPCs are not utilizing their power for enough benefit." pv

Blake Matich

Advertisement



Your solar+storage business plan

With many developers now working on solar+storage projects, it's time to look more closely at specific business plans. Siobhán Green, lead on battery storage in continental Europe for Everoze, looks at three key questions.

Developers frequently ask us: Will the solar+storage market make money? How will solar and storage integrate? And is it bankable? In this article, we provide our emerging view on all three, with reference to the most common set-up: a large, front-of-meter project (i.e., not co-located with consumption) in a well-interconnected location.

The assumption is that storage stores excess generation during the day and exports it in the evening (peak shifting) when prices are higher per MWh (arbitrage). There is some mileage in this, especially where the generation would otherwise be curtailed and where subsidies are paid on the stored energy (the contract-for-difference type subsidy scheme in France, for example).

However, with today's electricity price spreads, returns from capturing otherwise curtailed energy and/or price arbitrage are insufficient to justify the cost of a battery. Intraday price variation is likely to increase and a "duck-curve" could emerge in prices, but we are still many years away from seeing real value in this, and it is only likely to feature in a business model that goes beyond a PV subsidy scheme. Therefore, the dominant revenue for the storage part of the asset will be ancillary services.

If the battery is not being used to store PV generation, why co-locate? The opportunity in co-location is not so much a revenue opportunity, but an opportunity to make savings on capex and opex.

Capex savings of co-location mainly come from sharing a grid connection, with a PV project rarely exporting at its full grid capacity. For example, in mainland France, adding a storage system with 20% of installed PV capacity could have no impact on PV exports, while only limiting the operation of the battery <5%. Today this is significantly more cost-effective than paying for a larger grid connection.

Where grid charges apply to storage sites, they can be the single biggest opex line item for a standalone storage project. Co-location with generation can, in some regimes, significantly reduce this. Overall, a business model incorporating solar+storage should be designed to benefit from capex and opex savings, rather than to capture peak shifting revenues.

Integration issues

Today, solar+storage is simply connected at the AC-side, usually at the MV switchboard. But technology exists for these assets to be connected at the DC side – also called "DC-coupling." In this case, the PV and battery share an inverter, with the batteries connected through DC-DC converters or optimal voltage-matching. A shared inverter and transformer means fewer electrical balance of systems components, and so lower capex overall.

Where PV is charging the battery, DC-coupling has the advantage of reducing capex and also reducing conversion losses on the storage. However, where the battery is used for ancillary services, there are some hurdles to cross in a DC coupling arrangement. DC-coupled solar-storage interconnection is nascent, and there are some concerns with inverter/DC-DC converter systems' ability to meet the speed requirements of some ancillary services. Also, regulators need to determine if and how DC-coupled batteries could participate in ancillary services.

It seems likely the industry will move to DC-coupling as the technology matures.

Permian Energy Center, a project comprising 460 MW of PV capacity and 40 MW of battery storage, was connected to the grid in Texas in May. Projects combining both solar and storage are increasingly on the radar of developers, but combining the two is not without challenges.



Photo: Ørsted

Project finance

PV and lithium-ion batteries are both in themselves financeable. What is difficult to finance is the project revenue streams.

A typical solar+storage project has a 20-year off-take contract for solar generation, but no long-term contract for the storage, making it reliant on merchant markets. Merchant markets are not necessarily a barrier to financing – most non-renewable generation projects are merchant. But what is difficult for financiers is that there are multiple markets for storage services, most of which are limited (risk of saturation) and at risk of regulatory changes. It's easier to quantify the downside risks to today's markets than to quantify the value of tomorrow's new markets, and this means that a "downside case" can look unrealistically "down."

But let's think about how you actually model revenue. Without grid constraints, the revenue model can be "simply" the sum of revenues from both assets. But if the grid limits operation of one or both assets and/or the battery needs to charge using excess generation, then a time-domain model fits. Within this model, an operating strategy needs to be defined covering how the battery selects the best revenue stream and manages state of charge, and this can be complicated if overlapped with price forecasting and bidding strategies.

Certainly, a simplistic model won't optimize revenues. But without established norms, project owners should be careful of complexity when seeking project finance.

The value of optimization, particularly from arbitrage between markets, has a higher uncertainty than the revenue from each market independently, because it is dependent on the accurate forecasting of individual data points, rather than these being averaged out over time.

While debt financing of standalone storage projects is still rare, a solar+storage project is better adapted to debt financing because of the security of revenues from the solar generation. Also, where projects economize on capex and opex through co-locating, the IRR of the combined project can be better than the IRR of either asset in isolation, making the asset more financially interesting. pv

Siobhán Green



About the author

***Siobhán Green** is a partner at Everoze, a technical and commercial energy consultancy specializing in renewables, storage and flexibility. Siobhán has a strong background in supporting the development and financing of storage and flexibility projects, with a particular focus on continental European markets.*

Advertisement



pv magazine roundtables

A PV band-aid

DuPont has developed a repair kit for PV modules with backsheet failures. Cracked and chalking backsheets can cause problems for solar project owners, but this could easily be addressed in the field without swapping out the PV modules. Stéphan Padlewski, regional marketing leader EMEA at DuPont Photovoltaic Solutions, spoke to pv magazine about how the solution works.

DuPont plans to launch a backsheet repair kit for modules in the field. What does it look like and how does it work?

Certain types of backsheet used by panel manufacturers are known to degrade in the field earlier than the expected lifetime of the PV system. To restore the electrical integrity of the PV panel, we have designed a backsheet repairing tape solution built upon a structure similar to Tedlar-based backsheet, with an adhesive designed to bond onto the underlying degraded backsheet.

DuPont has developed a specific Tedlar repair tape and teamed up with Suncycle GmbH and its subsidiary, sc-refit GmbH, who developed a robust application process designed to be compatible with on-site field intervention. First, the panels are dismounted and cleaned. After an inspection of the backsheet, the team uses a special device to apply the tape to the module. The edges around the frame and junction box are sealed before final inspection and remounting. The whole repair process is quite short – less than 10 minutes.

Can the repair kit be used only on polyamide, or on any type of backsheet?

The DuPont Tedlar PVF tape has been designed to use a thick rubber-based adhesive widely used in the construction industry – with a very long track record in the field. The adhesive is particularly well adapted to provide a broad latitude from the lamination processing standpoint – particularly relevant to bond over uneven, rough, and cracked surfaces. These include the type of polyamide-based backsheets observed in the field. Such adhesive can also be used to bond over "smoother" and cracked PVDF-based backsheet surfaces. The DuPont team and sc-refit are committed to keep optimizing the tape, and process, to reduce the application cycle time without compromising the performance of the solution.

The repair solution can be applied to all sorts of backsheets, but all types of defects are not necessarily repairable. For example, when the backsheet damage results from a different dysfunction, such as broken cells generating hot spots, then repairing the backsheet will not successfully solve the underlying problem of the broken cell. In this case, it is preferable to replace the panel.

Can O&M service crews simply buy the kits and repair the backsheets, or do they need special training? Or are specialized maintenance crews necessary?

The repairing process involves a combination of a pre-engineered repair tape and a robust application process involving a special repair device that has been designed by our development partner sc-refit. Despite the robustness of the tape and the process, the personnel involved need to be properly trained to initially conduct a technical assessment of the reparability at the panel level, and to then deliver a consistent application process to protect the panels durably.

At this point, sc-refit will be delivering the repairing services in the EU. However, we're also contemplating appointing additional accredited third-party service partners to accelerate the market introduction of the joint solution in the U.S., and possibly in India later. Only accredited partners will be granted the right to use the same tape and equipment package and fully trained by DuPont and sc-refit to ensure a consistent quality service.

How big do you see the market for your new product?

According to the DuPont field survey data, the majority of the polyamide-based backsheets will undergo catastrophic degradation over time, exposing over 10 GW of panels to such risk. For PVDF-based backsheets, the process of degradation is somewhat slower and may affect about 20% of the panels within their expected lifetime. But the market share of PVDF-based backsheets is quite large, exceeding 40% or so, as it keeps on being widely used by most panel manufacturers.

Considering the cumulative panels deployed in the field involving such backsheets, we may have over 60 GW of panels deployed. We estimate that about 20% to 30% of the

Photo: DuPont Photovoltaic Solutions



panels with backsheet level degradation cannot be repaired, due to corrosion or cell cracking, for example – so the actual and addressable market may be around 5 GW to 6 GW per year at this point, and will keep increasing over time.

Who would be your direct customers?

Initially, panel manufacturers will be on the front line, dealing with the asset owners exposed to the PV panel level degradations. In the absence of repair solutions, they have to engage in a long “dialogue” to determine the extent of the problem and consider the replacement of the panels affected. In most cases, replacement involves only a sub-set of the panels deployed at the PV plant – while panels with no degradation of the semiconductor will be kept in-situ despite their probable backsheet degradation over time. Also, the warranty terms typically do not take into account the panel dismounting and the cost associated with the redesign of the plant if a newer generation of PV panels is used to replace old ones.

Partial or complete panel replacement is not a good approach to all parties from a cost perspective – and may not eliminate the risks if panels with a similar bill of materials are considered for replacement. The on-site repair can address the PV panel manufacturer’s needs well by reducing their cost exposure while restoring the safety of their PV panels still operational from a power output perspective, extending their lifetime with minimal operational disruption of the PV plants.

From the asset owner’s perspective, repairing can also minimize the plant disruption and downtime associated not only with the dismantling and replacement of the panels but also the partial redesign of the plant that would be necessary with the use of newer PV panel generation.

Have you already been in contact with underwriters and lenders? Do they accept this as a low-risk revamping option for older arrays?

This may not be required as in most cases the cost of the repair will be supported by panel manufacturers, as long as PV panels are covered by warranty terms.

Interview by Marian Willuhn

pv magazine Awards 2021: Round two

Entries for the pv magazine Awards have continued to flood in. After the second of four entry 'windows' throughout the year, we have stacked up a total of 112 entries across all six categories. So far, these have come from 18 different countries, with 25% received from China, followed by 17% from Germany and 14% from the United States. We will be accepting new award entries once again in July, and the process of convening with expert jurors to narrow down the list is already underway.
Now we're ready to announce the first finalists for the Modules category (see pp. 62-63). Winners in all categories will be announced in January 2022.
In the meantime, lets take a look at some of the top entries received in the Inverters and BOS categories. In both of these segments, flexibility is the name of the game, as suppliers trial varying strategies to adapt to the wave of large-format modules. And we see plenty of adaptability, with inverter innovations focused on ensuring operations in tough high temperature conditions. BOS suppliers meanwhile are looking to make life easier for installers and operators, with a host of products promising speedy work on site, as well as AI solutions to take some of the work out of monitoring.



High-density stringing

Ampner – 300 PV/ES

This string inverter shines with versatility in its compact design. Available in four power ratings from 261 kW to 333 kW, this is currently the most powerful string inverter on the market.
A new architecture allowed its creators to achieve a very respectable power density of 2.5 kW per kilogram and around 1,100 kWh per cubic meter. This improves logistics, as the company says it can fit 41 MW worth of inverters into a 40-foot shipping container.
On the DC side, a maximum of 48 strings can be connected, with oversizing possible up to a factor of 1.5. With a rated input current of 345 A on the MPPT, the inverter is fit for big modules and, the only MPP tracker kicks into life at 978V and will continue to optimize through to 1300 V on this 1500 V inverter.
Coming out on the AC side are 252 A and 690 V for the most powerful model. The inverter's maximum rated efficiency was clocked at 99%, with the European weighting method reaching 0.4% below that. To accommodate utility-scale storage, each string inverter can be extended with a storage inverter unit.

Show me some flex

Fimer – PVS 10-33 TL

Fimer says its latest three-phase string inverter for the commercial and industrial installation segment has been optimized to meet the demand for flexibility in this market. Rooftops with odd shapes, carports, and tracker installations can all be accommodated with this device thanks to a large input voltage range and DC configurations. The rated input voltage sits at 1,100 V, though the machine has a startup voltage of just 250 V, with the four MPP trackers working between 460 V and 850 V. There are two MPPTs with 26 A input current and two more that can handle 22 A. The system will short circuit at 40 A, which will allow the use of big-wafer modules. Overloading of the DC-side is possible up to a factor of 1.45, and the inverter features and export limitation are designed to comply with regional feed-in regulations and grid code requirements. There is no need to hide with a 98.4% maximum efficiency and 98.2% after European weighting in terms of efficiency.



Easy on the grid

Ginlong – Solis-255K-EHV-5G-Plus

Rated at 255 kW, this string-inverter is one of the biggest in its class. Its 12 MPPTs can connect to 24 strings, which can deliver a maximum input current of 15 A before the machine short circuits. DC oversizing is possible up to 200%, and temperature derating will not affect yield before the thermometer hits 45 C. With an eye into the future, the engineers at Ginlong have equipped this inverter with two algorithms, a weak grid adaptive algorithm, and an active harmonic suppression algorithm. In markets where grid operators have curtailed PV production due to grid stability concerns, this solution could improve the situation. On top of that come the DC energy storage terminals featured in each inverter. They will support a 125 kW charge. The MPPT voltage range is rather broad from 580 V all the way up to 1,500V, and maximum efficiency is at 99% and 98.8% in the Euro-weighting method.



Big optimization

Kehua Data – SPI4167K-B-HUD

This central inverter with a power rating of 4.167 MW comes with three MPP trackers. The odd count results from optimizations made to work with high-power modules rated between 525 W and 660 W, its makers say. Block sizes and BOS cost can be reduced on the back of such optimization.

Other notable features include a maximum DC to AC ratio of 2.5, and there is no temperature derating until 50 C.

Intelligent forced air cooling and other clever design features are behind this achievement, and should leave the device well prepared for use in desert regions, and thanks to C5 corrosion protection, the seaside as well.

The inverter has a maximum of 30 string terminals and can handle a maximum input current of 5094 A.

Startup voltage sits at 985 V, with the efficiency being 99% or 98.7% in the Euro-weighting. Also, the inverter comes as a modular design to configure turnkey inverter stations at different power classes, and added storage if desired.



Going the extra megawatt

Kstar – GSM6250C-MV

Despite this central inverter's nameplate power rating being 6.25 MW, Kstar says it has been designed to deliver an extra megawatt, as long as temperatures don't climb above 25 C. And for as long as temperatures stay below 50 C, this inverter will provide its 6,250 kW.

To support the extra power, DC-side overloading is possible up to 180%. This 1,500 V central inverter features four MPP trackers which connect to 56 strings and optimize the yield between 900 V and 1,300 V. The maximum input current is 8,160 A, and on the AC side, it produces from 10 kV to 35 kV, if needed. Efficiency has been measured at 99%, with the euro-weighting method taking 0.3% off that. For hassle-free installation and O&M, this inverter comes as a turnkey power station housed in a 40-foot shipping container.



Higher and higher

Sungrow – SG125HX



Sungrow has updated its 125 kW string inverter to be better compatible with modules in the 600 W class, and according to its makers, its economics play out best if it is used in 1.6 MW to 3 MW blocks. With an ingress protection class of 66, it is more resilient against the elements than the industry average, and its C5 corrosion protection class allows for its application in coastal regions without any cause to worry.

Peeking behind its protective shields, we find six MPP trackers, each of which can handle an input current of 30 A split between two input terminals. The trackers also shine with a vast operating range from 500 V to 1,500 V.

With an efficiency of 99%, its high yields should keep the operator happy. And with the product weighing in at just 70 kg, installation crews will probably be equally delighted.

Another noteworthy feature of this inverter is the maximum operating altitude of 5,000 m, which is well above the industry average.

Tracking all day long

Sunways – STS -1K-3.3KTL-S



Starting at just 1 kW, this residential inverter is available in six different power ratings, with 3.3 kW being the most powerful of them.

As the startup voltage is 60 V, power production will begin fairly early in the day and continue late into the afternoon. The maximum input voltage is 500 V. The single maximum power point tracker will optimize output almost throughout this inverter's entire voltage range, from 80 V up to 450 V.

The maximum efficiency is at 97.5%, and the European weighted efficiency reaches 97%.

With an IP65 protection class, this residential inverter can also be mounted outside without cause for concern.

On the software side, the manufacturer says that the device can support the intelligent positioning of abnormal strings within an array, and it also features an integrated I/V scanning function to support fault detection.

One phase, two uses

Aiswei – ASW3000H-S – 5000H-S

This single-phase residential hybrid inverter is available in power ratings from 3 kW to 5 kW. The two MPP trackers do their job almost the entire day, kicking into life already at 100 V, and doing their bit until 530 V, just 20 V short of the maximum voltage on this inverter.

Efficiency is clocked at 97.6%, with the battery to load efficiency being 94.7%. The nominal battery voltage is 48 V, with the battery voltage range being 40 V to 60 V. The maximum charging current is 50 A leading to a maximum charging power of 2.5 kW.



In case the lights go out, this machine has an emergency power supply, which delivers 12 A and 2.5 kW in just 100 milliseconds. For 10 seconds, the emergency power feature can even manage a load of up to 3.5 kW.

Customize your hybrid

Ginglong – Solis RHI-3P (5-10) K-HVES-5G

Solis has entered the fray with a new three-phase hybrid inverter which features a roundtrip efficiency of 98.4%. Available from 5 kW to 10 kW in four versions, its two MPP trackers can take in four DC inputs at a maximum current of 26A, for larger modules. With its algorithms, this hybrid inverter promises versatility to make the best use of the battery by allowing to switch between modes such as self-consumption, offgrid, or time-of-use. With a switching time from grid power to battery power in case of a power outage of just 40 milliseconds, the inverter also offers an uninterrupted power supply. The PV to battery storage ratio is 1.6, which Solis says allows scaling the array for the best return on investment. The battery voltage range is said to go from 160 V to 600 V, with the maximum charge power being equivalent to the inverter's power rating. During backup power, the machine can almost double its output for one minute. The maximum charge current is 25 A.



Finalists & more

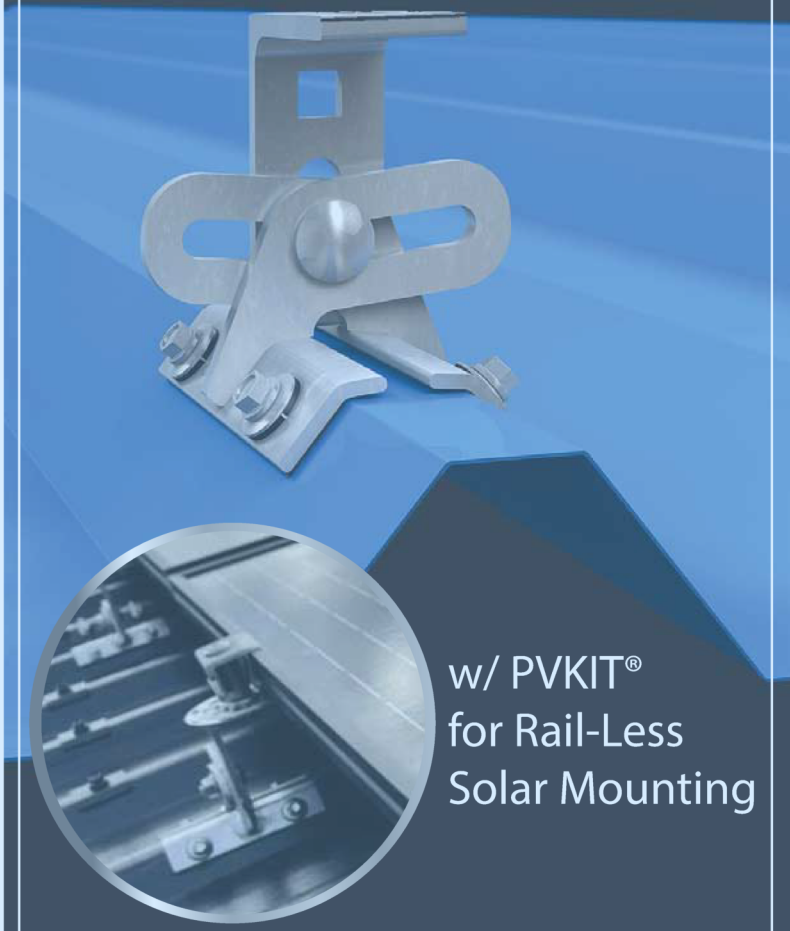
Keep an eye on our website & newsletters for **pv magazine** Award announcements: We will be accepting entries again for the whole of July, and will announce finalists for the categories featured in this magazine, as well as the first round of entries in the BESS and Sustainability categories, in our August and September editions. The overall winners will be announced in an Award ceremony set for January 2022.





Advertisement

ProteaBracket™
For Exposed-Fastened Metal Roofs



w/ PVKIT®
for Rail-Less
Solar Mounting

- **25%** less weight on the roof
- **(4) self-piercing screws** included
- **Adjustable**–fits rib profiles **up to 3"**

S-5!®
The Right Way!®

www.S-5.com

A fast switch

Infineon – EasyPACK 2B 1200 V ANPC, CoolSic MOSFET

Insulated-gate bipolar transistors, or IGBTs, are by far the most commonly used in the solar inverter industry. These switching semiconductors are the heart of an inverter, as they perform the job of switching the direct current generated in a solar cell into an alternating current suitable for appliances and the grid.

Metal-oxide semiconductor field-effect transistors (MOSFETS) like this one from Infineon are an alternative, used by very few companies so far. The MOSFETs allow higher switching frequencies, which leads to a better-quality sine-wave, improved temperature resilience, reliability, and reduced system weight. This MOSFET has an operating temperature range from -40 C to 150 C.

The drain-source voltage is 1,200 V, with the DC drain-current being 100A. If the switch comes in a three-level ANPC topology, it can handle the full 1500 Vdc voltage, as is the current trend in the solar industry.

With a design for a higher diode rating, this would also be a good option for storage applications.



No-fault design

IREC – Versatile and resilient power converter (CORV)

Faults and downtime of solar arrays incur financial damages to the owners, and keep grid operators busy, as unexpected downtime on a bigger array can lead to network problems.

To avoid this, researchers at IREC have created a prototype for a fault-tolerant inverter that will prevent any switching faults by its design. This has been achieved by a new internal configuration of the semiconductor-based switches. In case of a defect, the system reconfigures itself automatically to shorten the downtime and avoid a truck-roll.



Other approaches in the past saw redundant components being used, which drives costs up. According to IREC, capital costs would drop 40%, while the lifespan of inverters utilizing this technology would increase 50%. In terms of fields of application, this converter architecture can be used for solar and storage, wind, and electric vehicles, as its benefits of cost reduction and higher reliability would play out in all these fields. Especially in applications with high dependency and in remote areas, this solution would be very valuable.

The best of two worlds

Ingeteam – String Station

There are more power electronics than just the inverter. EPCs must procure AC combiner boxes, the medium voltage switchgear, a transformer, and some auxiliary components, as well. While for central inverters, turnkey power station solutions have long been on the market, Ingeteam is now floating the concept for string inverters, too. The components that are not a string inverter come pre-configured and assembled on a skid. According to the manufacturer, this saves installation costs and time. Also, the O&M job can be simplified as everything comes from the same supplier and has been designed together. The solution has been optimized for use with Ingeteam's Ingecon SUN- 160 TL string inverters. The inverters themselves will be installed across the field, as usual. The string station is available from 1.6 MW to 6.4 MW.



Balance of Systems

The first batch of BOS entries this year reveals a focus on installation speed among suppliers, with small yet significant innovations on show in connectors and cable management, alongside new solutions to handle soiling, cleaning and security. And of course, the industry maintains its focus on pushing solar into new areas, with innovations promising better yield in building-integrated solar, agrivoltaics, and floating PV.

Goodbye to gallops, farewell to flutters

Esasolar – Esa block

With its new anchoring solution, Esasolar promises to eliminate the risk of wind damage in tracker installations, without the need for stowing in less-than-optimal positions for energy generation. "Our technology allows the structure to follow the sun, but once it has reached its new position it stops and blocks itself as if it were a fixed structure," explained Esasolar Director Jose Maldonado. "This means it is always protected and safe, and makes the wind just one more environmental factor, but not a risk."

The Esa block system, according to its manufacturer, is compatible with any non-pendular tracker and can be retrofitted to trackers already in operation. It can be installed on all terrains on a north-south slope of up to 15 degrees. ESA Solar further notes that its solution offers protection at lower wind speeds which would not cause the panels to stow in other solutions, but can still lead to galloping and fluttering effects causing significant damage.



Closer inspection of soiling

Fracsun – Ares soiling loss management system

Fracsun's Ares solution applies artificial intelligence to calculating soiling losses and determining the most economic cleaning schedules. The solution comprises two reference cells, one of which is automatically cleaned daily.



The solution generates a daily soiling loss value through a comparative measurement of the clean and soiled cells. System owners or O&M providers are then able to sift through large amounts of soiling data to better plan their cleaning schedule. What is more, the data can also be imported into other monitoring platforms as part of a full understanding of plant performance.

Ares can also combine the soiling data with site-specific parameters like value of solar, cost of cleaning, weather forecasts, and more to calculate the best dates for cleaning – the system can provide asset managers with notification of when an array will require cleaning up to one year in advance.

Ares was developed out of the U.S. Department of Energy's solar technologies office, and has already been deployed to monitor more than 1 GW of operational solar projects in the United States.

A 50% yield gain for BIPV

ETH Zurich – Adaptive solar façade

With its adaptive solar building facade, ETH Zurich aims at offering both electricity generation and additional comfort for building occupants. The system comprises thin-film modules, which can be moved on two axes by soft material pneumatic actuators.

ETH Zurich says this means up to 50% more energy yield than a typical static building-integrated PV system, and the possibility to meet as much as 115% of the net annual energy demand for an office space.

Each module in the system moves silently on the actuators, and can be moved independently, allowing occupants control over light and shade in the room, as well as temperature.

A study published in *Nature Energy* has shown the system to be most effective in temperate, arid climates. Its creators also note that, though the full system weighs less than 10 kg/m², the actuators that hold the panels are robust enough to deal with wind and other environmental conditions.

As an example, ETH Zurich notes that the



system could have two rows 'open' to allow light into rooms, while others are set to track the sun for maximum yield. "Such a level of operational freedom makes the dynamic PV envelope an ideal system for balancing occupants comfort needs and energy savings," said ETH Zurich.

Keeping a hold on cabling

HellermannTyton – Ratchet P-Clamp

Cable management specialists HellermannTyton present their Ratchet P-Clamp, designed specifically for cable management in PV projects. From wire in transitions to end-of-row arrests toward the fixed posts, in both fixed-tilt and tracker installations, HellermannTyton's solution promises to keep cables under control for the project's entire lifetime.

The manufacturer notes that many PV projects built to date have relied on standard cable ties, which tend to fail and need replacement during the project's lifetime, particularly at arrest points. These can also



be a headache when it comes to required maintenance of the cables. The P-Clamp, meanwhile has proven to be effective at arrest points, and cables can be released from its grip with the turn of a flathead screwdriver, making cable access and maintenance or even replacement much easier.

When it comes to installation, the clamp is a single piece with ratchet closure, allowing easy installation in pre or final assembly.



Doubling up on land use

Montagebau Karl Göbel – GMS Double

The GMS Double mounting system brings a new twist to high density, east-west mounting systems – increasing the module height to target agrivoltaics and other dual-land use applications.

And the taller system, according to the manufacturer, also means no spaces between rows are needed for maintenance or other purposes – allowing even more generation capacity to be packed into an area of land.

With 3 to 5 meters between poles and plenty of headroom, agricultural machinery has room to operate underneath the mounting system. And when deployed in an east-west orientation, with the ridge spacing as well, the solution allows light to reach plants beneath.

The manufacturer also notes that the system can be optimized for south-facing installations, and layouts can be changed depending on the light or shade demands of different crops beneath. Aside from agrivoltaics applications, the system is also recommended for solar installations above animal grazing land, or storage space.

The system has already been deployed at two greenhouses in Büren, in western Germany. Semitransparent modules have been mounted to the structures, with planned gaps in order to additionally harvest rainwater to feed the crops – morello cherries and a variety of other berries.

Trackers go floating

SolarisFloat – PROTEVS floating tracking solution

Floating PV has grown steadily in recent years, and while much of the segment's recent focus has been on developing systems able to withstand the challenging environment of the open sea, Portugal-based Solarisfloat has opted for a different approach, adding single or even dual axis tracking to its floating mounting solution for inland water bodies.

As with land-based tracking solutions, the PROTEVS floating tracker promises as much as 30% additional yield thanks to keeping the panels facing the sun all day. Solarisfloat says that with its circular design and other architectural features the system can withstand waves of up to two meters, and wind speeds up to 220 km/h. The system is designed with gaps to avoid blocking all sun on the water, which the manufacturer says is an important environmental consideration for many projects. The solution is made of 100% recyclable thermoplastics, designed for at least a 25-year lifetime. The materials have additionally been tested against relevant standards for ecotoxicity and corrosion against salinity.



Advertisement



DG PV – straight out of the box

Soltec Solarfighter



With its new Solarfighter kit, Soltec says its aim is to bring technologies previously restricted to large-scale PV to the distributed generation segment. Designed for projects of up to 12 MW, the kit is an 'all in one solution' comprising module, string inverter, cabling, wind sensor, tracker, optional battery storage, and ongoing technical support from Soltec. The system is also supplied with Soltec's wireless communication system and backtracking algorithm, which it says makes the trackers up to 6% more efficient.

By offering an all-in-one solution like this, Soltec says it can greatly simplify the design and planning phases of a project, as well as reducing delivery times and labor requirements for installation. And the strategy, according to Soltec, also opens up access for smaller projects to technologies like trackers – which despite their potential for extra energy yield are largely considered viable only for large projects in markets with few land restrictions.

This in turn should boost the efficiency and profitability of smaller PV projects, further increasing uptake of renewables. Soltec also states that while its solution aims at standardization, it is also able to adapt to different environmental and regulatory environments, to provide the Solarfighters in many different regions.

Tool-free connections

Tyco Electronics – Solarlok 2.0

Tyco Electronics says that its Solarlok solution is the only PV connector on the market that can be installed without any tools, and by someone who is not a qualified electrical technician. Other connection solutions, says the manufacturer, require four to six tools and processes that are likely to damage the cabling in some cases.

Tyco estimates that with its solution, a mated pair of PV connectors can be installed in under 30 seconds, compared with over four minutes for conventional PV connectors. The connectors are also filled with a protective gel that prevents water or dust from damaging the electrical contacts, making the product suitable for harsh environments including floating PV installations.



The connector uses the industry standard insulation-displacement connection, and Tyco says that the gel solution has also been used successfully to provide waterproof connections in other applications. Solarlok 2.0 comes with IP 68 protection against liquid and particle ingress, is approved by TÜV and UL, as well as having a CE certificate.

Keeping an eye out

Viamon – Traps security solution



With reports of break-ins, theft and vandalism at PV installations all too common, security company Viamon presents a tailored solution combining cameras, various types of sensor, warning lights, alarms, and more.

The comprehensive security solution first aims to deter break ins with cameras, sirens and warning bars. Any attempted break ins are quickly detected by infrared sensors, which can be monitored remotely by Viamon.

The company further notes that many PV installatons thus far rely only on cameras for security, which have been shown not to be totally effective either as a deterrent or in detecting unauthorized entries to a power plant site.

Traps is installed based on a site specific assessment by Viamon, which says it can take into account the topographical situation and other factors to minimize the number of sensors needed, and ensure the system is as cost-effective and efficient as possible.

Viamon also works with various local security providers, who can be on site in minutes when an alarm is triggered.

Keeping it clean

Chemitek – Solar Wash Protect

Solar Wash Protect is a cleaning solution specially formulated for cleaning solar modules in the field, that promises to optimize all kinds of cleaning operations, and also reduce water consumption. According to manufacturer Chemitek, the washing solution has been tested by TÜV and approved by module manufacturers including JinkoSolar, Trina Solar, GCL and Longi.

The solution is suitable for all module types and all wet cleaning equipment. It is pH neutral and will not affect metal surfaces, sealing silicone or anti-reflective coatings.

It is also environmentally safe and biodegradable, with no risk to plant or animal life, or to water tables. Chemitek says it can even be used to clean floating solar installations.

The manufacturer says that its solution can help reduce both time, effort and water consumption in most cleaning strategies, particularly for installations dealing with heavy soiling rates.

"When cleaning manually, more scrubbing will be required, when using a robot several passes might be required, and when using a brush assembled on a tractor the speed of the tractor will probably need to be lower," Chemitek explained. "By using our Solar Wash Protect the cleaning efficiency will increase and therefore make the cleaning faster and use less water."

In manual cleaning, the solution is applied directly to the panel, brushed and then rinsed with water. For robot or tractor cleaning strategies, the solution can be applied ahead of cleaning to ensure no slowdowns or additional passes are required.



Advertisement

risen

550Wp

TITAN Series

The best choice

CONTACT US
WWW.RISENENERGY.COM

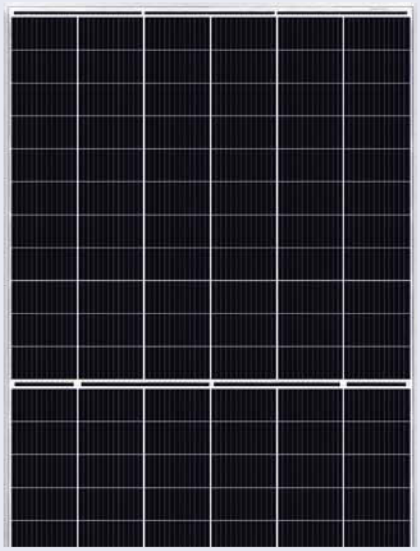
1H Finalists announced

It should come as no surprise that two large-format modules were selected as finalists from the entries in the Modules award category collected in the first half of the year. Notably, new BIPV concepts also impressed the independent jurors on their ability to accelerate deployment in this nascent but necessary market segment.

Selection criteria

- **Efficacy of the solution:** What problem does it solve for the industry? How well does it do this?
- **USP:** How does the approach differ from other solutions in the same market segment? How effective do you believe it is?
- **Economic feasibility and market impact:** How significant is the market impact and how does it contribute to reducing costs or improving quality in the solar/storage industries?

The most compelling technology does not always assume a dominant position in the PV marketplace. Various factors, largely economic in nature, must align for the widespread market acceptance of a technology to occur.
In 2021, it appears that the time has arrived for large format modules, and their 182 mm or 210 mm wafers, and this is reflected in the first batch of finalists that will go through for final consideration by the Modules jurors for the 2021 Annual Award.
There was a significant increase in the number of BIPV products entered into the Modules category compared to previous years, and two, in particular, piqued the interest of jurors. Potentially providing momentum to this promising yet hard-to-crack market segment, they address both aesthetic and deployment challenges to BIPV building facades. And the finalists are…



Canadian Solar

HiKu 7 & BiHiKu7

Canadian's HiKu7 (monofacial) and BiHiKu7 (bifacial) modules are big inside and out and can reach up to 665 W in power output, with a module efficiency of 21.4%. The modules use paving cell placement to pack in more cells, with heterotype ribbon (HTR) cell interconnection. And while the cell and module technologies incorporated into this new series are more standard than disruptive, the jurors could not go past the significant market impact the new powerful products are most likely to have.

Jay Lin: For me, as a technical guy, I'd like to see more breakthroughs, but I think as we are at the beginning of these new powerful modules they deserve a positive evaluation. It does represent a breakthrough as the wafer and module is a new design.
Pierre Verlinden: I think that it looks like there is no innovation, but there is quite a bit of innovation behind the large formats. Not only is there the big cell, but you can't put 210mm wafers into a module so you need to cut the cells in half or three, and to do that without killing the efficiency is a big innovation – as is the cell spacing.

Trina Solar

Vertex Series

The Vertex module series has a lot in common with Canadian's large format offering – the module efficiency is 21.4% with power output peaking at 670 W.
Due to Vertex's low voltage and higher module power output, Trina says that significant BOS savings can be made, resulting in lower LCOE: by 2-3% compared to modules using 182 mm cells.
In terms of the 210 mm wafer production, Trina says ingot furnace output is increased by 15%, slicing production boosted 5%, and cell line investment is 20% lower than for a 182 mm line, while line productivity is up 25%. The leadership shown by Trina and Canadian in spearheading these formats impressed the jurors – and is worthy of recognition.



Yali Jiang: The big modules do have a big market impact though the technology they use is very similar. Big volumes are expected, with Trina reporting that it has already secured more than 10 GW in sales.
Jay Lin: There are some concerns about transportation [of the large modules] or how the PV system can bear the weight. I don't see any problems with bankability as there isn't much difference between the traditional modules except for the cutting.

Hevel Solar

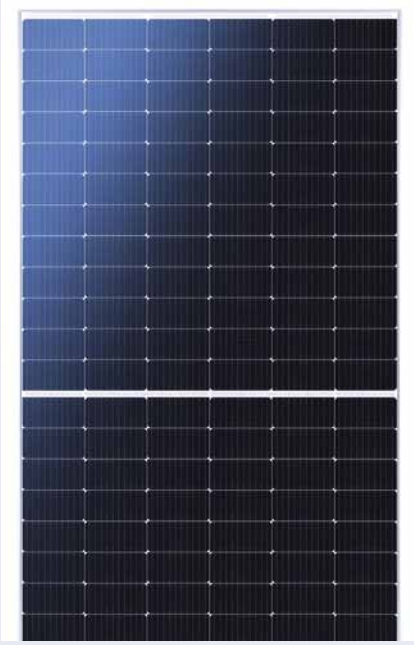
BIPV HJT module

Russian HJT module manufacturer Hevel has developed a building-integrated system involving a dual-glass module, which the company calls a "facing element", a "facing cassette" on which the module can be affixed, and a "rainscreen facade," including a bracket to affix the cassette onto the building. Hevel says that the front glass and frame can be ordered in over 100 colors which, along with an integrated mounting structure, could deliver on the dual requirements of the construction industry and architects: flexibility and standardization.

Pierre Verlinden: BIPV is a very difficult part of the market. As long as we don't have a standard product that everyone can use, like the 60-cell product that has the same dimensions, it's always going to be an expensive product and difficult for the traditional PV industry to be a part of it.

Jay Lin: What is missing in the market is how to use BIPV easily in combination with the current building technologies, and from this standpoint this solution is very good and it is easily used in construction. There should be more of this type of product.





Mitrex

Solar Cladding

The Mitrex Solar Cladding encapsulates monocrystalline PV cells in a tempered glass front sheet and a lightweight aluminum honeycomb backing. The company claims that a ceramic coating can be embedded into the tempered glass, allowing various colors and patterns to be added.

Mitrex claims to be currently supplying over 80 construction projects. Mitrex manages this under a number of models: the Mitrex Power Agreement, which is essentially a 30-year Power Purchase Agreement; a revenue sharing option, under which the cladding is supplied below market price, or a Direct Purchase Agreement.

Yali Jiang: It's not really new that you do leasing, like SolarCity used to do, but it is interesting to see how it will work as one of the two business models employed by Mitrex.

Jay Lin: The honeycomb substrate is not new, but no company has had success with it, so it's still new to the market. I also noticed that they have the special coating so that the module can take on a different appearance. For commercial sites this is a well suited product.

The Jury



Jay Lin – Chief Consultant, PV Guider

Jay is the chief consultant at PV Guider. He has more than 15 years of experience in photovoltaic research, production, and system integration. PV Guider is a consultancy offering quality assurance services for investors, insurers, and banks.



Pierre Verlinden – Founder, Amrock

Pierre is a veteran PV researcher, having carried out fundamental solar cell research at both KU Leuven and Stanford University. He has led R&D teams at SunPower and Trina Solar, the latter in the role of chief scientist.



Yali Jiang – Solar Analyst, BloombergNEF

Yali covers the PV manufacturing sector, tracking supply and price dynamics along the value chain. She also keeps an eye on technology trends that might impose near-term impacts. Yali started her career in a PV and battery firm in 2009.

China struggles with solar supply

Since July 2020, the PV industry has been experiencing price rises, which have affected almost all the components in a solar system. As these price increases spill out into higher installation costs, we see end user prices for solar rising for the first time in 10 years, threatening the competitiveness of PV in certain markets. Vincent Shaw reports from Shanghai on solar manufacturing's supply chain crisis.

It began last July, when an accident at GCL-Poly's factory in the western-most region of Xinjiang took a significant chunk of polysilicon capacity offline, just as China's PV supply chain was recovering from the initial chaos of Covid-19. Industry analysts quickly calculated the potential reduction, which would result in up to several thousand metric tons of polysilicon supply cut off in 2020. And at first, they believed it wasn't "a big deal," because the industry had already developed the capacity to withstand such accidents. As it turned out, this was just the beginning.

Most analysts were proved right about the GCL accident. It resulted in a slight rise in polysilicon prices, but they fell again within a few months and did not show any obvious impact elsewhere along the supply chain. Soon after this, glass took center stage in the price rise show. In the period from June 2020 to March 2021, the price for 3.2 mm PV glass almost doubled from CNY 27 ($4.20) to CNY 52 per square meter.

At the end of March 2021, glass prices suddenly slipped by more than 30%. But polysilicon, then, rapidly resumed increasing in price. Since February, prices for polysilicon have consistently grown – increasing roughly 100% in 100 days, from CNY 90/kg to CNY 180/kg. And this time, the reasons for the price rise are more complex than an industrial accident.

Bill of materials

As the fundamental material in the PV supply chain, the upstream polysilicon price determines downstream costs for wafers, cells, and ultimately modules. Wafer producers Longi and Zhonghuan Semiconductor, cell manufacturers Tongwei, Aikosolar, and Runergy have all raised their prices to transfer and release

Wind turbines in northern China. With prices going up across the solar supply chain, China's state owned energy enterprises are turning to wind rather than PV to meet their installation targets.



Photo: Land Rover our Planet

cost pressure downstream, to the PV module sector.

On top of this, several other components in a PV module bill of materials have raised prices since mid-2020. Silver paste, which accounts for around 10% of solar cell costs, almost doubled in price in August 2020 compared to the first quarter, due to a global silver price rise.

Prices for copper, used in connection cables, and aluminum, used in module frames, also increased by around 110% from low points last March. EVA films and polyvinylidene fluoride (PVDF), essential materials for module encapsulation, have also seen 200% price increases over the past 12 months.

Inverters, meanwhile, have been hit by a shortage of microchips, and mounting systems suppliers are struggling with rising steel prices. The extensive cost rise in so many links of the PV supply chain has resulted in rising prices for modules, pushing up the levelized cost of electricity at the project level.

Squeezed margins

Some have suspended project investments; waiting for prices to stabilize. The steep rise in module prices has left buyers worried that costs may keep rising to the point where prices at time of delivery exceed the contract price, putting the delivery at risk.

Insiders at China's major state-owned energy enterprises, the main investors in renewable energy projects in China, say many PV projects have been postponed, though development contracts are still in place. Many EPCs have also suspended project development because their profit margin was squeezed to almost zero.

There are three main reasons for the sudden price jump across the supply chain. One is polysilicon supply; now the biggest factor influencing the whole PV system. Current production capacity for polysilicon is much lower than for ingot and wafer demand. After a massive capacity expansion since 2019, ingot and wafer production capacity increased from 135 GW in 2019 to 161 GW by the end of 2020, and there's more to come, with further expansion set to happen in 2021.

However, China's polysilicon supply capability can only support around 140 GW, and supplies outside of China can meet another 20 GW of demand. This relatively short supply is the root cause of the price rise.

Photo: Daqo New Energy



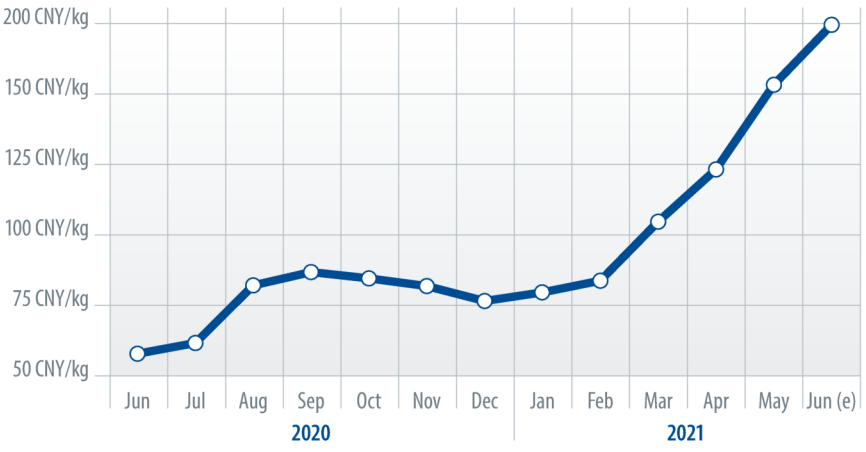
Polysilicon manufacturers have struggled to match the pace of capacity expansions further downstream, leading to constraints and rising prices.

Furthermore, polysilicon is highly monopolized by six domestic producers including Tongwei, Xinte, GCL, Daqo, East Hope and Asia Silicon. Especially Tongwei and GCL, which control the largest capacities, have strong abilities for price negotiation, and actually guide the polysilicon price. Downstream ingot and wafer products are, in the same way, monopolized by Longi and Zhonghuan Semiconductor. Cost pressures will transfer downstream, if the upstream players are not willing to reduce their profit margin.

The third reason is more like a "zero-sum game" played by the entire PV industry. Upstream suppliers have transferred cost pressure along the chain to the last manufacturer, the module maker. This segment, however, has refused to eat all

Polysilicon price (monocrystalline grade)

Source: PV InfoLink



Beginning in February 2021, polysilicon prices rose roughly

100%

in 100 days

the costs by itself, and looks to transfer price increases to its own downstream customers, including project investors. And this was a group the manufacturers had never considered upsetting before.

In China, the state-owned energy enterprises that invest in PV projects have installation targets that tie in directly with China's pledge to reach its carbon emissions peak by 2030, and to be carbon neutral by 2060. These investors know that reaching the target is more important than profit, and their upstream suppliers know this as well.

In mid-2020, rising glass prices squeezed module makers' profit margins. And they had no choice but to absorb the higher prices without increasing their own. But with the announcement of carbon neutral strategies, module manufacturers saw their chance.



Photo: Longi Solar

Cells at a Longi production facility. Shortages and rising prices for various materials essential to PV manufacturing have pushed prices up all along the supply chain.

By the end of November 2020, installations in China had reached only around 30 GW. But in December, new installations hit 18.2 GW. State-owned investors had realized they would have to compromise and accept higher prices to meet their targets, even if that means sacrificing profits. But this situation might not repeat itself in 2021, as China's state-owned enterprises are now turning to wind power to meet their renewable energy targets.

What about wind?

In contrast to the rising cost of solar panels, wind power continued its slow-but-steady price reduction throughout 2020 and 2021. In early May, for the first time China saw a wind power bid price of CNY 1.7 per watt in a tender of the State Power Investment Corp. (SPIC), almost equal to the lowest solar PV panel price at that time. Considering the much higher utilization hours of wind than solar PV, typically 1,800 hours versus just 1,250 hours for solar, the LCOE of wind power is now much lower than solar in China.

The country's SOEs take responsibility for installing renewable energy to help the country reach its carbon-neutral goal, but they are not limited to using PV. They will apparently turn to wind power to meet their renewables installation target and protect profit margins. Wind power installations reached a historic high of 47 GW in December 2020, almost double the total installation from January to November. The solution was already found.

The China Photovoltaic Industry Association (CPIA) has predicted this year´s annual PV installation will range between 55 GW and 65 GW. But without significant cost reductions of PV panel prices from their current highs, the downstream installation market will not accept the increased cost, and PV installations will be cut off. Bringing prices back down to those seen in the first quarter of 2020 will require the efforts of the whole industry, especially those polysilicon suppliers. PV

Vincent Shaw



NEXT GENERATION OF MERSEN PRODUCTS FOR EES SOLAR APPLICATIONS

DESIGN & INNOVATION FOR SAFETY & RELIABILITY

- Protection of DC fault current up to 50kA
- gBat fuses in compliance with new IEC 60269-7 standard for Battery protection



NH GBAT FUSES 1000V-1500V DC

- Surge Protection, IEC & UL
- 50kA DC fault current withstand w/125A NH fuse



SURGE-TRAP® PV-BESS 1000V-1500V DC

adncom.fr - 10568 - Mersen property

EP.MERSEN.COM

MERSEN
Expertise, our source of energy

New processes put TOPCon under pressure

Since the concept was first introduced by Germany's Fraunhofer ISE back in 2013, tunnel oxide passivated contact (TOPCon) cells have grown to become one of the biggest prospects for the industry to maintain a steady rise in cell efficiencies. Bringing this technology to scale, however, is not without challenges: Additional processing requirements, plus increased silver consumption, have kept TOPCon cell costs a little above where they need to be for mainstream production. pv magazine examines recent progress and the next steps for TOPCon cell production.

"That we still see very large PERC capacities being built suggests many are considering this upgrade route"

Further improvements to the current generation of PERC cell technology are becoming difficult to attain. And while larger formats have provided an alternate route to cost optimization for now, it won't be long before manufacturers return their focus to pushing for higher cell efficiencies at lower costs. At some point, this will mean a switch from PERC to n-type technology, with TOPCon and heterojunction (HJT) emerging as clear leaders.

Between these two, it's still anybody's guess which will come to dominate. Both will likely coexist on the market at least initially. Recent announcements, such as Longi surpassing the 25% efficiency mark with a TOPCon cell, suggest there is plenty of momentum for TOPCon, and serious interest from the major players.

"Owing to technology advancements and an increase in manufacturing scale, costs have started to decline and TOPCon is attracting more and more interest," said Karl Melkonyan, senior research analyst at IHS Markit. "However, some problems such as wraparound and edge leakage current require several cleaning processes, resulting in higher manufacturing costs, thus hurting the competitiveness."

For manufacturers already operating large capacities of PERC production, TOPCon is particularly attractive, as it allows them to continue using much of their existing equipment, adding new tools to the setup to upgrade from PERC to TOPCon. HJT, meanwhile, requires investment in a whole new production line, partly due to these cells' sensitivity to high temperatures.

The fact that we still see very large PERC capacities being built by leading cell makers suggests many are considering this upgrade route. Makers will be waiting for the moment when falling costs and rising efficiencies converge to make TOPCon the most economically attractive option. "We see that coming in the 2023-25 timeframe," said Alex Barrows, director of research at industry analyst Exawatt. "In the next two years we'll see a lot of smaller makers using n-type to differentiate themselves, and a lot of bigger manufacturers start to set up pilot lines or smaller mass production for either TOPCon or HJT."

Deposition and wraparound

The additional processing required for TOPCon production poses a few challenges to manufacturers, and among the largest of these is the need for different layers on either side of the cell. "The big challenge with n-type TOPCon is that you need two diffusions, one on the front and one on the rear," explains Loic Tous, team leader for PV cells and modules at Belgian research institute imec. "And you don't want them to touch at the edge, you want both to be isolated."

TOPCon cell production typically begins with wafer texturing, then boron diffusion to the front side of the cell, followed by a chemical etch to clean the rear side. Then, a thin tunnel oxide layer is deposited onto the rear side of the wafer to provide passivation, and a layer of doped polysilicon goes on top of this to provide carrier selectivity and further improved cell performance. To date, these two rear side layers have most often been deposited using low-pressure chemical vapor deposition (LPCVD) equipment, followed by phosphorous diffusion to dope the polysilicon layer. "First you do the boron diffusion then you etch the backside," explained Tous. "Then you do the LPCVD and ex-situ doping, and you etch the frontside, prior to depositing passivation layers on both sides. You have to do the etch twice, while in PERC you only have to do it once."

In LPCVD, wafers are loaded two-per-slot into a cassette with front sides touching to avoid deposition on this side. At low pressure, however, gases are able to flow between the wafers and leave a 'wraparound' deposit on the edges and front side. The diffusion processes are

Photos: Jolywood



TOPCon cells require different layers front and back, with uniform thickness controlled down to the nanometer, with no overlap. Developing deposition processes able to fulfill these demands without depositing 'wraparound' on the other side has been a challenge for the industry, although multiple solutions are in sight.

also inherently two-sided, necessitating an additional chemical etch after each to remove unwanted material from the surface.

"LPCVD is very robust. It's well known in the semiconductor industry and you have many European and Asian suppliers that can make these tools," said Tous. "But LPCVD deposits on both sides, so you need to find a smart way to remove the polysilicon on the front. You don't want polysilicon deposited on the front side, because then you get really massive absorption losses."

Each additional stage in production adds extra costs and increases the chance of cells being damaged in transport between stages. Manufacturers are keen to develop 'single sided' deposition processes for these layers, ideally eliminating both the separate phosphorous diffusion process and additional etch to remove polysilicon from the front.

TOPCon, top dog

Late last year, Chinese manufacturer Jolywood – currently the largest TOPCon cell producer with around 2 GW of production capacity – introduced its plasma oxidation and plasma assisted in-situ doping (POPAID) technology, which it developed in partnership with equipment supplier Jiangsu Jietai Optoelectronics Technology Co., Ltd.

"The POPAID equipment technology enables one equipment to replace the existing four – tubular high-temperature oxidation, tubular LPCVD, ion implantation, and plating cleaning." stated Jolywood at the launch of the tool in October 2020. "The original 12 manufacturing processes of TOPCon were shortened to 9 processes. This not only improves the cell efficiency, but also improves production yield and reduces production costs."

POPAID replaces LPCVD with plasma-enhanced chemical vapor deposition (PECVD) processing. This allows it to grow the tunnel oxide layer, and to deposit both silicon and the phosphorous doping material at the same time, eliminating another production step. Jolywood also says that with POPAID it can achieve more than double the doping concentration of its previous ion-implantation process, and that it expects to reach average cell efficiencies beyond 24% in production. Speaking at the presentation of the 2020 **pv magazine** Award in January, Jolywood's Chen Jia stated that the company had already upgraded a limited number of lines to POPAID, and plans to keep gradually rolling it out to more of its production. Jia also told the audience that Jolywood would be interested in sharing the technology with others in the industry to foster further growth in n-type.

Two sides

Jolywood, however, did not provide further details on its POPAID technology. And other PV cell experts have pointed out that PECVD is not inherently free of wraparound. "If you are using a vacuum process, some wraparound is likely unavoidable. In LPCVD the gas can flow behind the wafer quite freely, with PECVD it's better but there is still usually 1-2mm of wraparound," explains Martin Hermle, head of high efficiency silicon solar cells

> *"You don't want polysilicon deposited on the front side, because then you get really massive absorption losses"*



If the thickness of the cell layers is not uniform, there can be problems later on when it comes to laying down and firing silver paste for the cell fingers.

> *"Low cell yields have been a problem for those looking to produce TOPCon at scale"*

at Fraunhofer ISE. "Gravity [since the cells are laid out flat rather than in a cassette], and the pressure inside the vacuum, help. And you can reduce it further with special carrier design, reduced processing time or a thinner layer."

Imec also lists the second etching stage as "optional" after PECVD (depending on the exact technique) in its rundown of TOPCon process flows. A third option, still in the R&D phase for TOPCon, however, promises to be intrinsically free of wraparound and to completely eliminate the need for a second etching. Physical vapor deposition (PVD), currently used in heterojunction cell production to lay down transparent conductive oxide, is being investigated by research institutes and equipment suppliers for applications in TOPCon. "You really need techniques which are directional, where the deposition only goes straight, and not around," explained Tous. "PVD is one of those techniques: You have the wafer lying on a tray, you apply a very high bias between cathode and anode and sputter silicon onto the wafer. That is very directional, plus you can also use the tray to block the edges."

Equipment suppliers that already offer PVD tools for HJT manufacturing are looking at ways to apply the process to TOPCon cells. It is the doping that presents a challenge here. "It's very easy to sputter silicon, it's not so easy to sputter doped silicon," said Tous. "And you want really high doping to have the TOPCon layer working." He goes on to note that researchers are trialing various solutions including co-evaporation and co-sputtering of phosphorous and silicon to meet this challenge. German equipment supplier von Ardenne also told **pv magazine** in April that it is working on a PVD solution for TOPCon, in combination with a "very innovative doping method."

Cell yield

Low cell yields have been a problem for those looking to produce TOPCon at scale. Much of this is down to controlling the thickness of the additional oxide layer – when it comes to metallization, the silver paste should fire into the silicon layer, but if it also goes through the oxide layer the cell will be badly damaged. If the polysilicon layer is made too thick, meanwhile, it will absorb light and reduce cell efficiency. Combining these processes into one tool also reduces the need for transport, loading and handling between stages, which can be another source of breakage. With POPAID, Jolywood has claimed it can reach cell yields better than 97%, which would make it at least level with many PERC producers operating today.

And while breakage rates may have been brought under control, there are reports that efficiency distribution is still higher for TOPCon, with more cells falling toward the lower end of the range. But this is something that should be solvable as producers gain more experience with the technology. "It's not that the wafers break, but more that the efficiency distribution is higher and that some don't make the cut," explained Hermle. "But this is not unusual if you compare new technologies with what is already a 100 GW market."

Without details on the cost of POPAID or other alternatives to LPCVD processing, it's difficult to estimate their impact on the market or on the development of TOPCon. But cutting out steps from production should both reduce initial capex and increase cell yield. "Eliminating wraparound would be a major development and an important step for TOPcon," said Melkonyan. "This could impact substantially on the demand and growth of n-type technology."

When it launched the POPAID technology last year, Jolywood claimed a 0.2% efficiency boost over its previous ion-implantation method, and that it would be able to achieve average production efficiencies better than 24%. And whether this number keeps rising will be a deciding factor in TOPCon's future development. "Avoiding wraparound will save you a few process steps and an extra piece of equipment, and every little helps in terms of reducing costs," said Exawatt's Alex Barrows. "But the things that will take TOPCon to being a market leader will be efficiency and cell yield, alongside reducing silver consumption." pv

Mark Hutchins

OUT OF THIS WORLD.

BISOL SUPREME™ Series

25 years with 100% output power guarantee

BISOL
Solar company!



Available for
60-cell modules in full-black.

Soon also for half-cut technology modules
with higher powers (up to 455 Wp).



www.bisol.com

Firm foundations on shifting sands

Unprecedented capacity expansions and massive technology changes, all happening at a frantic pace, signal that PV is entering the terawatt era. However, challenges in supply and demand imbalances across the value chain, combined with emerging technical and quality risks, require detailed analysis and due diligence from buyers to avoid pitfalls, according to George Touloupas, Joseph Johnson, and Aditya Vardhan from Clean Energy Associates.

Module capacities vastly exceed the upstream stages of production and current annual demand, since module factories can be brought online faster, and with lower capex requirements, than cell, wafer, ingot, or polysilicon facilities. Major factories from Tier 1 players were completed and ramped to full production at the end of 2020, in anticipation of a 2021 recovery in solar demand. The chart below depicts CEA's estimates for potential production which can take place in 2021 based on available and online manufacturing capacities at each stage of production, without considering input restrictions.

Module capacities exceed all other stages, and even if all polysilicon capacity is fully utilized, there is almost 90 GW, or 35% more, module production than polysilicon production once thin-film technologies are removed from module production outlooks. On the demand side there are similar conditions where module supply exceeds even optimistic estimates for 2021 installations by nearly 100 GW.

Due to the mismatch between module production capacity and both upstream limitations and downstream demand expectations, some module production must go unused, and module expansions continue to overshoot the rest of the industry. With lacking demand, some suppliers are likely to slow production, idle some lines, and delay some new expansions to keep fleets online until the rest of the industry can catch up to the module production segment.

2021 Available production capacity vs. 2021 forecast installations Source: CEA



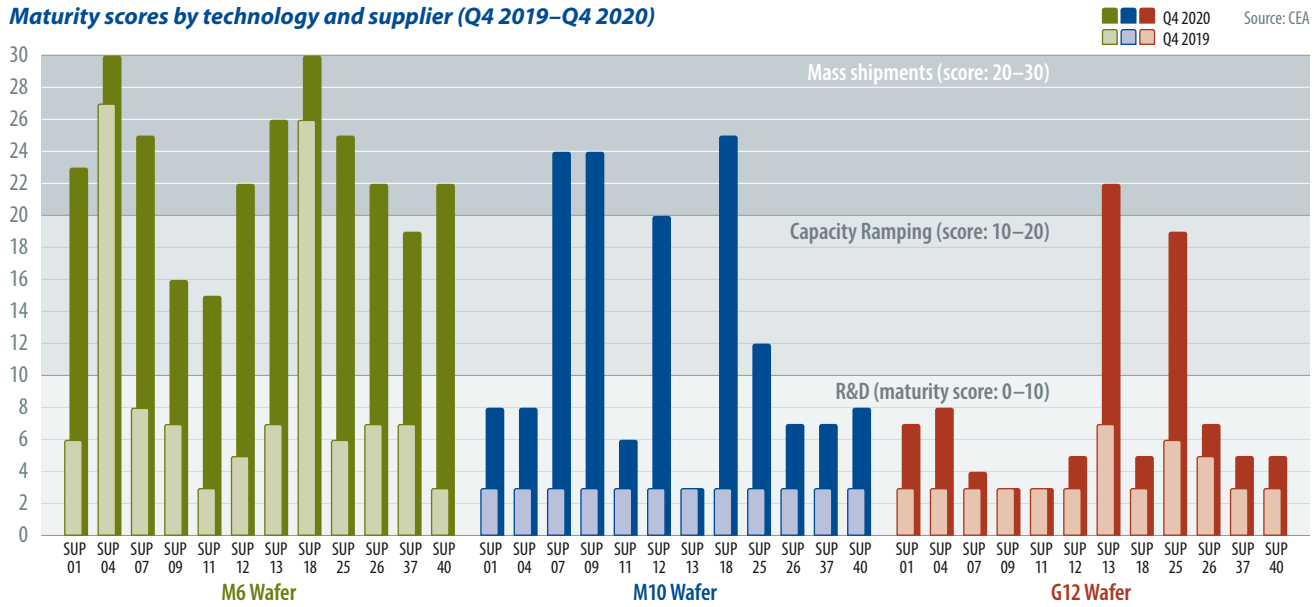
Technological change

When the M6 (166 mm) wafer was first launched in late 2018, it was expected to reign as the market standard for some time. However, things quickly changed after Zhonghuan launched its G12 (210 mm) wafer in late 2019, which was followed by the launch of the M10 (182 mm) wafer. The M6 wafer now stands at risk of being phased out by as early as 2022 or 2023 and is very likely to only remain as a 'transitionary' wafer size. Manufacturers have been very quick in forming alliances based on their preferred choice of wafer size and launched the mass production of these larger wafer products. Most mainstream manufacturers have announced grand plans for 2021, with several of them even announcing 20+ GW of new module capacity for these larger wafer products.

CEA introduced a new "maturity score" metric in the company's PV Supplier Market Intelligence Program, which can be used to compare suppliers based on the Manufacturing Readiness Level (R&D phase), Capacity Scale (ramping up phase) and Track Record (shipment scale) of different technologies, with scores ranging from one to 10 for each of these three stages, for each technology area. The rapid adoption of these new wafer sizes can be seen in the chart above right, which visualizes the change in maturity scores of suppliers for these wafer sizes between late 2019 and 2020.

The rapid uptake of larger wafers and new module formats has had a significant impact on auxiliary component supply chains like those of glass, encapsulants, and backsheet. While polymer supply

Maturity scores by technology and supplier (Q4 2019–Q4 2020)



chains eventually managed to catch up, prices are still in a stabilization period. Considering these, the alliances came up with a standardized set of module layouts for both the utility and residential markets. Additionally, manufacturers are adopting interconnection technologies like paving or shingling for higher module efficiencies and optimized material use.

All these module level changes were motivated by the desire to offer the lowest levelized cost of electricity (LCOE) for the end user. After mainly focusing on innovations at the module level, manufacturers are now expected to shift their focus back toward improvements in cell efficiencies and technologies, such as n-type.

New fabs

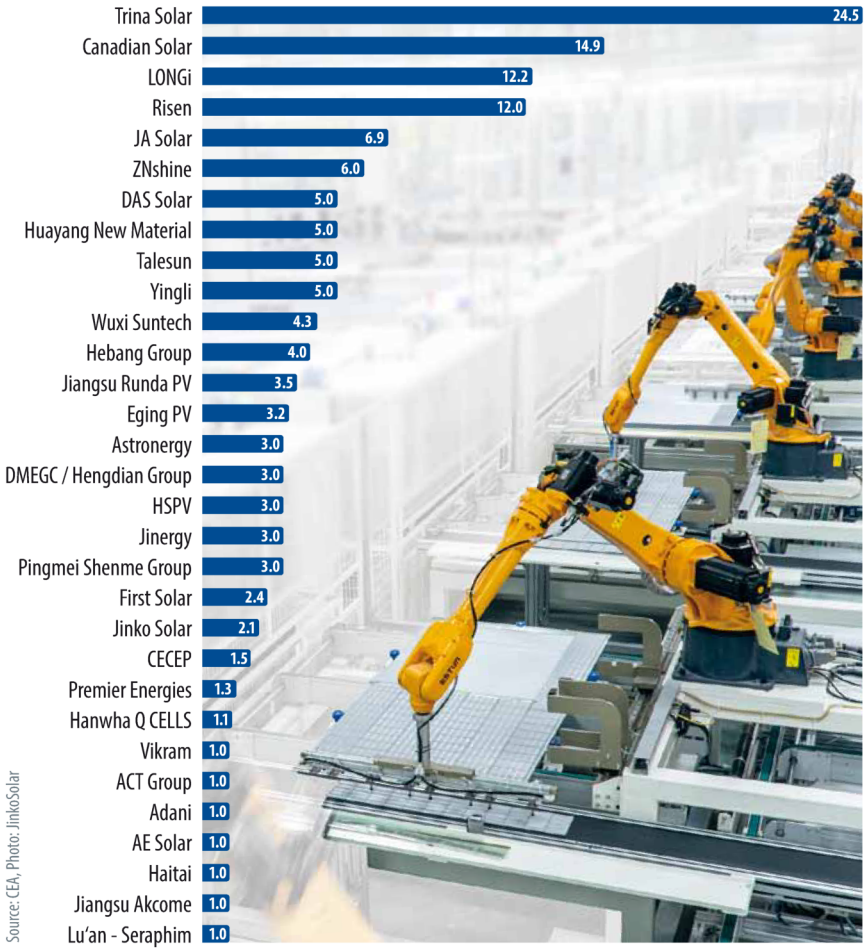
Five suppliers combined – Longi, JinkoSolar, Canadian Solar, Risen, and Talesun – added more than 28 GW of new module capacity between Q4 2020 and Q1 2021. In line with broader industry growth trends, many other suppliers also announced nameplate capacity increases in 2020 which are scheduled to come online this year. Currently, CEA is tracking just over 150 GW of nameplate capacity expansion announcements for module factories which are expected to be completed by the end of 2021. Of the 150 GW of new expansions, Trina Solar, Canadian Solar, Longi, Risen, and JA Solar constitute nearly half of new module production, with other major players like JinkoSolar spending 2021 ramping new cell facilities following rapid module expansions completed in 2020.

While large suppliers with sizeable expansions are foregoing updates to facility nameplate figures, we expect even more production capacity to be available once module equipment fully utilizes larger M10 or G12 cell inputs. Almost all new module factories are expected to be capable of producing up to a G12 format product, and any factory limited to a M10 product is likely to be easily upgradable if a clear wafer size preference develops in the market. Most factories finishing construction in 2020 were also designed with new format products in mind, and availability for large format products in most markets is anticipated to surpass all market demand by the end of the year.

“Availability of large-format products in most markets is anticipated to surpass all market demand by the end of the year”

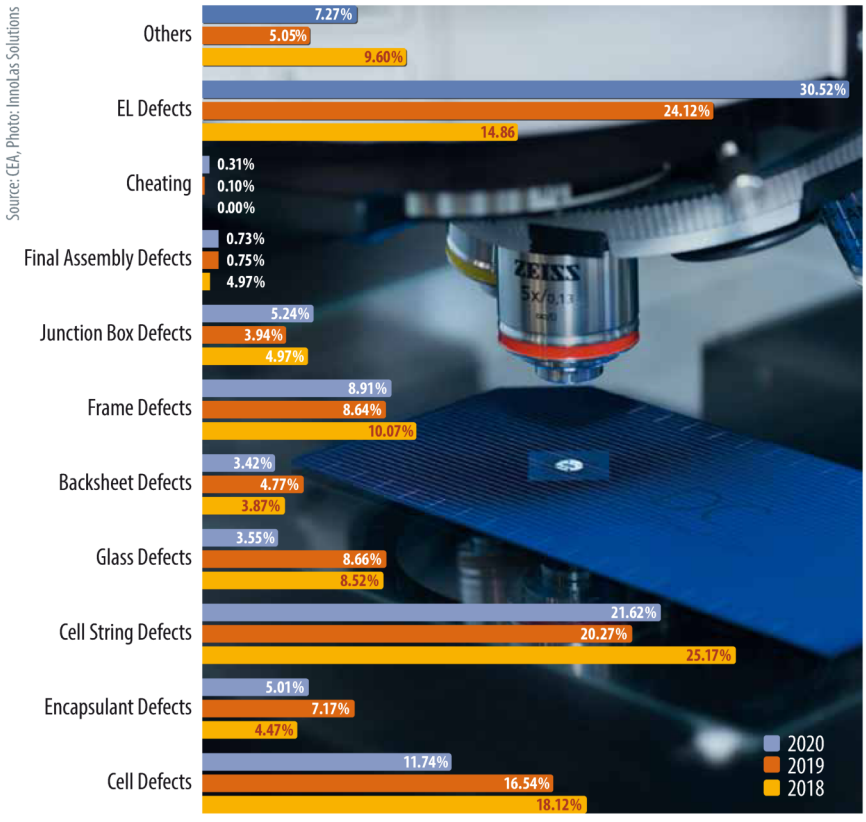
Major suppliers maintain expansion plans, but with module capacity gluts developing, there are doubts that all supplier expansions plans will materialize on time and at a scale matching initial factory announcements. For the largest suppliers in the industry, significant over capacity and low utilization can be maintained in the short term if financing costs are low and if profit margins in other segments of the suppliers’ fleets can support idle lines.

Module capacity expansions and nameplate increases in 2021 (in GW)



Source: CEA, Photo: JinkoSolar

Impact on PSI factory risk scores by defect category (2018–2020)



Source: CEA, Photo: InnoLas Solutions

For these suppliers, construction on new, multi-gigawatt facilities in China is currently underway and unlikely to deviate from initial plans. However, as high module costs are expected to persist throughout 2021, current conditions are certainly challenging for emerging suppliers that had hoped to run new factories at full capacity.

Quality concerns

Reliability concerns have been prevalent ever since the industry started moving away from mainstream technology such as modules with full cells from G1 (158.75 mm) wafers, five busbars, and cell interconnection with a 2 mm gap.

Pre-shipment inspection quality metrics from CEA's Supplier Benchmarking Program, shows a clear rise in quality issues and associated risk scores for inspected modules from 2018 to 2020. As seen in the chart below left, the impact of the EL defect category (primarily micro cracks and poor soldering) on the factory risk scores has almost doubled between 2018 and 2020. During the same period, the industry went through a transition towards larger wafers, half-cut cells, multi busbar technology and reduced inter-cell spacing. These advancements largely led to, among other issues, tabber-stringer malfunctions and subsequently much higher EL defect rates, exacerbated by the mass ramping up of gigawatts of new production lines, which typically take months to stabilize.

The new wafer sizes and larger module dimensions can make the module more susceptible to mechanical stresses, especially in high wind or snow regions. Among the dense interconnection technologies that are used in the latest modules, tiling has already had several long-term reliability concerns in the form of excessive stresses and microcracks which discouraged many manufacturers from adopting this technology. Paving, on the other hand, can also have reliability concerns unless damage free laser cell cutting and thicker encapsulants are used.

The rapid introduction and adoption of new technologies along with aggressive ramping of capacity, as in the case of the larger format modules can certainly cause several reliability concerns along the way. This concern is even more severe in the case of suppliers with less of a track record, since they might have to go through steep learning experiences accompanied with

process instabilities, high defect rates and low production yields.

Due diligence

Of course, all these new PV module products must be certified according to IEC standards before being produced. However, it is generally accepted that IEC testing standards are following a "minimum bar" approach and are not considered adequate to evaluate the performance and reliability of PV modules for 25 years or more in the field.

Extended Reliability Testing (ERT), which goes beyond the IEC requirements, is generally accepted to be a suitable approach to a more rigorous evaluation. There are several ERT protocols that are being used globally to test modules, such as PVEL PQP, RETC PQP, TÜV Sud Thresher, and CSA C450, etc., and the newly published IEC TS 63209-1 standard is attempting to unify these.

ERT takes six to eight months to complete, and it must cover all bill of material (BOM) variants that a supplier uses. So, by design, this requires careful planning and investment from suppliers. The current challenge is that the proliferation of product variants, and the need to use alternative BOMs because of raw material bottlenecks, creates situations where procurement decisions need to be made before ERT is completed for all candidate products and BOMs.

Additionally, production lines must overcome lengthy ramp up periods, where process instabilities, for example at the tabber stringer station or during lamination, can result in excessive quantities of inferior product being produced and shipped to buyers, unless a robust quality assurance program is applied both before and during production, and before products are shipped.

Buyers are therefore advised to be more proactive in performing due diligence when it comes to new product procurement decisions. Although all these new technologies are great for reducing LCOE, such claims for LCOE improvement are only valid when products are reliable and last for their designated lifetimes, producing the expected energy yields. pv

George Touloupas, Joseph C. Johnson and Aditya Vardhan

About the authors



***George Touloupas** is the director of technology and quality for solar and storage at Clean Energy Associates. He leads projects centered on developing CEA's internal quality standards, researching new production technologies, and developing new services. He has an extensive background in PV manufacturing, as well as downstream experience. Prior to joining CEA, he worked as the chief operating and technical officer at Philadelphia Solar in Jordan and technical and operations director at Recom.*

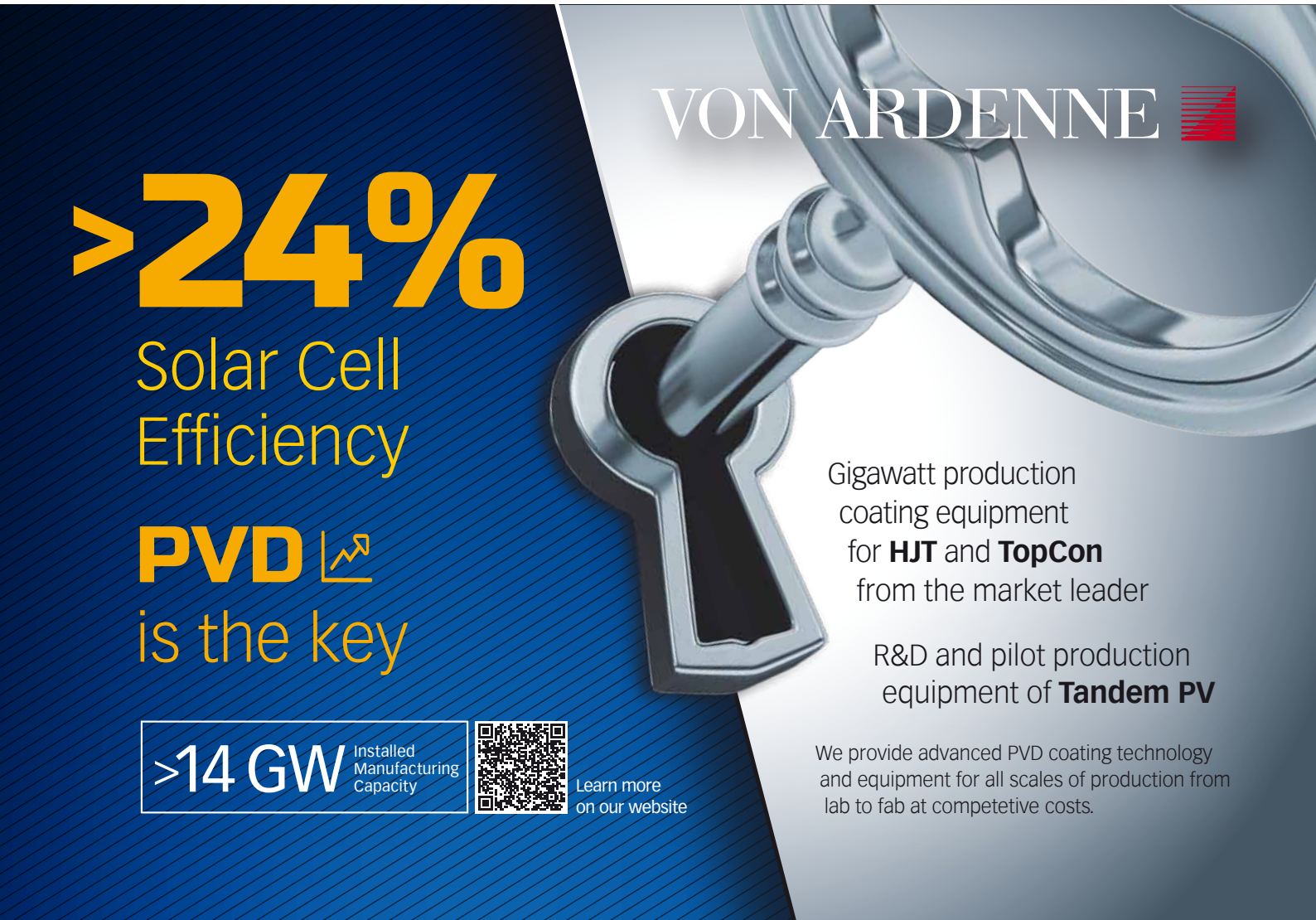


***Joseph Johnson** is a lead analyst for solar and storage at Clean Energy Associates, a company that focuses on solar PV quality assurance, supply chain management, and engineering services. At CEA, he explores market trends, supplier quality, and trade policy as part of CEA's technology and quality department.*



***Aditya Vardhan** has been working as a junior PV engineer at Clean Energy Associates LLC for more than 12 months. While based in India, he works with colleagues in China, Europe and the United States to provide technical expertise and market intelligence. His primary focus areas is identifying and analyzing technological trends across the PV value chain, along with maintaining client-facing market intelligence products.*

Advertisement



Custom standardization: unlocking BIPV

The creativity of architects and the need to standardize BIPV products to bring costs down may appear mutually exclusive. In reality, they are the concurrent needs of both the construction and solar sectors and must be considered for the promise of "PV everywhere" to become a reality in our built environment. Work is underway to bridge this gap and the initial results are building in innovation.

On brand and on message: A new building at Helmholtz-Zentrum Berlin (HZB) in Berlin is being powered by a 50 kWp solar facade installation that speaks to its mission and identity. Not only is the prominent solar research group practicing what it preaches by adopting the building-integrated photovoltaic (BIPV) technology for which it advocates, but the brilliant blue facade modules shine with the colors of the HZB logo.

The 360 modules each have a power output of 135 Wp. They cover some 400m² of facade, and were supplied by long-running copper indium gallium selenide (CIGS) producer Avancis, which was acquired by Chinese building-materials giant CNBM in 2014. HZB itself has a long history in CIGS research, stretching back some two decades. The modules are certified according to technical building approval (abZ) standards by the relevant German construction authorities (DIBt).

"There are different reasons [for selecting the Avancis Skala modules]," says Björn Rau, the deputy director of Competence Center PV at HZB. "The technical solution to provide a colored, frameless, homogeneous appearance works very well with the technology Avancis is using. And as the HZB has been working with CIGS for some decades we are interested in studying performance even on north-facing facades and really manage results." The array, says Rau, will be a "living laboratory."

Rau also heads up HZB's BIPV consultancy, called BAIP – in German, the "Beratungsstelle für bauwerkintegrierte Photovoltaik." He reports that since BAIP's founding some 18 months ago, the team of architectural and PV experts have consulted on more than 60 projects, ranging from heritage renovation projects to free-standing homes and public buildings such as universities, schools, and hospitals. One of the frequent challenges facing architects, builders, and owners when looking to adopt BIPV are the certification and building approval processes – particularly when it comes to safety.

"People are concerned and do not always understand from the beginning

The "living BIPV laboratory" at the HZB facility in Germany will integrate more than 100 sensors to measure a range of different temperature and performance issues.



Photo: HZB

what the key aspects are if we bring an electrical device into the building façade," says Rau. "One of the major results is that solutions can be found if fire protection is part of the planning right from the beginning." He notes that these approvals and processes are often conducted on the local level – either city or state, rather than national, and certainly not on an international basis.

Major hurdle

Here, it seems, lies one of the major challenges facing BIPV deployment and one of the reasons the application has not been able to expand in step with the global PV market. While there may be a desire for architects and building owners to adopt BIPV, approval processes can be onerous. And on the other side, PV manufacturers have developed and can produce attractive and effective BIPV products, but certification is complicated, costly, and time-consuming. And the multitude of jurisdictions, along with their individual requirements, is confounding.

"There are regulations and laws but in the end the building is an individual case and also the solution finally is building related, not general," Rau continues. And while these hurdles can appear insurmountable, there is progress being made, and projects such as the BAIP are moving forward.

Further south in Europe, another BIPV research project is showing promise. BIPVBoost was launched in October 2018 and is funded by the European Commission and its project partners to the tune of almost €11.5 million. Due to pandemic-related impacts, it is running slightly behind schedule. However, a new pilot line in Spain points to some imminent successes.

"The main challenge of the BIPV segment right now is to achieve mass adoption by the construction sector," explains Jose M. Vega de Seoane, who coordinates BIPVBoost at R&D commercialization organization Tecnalia, which is based in Spain's Basque region.

"The idea with BIPVBoost was to provide an answer to this market need in terms of being able to manufacture BIPV modules in a flexible and still cost-competitive way."

One "project milestone," according to Vega de Seoane, is a pilot production line that was recently installed at Spanish BIPV specialist producer Onyx Solar. It is pursuing this goal of mass adoption by enabling the production of a range of crystalline silicon BIPV modules that answer dual needs: customization and cost-effectiveness.

Flexible production

The pilot line was developed by European production equipment supplier Mondragon Assembly, which is one of the BIPVBoost partners. A key tool in the line is a tabber-stringer that has the ability to produce crystalline silicon BIPV modules with a variety of cell spacings and configurations – between cells in series, and also cell rows.

The flexible stringing feature allows for PV modules to be produced that let in more light through spacing cells further apart, such as for windows or canopies where less shading is desired. And then higher density modules where shading is not an issue.

In the specialized production tool itself, the flexible configurations are facilitated through the use of two mobile electroluminescence (EL) cameras and electrical power systems. By virtue of being mobile, the EL cameras can be positioned at various points along the module, according to the module configuration and cell spacing. The machine can handle cell sizes up to M6, with a 3BB or 5BB interconnection. It can also string half-cut cells and produce modules of various sizes – up to 3 meters in length.

"This is a very specific tabber stringer that is longer and more flexible than a standard one," explains Jean-Philippe Aguerre, the R&D and innovation manager for Mondragon Assembly. "We have the ability to have a distance between cells that is up to 200 mm. We also have a quite specific solution, that is patent pending, to have a very accurate positioning of the ribbons."

Aguerre explains that the positioning of the ribbons must be more accurate when narrow ribbons are used or when there are large distances between the cells. Each piece of equipment, he adds, from the tabber, to lay-up and EL control is self-adjusting according to the module parameters provided by the architect and construction engineers.

BIPV promoters believe the new manufacturing process presents significant promise in addressing a key challenge facing the segment. "The combination of standardized and customized is definitely

Photo: Mondragon Assembly



"We also have a quite specific solution … to have a very accurate positioning of the ribbons"

Jean-Philippe Aguerre

Mondragon estimates that its new BIPV line will result in a

18.5%

production cost reduction

Photo: Mondragon Assembly



Advanced EL cameras ensure more accurate alignment – important when cell spacing is increased.

a development for the future, because we need to have cost-effective production, otherwise we will not have an established BIPV manufacturing market in Europe," says HZB's Rau.

Cost down

Having a clear and BIPV-specific standardization framework would reduce the risk perception and facilitate its market adoption. The approach could see certain "product families" of BIPV modules certified by relevant bodies, bringing related costs down while still providing a wider array of options to architects, who value creativity and unique building concepts. "We are always speaking about customized solutions and you cannot demand BIPV manufacturers to go through the certification process for each project as it is costly, long and counterproductive for the deployment of the sector," says Tecnalia's Vega de Seoane.

Automation itself delivers additional savings. Mondragon Assembly calculates that the combined benefits of replacing manual processes, and therefore labor costs, along with reduced breakages will deliver an 18.5% cost reduction.

Also promising is the approach taken to software development in the BIPV-Boost manufacturing project. Building more effective links between the architectural and construction community and the PV industry has long been seen as an important task if BIPV is to become more widespread.

BIPVBoost looks to close this gap by implementing a digitalization strategy, allowing architects and construction engineers to address the design of solar envelopes directly via the BIM (building information modeling) tools they use in the building design process. This information can then be relayed to the manufacturer, and the individual production tools, to allow for their production effectively connecting design and manufacturing environments.

For manufacturer Onyx, this level of digital integration, while promising, represents a lofty goal at present. The company's CTO, Teodosio del Caño, says that the step from "offline" to "online" for BIPV production, such as the BIPVBoost digitalization proposal, remains a big one.

"This is a question of thinking of something very online is very difficult," says del Caño. "BIPVBoost represents an extraordinary effort and the findings and what we have learnt on the project are really promising but [in terms of digitalization] there still a long way to walk."

In terms of the automated stringer process itself, del Caño speaks in glowing terms about the ability to automate the various string and cell configurations, along with the added quality controls delivered by the advanced EL imagery. "String configuration in the past was a nightmare and we can tell [in production, with the new tabber-stringer] that this has really improved."

Like HZB, Mondragon Assembly is practicing what it preaches and will integrate modules running off the pilot line it developed for Onyx Solar on one of its industrial buildings in Aretxabaleta, Spain. The array will have a capacity of approxmiately 20 kW with construction set to be completed by the end of 2021. pv

Jonathan Gifford

Automating the cell stringing and bussing increases quality and drives down production costs.



Photo: Mondragon Assembly

PFEIFFER VACUUM







Vacuum solutions for battery manufacturing

Pfeiffer Vacuum provides dry and oil-sealed standard and ATEX pumps for drying processes (coils) under vacuum or pre-evacuation prior to electrolyte filling. We also offer leak testing systems with air and tracer gases for components (e. g. cell covers), cells, modules, packs and coolant circuits.

Pfeiffer Vacuum offers solutions for the following process steps:

- Drying
- Filling under vacuum
- Leak testing in various processes

Are you looking for a perfect vacuum solution? Please contact us:
Pfeiffer Vacuum GmbH · Germany · T +49 6441 802-0 · www.pfeiffer-vacuum.com

Rethinking degradation

PV module making is a brutally competitive industry. And for Slovenian module maker Bisol, in business since 2004, one of the keys to success has been to remain focused on the value its products deliver to the customer. And as company founder and CEO Uroš Merc explains, in 2021 this means reimagining module degradation.

The new module series from Bisol, the Supreme series, is being promoted as being a "zero degradation module." What was the motivation behind it?

All manufacturers are striving toward higher power, but we tried to find an alternate approach based on value for the customer. We are all, in principal, using the same cells – differences are small, mainly in quality. And while there are higher efficiency cells, n-type cells, they are more expensive and often drive manufacturers towards losses jeopardizing the value of the long-term warranties. In that sense, sticking to the mainstream's [cell technology] highly optimized cost structure, is very important. So then, how can a module manufacturer make something different? One approach is higher power, but as everyone tends to use the same cells we just see the modules getting bigger. I think, also, there are limitations when it comes to size.

My idea was to focus on the value for the customer. I asked, "what is something that the customer would and should appreciate?" The idea came from a comparison – when you are buying a German car you never ask, "what is the horsepower degradation over a number of years?" Everything naturally degrades over time. But, from the client's point of view there's risk in not knowing how degradation will affect module performance. It feels like the client pays for the product twice, first for the product itself and then for degradation. In my view, when you buy a PV panel, you should buy it for a certain price and at the rated power valid for the whole warranty period.

Our principle here is that the value for the customer is in not needing to worry [about degradation]. With this new trend-setting product we don't need to speak about degradation anymore, everything is considered in the product and in the data sheet already.

So, is it that the nameplate that you are selling at is below the nominal power output? For example, if a Supreme module has a nameplate of 370 W, then it may actually have a nominal output of 380 W.

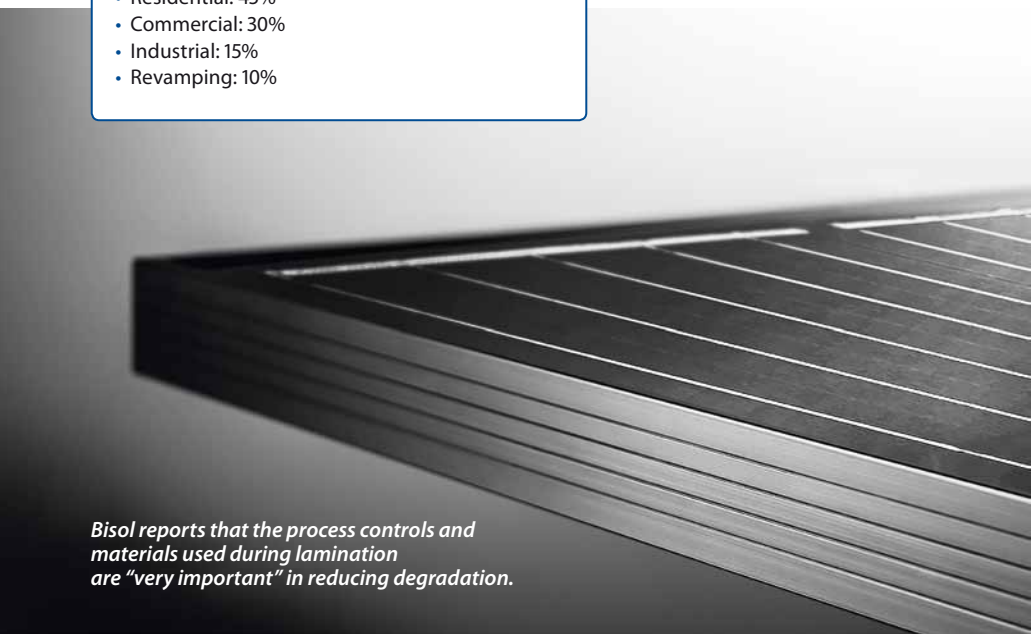
That's partially the case. In principle you see the same in many other module manufacturers: They claim a power output between 0 to +5 W of the rated power, but we all know that most of the time it's closer to zero. When you have a module that has standard degradation compared to one without it, the loss in power [on the former] adds up to around 11% or more of energy yield just within the warranty period.

If we produce modules according to our higher standards, our climate chamber shows that the modules are operational for more than 100 years – and the power drop is only 25%. I believe having high quality materials is absolutely important too.

Bisol by numbers

2021 sales forecast:

- 400 MW to 420 MW
- Residential: 45%
- Commercial: 30%
- Industrial: 15%
- Revamping: 10%



Bisol reports that the process controls and materials used during lamination are "very important" in reducing degradation.

How then are you able to reduce degradation in production?

For Bisol Supreme we say "zero effective degradation" as it is effectively zero for the client. By adding a little bit of additional power in the beginning, we can allow for small degradation later on. But it's essential to assure overall low degradation.

We can achieve this through attention to detail in module production. Highly specialized equipment upgraded by our engineers, materials that we use and test to destruction, and our unique processes combined are essential.

Our clients should be our only perspective. It is not about price, but the value of what they like. So we are not trying to make the highest power with the largest module, but the highest value for the client.

Photos: Bisol Group



Can you tell me more about how you achieve that in production?

For our standard modules we have our standard procedures. But with Supreme we exaggerate everything: more people on inspection, flawless procedures from input material onwards; we measure and calibrate the laminators, stringers, as well as other machines more often and we are using our own machine learning processes to do it. As a result, the product is so advanced that we are tracking everything, even the personnel, not only on production but on specific machines.

Are any production processes more important than others?

Perfect soldering and lamination cycles are vital. Of course, it is much more than just that. The main difference is that you do not focus predominantly on maximizing the throughput and therefore the cost per unit – hence Supreme modules are more expensive. But it is a combination of things. The thickness of the EVA is important. Thinner EVA foils can be linked to PID degradation. Gel content is important. For example, EVA manufacturers will tell you that EVA content of around 65% is sufficient, but we go far beyond that. We know that this reduces the nominal operating cell temperature and improves the performance of the module. A total number of solder joints play a vital role in low degradation process too, and more.

As a module producer with a relatively long track record, what are your tips for survival?

I believe in keeping the client in focus. We've had good clients in the Benelux region and other countries since 2008 and 2009, for some we are the only manufacturer that still has product on their shelves – a good testimonial. Everyone can expand capacity almost overnight. But it is more about how to penetrate the market and be successful doing it. Getting big can often turn into getting too big, and then the lowest price becomes the only driving factor to sell. With the lowest price, you will never receive the best quality.

And for a European module maker in particular?

Around 20% of the market is accessible to European manufacturers, even less because of price. And sometimes I am quite surprised by the market share we have in Austria, France and the Benelux.

When it comes to European competition, we are extremely successful in managing our expenses. There are not many companies worldwide and particularly in Europe in which management is totally aware of the cost structures. Over the last 15 years or more, we have been focused on keeping costs under control and then focusing on what the clients really need. After all the downturns and all the periods of consolidation, we have never registered losses, which is almost unbelievable.

A good example is when our sales manager in Belgium told me that clients wanted "all black" modules. At first, I thought this was outrageous, because it's better to have a white backsheet for temperatures and higher power. But clearly it was wanted. We are not the ones to tell the market what they want: It is our job to listen and to respond.

As a result, we were one of the first module makers on the market with an "all black" module and within three or four years everyone had followed. I believe we are doing the same here with the "zero degradation" Supreme. The client buys the module and shouldn't worry about degradation. pv

Interview by Jonathan Gifford

> *"For Biosol Supreme we say 'zero effective degradation' as it is effectively zero for the client"*
>
> **Uroš Merc**

Solar
JinKO
Building **Your Trust** in Solar

TIGER Pro · 585w

Rethink Power



www.jinkosolar.com

pv magazine

DOWNLOAD THE WHITE PAPER HERE



pv magazine group

SEIA seeks supply chain

As ethical concerns around the solar supply chain grow, the U.S.-based Solar Energy Industries Association (SEIA) has a new tool for improving transparency, backed by a traceability protocol. In late April, SEIA released the protocol, which it said would improve supply chain transparency and help ensure that solar components headed for U.S. projects are "made ethically throughout the solar value chain." pv magazine USA's David Wagman takes a closer look.

The Solar Supply Chain Traceability Protocol, launched in April by SEIA, offers guidelines intended to help solar companies meet compliance obligations and "provide customers with assurances that their solar products are free of unethical labor practices."

"Solar customers expect their products to be ethically produced, and this protocol helps ensure that solar products coming into the United States are not made using forced labor," said John Smirnow, SEIA's vice president of market strategy, in a statement timed with the release of the document.

Forced labor

The release comes at a challenging time for the solar industry, as allegations of forced labor use in China's Xinjiang region have implicated some segments.

In May, researchers working at the Helena Kennedy Centre for International Justice at Sheffield Hallam University in the United Kingdom published a report alleging that 11 companies in the solar energy sector were engaged in "forced labor transfers." It said another 90 Chinese and international companies had their supply chains affected by such forced labor.

The researchers said their work spanned the entire solar module supply chain "from quartz to panel" and aimed to better understand the extent to which allegations of forced labor in China affect international value chains. They said their work was meant to provide stakeholders with the "evidence base upon which to judge risk of exposure to forced labor in the solar supply chain."

Strong reaction

CNN Business, which first reported on the Sheffield report, quoted Chinese Foreign Affairs Spokesperson Hua Chunying as calling the claims of forced labor "an outrageous lie."

Maxeon has a plan to ramp up new cell capacity in Malaysia, as well as module assembly facilities in Mexico and the United States. It aims to expand its presence in the U.S. market, both for its interdigitated-back-contact modules and a shingled product targeting the utility-scale market.



Photo: Maxeon Solar Technologies

transparency

"A few Western countries and anti-China forces went all out to hype up the so-called 'forced labor' in Xinjiang's cotton-growing industry. Now they are turning to the solar energy industry," Chunying was quoted as saying. She added that "lies like 'forced labor'" were being used to create "forced industrial decoupling" and "forced unemployment" in the Xinjiang region to suppress Chinese companies and industries.

In a statement responding to the university report, SEIA's Smirnow said that "the use of forced labor at any stage of the supply chain is wholly unacceptable" and that the U.S. industry trade group was taking the report's findings "very seriously." He said that whether through U.S. Customs and Border Protection (CBP) enforcement, legislative action, or customer demands, "solar deployment in the U.S. could be jeopardized" without independent third-party audits, "which cannot happen in Xinjiang." It remains to be seen whether such independent third-party audits are in fact impossible in this part of China.

SEIA protocol

The SEIA's traceability protocol follows action taken in early February when some 175 solar companies, including some of the world's top solar manufacturers, signed a SEIA-led pledge opposing forced labor in the solar supply chain.

In an interview at the time with **pv magazine**, SEIA President and CEO Abigail Ross Hopper said that the industry trade group became aware of the forced labor issue late in 2020 and had been communicating with member companies that "they need to move their supply chains." She set a goal of late June for companies to adjust their supply chains to avoid conflicted regions.

A spokesperson said in early May that SEIA's goal of late June for a shift in the supply chain remains in place.

The SEIA supply chain traceability protocol is intended to have "universal application" across product lines intended for export to the U.S. market, and it expects key adopters to include equipment manufacturers and U.S. importers. Although its aim is to focus on "the provenance of material inputs," it also recognizes the importance of independent, third-party audits and a "strong corporate social responsibility and import compliance platform."

In releasing the protocol, SEIA said that the U.S. government has "identified forced labor as an area of concern for the solar supply chain." It went on to say that U.S. solar customers are "increasingly seeking assurances that the products they purchase are truly sustainable and, in particular, free of forced labor."

SEIA said that while the new tool "by itself will not stamp out forced labor, companies need to go through the steps laid out by the protocol."

Shift underway?

SEIA's overarching call to shift solar supply chains away from conflicted regions comes as other economic factors offer anecdotal evidence that some movement toward expanding domestic U.S. supply chains may already be underway.

During a quarterly earnings call, Maxeon Solar Technologies said it would ramp up efforts to sell its Performance line shingled module technology in the U.S. market, facilitated by deployment of up to 3.6 GW of new factory capacity. The expansion depends on the company obtaining debt or equity financing to buy equipment; initial sales could begin in the first quarter of 2022.

Maxeon said it would take a two-tiered approach to expanding its U.S. market presence. Large-format G12 mono-PERC solar cells would be manufactured at the company's site in Malaysia, and module assembly completed at a facility in Mexicali, Mexico.

The company would then select a site for a U.S.-based module assembly facility with a capacity of up to an additional 1.8 GW. Depending on site conditions and market demand, the second phase is expected to begin operation in 2023.

Separately, GAF Energy said in May that it planned to move its manufacturing out of Asia to a new facility in California as it develops technology to integrate solar panels with roof shingles.

"Some movement toward expanding domestic U.S. supply chains may already be underway"

Photo: USDA/Erich Glasgow



Customs agents inspect a package on arrival to the U.S. According to SEIA, U.S. Customs could soon require additional documentation for imported solar products, to verify material sourcing and working conditions all the way up the supply chain.

> *"U.S. Customs and Border Protection agents could engage in further scrutiny if goods are detained"*

Components for GAF Energy's building-integrated solar products are produced in South Korea, but manufacturing will be moved to a renovated 112,000-square-foot factory in San Jose, California, later this year. The facility will be capable of producing about 50 MW of solar panels a year.

In making the move, GAF Energy said it expected to benefit from what it said were reduced risks associated with offshore production, including tariffs on Asian-made solar goods and rising transportation costs.

Best practices

Those recent moves hint at the complexity of the solar supply chain and at factors that are beyond the forced labor allegations that underpin much of the SEIA's traceability protocol.

The protocol lays out a set of recommended best practices that SEIA said are designed to prevent forced labor in the solar supply chain; help companies meet their U.S. import compliance obligations; and provide customers value chain transparency. SEIA said the tool has been structured as an industry specification or de facto standard, with the expectation that it will be further developed into a formal industry standard.

The protocol includes an audit mechanism intended to measure a company's implementation and compliance. SEIA said that in assessing conformance, "no single factor will be dispositive," and that auditors would assess conformance based on a "holistic approach."

The protocol said that any organization should be prepared to provide information that includes such details as the legal name of the company, its length of time in business, the company structure – including organizational chart – and its importer status, when relevant.

In addition, a number of documents were identified as being important to provide. Those documents would include purchase orders and contracts between and among the links in the supply chain; associated commercial invoices and proofs of payment; customs entry documents; freight forwarder notices of arrival; international bill of lading/packing lists with shipper and product descriptions; foreign inland freight documentation from the manufacturer to the port of export; and customs broker instructions.

The SEIA protocol advised that U.S. Customs and Border Protection agents could engage in further scrutiny if goods are detained. Detention notices from federal border agents could require a laundry list of documents, including affidavits from each producer in the supply chain that identify where the input material was sourced; list production steps and records for the product, including records that identify the input materials; and supporting documents related to employees. Those documents could include documents related to wages and hours worked, along with daily production output for each factory in the supply chain.

In addition to the traceability protocol, SEIA also updated its Solar Commitment document, which defines common labor, health and safety, environmental, and ethical standards and expectations for solar companies. The update includes guidance on workplace safety and ethical labor practices.

The Solar Commitment includes recycling and refurbishment best practice, information on energy consumption tracking, procedures to avoid the use of conflict minerals, and additional guidance that companies can follow to hold suppliers to the standards.

SEIA also released a Solar Buyers' Guide on Traceability, which summarizes the protocol and offers a set of questions that customers, developers, financiers, and other stakeholders should ask suppliers about products in the solar and storage value chain.

David Wagman

Corporates' critical solar role

Despite the global pandemic and recession, corporate purchases of clean energy are booming. Several factors are driving this trend, including falling costs, heightened appetite for sustainability among consumers and investors, and increased political will for net-zero development. In recognition of this, the UP Initiative will spend the third quarter investigating sustainable electricity supply. How are PPA models evolving? What are the critical issues around residual energy? And how can greenwashing be avoided? pv magazine investigates.

The market for corporate clean energy purchases – primarily solar and wind – skyrocketed to a record 23.7 GW in 2020, according to BloombergNEF (BNEF). Development over the past year has been particularly impressive, given the effects of the Covid-19 pandemic and ensuing recessions. This underlines the increased appetite for sustainability in the business, consumer, and political realms with the falling costs of renewable electricity.

According to Kyle Harrison, BNEF senior associate, this upward trajectory continues in 2021. "Through April, companies have announced 7.2 GW of clean energy PPAs, ahead of the 4.2 GW signed in 2020," he told **pv magazine**.

He said policy conditions in several markets are easing, providing companies with easy access to clean energy. "European markets like Spain, Italy, France, and Poland, which historically had no activity, have all become hot spots for clean energy buying for various reasons," he explained. "In Asia, Taiwan officially liberalized its power market in 2020, opening up the option for PPAs and other procurement mechanisms. South Korea enacted similar changes at the end of 2020, and Japan is expected to be next. These changes will drive a significant amount of activity that previously has not existed."

Tech goliaths

Since 2008, Apple, Google, Amazon, and others have led the charge in corporate procurement of renewables. Their action has meant the U.S. has been the world's largest market since 2008, with 11.9 GW of corporate power purchase agreements (cPPAs) announced in 2020.

However, other markets are beginning to pick up the pace. In Brazil, corporations signed more than 1 GW of PPAs last year, while cPPA volumes in the Europe, Middle East, and Africa (EMEA) nearly tripled, from 2.6 GW in 2019 to a record 7.2 GW in 2020. The Asia-Pacific region also saw record volumes.

"More than ever before, corporations have access to affordable clean energy at a global scale," said Jonas Rooze, lead sustainability analyst at BNEF, in their January 1H 2021 Corporate Energy Market Outlook. "Companies no longer have an excuse for falling behind on setting and working towards a clean energy target."

Changing landscape

While the tech world is light years ahead in corporate renewable energy purchases, newcomers from industries like steel and heavy machinery are beginning to ramp up their clean energy commitments. This shift is noticeable in the recent uptick in global RE100 membership. Via the global initiative launched in 2014, 300 companies from more than 175 markets have now committed to buying 100% renewable electricity to power their operations.

In January, BNEF forecast that the 285 RE100 members (its figures were published before the 300-member milestone in April) will collectively need an addi-

Amazon, the world's largest clean energy buyer, has announced 206 renewable energy projects, including 71 utility-scale wind and solar installations and 135 solar rooftop arrays on facilities and stores worldwide.



Photo: Amazon

tional 269 TWh of clean electricity by 2030 to meet their goals. If met with offsite PPAs alone, it would catalyze an estimated 93 GW of new solar and wind build.

"Investor interest in sustainability is sky high, with inflows to sustainability-focused funds growing 300% between 2019 and 2020," said Harrison. "Companies in all sectors are feeling the pressure to purchase clean energy and decarbonize. This group is only scratching the surface of clean energy build it can catalyze."

"Corporate procurement can play a critical role in the energy transition"

Critical role

RE-Source – an alliance of stakeholders representing clean energy buyers and suppliers established by the SolarPower Europe association, among others – notes that corporate procurement can play a critical role in the energy transition.

However, the key is removing regulatory and administrative barriers, providing clarity and certainty of long-term Guarantees of Origin (GOs) from contracted supplies, encouraging cross-border transactions, and enabling a variety of procurement models and products.

Another trend is the recognition of workers' rights – a topic **pv magazine**'s UP Initiative addressed in the second quarter of this year. A new survey this May by LevelTen Energy, an online marketplace for PPAs, found that demand from corporate renewable energy buyers for improved environmental and social justice measures is growing – a development likely to have wide ranging consequences.

"According to the 2021 survey of 77 project developers on the LevelTen Marketplace, nearly seven out of 10 said they are working to improve organizational environmental and social justice practices as a direct result of buyer demand for additional measures."

Meanwhile, SalesForce, a U.S. cloud-based tech company, published a white paper, "More Than a Megawatt: Embedding Social and Environmental Impact in the Renewable Energy Procurement Process," last October. The aim was to highlight the need for a fast energy transition, and also one that is socially just.

In it, the authors state that buyers of renewable energy should align their request for proposals, bid review processes, and PPAs with worker expectations of Responsible Contractor Policies, as well as best practices of regulators and policymakers "who seek to ensure good local economic and workforce development for renewables projects." They also note that "buyers, with their developer partners, can look for appropriate opportunities to make other business investments and create local jobs in communities disproportionately impacted by energy transition and environmental injustice."

Business models

Historically, the leading business model for the corporate purchase of renewables were physical PPAs, although the virtual PPA market is now said to be the "fastest-growing" transaction structure, according to the Rocky Mountain Institute.

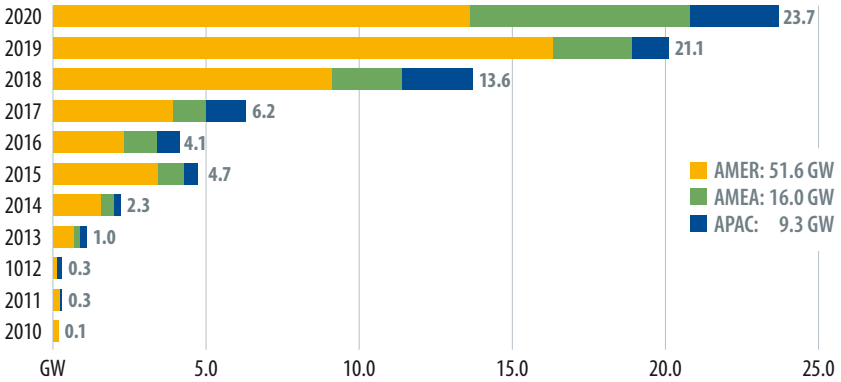
It defines a physical PPA as one where buyers own the electrons produced by a renewable energy project. "This transaction places responsibility on the buyer for monetizing/selling the electrons, which is typically achieved by selling them into the wholesale electricity market. Depending on the contract structure, the buyer could also pay for transmission charges." In comparison, for VPPAs, buyers don't own and are not responsible for the physical electrons. Instead, it is "a financial transaction, exchanging a fixed-price cash flow for a variable-priced cash flow and renewable energy certificates."

Those with enough capital and access to the wholesale power market can build renewable power plants for themselves. Amazon is a prime example. Not only is it the world's largest clean energy buyer, having signed cPPAs for over 7.5 GW, it has also announced 206 renewable energy projects globally. They include 71 utility-scale wind and solar projects and 135 solar rooftop arrays on facilities worldwide.

Green energy can also be purchased via green certificates. Due to low costs, how-

Global corporate PPA volumes, 2010–2020 (GW)

Source: BloombergNEF



Note: Data is through 2020, reported in MW DC capacity. Onsite PPAs not included. Australia sleeved PPAs are not included. Pre-market reform Mexico PPAs are not included. APAC number is an estimate. These figures are subject to change and may be updated as more information is made available.

ever – in Europe, a certificate costs less than €0.01/kW – they have little actual effect on the deployment of new capacity and thus, amount to greenwashing.

The growing storage industry is helping to create new business and investment models, and is starting to address the issue of residual energy. Due to their fluctuating nature, renewables cannot supply electricity 100% of the time. Thus, it is crucial to factor in overcapacity, which is currently expensive and not scalable, leading to the question of how they're compensated.

In the third quarter, **pv magazine**'s UP Initiative will investigate the world of corporate renewable energy purchases, the evolving business model landscape, how issues like residual energy are being addressed, what political measures are still needed to grow the industry, and how greenwashing can be avoided.

Regarding the latter issue, EnergyTag, a non-profit initiative, said in May that it is working on a framework to improve transparency for clean energy purchases. "Current Energy Attribute Certificates – known as Guarantees of Origin (GOs) in Europe, Renewable Energy Certificates (RECs) in the U.S. and Renewable Energy Guarantees of Origin (REGOs) in the U.K. – are issued for each unit (MWh) of renewable electricity. Companies then purchase certificates to meet their annual demand. These schemes, designed over a decade ago, were developed to encourage the growth of renewables from a very low starting point and do not provide the temporal granularity necessary for reaching 24/7 carbon-free energy," it said.

The idea is to add hourly timestamps to electricity when it is generated, so users will know where their power comes from. Currently six demonstration projects are underway in the U.S., Denmark, the Netherlands, Sweden, Norway, and Australia, while over 100 organizations are said to be backing the initiative, including Google, Microsoft, Vattenfall, Statkraft, and Engie.

We will be speaking to the main actors in the market, including experts at BNEF, RE-Source, the Renewable Energy Buyers Alliance, EnergyTag, and Energy Brainpool, a European energy market analyst focusing on energy trading. For more information or to get involved, contact up@pv-magazine.com.

Becky Beetz

Initiative partners

pv magazine thanks our UP Initiative supporters for their guidance and ongoing commitment to sustainability across the solar supply chain.

COVEME
THE VALUE OF INNOVATION

DuPont Teijin Films

nextracker
A Flex Company

Advertisement



pv magazine test

March 2021 results

We are pleased to present the next batch of energy yield results from the test field in Xi'an, China. In this issue, we look at the March 2021 results, alongside additional analysis from George Touloupas, director of technology and quality at CEA.

This is the last batch of data prior to dismantling and the rebuild, as detailed in the previous edition. The upgrade was finished at the end of April, and May generation data will be reported next month.

The chart (top right) provides the meteo station data (irradiance and ambient temperature) for the first 10 days of March 2021, prior to dismantling. No new products were added and the installed samples are the same as last month.

The average bifacial boost is 4.5% for March 2021. Bifacial boost is defined as the extra energy yield of the bifacial products compared to the average energy yield of all mono-facial mono PERC products.

The chart (bottom right) compares different PV module technologies. Bifacials are still performing above all the other technologies, with monofacial mono-crystalline modules having the lowest yield.

Energy yield measurements

- The energy yield comparison, including bifacial boost, will be analyzed using products installed after the beginning of 2019.
- The energy yield is given in Wh/Wp and calculated by dividing the energy produced by the module by the Pmax at STC of the module. This Pmax is the maximum STC power after a process of stabilization.
- The results are grouped per module type.
- Bifacial boost depends on the bifaciality factor, the installation geometry, the albedo of the ground, the sun angle, and diffuse irradiance. The ground in this case is gray gravel.

George Touloupas

Bifacial boost

all in Wh/Wp	Total Dec 2020	Total Jan 2021	Total Feb 2021	Total Mar 2021
Average monthly yield	60.33	84.88	63.36	32.89
Average monthly bifacial yield	66.65	93.25	65.97	33.99
Average monthly monofacial Mono PERC yield	61.36	86.58	63.19	32.52
Operation days	31	31	18	10
Average daily yield	1.95	2.74	3.52	3.29
Average daily bifacial yield	2.15	3.01	3.67	3.40
Average daily monofacial yield	1.98	2.79	3.51	3.25
Bifacial boost	8.6%	7.7%	4.4%	4.5%

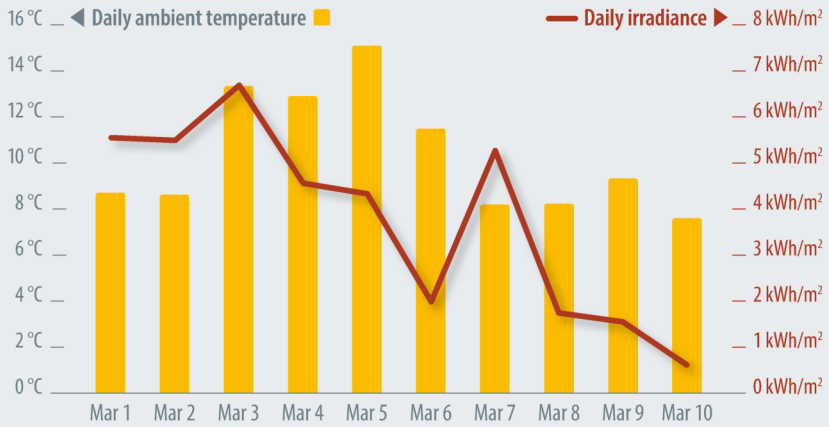
Energy yield ranking

#	Installation Month	Product	Type	Total Dec 2020 Wh/Wp	Total Jan 2021 Wh/Wp	Total Feb 2021 Wh/Wp	Total Mar 2021 Wh/Wp	Dec 2020 Rank	Jan 2021 Rank	Feb 2021 Rank	Mar 2021 Rank
18	Oct-18	LONGi LR6-60BP-300M	Bifacial Mono PERC	71.59	99.52	69.71	35.80	1	1	1	1
26	Aug-19	LONGi LR6-72HBD375	Bifacial Mono PERC	68.72	96.62	68.40	35.21	3	3	2	2
17	May-18	NSP D6L310L3A	Bifacial Mono PERC	69.70	97.25	68.09	35.03	2	2	3	3
1	May-18	Jolywood JW-D60N-305	Bifacial N-PERT	66.09	93.04	66.73	34.45	5	4	4	4
27	Dec-19	JW-D72N-400	Bifacial Mono N-TOPCon	66.44	92.70	65.51	33.83	4	5	6	5
16	May-18	LONGi LR6-60PE-310M 2	Mono PERC	64.90	91.71	65.72	33.59	9	6	5	6
20	Nov-18	Phono PS380MH-24/TH	Mono PERC	65.65	91.59	65.29	33.21	6	9	7	7
14*	May-18	Sample 2	Mono PERC	65.01	91.65	64.86	33.18	8	7	9	8
21	Mar-19	Risen RSM120-6-320M	Mono PERC	65.58	91.63	65.05	33.02	7	8	8	9
10	May-18	Recom RCM-275-6MB-4-BB21	Mono	60.37	84.89	62.61	32.95	18	18	16	10
28	Apr-20	Risen RSM114-6-405BMDG	Bifacial Mono PERC	64.80	90.43	64.00	32.93	10	11	13	11
12	May-18	NSP D6LM305E3A	Mono PERC	63.61	90.72	64.24	32.92	11	10	10	12
8	May-18	Aiduo AD280-60S	Mono	62.73	89.96	64.17	32.86	15	12	11	13
9	May-18	Aiduo AD265-60P	Multi	63.17	89.35	64.06	32.71	14	13	12	14
3	May-18	Risen RSM60-6-270P	Multi	63.46	89.21	62.41	32.39	12	14	17	15
4	May-18	Perlight PLM-300M-60	Mono PERC	61.84	86.01	61.59	32.24	17	17	18	16
22	May-19	Znshine ZXP6-60-275/P	Multi	63.17	87.78	62.70	32.22	13	16	15	17
2	May-18	Phono MWT-60-280	Multi MWT	62.58	88.35	63.03	32.19	16	15	14	18
29	Jul-20	CSI CS3U-390MS	Mono PERC	48.65	69.87	60.12	32.07	20	20	20	19
31*	Oct-20	JA JAM60S10-345/MR	Mono PERC	57.13	81.53	61.33	32.01	19	19	19	20
30	Jul-20	GCL GCL-M3/72H380	Cast Mono PERC	48.14	68.47	59.78	31.87	21	21	21	21

**Purchased products from the market, which bypassed the random sampling process. Rest of the products are provided by the suppliers.*

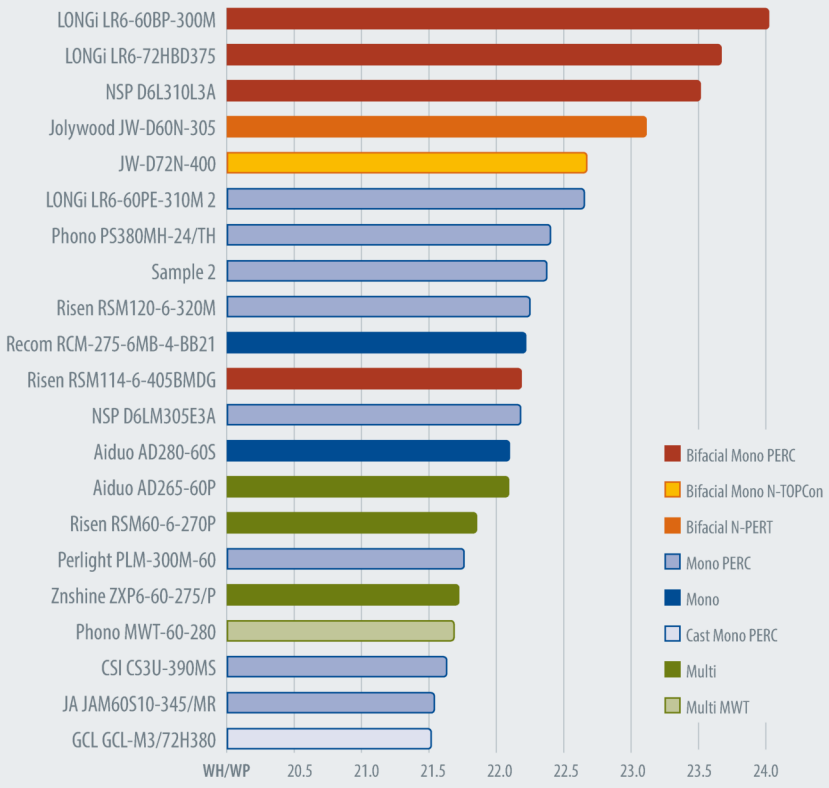
Daily temperature and irradiance data *(March 2021)*

Source: pv magazine test data



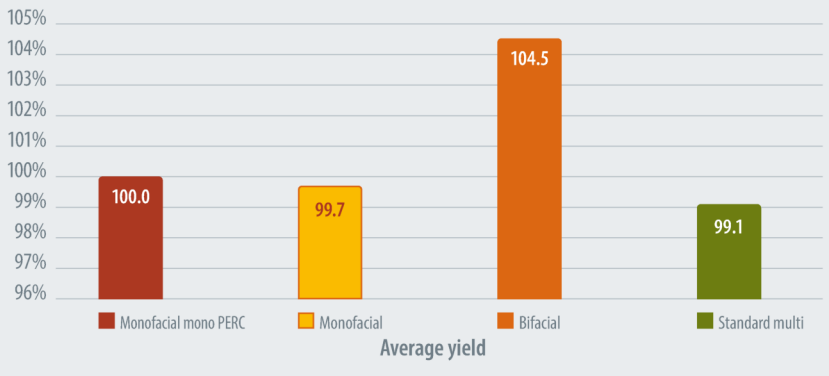
Total energy yield *(March 2021)*

Source: pv magazine test data



Relative yield of different technologies *(March 2021)*

Source: pv magazine test data



VERY GOOD
pv magazine test
MODULE

Test cooperation

pv magazine test is a cooperative effort involving **pv magazine**, CEA and Gsolar. All testing procedures are carried out at Gsolar's test laboratory in Xi'an, China. CEA supervises these tests and designed both the indoor and outdoor testing procedures.

CEA Clean Energy Associates
GSOLA®

Dial manganese for stability

Often sidelined by nickel and cobalt when it comes to batteries, the metal manganese is finding proponents in science and industry – in particular, by those attempting to avoid supply and cost issues. Ian Morse reports on the role of manganese in battery cell production.



Mixed cathode material extracted from a spent battery. Low prices provide little incentive for recyclers to recover manganese, but this could change as demand for the metal increases.

Photo: David Baillot/UC San Diego Jacobs School of Engineering

Manganese is making a comeback in the battery world. In March, Volkswagen said a significant portion of its popular vehicles will have high-manganese batteries. Chinese battery maker SVOLT is supplying carmaker Great Wall with a quarter-maganese cobalt-free cathode, and Tesla's mid-range vehicle line-up is also set to rely on a cathode with a composition of one-third manganese. And, in a recent white paper, Roskill reported manganese-rich chemistries were the focus of most new battery research.



The shifts away from nickel and cobalt have long been expected, but the question about what would fill the gap has lingered. Manganese has the potential to bring both supply stability and chemical stability to the cell.

"It doesn't surprise me that materials manufacturers want to go toward manganese, because it's inexpensive, and the cathode makes a significant cost of the battery," Jason Croy at Argonne National Laboratory, told **pv magazine**.

The heavy metal has a long history in battery science, but in the past decade it has been sidelined to the more sensational nickel- and cobalt-rich chemistries. Its prominence in batteries has shrunk alongside cobalt; from nickel-manganese-cobalt (NMC) 111 batteries to the more popular NMC 811 now. The numbers in the particular "recipes" indicate the relative ratios of nickel, cobalt and manganese cathode composition, respectively.

As the battery industry matures and manufacturers pay more attention to the supply issues of nickel and cobalt, some are increasingly seeing manganese as an "issue-free" option. A 2020 Nature paper deemed it more "environmentally benign" than cobalt and nickel. A report from think tank Hallgarten & Company calls it the "least problematic battery metal." Compared to many other cathode options, manganese is more abundant, cheaper, and devoid of intense consumer scrutiny.

While EV makers are worried about material shortages and bottlenecks, manganese offers more stable supply, as well as more stable chemistry as other metals are abandoned. The IEA recently noted that manganese demand would increase eight times in fulfilling the most aggressive sustainable development scenarios, and three times in the stated policies scenario. More high-profile elements like lithium and cobalt would increase significantly more, but scientists think manganese could play a much larger role and reduce the pressures on other mineral supplies.

"In our opinion, one of the reasons we're interested in manganese is that a market is not going to be sustainable if it's dependent on one element like nickel. Every EV in the world is not going to be 90% nickel," says Croy. "It only seems logical to broaden the portfolio of materials, even if you're not going to have something that's the highest energy density material that's possible."

"Compared to many other cathode options, managese is more abundant, cheaper, and devoid of intense consumer scrutiny"

"In theory, lithium-ion batteries could have 90% of their manganese recovered"

Manganese has been a small part of the composition of EV batteries; there may be more manganese in the steel casing of a car frame than in a battery. However, evolving understandings of mineral supply chains and consumer choices may make manganese a core part of EVs.

Potential crunch

The manganese market is already robust and large, providing vital components for the steel industry. But batteries require a form of manganese that hasn't previously been in high demand. The manganese that has traditionally been used in steel and aluminum alloys comes from a smelting process. Batteries like NMC and lithium-manganese-oxide (LMO) require dioxides and sulphates, which complicate legacy producers' ambitions to ride the wave of battery demand.

Batteries comprise a small portion of global manganese demand, but as EV makers begin to seek stability, batteries have the potential to dominate the market, says Xin Sun, a researcher at Tsinghua University who wrote on manganese supply for batteries last year.

"If LMO batteries become mainstream, demand for manganese could increase tenfold," he says. "Battery demand will then be the most important part of manganese's consumption mix."

Manganese supply is concentrated in a few countries and processing is largely dominated by China, as with other battery metals. However, manganese is widely distributed around the world in places that are beginning to build up capacity to process manganese oxide, which can be used in battery manufacturing. As China's industrial boom slows and environmental rules inch higher on the policy agenda, it may seek to shift manganese processing and sourcing offshore.

Not every company is building up manganese production in traditional ways. In Europe, Euro Manganese plans to provide half of the bloc's predicted demand to 2025 by revisiting mine tailings. The Chvaletice project in the Czech Republic can produce battery-grade manganese from a former pyrite open-pit mine, and it plans to open in 2022.

South African companies stand to benefit from a manganese boost. A report this year from the think tank Trade & Industrial Policy Strategies found that South Africa is party to a quasi-monopoly on manganese ore production. The country hosts 80% of known resources, which it has turned into about one-third of global production. Most ore is sent outside the country for processing due to rising electricity costs and disruptions at home, but the only major refiner outside of China, Manganese Metal Co., is located in South Africa and has a reputation for high-purity products.

The same report found that the manganese market was much more resistant to price shocks than other battery metals, in addition to being one of the cheapest. As manganese consumes more and more of the market that was once held by nickel- and cobalt-rich batteries, supply may have trouble keeping up, in which case prices could rise.

"The supply of battery-grade manganese dioxide could become a bottleneck when the technological route changes. Its price may skyrocket, as lithium carbonate and cobalt sulfate did in 2017-18," says Xin Sun. "The potential reason is that output of manganese dioxide may not be growing as fast as demand."

Re-use it

Recycling has the potential to avoid this bottleneck, although most manganese recycling has so far targeted scrap from steel manufacturing. Manganese itself has not been a target of most recycling, but in theory, lithium-ion batteries could have 90% of their manganese recovered. Most battery recyclers don't spend the money to recover manganese when prices are low, but if miners have trouble building projects, prices may rise and recyclers could play a bigger role.

"Recovery of manganese from steel slag is critical to improve manganese recycling," says Xin Sun. Even in steel scrap, the proportions of manganese are often too low to worry about recycling, but they can be a large source of recycled materials.

With the absence of recycling options facing a predicted uptick in demand, companies are only just beginning to mobilize, but with caution. It's not yet certain whether manganese will grow in importance as some anticipate.

This uncertainty hasn't stopped proponents of deep-sea mining in the Clarion Clipperton Zone, which point out that the industry could produce several times the manganese required by even the most aggressive climate policies. However, seabed miners have not yet proven that they can reduce risks to ecosystems and peo-

Photo: South32



Manganese mining in South Africa. The country hosts 80% of known resources, which it has turned into about one-third of global production. However, most of the ore is shipped abroad for processing.

ple, as well as a valid business case that can fit within strict regulations. Opponents of the practice note that there are other ways to fulfill or shrink demand before it's ever necessary to dredge unknown parts of the Earth. More likely, legacy players distributed around the world on land will build up manganese dioxide plants.

"Battery-grade manganese dioxide is likely to have the same price spike as lithium [and] cobalt if commercialization of the lithium-rich manganese base material is achieved," says Xin Sun.

Stable cathode crystals

A few years ago, Croy and scientists at Argonne set themselves a goal: engineer a battery that was as energy-dense as the prominent NMC-622 battery, but with 50% manganese and no cobalt.

"A cathode like that we think has a place in this massive energy storage future, specifically in terms of sustainability and supply chains," Croy says. More abundant and cheaper manganese could lighten the load on nickel and cobalt, as well as target specific market niches.

In a battery cell, manganese has played a largely "spectator" role, Croy says. It's not directly involved in electro-chemical processes, but it provides a critical role in stabilizing the cathode as lithium is taken out and the cathode approaches high oxidation. Cathodes with these kinds of stabilizing metals, like lithium-iron-phosphate, regularly rank higher in safety.

Designing a manganese-rich cathode has thus come in conjunction with designing a lithium-rich cathode. With additional lithium, the battery has added capacity and the manganese ensures that the cathode structure doesn't collapse. In essence, the manganese provides enough stability for more lithium to be used to store and release energy. These batteries, also invented by Argonne scientists, typically have 5-10% more lithium, one-third manganese, and more than half nickel. In some cases, they've been able to reduce the cobalt content down to 4% and still achieve performance that rivals NMC-622, which is 20% cobalt.

"It turns out for these lithium-rich materials, that manganese is one of the most attractive options. Not only is it abundant and cheap, but it tends to form these structures that we like when it comes to excess lithium," Croy says. Stability, though, continues to be an issue. The trick to achieving high-manganese, cobalt-free, lithium-rich cathodes, he says, is designing the cathode on an atomic level.

"The problem is that the structure is not as stable over long-term cycles, like a layered oxide like [NMC-622]," says Croy. "So that's pretty much where all the work is going right now, to engineer those local structures to make them behave like we need them to." pv

Ian Morse

New support for Europe's green transition

The European Commission will propose a number of new laws this summer and fall that are set to boost investment in renewable electricity and green hydrogen, reports Andreas Walstad in Brussels.

The Revised Renewables Directive (RED lll) under the "Fit for 55" package, set for release in July 2021, is expected to see the 2030 renewables target increased



A container ship bound for Hamburg. Planned reforms to the EU's Emissions Trading System may also include the shipping industry, which could increase demand for allowances.

Photo: Roel Hemkes

In July, The EU is expected to raise the 2030 renewables target to

38-40%

of final energy consumption



Photo: CMS

to at least 38% to 40% in final energy consumption, up from 32% currently. This is to better align the target with the EU's goal of reducing greenhouse gas (GHG) emissions by 55% by 2030 compared with 1990 levels, up from the previous 40% target.



At first glance, a revised 2030 target seems to be a significant boost for solar power and other renewable energy. The EU's 20% by 2020 renewables target, for example, was instrumental in getting renewables projects off the ground.

"A 38% to 40% renewables target by 2030 would be significant. The target will support further growth in solar auctions and PPAs also in emerging markets such as Bulgaria, Croatia, Romania and Hungary. But power is the easy bit – the new target should also support decarbonization of the heating, cooling and transport sectors," Coralie Laurencin, senior director for European power, renewables and climate at IHS Markit told **pv magazine**.

The 20% by 2020 target was binding and broken down to national targets depending on member states' starting point and renewable resources. The 2030 target, on the other hand, is an EU-wide target and is not legally binding. Yet many think this softer regime will be enough to support growth at least in mature renewables technologies.

"I do not think it is a big issue for solar PV that the target is not legally binding for member states. Solar faces a lot fewer hurdles than wind when it comes to planning permission and public opposition. And governments are very much aware of that," said Laurencin.

Some say even a 40% renewables target may be too modest to align with the 55% GHG target for 2030 and the 2050

> *"There is a lot of goodwill toward renewables at the political level and solar stands to benefit"*
>
> **Dalia Majumder-Russell**

Photo: Uniper



Upcoming revisions to the EU Gas Directive are expected to include details on how transportation networks for green hydrogen will be operated. The changes will set rules to retrofit existing gas networks, as well as rules for gas blending.

net-zero target. WWF, for example, is calling for a 50% target, while SolarPower Europe is calling for an even higher 55%. Yet an overall 38% to 40% target would likely mean doubling the share of renewable generation.

"(A) 38% to 40% renewables is a significant increase to the current levels, especially as 2030 is only nine years away. I think we may see more regional cooperation, such as statistical transfers and joint projects, to attract foreign investment," Dalia Majumder-Russell, a partner in the energy, projects and construction team at law firm CMS, told **pv magazine**. "There is a lot of goodwill towards renewables at the political level and solar stands to benefit because it is an established technology with a relatively well understood regulatory framework."

EU carbon prices have risen to unprecedented levels despite the Covid-19 pandemic and lower demand for energy. The Benchmark DEC 21 contract closed above €56/ton on the ICE exchange on Friday 14 May, up from around €20/ton the same time last year.

The price rally has been driven by regulatory reforms and the decision by the EU institutions to limit the supply of allowances and take credits out of the market if the number reaches certain thresholds, also known as the Market Stability Reserve. The bull run in carbon prices has led to a sharp reduction of coal-fired power generation across Europe, much to the advantage of solar and wind. Even older gas-fired plants may struggle to be profitable if carbon prices continue to rise.

Coal-fired generation decreased by 20% year on year in the 27 EU countries in 2020, according to data from the European Commission and Agora Energiewende. At the same time, generation from solar installations increased by 15%.

The July package will include a proposal to further limit the supply of allowances – the linear reduction factor – and possibly to include the shipping sector under the ETS. The latter could bolster demand for allowances further. Including shipping under ETS has support from the European Parliament, but the question is if member states will also come onboard.

"In the next few years, we are going to see funds from multiple sources pouring into building renovation"

Carbon price rally

The July package will include a number of other legislations that are relevant for the PV industry. Further reform of the EU's Emissions Trading System (EU ETS), for example, could support a continuation of the price rally witnessed in recent months.

"The solar industry is not shielded from ETS reform as higher carbon prices could affect the supply and cost of materials. But the EU ETS needs reform if governments are to meet their net zero aims. Higher carbon prices are helpful for changing investors' mindsets. Including shipping is

a good idea, but it will be difficult as it is a very international industry with many stakeholder interests to manage," said Majumder-Russell.

Rebuilding buildings

Brussels may also table a separate ETS for transportation and buildings. The Energy Performance in Buildings Directive is also up for review this summer, and more ambitious targets for lower energy consumption are expected. That would be a boost for solar panel installations in buildings, for example.

The building sector is one of the largest energy consumers in Europe, accounting for around 40% of energy demand. Many of Europe's ageing and inefficient buildings rely on fossil fuels for heating and cooling. But the EU's €672.5 billion post-Covid-19 recovery package could help accelerate the renovation of buildings. Support will also come from the European Structural and Investment Funds and from the European Fund for Strategic Investment, according to European energy commissioner Kadri Simson.

"In the next few years, we are going to see funds from multiple sources pouring into building renovation," Simson said in a recent speech.

Green hydrogen

The EU Gas Directive is outdated and a new proposal is expected in the fourth quarter of this year. The revised directive aims to outline how transportation networks for green hydrogen will be operated, and will set rules for retrofitting existing gas networks as well as gas blending. This is key for the scaling up of green hydrogen projects.

One of the main sticking points is if transmission system operators (TSOs) should be allowed to own and operate electrolysis facilities converting water to hydrogen using renewable energy. The unbundling obligation under the current gas package – which came into effect in 2012 – states that companies cannot operate production, supply, and transmission assets as a vertically integrated business. This is to avoid conflict of interests by restricting competitors' access to pipelines, for example.

A stakeholder consultation revealed that many energy companies want the principles under the existing gas package to be transferred to the hydrogen sector. For example, solar power producers should get fair access to electrolyzer capacity if they want to convert the electricity and ship it to customers in the form of hydrogen or otherwise.

EU carbon price soars (€ per ton)



> *"...solar power producers should get fair access to electrolyzer capacity..."*

"This package should reinforce the key principles of liberalization," said E.On in its reply to the stakeholder consultation. "Regarding unbundling, it should be made clear that emerging technologies such as electrolyzers are not natural monopolies and, hence, cannot be owned or controlled by TSOs/DSOs."

A number of energy companies have also called on the commission to set specific targets for renewable gases – for example, 11% of European gas demand by 2030 as proposed by Eurogas. Many stakeholders – EDF, Engie, Shell and Total among them – also support an EU-wide market for tradable Guarantees of Origin for low-carbon gases and electricity. Such measures may fall under the scope of both RED lll and the Gas Package. The stakeholder consultation for the Gas Package closes on June 18. pv

Andreas Walstad

Update: solar hydrogen in Europe

Smartenergy is driving solar hydrogen production in Portugal. Christian Pho Duc, the company's CTO and managing director H2 projects, discusses the EU regulatory environment, costs, and his motivation to equip photovoltaic plants with electrolyzers.



Photo: Smartenergy

> *"€1.50/kg is ambitious but reachable by 2030 or even earlier for large-scale projects"*
>
> **Christian Pho Duc**

At the pv magazine Roundtables Europe event last year, you presented your plan for green hydrogen production in Portugal, in which you couple a utility-scale PV plant with an electrolyzer. What's the status of the project?

We continued our development at full pace, [even though] the legislative and permitting framework is not yet fully in place. The project has been shortlisted by the Portuguese IPCEI [Important Project of Common European Interest] selection process and we are front-runners at the various entities for registering and permitting the project.

There is still a lot to be done on the regulatory side, but you've reported that the regulations are evolving. What do you mean by this and what remains to be done?

Following the launch of the EU hydrogen strategy and the increase of climate action goals, the [European Commission] is expected to launch the proposal for a complete regulatory framework on hydrogen this year. Discussions are ongoing in the context of, among others, the revision of the REDII, the Alternative Fuels Infrastructure Directive, the EU ETS in connection with the Carbon Adjustment Mechanism, and the EU Taxonomy.

Going a bit deeper, what is particularly important for you as project developer and investor in the solar and hydrogen space?

The introduction of the additionality principle, meaning that hydrogen projects shall only be fed by electricity from additional RES, should happen in a phased approach. Imposing too demanding restrictions with respect to time and geographical correlation at the very start of the enabler projects can stop the required momentum. In terms of EU Taxonomy, the threshold for carbon emissions by hydrogen production should be set low enough that subsidies go to RES-based hydrogen – meaning the value of 2.256 $tCO_2eq/tH2$ should not be increased further. … 2021 will be decisive for the development of the hydrogen framework at the EU level, but national regulation has to follow. In order to accommodate the development of green H2 projects, we urgently need clear definitions of renewable H2, less complexity in the licensing procedures, definitions for technical regulations to access the gas grid, and suitable territorial instruments that enable the production of green hydrogen outside of industrial areas to co-locate PV or wind with electrolyzers. [But] 2030 is only one investment cycle away and therefore, despite the strong commitment of the EU industry toward the energy transition in Europe, the uncertainty associated with the regulatory framework may jeopardize timely investments into green H2 projects.

We've already reported on projects claiming that in the near future, they will be able to produce green hydrogen in southern Europe for €1.50/kg. Is this reasonable? What are your cost expectations? Which costs have to be included in a serious comparison?

The most decisive factors on the achievable cost of hydrogen (LCOH) are the electricity costs (LCOE), the loading factor which you can achieve, and the electrolyzer cost. Assuming optimum conditions, €1.50/kg is ambitious but reachable by 2030 or even earlier for large-scale projects – excluding works. However, often current business cases don't see the full reality and are overly optimistic. For example, you cannot only put the capex cost expectation of the electrolyzer in your project – what about the local EPC, all the auxiliaries, and other balance of plant (BOP), which in smaller projects can be more expensive than the electrolyzer? Also, on the LCOE – if you plan to use the grid with a dedicated PPA besides a potential direct connection to RES, grid fees apply which can kill your business case. Given the additionality principle, this PPA also cannot necessarily balance your electricity supply and you may end up with a lower loading factor. And obviously you have to consider the logistics and transport costs, which are very important, until a dedicated pipeline network for H2 will be available. In our projects in Portugal and Spain we are calculating – depending on the specifics – LCOH ex-works between €3/kg and €5/kg. These are the kind of projects happening now to enable the scaling to achieve the intended cost below €2/kg for projects in 2030.

One cost factor is full load hours with which you can operate the electrolyzers. PV has lower full load hours in the northern latitudes, while wind generally has more but higher generation costs. What is your strategy when it comes to the geography of green hydrogen production? Do you think solar PV+electrolyzers in northern Europe is a possibility? How competitive is it in southern Europe?

Smartenergy has a strong focus on PV and we are targeting sites in southern Europe – such as Portugal, Spain and Italy. Although the loading factor is an important parameter, with the expected reduction of electrolyzer costs, the load factor as provided by PV, at approximately 30%, can be the best choice. Combination with other RES, in particular wind, is feasible with a combined load factor of above 50%, and should be absolutely developed. As mobility and transport of hydrogen will remain costly until a dedicated pure hydrogen pipeline system will be available in 10+ years, decentralized projects with dedicated off-take in industry and mobility can be competitive also in northern Europe instead of imported from the south. On the other hand, the more competitive conditions for H2 generation in southern Europe may also attract corresponding industries to "re-locate" over time. The production of ammonia could be one example.

Are investors already interested in investing in PV-sourced green hydrogen generation? And what are your plans for the future?

For Smartenergy, adding H2 to our RES portfolio is both an investment opportunity and a hedging mechanism to reduce risk on pure PV and wind investments. PV merchant prices are expected to decouple more strongly than other energy sources being by far the cheapest electricity at levels below €25/MWh, depending on the location. Making use of this development with hydrogen projects is a great opportunity for new PV projects. But until a commodity market for hydrogen develops, the targeted application and off-take matching with the project is key. pv

Interview by Michael Fuhs

> *"Making use of this development with hydrogen projects is a great opportunity for new PV projects"*

Advertisement

pv magazine group

NO TRADE SHOWS?
NO PROBLEM!

Launch your product online with pv magazine!



Get in touch
sales@pv-magazine.com

Return of the sun tax

Australia's success with widespread residential take-up of solar PV installations may be facing a stumbling block, a new proposal by the Australian Energy Market Commission (AEMC), the rule maker of the nation's grid. And for solar veterans, the development summons the ghoul of Spain's infamous "sun tax."

The draft rule determination, or guidelines for all players in the industry, handed down by the AEMC in March focuses on Distributed Energy Resources (DER) – and follows nine months of consultation with stakeholders. The final determination for DER, following a public consultation process, is set for July 2021. The current format in the draft includes a fee to be paid by energy-exporting households. It's quickly been dubbed a "solar tax" by critics.

This marks the second attempt by the AEMC to establish an export charge. In 2017, the regulator also published a draft report on the Distribution Market Model, with reasoning for a solar tax. After a backlash, the final report removed the tax.

Now with a second effort, how bad can it be?

The Australian way

The AEMC's draft rule determination didn't go unnoticed. Interest groups were quick to disparage the Australian government's approach to renewable energy.

While the residential segment stands out, the growth in Australia's C&I installations is also impressive, such as this 1 MW system at G.James, the country's largest integrated glass and aluminum manufacturers in Western Sydney.



Photo: Verdia

Australia, the sunniest continent in the world, has shown a perplexing hesitancy to fully embrace renewables.

However, rooftop PV uptake by households has been a true bright spot in the country. The AEMC's own figures suggest that around 20% of all grid connected customers have rooftop PV installed, and are able to sell excess electricity into the grid. As recently as 2007, the same figure was less than 0.2%. By 2030, the nation's small-scale solar generating capacity is expected to triple.

Part of the success has been generous subsidies and feed-in tariffs, with billion-dollar grants in the late 2000s and early 2010s dubbed "middle-class welfare" by critics. However, with the industry given a kickstart by governments, success followed through growing awareness, improved installer experience and expertise, economies of scale, and indirectly related technological advancement.



On the other hand, Australia has offered limited subsidies for other green initiatives. Despite Australia's rich offshore wind resource, offshore wind projects have been slow to get off the ground, with the first project, a massive 2.2 GW scheme, only approved in 2019.

Electric vehicles account for just 0.7% of total Australian car sales in 2020, compared with 10.7% in the UK, and California's 8.%. Despite this, the state of Victoria, proposed an AUD 2.5 cent/km tax on electric vehicles, described as "the worst in the world."

Behind the "solar tax"

The AEMC announcement said the driving force behind the rule change is the shift from one-way power delivery, to rooftops delivering large-scale exports to the grid during the day.

The AEMC states: "The system wasn't designed for power flowing both to – and from – consumers. Because of this, so much solar potential is locked away. Not everyone can export their solar energy because of daytime 'traffic jams' on the network."

A strong critic of the draft rules, Professor Bruce Mountain, Director of the Victoria Energy Policy Centre at Victoria University, argued to **pv magazine** that driving forces were politically motivated.

"What's really behind it, I think, is [that] the first job of government is to look after government. It's central authorities trying to centrally coordinate things; not keen on a distributed power supply and microgrids; the devolution of electricity to local production. Something like that, where they are not in the center, nor controlling, goes against their DNA."

Mountain insisted the evidence doesn't stack up. "I've put all of my arguments [against this draft ruling] on the evidence. The evidence is that connecting distributed solar costs two-thirds of nothing. It's not arguable. There is no cost rationale for this." Mountain also argued that Australia's retailers just "flat out don't like solar."

"The retailers, generally, don't like solar. They'd obviously rather customers were buying from them directly. And they're further worried about customers taking a battery … and when they have a battery, customers use about everything they produce. And they then make no money out of customers. And solar is seen as a stepping stone along the way, and they don't like it."

Photo: Victoria University



"The retailers, generally, don't like solar. They'd obviously rather customers were buying from them directly"

Professor Bruce Mountain

Photo: Suntrix



The state of South Australia has seen rapid coal generation retirements and surging rooftop PV.

"The reality is, it'll make solar a lot less attractive. The social license of the market will be badly damaged."

What's proposed: the detail

While the AEMC draft ruling only allows for the distribution networks to pitch a new method of pricing during the regulatory phase, it does model likely costs:

A household PV installation of around 4–6 kW, currently earning around $970pa on average, would incur a AUD 70pa charge.

Installations across multiple roofs on Australian homes have become increasingly popular.



Photo: Penrith Solar

Smaller systems of around 2-4 kW, currently earning an average of around $645pa, may earn around $30 less, on average, from their exports.

The changes, as currently presented, would take some years to affect households.

Following the AEMC's final ruling, distribution networks in each state will need to submit new plans for determinations by the Australian Energy Regulator. The next renewal of these policies happens on an individual state-by-state basis – with the states' renewals occurring between 2024-2026. Therefore, possible export pricing changes are as much as five years away; if the states agree.

State support splinters

Already, and unusually, state support for the AEMC's draft ruling is unravelling. Two states, Victoria and Queensland, have signaled their opposition to the tax.

Victoria opposed the move during the AEMC's initial consultation process in September 2020, with the department of environment, land, water and planning noting in its submission: "The Victorian Government does not support export charging, as the case for implementing this element of the proposed reforms has not been demonstrated at this time."

Queensland's state energy minister, Mick de Brenni, also opposed the rule change, and was quoted in an online newspaper last week as saying, "My department is preparing a response to the proposal and I expect it will indicate that system-wide measures, especially investment in more storage, will encourage more solar and are preferable to the proposed rule change."

Professor Mountain explained that because the AEMC was established by the states, public disagreements are rare, even if private discussions are robust.

"The states generally don't want to have a blatant fight with regulatory authority, most notably with the AEMC, which the states set up in 2005 as an accountable body, and they agreed to the AER on the condition the AEMC make the rules," said Professor Mountain. "They are loath to argue with it publicly."

PV disincentivized

From a sample of Australians polled by **pv magazine** Australia, households haven't fully comprehended what might be to come but are worried.

Chad Bennett, a new property owner in Newcastle, NSW, said that he'd been considering PV installation on his recently purchased existing home, until now.

"An upgrade to solar makes sense on a number of fronts for us, and it's something that we're definitely considering in the near future," said Bennett. "Any pricing changes or tax would definitely have an effect on the decision, given the installation would be a substantial outlay. It's disappointing that something positive could be disincentivized."

Another prospective solar buyer, and engineer, Avinash Raju, confirmed his opposition to any tax.

"I am in fact a huge fan of renewable energy, particularly solar," said Raju. "I was annoyed about the fact that they even reduced the export rate in the first place, let alone this tax on the sun they are proposing."

"I believe that a well-engineered smart grid system has the capability to manage any export problems. But taxing the solar owners won't solve this and will hurt Australia's efforts to increase renewables."

Spain's infamous PV tax

Spain's so-called "sun tax" (or solar tax) era is now over, but it shows the dangers of disincentivizing solar. In Spain, a self-consumption tax was established in 2015 by the then conservative government, which argued that a "backup charge" was required to take into account the availability of the electricity grid.

Jose Donoso, Director General, Unión Española Fotovoltaica (UNEF), told **pv magazine**, "Everyone knew this tax was to ensure solar and self-consumption would grow more slowly."

In effect, the tax levied a charge on every kilowatt-hour generated even if it was used for self-consumption. In an analogy, Donoso explained it would be like having an apple tree yet having to pay tax on each apple you ate.

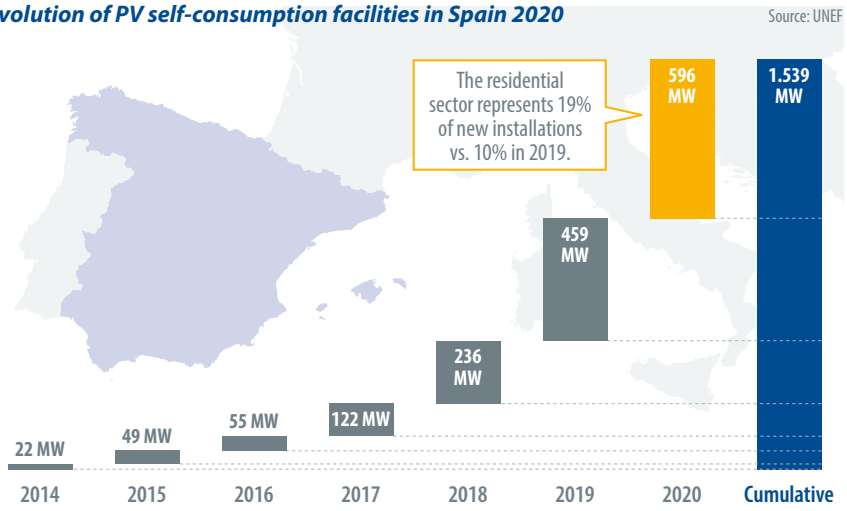
"It was an irrational tax, on something that came free from the sun. We spoke and campaigned with everyone regarding this. Once we explained it was a tax, a tax on the sun, everyone understood it was unfair," said Donoso. "The other side was that households almost completely stopped installing new PV."

"The government at the time said self-consumption was just for rich people, and therefore, the poor people [without PV installed] would need to pay for rich people. But we showed how the PV installations would reduce the electricity price for everyone. Now, again, after this tax was removed, solar is growing."

The data agrees: Spain doubled current installed capacity in the first year post-tax and continued to grow.

Evolution of PV self-consumption facilities in Spain 2020

Source: UNEF



Unfair application

Spain still has a general generation tax in place, called the Tax on the Value of Electricity Generation, a generation tax of 7% applied uniformly on all who export power, from small PV installations to large generators of all types. Donoso confirmed that UNEF has less opposition to this tax, as it is applied to all.

In the state of Minnesota, in the U.S., a tax of $1.20/MWh produced applies to installations larger than 1 MW. Others under this nameplate generation capacity are exempt.

In Australia, Mountain explained that this proposed tax will only be applied to households and residential installations, and not on large wholesale generators, and that would be a bad look once scrutiny intensified.

"The politics of charging for network usage at a retail level, but not wholesale level, stinks. You can just picture the shock jocks on the radio, calling the state minister in, saying: 'So you're happy to charge households to use the grid, but these big generators, you're not charging, can you justify it?'," said Professor Mountain.

The AEMC's initial deadline for feedback and submissions was May 13, however, that has subsequently been extended out to May 28, with the regulator noting "strong interest." A public forum will also be held on May 20. *Tristan Rayner*

AEMC estimates that

20%

of all grid-connected customers in Australia have rooftop PV installed and able to export to the grid

Probes confront EU market

The European Commission's antitrust investigation into EPEX Spot has revealed barriers for the integration of renewables in wholesale power markets. Challenges appear in a range of European marketplaces, but investigations and reforms appear to be clearing barriers to entry.

The European Commission (EC) announced in late March that it had opened a formal investigation into EPEX Spot to assess whether the Paris-registered power exchange had been taking advantage of its dominant position on intraday markets in at least six EU member states: Germany, France, the Netherlands, Austria, Belgium, and Luxembourg.

On intraday markets, sellers and buyers of electricity can trade power up to five minutes or even seconds before the electricity is injected into the grid. Hourly, half-hourly, and quarter-hourly contracts are also available. The intraday markets play an essential role in balancing the network and for using renewable technologies such as solar and wind efficiently. This is because output from solar PV and wind can be forecast most accurately just prior to production.

Competition concerns

Market observers told **pv magazine** that the "competitor" that may have been "hindered," as referred to in the commission's press release, is Nord Pool Spot. The Oslo-registered power exchange offers intraday services in many of the same markets as EPEX Spot. EPEX Spot has allegedly been restricting access to its order book for Nord Pool Spot customers, hence making it difficult to match bids and offers across markets. A shared order book between the two exchanges could have resolved this issue, market observers say.

"A shared orderbook means all traders have the same opportunities to trade as they can see all the bids and offers. Let's hope the antitrust investigation will improve the current situation," said Axel Baudson, an independent energy consultant and Member of the Board at European Commodities.

"The alternative would be for the European Commission to update the CACM [Capacity Allocation and Congestion Management] network code, but this would take a long time to implement."

An analyst monitors Germany's transmission grid at a 50Hertz control center. The EU's intraday market mechanisms play an important role in balancing networks and allowing more output from solar and wind into the system.

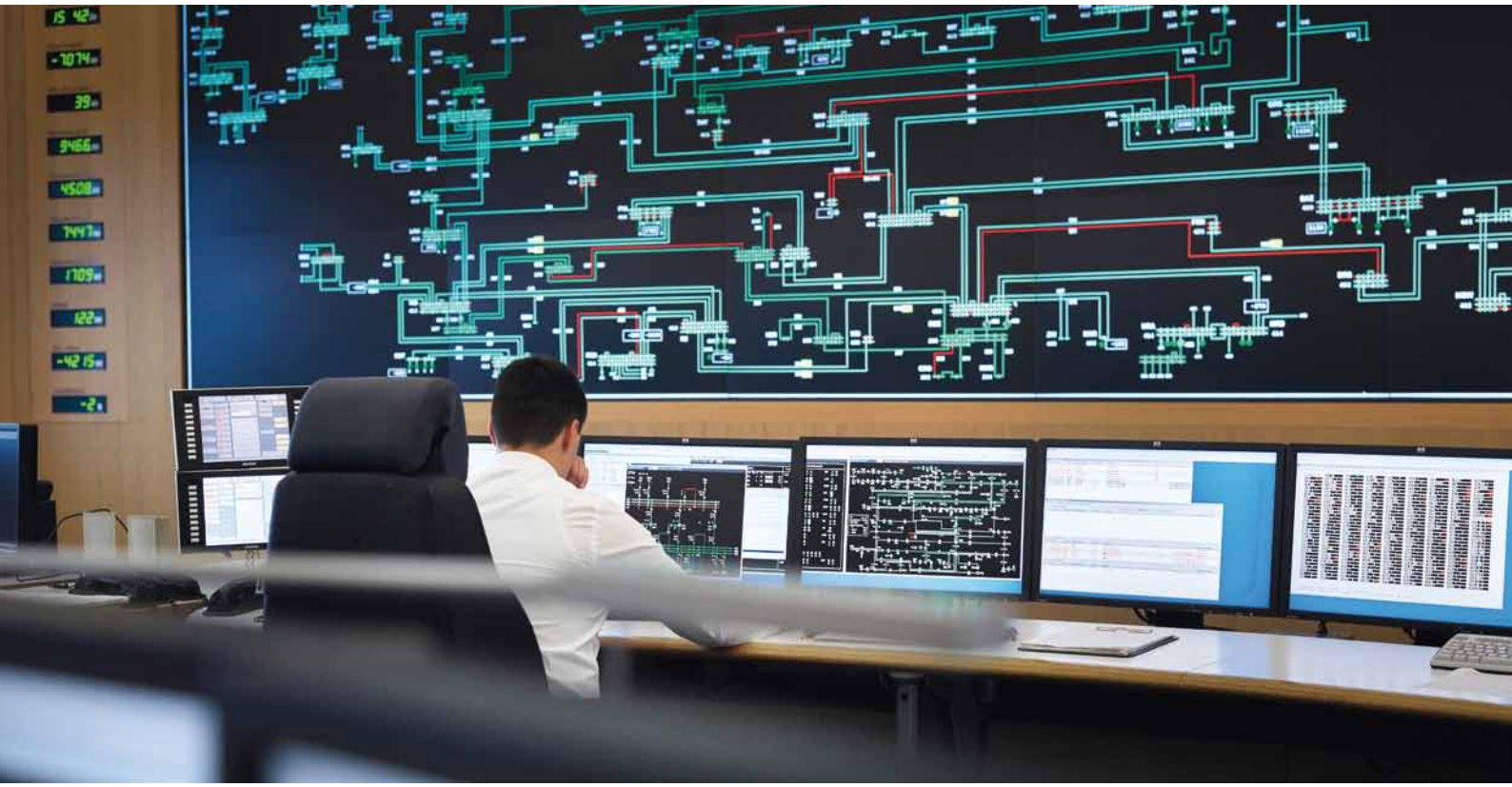


Photo: 50Hertz

barriers

Antitrust outcomes

If the commission's investigation finds proof of alleged abuse of dominant market position by EPEX Spot, the company could be in breach of EU antitrust rules under Article 102 of the Treaty of the Functioning of the EU. It said barriers on intraday markets could slow down the energy transition by preventing cost-effective integration of renewable technologies into the electricity mix.

"Without properly functioning intraday markets, you cannot integrate solar and wind. It increases balancing costs and makes it more expensive for new renewables which compete without subsidies. Proper market design is key for traders, key for TSOs," said Baudson.

EPEX Spot is the largest power exchange in several countries on the European continent, while Nord Pool Spot is the dominant exchange in the Nordic Countries. In April alone, around 10.6 TWh of electricity was traded on EPEX Spot's intraday markets, a new monthly record. By comparison, the day-ahead market saw around 40.3 TWh traded the same month.

The intraday market on Nord Pool Spot is much smaller; around 2.7 TWh of intraday electricity was traded in April compared with 74.1 TWh on the day-ahead market. Nevertheless, EPEX Spot said in a statement it is "fully committed to cooperate in good faith with the authorities" and to continue a "constructive dialogue" with the commission. "As long as the investigation is ongoing, EPEX SPOT is not in a position to comment beyond the information published by the European Commission," the statement added.

Spotlight on EPEX

It is not the first time regulators have challenged EPEX over its practices on intraday markets. In December 2018, UK energy regulator Ofgem opened an investigation to examine whether EPEX Spot SE, its subsidiary in Great Britain, was abusing a dominant position by restricting access for Nord Pool to certain cross-border intraday auctions between GB and Ireland. The investigation was closed in June 2019 after Ofgem accepted the commitments offered by EPEX.

There are other examples of investigations that have been settled quickly. In March 2018, the commission opened a formal investigation to assess whether TenneT infringed EU antitrust rules by limiting southward capacity on the electricity interconnector between Western Denmark and Germany.

The commission had concerns that TenneT discriminated against non-German electricity producers by limiting the export of relatively cheap electricity from the Nordic countries, mostly produced by wind and hydro. However, the investigation was settled just a few months later, after TenneT put forward commitments to increase available capacity on the interconnector.

Market participants will hope the EPEX Spot investigation will be settled swiftly, but this is not a given. If EPEX Spot contests the arguments put forward by the commission, the case could drag on for several years, according to legal experts.

"In April alone, around 10.6 TWh of electricity was traded on EPEX Spot's intraday markets – a new monthly record"

Market barriers

Nevertheless, there are other ongoing EU antitrust cases which also illustrate that barriers persist in Europe's power markets. In March, the EC launched an antitrust probe into suspected anticompetitive behavior by Greek state-owned power producer Public Power Corp. (PPC). Brussels suspects "abusive behavior" by PPC in wholesale and retail markets, which may have slowed down investment in solar and wind power in Greece.

The commission said it had concerns PPC may have adopted "predatory bid-

Photo: TenneT TSO GmbH



Workers handle cables for the NordLink interconnection between Germany and Norway, which was completed in 2020. Despite increasing interconnection and market integration, barriers still stand in the way of European energy trading.

> *"Market coupling should make it more difficult for incumbents to hoard capacity on interconnectors"*

ding strategies" in wholesale markets hindering the ability of its rivals to compete. **pv magazine** understands that PPC is being investigated for allegedly placing bids below generation costs in a move to force competitors out of the market. In a statement, PPC said the investigation related to "past activities" on the power market and that it was "fully committed" to cooperate closely with the commission to "clarify all open issues."

Greek reforms

Greece is phasing out all existing coal plants by 2023 – around 4 GW in total – and has grand plans for wind and solar. Its goal is to increase solar PV capacity to 7.7 GW by 2030, up from 3 GW now. But PPC's dominant position may be a concern for new entrants. PPC owns 11.4 GW or 55% of the installed power generation capacity in Greece, including coal, hydro, gas, oil and some renewables. The company supplied around 41% of Greek power consumption in 2020.

PPC's market share in retail, though, dropped from around 76% in 2019 to 69% in 2020, according to the company's annual report. PPC is betting on more renewables and energy storage as it closes lignite plants. It has secured 2 GW of solar PV licenses and has filed applications for an additional 600 MW of capacity, including floating PV. Nevertheless, recent market reforms in Greece should support investor confidence.

Greece began real-time trading on the day-ahead, intraday, and balancing markets on Nov. 1 – the last EU member state to do so. It also introduced market coupling with Italy in December last year and with Bulgaria in May 2021. Market coupling should make it more difficult for incumbents to hoard capacity on interconnectors, the commission noted in a recent market report. Market reforms coupled with more generation from renewables also contributed to a 29% drop in wholesale electricity prices year on year in 2020, according to the same report.

Belgian market

The EU Commission also has concerns that Belgium's planned capacity market may discriminate against solar and wind. Brussels opened an in-depth investigation in September last year which is still pending. Capacity markets – or Capacity Remuneration Mechanisms (CRMs) – are support schemes whereby power generators can bid for capacity contracts in auctions which will provide them with a fixed revenue stream in return for making future supply commitments. This is to avoid plants being mothballed and incentivize investment in new generation assets. Belgium plans to phase out its nuclear power plants by 2025, which amount to 6 GW or almost half of the country's power capacity.

Wind and solar can participate in the Belgian capacity auctions. However, there appear to be limits on the duration of their contracts. For example, gas-fired plants can bid for subsidy contracts with a duration of up to 15 years whereas renewable generators can ostensibly only bid for 1-year contracts, according to draft rules.

Brussels might approve the scheme with modifications, but the first T-4 auction – for electricity delivery in 2025 – could go ahead in October of this year without solar and wind participating. The next auction is the T-1 auction in 2024, also for 2025 delivery.

"Although the CRM is seemingly technology-neutral, renewables are not expected to participate in the T-4 auction this autumn, but they might do so at the T-1 auction in 2024," David Haverbeke, a Brussels-based Partner at Fieldfisher law firm, told **pv magazine**. *Andreas Walstad*

inter solar

connecting solar business

The World's Leading Exhibition Series for the Solar Industry

INTERSOLAR EVENTS 2021–2022

www.intersolar-events.com



SEPTEMBER 7–9, 2021, MEXICO CITY, MEXICO

www.intersolar.mx

OCTOBER 6–8, 2021, MUNICH, GERMANY

www.intersolar.de

OCTOBER 18–20, 2021, SÃO PAULO, BRAZIL

www.intersolar.net.br

DECEMBER 14–16, 2021, MUMBAI, INDIA

www.intersolar.in

JANUARY 13–15, 2022, LONG BEACH, USA

www.intersolar.us

MARCH 7–9, 2022, DUBAI, UAE

www.intersolar.ae

INTERSOLAR SUMMITS WORLDWIDE

www.intersolar-summit.com

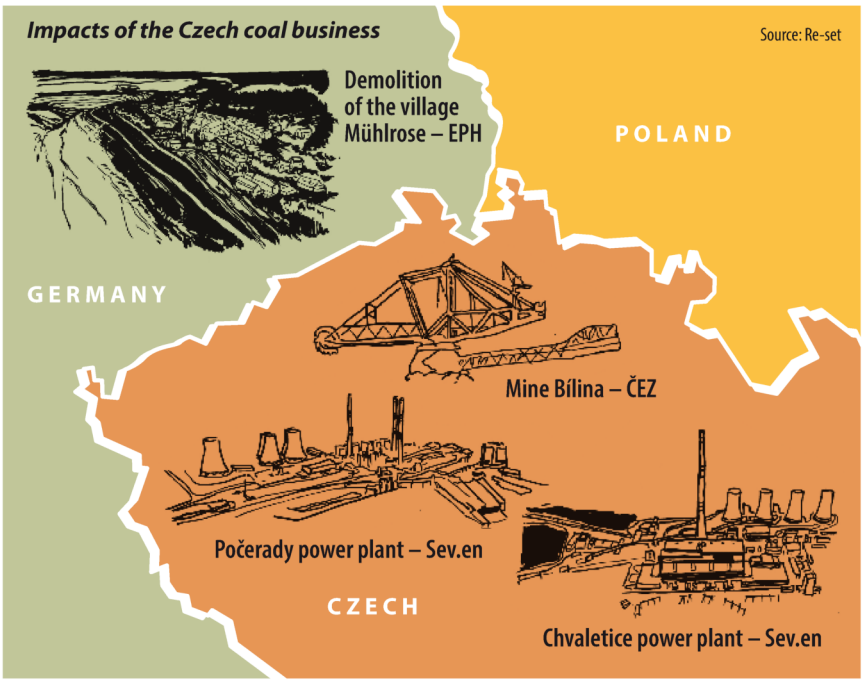
FOLLOW US

Insurers derail EU decarbonization

Though the shift away from burning fossil fuels for power is essential for meeting climate coals, Czech coal plants are backed by major insurers, often with careful loopholes designed to support ongoing arrangements. Radek Kubala and Josef Patočka from Re-set explain.

With the climate crisis occupying the top of the political agenda in recent years, there has been an increasing willingness among insurance companies, especially in Europe, to adopt progressive investment and underwriting policies on climate. In particular, new projects in coal have been excluded by some major insurers. However, glaring gaps with insurer coal policies remain open, helping dirty fossil fuel companies derail decarbonization throughout the European Union.

This is evidenced by information revealed by Re-set in a recent report "Betting against our future," which details how major insurers Allianz, Generali, and Vienna Insurance Group (VIG) continue to support Czech coal companies, despite pledged coal policies.



Czech energy companies Se.ven Energy, EPH and ČEZ – among the dirtiest in Europe – do not have any plans to phase out coal in line with the Paris Climate Agreement target to keep global warming below 1.5 C. To the contrary, the companies plan to prolong the operations of outdated coal power plants, contravening both the state's own energy strategy, and, more importantly, the European Union climate strategy embodied in the European Green Deal.

In other words, they are "betting their money against our future" – hence the name of the report. And among others, it's big insurers who enable them to operate.

Ongoing developments

Allianz, Generali, and VIG continue to insure the Czech majority-state-owned energy corporation ČEZ, despite its confirmed plans to continue burning coal until 2050. Allianz is also insuring Sev.en Energy, the operator of, amongst other facilities, the Počerady power plant, which is the Czech Republic's biggest source of CO_2 and the most carbon-intensive plant in the country. It is also No. 16 in the "the dirty 30" list of European coal power plants with the highest CO_2 emissions. Allianz and Generali have also been confirmed to insure the EPH corporation of Czech oligarch Daniel Křetínský, whose subsidiary, LEAG is operating the lignite mines and power plants in Germany's Lusatia region.

In its coal assets alone, EPH has higher emissions than half of the EU countries. It is also known as an opponent of climate-protection policies throughout Europe. Apparently under threat of lawsuits under the Energy Charter treaty, Germany has promised LEAG more than €1.7 billion as "compensation," despite official docu-

Germany reportedly promised coal mine & power plant operator LEAG

€1.7 Billion

in compensation for the closure of power plants in Germany

ments hinting at the real costs being up to 50 times lower – a deal which is now being investigated as potentially illegal state aid by the European Commission.

All three insurance companies have in previous years adopted policies to reduce exposure to coal in their portfolios in which they commit to not insure new coal projects. But this is not enough to ensure compliance with the targets of the Paris Climate Agreement, which would, in OECD countries, necessitate a coal phase-out by 2030 at the latest. For that, including old power plants like those currently insured by these companies, have to be phased out fast.

Generali has an exception for ČEZ's coal projects allowing them to insure them also in the future. Based on its business policy, VIG does not support coal in countries where coal phase-out has been scheduled. As the Czech government has not approved the coal phase-out yet, VIG can continue insuring coal projects.

Moreover, none of these insurance companies have policies excluding the projects based on the extraction and combustion of fossil gas. Most of the Czech coal companies already have plans to switch from coal to gas, despite the fact that, as the UNEP-backed 2020 Production Gap Report clearly outlines, fossil fuel gas usage must be reduced by 3% globally per year until 2030 if we are to stand a chance of remaining under 1.5 C warming.

There is still a lot of work that Allianz, Generali, and VIG must do to ensure that they are on the right side of history in the efforts to solve the climate crisis. They should close the loopholes in their policies and exclude all coal companies, including "smaller" ones like Sev.en Energy, from their portfolios, as well as ruling out new gas infrastructure. pv

Radek Kubala, Josef Patočka

Big insurance companies and Czech coal companies in a nutshell

	Allianz	Generali	VIG
ČEZ	✔	✔	✔
EPH	?	✔	?
Se.ven Energy	✔	X	?

Legend:
✔ Insurance services provided
? Indications of insurance provisions, company did not rule it out
X No insurance services provided

> *"In its coal assets alone, EPH has higher emissions than half of the EU countries"*

Insurer loopholes

Allianz is able to provide insurance for coal through loopholes in their policy that allow them to continue to insure coal companies until the end of 2022. And even after that date, Allianz will only exclude companies that derive 25% or more of their generated electricity from thermal coal, and have 5 GW or more of installed thermal coal capacity. Given that Sev.en owns less than that, it will still be insurable after 2023, unless Allianz strengthens its policy.

About the authors



Radek Kubala *is campaigning for Re-set on the issues of climate justice, degrowth economies, and finance. As a writer and organizer, he is also a journalist of Deník Referendum, and has previously worked as a campaigner with Greenpeace Slovakia.*



Josef Patočka *focuses on fossil finance, the politics of socio-ecological transformation, and movement building in the climate justice program. As a contributing editor, he comments on politics and ecology for Deník Referendum, a leading progressive newspaper.*

pv magazine Webinars

pv magazine webinars

pv magazine has an established virtual-event presence by virtue of our hugely successful webinars. Since 2015, we have been hosting in-depth webinars with innovative partners in German, English, Spanish, French, and Portuguese, and we'll keep adding more languages as the demand and our audience grows. In the last year alone, we welcomed more than 58,000 international registrants to our pv magazine Webinars. Our webinars cover the latest trends and innovations, while ensuring an interactive discourse between our expert speakers and virtual audience.

Coming up next…

Predictable profitability: The Importance of Soiling Monitoring and Mitigation

In partnership with OTT HydroMet

Wednesday, June 16, 2021

10 am – 11 am PDT, Los Angeles | 11 am - 12 pm CDT, Chicago | 1 pm – 2 pm EDT, New York City | 7 pm – 8 pm CEST, Berlin

Extreme damping – A new wind mitigation strategy for trackers

In partnership with FTC Solar

Tuesday, June 29, 2021

11 am – 12 pm EST, New York | 10 am – 11 am GMT-5, Mexico, Colombia | 7 pm – 8 pm GST, Dubai | 5 pm – 6 pm CEST, Berlin | 4 pm – 5 pm GMT, London/ WEST, Lisbon

More exciting pv magazine Webinars to come

You can look forward to a summer packed with pv magazine Webinars. In the upcoming weeks, we will continuously add more webinars with innovative partners and the latest topics. We will welcome back Jinko Solar, Soltec, Trina Solar, EDF Renewables, Maxeon Solar Technologies, REC Solar, and many more.

Our up-to-date program can be found at

Check out Spotlights you've missed

Did you know you can access all our pv magazine Webinars and Spotlights on our website after they've happened? Check out these Spotlight highlights you might have missed:

Designed for higher reliability and enhanced adaptability – the new TrinaTracker Agile 1P Dual Row

In partnership Trina Solar

Stakeholders' Needs at the Core – the Smartly Designed and Highly Efficient Tiger Pro 415W Module

In partnership with Jinko Solar

pv magazine spotlight

SNEC
PV POWER EXPO
Dialogue & Conference & Exhibition

www.snec.org.cn

SNEC 16th (2022) International Photovoltaic Power Generation and Smart Energy Conference & Exhibition

2022 | May 24-26
Shanghai·China

Venue: Shanghai New International Expo Center (SNIEC)

SNEC Homepage

◎Asian Photovoltaic Industry Association / Shanghai New Energy Industry Association

Follow Me Int'l Exhibition (Shanghai), Inc.

◎Show Management: Follow Me Int'l Exhibition (Shanghai), Inc.

Add： RM905-907 No 425 Yishan Rd, Xuhui District, Shanghai 200235, PRC

Tel： +86-21-33685117 / 33683167

◎For exhibition: info@snec.org.cn For conference: office@snec.org.cn

Final thought

Taking charge

Claire Miller, head of technology and innovation at Octopus Electric Vehicles



Photo:Octopus Electric Vehicles

In a world that will require more energy flexibility and see increased demand for electric vehicles (EVs), companies and governments need to start thinking innovatively. Vehicle-to-grid (V2G) is a form of discharge which allows energy stored in an EV battery to be sent back to the grid to deal with demand spikes. Octopus Electric Vehicles' Powerloop trial is the first large-scale European Vehicle-to-Grid (V2G) process in action, using the Nissan LEAF and the Wallbox Quasar charger.

Powerloop enables us to bring together smart energy tariffs with the technology to charge and discharge on demand to easily access household energy flexibility and small-scale generation. We're actively shaping the customer journey to upgrade domestic electrical equipment and enable export. Our experience contributes to a framework for implementing V2G on a broader scale, helping create a smarter, more sustainable grid.

We have learned a great deal about what excites people about V2G. This will help us streamline the setup process for V2G and other smart, renewable tech – vitally important for mass adoption, which is looking inevitable with major manufacturers, such as Ford and VW, incorporating V2G capability into their new EVs.

Through the trial, we have optimized the powerloop app to make managing charging cycles simple. The pandemic made us reconsider what 'expected' energy consumption and driving patterns will look like now and in the future, and being able to observe users interacting with the charge and discharge process in practice enabled us to consider what systems may work best in the future, and how we can tailor this to different consumer needs.

Now that we have filled all 135 places on the trial, we'll continue to gather data whilst testing different customer propositions and participating in a range of novel flexibility and grid service markets. Over the coming year there's a lot to come from Octopus Electric Vehicles and V2G, so watch this space. pv

Preview of issue 07/2021



Photo: Sungrow

Change in SE Asia

The energy landscape is changing across Southeast Asia, as policies shift and investors gain a foothold in new markets.



In Conversation

The next generation of solar innovators brought into focus, in a 20-page interview special.



Photo: Mohamed Hassan/Pixabay

Photo: JA Solar

Tech trends from SNEC 2021

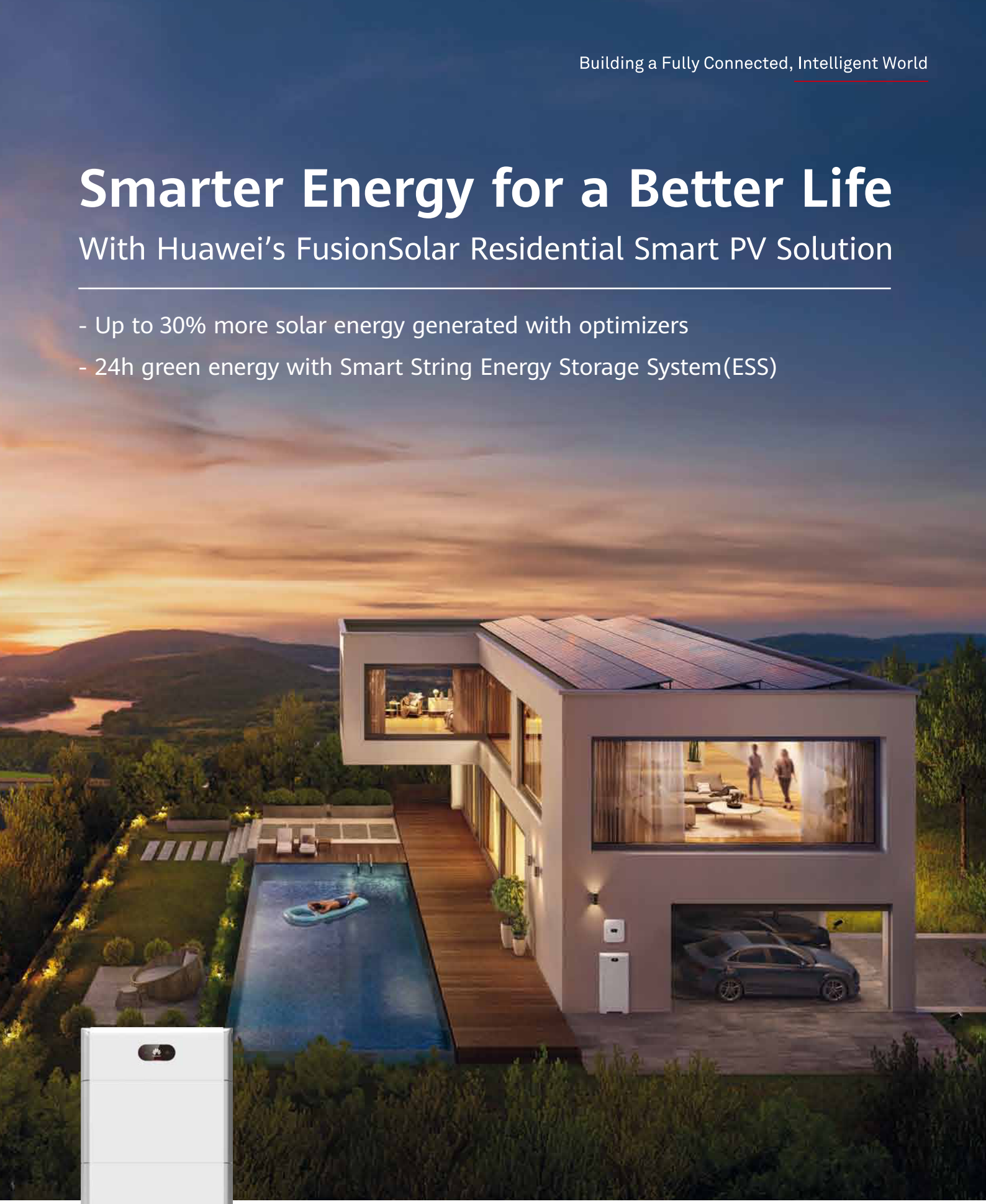
The Shanghai show may be effectively closed to foreigners this year, but **pv magazine** was on the spot.

Building a Fully Connected, Intelligent World

Smarter Energy for a Better Life

With Huawei's FusionSolar Residential Smart PV Solution

- Up to 30% more solar energy generated with optimizers
- 24h green energy with Smart String Energy Storage System(ESS)









HUAWEI

Solar
JinKO
Building **Your Trust** in Solar

TIGER Pro · 585w

Rethink Power



www.jinkosolar.com