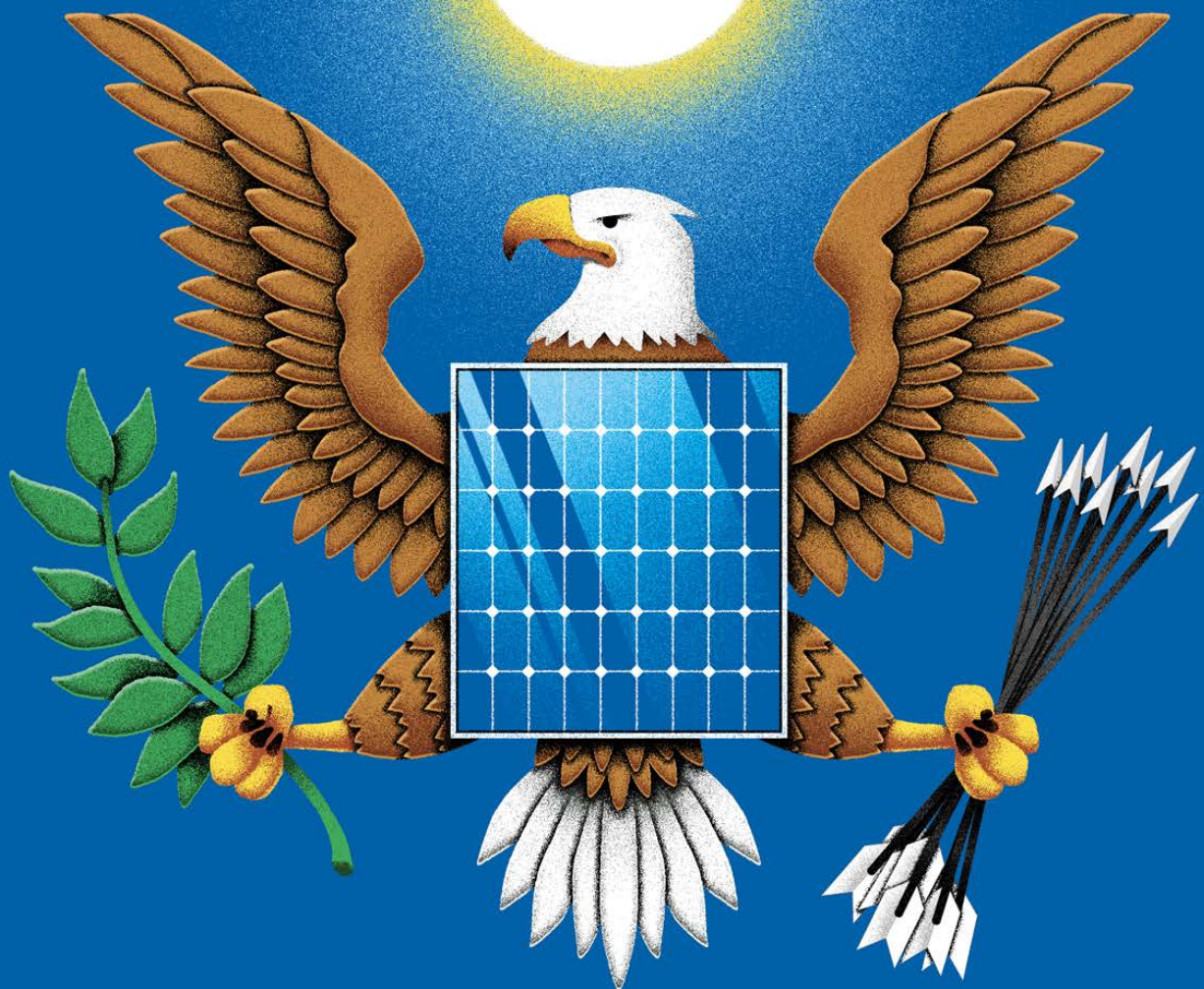


# SOLAR POWER IN THE US

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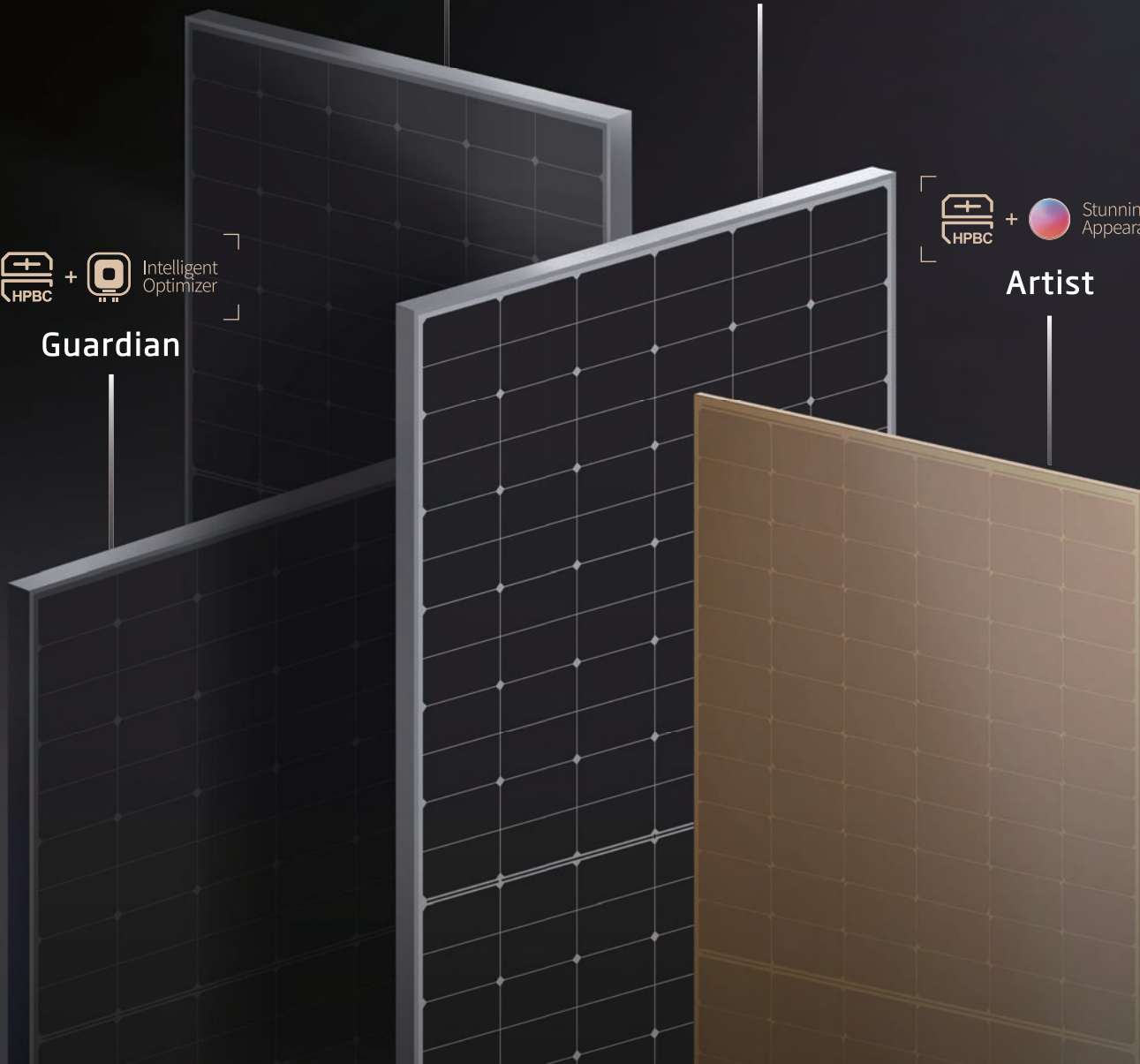
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# Introduction



Welcome to PV Tech Power 36, our third edition for 2023. Since the Inflation Reduction Act became law in the US a year ago, the clean energy sector in the largest economy in the world has seen a massive boost.

In July, the Clean Energy Boom Anniversary Report, analysing public announcements from the private sector since the passage of the IRA, stated that companies have announced or created more than 170,000 new clean energy jobs across 44 US states. Nearly 300 new projects have been announced or put into operation, and US\$280 billion in new investments have been made or committed.

The multi-layered incentives have also given the clean energy manufacturing sector a shot in the arm. In this, our US-focused, edition of PV Tech Power, Martin Pochtaruk, the founder of solar photovoltaic manufacturer Heliene, writes about the new opportunities of building out the US domestic supply chain, but also sheds a light on the obstacles that remain.

In one of his features for the magazine, reporter Jonathan Touriño Jacobo concentrates on the community solar sector, specifically in California, Ohio and Minnesota, and investigates what the IRA means for solar projects at the grassroots level. His other contribution looks at how the new legal framework can benefit the communities and operators of former coal power generating and mining sites, and how redevelopment can create a future for them.

For the Design & Build section, we got Yezin Taha, the founder and CEO of tracker specialist Nevados

Engineering, to present the findings of his company's white paper on mass grading, ie the levelling of greenfield sites to accommodate solar parks. He makes a case for solar tracking and how the technology can avoid the problems, environmental impact and cost associated with site grading.

Touching on the consequences of climate change, reporter George Heynes speaks with Solargis, a Slovakia-based weather data and software provider for solar power investors and operators, for a deep dive into maximising solar technologies in hot locations which, sadly, looks set to become more important to take into account going forward, considering the recent devastating wildfires in many regions as this edition went to print.

On a somewhat lighter note, our editor Simon Yuen brings us the low-down on some large projects linking solar power producing hot countries in North Africa with electricity-hungry markets in Europe.

In an (almost) global collaboration, editors JP Casey and John Lubbock and George Heynes collected the views from experts in the US, Europe and the UK on how to tackle the acute solar skills shortage, which is one of the most pressing topics for everyone out there who wants to push the sector to its full potential.

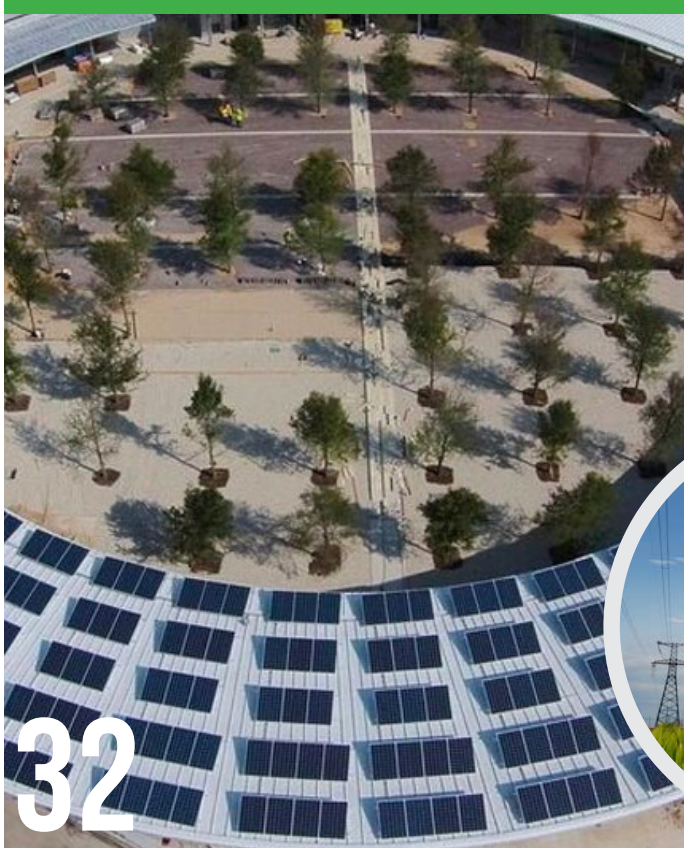
Thanks for reading these and the other insightful articles we are bringing you in this journal. We hope you enjoy them.

**Andre Lamberti**

Editor In Chief  
Solar Media



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### Optimisation of Energy Storage Assets in the US' Leading Markets

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# WHY **TONGWEI** MODULE

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High-powered  
Performance



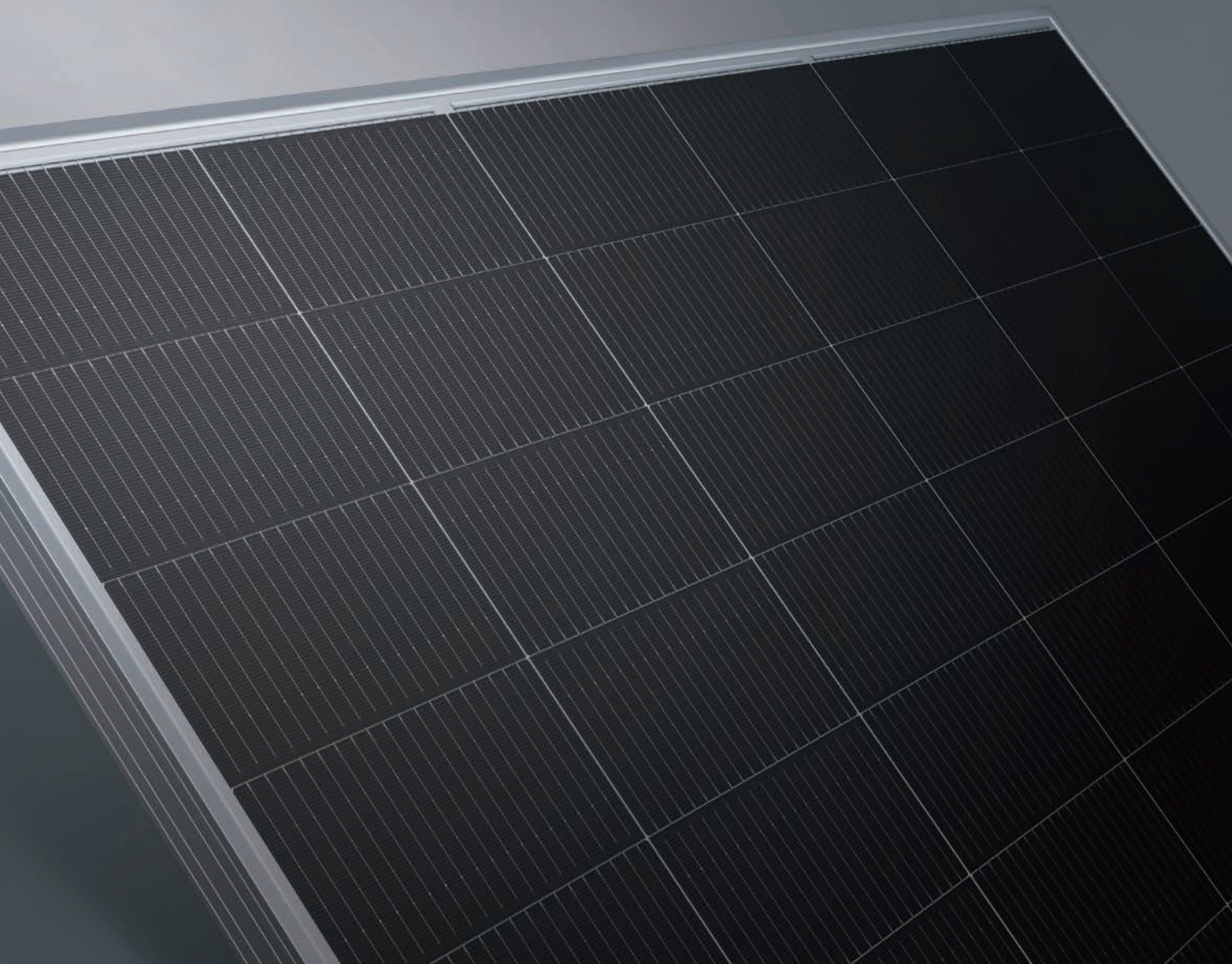
Aesthetic  
Appearance



Exceptional  
Reliability



Eco-friendly  
Design





# TW (Tongwei) Solar eyes going global with a local focus



TW (Tongwei) Solar entered the PV industry in 2006, initially specialising in polysilicon production before going on to establish itself as a world-leading manufacturer, currently creating waves in the high-efficiency PV module sector. With significant experience in plant construction and O&M making it a fully vertically integrated organisation, Tongwei made its debut on the Fortune Global 500 list in August, ranking 476th with a revenue of CNY 214.882 billion.

The company's products come from four major bases in the Chinese cities of Hefei, Jintang, Yancheng and Nantong and, as of the end of 2022, its module shipments had already reached an impressive 7.94GW, placing it among the top ten manufacturers in the world and recognised as one of the fastest growing players in the sector. For 2023, the module production capacity target has been set at 80GW, with a shipment target of 35GW.

As part of its expansion during the second half of 2022, the company offered two new module products, based on half-cut and shingled module technology.







The Terra series shingled modules have since enjoyed great success within the high-end residential market, with European shipments last year reaching 3GW and company analysts suggesting that, of every seven households to install a rooftop PV unit, one had chosen Terra.

Demand for the company's products has been strong in Europe, partly due to the widespread issue of high energy prices and a continent-wide momentum to implement the energy transition, with European governments actively promoting the adoption of green energy.

With a footprint now covering over 40 countries, including France, Germany, the Netherlands, Chile, Brazil and Japan, the company's rapid emergence as a module manufacturer has cemented its status as one of the industry's major vertically integrated players.

With the solar industry currently undergoing a period of evolution, with a range of new technology options in terms of wafer sizes, module types and manufacturing approaches, Tongwei Solar has placed itself firmly at the forefront of the move towards n-type, unveiling two new n-type module products: the TNC-182, with optimized size and rectangular wafer cell technology, and the silver-free 210-THC.

### **Tongwei N-type passivated contact Cell (TNC)**

The company's new TNC-182 innovates on the 182-72 version and is designed for optimal cell and module sizes. The power of the new module has been further increased by 25-30W and can now exceed 600W.

### **Tongwei Heterojunction Cell (THC)**

The newly unveiled 210-THC module features multiple technological breakthroughs, including the adoption of silver-free, ultra-thin wafer and bifacial microcrystal technologies, plus high-performance target doping and light injection.

The substitution of silver with copper electroplating has further narrowed the cost gap with PERC modules, with the new product also having a lower temperature coefficient and higher levels of bifaciality, which can further increase power generation. The company expects to commence mass production of the module in the near future.

### **THC cell records**

Tongwei Solar completed China's first gigawatt-scale HJT production line in 2021 and went on to complete the development of the industry's first 210 double-sided microcrystal module in early 2023. In March, the company set a world record of 26.18% for HJT cell efficiency in mass production, certified by the Institute for Solar Energy Research in Hamelin, Germany (ISFH), and has since gone on to break its own HJT power records on four occasions. The power of the TWMHF-66HD module can now reach up to 743.68W, ushering in the 740W+ era.

PV Tech recently reported that the company had made huge strides in its product line expansion and deployment of new technology, whilst also increasing its investment on R&D to pursue technological innovation and product upgrades. However, it was aware of strong competition from other major global PV players, and its primary strategy to combat this is to expand globally as quickly as possible.

The planned establishment of a local presence in key markets will enable the company to better serve its growing customer base, taking its worldwide expansion to the next level and allowing it to take advantage of the current widespread demand for high-efficiency modules.

More information: [en.tw-solar.com](https://en.tw-solar.com)

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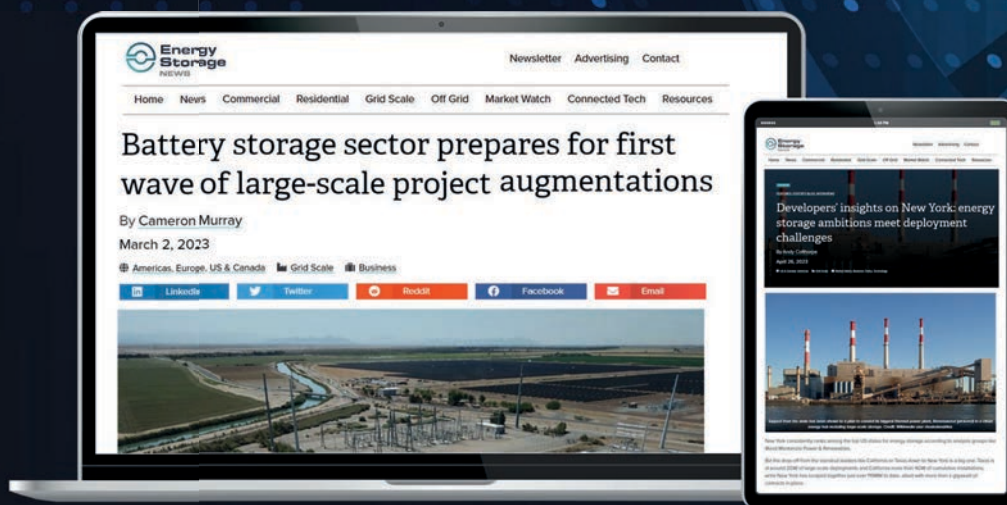
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## EUROPE

## EU policy

**Resilient supply chain and strengthened grid key to speed up EU renewables transition**

The EU will need to create a more resilient supply chain, improve the grid, and reexamine multiple constraints to achieve a more orderly energy transition, according to a study conducted by analysis company McKinsey.

The EU has published several plans for energy transition, including the European Green Deal in 2020 and the Fit for 55 plan in 2021, which aim for a 55% cut in CO<sub>2</sub> emissions by 2030 from 1990 levels and for net-zero emissions by 2050.

McKinsey defined orderly transition as a situation in that “the European Union achieves its stated commitments of a 55% cut in CO<sub>2</sub> emissions by 2030 and net-zero emissions by 2050 while balancing affordability, reliability, resilience, and security”.



Credit: Wikimedia, Kallerna.

**The EU needs to scale up the manufacturing of critical technologies for energy transition.**

**Revised NECPs increase EU's 2030 solar PV capacity target by 90GW**

With multiple European countries submitting their revised National Energy and Climate Plans (NECPs) over summer 2023, the European Union (EU) is targeting an extra 90GW of solar capacity by 2030. SolarPower Europe said in a study published in 2023 that as of 2022 the EU boasts 208GW of installed solar capacity. Based on NECPs submitted in 2019, the EU was targeting 335GW of installed solar capacity by 2030.

However, after the revised NECPs submitted by 12 countries, the EU is targeting installed solar capacity of 425GW by 2030, 90GW higher. Eight countries look set to reach their new 2030 targets at least three years early.

**EU Commission approves €2.4 billion Hungarian renewable manufacturing scheme**

The European Commission has approved a €2.36 billion (US\$2.6 billion) Hungarian scheme to accelerate investment towards renewables manufacturing. In line with the European Union's Green Deal Industrial Plan, Hungary would use the scheme through direct grants and/or tax advantages.

The scheme was approved under the Temporary Crisis and Transi-



Credit: Mytilineos.

**A Mytilineos PV project in the Atacama Desert, one of the sunniest places in the world.**

tion Framework, a measure adopted by the Commission in March 2023 and that was aimed to accelerate the green transition and fossil fuel dependency from EU member states.

## Capacity investment

**EDP to invest €2.5 billion to add 4GW of distributed solar capacity by 2026**

Electric utility and renewable energy company Energias de Portugal (EDP) plans to invest €2.5 billion over the next three years to install an additional 4GW of distributed solar capacity around the world.

EDP currently has a portfolio of 1.6GW of distributed solar capacity in both business and residential sectors. The company's solar capacity accounts for just 8% of its total renewable capacity, compared to the group's wind portfolio that accounts for 59% of its installed capacity.

EDP plans to expand its European distributed solar capacity by five times between 2023 and 2026, and three times in its Asia-Pacific portfolio over the same period.

## Poland

**Qair bags financing for 130MW of Polish PV**

French-headquartered independent power producer Qair has secured a PLN335.3 million (US\$83.1 million) loan for 130MW of solar PV projects in Poland.

The loan from a consortium of Santander Bank Polska and PKO Bank Polski will finance three solar parks in the towns of Golczewo, Rokietnica and Pakość. They are expected to begin operations in 2024.

Qair said that “identified offtakers” will buy the power from the sites under corporate power purchase agreements.

## Greece

**RWE, PPC to build 280MW solar PV in Greece**

Greek renewables firm PPC and international energy company RWE have taken the final investment decision to develop, through their joint venture Meton Energy, 280MW of solar capacity in Greece.

Comprised of three solar farms, the projects – dubbed Amynteo Cluster II – will start construction in autumn 2023 and are expected to be operational by the end of 2024.

Total investment for the projects is €196 million (US\$215 million), of which €98 million have been secured from the European Union's Recovery and Resilience Facility. The remaining amount is being financed through a €59 million commercial debt financing provided by financial firms Alpha Bank, Eurobank and National Bank of Greece and €39 million from shareholders' equity.

**Mytilineos posts energy sector turnover of €1.99 billion in H1 2023**

Greek energy company Mytilineos has released its financial results for the first half of 2023, with its energy sector posting a turnover of €1.99 billion. This accounted for 79% of the company's total turnover and was a 22% increase over the first half of 2022.

“The strong financial performance, of the first half of 2023, confirms, once again, the resilience of Mytilineos' business model in the face of constantly changing market conditions, the unprecedented volatility over the past two years as well as the most severe inflationary pressures recorded in recent years,” said Mytilineos chairman and CEO Evangelos Mytilineos.

## AMERICAS

### US

#### SEIA: solar and storage has added US\$100 billion to US economy following IRA

The Solar Energy Industries Association (SEIA), the trade body representing the US solar industry, has published research concluding that solar and storage companies have added over US\$100 billion to the US economy following the implementation of the Inflation Reduction Act in 2022.

The landmark legislation introduced new incentives for renewable power companies to source their manufacturing work in the US, in order to create a resilient domestic supply chain for the renewable sector.

This has already had a profound impact on the US solar sector, with industry leaders Moxen and First Solar announcing new manufacturing facilities in the US in August, and the SEIA reports that a total of 51 new facilities have been announced or expanded in the last year.



Credit: SEIA

Solar panels at L'Oreal's facility in Franklin, New Jersey.

#### Perovskite startup Caelux bags US\$12 million for tandem solar glass facility

California-based perovskite solar startup Caelux has closed a further US\$12 million in financing to support its factory expansion in Baldwin Park, California, research and development and eventual product launch.

The funding was led by global investment fund Temasek with additional contributions from Reliance New Energy Limited – which owns a 20% stake in Caelux – Khosla Ventures, Mitsui Fudosan and Fine Structure Ventures. The Series A raise has now closed US\$24 million.

#### US govt pledges US\$450 million to install rooftop solar PV in Puerto Rico

The US Department of Energy has announced US\$453.5 million from the Puerto Rico Energy Resilience Fund to install up to 40,000 rooftop solar PV and battery storage systems for low-income single-family households.

Eligible households include those who either live in areas that have a high percentage of very low-income households and experience frequent and prolonged power outages, or are with a family member with an energy-dependent disability.

Energy cooperatives and state and local governmental entities could apply for the fund.

### Canada

#### Rio Tinto plans solar PV plant at Diavik diamond mine in Canada

Mining company Rio Tinto plans to build a solar power plant at the Diavik diamond mine in the Northwest Territories in Canada. The plant will feature more than 6,600 solar modules and provide up to 25% of the mine's electricity. The plant will be equipped with bi-facial panels to generate power from light that reflects off the snow which covers the mine for most of the year.

Construction will start in August 2023 and the plant will be fully operational in the first half of 2024. The company did not provide the capacity of the solar PV installation, but said it would generate around 4.2GWh of electricity annually.

#### Canada seeks nationwide collaboration on clean energy, aims for net zero electricity sector by 2035

The Canadian government has outlined its intentions for the country's energy transition away from carbon power generation. The Powering Canada Forward document calls for collaboration between provinces, states, and Indigenous communities with the federal government to decarbonise Canada's electricity sector by 2035 and reach Net Zero emissions by 2050. Anticipated responses to the call will inform the government's first Clean Energy Strategy, due to be released in 2024, it said.

The document prioritises grid expansion and development. It says that investments in excess of CAD\$400 billion (US\$298 billion) will be needed to replace old grid infrastructure and expand the transmission network.

#### Alberta pauses renewables development for 6 months to address land use concerns

The Alberta Utilities Commission (AUC) in August announced a 6-month moratorium on renewable energy project developments above 1MW in size, primarily to review concerns around land use.

The announcement was met with concern by the Canadian Renewable Energy Association, which said that the pause was a "mistake" and could undermine the state's hitherto strong market and reputation for renewables.

The AUC said that it was responding to a letter received from municipalities and landowners raising concerns over the pace of renewable energy development and responsible land use.

### Colombia

#### Atlas Renewable Energy, Isagen to build 1GW solar PV in Colombia

US-based Atlas Renewable Energy and Colombia-headquartered Isagen have partnered to develop, build and operate 1GW of solar projects in Colombia.

The two renewable power developers described the deal as a "strategic alliance", although neither specified how much money they would invest into the projects or the expected timeframe for the new facilities.

The addition of new power generation facilities will be important for Colombia as its energy demand is set to increase. Fitch Ratings forecasts that national electricity demand will grow by 1.5TWh by the end of this year, compared to the end of 2022, which will require 1GW of annual capacity additions to meet this demand.



## MIDDLE EAST &amp; AFRICA

## UAE

**Masdar to add 1.2GW to Mohammed bin Rashid Al Maktoum Solar Park in sixth phase**

The Dubai Electricity and Water Authority (DEWA) has selected UAE state-owned renewable power company Masdar as preferred bidder to build and operate the sixth phase of the mammoth Mohammed bin Rashid Al Maktoum Solar Park. The project is already the largest single-site solar farm in the world by capacity. The fifth phase of the project came online earlier this year, bringing its total capacity to 2.4GW, and the authority plans to add a further 1.2GW of capacity in the sixth phase of construction. While the park will help the UAE shift its energy mix towards renewables, it remains a country heavily reliant on fossil fuels.

## Saudi Arabia

**Sungrow to supply 2.2GW of inverters for NEOM green hydrogen project in Saudi Arabia**

Inverter manufacturer Sungrow has signed an agreement with Indian conglomerate Larsen & Toubro to supply 2.2GW inverters for a hydrogen project in Saudi Arabia. The company said its 1+X modular inverter solution will be supplied to the NEOM Green Hydrogen Company for the NEOM Green Hydrogen project, which features a 1.1MW single unit as the minimum, and the maximum capacity can be expanded to 8.8MW by combining eight units, with each module designed with an independent maximum power point tracking. Sungrow added that its inverters are resilient to sandy, dry, and windy conditions and can be operated in high temperatures. The inverters are also equipped with intelligent string-level diagnosis to improve the power yield and real-time parallel arc detection to protect system safety further.

**PV Hardware signs 805MW solar tracker deal for Saudi project**

Spanish solar tracker provider PV Hardware (PVH) has signed a supply agreement with Indian conglomerate Larsen & Toubro for 805MW of trackers. The agreement is for a solar project located at Ar Rass City in the Qassim province, Saudi Arabia.

PVH said the trackers for the solar project will be sourced from its recently renovated manufacturing facility in Jeddah, Saudi Arabia. It added that the trackers will be designed to withstand high temperatures and sandstorms, while the advanced safety features will ensure its stable operation and corrosion resistance with an estimated life of 25 years. Currently, PVH's deployment spans five continents with a total capacity of over 28GW. It also has a pipeline of 8GW in Saudi Arabia.

## Morocco

**Morocco opens 400MW solar-plus-storage Noor Midelt III tender**

State-owned Moroccan Agency for Sustainable Energy (Masen) has opened the third tender of its solar-plus-storage Noor Midelt project. Noor Midelt III is seeking a developer to build a 400MW solar PV plant along with a 400MWh battery energy storage system (BESS). Once completed, the Noor Midelt projects will add 1.6GW of solar capacity to Morocco's electricity generation and will help towards the country's goal of reaching a 52% share of renewables by 2030. The successful bidder will enter into a 30-year power purchase agreement (PPA) between Masen as the off-taker – and provide the land lease for the project to be built on – and the company developing the project.

## Madagascar

**Madagascar launches two tenders for 210MW solar projects**

Madagascar has launched invitations to tender for two solar PV projects with a combined capacity of 210MW. The larger plant, with a capacity of 200MW, will be located in Ihazolava near the capital Antananarivo. The second tender is for the construction of a 10MW project in Mahajanga, a city located on the north-west coast of the country. According to the tenders issued by Madagascar's Ministry of Energy and Hydrocarbons, bidders for the construction of both plants need to submit a preliminary report indicating the nature and capacity of the facilities envisaged and the amount of investment. Madagascar published its new energy policy in 2015 which stated that the country aims to attain 85% of renewable energy in the energy mix by 2030, according to the Solarize Africa Market Report.



## ASIA-PACIFIC

### Australia

#### Over 90% of Australian renters lack direct access to solar

According to a study conducted by Macquarie University, wealthy renters in Australia are more likely to benefit from properties with solar power access. The co-authors found that renters who benefitted from properties with solar power access could have their savings translated to more disposable income to spend on consumer items or investments. However, more than 90% of tenants in Australia lack direct access in the study period. The researchers also said that net wealth was better for identifying solar-access inequality than other socio-economic variables such as income, welfare receipt, or education. To narrow the gap between renters who have access to solar panels and those who do not, rebates could be higher for the least wealthy 20% of renters compared with wealthy renters.

#### Brookfield signs plan with India's Reliance Industries to onshore Australian PV manufacturing

Brookfield Asset Management and Indian conglomerate Reliance Industries have signed a memorandum of understanding (MoU) to pursue renewable energy manufacturing opportunities in Australia. The MoU will look to develop solar PV, battery energy storage and wind component manufacturing through direct capital investment opportunities, and facilitate developing skills, knowledge and expertise in Australia's renewable energy sector, the companies said. According to Brookfield Renewable, Australia has a history of manufacturing and an abundance of raw materials, but the industry is not currently cost competitive. The energy transition creates an opportunity to bring advanced manufacturing processes created offshore to Australia.

### China

#### JinkoSolar shipped 17.8GW of modules in Q2, continues n-type growth

Solar PV manufacturer JinkoSolar shipped 17.8GW of solar modules in the second quarter of 2023, of which 10.4GW were n-type products. Total module shipments were up 36.2%, from 13GW in Q1, and n-type shipments rose 74.1%, up from just under 6GW. The company expected its n-type products to account for almost 60% of its module shipments in 2023, following the completion of its 56GW wafer-cell-module n-type production facility in Shanxi, China and its 1GW US n-type module facility this year. It also said that its n-type capacity outside of China would exceed 8GW by the end of this year. In terms of annual total capacity, Jinko expected 85GW, 90GW and 110GW of mono wafer, cell and module capacity respectively, of which n-type would fulfill up to 75%. The company's order book visibility now sits at around 80% for the rest of 2023.

### The Philippines

#### ACEN to build 1GW of floating solar in the Philippines

Energy platform ACEN plans to develop 1GW of floating solar PV (FPV) in Laguna, in the northern Philippines. Through a renewable energy contract area utilisation (RECAU) agreement, the company has secured an 800 hectare lease with the Laguna Lake Development Authority (LLDA) to develop FPV in Laguna Lake, the country's largest freshwater lake. This is the Philippines-based developer's first large-scale floating solar project as it explores and integrates new technologies into its renewables

portfolio. Floating solar is expected to be driven by Southeast Asian countries, such as the Philippines, with the market targeted to surpass 6GW of installed capacity by 2031. China, India and Indonesia are expected to encompass 70% of the global market's share of that segment during the next decade.

### Indonesia

#### Vena Energy to build Indonesian clean energy hybrid project, including 2GW solar PV capacity

Asia-Pacific renewable energy developer and independent power producer (IPP) Vena Energy is planning a project that would combine up to 2GW of solar PV generation capacity with as much as 8GWh of battery storage. A recent agreement covers the exploration of opportunities to create local production lines for solar PV modules and BESS components. Production lines would support what Vena Energy described as its hybrid megaproject, in development on Indonesia's Riau Islands province. The three other counterparties to the agreement are Chinese solar technology company Suntech, US-headquartered BESS system integrator and manufacturer Powin Energy and battery cell maker Rept Battero, another Chinese company. Vena Energy also signed a collaboration agreement with Shell Eastern Trading, the Singapore-based subsidiary of Shell, for power from the Riau Islands facility to be supplied cross-border to Singapore.



**The agreement covers the exploration of opportunities to create local production lines for solar PV modules and BESS components.**

### India

#### Adani raises US\$394 million for 10GW integrated solar manufacturing

Indian conglomerate Adani has raised US\$394 million for solar manufacturing in India through its renewable energy subsidiary Adani New Industries. The financing came from Barclays PLC and Deutsche Bank AG through a trade finance facility, as reported by Mercom Clean Energy Insights, and will support the construction of a 10GW vertically integrated manufacturing facility. The site will cover the whole manufacturing stream from polysilicon to finished modules. The facility will form part of an integrated green hydrogen ecosystem, which will also include wind turbine manufacturing. Late last year, the company announced a plan to have 2GW of silicon ingot and wafer capacity in India by the end of 2023.





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## MANUFACTURING

**EU Innovation Fund****Meyer Burger secures €200 million from EU Innovation Fund to build 3.5GW capacity**

PV module manufacturer Meyer Burger's project HOPE (High-efficiency Onshore PV module production in Europe) obtained €200 million from the EU Innovation fund. The project will involve constructing an additional 3.5GW of production capacity for solar cells and solar modules by Meyer Burger in Germany and probably in Spain. According to the EU, this project will introduce new innovative heterojunction (HJT) technology, producing PV modules with higher efficiency. "We are very pleased that the EU Commission wants to support our project. The EU is not only contributing to the decarbonisation of the energy system and the transformation of the industry. It is equally investing in the resilience of supply chains in the solar industry," said Gunter Erfurt, CEO of Meyer Burger.



Credit: Meyer Burger

**Meyer Burger will add 3.5GW of production capacity in Europe.****India capacity expansion****Waaree closes US\$121 million for 6GW integrated capacity expansion**

Indian solar manufacturer Waaree Energies will expand its ingot, wafer, cell and module production capacity by 6GW following a second round equity funding raise of around INR10 billion (US\$121 million). The funding was led by Indian-headquartered investment firm ValueQuest and follows the INR19.23 billion awarded to Waaree under the Indian government's production-linked incentive (PLI) scheme in March, for which the company received the maximum 6GW of wafer, cell and module capacity that was available. With this funding, the company continues to ramp up its production capacity after announcing last year a module manufacturing expansion to 12GW per year that was set operational in March 2023.

**TOPCon plant****Maxeon to build 3GW cell and module manufacturing plant in Albuquerque**

Solar module manufacturer Maxeon Solar Technologies has announced a plan to build a 3GW new solar cell and module manufacturing facility in Albuquerque, New Mexico. Maxeon said the new manufacturing plant, consisting of a solar cell

fabrication, panel assembly, a warehouse, will produce its latest-generation tunnel oxide passivated contact (TOPCon) PV-silicon cell technology and proprietary shingled-crystal-line-cells of high-performance modules. With an investment of over US\$1 billion, the new manufacturing plant will serve the utility-scale solar power market and distributed generation rooftop applications.

**US solar jobs****US to triple solar manufacturing jobs to 120,000 by 2033**

Solar manufacturing jobs in the US will more than triple in the next 10 years, according to the Solar Energy Industries Association (SEIA). As of 2023, there are about 35,000 jobs in the solar manufacturing industry. As the US is increasing production and investing billions of dollars to expand domestic solar manufacturing capacity, more jobs will be created throughout the US, taking the number of jobs in the solar manufacturing industry to 120,000 by 2033.

**Investment in US****Canadian Solar to build first solar PV manufacturing facility in the US**

Ontario-based Canadian Solar will build its first production facility in the US, a PV module manufacturing plant with the capacity to produce 5GW of solar modules a year. Canadian Solar will invest US\$250 million into the facility, which will be built in the town of Mesquite near Dallas, and will be the company's first production facility in the US. "Canadian Solar's new US\$250 million manufacturing plant in Mesquite will bolster Texas' status as the energy capital of the world and secure our leadership as a global tech hub," said governor Greg Abbott.

**Solar tender****Germany launches expression of interest call for 10GW of solar manufacturing**

Germany's Federal Ministry of Economics and Climate Protection (BMWK) has launched a request for expressions of interest (EoI) to boost the country's solar PV manufacturing supply chain. The target is to build up 10GW of solar PV manufacturing across the value chain – i.e. from silicon to modules – per year, with an annual capacity of at least 2GW for modules alone. Among the requirements sought from the BMWK is a module efficiency higher than 24%, no use of soldering processes in the PV module production, a recyclability design of the modules – including a declaration of the 'ingredients' – or a degradation of the modules of less than 0.2% per year.

**US production****First Solar to open 5th US manufacturing facility in Louisiana**

Thin-film solar PV manufacturer First Solar has confirmed the Louisiana location of its fifth US manufacturing facility, a 3.5GW, US\$1.1 billion dollar Cadmium Telluride (CdTe) module production factory. Acadiana Regional Airport in Iberia Parish, Louisiana will play host to the new facility, which is expected to be online and producing First Solar's Series 7 modules in the first half of 2026. By then, First Solar said that it expects Series 7 products to make up over two thirds of its domestic nameplate capacity, which it anticipates to be around 14GW.





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# Building the Downstream PV Market Back Better

**Supply Chain** | Martin Pochtaruk, President of Heliene, Inc. on the challenges and opportunities of building out the domestic PV supply chain in the US.



**Heliene, Inc. is among the companies expanding solar PV manufacturing in the US with a recently-expanded 420MW facility in the Iron Range region of Minnesota. Credit: Heliene, Inc.**

The recently passed Inflation Reduction Act (IRA) contains the most ambitious climate investment policy in US history. This legislation, which includes billions of dollars in tax credits and other incentives for growing the manufacture and deployment of solar and other renewable energy technologies in the US, will help supercharge expansion of the domestic solar PV market.

However, this market was growing at a robust pace even before the passage of the IRA. According to the US Energy Information Administration, total annual solar power installations in the US tripled between 2015 (5.7GWac) and 2022 (17GWac). Thanks to this growth, in 2021 the US was able to add twice as much new solar electricity generation capacity (15.4GW) as new natural gas electricity generation capacity (6.6GW).

This growth occurred despite a period from 2016-2020 in which the US president and his administration actively worked against efforts to encourage renewable energy development. Yet the US solar PV power market was still able to grow during this period because such investment made good business

sense. Solar PV's environmental and energy reliability benefits – it generates electricity without releasing greenhouse gas emissions and can provide customers with power even when there is a grid outage – were two of the reasons for this growth. But in the end, the primary reason companies and households continued to invest in solar PV even as its pre-IRA government incentives were being phased out was an economic one

– solar PV provided them with a strong return on their investment.

Now, with the new, long-term solar incentives contained in the IRA further increasing the returns (and lowering the risk) of US solar PV investments, research firm Wood Mackenzie forecasts that this market will grow rapidly over the next five years, with total installed US solar capacity rising from 142GW today to 378GW by 2028.

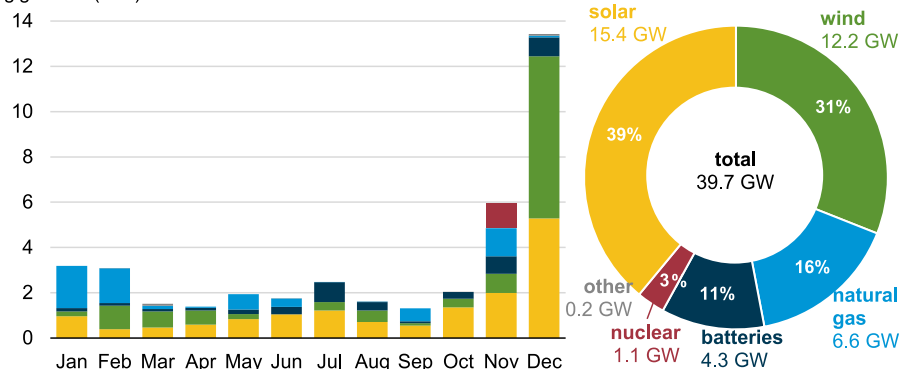
## Obstacles That Might Slow Growth of the U.S. Solar PV Market

While the IRA provides fertile soil for the rapid growth of the US solar market over the next decade, several obstacles that have hindered this growth over the last ten years remain. If solar PV manufacturers, developers and installers, government policymakers, utilities, and other key industry stakeholders hope to not just continue to grow the US solar PV market, but fully leverage the IRA's new incentives, they need to address these obstacles.

Specifically, these stakeholders need to build the solar PV market back better by addressing three obstacles that threaten to hinder its growth over the next decade:

**In 2021, new US solar generation capacity doubled compared to new natural gas capacity.**

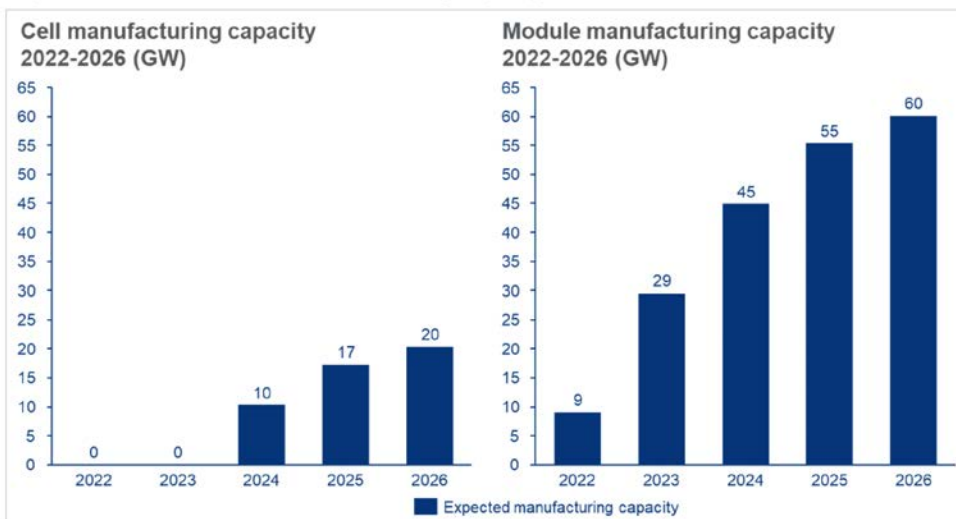
**Planned U.S. utility-scale electricity generating capacity additions (2021)**  
gigawatts (GW)



Source: US Energy Information Administration, Preliminary Monthly Electric Generator Inventory, October 2020



## Expected US cell and module manufacturing capacity



Source: Wood Mackenzie's Q1 Global Solar Supply Chain Briefing. Note: Expected manufacturing capacity is based on full materialization of announcements through March 2023

- **Supply chain issues** that could limit the ability of solar developers and installers to receive in a timely manner the solar PV panels they need to meet growing customer demand.
- **Labour issues** that might prevent solar manufacturers, developers, and installers from being able to recruit and retain the skilled talent they need to manufacture and deploy hundreds of gigawatts of new solar PV capacity.
- **Transmission issues** that will make it difficult for solar PV systems to reliably and affordably transmit the energy they generate to consumers.

### Obstacle: Overdependence on Asian Solar PV Equipment Manufacturers

One of the biggest risks faced by the US solar market over the next decade is that the global solar PV manufacturing supply chain will not be able to deliver enough solar PV panels to reliably meet domestic demand. One major reason for this risk is that one country – China – today claims an 80% share of all stages of the global solar panel manufacturing market.

If US access to Chinese or other Asian solar PV manufacturers were hindered or cut off – due to geopolitical tensions, a new pandemic, a natural disaster, or other events – the growth of the US solar PV downstream market could grind to a halt. Europe's recent energy crisis, caused by cuts of Russian natural gas and oil imports due to the invasion of Ukraine, provides a vivid illustration of how overreliance on a single country

**US-made solar cells will meet 33% of announced domestic module manufacturing capacity by 2026. Manufacturers will need reliable access to solar cells and other components and materials used in their products to meet demand.**

or region for an essential commodity can disrupt not just markets, but entire economies.

### Solution: A Diversified, 'Friendshored' Solar PV Supply Chain

The US has already made some headway in mitigating its overreliance on Asian solar PV equipment supplies by increasing its domestic solar PV equipment manufacturing capacity over the past few years. For example, according to the NREL, US c-Si solar module manufacturing capacity grew from less than 0.5GW in 2018 to almost 2.5GW in 2022.

In addition, the IRA contains an industrial policy with robust incentives to encourage further growth of the US solar PV manufacturing sector. Research indicates these clean energy manufacturing incentives will boost US solar PV manufacturing over the next decade. For instance, a February 2022 report from the DOE forecast that domestic US solar module production capacity could reach 10GW in two years, 15GW in three years, and 25GW in five years with the right federal investments (like those found in the IRA) in place. These forecasts are being borne out – since the IRA's passage, companies have announced plans to build manufacturing capacity across the entire solar PV supply chain, including 26 separate new manufacturing plants.

However, such new manufacturing capacity would likely not be enough to meet future US domestic PV module demand. In addition, investment is particularly needed in the upstream sector of the solar PV supply chain to

support the reshoring of the industry. For example, according to Wood Mackenzie, solar cells domestically manufactured in the US will meet just 33% of announced domestic module manufacturing capacity by 2026. US solar PV module manufacturers will need reliable access to solar cells as well as the other components and materials used in their products – including wafers, polysilicon ingots, and raw polysilicon itself – if they want their solar PV supply chain to be secure.

Such a secure supply chain will require existing US companies to expand their operations into the solar market, as well as the launch of new companies in the US to manufacture components for solar modules. This is already happening – until recently no companies in the US produced the two types of polymers used for solar module encapsulants and backsheets. However, today two companies – Endurans and HB Fuller – are producing these polymers in the US for solar PV module manufacturers.

It will also require working with companies in Canada, Mexico and other friendly nations and US allies to manufacture key solar PV module components. For example, the vast majority of solar glass used in solar PV modules is sourced from companies that manufacture it in China, Malaysia, and India. However, a Canada-based company, CPS, in May announced that it is building a plant in Manitoba to manufacture this type of solar glass in Canada – the first plant of its kind and size in North America.

Such a diversified, friendshored solar PV supply chain strategy – in which we can source all the components and materials needed to manufacture solar modules from companies operating in the US or our close allies – lowers the risk that geopolitical tensions, natural disasters, or similar events might disrupt the US downstream PV market. In addition, a diversified, friendshored supply chain strategy also reduces shipping costs, simplifies supply chain logistics, and lowers solar PV manufacturing's carbon footprint.

### Obstacle: Lack of a Large, Skilled Solar PV Workforce

Developing a diversified solar PV manufacturing supply chain that spans across the US and its close allies will help provide the US solar PV downstream market with the reliable supply of the modules it needs to maximise its growth.

However, this supply chain might not be able to operate at its full capacity if the US does not have a large, skilled workforce able to manufacture solar PV equipment or deploy solar PV systems.

This is why it is important for the US solar PV industry and its key stakeholders to foster expansion and training of the US solar PV workforce. Even before the passage of the IRA, the US solar workforce was growing, with the Interstate Renewable Energy Council reporting that, as of December 2021, the industry supported 255,000 jobs, a 9.2% increase from 2020. But with the passage of the IRA, the growth of this workforce will need to accelerate – according to a recent SEIA study, the solar and storage industry will need to double its workforce over the next decade.

### **Solution: Improve Solar Worker Compensation, Expand Recruiting, and Increase Training**

One way in which US solar PV manufacturers, developers, and installers can recruit and retain the skilled talent they need to support rapid growth is simple – better pay.

In a world where many jobs now offer workers flexible schedules and the ability to work from home, solar companies need to offer their workers competitive salaries and comprehensive benefits if they want to attract workers that are willing to commute to a solar PV manufacturing facility for an early-morning or late-night shift or to climb on roofs to install solar panels.

They also need to expand their recruiting efforts to groups – particularly women – that are currently underrepresented in the solar PV workforce. For example, according to the IREC, just under 30% of solar employees in 2021 were women, while women represent 47% of the overall US workforce. Women and other underrepresented groups could provide the solar PV industry with many of the skilled workers it will need to support its rapid growth. But first companies in the solar industry need to demonstrate to people in these groups that they are actively working to make their cultures more inclusive and their workforces more diverse.

Finally, the US solar PV industry needs to ramp up its efforts to partner with high schools, vocational schools, community colleges, and other educational institutions on apprenticeship and other training

programs. Without such partnerships, the industry will find it difficult to recruit the large number of skilled entry-level workers it will need to grow both rapidly and efficiently.

Providing solar PV workers with good wages and benefits, expanding solar PV industry recruitment efforts to women and other underrepresented groups, and launching new mechatronics and electrical apprenticeships and other training programmes will require significant investment by the solar PV industry. However, over the long term, these investments will build the large, well-trained workforce that the US solar PV market needs to reach its potential.

### **Obstacle: Fragmented Electricity Transmission System**

A diverse friendshored solar PV supply chain and large, skilled solar workforce will both help the US solar industry fully leverage the incentives contained in the IRA. However, there remains an issue that could throw sand in the gears of this growing market.

This is the patchwork, non-optimised state of the US long-distance electricity transmission system. Currently, its operations are fragmented, with separate Western, Eastern, and Texas grids that share few connections with each other. These grids are subdivided as well, with a large number of different operators managing different parts of these grids.

This fragmentation makes it difficult to use the existing US grid infrastructure to transmit power from areas where it is being generated to where it is needed. It also complicates efforts to build new grid infrastructure that would enable clean, low-cost solar power to be transmitted to areas where power is expensive or capacity is constrained.

### **Solution: A National Long-Distance Electricity Transmission System**

There are signs that transmission operators are waking up to the fact that a clean energy economy needs a national long-distance electricity transmission system optimised to support clean energy generation. For example, the recently approved Champlain Hudson Power Express transmission line (CHPE) will help deliver 1,250MW of clean energy from hydropower facilities in Québec to energy consumers in New York City. But there is still a lot of work to be done before the US long-distance electricity transmission

system is updated to support an economy powered by solar and other forms of clean energy.

It will be difficult to get regional transmission authorities, state and local governments, and utilities to work together to develop and implement a comprehensive national transmission system that enables solar and other types of clean energy to be efficiently transmitted from many of the rural locations where it can be best generated to the more populous locations where energy demand is high. But the stakes couldn't be higher. According to a recent study by the Princeton-led REPEAT project, 80% of the potential emissions reductions delivered by the IRA in 2030 could be lost if we only expand transmission at a rate of 1% per year, and approximately 25% might be lost if transmission growth is limited to 1.5% per year.

With the passage of the IRA, solar and other types of renewable energy won an important battle in the war against fossil fuels. But unless the solar industry and its stakeholders ensure clean energy can be affordably and reliably transmitted from where it is produced to where it is needed, it will delay the arrival of the day when solar, wind, and other renewables finally win the war to replace fossil fuels.

### **Faster US Solar PV Market Growth Will Speed Our Transition to a Clean Energy Economy**

The supply chain, labour, and transmission issues described above are not the only obstacles that could slow the growth of the US solar PV market over the next ten years. However, if the solar PV industry and its key stakeholders address these supply chain, labour, and transmission obstacles they can build this market back better. In doing so, they will not just maximise the growth of the solar PV market enabled by the IRA, but also accelerate the development of a US economy fully powered by clean, renewable energy.

#### **Author**

Martin Pochtaruk has 35 years of experience managing manufacturing and innovation businesses across Europe and the Americas. He founded Heliene, a technology-leading high quality solar PV manufacturer in 2010. Heliene is challenging the solar industry status quo by putting customers first and manufacturing high quality, competitively priced solar PV modules made to order in North America. To learn more, visit [www.heliene.com](http://www.heliene.com).







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# From Coal to Solar: Repurposing Brownfield Sites to Accelerate the Renewables Transition

**Redevelopment** | PV Tech Power Reporter Jonathan Touriño Jacobo looks at how the Inflation Reduction Act could help in redeveloping closed-down US coal assets to host solar PV projects.



Credit: BrightNight

Sometimes an image can say more than a 1,000 words, and in the electricity transition this image is probably the development of renewable projects in a former coal mine or plant. As more and more sites are being closed in order to decrease the carbon emissions generated by fossil fuel-powered plants, these sites also present a good opportunity to be repurposed in order to achieve this much needed and accelerated transition. All while using land that would otherwise be of no use for many other purposes.

Redevelopment can also offer a solution to coal communities, especially the workers, to not be left behind in this transition and give a social connotation to these projects. In the US, the Appalachian region might be the one more prone in the coming years to these types of projects. Ensuring that communities in states such as Virginia, Kentucky or Pennsylvania are part of the renewables transition and benefit from it, both with projects built at former fossil fuel sites and with new job opportunities, will be key for the complete decarbonisation of the US. A country that

**Starfire render image of the 800MW coal to solar project from IPP BrightNight**

has for many decades depended a lot on coal but has slowly closed its mines which could now be used to build solar PV or battery storage plants instead.

Using former coal mines or coal plants for renewable projects will create an opportunity to accelerate the growth of solar. Just to give an idea of scale, in 1990 the US had 675 coal facilities in operation with a combined generation capacity of 330GW, according to data from the US Energy Information Administration. The latest data available, 2021, shows that 269 facilities remained operational, represent-





ing a nameplate capacity of 228GW.

This feature will look at the benefits of developing solar PV on such sites, the challenges of doing so and how the Inflation Reduction Act (IRA) could help more developers to carry on building projects in brownfield sites.

### Adders for coal community projects

Earlier this year the US Treasury Department released guidance on the IRA bonuses for historically fossil fuel-producing energy communities, predominantly coal-fired ones. Solar developers who end up building a solar PV plant in areas or communities that are historically focused on energy production or have hosted significant fossil fuel plants can receive up to a 10% bonus on both the Investment Tax Credit (ITC) and Production Tax Credit (PTC) facilities of the IRA. This would allow to balance the extra cost associated with building a project on a brownfield site, says Chad Farrell, founder and co-CEO of renewables developer Encore Renewable Energy, adding: "Generally, the added cost of doing a landfill project is right around 10%. So getting that boost is really going to be helpful for bridging that gap."

This 10% bonus will undoubtedly attract more developers to build projects on this type of land, adds Ron Kiecena, chief development officer at independent power producer (IPP) BrightNight which recently announced a 800MW solar PV plant on a former coal mine in the state of Kentucky which is explored in this feature.

The tax benefits are a game changer as they make it more attractive to investors, adds Adam Edelen, CEO of solar developer Edelen Renewables. And if having tax benefits to build a solar project will attract more companies to fund these

**Image of the Appalachian Mountains region where many coal mine sites could be used for solar PV plants**

projects, the mere social aspect of building these on former coal mines or plants would show the commitment from the biggest companies to transition towards clean energy. "For some of these projects, Fortune 500 companies are willing to pay a premium for demonstrable social and economic impact in the communities where they were developing," says Edelen.

### A boon for coal communities

Probably one of the biggest advantages of building a solar PV plant on a former coal mine or a coal plant for a solar developer is that it will help avoid going through the strenuous permitting process of securing or building transmission infrastructure. Sean Rai-Roche, policy advisor at climate change think tank E3G, says: "In the US, former or soon to be retired coal plants represent a huge opportunity to speed up solar deployment. These coal sites already have transmission infrastructure in place that can enable faster connection to the grid, avoiding the lengthy interconnection queues currently seen in the US. Previously polluting coal plants can be used to fast-track grid connection for new, clean technologies, reducing costs and regulatory issues at the same time as breathing life into communities which have historically depended on that coal."

Aside from the transmission infrastructure, Edelen points out, these sites also have a good transportation access to the facilities that was built to facilitate the transportation of what was mined, for instance.

But probably one of the most important benefits these projects can offer to coal communities is an economical boost with the creation of jobs, giving

former coal workers a chance to continue working in the energy industry.

"I'm not sure that there's anything a lot more fitting than putting out-of-work coal miners or out-of-work oil and gas workers back to work in the green energy economy," says Edelen, adding: "We have a moral obligation to create opportunities for these folks. They literally powered the industrial development of America for hundreds of years, and these folks shouldn't be left behind just because the economy is transitioning."

Edelen Renewables works closely with communities and technical college systems, workforce and economic development authorities and local elected officials in order to build the infrastructure that not only supports being able to hire workers locally but also that the workers get the necessary skills, training and credentials to work on the projects. In an industry where skilled workers are scarce – which is often the highest or second highest preoccupation for solar developers when developing a project – allowing former coal workers and oil and gas workers to be brought to the renewables shift will be a great help to accelerate the uptake of renewables capacity across the US.

"In all of our projects we recruit, hire, train and credential workers locally. So we have a heavy focus on legacy impact to the community. Where we develop our projects, they tend to generate more in tax revenue for the local community," says Edelen.

Farrell concurs and adds the aspect of how a piece of land that is either unusable or complicated to redevelop can be used to return the property to a productive reuse. Not only that but it also brings taxes, new jobs, and in the end produces renewable energy with the construction of a solar plant.

"Part of that is specialising in reclaiming undervalued real estate for clean energy generation and storage, which ultimately helps us revitalise communities and create a cleaner and brighter future for all. We like to call it from brownfields to bright fields. And that we're actually giving these properties a second act or an encore, as a renewable energy project," says Farrell.

Farrell points out that after the IRA was passed and the industry celebrated the legislation, two main challenges still remained in order to allow for renewables' growth across the US. If one of them is the grid, which in this case is less of an issue for solar projects on former coal

land due to already existing transmission infrastructure, the other one is indeed a major issue: the lack of labour force. Or rather the increased need of workers in order to add all the capacity in such a short time.

To put things into perspective, the US solar industry employed more than 263,000 people at the end of 2022, according to the Interstate Renewable Energy Council (IREC), while a paper from trade association Solar Energy Industries Association (SEIA) forecasts more than half a million jobs across the industry by the end of the decade.

Among the many programmes included in the IRA, there are some directed towards jobs and more specifically apprenticeship programmes which would allow not just to bring new people in the industry but also former fossil fuel workers, from the coal, gas or oil industries too.

"Everywhere we go, we were saying: 'where are we going to get all these workers?' And I think people coming out of the coal industry and the fossil fuel industry are going to be a big part of the labour pool that's going to be required to make this transition," says Farrell.

Another benefit for coal communities is that these sites would also be able to allow the development of more storage projects – as a standalone – in brown-field sites as they are much smaller projects than solar ones, according to Farrell. "A five megawatt solar project in the Northeast is like a 25 acre land requirement. There aren't enough brownfield sites, unfortunately, that are that large. And they're not as many coal sites either."

Whereas a 5MW storage facility occupies less than one acre of land and would also reduce all the difficulties associated to develop a solar project in a former coal site, no matter the size. "There's a proliferation of that size of brownfield sites out there."

Many brownfield sites in the US have been built close to urban locations which usually require a greater electrical demand. Installing energy storage near those densely populated areas would help improve the grid resiliency. Farrell expects the boom of solar PV projects to be built on brownfield sites to also happen with energy storage in the next five to ten years.

**Developing solar PV on coal: "Diffi-**

## BUILDING A 800MW UTILITY-SCALE SOLAR PROJECT ON A FORMER COAL MINE

IPP BrightNight unveiled in July 2023 that it was to develop an 800MW solar PV plant located at a former coal mine in the state of Kentucky. One of the largest in the US in that type of land and the company's flagship project on mine land, says Ron Kiecena, chief development officer at BrightNight, which has a development portfolio of 23GW of renewables.

The Starfire project will represent a US\$1 billion investment and will also include the construction of a 20-mile transmission line which would enable the addition of 1GW of renewable capacity to be built in the region. "The transmission infrastructure to be added as part of this project will help drive future economic growth in the region. Starfire will provide low-cost renewable power which will help attract new business opportunities," says Kiecena.

Given its size and the implications of it, the company partnered with automaker Rivian and environmental nonprofit The Nature Conservancy to develop the project, and Kiecena highlighted the importance to build partnerships for such a large-scale project on a former coal mine. "Like-minded partners are a necessity when taking on a project of this magnitude. The roadmap to transforming formerly mined land is not yet written and therefore it is imperative that a network of companies, policy makers and regulatory bodies join forces to partner on this opportunity, to achieve completion of an extraordinary, literally one-of-a-kind, regional economic impact project. BrightNight is planning to apply for a grant with the Department of Energy and has assembled a full team of key partnerships for the project to support that application."

### CONCLUSION

"States across the country, irrespective of political stripe, are already transforming old coal facilities into new wind and solar projects. As more and more coal plants in the US come closer to their retirement date, there are even greater opportunities to come. The US has committed to cleaning up its electricity system by 2035 and has sent strong signals on the need to phase out coal from its power mix. If it is serious about this, it needs to consider all available options. States should be working to identify suitable coal projects for conversion. Doing so would benefit solar developers, local communities, and the battle against climate change," says Rai-Roche.

Chad Farrell points to how these communities have borne the burden of providing energy for the greater population and because these sites are getting closed should not mean they are left behind in the renewables transition. Thanks to programmes included in the IRA, it will be easier for developers to build solar PV plants on former coal mines or plants which are expected to be more frequent in the coming years.

### culties are legion"

If the advantages of developing solar PV on former coal mines are all too important to take into consideration, the list of challenges on the other hand are "legion", says Edelen.

The engineering aspect of these projects alone can be a complicated jigsaw puzzle to make sure they still remain cost effective. "Because you've got a mountaintop removal site in Eastern Kentucky, or an Appalachian mountain site, you may have geotechnical challenges that drive up the cost of your array," says Edelen.

"These projects generally have an elevation of 100 feet or higher. The mountains have been reduced to bedrock. The way you anchor the modules into the ground is fundamentally different, because you can't sink a pylon eight feet into the ground on a mountaintop removal site the same way that you can in a Kansas wheat field. There are all sorts of technical challenges that are extraordinarily difficult to circumvent. And as a result, the price of the power necessarily goes up," adds Edelen.

Unlike most greenfield sites, where it is easier to use a similar approach from project to project, brownfield sites are all too different from each other and unique.

This extra process of engineering also needs to take into consideration the land it will be built in and avoid any further damage to it or create further health or environmental issues, which in itself would require more permitting work.

Brownfield sites – of which coal mines are part of – often come with contaminated soil or groundwater whether from industry or commercial use and usually require additional engineering and permitting work, says Farrell. "We need to make the regulatory community comfortable that we can actively construct a solar project on this land without creating concern with respect to exposure to the contaminants to human health or the environment."

In terms of the different uses of technologies between a brownfield site or a greenfield site, there are no real restrictions or differences between both other than the topographic constraints that will decide if a solar project can or cannot use trackers or if any type of site work is required, says Farrell. "That's the same whether you're on a greenfield site or a coal site. You're always going to have topographic limitations. Whether we're doing ballasted or fixed, there are certain sloped thresholds that we just can't exceed." ■





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# Community solar in the US set to accelerate post-IRA and new state legislations

**Community solar** | One year after the Inflation Reduction Act was passed, growth of community solar is expected to accelerate in the coming years thanks to federal help but also at state-level with states passing or improving new legislation. PV Tech Power Reporter Jonathan Touriño Jacobo looks at three different cases: California, Ohio and Minnesota, and investigates the challenges community solar still faces.

Credit: Reactivate



Even though utility-scale solar PV in the US added more than half of all capacity in 2022, followed with residential solar as the top market segments, community solar is slowly working towards an accelerated growth in the coming years. By the end of the first quarter of 2023, community solar installed capacity reached 5.8GW, according to data from trade body Solar Energy Industries Association (SEIA). That number is expected to double in

the next five years, according to a report published by the Coalition for Community Solar Access and Wood Mackenzie earlier this year with at least 6GW of community solar to be added between 2023 and 2027.

The impetus for this future growth of community solar will without doubt come from the Inflation Reduction Act and new guidance on community solar that was published this year. But the boost will not only be coming at a federal level – many

## Preparing the build of a community solar project.

states are working towards implementing or improving bills or programmes directed at community solar.

At the time of writing, 21 states had a legislation or policy either approved or in the works, with more to come in the coming months and years. And the number of states with a least one community solar project that is operational stood at 41, including Washington DC, according to SEIA.



"We're seeing kind of a new state pop up with community solar legislation and/or an actual programme about once every nine months or so. It's a very systematic growth of the industry propelled by both legislation at the state level, and at the federal level," says Jeff Cheng, CEO at community solar developer Nautilus Solar which is present in more than ten states. This rollout of new programmes or legislation from a new state in a timely manner allows developers enough time to plan ahead for a gradual rollout, adds Cheng.

Here's a look at three different states – California, Ohio and Minnesota – that have set out to help boost the growth of community solar. This also encompasses how diverse legislation can be from state to state and how the Inflation Reduction Act (IRA) is likely to help accelerate the growth of community solar across the US.

### IRA boost for community solar

Among the many provisions included in the IRA, there have been several that will be a major boost for community solar to thrive in the coming years in the US. Starting with the extension of the solar Investment Tax Credit (ITC) for a decade with a 30% rate deduction for commercial and residential solar systems. Within the ITC there is also a provision with bonus credits towards low-to-moderate income (LMI) consumers in mind.

"In my mind, what the IRA has done, is it's given some medium- to longer-term stability for the industry. It's a 10-year programme. It allows us to plan for that systematic growth over a much longer period of time, without fear that in a year, the policy will change completely and we will have to revamp the business again," says Cheng.

Earlier this year the US Department of the Treasury released guidance on a programme directed towards low-income consumers, the Low-Income Communities Bonus Credit. As the goal is to increase the renewables intake from low-income communities, projects that apply to this programme – which allocated 700MW of solar and wind capacity to low-income communities – will benefit from a 20 percentage point boost on ITCs.

At a state-level, some programmes require a certain percentage of a community solar projects to have LMI customers, with Delaware at 10%, Virginia at 30% or California at 51% for low-income, which will be explored in this article.

"In many cases, because of the Inflation

Reduction Act, we're going to pursue to get some of those ITC adders for our projects that allow us to actually provide more bill credits and more savings to low-income customers. Because they carved out in the IRA the moderate element, it has to be low-income. So we're actively pursuing and aggregating low-income customers across many markets, the most that we're doing right now is in the state of Virginia and Illinois," says Jason Spreyer, executive vice-president of business development at solar developer Summit Ridge Energy.

Spreyer added that due to how the minimum bill credit requirements are implemented in Virginia, the company is only pursuing LMI offtake, rather than the 30% minimum requirement.

### California's 51% low-income target

California has long been the leading state for solar PV across the US, with more than 40GW of capacity installed as of the end of Q1 2023, according to data from SEIA. This represents more installed solar capacity than the next three states in the list combined, Texas, Florida and North Carolina.

It should therefore not come as a surprise that the leading state in solar PV worked towards implementing a legislation around community solar that could be used as a blueprint for other states. Assembly Bill (AB) 2316, which was passed by the governor of California Gavin Newsom, in September 2022, is now going through the California Public Utilities Commission (CPUC), which is working towards evaluating several proposals for community solar programmes. A Net Value Billing Tariff (NVBT) proposed by the Coalition for Community Solar Access is supported by a broad coalition of environmental justice groups, ratepayer advocates, labour, and the building industry association.

"This bill moves faster than any other I've ever seen in my policy career. One of the reasons is just that the appetite for community solar is there," says Theodora Okia Quarles, former policy and strategy manager – West at community solar developer Lightstar Renewables, which has a pipeline of projects of nearly 1GW and is present in 12 states.

Probably the most important aspect of the bill was the requirement that any community solar programme enforced in California would "ensure at least 51% of its capacity serves low-income custom-

ers", putting once again community solar at the forefront of allowing everyone the possibility to transition from fossil fuels to renewables.

"The bill was definitely ambitious in having that language. But, that's the goal, for low-income customers to benefit. Because I've seen in the past that when legislation doesn't have that prescriptive number you can't necessarily hold anyone to account after the fact," says Quarles.

Community solar has this ability to bring renewables to people near where a project is being built and give the benefits of its power generation to its consumers, says Cheng. "It's probably one of the best reflections of really what community solar is trying to do. To give the benefits of renewable power to an audience that, arguably, wouldn't normally be able to have that."

For new or improved legislation to actually allocate a certain amount towards low-to-moderate income (LMI) consumers in community solar projects will ensure that no one is left behind, and California's push goes a step further as it would require more than half of low-income customers to be signed in.

"California has led the nation in rooftop solar capacity for a number of years now. And it's been on top from a community solar standpoint, it's a large state, with vast territories. And from that standpoint, there's a lot of opportunity for community solar," adds Quarles.

### Ohio embraces community solar

Ohio's case is quite peculiar given the presence of cadmium telluride thin film manufacturer First Solar in the state with a module facility. The Midwest state will also be home to Chinese solar module manufacturer LONGi and US developer Invenery's 5GW module assembly plant and yet, before bill HB 197 was introduced, community solar was non-existent in Ohio.

This brings the number of US states with a programme for community solar, either approved or pending, to 21. "Community solar truly only exists, in our definition, in 21 states in the United States," says Carlo Cavallaro, Midwest regional director at US trade association Coalition for Community Solar Access, adding that the bill serves more as a foundational stone for community solar in the state.

The new programme for community solar targets to bring 1GW of community solar that can be placed anywhere within



Credit: Summit

the major electric distribution utility territories, 500MW of capacity targeted for distressed sites – such as brownfield or wastelands – and 250MW of capacity specifically allocated for Appalachian communities in Ohio that have been affected by the transition towards renewables, such as former coal-fuelled power generation sites.

Going from a non-existent market for community solar to more than 1GW will also have a big impact economically in Ohio, with US\$5.6 billion, along with US\$490 million in local tax revenues, based on a report that CCSA wrote in partnership with Ohio University's School of Business, says Cavallaro.

After what happened in other states, Cavallaro expects that if the legislation passes, it would take less than the four-year mark the programme was set for the state to see what benefits community solar will bring in Ohio and look at ways to improve it or expand further from the initial 1.75GW capacity.

Moreover, this makes Ohio the first state in its region to move forward into

implementing a programme directly targeted to community solar, with the closest state being Illinois, says Cavallaro. A state that is working on the second iteration of its community solar programme. This allows for major growth in the Midwest, where there is space to accelerate the growth of community solar in the US.

"Community solar is continuing to grow because of the fungible nature of the programmes. Across the states, Michigan is looking at it very seriously. Wisconsin and Pennsylvania are very active. There's a lot of activity in the Midwest for growth," says Cavallaro. The next step now for Ohio is to pass the bill and welcome the first community solar project in the state.

#### **Minnesota's overdue programme revamp**

Minnesota, which is one of the leading states in the country in installed community solar capacity, the community solar garden (as they are known in that state and in Colorado) programme has recently seen an "evolution" as Kevin Cray, Mountain

#### **Community solar project located in Rockford, Illinois.**

West senior director at The Coalition for Community Solar Access, would put it.

"I'm kind of seeing this as community solar 2.0. If you look back at the actual statutory language, the entire legacy programme is, in a way, retained in the statute," says Cray, adding that new statutory sections have been established to the programme moving forward from next year. During the run of the initial programme, community solar added 800MW of capacity.

Some of these changes are the increase of the maximum size of a project going from 1MW to 5MW, which is more aligned with the average size of a community solar project; the removal of a restriction that impeded customers from a contiguous county to be subscribed to a solar project that was in a different county they are living in; and 55% of a project capacity to be allocated to public interest subscribers, such as schools, tribal entities, affordable housing buildings and low-income residential. With an additional requirement of 30% of the project capacity needed to be allocated to LMI customers.



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"That's kind of embracing the equity focus that we've seen in other solar community markets, such as New Jersey, Maryland, California or New Mexico. A lot of the kind of newer leading markets. I'm viewing this as Minnesota catching up with where the rest of the country has gone since the enabling legislation passed in Minnesota in 2015."

Having it in writing that a certain percentage of customers must be from moderate or low-income households will guarantee that these customers are not left behind, as was the case in Minnesota's previous programme which only required to have at least five subscribers, and this caused many of the projects being targeted towards commercial customers instead of residential ones.

"You would see projects that were only made up of five to 20 subscribers, largely commercial. And you didn't really see those benefits trickling down to residential customers, in particular, to low-income or low- to moderate-income customers. Now there's a very specific requirement, that those people make up at least 30% of the project," says Cray, adding that the number would likely be even higher due to how the rate construct works. LMI residential customers get the highest credit rate which would encourage developers to target a bigger percentage than the 30% minimum required.

This new legislation is expected to give a boost to community solar in Minnesota which had seen a deceleration of projects in the past few years, with around 40 to 50MW of capacity added, says Cray, who expects the number to reach 100MW in the coming years. Which is also the cap the state has put for 2024 to 2026, and will then be reduced to 80MW per year between 2027-2029. However, like all the developers consulted for this article have mentioned, interconnection could alter the pace of the growth in Minnesota.

"There are still some concerns with the interconnection process, and how long it takes to get through the interconnection process. The fact that they're doing some serious studies, we're going to continue to work on that. And there was some language in the bill that talks about improving the integrated distribution planning (IDP), to focus on areas of the grid that need to be upgraded proactively to accommodate more distributed generation, in particular community solar."

Increasing the size cap of a project from 1MW to 5MW could in itself reduce

the cumbersome process of getting grid access as, rather than waiting for five different 1MW projects to go through the entire permitting process and grid connectivity, developers will only need to submit a single 5MW project.

### Solving interconnection issues

When asked about the main challenges community solar currently faces, the first response is almost always the same: interconnection.

"The community solar market, like much of the industry, also faces challenges with interconnections and permitting. We need more transparency at the distributed generation level to understand hosting capacity for potential projects," says Utopia Hill, CEO at solar developer Reactivate, which has several projects in construction in Illinois and New York and is aiming to have a solar portfolio of 3GW by 2030.

When asked about what drives solar developer Summit Ridge Energy to select or enter a new market to develop community solar, Jason Spreyer, executive vice-president of business development at Summit Ridge Energy, did mention interconnection being one of the aspects the company looked at. "Some of the characteristics that we look for are good strong state policies around the incentives. Clear interconnection paths. Even if interconnection becomes a challenge, you want to have clear understanding of that path. Strong marketplaces. And more importantly the ability to build at scale."

This does not mean interconnection is not one of the biggest challenges the company faces in general across the markets where it is present, the costs associated with interconnection or the timeframe to study projects are among the biggest challenges too. And as more capacity is added across the states or more players enter a market, grid connectivity will get worse. "Markets that ultimately have higher levels of penetration, could result in some investment necessary in the grid," says Spreyer.

Both transmission and distribution networks will have to increase the investment in the grid, especially if more distributed projects are connected closer to the load.

If interconnection might be the more pressing issue that needs to be solved, as soon as possible, other challenges, such as the continued difficulty to find skilled workers is also present in community solar, according to Cheng. "Whether it's our EPCs

who build the projects for us, or even on the utility side, they're suffering from a lack of qualified personnel, quite frankly. So labour is at a premium still in this industry, which of course, drives up costs."

Meanwhile, challenges at state level are more easily overcome with effective communication, adds Spreyer. Especially in counties that might assimilate utility-scale solar projects and community solar as the same side of a coin even though the latter offers a direct impact to the communities near a solar PV plant, with direct savings on their bills.

### Bright future for community solar

Despite some of the challenges community solar is facing, the future is looking quite bright for this segment of the solar industry with an accelerated growth that could double its numbers in less than five years, thanks not only to the tax incentives in the IRA but also through dedicated programmes at a state level.

"We will see tremendous growth in community solar in the US in the coming years. There are many people that want a choice for solar supply but live in multi-family housing, their roof may not be adequate, or there may be other constraints that limit their ability to have rooftop solar. For those individuals, community solar is an option that provides economic savings and environmental benefits," says Hill.

The fact that each state implements different setting for community solar could seem intricate for developers to adapt to each state's requirements but the optics of seeing more and more states slowly implementing a legislation that can help boost installation of community solar projects is in itself an achievement, such is the case of Ohio mentioned earlier which, before the introduction of a community solar bill, had no activity in that market.

"It's a market momentum. You see new states that are starting to adopt legislation. There's pending legislation in Michigan, Wisconsin, Illinois and Ohio. There are new states that are coming on board but they're not quite there yet, such as Pennsylvania. But we see them on the horizon," says Cheng.

Community solar might not have the numbers of utility-scale solar but it does offer a possibility to US households to be able to switch their electricity consumption to renewables, especially those who cannot install rooftop solar as they do not have that option or those who cannot afford the cost of the installation. ■



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# ‘In the Name of Grid Reliability’: Challenges and Opportunities in Solar Power Permitting in Texas

**Solar Permitting** | PV Tech Power Editor JP Casey looks at the balancing act legislators in Texas face when considering grid reliability and the ratio of the different methods to generate power in the US state.

The phrase that ‘everything is bigger in Texas’, oddly, might apply more to its energy mix than to any other aspect of the US state. From the government’s own figures, Texas leads all US states in energy production and consumption, and in 2021, the state produced the most energy in the country, accounting for 43% of the US’ total oil production, and one-quarter of its gas output.

Yet this is not to say that Texas is entirely reliant on fossil fuels. Indeed in 2021, the state was the largest producer of wind power in the US, accounting for 26% of the country’s total wind production, and in 2022 ranked second among all states in solar production, behind only California. Critically, the Solar Energy Industries Association (SEIA), the trade body representing solar developers in the US, projects that the state’s solar capacity will grow by 34.3GW over the next five years, the most of any US state.

Part of this optimism stems from the standing of renewable power in general, and solar power in particular, in the US. The US Office of Energy Efficiency and Renewable Energy reports that by the end of 2022, there were 110GW of photovoltaic installations alone in the US, and the SEIA notes that the country’s solar pipeline contains more than 99GW of additional capacity in large-scale projects alone, to say nothing of the small-scale solar projects under construction.

Much of this development has come in the wake of the Inflation Reduction Act (IRA). The SEIA reports that the incentives offered by the IRA will lead to the US



Credit: Axium Solar

installing 69% more solar capacity by 2032 than if the IRA had not been implemented, and the Act has largely been hailed as a vital step facilitating the realignment of the US energy mix.

Yet tying together the renewable power incentives proposed on the federal level and the significant solar potential in Texas on a state level has proven challenging. While these bills were not passed by the Texas legislature, House Bill 3707 and Senate Bill 624 threatened to impose more arduous permitting requirements for new solar farms, and retroactively apply higher standards of billing and permitting to existing projects, moves that might have

## The Multimodal Transit Center in Texas.

discouraged new solar investment, and made existing projects less profitable.

The episode has highlighted the influence that a legislative body can have over power project permitting and approval, and in turn how this can dramatically shift an area’s energy mix. Yet while much of Texas remains eager to invest in solar and live up to the state’s considerable potential, the state’s permitting framework has worked to ensure a balanced, reliable grid that prioritises access to energy over the growth of any particular power source.

The lawmakers’ delicate balancing act is a clear indicator that, regardless of an area’s climatic conditions or existing power infra-



structure, it is the permitting and regulatory process that can ultimately have the greatest impact over an area's energy mix.

### The Legal Landscape

While Texas lawmakers did not pass House Bill 3707 and Senate Bill 624 into law, they did approve Senate Bill 2627, which sets a new legal framework for Texas' energy grid as a whole. The bill creates a new body, the Texas Energy Fund, to which power companies can apply for loans for the construction, maintenance and upgrading of energy facilities.

The fund is only available to companies whose work is connected to the grid operated by the Electric Reliability Council of Texas (ERCOT), which covers 90% of the state and, crucially, is open to so-called 'dispatchable' forms of power, such as coal, oil and gas. With this US\$10 billion fund set to provide funding for fossil fuel generation, the emphasis of the Texas legislature is on ensuring reliable power, regardless of source.

"The legislature had a desire to increase the amount of dispatchable generation on the grid, however, renewable generation will continue to be a key piece of the ERCOT portfolio," says Tonya Miller, executive director of the Texas Solar Power Association (TSPA). "There is a need for all types of generation on the ERCOT grid; we support the development of all resources, though prefer policies that advance generation in a technology-agnostic manner."

Miller's idea of an agnostic permitting framework aligns with the permitting framework in which power generation as a whole is encouraged, rather than electricity derived from a single source. This is reflected in the very mix of Texas' energy grid, with ERCOT reporting that 42% of the state's energy comes from natural gas, but that wind and nuclear account for 24% and 10% of power, respectively, in this very diverse grid.

When asked if the current legislation encourages new solar power developments, Winston P Skinner, a lawyer at Texas law firm Vinson & Elkins, agrees: "I would say by and large, yes."

"Currently, there's not a whole lot in the way of permitting for solar projects in particular," adds Skinner. "There were several different legislative proposals that the Texas Legislature debated in this past regular session, which ended in late May ... the Texas Senate passed a version [of a bill to extend the boundaries of permits], the Texas House did not really take it up."

The bill that Skinner refers to would have significantly changed the power facility permitting process in the state. Under the current law, a company aiming to build a renewable energy project must deliver notice to all people living within 500 feet of the perimeter of the project, but this bill would have increased this range to 25 miles, making the award of new permits considerably more challenging.

### Setting a Precedent

Of course, this hands-off approach to delivering specific legislation can create challenges for relatively new forms of electricity generation. If the laws are broad enough as to encourage business as usual, anything that deviates from that default state of affairs will face additional obstacles to implementation, and this is reflected in Texas' energy mix in the early years of the last decade.

In 2011, according to the US Energy Information Administration (EIA), natural gas facilities in Texas generated 250,000GWh of power, compared to 30,000GWh of wind power and just 28,639MWh of solar. In 2015, the year in which the Paris Agreement was signed, the EIA heralded Texas for generating just 9.9% of its power from wind, less than half of its current contribution to power in the state, reflecting the slow pace of renewables adoption in Texas in earlier years.

"When Texas enacted some of its renewable-friendly legislation, it was mostly aimed at wind energy, which had a lot more precedent in the state," says Skinner, pointing out that, even within renewables, there are discrepancies with regard to how well-established, and consequently how straightforward, it can be to get new projects off the ground. "That was drawing on the known quantity, the known entity at that time, which was really more wind power in Texas than solar power."

"Certainly, as solar has come to dominate the interconnection queue within ERCOT, which oversees the intra-state electric grid, a lot more attention is being paid to solar now," adds Skinner.

However, the fact remains that the relatively unproven nature of solar power, in a state where the legislation does not encourage development of any particular kind of power, means that each new solar project is helping to set a precedent. Solar power in Texas has few guidelines to follow, either from legislative direction or historical precedent, but this is something that may well change in the future.

"Sometimes you see proposals that are attempting to govern something in a wholly new way, and then sometimes you see proposals that are really more aimed at drawing on and extending the legal framework that already exists for similar types of infrastructure," says Skinner.

### Challenges Beyond Permitting

A lack of historical precedent for solar power in the state and a hands-off legislative body are not the only challenges facing solar in Texas.

"One is the landowner concerns, given the siting requirements for solar power, but also for wind power," says Skinner. "That burden, if you will, often falls on more rural areas, because they have the space to accommodate those types of installations ... the shoe's on the other foot [where] more urban areas are generally more solicitous of renewable power."

The discrepancy between rural solar power generation and urban solar power consumption is visually striking. The largest solar plant under construction in Texas is Invenergy's 1.6GW Samson Solar Energy Center, with close to quadruple the capacity of the state's largest operating facility, the 497MW Roadrunner Solar Farm. This mammoth project will be built in the rural north-east of the state, between the cities of Bogata and Deport, which have a combined population of 1,629.

Much of the power from this project, which is expected to come online this year, will be sold to a number of corporations with heavy presences in major cities, including AT&T, McDonald's and Honda. This contrast can lead to, as Skinner puts it, "a rural-versus-urban dynamic at play, in terms of the dissatisfaction with renewable energy".

In addition, the recent Texas heat wave has exposed vulnerabilities within the state's energy grid, with ERCOT struggling to meet unprecedented demand for electricity to power devices such as air conditioners. Skinner pointed to Winter Storm Yuri, which hit the state in February 2021 and froze considerable amounts of power infrastructure, as exemplifying the same problem, despite the radical differences in climatic conditions, that Texas' energy grid has recently struggled to compensate during extreme weather events.

Any push to dramatically add solar capacity to the grid, therefore, is unlikely to be perceived as an act that adds stability and security to the network, considering the challenges the grid is already facing.



Credit: Texas Solar

### Ensuring Balance

Yet new legislation, or at least new legislative approaches, could alleviate some of these challenges. Indeed, a change in perception of legislation, from a series of obstacles to clear in order to build a project, to a series of incentives and encouragements to develop solar power, could change the future of Texan energy.

When asked about the role and work of the government in regulating the state's solar power, Miller is eager to stress that: "Texas has been, and continues to be, a private property rights state."

"The failed passage of [House Bill 3707 and Senate Bill 624] is a strong indicator of the continued protection of those rights," Miller continues. "Currently, Texas does not have these unnecessary and overly burdensome permitting requirements on the renewable sector, therefore we can expect solar projects to continue to move forward in Texas. This is extremely important given the increase in load at peak times when solar is abundant."

This balanced approach could also encourage investment in other aspects of the solar industry, with Skinner pointing to solar-plus-storage projects and improved battery facilities as relatively new technologies that could benefit from this approach to permitting.

"As the storage technologies improve, as the duration of that storage output can be increased ... I think that as well can shift the narrative in terms of how reliable that technology can be and whether it's standalone or whether it's paired with renewable projects," says Skinner. According to the EIA, of the 20.8GW of utility-scale

battery storage capacity that companies plan to build in the US between 2022 and 2025, 7.9GW will be built in Texas, more than in any other state.

Yet in the same manner that this balance does not discourage solar permitting and construction, it does not actively encourage it. Indeed, considerable effort from the private sector has been necessary to submit applications for new power projects, with the three largest operational solar projects in the state all being privately-owned, and the continued support of the private sector will be integral to ensuring solar generation makes the most of this permitting framework.

### Building a Resilient Network

Ultimately, the state legislature has considerable sway over the energy mix of Texas. The desire of the state's legislature to create a balanced, open-ended permitting structure, where all manner of projects and facilities can be proposed and constructed, is ultimately to create a resilient grid. Part of this motivation stems from the fact that, as the production figures demonstrate, Texas is a solar power leader among US states, and could meet much more of its power demands with domestic renewables than many other parts of the country.

"I think, in the legislature's view and the in the state leadership's view, the more that we can rely on ourselves and the less we have to rely on [solely] the wind [or] on the sun, the better," says Skinner. Should the forecast improvements in Texas' battery storage capacity take place, it is possible that any reputation solar power may have developed as being unreliable, or reliant

### Solar panels in Texas

on external factors, will fade.

Skinner's comments also suggest that, for at least a portion of the Texas lawmakers, the principle of self-reliance is of equal or greater importance than the practical concerns of grid connectivity. This is reflected in that Texas does not use power generated elsewhere in the US, and Skinner suggests that this principle is a point of pride for many in the state.

"The ERCOT grid, the intrastate Texas electric grid, is more self-reliant than grids in other areas of the country where there's more interconnections between neighbouring states," Skinner says. "Texas obviously prides itself on its independence in a lot of different ways, and this is certainly one of those sources of pride and something that's been very jealously guarded for decades. I do see that as continuing."

Ultimately, then, both the priorities of the Texas solar power sector, and the priorities of the state's lawmakers, are aligned: to build an energy framework that can reliably provide power and is free from legislation that could needlessly impede or make difficult permitting.

Such a framework means that, while any power source can succeed in Texas, the responsibility for delivering large-scale solar in particular is likely to fall on private investors, technological innovators and individual companies, with the state satisfied as long as the grid remains reliable.

As Skinner surmises: "All of this has been done in the name of grid reliability, and so dispatchability has really become the buzzword and the policy end that the legislature seeking to [deliver]." ■





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# Is transferring power from North Africa to Europe a viable option?

**Solar Interconnector** | As Europe is increasing its solar PV capacity to reach its goal in the REPowerEU plan, countries in the bloc are accelerating solar PV installation. But some EU countries also look at the solar potential in North Africa, as the region boasts better solar irradiance and longer sunshine hours. PV Tech Power Editor Simon Yuen examines a project that is envisaged to transfer power from Egypt to Greece, and experts' views on the challenges and benefits of a Mediterranean interconnector.

In May 2023, Infinity Power, a joint venture between United Arab Emirates state-owned renewable energy developer Masdar and Egyptian renewable energy provider Infinity, signed a memorandum of understanding (MoU) with Greek infrastructure investor Copelouzou Group to co-develop renewable energy projects that will provide the Gregy-Elica Interconnector project with a source of green energy.

According to Infinity Power, the projects involve the electrical interconnection between Egypt and mainland Greece through a submarine cable of 3GW capacity with a length of approximately 950 kilometres, and the possibility of bidirectional energy transmission. It carries only green energy between Egypt and Greece, which 'makes a decisive contribution in tackling climate change and the greenhouse effect by significantly reducing CO<sub>2</sub> emissions' and reduces Europe's dependency on energy produced from fossil fuels.

The 3GW of green energy transferred from Egypt to Greece will be generated from 9.5GW of renewable energy sources that Copelouzou Group will build and operate in Egypt.

Additionally, Copelouzou Group says about one-third of the electricity will be consumed in Greece by households and businesses, another third will be exported to neighbouring countries of the EU, while the remainder will be used in Greece for the production of green hydrogen, with the bulk of this hydrogen being exported to neighbouring European countries.

"This project is a remarkable opportunity



Credit: United Nations Climate Change (UNFCCC)

for Egypt to benefit through economic development and revenue growth. It will also enhance the country's energy security and be a key venture in promoting international cooperation," said Mohamed Ismail Mansour, chairman of Infinity Power. "By supplying renewable energy to Europe, we are not only bolstering our economy but also positioning ourselves as a key player in the global energy market."

## Solar PV market and potential in Egypt

Generally, North African countries boast higher potential in solar PV thanks to solar irradiance and sunshine hours. For example, Egypt offers ideal conditions for

## Installation work at the Benban Solar Park in Egypt's western desert.

the use of solar PV to generate electricity as the average annual global horizontal irradiation ranges between 2,045 and 2,483 kWh/m<sup>2</sup>, according to the Solarize Africa Market Report published this year by the German Solar Industry Association (BSW).

Most of the capacity would come from the Benban Solar Park in Egypt's western desert. Made up of 41 solar projects, the solar park spans 37 square kilometres and has a total generation capacity of around 1.8GW.

Egypt's ministry of electricity and renewable energy had previously announced its aim of generating 20% of its electricity from renewables by 2022, with solar PV





**Aerial view of the Benban Solar Park in Egypt**

accounting for 2% of the total generation capacity. As of 2035, Egypt plans to generate 42% of its electricity from renewables, with solar PV gaining much more importance to account for 22% of the energy mix, higher than all other renewable sources.

However, the target of 20% electricity from renewable sources by 2022 was not met. Reaching the 2035 target of 42% would require an estimated 31GW of solar power capacity addition to the grid by 2035.

According to the International Renewable Energy Agency (IRENA), Egypt has the potential to reach 44GW of installed solar PV capacity by 2030, while the Egyptian ministry of electricity and renewable energy estimated a solar power potential of more than 50GW.

IRENA said Egypt's estimated newly installed capacity was only 49MW in 2022, but solar PV additions accelerated this year as construction started for a 560MW PV installation in the country, which was backed by funding from the International Finance Corporation, the Dutch Entrepreneurial Development Bank and the Japan International Cooperation Agency. Owned and operated by AMEA Power, the solar power plant is expected to be completed by mid-2024.

### Morocco's solar PV market and potential

Morocco also boasts high levels of solar resources since a big part of the country is covered by desert. Having about 3,000 hours of sunshine per year, Morocco averages annual global horizontal irradiation ranging from 1,753 to 2,264 kWh/m<sup>2</sup> in the desert.

Regarding its renewable energy policies, Morocco increased its official target in 2015 to have more than half of its energy coming from renewables by 2030, translating into a target of 4.5GW solar.

By 2050, renewable energy will account for 80% of Morocco's electricity mix based

on Morocco's official target. In 2022, the estimated total installed capacity reached 318MW thanks to the construction of several utility-scale plants in earlier years, mainly comprising combined solar PV and concentrated solar power plants within the 580MW Noor Solar Power Complex.

In July 2023, Morocco's renewable energy agency Masen announced that six consortiums were pre-qualified to build the 400MW Noor Midelt II solar PV plant project. The project consists of the building of a solar PV power plant with a two-hour storage capacity.

But Morocco is not new to supplying energy to Europe. It has two energy interconnections with Spain, while both Morocco and Spain signed a MoU in 2019 to build a third power link.

A more prominent example of Morocco supplying energy to Europe is a 10.5GW solar-plus-wind project in Morocco's Guelmim Oued Noun region, with 3.6GW of this to be exported to the UK via 3,800 kilometres of subsea cables.

According to Xlinks, the company behind the Morocco-UK power project, the project can generate power for 20 hours a day on average, taking advantage of the high solar irradiance in the south of Morocco alongside consistent convection desert winds, providing an alternative source of zero carbon electricity to the UK. Xlinks claims that the project will be capable of supplying 8% of the UK's electricity needs.

### Tunisia's solar PV market and potential

Tunisia has an average annual global horizontal irradiation between 1,607 and 2,191 kWh/m<sup>2</sup>. However, electricity generation from renewables, particularly from solar PV, only accounted for about 3% as of 2021, while only about 0.3 % of electricity production came from solar PV.

The installed solar PV capacity is estimated to remain at 197MW by the end of 2022.

Although renewables only accounted

for a small portion of Tunisia's power generation, the Tunisian ministry of industry, mines and energy set the goal in 2022 of achieving 35% of the country's energy production through renewables in 2030. The government also launched more measures to encourage solar adoption. For example, in 2017, feed-in tariffs were introduced for solar installations under 10MW, including the possibility of net metering and net billing within selected grids.

Since early 2020, a new regulation for net metering has allowed renewable power companies to produce and sell excess electricity to either the national power utility, the Tunisian Company of Electricity and Gas (STEG), or private third parties through power purchase agreements (PPAs).

Tunisia also explored the potential of offshore solar systems. Last year, the first floating PV plant in the North African region was inaugurated by French independent power producer (IPP) Qair in Tunisia with a total capacity of 200kW. In January 2023, Tunisia announced a plan to build a 100MW solar PV system in El Metbassta, a region north of the city of Kairouan.

Looking forward, Tunisia will increase its solar PV capacity since 1GW was tendered in January 2023 under the current authorisation regime and a subsequent tender with 200MW capacity was announced for the near future.

### The African market

As of 2020, installed solar capacity, including both solar PV and thermal, in North Africa surpassed more than 3GW, according to IRENA's report 'Planning and prospects for renewable power North Africa'. However, such installed capacity corresponded to only 2.7% of the region's total installed electricity generation capacity of approximately 116GW.

But the reduced costs of installing solar PV capacity make it an alternative to replacing electricity generation based on fossil fuels. The report states that the average total installed cost for solar PV in the North African region dropped from US\$2,000 per kW in 2015 to US\$1,306 per kW in 2019, representing a 34.7% decrease.

Mohamed Alaoui, managing director of energy consultancy Africa Climate Solutions, says developing renewable energy in North Africa can bring numerous benefits to the region's economy and contribute to sustainable development, including attracting foreign invest-

ment, establishing supportive policies and regulations, fostering cooperation between North African countries and the European countries, and enhancing technology transfer and skills development.

For example, Copelouzos Group says that a total budget of €4.2 billion (US\$4.6 billion) will be allocated for the Gregy-Elica Interconnector project.

Moreover, the Xlinks project budget is likely to reach US\$21.9 billion, according to a news outlet in Morocco. This project will create 10,000 jobs in Morocco, including 2,000 permanent jobs. It also creates 1,350 new permanent jobs in the UK by 2024 and a thousand more jobs in the supply chain.

### Challenges of developing solar PV in North Africa

Nivedh Thaikoottathil, renewables and power analyst at Rystad Energy, says Africa only accounts for a very small part of global investment in renewable energy, and most of the investments are focused on North Africa and South Africa. Such a background offers opportunities to renewable energy companies when they plan to develop and explore business opportunities in the continent.

But there are several issues that need solving before realising the region's potential.

"One of the common issues in African countries, even in North Africa, is the high upfront cost. While funding is usually from the private sector, gathering investment and incentivising the power sector has been a challenge in the past," says Thaikoottathil.

Egypt and Morocco tackled the challenges by launching PPAs or feed-in tariffs. For example, the Moroccan Agency for Solar Energy (Masen) signed a PPA with ACWA Power to develop 170MW of solar projects in 2016. Egypt launched a feed-in tariff support system for solar PV and wind projects with a capacity of less than 50MW in 2014.

As for the operation of solar power plants, although deserts are suitable for building solar PV plants, Thaikoottathil says the accumulation of sand particles, as well as the high temperature, could lower the efficiency of those plants.

The supply chain is also another major issue when it comes to building solar PV plants in North Africa, as there are no manufacturing capabilities in the region, which makes setting up solar PV plants more difficult.

But this situation could change in the near future. The Africa Renewable Energy Manufacturing Initiative (AREMI) was launched in early 2023 with the aim of scaling up renewable energy manufacturing capabilities in Africa. It focuses on capacity building, knowledge transfer, policy dialogues, and advocacy, as well as enabling pilot projects that drive low-emission development and carbon neutrality in Africa.

The initiative suggests African solar PV manufacturing could start by prioritising cell manufacturing and module assembly as they require less technological and chemical complexity, labour availability and existing solar panel assembly among others.

Another reason that could prevent North African countries from opting for more renewables could be the cost of making any changes to its energy mix. North African countries are heavily reliant on fossil fuels and gas to produce electricity, and Fabian Rønningen, senior analyst of renewables and power research at Rystad Energy, says the countries could spend their CapEx on gas plants instead of renewables.

"It could be cheaper for them to maintain the current energy mix instead of building renewables."

### Difficulties in transferring power to Europe

Speaking of building subsea cables between North Africa and Europe, Thaikoottathil highlights three major challenges, namely the manufacturing capacity, location of the cable manufacturer, and maintenance.

Currently, each vessel can only carry about 200 kilometres worth of cable. In comparison, the cables connecting Greece and Egypt could be as many as 1,000 kilometres, meaning that building the cables will require travelling to and from the manufacturing site and the location of the project at least five times.

"Manufacturing capacity of such cable is about 500 kilometres a year, equivalent to two years' time of manufacturing for this project. These cables are in the ocean and prone to damage due to anchors of the ships or even fishing equipment, in addition to identifying the location of the damaged cable," Thaikoottathil says.

### Transferring power to sub-Saharan countries instead?

Last year, the European Union (EU) announced the REPowerEU Plan to trans-

form Europe's energy system. It hopes to end the EU's dependence on Russian fossil fuels and tackle the climate crisis. The EU Solar Energy Strategy even aims to bring online over 320GW of solar PV by 2025 and almost 600GW by 2030.

According to SolarPower Europe, the 27 EU member states saw 41.4GW of new solar PV capacity connected to their grids, a 47% increase compared to 2021. Such an increase represented a back-to-back impressive growth as there was 28.1GW of solar PV added to the grid in 2021.

As of 2022, the EU's solar power generation capacity increased by 25% to 208.9 GW, from 167.5GW in 2021, only four years after it passed the 100GW milestone in 2018. Solar Power Europe also estimated that the installed solar capacity could grow from 54GW to up to 68GW in 2023.

Asked whether supplying energy from North Africa could help Europe reach its goal, Thaikoottathil says it depends on how serious the project developers are. "It will be possible to reach the target, but supply chain issues can hamper progress."

Although building a subsea cable could be technically difficult, North African countries are still exploring the possibilities of developing such projects instead of supplying energy to sub-Saharan countries.

Currently, 600 million people in Africa, or 43% of the total population, lack access to electricity, most of them in sub-Saharan Africa, according to the International Energy Agency's (IEA) Africa Energy Outlook 2022, while the majority of the people without electricity access in Africa are based in rural areas.

"When it comes to increasing electricity access in the continent, it will be hard to give access to this population that lacks electricity by extending the main grids," Thaikoottathil says.

One of the ways to tackle this problem is to set up solar-based mini-grid and stand-alone systems.

"These methods will be isolated and for a specific area. Therefore, extending the grid from North Africa will be expensive and difficult as most people live in rural areas."

Lastly, Thaikoottathil says political conflicts between countries in Africa, along with IPPs' reluctance to invest in Africa due to obsolete procurement methods, also prevent supplying energy to sub-Saharan countries from happening. ■





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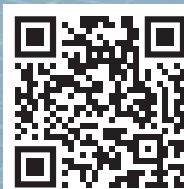
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# Product reviews

## Modules

### LONGi Hi-MO 7 solar modules with Hybrid Passivated Dual-Junction technology

Solar Module Super League member LONGi unveiled its Hi-MO 7 solar module at the 2023 edition of SNEC in May this year. The module is based on hybrid passivated dual-junction cell technology, and features the conventional M10 cell/wafer size, a mass production power of 580W and a conversion efficiency of 22.5%.

**Market & applications:** The module is designed for use in the utility market, building on the company's Hi-MO 5 module which was designed for use in the same sector. It measures 2,279mm x 1,134mm, as do other M10 modules, and the widespread adoption of this size of modules means that new iterations like the Hi-MO 7 will benefit from a sector that is very familiar with the panels.

**Industry challenges:** LONGi's latest module looks to ensure demand remains high for large-scale solar modules. The world has entered the 'Terawatt Era', in which global solar power capacity has exceeded 1TW, and SolarPower Europe estimates that the world's solar capacity could double to 2TW by 2025.

Meanwhile the US Solar Energy Industries Association (SEIA) estimates the country's solar capacity will grow from 5GW in 2013 to 50GW by 2028, with the vast majority of new installations expected to come from the utility sector. As both solar modules and solar farms grow in capacity to meet this growing capacity demand,



Credit LONGi

there will be increased interest in modules that are effective in large-scale and utility-scale installations.

**Technical solution:** The Hi-MO 7 modules feature a bifacial dual-junction cell, which is passivated during the production process, which prevents electrons from recombining on the surface of the cell. This improves the cell's conversion efficiency and reduces the cost of electricity produced by the module of which it is a part. The cell also features a local low-resistance contact layer that enhances cell efficiency.

The module also features different cell passivation technologies that are used on the front and back of the panel. As a result, the module has a high open-circuit voltage, improved efficiency and is expected to degrade to a lower extent over time, as well as reduce its temperature coefficient.

**Unique features & benefits:** PVEL's PV Module Reliability Scorecard has awarded LONGi high marks for eight consecutive years, and named it a 'Top Performer' in its 2022 awards. LONGi's models were awarded strong marks in tests involving thermal cycling, damp heat, mechanical stress sequences and a number of degradation tests, all of which will benefit the company's latest module, the Hi-MO 7.

In addition to its high efficiency, the Hi-MO 7 also benefits from world-leading product quality and long-term reliability, which will significantly reduce the levelised cost of electricity (LCOE) associated with large-scale PV projects where the modules are used.

**Availability:** The Hi-MO 7 modules are currently available.

## Modules

### Sunport announces full black panels, using MBC2.0 technology

Chinese solar cell developer Sunport Power announced its 'full black' series of solar modules, based on its Metal Back Contact (MBC)2.0 technology, at SNEC 2023 in May this year. The technology builds on a previous generation of technology, the C10-Pro panel, which was first announced at the 2021 edition of SNEC, and brings together several innovations for the solar power sector: heterojunction technologies (HJT), a metal wrap through (MWT) structure and a conductive foil back sheet.

**Market & applications:** The full black PV panels are designed for use in utility-scale

power generation and power plants, and on residential and commercial rooftops, and Sunpower's next generation of modules will build on these uses. Crucially, the MBC2.0 technology is a refinement of the MWT process, that moves all electrical components from the front to the back of the panel, significantly improving the conversion efficiency of the module.

**Industry challenges:** Constraints of space and temperature are particularly relevant for domestic rooftop installations. Sunport has tried to overcome these challenges with the full black panels by aiming for a high conversion efficiency, so

residential users can maximise their solar generation potential, and by including the reflective foil sheet, which could help regulate the temperature of the panels, to ensure they can operate as efficiently as possible.

**Technical solution:** The main features of the full black panels are those that look to optimise efficiency. An HJT cell can achieve higher conversion efficiency figures than other kinds as it combines a crystalline silicon cell with layers of thin-film silicon.

The MWT manufacturing process, meanwhile, involves the drilling of holes





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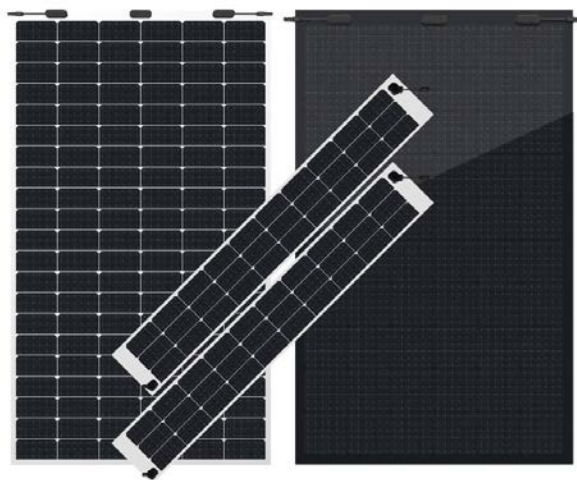
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into the cell, and their filling with silk screen printed paste, to connect emitters on the front-side of the cell to the back via these filled holes. This removes the need for metal cables to be draped from the front-side of the cell to the back, improving the overall efficiency of the cell by ensuring that as much of the front-side of the cell as possible is clear for receiving sunlight.

**Unique features & benefits:** According to Sunport, the MWT process reduces the amount of shade falling on the panel by 3%, the module's maximum power output can reach 700W and boasts a conversion



Credit Sunport Power

efficiency of up to 22.8%. The module's foil back sheet serves another purpose, as it can conduct electricity.

As a result, receivers on the panel can be connected to the sheet itself, rather than each component having to be affixed to another particular component, which Sunport notes will reduce the panel's working voltage.

**Availability:** The modules are currently available.

## Microinverters

Hoymiles launches next generation of microinverters for use in domestic mini-PV



Credit Hoymiles

Chinese electronics developer Hoymiles has unveiled its latest microinverter series, the HMS-1000W. Announced at the Intersolar Europe event held in Germany in June this year, and designed for use in miniature PV systems such as balcony solar, products in the series feature an industry-grade Wi-Fi module, which enables the converter to connect to nearby devices and record data remotely.

**Market & applications.** The microinverters function to convert the energy generated from solar modules from direct to alternating current for use in homes, and the devices' small size makes them ideal for use in residential environments, such as rooftop and balcony solar where space is limited.

**Industry challenges.** As residential solar power generation becomes more common, the infrastructure necessary to

support this sector will need to be more resilient. The HMS-1000W microinverters can endure temperatures of up to 105 degrees Celsius, and have received an IP67 rating from the International Electrotechnical Commission for their resilience against water and dust.

**Technical solution.** The microinverters themselves can connect to systems with a capacity of between 600W and 1kW, and as each has two input channels, they can each be connected to two PV modules. The series is Hoymiles' latest microinverter to be released in Europe, and measures just 261mm by 180mm by 31mm.

**Unique features & benefits.** The devices make the most of the maximum power point tracking algorithm to determine how and when modules are producing the most power, enabling users to maximise their power yield and reduce the time necessary to recoup installation costs. The microinverters can also be connected to Hoymiles' HMS Field Connector and Plug and Play Cable, to connect directly to plug sockets.

**Availability.** Following Hoymiles' announcement of the microinverters at Intersolar, the devices are now available in Europe.



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# Product reviews

## Cells

### Huasun launches new high-conversion efficiency heterojunction solar cells

Chinese solar company Huasun has launched its latest series of N-type silicon-based heterojunction (HJT) solar cells and modules. This range of new products includes the Himalaya V-ocean series, the G10 series and the M6 series, and the company plans to deploy the majority of these cells and modules in residential, commercial and large-scale utility areas.

**Market & applications.** Alongside the cells and modules for residential, commercial and utility areas, the series also includes bifacial modules, as well as the Himalaya V-ocean series, designed for use in floating solar farms, and products designed to be deployed in agricultural settings.

**Industry challenges.** As solar power grows to account for more of the world's energy mix, ensuring each solar module operates as efficiently as possible is of interest to many in the sector. HJT cells use two technologies, a crystalline silicon

cell placed between layers of thin-film silicon, to deliver greater conversion efficiency over a long period of time.

**Technical solution.** Huasun's latest generation of HJT cells look to capitalise on this high conversion efficiency. In 2022, cells in the G10 series were shown to have a maximum conversion efficiency of 26.81%, and two of the company's HJT cells, the HS-210-B120 and HS-210-B132, received favourable scores from the latest round of PVEL testing.

**Unique features & benefits.** Through testing by PV Evolution Labs (PVEL) for its latest PV Module Reliability Scorecard, these cells in particular impressed in the thermal cycling and damp heat tests, important assessments of a module's resilience in conditions where temperature and humidity can vary, and mechanical stress tests, which show how easily the module is likely to crack or break, and

whether this will cause it to lose power. In the mechanical stress test sequence (static load + dynamic load + damp heat cycle + damp freeze cycle), power degradation of the Himalaya G12 series modules was only 1.29%, demonstrating the capabilities of Huasun's double-glass 210 large-cell format and HJT modules. Average power degradation rate of 1.2% was measured across Huasun's modules in all six tests conducted by PVEL. The cells' strong performance suggests that they are likely to endure many of the conditions that can interfere with solar power generation over a long period, such as variations in temperature over the course of the year.

**Availability.** Cells in the Huasun G10 series are available now, while cells and modules in the Himalaya series were first unveiled in June at Intersolar Europe.



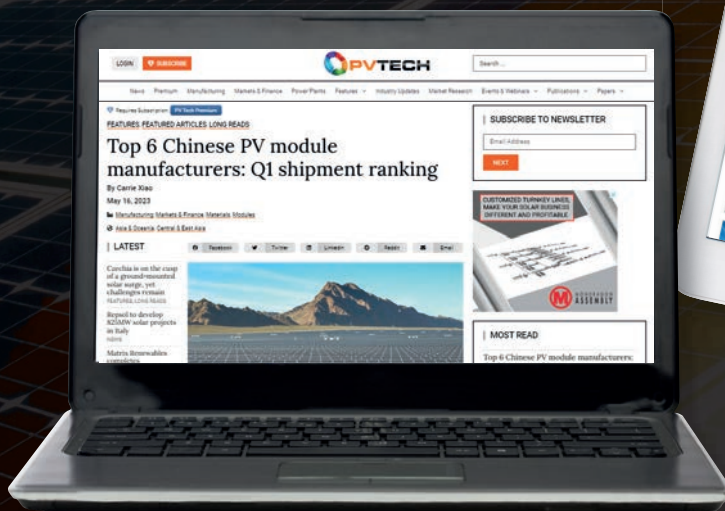
Credit: Huasun





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# UK Grid Connections: Impact on the Renewables Rollout

**Grid Connections** | PV Tech Power Reporter George Heynes on the troubles the UK is facing as its electricity network is being adapted to accommodate multiple renewable energy sources.



Credit: UKPN

One of the biggest bottlenecks impacting the transitioning UK energy sector is grid connectivity. The UK energy grid, which was first created in 1935 for transmitting power from coal-powered plants around the country, must adapt to the era of renewable energy – and fast, if the UK wants to play a significant leadership role in the journey to net zero.

National Grid Electricity System Operator (ESO) recently revealed the extent of the challenge facing the UK. The organisation stated in June 2023 that there were approximately 220 projects due to connect to the national transmission system before 2026, totalling circa 40GW and equating

to more than double peak demand in the summer months for all of the UK.

Only half of these have secured planning consent at this stage, and some have had to move their connection dates back by over 14 years. With many developers facing connection dates well into the 2030s for their projects, this is the single main obstacle the UK is currently facing in its race to an emissions-free economy.

## The scale of the issue at hand

Many renewable generation projects that could contribute great volumes towards the decarbonisation of the UK energy

system are consistently being set back by grid connection delays.

This hinders the UK's decarbonisation goals in a number of different ways. Perhaps one of the most obvious issues is that the renewable generation projects, which could grant UK households relief on energy bills amid the energy crisis, are unable to be connected to the grid for consumers to access.

Alongside this, many of the UK's industry sectors are turning their attention to electrification in a bid to reduce emissions. This includes heat, transportation and other key sectors. National Grid estimated last year that electricity consumption in the



UK and US would increase by approximately 50% by 2036 and more than double by 2050 as a result of increased electrification.

To cater for this, renewable generation projects must come online in the coming years to enable these technologies to be used to their full potential and contribute fully to decarbonisation. Not reaching these milestones will set the nation back significantly in the transition schedule towards net zero.

A prime example is the electric vehicle (EV) charging infrastructure. There is a critical need to scale up the infrastructure needed to rapidly increase adoption rates via access to EV charging. Without doing so, the UK will fall well short of its target of phasing out fossil-fuelled internal combustion engine (ICE) vehicle sales by 2030.

For the UK solar sector, grid connections are also a stumbling block, and it could derail the positive motions being put into play by the industry. To highlight the issue, the beginning of 2023 reached 300GW of projects seeking grid connection dates, leading to a 'clogging' of the Transmission Entry Capacity (TEC) register – a list of projects that hold contracts for grid connections. In comparison, there is approximately 80GW of total generation currently connected to the GB grid.

According to the Energy Networks Association (ENA), one of the main ways to solve grid connectivity woes is by scaling investment within grid infrastructure.

"Network operators will deliver £22.5 billion of investment over the next five years to improve grid infrastructure and help ensure the UK's energy systems can meet the demands of the net zero transition, including connecting renewable generation schemes large and small," says a spokesperson from the ENA.

"To reach our net zero targets, we need more than just investment as other issues remain, particularly around planning and regulation. In order to more quickly connect more renewable generation, we need three things – a continued focus on innovation and flexibility, investment to enable network capacity in anticipation of future need, and a coordinated and accelerated planning system which brings together local and national ambitions."

It is also important to note that renewable projects have surged in recent years – faster than many expected – thanks in large part to the continued drop in the cost of development. For example,



Credit: Andreas Guckhorn

between 2010 and 2019, the cost of solar PV globally dropped by 82%.

This has driven renewable developments in the UK, but in turn "distribution capacities have been hammered since around 2012 amid the big solar rush," says Pete Aston, specialist connections engineer at Roadnight Taylor.

Demand for renewables has only been exacerbated over the last year amid the wider energy crisis, highlighting the growing need for network investment. Additionally, investment is not the only barrier to expansion, a further point highlighted by Aston.

"It's easy to draw a line on a map and say let's put a new transmission circuit there. But when it's hundreds of kilometres long, they need development consent orders and government level planning permission. It's probably five to ten years in the planning process, let alone building the thing," he says.

Scaling investment will provide further opportunities for projects to acquire grid connections and create a booming renewable industry across the UK. This could be achieved by expanding the current transmission network to cater for this additional generation capacity. Early investment in particular could be beneficial for the development of the UK grid.

Commenting on this topic, Stewart Reid, head of future networks at Scottish and Southern Electricity Networks (SSEN) Distribution, says: "Through coordinated early investment, we will be able to keep costs down and develop our network to

enable low carbon technologies, such as electric vehicles and heat pumps, to connect when they need to, more swiftly than if new connections were dependent upon network reinforcement.

"We are developing a stakeholder-led investment strategy to deliver a coordinated, efficient and cost-effective network for our customers, consumers and stakeholders."

Another crucial area that could be bolstered via early investment is supply chains whilst it could also help reduce the costs associated with the development of projects. This could improve investor confidence and speed up the creation of the projects.

"Early investment can also help drive efficiencies and potentially reduce costs for future consumers. By avoiding an incremental approach to network investment, we can plan effectively with our supply chain, driving costs down and releasing investment at pace. This is particularly important in the current environment, with rising costs of materials and significant pressure on the supply chain resulting from the drive to net zero not only in the UK, but across Europe and beyond," added Reid.

### The backlog of generation projects

One of the biggest issues plaguing grid connections is the backlog of projects to join the grid. The backlog of projects at the start of 2023 reached 300GW and must be addressed. But how has the UK found itself in this situation?

Because of the nature of the TEC register application process, the register has many projects that have not entered any concrete development. This comes at the expense of others that are further along in development who are being situated further down the register with connection dates well into the 2030s.

"Ofgem does not allow network companies to discriminate between projects seeking a connection whereby connectees are treated on a first-come, first-served basis, with any required network upgrades only progressed when connections are formally agreed," the ENA says.

This is a problem for the industry, because as renewable generation projects continue to be added to the TEC register, it will continue to become more congested. This highlights the urgency in needing to solve the grid connection conundrum immediately with new projects expected to become larger and more frequent as net zero targets loom larger.

"Network companies are taking steps to speed up connection times; they are offering generators flexible contracts, digitalising the connections process and managing the queuing process more efficiently for connecting customers," says the ENA.

National Grid ESO has launched various initiatives aiming to solve this great grid connection conundrum. The first of these was ESO's five-point plan, released in May 2023, outlining plans to speed up electricity grid connections for 70% of projects due to connect after 2026 by two to ten years.

Central to this plan is to not only to free up space for both solar and wind generation – but also energy storage projects that are widely touted as a complementary technology to intermittent generation.

ESO said that its five-point plan would speed up connections for 95GW of energy storage projects in the pipeline, and that they will also be reviewing contracts to make sure parties looking to connect to the grid in the next two to three years are on track to meet their connection dates.

This initiative enables companies to leave the grid connection queue without incurring penalties – something that traditionally would happen. The ESO said there were 8GW of projects interested in this, and that it was now in the process of approving these contract terminations.

Allowing generation projects to leave could be vitally important for the wider industry and reduce connection times. Removing the projects from the TEC register could provide additional capacity for

other projects, which are more likely to be energised faster, to be advanced.

### How does technology negate the need for network upgrades?

One area where allocating investment could be effective is into technologies that can help negate the need for the vast sums of capital required for network upgrades. ENA highlights that the utilisation of flexibility markets is helping to "unlock capacity" and thus further technological enhancements could help reduce connection delays.

"Network operators are applying an innovative approach to addressing constraints. They are using new technologies such as our world-leading flexibility markets to quickly unlock capacity, with the least disruption and cost to the consumer. Networks are also introducing new and innovative connection design solutions where one physical connection can accommodate multiple customers," says the ENA.

Harnessing flexibility markets is a useful tool to ensure that network upgrades can be made without jeopardising the flow of electricity. Alex Howard from distribution network operator (DNO) UK Power Networks touches on this topic.

"Since our first tender, we have awarded more than 850MW of flexibility contracts across more than 200 zones. The primary use of this has been to defer needs to upgrade the network," Howard says.

"This experience of procuring and dispatching flexibility provided the learning and confidence to make flexibility a central part of our latest business plan (covering 2023-28) – deferring more than £400 million of new infrastructure that we would otherwise expect to be required. We are currently running our biggest flexibility procurement to date – seeking more than 500MW across more than 1,000 zones."

Paul Glendinning, director policy and markets at Northern Powergrid, also addresses the potential use of network flexibility.

"Understanding what is happening out on the network unlocks opportunities for flexibility – that is why network monitoring is so important," Glendinning says.

"Our flexibility-first approach to investing in our network is based on the principles of monitor, manage, reinforce. We are able to leverage information from monitoring out on our network to understand what is happening.

"This then enables us to manage the

network by deploying network flexibility (such as active network management to release capacity when it is needed) or customer flexibility through incentivising customers to increase or reduce electricity use or production, or flexible connection arrangements."

UK Power Networks has been exploring how technology could help negate the need to scale grid connection investment. Howard highlights that "data and technology have been key to our success to date".

"We have developed a world-class Distributed Energy Resource Management System (DERMS), which enables us to monitor constraints in our network in real-time. It means we can offer highly accurate flexible connections and manage the available capacity on our network in an intelligent way," Howard says.

"We have built an unrivalled picture of what is happening on our low voltage network thanks to our ongoing investment in Low Voltage visibility and drawing on data from a wide range of sources. This means we have a really granular understanding of network utilisation, enabling us to fast-track connections applications where we know there is spare capacity.

"We also use a software platform called Piclo to advertise our flexibility requirements and allow flexibility providers to record their capabilities and pricing. We plan to extend this 'market platform' capability – focusing on better user experience, more automation and greater use of APIs to ensure flexibility works seamlessly for the whole energy system."

### Grid connection conclusion

As shown throughout this article, it is crucial for the UK to collaborate to solve the grid connection delays plaguing the UK energy system. Although DNOs and industry players are exploring their own means to support the system, it is obvious that investment will be one of the biggest factors in solving the issue.

But what is clear to see is that all industry players and government are working together to bring fresh ideas to the table. Some of these may need accelerating if the UK is to achieve its decarbonisation targets and bolster its renewable fleet to also ensure its energy security.

This is also an everchanging area for the energy industry with new measures being introduced in quick succession, and as we approach 2030, it is anticipated that the spotlight in UK will truly be on the national grid. ■



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# New suppliers, new opportunities, and new risk: the IRA's implications for PV module reliability

**PV Modules** | Tristan Erion-Lorico, VP of Sales and Marketing at PV Evolution Labs (PVEL), on the Inflation Reduction Act and its implications for the selection of materials going into producing solar modules.



Credit: PVEL

**W**hen the Inflation Reduction Act (IRA) was passed by the U.S. Congress in August 2022, the historic US\$369 billion investment seemed poised to revolutionise the clean energy industry in the United States. New incentives would accelerate the manufacturing of key solar and wind components domestically, while additional tax credits stood to further increase project economics for wind and solar developers.

Research firm Wood Mackenzie predicted that the U.S. solar market could triple over the next five years. Likewise, a team of researchers at Dartmouth College and Princeton University released a report

noting that the bill would create 1.6 million additional renewable energy jobs. The same report found that the IRA would allow solar projects to cut the cost of producing electricity by up to 60%.

The solar provisions of the IRA have two priorities: to increase domestic solar manufacturing, and to reduce dependence on Chinese imports. The bill aims to encourage more manufacturing of key solar components, including cells, wafers, frames, glass, and backsheets in the United States – and the solar industry is responding. By April 2023, the American Clean Power Association noted that over US\$150 billion in domestic utility-scale

## Testing of modules in the laboratory

clean energy investments had already been announced, along with 47 new manufacturing facilities. According to the Solar Energy Industry Association (SEIA), the IRA is expected to lead to more than US\$600 billion in new solar investments and 200,000 new jobs over the next decade. Some of the most exciting elements of the bill have expanded on the existing investment tax credit (the Qualifying Advanced Energy Project Credit or Section 48C), and created the Advanced Manufacturing Production Tax Credit (Section 45X). Both the investment tax credit and production tax credit include adders for projects meeting domestic content requirements. However, there are lingering doubts about the industry's ability to manufacture all the necessary components in the United States, and exactly what projects will qualify for the additional tax incentives.

The recently released guidance on the domestic content adder states steel and iron products such as racking will need to be made 100% in the United States, while manufactured products such as trackers, photovoltaic (PV) modules, batteries, and inverters will need to be 40% made in the United States (for projects under construction before the end of 2025; 55% beginning in 2026). In our latest Solar Technology and Cost Forecast (STAC Report), PVEL and Exawatt conclude that that current domestic crystalline module manufacturing is unlikely to allow developers to satisfy these requirements for at least the next couple of years.

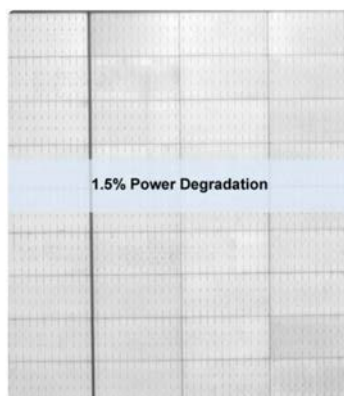


Confusion around which suppliers and what projects qualify for tax credits is only part of the headache. New factories and new raw materials inherently create new risks. Changing material suppliers or components during the procurement process can have impacts on both the immediate and the long-term performance of modules in the field. For over a decade, PVEL's lab data has shown that minor changes to a PV module's unique bill of materials (BOM) can have major impacts on its reliability and performance. Along with following other procurement best practices, the risks associated with module procurement and changing supply can be mitigated through independent, third-party testing. While the IRA offers an exciting opportunity to rapidly advance the solar industry in the United States, understanding BOM-level performance and reliability is going to become even more important to maintain quality.

#### Why BOMs matter: not all modules are created equal

Through our suite of extended reliability and performance tests, known as the Product Qualification Program (PQP), PVEL has tested over 500 unique BOM combinations. The PQP tests all BOMs consistently, using world class equipment via testing at PVEL's facilities in California, or overseen by PVEL's experts at our partner lab within the Kiwa Group, PI China, in Suzhou, China. Every year, we publish the Top Performer modules in our PV Module Reliability

DH2000 - GLASS//GLASS



Glass//glass BOM post-DH2000 with a pristine EL image and 1.5% power loss.

DH2000 - GLASS//BACKSHEET



Glass//backsheet BOM post-DH2000 the module experienced >7% power loss and signs of corrosion are clearly seen around the cells' perimeters and along some bus bars.

Scorecard (available at [scorecard.pvel.com](https://scorecard.pvel.com)), with relevant case studies to support the methodology of our tests.

PV modules with the exact same model type can be manufactured from completely different BOMs. Suppliers are free to mix-and-match integral materials – even the cells – as long as all the components are listed in the manufacturer's IEC/UL certification report. Results from PVEL's testing have repeatedly shown that changes to these individual module components can dramatically affect product quality, and therefore, relying on certification testing alone is not sufficient to determine long-term performance and reliability.

In a recent example from our damp heat (DH) test, PVEL received two BOMs produced by the same module manufacturer that used the same cells and same front encapsulants. The DH test simulates long-term degradation and failure modes that are typical in high temperatures and high humidity conditions where moisture and heat can weaken the materials binding the module together. One of the modules tested was glass//glass, while the other used a glass//backsheet design. The glass//glass BOM was a Top Performer in DH testing, but the glass//backsheet BOM had more than 7% power loss after the same test. The backsheet had clearly allowed moisture to enter the laminate leading to cell corrosion.

In another example from our 2023 Scorecard, PVEL tested two almost identical glass//glass BOMs from the same manufacturer for potential-induced degradation (PID). PID is triggered by high PV system voltages on ungrounded installations. PID is more likely to occur in projects that use transformerless inverters, and is further accelerated by high-temperature and high-humidity environments. While it is sometimes reversible, severe and permanent PID can lower energy yield by as much as 30%.

The cells, glass and almost all other materials tested for PID were identical; the only differences between the BOMs was that the encapsulants were from two different suppliers (although both were front side EVA + rear side POE), and different frame and junction box sealants were used. After PID192(-) testing one BOM had 1.1% power degradation, and the almost identical BOM had 4.5% power degradation.

PID192(-) - BOM-1

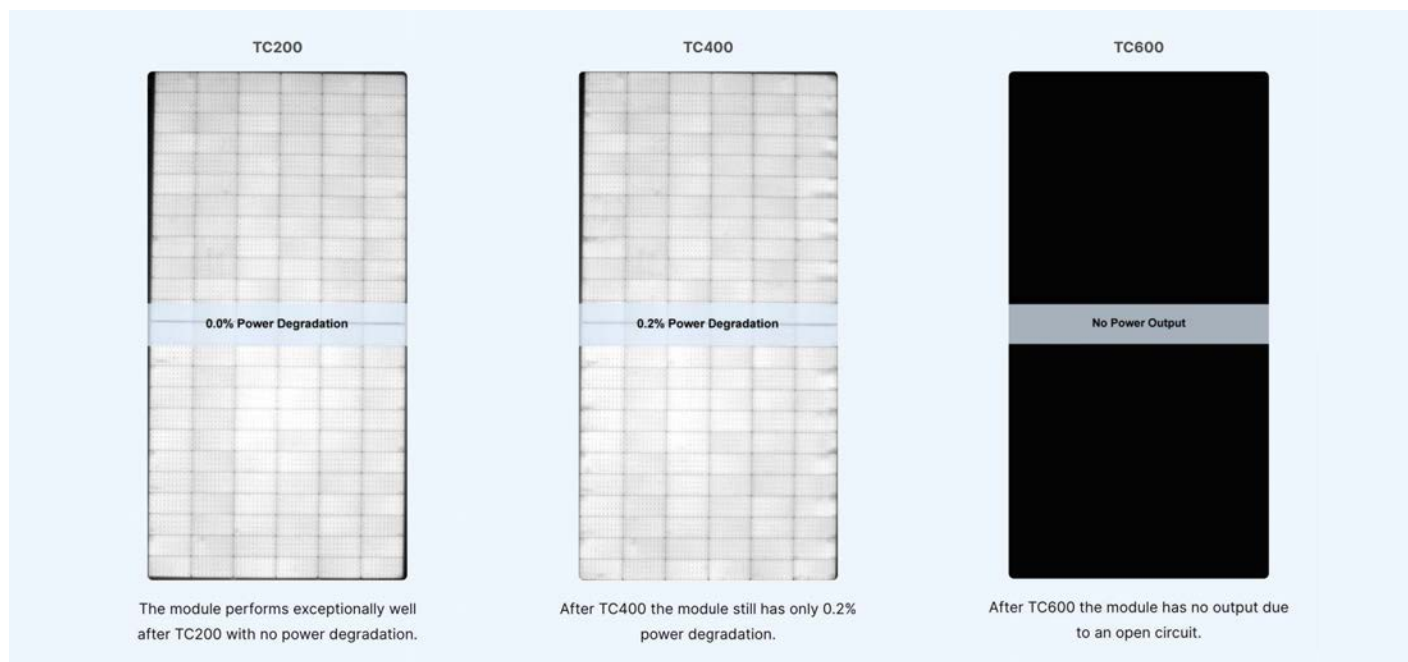


Post-PID192(-) on one BOM with 1.1% power degradation.

PID192(-) - BOM-2



Post-PID192(-) on an almost identical BOM with 4.5% power degradation.



tion. What some may consider minor BOM changes resulted in one BOM having four times higher PID susceptibility.

During PVEL's thermal cycling (TC), another sequence in the PQP test, modules are subjected to extreme temperature swings in an environmental chamber. They are first brought to a temperature of  $-40^{\circ}\text{C}$ , after which the temperature increases to  $+85^{\circ}\text{C}$ . While the temperature is increased, the modules are subjected to maximum power current providing additional field-relevant stress. The cycle repeats 600 times in total, and characterisations are conducted every 200 cycles.

While most modules we test perform well for the IEC 61215 standard's 200 thermal cycle test duration, some of those same modules experience catastrophic defects during the PQP extended thermal

cycling. In a recent TC example, the module performed well through TC200 and TC400. However, after TC600 the module had no power output and a black EL image. PVEL investigated the failure and discovered an open circuit inside one of the module's junction boxes. Had this been installed in the field it would have caused the entire string to have no output.

#### Failures occur in the lab and the field

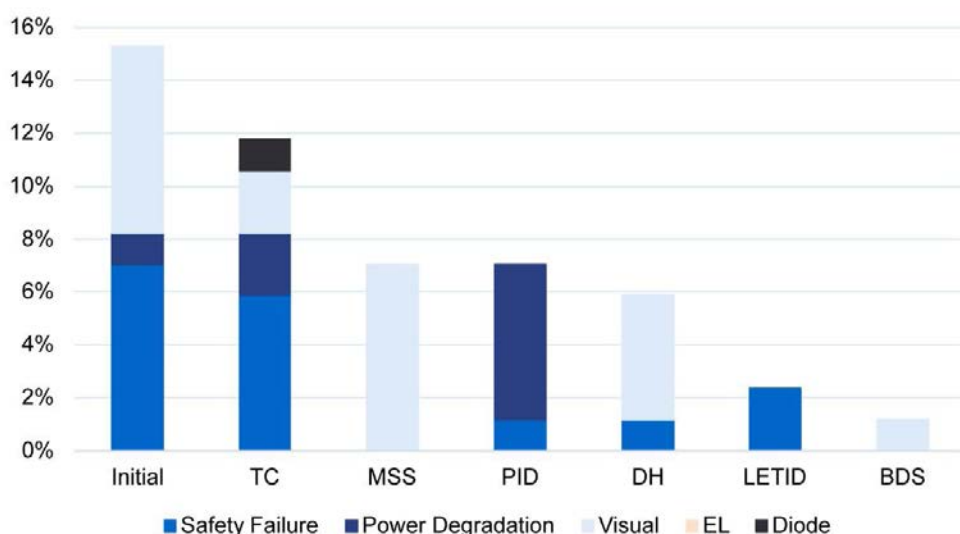
While our 2023 Scorecard showcases the ways that overall PV module reliability trends are improving, the above examples are not unusual. In fact, 54% of manufacturers eligible for the 2023 Scorecard experienced at least one failure during PQP testing.

There are various types of failures observed in PQP testing. Modules can

fail during visual inspection, including modules breaking during mechanical stress, junction box lids falling off, burn marks, melted/failing connectors, delamination, and power labels peeling off or becoming illegible. Safety failures are recorded when modules do not meet the minimum requirement for electrical resistance, something that is increasingly common during pre-stress testing. Power degradation failures happen when the power loss is beyond what the module manufacturer (or their customer) deems to be acceptable. And finally, diode failures are when the module's bypass diode is no longer functional. Diode failures fall into a larger category of junction box failures which also include melted connectors, exposed wires, wet leakage failures traced to the junction box and failed junction box soldering. In the 2023 Scorecard, we reported that 29% of manufacturers and 19% of BOMs had at least one junction box related failure.

Failures observed in the lab can have real implications in the field. In a recent case, fellow Kiwa Group member Extel Energy was contracted to visit a 12 MW rooftop site in Taiwan. The project used 340W half-cut 120-cell mono PERC modules and was commissioned in 2021. Routine drone infrared (IR) imaging revealed hot spots at the junction boxes for some modules, along with some activated bypass diodes. Upon further inspection of the site, Extel found some completely burnt junction boxes. Of the around 35,000 modules on site, 700 had hot spots at the junction boxes visible in IR images,

**This graph shows the percentage of BOMs experiencing a failure in each test sequence of the PQP by failure type**





70 had bypass diodes activated and 10 had extreme junction box burning. The module manufacturer investigated and determined that these were all due to a soldering issue within the junction box. They have since updated their quality and process control to implement pull testing on their junction box soldering.

While replacements for the affected modules were provided by the manufacturer, the cost of labour to replace these modules and to diagnose the issue was not covered by the module manufacturer's warranty. It is unclear if other modules will be affected by this failure mode in the future, given that they will experience natural temperature cycling in the field and its effects on soldering reliability.

PVEL has reported junction box related failure issues in every edition of the Scorecard since 2019. This problem remains persistent both in the failures identified by PQP testing and on modules in the field. As we diversify supply, and source components from new market entrants or factory locations, buyers need to do their due diligence to avoid the risk of unforeseen replacement costs if issues occur.

### Taking steps to mitigate risks during procurement

Specifying top performing PV modules is only one aspect of risk mitigation during PV module procurement. As part of the Kiwa Group, PVEL and other member companies support downstream project stakeholders at every step of project development, construction, and operation. Below, we outline some of the Kiwa recommended best practices for module procurement:

- **Specify Top Performing Bills of Materials.** At PVEL's labs, we test and report on the module's unique bill of materials, providing this information to downstream partners so they can use this data to specify the BOM combinations that meet project requirements in PV module supply agreements.
- **Audit and Monitor Factories.** Sophisticated module purchasers require factory audits (independent inspections of a manufacturer's production process) before PV module procurement to ensure suppliers meet quality standards. Monitoring PV module production during the manufacturing process also helps prevent quality issues in the modules produced for a specific project and ensures that the PQP-tested BOM is being used. These services are



Credit: PVEL

### PV module testing chambers

performed by companies like PI Berlin and others in the Kiwa Group.

- **Validate Quality.** Testing statistically significant samples of PV modules during module production helps buyers identify and remedy quality issues in the modules being deployed to their sites. This process, known as batch testing, requires shipping a randomly selected subset of PV modules from the factory to PVEL or other Kiwa Group labs for assessment. This can also be performed via third party oversight in the manufacturer's in-factory lab.
- **Verify Performance.** Kiwa recommends on-site testing for large and utility-scale solar projects. Testing PV modules upon delivery to the project site and prior to system commissioning helps identify damage that has occurred during transportation or installation. When performance or reliability issues arise in the field, PVEL and the Kiwa Group are available to diagnose problems and provide guidance for remediation.

### Working together to ensure a strong solar future

The solar provisions in the IRA could bring massive benefits to the U.S. industry, transforming the manufacturing landscape

in the country and rapidly creating new jobs. But as the industry moves to quickly expand and change the PV module supply chain in the United States, proper due diligence must be conducted to ensure that quality and reliability are maintained. Years of PVEL's lab data show that small differences to materials and components could have huge impacts on project economics. Manufacturers have a remarkable opportunity to expand production in the United States, and developers in the country can source domestic products. However, regardless of their source, buyers need to take caution that not all PV modules are the same.

Module buyers can help to mitigate overall project risks by following best practices during procurement, including reviewing third-party reports and specifying BOM combinations. For manufacturers in an increasingly competitive market, submitting modules for third-party testing can help differentiate products and increase customer confidence. And when working together to continuously prepare for, review, and address issues in module performance both during production and operation, we can help ensure that the billions of dollars invested in our industry creates a strong solar future that benefits all. ■

### Author

Tristan Erion-Lorico has over 15 years of solar and electrical industry experience that spans manufacturing, testing, project development and operations and maintenance. As vice president of sales and marketing at PV Evolution Labs (PVEL), Tristan oversees PVEL's commercial activities including collaborating with PV module buyers, investors and manufacturers to develop innovative test programmes for product qualification.



# Turning up the heat on PV: How to maximise solar tech in hot locations

**Solar Tech in Hot Conditions** | PVTech Power reporter George Heyes got in touch with Solargis, a Slovakia-based weather data and software provider for solar power investors and operators, for a deep dive into maximising solar technologies in hot locations.

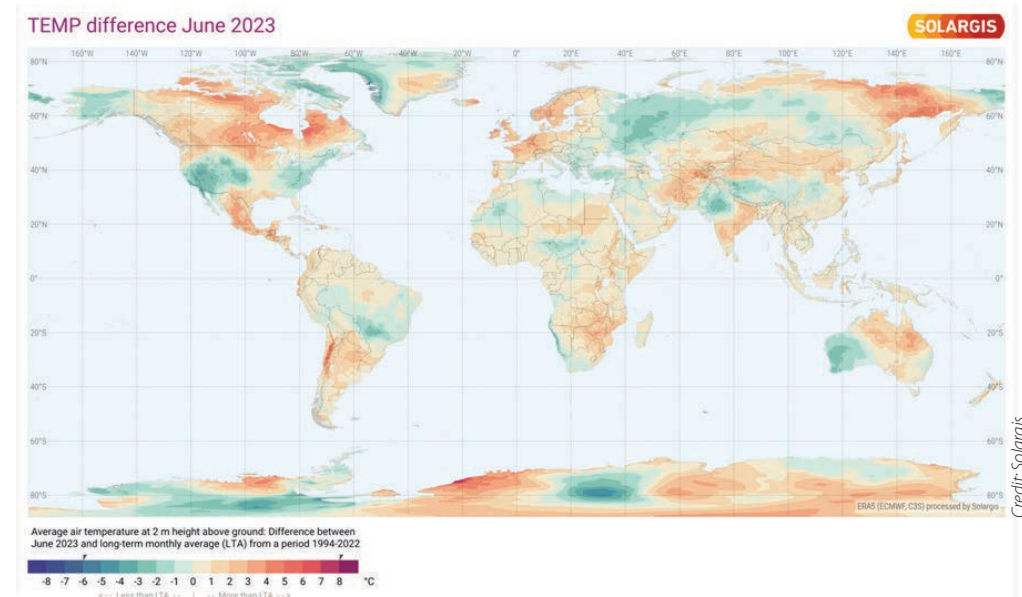
One of the key issues around deploying solar technologies is the way they operate in extreme conditions, or in the case of this article, hot areas. It is crucial the technology adapts to the gradual heating of the Earth's surface especially with the latest heatwaves witnessed in Southern Europe.

It is important to dispel myths surrounding the technology, especially those that were coming out of the UK in both the summer of 2022 and 2023 in which many publications and politicians speculated that solar technology does not perform well enough or generates power efficiently in higher temperatures.

In fact, the Telegraph recently claimed that "solar panels are tested at a benchmark of 25C. For every degree rise in temperature above this level, the efficiency is reduced by 0.5 percentage points".

Although this can be said for older PV modules, many of the newer editions do not display such drops in efficiency. And any drops in efficiency that occur do not warrant dispelling solar as a proven, capable technology that could spearhead the energy transition and support net zero targets.

To support this argument, it is important to note just how much solar has been developed in regions with higher average temperatures than prevalent in the UK. Australia has been boosting its solar PV generation capacity, as have the US, nations in the Middle East and Africa, and in many other arid regions. In fact, harnessing hot areas of land for large-scale solar farms could benefit society by providing an area to develop solar farms without taking land up for vital infrastructure.



But how effective has solar been in these heightened conditions? And what are some of the challenges and key considerations when developing solar projects in regions with consistently high temperatures?

Slovakia's Solargis has since 2010 been developing and operating software and data sets enabling fast access to historical, recent, and forecast data for almost any location on Earth. The following is Solargis' article on the topic, kindly provided to PV Tech Power for this issue of our magazine.

## How to Maximise Solar Tech in Hot Locations

The growing potential of solar energy across the globe is persistently challenged by a plethora of uncertainty surrounding module inefficiency. An increasing prevalence of extreme heat has changed the risk profile for solar energy, as temperature variability becomes a key challenge

**Graph showing difference in average air temperature for June 2023 in comparison with the long-term monthly average.**

for solar investors and operators. To validate the capability of PV technology, and therefore ways of mitigating the impact of hot conditions, we must use reliable and accurate data to inform decision-making and maintain system reliability as energy demand continues to rise.

The solar outlook for 2023 has, so far, displayed a trajectory towards increasing temperatures across Canada, North America, and Europe as imminent heatwaves loom. Throughout June 2023 we saw Belgium, Germany, and France experience up to a 4°C increase above long-term average temperatures, whilst wildfires raged across Canada and southern Europe. The shift in global temperatures has placed the potential of solar energy and the subsequent relationship between heat and solar irradiance under increased scrutiny.



## The relationship between heat and solar irradiance

There is no consistently defined correlation between heat and higher solar irradiance. Instead, solar resource output hinges on project design informed by geographical location, climate, and topography. Depending on these variables, hot conditions can create different risk profiles that increase uncertainty for solar investors and operators.

For example, in June 2023, the MENA region, which has an arid and hot climate, produced up to 280 kWh/m<sup>2</sup> of Global Horizontal Irradiance (GHI). The by-product of this intense solar irradiance is heat, which increases the overall air temperature. Solar cells are temperature sensitive, which in extreme heat can cause issues relating to overheating of PV components, causing disruption to project output.

In tropical climates, solar irradiance increases the air temperature and therefore the rate of ground water evaporation. As a result, it can produce scattered clouds which increase solar irradiance variability. Solar projects in these regions often require bespoke strategies and additional storage to manage variability.

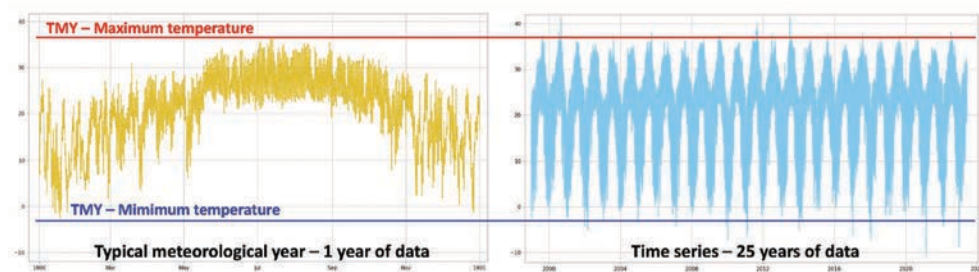
These examples capture two different risk profiles relating to hot conditions that solar investors and operators need to navigate. Integrating this understanding into the design phase of a PV project can help to ensure that PV plants maintain system reliability and avoid costly downtime.

## Navigating the impact of hot conditions on PV technology

For traditional crystalline modules, every 1°C above 25°C loses approximately 0.4% efficiency, reducing the maximum power output for the PV module. Therefore, the higher the temperature, the less power generated.

### Direct causes: increased degradation, failure risks, soiling, corrosion, reduced output

In a hot climate PV technology will be subjected to more extreme temperature ranges between day and night. Each material has its own expansion coefficient and with higher temperature changes, higher dimension changes can occur. These additional movements result in a faster rate of mechanical degradation of materials since they are put under greater strain.



**Comparison of temperature information in TMY (left) and time series (right)**  
**Note: observe time series temperatures outside TMY range (min and max).**

Additionally, sudden temperature shifts from morning to afternoon may increase the accumulation of dew on cold surfaces. As a result, PV modules get sticky and accumulate more dust, causing steel parts to become more corrosive. Also, any wet surfaces that come into contact with electronic components are more likely to fail through problems such as an increased risk of short circuiting.

Hot conditions can also impact the efficiency of the inverters. Inverters contain a temperature overloading protection system, whereby if the internal temperature rises above a given level, typically between 40-50°C, depending on the model, the inverter will reduce its output to protect itself from overheating. Therefore, the overall expected power output will be lower than in the original design.

### Indirect causes: surface albedo, cooling effect of vegetation

As the climate changes, an increase in heat can alter the landscape surrounding the PV power plant. This can impact power generation through a change in surface albedo, especially in bifacial PV module installations. The increased heat can reduce the growth of vegetation and therefore modify the rate of diffuse reflection of solar radiation from the ground back to space.

For example, green grass has a diffuse reflection value of 0.20-0.25 which means that the surface reflects 20-25% of the received radiation, whereas bare soil only reflects around 17%. Additionally, the cooling effect of the environment surrounding a PV power plant is reduced, causing further temperature increases at the site.

As a result, the alteration of the landscape can result in a generated power output that significantly diverges from the expected power output set by solar project operators. An understanding of the impact of hot conditions is frequently absent from PV project design. The variability between projects can make financing problematic due to high uncertainty regarding future production.

## Improving PV design to customise for hot conditions

To mitigate this, solar operators and investors require accurate data to inform better decision-making. Understanding the spatial and temporal variability of GHI provides a necessary insight for assessing the efficiency of a given solar project. However, there is a lack of reliable and accurate data available that captures a true representation of temperature variability.

To improve the efficiency and resilience of solar projects in hot conditions it is vital to leverage accurate and meaningful data, most importantly throughout the early design phase. Having access to precise historical temperature and current irradiation values is highly valuable in analysing trends and predicting future scenarios. Using this in the design phase, where estimation of power output is considered together with technology, is central to informing best practice and intelligent decision-making.

Time series data – for example, at a resolution of 15-minute intervals – uses high frequency collection to pinpoint temperature variability and improve the resultant accuracy of modelling. For simulation and future estimation, it can provide a dramatically clearer picture of the existing and anticipated behaviour of a PV power plant.

Moving beyond typical meteorological year (TMY) datasets, that only show long-term annual averages, allows solar operators and investors to monitor and analyse multiple parameters to elevate the operation and output of their PV technology. These include wind speed, direction, relative humidity, and rainfall.

Solar investors and operators need to optimise their project using accurate and granular data. Doing so will improve confidence and strengthen future decision making to unlock the full potential of PV projects. As temperature variability becomes more frequent, never before has there been a greater need to understand how hot conditions can affect solar energy management.

Credit: Solargis

# Enhancing renewable energy production in Antarctica through design and planning

**Solar in harsh climates** | Antarctica is one of the harshest and most inhospitable environments for human activities due to its extreme climate. Traditionally, research stations in Antarctica were powered by fossil fuels. The comparably simple requirement of supplying a research station with electricity and heat in most other parts of the world can become much more challenging in Antarctica. The picture can be quite different when using solar power, as is the case at Belgium's Princess Elisabeth Antarctica Research Station in the continent's Queen Maud Land. PV Tech Power's Simon Yuen talks to Slovenian solar company Bisol and the International Polar Foundation about features of renewable energy production at the research station which was established in 2009.

Solar power plants have in the past been limited to climates with an abundance of irradiance, but it is getting more competitive at higher latitudes thanks to advanced technology and decreased production costs.

Characteristics of high latitude climates can affect the performance of solar power plants, according to the study 'Polar solar power plants - Investigating the potential and the design challenges' co-conducted by Iver Frimannslund and Thomas Thiis from the Norwegian University of Life Science; Arne Aalberg from the University Centre in Svalbard, and Bjørn Thorud from consulting engineers and designers Multiconsult ASA.

For example, a decrease in cell temperature increases the solar cell voltage and slightly decreases the current, but the net outcome is an increased power output of about 0.35 to 0.5%/K. Moreover, the reflected irradiance caused by the high reflectivity of snow can enhance the irradiance collected by a solar module. As a result, bifacial solar modules can produce power from the irradiance received on both sides of the modules, and can greatly increase the power output in high-reflectivity climates.

In other words, reduced solar irradiation in the polar regions, compared to areas with lower latitudes, is compensated by increased efficiency resulting from



Credit: René Robert, International Polar Foundation

low temperatures and high reflectivity, according to the study.

Apart from efficiency, settlements relying on fossil fuels as the main energy supply need to pay higher fuel costs due to the transportation of the fuel because of remoteness. Research stations in Antarctica also rely on fossil fuels which faces two challenges. First, fuel needs to be shipped by boats from settlements or ports in other continents; second, the fuel needs to be transferred to inland stations by overland vehicles.

**Solar panels installed at Belgium's Princess Elisabeth Antarctica Research Station in the continent's Queen Maud Land.**

Considering the limitations of using fossil fuels, solar PV's competitiveness, such as on-site power production, can outweighs the high fuel costs of the existing solutions.

Despite the fact that there is potential for solar PV in polar regions, the extreme climate is one of the major problems in building solar power plants. The study highlights that the implementation of solar power systems must confront the climate effects caused by snow. Snow can shade the surface of modules, resulting



in a lower power generation efficiency. Moreover, the development of snowdrifts in a solar power plant can also impose a mechanical load on the PV arrays.

### Installing solar in Antarctica

In the same study, the authors detail how to build a sustainable solar power plant in polar regions.

The authors use a solar power plant in Adventdalen, on Norway's Svalbard, as an example. The weather there is characterised by significant horizontal redistribution of snow due to little shelter and strong winds, causing snowdrifts to develop in the aerodynamic shade of the PV arrays.

The study also indicates that PV array snowdrifts exhibit a similarity with snow fence snowdrifts, so the snow fence theory can be used to minimise the accumulation from the PV arrays. Snow fences can cause turbulence in the wind so that it drops much of its snow load on the lee side of the fences.

By using the snow fence theory, developers can consider the adjustment of azimuth, array tile and bottom gap of PV arrays to minimise snow accumulation in the plant.

A strong inclination for snow fences can reduce the net height of the fence and the subsequent snow storage capacity. Therefore, inclining the PV arrays significantly while maintaining a bottom gap is likely to reduce the storage capacity of the PV produced snow drifts.

Another key area developers need to take note of is that the plant should be resilient against snowdrifts, which are a direct consequence of the aerodynamic shade from objects and terrain. The authors suggest that a modification of the design of the solar power plant can be used to control snow accumulation and erosion in the plant.

According to the study 'Renewables in Antarctica: An assessment of progress to decarbonise the energy matrix of research facilities', solar energy became prevalent in Antarctic operations in the last decade. It was mainly introduced either to complement wind energy or in summer bases, summer shelters and on expedition equipment powered by solar energy such as radios and very-high-frequency repeaters.

The study listed four main reasons for using renewables in Antarctica based on interviews with personnel in charge of energy operation and contractors responsible for installing renewables systems, namely fuel cost reduction or avoidance,



**Aerial view of Princess Elisabeth Antarctica Research Station.**

reduction of greenhouse gas emissions, a secure electricity supply for the operations of scientific equipment during the winter when fuel deliveries are very difficult, and the development or testing of new technologies.

However, several obstacles and constraints hamper the use of renewables in Antarctica, with the main one being technical challenges.

For example, the authors said panels at the Princess Elisabeth Station were initially installed too close to the station which created extra work for the team when snow accumulated. In response to this problem, new installations, including cylinders with 360-degree PV cells and bifacial panels, were added to double their capacity and allow for heating of the annexe buildings.

Other challenges include the comfort of the staff as diesel generation is still required as backup, and logistics. In addition to difficulties in delivering renewables systems components, any missing components or tools can postpone projects for months or even a year as these items would have to be shipped in the next expedition or supply mission.

### How can the Princess Elisabeth Antarctica Research Station tackle the problems and thrive in Antarctica?

Antarctica has been the home of scientific research for decades, with multiple research stations operated by different countries on the continent. Located on Queen Maud Land, a region of Antarctica claimed by Norway as a dependent territory, the Princess Elisabeth Antarctica Research Station was designed as a prototype that can continually be improved over

time, according to the International Polar Foundation, administrator of the station.

The research station can access two of the most omnipresent features of the Antarctic weather: the wind and the sun. They are renewable sources that provide energy to the research station which claims to be running with zero emissions.

According to the International Polar Foundation, the Princess Elisabeth Antarctica Research Station has 284 solar PV panels that produce an average of 420kWh per day. In addition, to better leverage solar irradiance, the station has 96 bi-facial modules that can benefit from snow-reflected irradiance.

In addition to solar panels, nine wind turbines that can produce 6kW each are installed at the research station. The solar modules and wind turbines supply 76% of the energy required by the station. The energy produced by these two sources are stored by 192 lead-acid batteries.

A total of 30 solar thermal panels are included in the station, providing 21% of the energy with the remaining 3% of energy being provided by a generator set.

### Intelligent systems

As renewable energy production is variable, an intelligent system is installed to balance available energy and energy demand through a system of dynamic prioritisation. Generated energy will be transferred to a battery storage system with a total capacity of 438kWh before being transferred to a programmable logic controller.

The station consumes between 10 and 20kW on-season, so storage lasts for 13 to 26 hours if there is no sun or wind. The demand for energy can be divided into five categories, including safety, scientific research, daily usage from

Credit: René Robert, International Polar Foundation

stationed researchers and staff, leisure and operations consisting of water treatment and distribution, snow melter, ventilation and heating.

Additionally, there are mobile solar-powered energy field units producing up to 25kWh per day so that scientists can use them while on extended research missions in the field.

The Princess Elisabeth Antarctica Research Station has a smart microgrid designed by research centre and technical service provider Laborelec, and an automated energy management system designed by Schneider Electric.

David Orgaz, CEO of Schneider Electric Belgium and the Netherlands, said that ensuring smart energy management is crucial to the polar station, adding that energy produced by solar modules and wind turbines is either stored in batteries or used immediately. Therefore, maintaining a balance between what is produced and what is consumed is critical, minimising the station's energy usage and eliminating energy waste.

### Bisol's role in the station

Recently, Slovenian solar company Bisol has installed more solar modules to power the research station.

Bisol says its 22kW project aims to meet the increasing energy needs of the Princess Elisabeth Antarctica Research Station. In February this year, the containers with the company's 60 solar modules arrived in Antarctica, and installation is nearly complete.

"Adding the new Bisol PV panels is not just about having more energy available. The panels are facing east because we want to harvest the morning sun," says Guus Luppens, renewable energy system engineer of the International Polar Foundation.

The research station used to have a production gap between midnight and morning, but this is now covered by the new Bisol PV modules once they are all installed.

In the 'Polar solar power plants - Investigating the potential and the design challenges' study, the authors highlight that the redistribution of snow is "caused by snow eroding from exposed areas and accumulating in sheltered areas, creating snowdrifts". To reduce snowdrifts in unwanted areas, the design of infrastructure in polar regions needs to control where snow is deposited and eroded.

To ensure the resilience of solar power plants in snowdrift climates, the design should be adapted to snowdrift development. This can be performed by adapting the configuration of the PV arrays so that snow is deposited in designated areas or so that the deposition is minimised.

Luppens says due to the strong katabatic wind – a wind carrying high-density air from a higher elevation down a slope under the force of gravity – and the acceleration of the wind on the ridge, almost no snow is accumulating on this PV array.

But some special designs are adopted in such an extreme environment. "We learned to never underestimate the power of the katabatic winds in Antarctica. The mounting system has been carefully designed to withstand the high winds," says Luppens, adding that the PV modules did not receive any adjustments as they are -40°C-rated.

For wind turbines, they are designed for harsh conditions, according to Luppens. The blades tilt when the wind speed is too high, causing them to catch less wind and preventing the blades from overspeeding. The company also installs a dumpload system to ensure enough braking power by consuming all produced energy.

### Operation and maintenance

The operation and maintenance of the solar modules could be a problem due to the extreme weather. To prevent the solar modules and wind turbines from being damaged by any external factors, the systems are designed to be firmly fixed to minimise vibration. However, Luppens admits that the solar power systems and wind turbines are more prone to damage due to the extreme weather they are deployed in.

For the wind turbines, Luppens says they need yearly maintenance, while the PV modules – lacking the moving parts – do not need any maintenance.

Speaking of the design of the systems, there were some difficulties during the construction process. According to Luppens, the ridge on which the Princess Elisabeth Antarctica Research Station is built can be a very windy place. What makes the installation process more difficult is that the winds accelerate in the area close to the station. To successfully install the systems and modules, the process needs to be done on days with low wind speed.

The research station is designed to operate without any people on site, and

it can remain unstaffed for up to eight months. By using programmable logic controllers and supervisory control and data acquisition systems, operators can monitor and control light, switches, valves, and thermostats from a remote place.

"Excluding all possible failures is, of course, not possible, but we do try to make sure all scientific instruments stay operational during the whole winter until the first crew member arrives again," Luppens says.

### What made Bisol start working on this project in Antarctica?

The Princess Elisabeth Antarctica Research Station was established in 2009. Bisol first contacted Brussels-based International Polar Foundation in January 2022 to plan the project.

The company said that the design and clean energy concept of the research station integrates passive building technologies, renewable wind and solar installations, together with power electronics in a micro smart grid that delivers maximum energy efficiency.

The quality, reliability and low degradation of solar modules are areas that are particularly important in the severe weather conditions in Antarctica. Bisol says it only uses top quality EVA foil and longer lamination. Additionally, the company invests in its own climate chamber, performs peel tests on every module and also develops tailor-made BISOL tracking systems.

Asked by PV Tech Power about the reasons for working on this project, the spokesperson of Bisol says that the project's zero-emissions goal aligns with the company's values and missions, which involve energy solutions that are being commercialised in mainstream applications. Second, Bisol hopes to use this project, located at an unusual location, as an opportunity to showcase its products as the company's presence spans more than 100 countries at present.

"We believe that companies can play a key role in building a sustainable economy and society, which is why we take our responsibility towards the environment and the community around us very seriously," the company says.

Bisol started manufacturing solar PV modules in 2004, and expanded its business to PV mounting solutions and investments in solar power plants in 2009. Currently, with an annual capacity of 750MW, the company's products are sold in more than 100 countries. ■



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# The End of Mass Grading For Solar Projects

**Solar Tracking |** Yezin Taha, Founder and CEO of Nevados Engineering, on how solar tracking technology can help eradicate the still common practice of levelling sites prior to installing solar panels – and thus avoid the problems, environmental impact and cost associated with site grading. This is an executive summary of a recent white paper by Nevados.



Credit: Nevados

**G**radings, or the process of levelling land, has been an essential step in the construction of large-scale solar facilities since the earliest days of the PV industry. While the practice is common in all types of civil works, mass grading is inherently destructive to the natural landscape, and thus increases both the costs and the risks associated with solar development, permitting, and construction. Minimising the negative consequences of grading is particularly difficult and expensive at greenfield solar projects on hilly terrain. These sites have become increasingly common as the utility-scale market expands and matures.

The greater the scale of grading, the more significant the environmental risks and the greater the permitting burdens. When grading is widespread and/or poorly managed, the costs of mitigating erosion, revegetating the landscape, and preventing stormwater pollution can dramatically increase construction timelines and costs as well as impact long-term operations and management budgets for solar assets. In certain communities, especially in the rural U.S., grading for solar projects has triggered local opposition to solar that stops projects in their tracks before construction even begins. It's time to end the practice of mass grading.

**Nevados trackers deployed on rolling terrain in Utah, US.**

Here's the good news: mass grading is no longer required for large-scale solar deployments that use trackers to boost energy yield. New all-terrain tracker technology developed and innovated by Nevados has enabled the solar industry to build high-performing, cost-competitive solar farms that respect the land without the need for grading.

## The Grading Process For Solar Projects

In large solar developments on uneven land, cut and fill grading is employed to achieve level ground. This consists of scraping high points off, then using that soil



Increased Burdens	Additional Risks
<b>Site Acquisition &amp; Development</b>	
<ul style="list-style-type: none"> <li>• Authorities having jurisdiction (AHJs) frequently require the sizing of stormwater (quality and quantity) retention basins based on area of land disturbed</li> <li>• Additional local permitting and zoning approval processes are common</li> <li>• Higher requirements for civil and environmental engineering services</li> <li>• Grading can only be done in certain seasons and weather conditions, limiting construction schedules</li> <li>• Local concerns over disruption to natural landscapes and agricultural assets are more likely</li> </ul>	<ul style="list-style-type: none"> <li>• Risk to timeline after site acquisition due to permitting requirements</li> <li>• Risk of weather-related delays and increased costs</li> <li>• Increased administrative costs for documentation required for approval</li> <li>• Risk of negative local sentiment</li> <li>• Possibility of legal action from environmental and cultural conservation groups</li> <li>• Negative press driven by local community, especially in agricultural areas</li> <li>• Delays or stop-work orders from AHJs for improperly or non-stabilised sites</li> </ul>
<b>Construction</b>	
<ul style="list-style-type: none"> <li>• Additional labour and subcontractor costs</li> <li>• Weather conditions dictate installation timeline</li> <li>• Dust control burden on EPC</li> <li>• Additional labour and expenses for revegetation process</li> <li>• Increased potential for erosion due to compromised soil structure</li> </ul>	<ul style="list-style-type: none"> <li>• Unpredictable costs and timeline due to unforeseen topological and hydrological barriers</li> <li>• Risk of weather-related delays and damage</li> <li>• Difficulties with revegetation leading to erosion, soil compaction, introduction of invasive species, and harm to pollinators</li> </ul>
<b>Long Term</b>	
<ul style="list-style-type: none"> <li>• Ongoing erosion, soil compaction and washout issues</li> <li>• Ongoing soil importation and reseeded until soil stabilisation is achieved</li> <li>• Introduction of invasive species that increase mowing costs</li> <li>• Ongoing potential for higher operations and maintenance costs due to erosion and higher decommissioning bond rate</li> </ul>	<ul style="list-style-type: none"> <li>• Legal issues from neighbouring properties and local municipalities</li> <li>• Permanent damage to agricultural properties causing legal issues with leasing landowners</li> <li>• Potential that site will be forced to shut down if erosion issues are not addressed</li> <li>• Destruction of biomes, local species collapse</li> </ul>

as well as imported soil to fill low points. Hundreds of thousands of cubic yards of soil may be moved during this process.

When land is graded, topsoil is typically stripped or covered, destroying the ability to farm or plant the land. Soil stabilising plant roots may be removed, which escalates erosion and increases sedimentation to downstream areas. In severe cases, erosion and sedimentation issues may violate local watershed protection regulations, harm plants and animals in local streams and lakes, and cause lengthy construction delays.

Level terrain has long been a requirement for utility-scale PV installations because conventional solar ground-mountings can only be installed on flat land. However, viable greenfield sites that meet key developer requirements (i.e., flat topography, proximity to transmission infrastructure, low cost) are now scarce: in many markets, solar projects on any parcel of level, rectangular property that is well-located for utility-scale PV deployment.

As level sites continue to dwindle, developers are more and more limited to installing solar assets on hilly terrain. Many EPCs have turned to mass grading

to achieve the flat land required for conventional tracker technology on available project sites. The greater the scale of grading, the greater the risks – and the greater the costs if issues arise.

As the industry matures, the risks of grading for solar projects are rapidly garnering increased attention from regulators. In the U.S., many localities are becoming savvy to the risks of grading for solar farms, implementing moratoriums and local level restrictions on solar projects within their jurisdictions. In areas where such measures are in place, grading functionally halts projects.

#### Grading Increases Project-Level Costs and Risks

According to industry leading engineering firm Primoris, U.S. solar projects that are subject to Stormwater Pollution Prevention Plan requirements average an additional cost of \$0.75 per watt. The costs are even higher for sites with significantly variable topography.

As detailed in the table above, grading increases the risk of permitting challenges, project construction delays, and cost overruns. All of these risks add up to higher costs and less profitable projects.

#### Grading Invites Unexpected Problems

Unforeseen costs are many and varied when site preparation plans include mass grading. At every level of execution, a graded solar project site runs higher risks of unforeseen delays and unanticipated costs.

Seasonal constraints on grading activities mean that in many regions, a graded site may require additional months to accommodate weather related delays, and the limited windows when grading can be executed. Vulnerability to extreme weather during and after grading is completed further increases the risk of increased costs and delays for a project.

Hidden geological features which are discovered during the use of large-scale excavation equipment can delay or even completely derail a project reliant on major restructuring of site topography.

Additionally, the high cost of dust control is an often-overlooked additional burden on developers who choose to grade during site preparation. Especially in dry and drought-affected regions, dust control measures are necessary to preserve local air quality whenever grading occurs.

In water-scarce regions, this can mean that in addition to the equipment and labour required to conduct dust control activities, water must be trucked onto a site at great additional expense.

Decommissioning bond rates may also pose an increasingly substantial liability for graded sites. As the risks to site infrastructure, negative environmental impacts, and the scope of regulatory compliance burden associated with grading become more widely understood, the grading process will soon become a major red flag to bond issuing agencies.

### Leveraging Technology to Eliminate Grading

The 50 MW Iris Solar facility in Washington Parish, Louisiana is a case study in utilising Nevados' integrated all-terrain solar tracking technology platform to dramatically reduce grading requirements.

Primoris, the construction and engineering firm that built the Iris facility, conducted a desktop study comparing earthwork and grading requirements at Iris for conventional 1P trackers vs. the Nevados technology platform. The study revealed that Nevados trackers reduced grading requirements and disturbed land acreage by 95%.

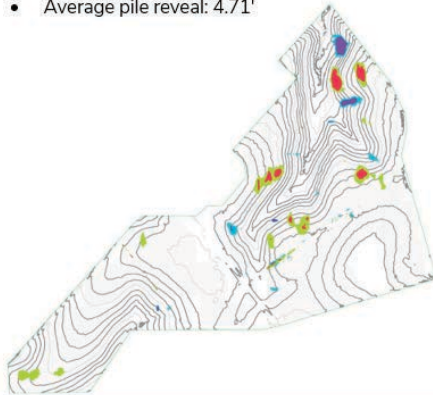
Primoris ultimately utilised 13MW of Nevados trackers in conjunction with 37MW of conventional 2P tracker technology for the Iris project. The cost-effective hybrid solution maximised utilisation of available land for solar production and minimised grading.

### Nevados: An Integrated Solar Technology Platform

Nevados solar trackers use a proprietary product design that is engineered to eliminate or greatly reduce grading requirements on solar projects. The structures are uniquely characterised by highly flexible bearings and non-continuous torque tubes. Nevados maintains constant reveal heights which results in less above ground steel than is typical for 1P trackers.

#### CONVENTIONAL 1P

- Grading cut/fill: 1,100 yd<sup>3</sup>/MW
- Disturbed area: 0.34 acres/MW
- Pile reveal range: 4' - 6'
- Average pile reveal: 4.71'



Elevations Table			
Min. Elevation (ft.)	Max. Elevation (ft.)	Area (ac)	Color
-5.00	-1.00	0.60	Red
-1.00	-0.50	1.64	Yellow
0.50	1.00	0.47	Green
1.00	5.00	0.30	Purple

Most trackers require flattening the land because they use a continuous torque tube across an entire row. Nevados trackers have segmented torque tubes and cost-effective flexible bearings, so they can accept angle changes of up to 15 degrees (26%) between posts and all bearings can handle maximum slopes of up to 37% (20 degrees). Nevados trackers also use standardised short piles that reduce steel as compared to conventional trackers.

No terrain is the same, so the Nevados solution is highly adaptable and customisable. We offer three separate bearing options with the same mounting and construction method for a tracking structure that molds to variable topography. Bearing types can be mixed and matched throughout a project site to maximise available land for solar deployment.

The Nevados tracker system is designed for easy installation. The tracker has very few steps for assembly because the driveline and factory-assembled bearing are integrated into the same assembly. No specialised tools, jigs, or fixtures are



#### 95% reduction in grading volume and disturbed area:

- Grading cut/fill: 66 yd<sup>3</sup>/MW
- Disturbed area: 0.02 acres/MW
- Uniform pile reveal



Elevations Table			
Min. Elevation (ft.)	Max. Elevation (ft.)	Area (ac)	Color
-5.00	-1.00	0.01	Red
-1.00	-0.50	0.06	Yellow
0.50	1.00	0.05	Green
1.00	5.00	0.03	Purple

**The heat maps compare the grading requirements at the Iris site for a conventional 1P tracker and the Nevados All Terrain Tracker. Disturbed land is highlighted by color as shown in the tables. The Nevados tracker eliminated almost all cut-and-fill grading from the project site.**

**Nevados tracker system that follows the natural terrain.**

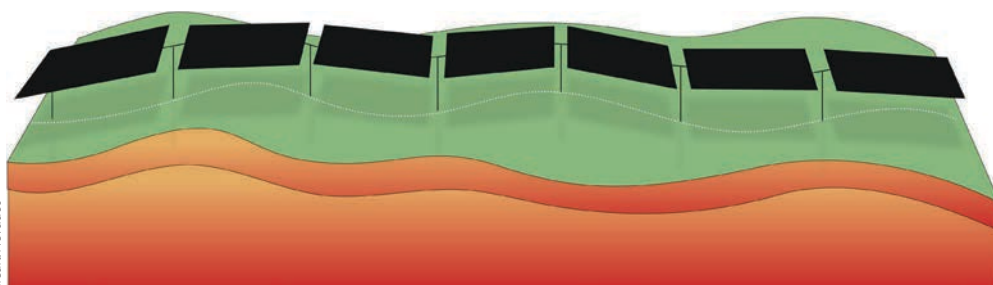
required for installation. The entire system has only two bolt sizes with two torque specifications.

Non-continuous torque tubes, shorter pilings, and large tolerances also simplify and speed up the installation process. The shorter torque tubes are easily handled and installed by two people. Tracker installation occurs at chest-height, so no ladders or step stools are required. Torque tubes and straight bearings auto-align during installation while articulated bearings are hand-aligned whenever they are used. Solar modules also self-align during installation with top-clamp clips that can easily accommodate different module sizes.

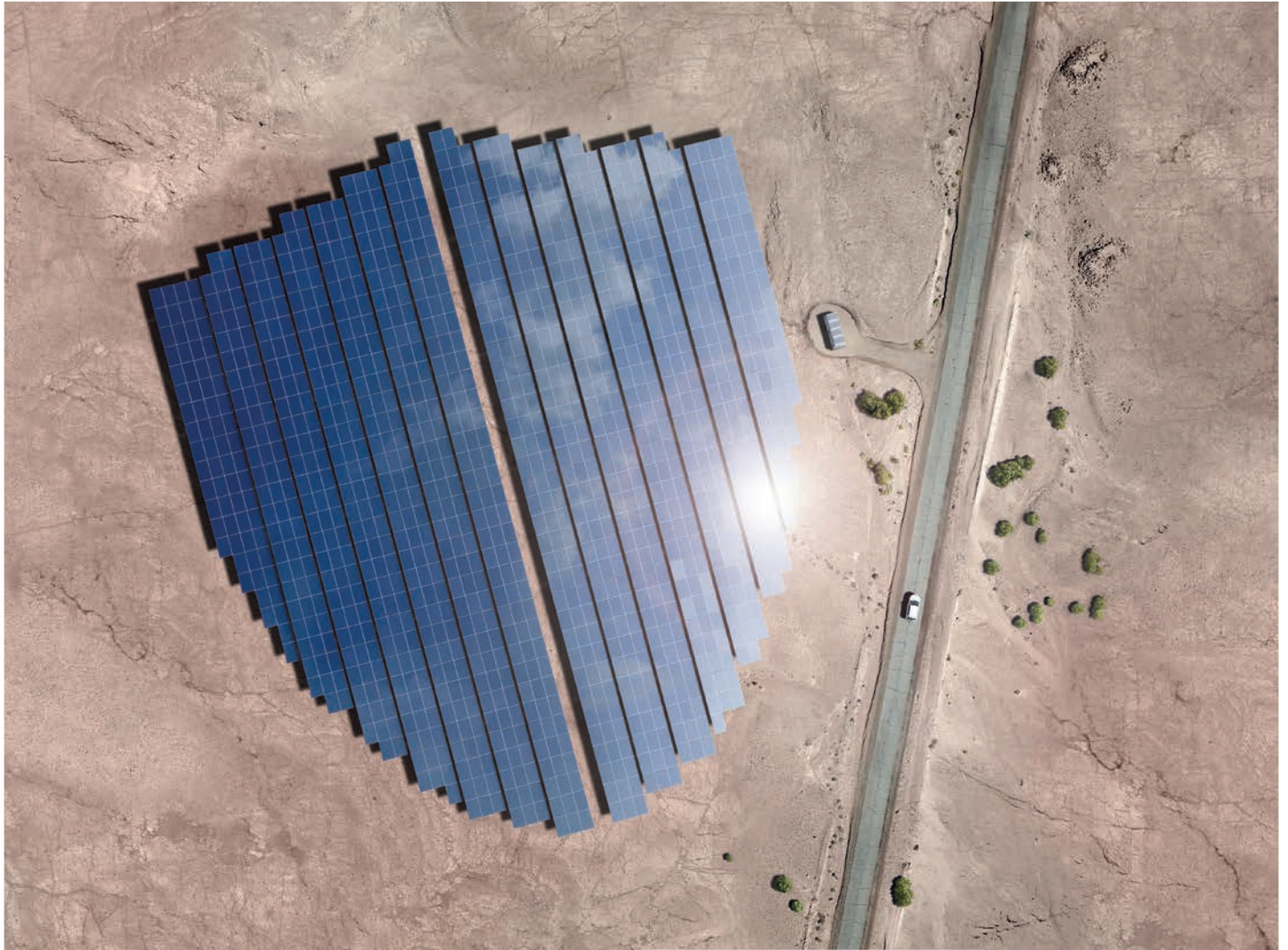
The Nevados team engineered every aspect of its technology platform with topography in mind. It includes proprietary performance optimisation software, TRACE. Each row is programmed with its own tilt schedule to prevent all row-to-row shading for any topography and ensure maximum energy yield.

### Call to Action

Grading is a destructive practice that undermines the solar industry's ability to consider itself an environmentally responsible power source. Grading also introduces serious risks throughout the project lifecycle, which can threaten the long-term financial performance of solar assets and the viability of project development in rural areas. As variable topography becomes less the exception and more the rule in the identification of greenfield







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sites, new project sites are more vulnerable to the negative consequences of grading than sites that were developed in the past.

Continuing to engage in mass grading as an industry standard is likely to engender further regulatory action, preventing the continued expansion of the solar market into new geographies.

Fortunately, the harms and inherent risks of grading can be easily avoided with the All Terrain Tracker technology from Nevados. Nevados' technology opens up potential greenfield sites that have previously been deemed non-viable for utility-scale installations. Additionally, older sites that utilised fixed-tilt racking to avoid intensive grading can increase energy yield by upgrading to All Terrain Trackers from Nevados.

The future of utility-scale solar cannot rely on the destructive strategy of mass grading. It is time for project developers and EPCs to end this practice by leveraging the most advanced technology from Nevados.

#### Q&A with Yezin Taha, Nevados Founder and CEO

**PV Tech Power: Nevados has strong views on mass grading for solar projects. What exactly does it entail and what makes it such a destructive practice?**

Yezin Taha: Mass grading is a heavy-duty construction process that flattens the land. Thousands of tonnes of topsoil and the vegetation that it supports are ripped from the earth, denuding the landscape. I was first exposed to mass grading for solar projects as an independent engineer conducting technical due diligence for investors. It shocked me because solar PV technology is touted for its environmental benefits – yet the process of building solar farms was destroying local habitats. These personal encounters with the harmful effects of mass grading inspired me to found Nevados.

**How does Nevados' technology negate those adverse effects?**

The Nevados technology platform helps developers and EPCs avoid mass grading and minimise grading requirements. We designed our tracker system for deployment on variable terrain from the outset – it is not just a flat-land tracker adapted for hilly sites. Using our tracker system allows developers to dramatically reduce land disturbance at project sites.

**What are the cost implications for a solar assets operator which avoids grading a**

**Nevados trackers in the field at the Iris site, featured in this article.**



Credit: Nevados

**site? What other reasons make it attractive for them to avoid the practice?**

The economic benefits of reduced and avoided grading go far beyond lower construction costs. Projects that are not graded require fewer and faster permits and reduced or eliminated revegetation activities, and they are far less likely to suffer from erosion and watershed management issues that result in fines from local authorities and drive up operations and maintenance costs over time.

**How does the efficiency differ between an ungraded site deploying solar trackers and one that deploys conventional technology?**

The Nevados Technology platform delivers the same or better efficiency gains as conventional trackers on graded sites. From a construction point of view, no alignment labour is needed to assemble the bearings, torque tubes, or modules. From a financing and layout standpoint, our team optimises the tracker layout, tilt schedules, and energy generation estimates prior to construction to allow the customer to both pack in more MWs and more accurately estimate energy generation prior to construction. Once the power plants are up and running, the highly accurate Nevados TRACE program enables the solar trackers to capture the most sunlight possible without casting shadows from one row to the next. This eliminates the typical rudimentary approach of sacrificing some sunlight capture to eliminate inter-row shadowing. With Nevados, asset owners can leverage industry-leading tracker-boosted energy yields without the risks of grading.

**Has Nevados seen a significant change lately in the industry's attitude towards grading? Are there notable differences between the regions where you operate?**

Nevados focuses on the U.S. as our key market, and attitudes towards grading are changing quickly here. The key driver

is local community opposition to solar projects because of grading's environmental impacts. Projects in states like Ohio, Virginia, and Connecticut have been cancelled because of local environmental concerns, and some communities have enacted strict regulations on solar development. Developers that seek to operate in these high-potential, relatively untapped markets have no choice but to minimise grading or face the increasing likelihood of protests at permit hearings.

**What are the most promising countries/regions for your products outside the US and why?**

The most promising countries/regions for Nevados have highly topographic terrain and fairly mature solar industries, such as Italy, Spain, Australia, and Japan.

**Can you envisage a solar power industry that operates entirely without graded sites?**

I imagine a solar industry that operates entirely without mass grading every day. It's the vision that drives all of us at Nevados. While we recognise that some land disturbance will always be necessary for large-scale solar development – after all, we need roads to truck in equipment and piles must be driven – we are committed to engineering the best technology solutions for reducing land disturbance. Solar deployments that respect the land are the future of the industry. ■

#### Author

Yezin Taha is the founder and CEO of Nevados Engineering. Nevados provides a comprehensive All Terrain Tracker (ATT)



solution for the solar industry that eliminates the need for grading on almost any site. He founded Nevados to enable installation of solar power plants in less time, at lower costs, and in more locations.



# Review of Electricity Markets reform: will it impact confidence in the UK renewable sector?

**UK Electricity Market** | PV Tech Power Editor John Lubbock examines the challenges of reforming the UK's electricity market in the face of the increased rollout of renewables in the country.

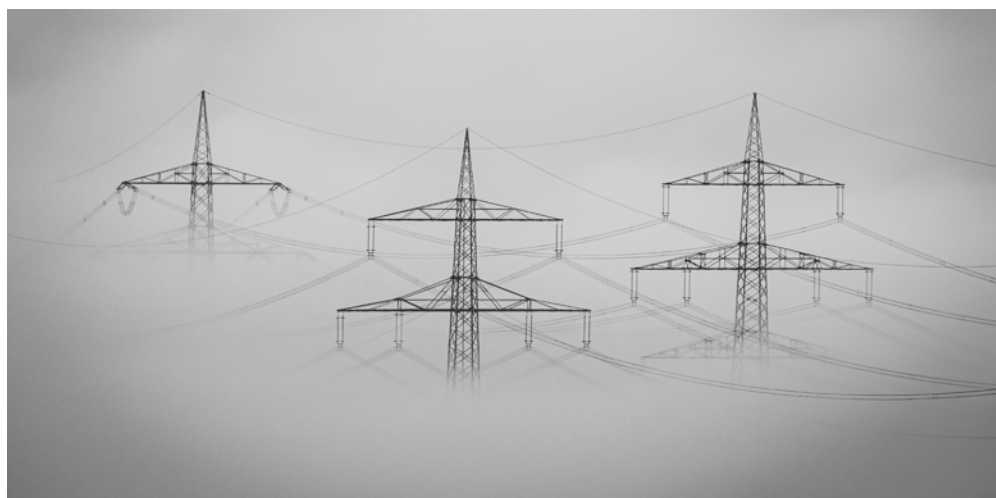
**R**eforming an entire market structure is complex, let alone reforming one as complex as the electricity market, yet most stakeholders are in agreement: the UK's electricity market needs reform.

The Review of Electricity Market Arrangements (REMA) reform has been on the cards since 2022, when the UK government decided to launch its consultation on the far-reaching reforms needed to cope with a market set up for a world with a small number of big energy sources, not a world with lots of small-scale renewable generation.

The intermittency of renewables on the grid is leading to increased costs. The Nuclear Industry Association (NIA) says that "The cost of balancing Britain's power grid hit £4.19 billion last year [2022] according to Nuclear Industry Association analysis of National Grid Electricity Systems Operator (ESO) data... Costs have increased 250% since 2019, when the total was £1.2 billion. In those last four years, balancing the grid has cost British consumers £9.83 billion in total."

The NIA says that without reform of the current market arrangements, "there is a risk of consumers having to pay spiralling costs to balance the electricity system. Currently electricity generators can sell into the national market even if the power network cannot physically transmit the electricity to where there is consumer demand."

Over £1 billion is being spent a year on 'balancing actions' which are the result of wholesale markets too simplified to reflect real conditions on the grid. The Energy



Credit: analogicus via Pixabay

Systems Catapult – set up to accelerate the transition of the UK's energy system – has looked at the reforms to do with locational pricing being considered by REMA, and concluded in a report that locational pricing could save consumers money.

National Grid ESO's Net Zero Market Reform project, established in 2021, looked at what kind of market design would help to achieve net zero, and in March 2022, NGESO recommended the adoption of a nodal pricing system, which it said would achieve net zero at the lowest total cost.

However, there are potential drawbacks to a nodal pricing system which are causing concerns about attracting investment, as a prolonged period of transition and uncertainty could cause. As RenewableUK also noted, a nodal system "would lead to increased price volatility and complexity (indeed,

this is the objective in order to incentivise behaviour)."

RenewableUK warns that this would "increase risk and adversely impact investor sentiment, which could slow the pace of deployment of renewable projects needed to reach net zero by 2050."

However, there is also a concern that the continued lack of clarity around future market arrangements is hampering investment, with concerns being raised that the REMA consultation process has been going on too long. PV Tech Power talked to Tom Luff, senior advisor at the Energy Systems Catapult and Joe Perkins, senior vice president and head of research at Compass Lexecon, who has analysed nodal pricing for Ofgem, to understand the concerns and where REMA is heading.

"Fundamentally, change is needed," says Tom Luff, because "we won't get to net

### Single national price and locational network charges

Uniform price clears across entire market



### Zonal pricing

System divided into a small number of zones with individual prices



### Nodal pricing

System divided into many 'nodes' with individual prices



Credit: National Grid

zero with the current arrangements."The challenge is deciding the specific changes we need, Luff says, and how radical and fast they need to be.

The basic problem is that there's not enough flexibility in the market to deal with the changing nature of energy production and the intermittency of renewables, Luff says. The way to achieve this is "to make sure that the value of energy is properly reflected so that the actual realities of the grid are properly reflected."This means shorter trading windows and locational pricing to more accurately represent prices. Ofgem announced in June 2023 that the completion date for the market-wide half-hourly settlement (MHHS) programme would be pushed back from October 2025 to December 2026.

However, there is pushback to radical change from some parts of the industry, especially from companies that manage the grid and generate power in areas with high supply but low demand, like Scotland. Luff says that the government should set out a clear direction of travel if they decide to introduce locational pricing and stick to it to give investors confidence. Zonal pricing, rather than nodal, could be a halfway house on the road to nodal pricing which could cause less disruption, but would also give less flexibility.

Market reform is "not so much about giving more subsidy, it's just giving a fair price," Luff adds. In places where demand is high, like urban areas, reflecting the real electricity price would incentivise more rooftop solar, for example, which is something that community energy groups are enthusiastic about. Creating more supply where there is demand would also

### National Grid ESO's map of different regional systems.

reduce the need for bigger transmission cables to take power from areas of production to where the demand is.

National Grid ESO is also in favour of locational pricing, because this would help reduce the problem of balancing costs we looked at earlier. This is important, because building out grid infrastructure is the biggest obstacle to the rollout of renewables, and locational pricing should help to incentivise the network upgrades needed.

Joe Perkins, who has been advising Ofgem on energy market reform, says that as far as the potential damage to investor confidence goes, "the status quo is not an option", and there will need to be considerable reforms. There is already investor uncertainty around the transition period of reforms, and locational pricing would probably increase the riskiness of investments in the renewables sector.

Perkins looked at other jurisdictions which had moved to a locational pricing system over the past 10 or 20 years while expanding renewable generation, and "we didn't really see any sign of a hiatus [in investment in the sector]". Perkins added that "the broad sense was that what really mattered was the policy support mechanisms."

Locational pricing is unlikely to impact on the cost of capital, Perkins said, and while it is possible that it could affect wind power generators in Scotland, it could also help to incentivise the rollout of battery storage to take advantage of locational price fluctuations. Perkins also thinks it would help incentivise community energy projects in urban areas, if these projects are allowed to sell their electricity locally and bring down consumer bills, and that it would also assist with vehicle to grid (V2G)

interactions which create grid flexibility with electric vehicle battery storage.

"For me, it comes down to an empirical question, really: do you think that you get a better functioning energy system with locational prices or not?", Perkins says. However, "if you were just doing the very head-down economist approach, you probably would say nodal pricing is the answer, because it just comes out with a much higher benefit cost ratio. For a more political perspective, I think there's a case for zonal pricing."

Fundamentally, the main bottleneck in rolling out renewable generation is increasing the capacity of the electricity grid by building out infrastructure. Arguably, the current energy market system in the UK doesn't incentivise this, because there is one price for electricity all over the network, which means that there is no incentive to build capacity where demand is high.

Investors want certainty. They want the government to say what kind of energy market system they prefer, and lay out a roadmap to achieving it so that they can plan long term investments. There is already uncertainty about the direction of travel for the UK's energy system, and the government can reduce this by speeding up the REMA process.

Energy UK has recently forecast that the UK will have the slowest growth in low-carbon electricity generation of the world's largest eight economies, and some of the blame for this must lie in the slow pace of market reform and a lack of urgency by energy companies to upgrade their grid infrastructure. The only thing for certain in energy market reform is that doing nothing is not an option. ■





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# Why we need more renewables PPAs

**Energy Transition |** Maria Popova of the European Federation of Energy Traders makes the case for power purchase agreements from renewable sources, as the sheer volume of renewables growth required to reach Europe's climate target means that public financial support is unlikely to be sufficient for the task, and market-based instruments and mechanisms need to be deployed alongside.

Credit: Gerry Machen via flickr



It is unlikely that there is an energy professional who has not heard of long-term power purchase agreements for the offtake of energy from renewable energy sources (RES), or the so-called RES PPAs. Be it in recent legislative proposals, from the revised EU Renewable Energy Directive and RePowerEU to the electricity market design reforms in the EU and the UK, in corporate sustainability statements, or on the pages of the Financial Times, PPAs are pretty much the talk of the town.

There are two reasons for that: the need to decarbonise our energy system and the need to hedge against future

price risks. Reaching Europe's 2050 climate target would require the rapid scale-up of renewable energy, including adding more than 700 GW of new RES capacity already by 2030. In addition, the energy crisis has been a stark reminder of the importance of diversifying energy supplies, optimising energy use and prudent risk management.

## **An invaluable instrument for the market-based growth of renewable energy**

Over the past decade, there has been an increasing interest in RES PPAs in Europe.

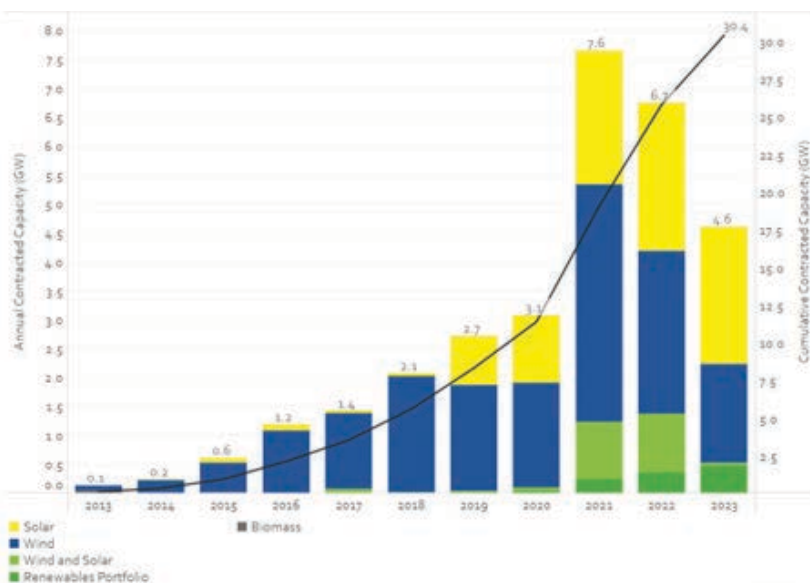
These are long-term commercial contracts for the offtake of renewable energy with a typical tenure of seven to 15 years ahead of delivery. While earlier PPAs had a longer tenure, of 15-25 years, with the energy crisis and in certain regions, PPAs with much shorter tenure – 2-3 years ahead of delivery – have also emerged.

RES PPAs allow buyers, such as corporate and industrial bodies, to make claims that they are consuming renewable energy, as the Guarantees of Origin (GoOs) exchanged under a RES PPA offer a unique claim to the renewable attributes of the consumed electricity, or even that they are contributing to the financing of additional renewable capacity. The ability to evidence renewable energy consumption is becoming increasingly important. It can be used for reporting in compliance with the Greenhouse Gas (GHG) Protocol Corporate Standard and under voluntary renewable sourcing and reporting initiatives. Moreover, a sustainable business is a business that can attract green investment and is also better prepared to meet the requirements of the growing body of sustainability regulation.

Renewable PPAs can also be beneficial from a costs management perspective. They can offer competitive prices, give buyers greater predictability over their long-term electricity costs and allow them to manage the risk of electricity prices going up in the future. Thus, a RES PPA would not only strengthen the green credentials of a business, but also benefit its long-term competitiveness and resilience.

Renewable PPAs are valuable to project developers, as without them a renewable energy project may not even be possible. They provide long-term predictability of





returns and are an important indicator for lenders about the viability of a project, which can reduce the cost of borrowing.

With public financial support for renewable energy decreasing, long-term PPAs offer an alternative that ensures the continued growth of such assets. They can also support the continued operation of existing renewable energy assets by providing them with a stable revenue stream and helping them to manage future price risks.

### Long-term commitments in challenging times

The extreme price volatility over the past two years did not spare the PPA market. However, given the circumstances, it has shown remarkable resilience. As per a Pexapark report, there has even been a slight increase in deal count across Europe between 2021 and 2022, from 154 to 161, and a strong start to 2023, although a 21% drop in contracted volumes was observed, as corporate demand for renewable energy remains high.

Performance was affected both by the energy crisis and the uncoordinated responses to it. The high prices and volatility made some buyers more hesitant to conclude long-term contracts. Interest in shorter-term deals, however, increased, as they allowed buyers to spread out their high energy costs. In addition, investment uncertainty, as well as supply chain, permitting and grid connection issues, contributed to a shortage of projects and moved the market from the traditional buyers' market to a sellers' market.

### The trend in RES PPAs growth in Europe over the past ten years. Source: Re-Source Platform

The second critical element was the patchwork of national level emergency measures put in place in response to the crisis. The Agency for the Cooperation of Energy Regulators counted 439 such measures across the EU. This lack of coordination and the disruptive effect of regulatory interventions on the market has had a significant impact on investor confidence, further impacting the availability of projects. Whether that would have a lasting impact on renewables investment in Europe depends – in no small part – on the outcome of the ongoing EU Electricity Market Design reform.

The relative roles of RES PPAs and continued public financial support for renewables are also under discussion in the context of electricity market design reforms both in the EU and the UK. It is the view of this author that any future electricity market design needs to allow commercial contracts for the procurement of renewable energy, that is to say consumer-led demand for renewable energy, to develop to their full potential. This would ensure the availability of resources to meet our ambitious climate targets, where public financing is unlikely to be sufficient, and cost-efficiency in renewables growth. It would also incentivise better risk management, which would improve the resilience of businesses to future price fluctuations.

### A variety of PPAs to fit diverse needs

One of the benefits of RES PPAs is that they offer a great variety of contractual structures, which could meet the diverse needs and preferences of different buyers and

sellers. Some common PPA types include:

- **Pay-as-produced.** The off-taker buys whatever volumes are produced. Additional volumes to match their load would have to be procured from the market and excess volumes would have to be sold in the market. Such contracts remain widespread and are also the preferred choice of sellers without trading capabilities.
- **Baseload.** The volume to be delivered to the off-taker is determined in advance and is independent from the actual production. The seller is then responsible for procuring in the market any further volumes that may be needed to meet the required profile. Baseload PPAs would normally be priced at a premium to pay-as-produced PPAs, because the shaping risk would be managed on the seller's side.
- **Physical.** There is physical delivery of the contracted electricity – usually on the wholesale market – to the buyer's supplier if the buyer is a consumer.
- **Virtual.** This is a financial contract where there is no actual physical exchange of electricity, however GoOs are usually transferred to the buyer. Virtual PPAs are essentially a contract for difference where the seller and the buyer agree on a strike price. The buyer pays the difference when the market price is below the strike price and the seller pays the difference when the market price is above the strike price.
- **Cross-border.** This is not a different contract structure, but there is a cross-zonal element, that is to say the producer is located in one market zone, while the off-taker is in another. Usually, such contracts would take the form of virtual PPAs. Physical cross-border PPAs would require acquiring long-term cross-zonal transmission rights. Those are usually limited to one year ahead of delivery, which is a constraining factor on the growth of cross-border PPAs. However, it is likely that transmission rights with longer durations, of two to three years, will also become available.

### Key sticking points in PPA negotiations

As long-term contracts, PPAs usually involve complex and time-consuming negotiations. A number of commercial risks need to be allocated between the counterparties and managed by them or a third party acting on their behalf. Some common types of risks include:

- Price risk. For developers, the main risk is that the price of a contract will be below the Levelised Cost of Electricity, while for an off-taker, that it will be above the market price. Therefore, the objective is usually to strike a balance between these two concerns.
- Counterparty credit risk. This is the risk that a counterparty may default. The risk is greater in cases where credit ratings are weak or not available. When credit ratings are not available, for example in the small and medium enterprise segment, this could be a barrier to PPAs' growth. In such cases, public or private credit guarantees could be a valuable instrument to facilitate the conclusion of such long-term contracts.
- Volume risk. The risk stems from the variability of renewables output over a longer period of time. This may result in fewer GoOs being available to the buyer, or lower revenues to the seller, for instance in pay-as-produced PPAs.
- Shaping risk. Shaping risk refers to the intermittency of renewable energy generation in the short-term, as a result of which the production profile of the seller is likely to differ from the demand profile of the buyer. This discrepancy means that additional volumes would have to be procured from or sold in the market, exposing the party that has taken on that risk to spot market prices for the respective volumes.
- Balancing risk. This is the risk of exposure to imbalance prices resulting from an asset's forecast generation differing from its actual generation. With the costs of managing the system increasing, balancing costs are also going up to the extent that they could have a considerable impact on PPA deals.
- Regulatory risk. This concerns the risk of aspects of the regulatory regime changing while the contract is still in force. With the responses to the energy crisis, PPA counterparties saw this risk increase considerably.

Contractual standardisation could help to reduce negotiation time, such as the use of standard clauses, limiting the negotiation process to the commercial and project-related clauses only, and transaction costs, including reduced need for advisory services. The European Federation of Energy Traders, in cooperation with the Re-Source Platform, have developed one such template, free of charge and available in several languages,

which offers a sound legal framework, as well as flexibility, allowing users to tailor the contract to their needs.

#### GoOs as the essential proof of renewable content

GoOs are electronic certificates that attest to the renewable origin of the energy that has been produced. They are instruments that can be traded separately from the associated energy. GoOs are also an essential component of RES PPAs where they are sold together with the contracted electricity. They are the element that allows buyers to make sustainability claims.

For years, the prices of GoOs across Europe were low, between €0.30-€0.40. More recently, this situation has changed, with GoO prices shooting up to highs of €9-10/MWh. They have now dropped slightly to €6-7/MWh, but remain high.

While in the past their low and stable prices made them a financially marginal element of PPA deals, the importance of which came mainly from their role as a disclosure instrument, the more recent price increases and growing market volatility have made them more financially relevant.

Negotiations on GoOs clauses are becoming more complex, with GoOs being increasingly priced separately from the associated electricity. Merchant structures are emerging, with possibilities for periodic changes to the price and the use of price floors or caps.

#### Renewables need long-term price stabilisation and short-term optimisation

RES PPAs are commercial instruments. As such, they are part of the wholesale electricity market in the same way as over-the-counter forwards and futures, and spot market contracts, both for day-ahead and intraday periods. Due to their long-term tenure, they belong to the forward market timeframe, the purpose of which is to offer opportunities to hedge the risk of future changes to electricity prices.

Due to their intermittency, renewable energy assets also require short-term optimisation close to real time. The allocation of shaping and balancing risks is a matter of negotiation and capabilities. It can also be outsourced to a third-party. Using the services of skilled traders acting as intermediaries could help parties optimise resources and reduce costs. The alternative would be developing one's own trading capabilities.

Co-locating renewable energy assets

with battery storage or demand-response capabilities, where this is possible, is also an area of growing interest. The assets can be contracted under the same PPA, which would reduce cannibalisation effects and extend the revenue certainty to the respective flexible assets. At the same time, the buyer would benefit from continuous renewable energy supply.

Such contracts could also offer benefits to the grid. The growing volumes of intermittent renewable energy are posing considerable challenges for grid management and development. If balancing can be done at the individual contract level and in the same location, then that would contribute to reducing grid management costs.

#### We need more renewable PPAs for the climate and for business resilience

In summary, renewable PPAs are a commercial instrument for the offtake of renewable energy, supported by evidence of renewable energy origin in the form of GoOs. They allow for the consumer-led growth of renewable energy.

This helps to reduce the need for public financial support and decrease the costs of the energy transition. They make renewable energy projects possible by providing the long-term revenue stabilisation required by lenders, and offer buyers visibility on long-term energy costs and shields them from future price volatility.

We need more of them to accelerate the growth of renewable energy; the sheer volume of renewables growth that is required to reach Europe's climate target means that public financial support is unlikely to be sufficient, while market-based instruments and mechanisms help to reduce the costs of the transition.

We also need more of them to improve corporate and industrial buyers' competitiveness and resilience at a time when European businesses and industry have been severely impacted by the energy crisis of the past two years and global competitive pressures. ■

#### Author

Maria Popova is director for carbon neutrality and renewable electricity at the European Federation of Energy Traders, an association which represents more than 130 companies trading energy and environmental products across Europe. Maria has over 14 years of experience with European energy and climate policy and regulation and is currently focusing on the market-based growth of renewable energy and low carbon technology.





# Tackling the solar skills shortage: experts from the US, Europe and the UK on best hiring and training practices

**Skills Shortage** | PV Tech Power Editors JP Casey and John Lubbock and Reporter George Heynes caught up with several experts to talk about the skills shortage in the solar industry in the UK and abroad and how this growing industry is approaching the issue.



*Credit: Ricardo Gomez Angel via Unsplash*

**W**ith national governments setting increasingly ambitious solar power generation targets, private companies more eager than ever to invest in the sector and think tanks around the world forecasting greater solar power production over the coming years, there is much to be optimistic about in the global solar sector.

However, the shift in the global energy mix from one reliant on fossil fuels to one driven by renewables, and solar in particular, will require many aspects of this industry to change, and in short periods of time. One form of pressure on the global solar supply chain is in recruitment and training, with the world's

demands for clean power changing faster than the years-long processes such as the education of a student to university level, the latter will have to change to meet new employment demands.

Each new forecast about employment in the solar sector, therefore, brings challenges as well as opportunities. SolarPower Europe, for instance, reported that in 2020, the European solar sector created 357,000 jobs, up from 81,000 in 2016. The industry body expects this figure to more than double to 742,000 by the end of the decade, and adequately educating and training nearly 400,000 people in the solar power sector will be no mean feat.

## Workers installing a solar panel

This phenomenon is apparent all over the solar sector, from research to installation, and all over the world. Earlier this year, the US Solar Energy Industries Association estimated solar manufacturing jobs in the US alone to triple over the next decade, mirroring the trend in European solar power, and raising questions as to how these positions will be filled.

PV Tech Power speaks with a number of experts from the global solar industry about how their particular sub-sectors, and jurisdictions, are aiming to tackle these challenges.

Aaron Brickman, senior principal of the US programme at think tank RMI,

speaks on the opportunities in US solar following the passage of the Inflation Reduction Act; Arthur Daemers, policy advisor at SolarPower Europe, discusses the impacts of shifting solar demand on individual European countries; and Gareth Simkins and Gemma Grimes, senior communications adviser and director of policy and delivery, respectively, at Solar Energy UK, explore a number of initiatives in the UK to overcome these obstacles.

### Do you believe there has been a skills shortage in your sector within the past 10 years?



**Aaron Brickman**  
Senior principal at RMI  
*Credit: RMI*

In solar, there are just not enough workers, and there are not enough trained workers. Who's going to be doing the research and development? Who's going to be doing the testing and all those interesting things? And then who's going to be installing all the solar and [performing] whatever limited maintenance [is necessary]?

The solar workforce needs are growing enormously. The projections for that necessary workforce have ballooned, and yet these aren't unskilled jobs. There does need to be a strategy, and in lieu of a national strategy, which the US typically doesn't have in the labour market, it's up to states and metropolitan areas to figure this all out.

There's going to be a tonne of investment, new entrants, existing entrants, expanding capacity, [the] opening [of] new facilities, and then our workforce needs. If you're hovering over the scene, you're trying to figure out, well, 'what does this mean?' 'How would a place approach this?'



**Arthur Daemers**  
Policy adviser at Solar Power Europe  
*Credit: SolarPower Europe*

There has been a skills and workforce shortage in our sector, and it risks increasingly impacting the market.

The sector has been feeling pressure at the end of the value chain, at installations. The number one reason for citizens across the continent waiting months – or over a year – for their rooftop solar systems is a lack of installers and electricians. Last year, for example, the German

Solar Association recorded almost 17,000 vacancies for 'construction electricians', who are key workers for solar. We need to attract workers fast, to ensure they do not become regular bottlenecks for deployment.

On the other hand, we also face risks related to the quality of installations. Here it is really about skills more than numbers. Workers installing solar at the moment can be from several professions, depending on the availability of workers, national legislation or choice of the company.

Because those are not necessarily specialists, project developers and asset managers are warning of quality and security issues, which in turn can hurt the reputation of solar. Quality training and high standards of installation are critical to the future of solar. Quantity and quality are two equally key challenges.



**Gareth Simkins**  
Senior communications adviser at Solar Energy UK  
*Credit: Gareth Simkins*

It is certainly a challenge to find suitably qualified people for roles in the UK solar industry at the moment. The skills agenda ranks with the difficulty in securing grid connections as the biggest brakes on the sector's growth.

The situation has had obvious consequences. The lack of personnel, combined with Covid-related supply chain hiccups contributed to long waiting times for residential installations last summer. Solar Energy UK anticipates that the industry will support around 60,000 jobs in 2035, up from around 7,000 in 2020. Action is needed to fulfil this potential. Without it, the skills challenge will become ever more acute, restricting the pace of installation and raising prices as demand rises ever upwards. The situation clearly cannot be allowed to continue.

That is why addressing it is one of the key priorities for the government-industry Solar Taskforce, which first convened in May. The taskforce's skills sub-group will identify the skills and training needed for the solar industry's future workforce, looking at both the short and long terms. The taskforce is expected to deliver its conclusions in February 2024, setting out a roadmap for reaching the UK government's 70GW capacity target by 2035.

### What is the current climate for hiring new graduates to join the solar sector?

**AB:** I think there's a strong need to develop multiple pipelines, not just one. You're looking at ensuring that folks know there are different career paths. There's also a generational battle against legacy sort of mindsets around what manufacturing is, and means, in the US. People have a mental image of manufacturing that no longer meshes with the reality of advanced manufacturing in this country.

And there's this, of course, systemic thinking that college is important, and, of course, it is, for so many people. But there are [a variety of] paths to a family-sustaining wage, a good career, good benefits in an industry that is projecting growth for the foreseeable future.

I think it's fair to say [that] apprenticeship is not new in the US, but it's not well understood, in contrast with several European models, [such as] the Swiss or Austrian or German models. Apprenticeship in the US, particularly straight out of high school, is not a commonly-discussed career path. I think that's also part of the equation, and that's also where policy and industry and workforce development and planning and economic development come together around changing mindsets around what this is and what it can be.

**AD:** The current climate for hiring new recruits is relatively tense. In the energy, digital and engineering sectors, there is fierce competition to attract the most qualified professionals.

[This is true] amongst energy and installation companies, but also with the rest of the digital world, including telecoms. We see this as a sign of a fast-growing sector that is eager to hire the best project developers and engaging in a race against all other sectors.

One key consideration is the diversity of legal frameworks for training solar installers in various EU member states. In Germany, after two weeks of training, you can carry out the basic work of rooftop installations, without being able to handle electricity. In Ireland, any worker involved with a solar installation needs four years of state-recognised education.

There is probably a middle ground to be found here. On one hand, we may



look at the German system and think it is fast, but not without risk. On the other hand, the Irish system requires you to go through very generic and long electrical training, which in some cases is probably surplus to requirements. We may want to have standardised re-training schemes that allow you to utilise pre-existing skills and micro-credentials and teach you specifically the skills that you lack for solar installation.



**Gemma Grimes**  
Director of Policy & Delivery  
at Solar Energy UK  
*Credit: Solar Energy UK*

Skills will be a new focus for this year's Solar & Storage Live, with the introduction of the recruitment zone, sponsored by SSE Energy Solutions and run by Solar Energy UK. This will allow hiring businesses to promote their vacancies [and] recruit candidates directly from primarily Midlands region organisations, including dozens of colleges, universities and job centres.

High-calibre talent can also be hired via specialists such as Totaljobs and Mission Renewables. Furthermore, visitors will be able to join high-level conversations about workforce development within the industry.

**What are the key considerations when retraining professionals to work within the solar sector? Are there examples of collaborative projects that have been effective in this area?**

**AB:** RMI is leading work in the Great Lakes around helping seven Great Lakes states to determine clean tech sectors that make the most sense for regional competitiveness. And as part of that work, we've extensively looked at existing industrial capacity and existing skills capacity, and that has helped us narrow down the sectors in those states, where we think there's the greatest likelihood for cluster development and business attraction for job creation.

We know that places can figure out what skills they have, and from that an understanding, [of] what job sets are taking place and what skills their workers have in large numbers, and how that information can then be applied to other existing industries, and attracting new industries. That is playing out in solar.

Offshore oil and gas to offshore wind

is one of the easier transferable skill sets; not every position, not every role, not every person, but it's one of the easier skill sets to think about in terms of that transferability. It's not always as simple obviously; semiconductors and solar have some commonality [and] certain clean manufacturing processes certainly have commonality. But there's always going to be certain training necessary, specific to a manufacturer, specific to that company and then specific to that industry.

**AD:** For the blue-collar workers, the challenge is different, and potentially more difficult. There is not necessarily an intuitive overlap between coal mining and climbing on a rooftop, place modules and connect an electrical system. This will require reskilling to overcome. We already see successful communication campaigns in this area, like the one Enpal is running. The German solar company is attracting workers from even non-traditional backgrounds, like hospitality or food delivery, to retrain and join them as solar installers.

Skills projects like this benefit national decarbonisation efforts and support the just transition and social cohesion. So there could be a role for governments to help replicate that best practice, and cover the additional costs of training new hires, or retraining from declining industries.

**Rooftop installation**



*Credit: Bill Mead via Unsplash*

**GG:** Participants [in the UK Solar Taskforce] include British Solar Renewables, the Energy and Utility Skills Partnership, the Institute for Apprenticeships and Technical Education, Octopus, South Thames College, the National Open College Network, the Electrical Contractors' Association and the Institute of Environmental Management and Assessment, to name a few.

Key aims are to maintain and improve the quality of installations as the sector scales up, improving diversity and ensuring that young people, those changing career and those returning to the jobs market are aware of employment and training opportunities in solar energy and the skills needed for it.

Even before the Solar Taskforce was agreed, Solar Energy UK was working with the Mayor of London and MCS on the Solar Skills London project. This involved going into schools to deliver talks on the jobs available in solar, and encouraging young people into 'bootcamp' courses to prepare them for apprenticeships. MCS is now managing the scheme.

Meanwhile, the Green Skills Academy, launched in Manchester earlier this year, trains people to install PV, heat pumps [and] EV charging. A number of similar institutions and courses have also popped up lately, a clear indication of the demand for such skills.

## What is hiring and training going to look like in 2030 for the solar sector? What innovative methods do you believe will be introduced?

**AB:** I think what we need to see is much more methodical coordination and collaboration in states and metros that pull together the non-college workforce development and training, university- and college-level training and policies at the governmental level that incentivise those things, to not just make those locations attractive for investors, but to play in and play well with the Inflation Reduction Act.

When these announcements have turned into investments – so an announcement of committed capital versus turning Earth and readying a site versus finalising the investment and hiring people and then understanding what the production capacity is, what the manufacturing capacity is – a solid trackable data set that's as close to real time as possible would be, I think, really important.

**AD:** This requires numerous reforms and efforts, among which two are particularly urgent. First, education systems must adapt to this reality. Climbing on rooftops and installing solar systems is a job of the future. Schools must integrate this and communicate this to students. Vocational [and] technical education must be encouraged from a young age everywhere.

Electricians are already high in demand, and we will need more. Why are we not pushing students to go in this direction? This [affects] communication, but also resources, language used in classrooms and overall appreciation for those branches.

The second would be a recognition of 'DC electricians' as a new profession in Europe. Rather than asking for electricians to carry out the entire work, we may want to train specialists in less than five years, to undertake work that would take some load off the electricians. They would have a faster training, using modular apprenticeships. Recognising their micro-credentials and overall skills acquired via different experiences and retraining them to become DC electricians efficiently may be the way to go. Then, hopefully, this kind of model can be replicated and harmonised across Europe, allowing movement and synergies.

Gemma Grimes, on the UK: I think the main problem is that people aren't aware of the potential jobs in the sector, and

we as government and industry aren't pro-actively promoting the sector in a joined-up way, or as much as we could be.

## How can legislation make a difference on solar project development? Has this translated to any particularly impactful initiatives?

**AB:** An economic development organisation is an entity trying to build out an industrial cluster we want. We are doing these things related to solar or directly related to solar, and because we have strengths there, we know that we can attract more businesses, we're talking to these businesses [and] some of them are already committing.

That means that's a location that can feel pretty positive that investments by their workforce development, board or organisation, or investments by government, or passing new laws to incentivise training programmes or similar, would be money well spent.

If you don't make the investments, then you'll be less attractive to potential investors, new entries, or if you don't make the investments, you could be in a healthy situation now, but with workforce needs and what they're going to be, you could be much less attractive later, or worse. What's worse is when you position your location as having assets that can be directly attributable and beneficial to potential new entrants in an industry like solar, and then not meeting those expectations.

**AD:** There are multiple initiatives already helping companies recruit solar workers and train them. The way forward may now be to spread good practices around the continent and harmonise the legislation.

At SolarPower Europe, we've launched the #SolarWorks platform. It's a one-stop-shop for potential solar workers to find job vacancies, or training to attain the jobs they seek. We even run a #SolarWorks TikTok account aimed at the next generation of solar workers.

We will need 1.5 million workers by 2030. That is to reach our target of 1TW installed solar in the EU. Currently, 79% of jobs are associated with the deployment of solar, as opposed to building or recycling them, for instance. Out of those deployment jobs, 76% are associated with rooftop solar. This tells us that there needs to be a clear focus on hiring and training vast numbers of people into rooftop installation jobs.

## Are there examples of projects and initiatives on the state level in the US, or on the level of individual countries in Europe, that have been particularly significant?

**AB:** Think about it in terms of viewing the intersection of industry – existing and future industry – new entrants, economic development organisations, workforce development organisations and government and policy. How those different elements can be coordinated around understanding what's there now, and what's coming; it is so important to understand what the workforce they're going to need is, not the workforce they need today, but the workforce that they're going to need.

Training programmes, apprenticeship programmes – the Inflation Reduction Act incentivises apprenticeship – [are all] part of the stacking, in terms of tax incentives and other incentives that can be brought to bear.

**AD:** On the European level, we're leading the Renewable Energy Skills Partnership, with the backing of the European Commission. It's a platform where renewable industries get together and share good practices and challenges in this field. Together, we have the opportunity to launch an EU-funded project aimed at developing training materials to be disseminated across the continent.

If European training providers are willing to join us on this journey, we could successfully tackle both the quantity and the quality challenges within the next three to four years.

Generation Spain is a wonderful example of an NGO in Spain giving opportunities to unemployed, or transferring professionals into solar. They help them get internships or apprenticeships, which turn into long-term jobs.

We also follow closely the German start-up initiative 'Ohne Hände keine Wende' (paraphrased: 'no industry transition without workers'). They are developing a training platform for solar and heat pump workers via modules. It is a very flexible and quick method allowing for recognition of micro-credentials from other experiences. People would only take up the modules allowing them to learn their missing skills.



# STORAGE & SMART POWER



## 80 NEWS

### 82-85 What You Need to Know About the IRA and Tax Equity

The Inflation Reduction Act brought a sense of confidence and certainty to the business of clean energy. Lawyers Adam Schurle and Morten Lund at Foley Lardner take a closer look at what that means for tax equity financing of energy storage, while exploring some of the questions still to be answered.

### 86-87 A Year on From the IRA: A Lawyer's View From Past to Future

Andy Colthorpe speaks with John Leonti, head of the energy transactional practice at law firm Troutman Pepper, who reflects on the year since the Inflation Reduction Act (IRA) passed, and considers what we might see going forward.

### 88-93 Optimisation of Energy Storage Assets in the US' Leading Markets

As the US energy storage market continues its phenomenal growth trajectory, the role batteries can play in keeping the grid stable has been highlighted by recent heatwaves. These are also a good case study for figuring out the value of storage in dollar terms, writes Wayne Muncaster of GridBeyond. p.87

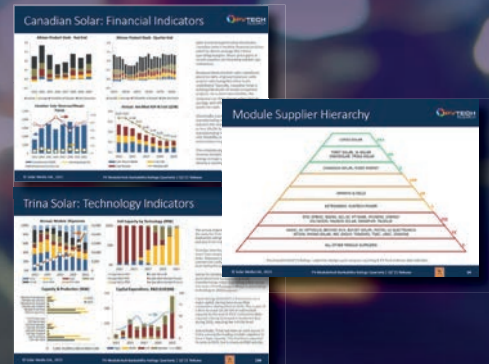
### 95-96 Mitigating Energy Storage's Unique Natural Catastrophe Risk With Insurance

Ross Kiddie of bespoke battery insurance company Altelium on the specific requirements for natural catastrophe (nat cat) planning and risk assessment for battery energy storage systems.

## The industry's most trusted PV module supplier bankability rankings – quarterly-updated analysis from PV Tech Research

The report provides everything you need to benchmark all your existing/potential suppliers against each other in terms of bankability, limit your supplier short-lists to only the most financially stable, risk-averse companies and help you avoid the near-bankrupt entities claiming to be “Tier 1 suppliers”.

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# Introduction



Welcome to another edition of 'Storage & Smart Power', brought to you by Energy-Storage.news. What a year it has been since the passing of the Inflation Reduction Act brought along a wave of optimism, excitement and policy certainty to the US energy transition.

It brought in the investment tax credit (ITC) for standalone storage that so many good people in the industry – some of whom may well be reading this edition of PV Tech Power – had campaigned for so tirelessly for the best part of a decade.

That was perhaps the standout for those in the energy storage part of the clean energy industry, but in many ways the IRA's package of investment stimulus brought more than had even been hoped for.

Those waves of good feeling have created ripples throughout the international conversation, leading other governments around the world to watch closely and plan their own moves.

We're looking forward to seeing evidence of these sea changes in the market firsthand at RE+ in Las Vegas. It's a show we've attended for a long time now, and covered with great interest.

It's not only the US where energy storage has become, or is becoming, a vital tool in the energy system toolkit. In the next couple of months, our publisher Solar Media will be hosting the second Energy Storage Summit Latin America and the first-ever Energy Storage Summit Central and Eastern Europe, carrying on our Summit series which has been such a success in Texas and London.

In this edition, you can read about the Inflation Reduction Act from the perspective of lawyers and experts at Foley Lardner and Troutman Pepper. Foley Lardner's Adam Schurle and Morten Lund bring you their in-depth take on 'What you need to know about the IRA and tax equity', while in my interview with Troutman Pepper's John Leonti, we discuss what the first year of the IRA has meant for energy storage, and what it means for the future.

One of the most exciting aspects of the industry today is how the versatility of battery storage technology is being freed from legacy regulatory structures to deliver multiple services. In a technical paper from energy storage optimisation specialist GridBeyond's North America head Wayne Muncaster, we learn about how that versatility, that value, is already being delivered into the US' leading markets in California and Texas.

Away from the Inflation Reduction Act, but still a highly relevant topic to the US – as well as to the international industry – is the role insurance plays in mitigating the risk of natural catastrophes. Ross Kiddie from specialist battery insurtech group Altelium offers some eye-opening insights.

Of course, for all the positive actions being taken, it should never escape our attention that they have been taken due to the climate crisis engulfing us all. That hasn't changed, but at least it seems the industry's capability to do something about it is finally being unshackled, in the US and elsewhere.

Hopefully the articles in this edition can make their own small contribution to those efforts and you enjoy reading them.

**Andy Colthorpe**

Editor

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Credit: Recurrent Energy.

## California passes 5GW of grid-scale battery storage

California has passed 5GW of grid-scale battery storage, grid operator CAISO has revealed. The state has long been a leader for BESS deployments, with an ambitious renewable energy goal of 90% by 2030 and the Resource Adequacy framework enabling long-term remuneration of large-scale BESS projects providing certainty for investments. As of early July 2023, the state had 5.6GW of grid-scale connected BESS online. The year started off quietly for the state, however, with CAISO's official figures showing virtually no large-scale projects coming online in the first quarter. In its place, the ERCOT, Texas market, led the charge, accounting for 70% of nationwide deployments in the first three months of the year.

## 'World-first' grid-scale sodium-ion battery project in China launched

A BESS project using sodium-ion technology has been launched in Qingdao, China. The demonstration project of 5MW/10MWh was officialised in July with a definitive agreement between project partners Great Power, a battery technology company, Qingdao Beian Holdings and Noan Technology Co. It is located in Qingdao North Coast Data Center (QNCDC), in the north-eastern town. It is the first application of sodium-ion batteries in new energy storage and new infrastructure of big data centres, the companies claimed. It will improve QNCDC's energy efficiency and support the further construction of more green data centre infrastructure when it goes into operation.

## Moss Landing: World's biggest battery storage project is now 3GWh capacity

Vistra Energy has announced the completion of work to expand its Moss Landing Energy Storage Facility in California, the world's largest lithium battery storage asset. The Phase III expansion achieved the start of commercial operations near the beginning of June. An additional 350MW output and 1,400MWh energy capacity has been added to the plant, bringing it to a total 750MW/3,000MWh. This comes after the 300MW/1,200MWh Phase I was completed in 2020, followed by the addition of another 100MW/400MWh in Phase II the following year. As with the first two phases, offtaker of the new batteries will be California investor-owned utility (IOU) Pacific Gas & Electric (PG&E).

**The 1,400MWh Crimson Energy Storage project in California, the largest BESS to come online last year anywhere in the world.**

## New South Wales planning approvals for 270MW BESS in Renewable Energy Zones

The government of New South Wales (NSW) has granted planning approval for two large-scale BESS projects in the Australian state's Renewable Energy Zones (REZ). The new BESS projects, one of 120MW output and the other of 150MW, will help 'future-proof' energy supplies and enable REZ developments to function as modern day equivalents to centralised power plants, the government said. Renewable Energy Zones are large areas of land zoned specifically to host a mixture of large-scale renewable energy generation sources, enabling the transition away from dependence on fossil fuels, while also bringing investment into regional economies.

## 'Spain could eliminate economic curtailment' with 15GW of long-duration energy storage

More than 5% of Spain's renewable energy generation could face economic curtailment between 2025 and 2030, but long-duration energy storage (LDES) could reduce or eliminate that need, according to Aurora Energy Research. Spain wants renewables to account for 81% of total electricity generation by 2030, almost double the already high share of 42% it recorded in 2022. That means an increase of 173% in installed renewables capacity between 2022 and 2030. Long-duration storage, defined as technologies with a storage and discharge duration of between eight hours to four days, could be a 'vital' solution to enabling the race to net zero while reducing power system costs and curtailment alike, according to Aurora.

## Grid-scale battery boom as US quarterly installs go up 32%

The US saw roughly triple the amount of grid-scale battery storage installed in the second quarter of 2023 as it did in the preceding quarter, in megawatt terms according to the American Clean Power Association (ACP) trade group. ACP said 1,510MW of large-scale BESS deployments were made in Q2 2023. Figures published earlier this year by research group Wood Mackenzie Power & Renewables – in association with ACP – showed 554MW grid-scale installs in Q1, while in Q4 2022, the number was 848MW. ACP said the 1,510MW of new battery storage output corresponded to 5,098MWh of energy storage capacity, implying a continued growth in storage durations.



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# What you need to know about the IRA and tax equity

**Energy Storage Finance in the US** | The Inflation Reduction Act brought a sense of confidence and certainty to the business of clean energy. Lawyers Adam Schurle and Morten Lund at Foley Lardner take a closer look at what that means for tax equity financing of energy storage, while exploring some of the questions still to be answered.

**T**he Inflation Reduction Act of 2022 (IRA), enacted in August 2022, had the potential to flip on its head the manner in which solar and battery energy storage system (BESS) projects were developed and financed, in particular how tax equity financing is utilised in the industry.

Now that we're a year removed from passage of the IRA, it's a good time to revisit whether some of the predictions, hopes, and fears attendant to tax equity financing and the IRA have been realised.

## Double-edged sword

The investment tax credit (ITC) is a one-time US federal income tax credit based on the cost basis of certain eligible property, including solar energy systems and BESS. As a general rule, the ITC is claimed by the owner of the property for the taxable year in which the property is placed in service. Prior to enactment of the IRA, the ITC for solar energy systems was subject to a phase-down from 30% of eligible basis to 10% over the course of several years, and standalone BESS was not eligible for the ITC.

Solar projects and BESS also benefit from bonus depreciation. The owner of a project placed in service in 2023 is permitted to deduct 80% of the cost (after reduction for one-half of the ITC) currently, rather than over five to 12 years. Bonus depreciation is set to phase down over the next few years, but it still offers a significant financing enticement.

The ITC has always been something of a double-edged sword. On the one hand, the ITC has without a doubt been the most significant financial incentive for solar energy in the US and has attracted immense amounts of capital investment to the solar energy industry. On the other hand, the nature of the ITC as a tax credit has excluded many funding sources and



Credit: The White House

introduced potentially detrimental artificial incentives to the industry.

Between the ITC and depreciation, the tax incentives have always been too big to ignore. The basic 30% ITC, plus bonus depreciation returning almost 20% of project costs as immediate deductions, means that roughly half of the project value lies in tax benefits. Building a project without considering the ITC is not a viable strategy. At the same time, the ITC and the depreciation together create a tax benefit so large that it is essentially impossible for a project to generate enough taxable income to fully utilise its own tax benefits.

## Nothing is certain, except taxes

To utilise the ITC, a significant amount of income subject to US Federal income tax is required, and the claimant generally must be a US taxpayer. Except under unique circumstances, the 'US taxpayer' requirement excludes many potential investors and customers: foreign companies, govern-

**President Biden signed the Inflation Reduction Act on 16 August 2022.**

ment entities, and tax-exempt entities – including most universities, schools, and hospitals. Due to other (more complex) requirements, individuals are in most cases also excluded from claiming the ITC.

Prior to the IRA, the ITC was not transferable. Depreciation is not transferable. As a result, and because project developers typically can't absorb all of the tax benefits themselves, outside financing is generally required to realise the value of the ITC and depreciation.

The structures used to monetise the ITC are complex. The most common are partnership flip and sale-leaseback structures; some tax equity participants use inverted lease structures, but those are less common. These complex structures come with high transaction costs. Transaction costs for a single tax equity financing frequently exceed a million dollars. Even for a simplified and streamlined transaction, the total transaction cost will almost certainly exceed US\$250,000.



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### Solar and storage markets shaped by tax credits

These requirements combine to create a set of circumstances where there is a fairly small pool of possible ITC investors. In practice, most tax equity investors are banks and insurance companies.

This has impacted the shape of the solar energy industry in the US. Third-party ownership structures are common. Small commercial projects (less than ~300kW) are very difficult to finance, and therefore are quite rare. Generally speaking, larger projects are favoured. Bundled financings are favoured – combining multiple projects into single financings. This effectively requires a developer to have multiple projects ready for financing in the same year, which can be difficult for smaller developers.

Solar has to be structured and financed separately from other assets, even if part of a larger project. This complicates and discourages including solar as part of general developments. Most large solar manufacturers are generally unable to own projects, as most are not US companies and do not have significant US taxable income. This removes vendor finance as an option for manufacturers to encourage

**Prior to the act, energy storage would only be eligible for the ITC if sited with, and charged from, solar.**

adoption of their products, which in turn makes it more difficult for new competitors to enter the US market.

For energy storage, the impacts have been more severe. Pre-IRA, BESS were not eligible for the ITC on a standalone basis. Instead, BESS were eligible for the ITC only if they were paired with other ITC eligible electricity producing property, such as a solar energy system. There were also significant limitations on how the BESS could be used. In order to qualify for the full ITC, under what are known as the dual use equipment rules, BESS had to be charged only by the associated solar energy system or other ITC eligible property through at least the first five years after the BESS was placed in service.

Any charging from the grid or other ineligible property, and the ITC was subject to reduction; and if the total energy input for the BESS from non-ITC eligible property was greater than 25% then no ITC was permitted with respect to the BESS.

These restrictions made standalone BESS much less attractive, and most storage systems installed pre-IRA were part of hybrid systems – i.e. combined solar and storage projects, or wind and storage projects. BESS within hybrid

systems are inherently limited in functionality, and do not utilise the full potential of the storage technology.

The IRA significantly changed this landscape, for both solar and storage. The full ITC rate was reinstated to 30%, and standalone BESS were added to the list of facilities that are eligible for the ITC, meaning that BESS now no longer need to be paired with other ITC-eligible generating property. The IRA extended the window for ITC eligibility for projects that begin construction no later than 2033, and possibly longer.

The IRA also introduced several ITC adders, such as a 10% adder for facilities located in certain 'energy communities', a 10% adder for facilities that satisfy certain 'domestic content' requirements, and a 10-20% adder for wind and solar (and associated BESS) facilities located in certain low-income communities, that collectively have the potential to increase the ITC to 70% of the eligible basis of a facility.

In addition to the extension, the IRA added new eligibility requirements. On a going-forward basis, any facility that is over 1MWac must satisfy certain prevailing wage and apprenticeship requirements (although projects on which construc-



tion began before January 29, 2023, will be exempt from these requirements). These prevailing wage and apprenticeship requirements generally require that in the construction, repair, or alteration of a facility the taxpayer, contractors, and subcontractors must pay wages at local prevailing wage rates published by the US Department of Labor and a certain percentage threshold of such work must be performed by qualified apprentices.

If an otherwise eligible facility is subject to but does not satisfy these prevailing wage and apprenticeship requirements, the credit rate for the facility drops to 6%, rather than 30%. Further, for projects placed in service beginning in 2025 that didn't begin construction before then, a new rule will require that those projects have an anticipated greenhouse gas emissions rate of not greater than zero.

The IRA also made solar facilities eligible for the production tax credit (PTC), which is a tax credit available to the owner of a facility based on electricity produced by the facility for a 10-year period beginning when the facility is placed in service. The statutory rate for the PTC for new facilities in 2023 is 2.75 cents per kWh, and is subject to inflationary adjustments. As with the ITC, going forward a taxpayer generally must satisfy the prevailing wage and apprenticeship requirements to claim the full PTC, and similar rules apply with respect to greenhouse gas emissions rates beginning in 2025. The PTC was likewise extended through at least 2033.

### Transferability, direct pay options

Aside from the extensions to the ITC and PTC, new eligibility requirements, and adders described above, the more significant two other changes had the potential to reshape how solar facilities and BESS were financed.

For the first time ITCs, PTCs, and other renewable energy credits can now be sold to taxpayers on the open market.

Second, tax-exempt entities, including many universities and hospitals, state and local governments, and tax-exempt organizations, are now entitled to claim direct cash payments from the US government for the tax credits they otherwise would have been eligible to claim (but could not use due to their tax-exempt status).

These changes – transferability and direct cash payment, respectively – left some within the renewable energy industry hoping (and others concerned) that we would soon see a day when the complex-

ity of tax equity financing would be no more. One year on, it is clear that neither those hopes (nor the fears) have been fully realised.

There have been some changes. We have seen interest in tax credit transfers, and some transactions have already been signed up. Many direct pay transactions involving tax-exempt entities building solar and BESS projects that they will own are in the works, and more are expected as more such entities dip their toes into renewable energy investing.

### Third-party tax equity financing here to stay

What we have not seen is any movement towards abandoning third-party tax equity financing. There are two principal reasons for this. First, a tax credit transfer is itself a form of tax equity financing. While these transactions have the potential to be less complex and costly than other tax equity financings, they still add significant complexity and cost to the project.

Moreover, the tax credit purchaser is subject to the same qualification requirements and general limitations as any tax equity investor, so the pool of eligible investors has not grown, although there will certainly be some tax credit buyers that would not be willing to participate in traditional tax equity. Taxpayers without experience in traditional tax equity might be hesitant to make the leap to buying credits. This reluctance could be eased by third-party brokers of tax credit purchases, which the transferability guidance expressly permits, but that is a nascent marketplace at this time.

Second, and more significantly, only the tax credits themselves – the ITC and the PTC – are transferable. The depreciation benefits cannot be sold. With a potential value of roughly 20% of project cost, this by itself is often enough to justify a full-on tax equity financing. While smaller projects may elect to forgo the deprecia-

tion benefits (because owners don't have taxable income to utilise depreciation), this is not a realistic option for larger projects. A similar effect is in place for tax-exempt entities: the direct pay option only applies to the ITC. Depreciation benefits are forever lost if a tax-exempt entity is the tax owner of the project.

It is perhaps not surprising that what we are seeing so far is analogous to what happened during the Section 1603 cash grant programme in the wake of the 2008-2009 economic crisis. Then, as now, some small projects took the cash grant and used what they could of the depreciation without outside finance. But for larger projects (and larger bundles), tax equity financing was still an easy choice. This effect may become more pronounced as bonus depreciation phases down, but tax equity financing will continue so long as there is any additional value to be extracted.

On the storage side, the story is similar, but for different reasons. An ITC for energy storage (without solar) removed a major hurdle to widespread adoption of standalone storage projects. Other hurdles remain, however.

There are significant regulatory hurdles to standalone storage in many states, and there are only a few states with active markets for energy storage services. It is therefore no surprise that we have seen a substantial increase in standalone projects in states where standalone storage was already growing (principally California and Texas), but no apparent impact in jurisdictions where other obstacles remain.

This is where we are, and where we expect we will remain. Some projects are now financeable that were not before the IRA. Other projects can now choose to forgo outside tax equity financing. But the era of complex tax equity financings is not over. On the contrary, the IRA all but guarantees that tax equity financings will continue for at least another decade. ■

### Authors

Morten Lund is Of Counsel at Foley & Lardner LLP's San Diego office, and a member of the firm's Energy section. For more than 25 years, Morten has advised developers, lenders, investors, and other project participants. Morten has a particular focus on solar energy and energy storage projects, but Morten's wide range of project experience also includes wind energy projects, combustion generator projects, nuclear energy facilities, hydroelectric facilities, cogeneration facilities, chemical facilities, forestry/paper facilities, large aircraft, and shipping fleets.



Adam Schurle is a Milwaukee-based partner in Foley's Tax Practice Group. Schurle counsels clients on a wide variety of federal and state tax matters. A significant portion of his practice is focused on tax advice for developers and financial institutions in wind, solar, hydroelectric, biomass, and other renewable energy finance transactions. He helps these clients qualify for federal, state, and local tax incentives and implement transaction structures that maximise the value of those incentives.



# A year on from the IRA: A lawyer's view from past to future

**Inflation Reduction Act** | PV Tech Power Editor Andy Colthorpe speaks with John Leonti, head of the energy transactional practice at law firm Troutman Pepper, who reflects on the year since the Inflation Reduction Act (IRA) passed, and considers what we might see going forward.

John Leonti has represented sponsors and investors in the energy sector for over a decade, and says “probably 99%” of his time these days is spent working on solar, wind and battery storage deals. His and Troutman Pepper’s track record includes “helping some of the utilities craft their first power purchase agreements, tolling agreements in respect of standalone batteries”.

“We’ve really seen the space grow up, it’s been exciting to watch and learn, and see how these transactions are going to be transformative for the US power grid.

This Q&A can be read as an accompaniment to our contributed article from lawyers Adam Schurle and Morten Lund from Foley Lardner, also in this edition of ‘Storage & Smart Power’.

Leonti says Troutman Pepper is “very excited” about the IRA, especially the inclusion of the investment tax credit (ITC) for standalone energy storage. It’s “a game changer for the industry and how we’re going to be able to build out this technology in the space,” Leonti tells Andy Colthorpe.

## What has the impact been of the IRA in the year since its passing?

The first thing that we really noticed was the influx of new entrants into the market. Most folks outside the US, a lot of European, whether private equity, infrastructure, or utilities, conglomerates really moved into the US pretty quickly after the passage of the IRA.

That was certainly true in the battery space, whether that’s being an independent power producer (IPP) for batteries, or wanting to build a manufacturing plant for batteries. It felt like



Credit: QCELLS

almost overnight, we saw lots of new entrants into the market.

For batteries, you went from a market where there was no investment tax credit (ITC) available for standalone storage. It had to be co-located with solar. Then you went to a market now where standalone batteries are eligible for the ITC. So the excitement level went through the roof.

On top of that, you now have this transferability market where potentially you didn’t have to do a traditional third party tax equity transaction to finance your project, you could just sell your credits.

**Aerial view of the first grid-scale BESS acquired by international solar player QCELLS, a 190MW/380MWh project in Texas.**

One of the really interesting things that battery folks got excited about is that on the energy storage side, lots of battery IPPs would like to run their projects, either 100% merchant or on a quasi-merchant basis, which doesn’t lend itself well to traditional tax equity, because tax equity is conservative. There’s more demand and supply of tax equity in the United States and therefore, it allows them to be more conservative on the types of projects they finance.

So the transferability market is there, allowing battery IPPs to really open up the market, run the battery and



optimise the battery how they see fit in their market, whether it be the CAISO or ERCOT or otherwise, and not have to worry about getting what they view as contracted revenue that can potentially impact their returns. So the transferability market is really a helpful tool for battery players to play in the market and keep their projects less contracted than they otherwise would have to be to get traditional tax equity.

**Those are some really big changes. Of course, prior to its passing, for many years, the industry's biggest ask of government was for an ITC. But without transferability, it sounded at first as though financing might get complex and even a little expensive for some market participants.**

I think that's right, but maybe not even so much that it gets expensive. It was just, I think, how they (IPPs) built their business models and how they were going to run their battery plants may have to have shifted. If you have to get a long-term contract when you were looking at more short-term contracts and some merchant optimisation, it's just a different business model.

**I think we all saw that California raced into a leading position in the US grid-scale battery energy storage system (BESS) market with long-term contracts for resource adequacy (RA), but Texas is set to overtake, probably during 2023, based on merchant opportunities with few, if any, long-term contracts. Are the deals and transactions that come across your desk shifting more towards merchant revenue based projects, or are people still kind of looking where possible to limit their exposure to risk with long-term contracting where they can?**

In California, we're certainly seeing long-term contracts continuing to be executed, and that is what we're seeing in the market for standalone storage. For some co-located batteries, we're seeing different types of strategies. But for standalone storage, we are seeing most of those deals being [locked] up with long-term contracts, and it's great that that's available in that market.

In ERCOT, we're seeing a mix where battery sponsors, energy storage sponsors, are really trying to balance running their projects on a merchant basis with what will optimise their financing opportunities.

Because if you do have some contracts, you could potentially raise more debt,

you can maybe get a traditional tax equity player in there and so your economics may look better than on a fully merchant basis. So we are seeing a mixture there, but certainly in the portfolio deals that we're seeing, there's a large merchant component to these deals.

The other thing in ERCOT is, there's not a vast ability to contract your storage project. There's limited offtake opportunities right now that seem to be economically viable for battery sponsors. That's one area where I think the market needs to find a solution; if folks want to move to more of an offtake structure in ERCOT, what are those battery offtake contracts going to look like?

**In a recent report Troutman Pepper published, the firm offered up five trends for US energy storage investment post-IRA to watch out for. One of those was that despite the standalone storage ITC's introduction, solar-plus-storage will remain a popular asset class for development. Can you elaborate on that view?**

I think co-location of batteries, in particular with solar, is something that we will continue to see, particularly here out west. It seems to make sense. There's an offtake market for the battery, there's an offtake market for the solar, so we will continue to see solar-plus-energy storage projects being built. At this point, based on the deals that we're helping finance this year, when we're financing a solar project, I would say the split right now is 50:50, meaning that 50% of the projects are being built with batteries and 50% of projects are being built without batteries, and a lot of them are being driven by the location where they're being built. We're certainly seeing solar-plus-storage in California, as well as in ERCOT.

Generally speaking, folks are really interested in trying to see how they firm up renewables, and obviously energy storage can help with that. With the battery storage eligible for its own ITC, it doesn't have to be co-located with solar to get the ITC which was somewhat of a driver of some of that [solar-plus-storage development]. Previously the battery always needed to be charged from the solar in order to get the ITC for the first five years, you can do some grid charging, but more or less, you have to charge it from the solar facility.

So now that batteries has its own standalone ITC, you don't have to worry about that connection. Now the co-location just has to do again, with

optimising the grid, plus your solar facility. I would take that one step further: now with the Inflation Reduction Act and Federal Energy Regulatory Commission (FERC) efforts to reform grid interconnection, broader than just co-locating with solar, you can think about co-locating with wind, with existing gas generation. These incremental steps that are supporting the energy transition, are really benefiting batteries in ways that prior to the IRA were on the table, but the economics were more challenging.

**Another post-IRA investment trend Troutman Pepper identified is that the firm expects large institutional investors to back grid-scale BESS projects, with the inclusion of tax credit transferability having broadened the pool of companies that can benefit from tax credits. Attracting institutional investors has always been an aim of maturing clean energy markets. How do you see that playing out?**

We always had our traditional tax equity investors, basically the large US banks, and on the wind [industry] side, several insurance companies, and then several OEMs. That was kind of the market for tax equity, generally speaking.

Over the last several years, we've had a few large corporates, mostly on the tech side, come into the market to do traditional tax equity. Although the IRA passed just over a year ago, the proposed regulations for transferability rules just came out early this summer and the amount of folks who are non-banks and not large corporates, but are in the market to buy tax credits -- we're just constantly seeing new entrants, companies that have US tax capacity as a US tax liability, looking to buy tax credits. It will be and it is a massive sea change in the market.

You are going to see more availability of ways to monetise the tax credits. Whether it is a better economic deal than doing traditional tax equity, I think remains to be seen, because you are just transferring the tax credit and you're not transferring the depreciation. So there is some potential economic hit if the depreciation is stranded, and there's some other [potential] economics that are being left on the table. But the transferability market is a fantastic strategy to allow for projects to be built. It's great for the industry, and it allows for another tool that can be utilised by sponsors to get their projects built and help accelerate the energy transition. ■

# Optimisation of energy storage assets in the US' leading markets

**Battery Optimisation** | As the US energy storage market continues its phenomenal growth trajectory, the role batteries can play in keeping the grid stable has been highlighted by recent heatwaves. These are also a good case study for figuring out the value of storage in dollar terms, writes Wayne Muncaster of GridBeyond.

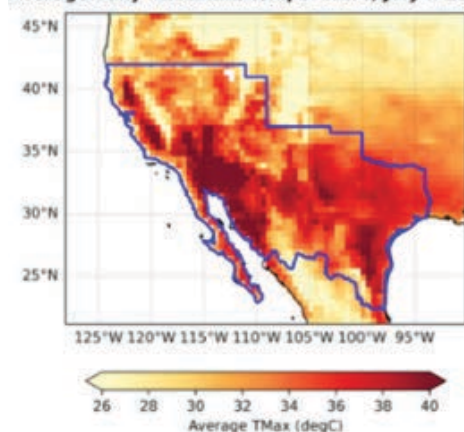
The recent heatwaves in Texas and California have highlighted the need for optimised market participation for battery storage, while delivering maximum value to clients and the grid. In this article, we will look at the evolution of CAISO (California Independent System Operator) battery dynamics and how these may be predictive for the ERCOT (Electric Reliability Council of Texas) market.

## Heatwaves sweep the States

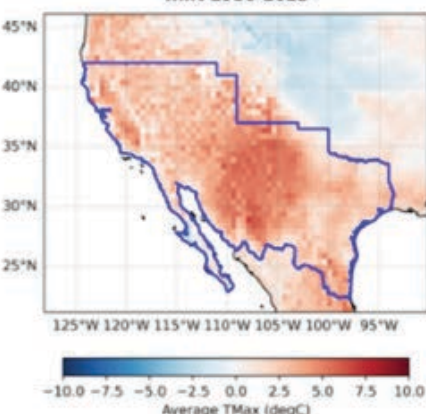
The period of June-July 2023 saw an unprecedented number of maximum load records broken in ERCOT (relative to the prior five years) as a result of the recent heat wave. Previously, ERCOT's record for hourly demand was 79,830MWh on 20 July, 2022, but, according to the latest data from the US government's Energy Information Administration (EIA), this record was broken every day from 26 June to 29 June of this year; the highest demand hour for each of those days was more than 80,000MWh.

Continued high temperatures drove new demand records on 12, 13 and 17 July. Those records were all topped on 18 July, when demand peaked at 82,579MWh in the 6:00 p.m. hour, central time (CT). Maximum temperatures were over 100°F in demand centres in Houston, Dallas, and San Antonio for several days during the weeks-long heat wave. To maintain grid security, ERCOT has issued calls to customers to conserve energy, and real-time prices in ERCOT over some periods this summer have soared to around US\$5,000/MWh, but to-date the grid has remained reliable.

Average daily maximum temperature, July 1-18 2023



Anomaly of average daily TMax July 1-18, 2023 w.r.t 1950-2023



Source: World Weather Attribution

A similar situation has been seen in CAISO, which has seen high power demand due to the heatwaves. While the 2023 Summer Loads and Resources Assessment notes that the ISO approached the summer of 2023 with a moderate surplus for meeting the 1-in-10 standard, the ISO forecast demand would rise from 42,266MW on 20 July to 43,512MW on 21 July – below the grid's all-time high of 52,061MW recorded on 6 September 2022. On 20 July, the ISO declared an emergency alert for about an hour “due to heat conditions and higher than anticipated demand” at around 7:30 p.m. local time. This was later cancelled but over the weeks since, a number of similar alerts have been issued.

Analysis by World Weather Attribution has said heat waves are not rare in today's climate with an event like the 2023 summer now expected approximately once every 15 years in the US/Mexico region. Without human induced climate

## Temperatures, USA/Mexico

change these heat events would however have been “virtually impossible to occur in the US/Mexico region”, it added.

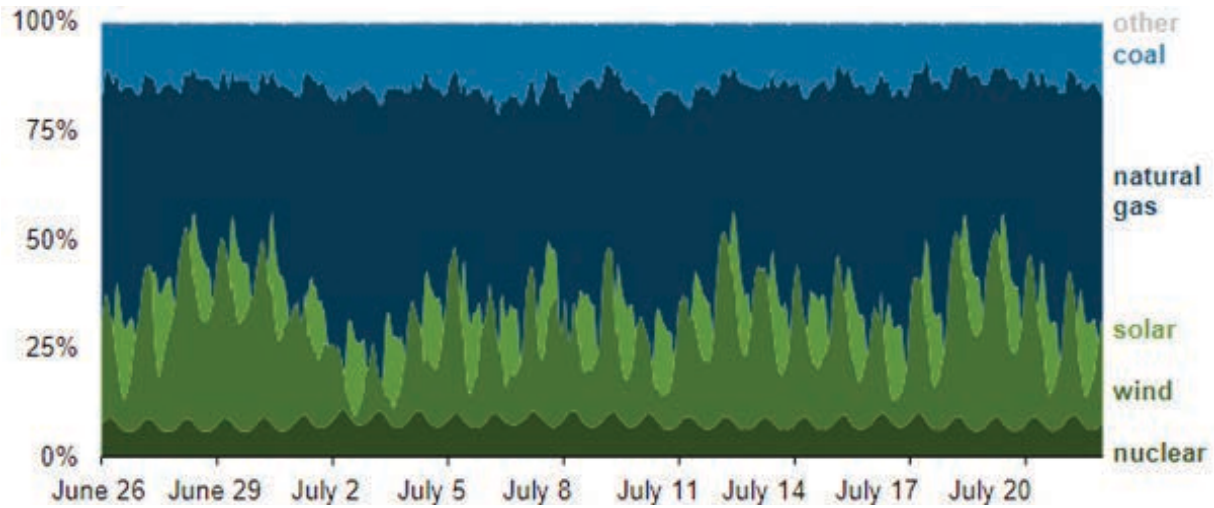
## Curves, capacity and contingencies

Coal and gas power plants exhibit higher susceptibility to breakdowns in severe weather conditions compared to renewable energy sources and batteries, as demonstrated during the recent events in Texas.

Winter Storm Uri led to the freezing of equipment at both natural gas and coal plants, as well as natural gas pipelines. Similarly, the ongoing heat wave has compelled coal and gas plants to shut down. These traditional power facilities are considerably intricate, featuring numerous valves, pipelines, and other moving components, thereby introducing multiple potential failure points when exposed to extreme environments. In contrast, renewable energy sources such as solar and wind, along with battery



Source: EIA



systems, have minimal moving parts and simpler designs, which significantly reduces their vulnerability to weather-induced failures.

Wind, solar and battery storage have all played a crucial role in meeting the demand during the most recent heatwaves. As these events are expected to become more frequent, there is likely to be a knock-on impact on the power sector of the future.

For Texas, unlike during Winter Storm Uri, the state's grid has held up under the significant demand peaks, largely due to a shift in the type of resources used in ERCOT in recent years, especially compared with

#### ERCOT share of electricity generation (June 26 – July 21, 2023)

heat waves in previous years.

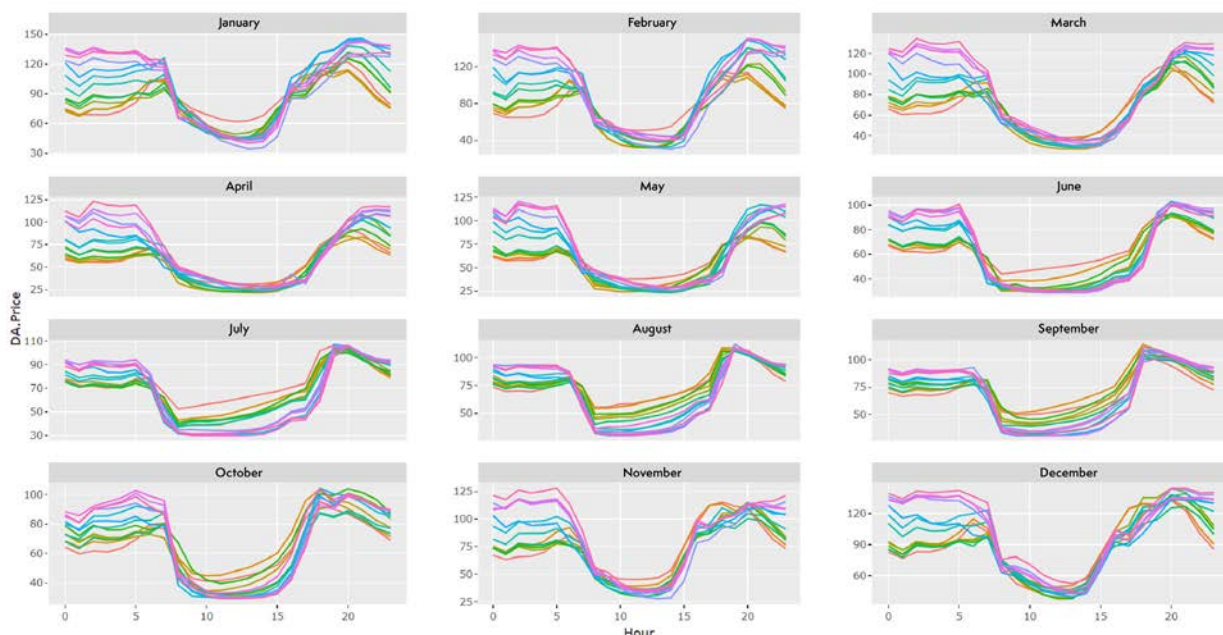
At the peak hour on 27 June, wind and solar provided about 35% of the power in ERCOT, with gas contributing 44%, coal 14%, and nuclear 6%. Solar power generation peaked at a record of 13,086MW on 25 June, and wind power reached a high of 24,237MW on 28 June. Non-fossil fuel resources contributed as much as 55% of total generation on 28 and 29 June and between 43%-47% in the evening peak load hours of 4:00-8:00 p.m. CT, keeping the share generated by natural gas below 50% of the fuel mix during those hours. In prior periods of high demand, such as in August 2019 and August 2022, non-fossil

fuel resources never reached more than 50% of total generation in ERCOT.

Traditionally, the electricity demand curve follows a pattern with spikes in the morning and evening. However, the increasing deployment of solar photovoltaic (PV) panels has caused a shift in this curve. This is demonstrated in California: with more solar capacity coming online CAISO is routinely experiencing a dramatic drop in net load during the midday hours when solar generation is at its peak.

The graph below (the California 'duck curve') shows a typical spring day with the midday dip in the net load curve followed

#### The California 'duck curve'



Source: GridBeyond

by a steep rise in the evenings as solar generation drops off. With more solar capacity added each year, the dip in net load has become more of a challenge to handle. This leaves CAISO with the option to reduce generation from all other resources, export the excess renewable generation to neighbouring regions (if adequate transmission capacity is available and there are willing buyers), store excess power or to curtail renewables off the system. Similar (but possibly less extreme) changes to the net load curve are being observed in other RTOs which have seen a significant increase in solar PV capacity.

This dip in net load is followed by a significant ramp-up as the sun sets. The result is that the 18.00-19.00 peak has become a key battle ground for energy prices – as demand remains high but solar generation starts to fall away. On days with low wind conditions this can result in tight system conditions and the inevitable high prices that follow.

The deepening of the net load clearly presents at least two challenges for grid operators:

- Low (and in some cases negative) mid-day prices reduce revenues of thermal power plants because they are utilised for far fewer hours on many days, potentially making some flexible plants uneconomic.
- The extreme swings in the net load exert additional wear and tear on conventional thermal generators which are required to ramp up and down quickly to meet the peak demand.

The big beneficiary of the 'duck curve' is energy storage. This is largely because batteries contribute other services and benefits to the grid besides energy. Because of their fast response times, they are ideal for providing services such as frequency regulation and flexible ramping product. In addition, batteries can moderate the extremes in daily price swings through arbitrage, by increasing demand for renewables during the very low-priced hours of the day and increasing supply in the evening to bring prices down.

It should be noted that both CAISO and ERCOT have mechanisms in place to ensure sufficient supplies during these peak periods.

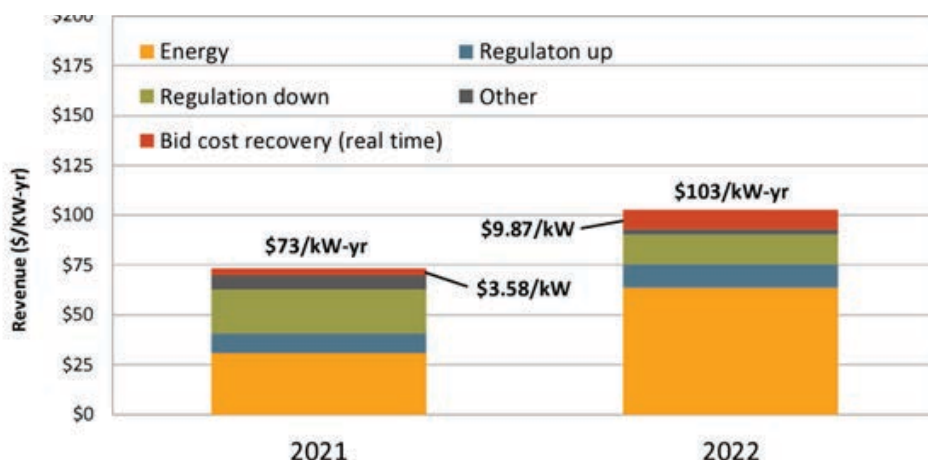
In ERCOT forecasts relating to load and renewables have been conservative (overestimating demand, underestimating renewables) to ensure sufficient dispatchable power is scheduled day ahead ensuring the system remains

#### Bid cost recovery payments in 2021 and 2022 (US\$M)

	2021		2022	
Batteries	\$3.6	2%	\$30.3	12%
Gas: Once-through-cooling	\$56.4	36%	\$63.1	25%
Gas: Combined Cycle	\$56.1	36%	\$77.6	31%
Gas Turbine: Fast Start	\$18.0	12%	\$32.0	13%
Gas Turbine: Non Fast start	\$4.6	3%	\$11.6	5%
Other (reciprocating engines, etc)	\$6.7	4%	\$16.0	6%
QF/CHP/Must-take	\$6.6	4%	\$19.6	8%
Reliability must-run	\$2.5	2%	\$2.3	1%
Hydro	\$1.6	1%	\$1.9	1%
<b>Total</b>	<b>\$155</b>		<b>\$252</b>	

Source: CAISO

#### Average annual revenue for batteries with a full year of operation in CAISO



reliable – leading to days with dramatically higher prices in the day ahead market which then don't materialise in real time.

In addition, in June, ERCOT launched the Contingency Reserve Service (ECRS), a daily procured ancillary service that is the first such service in 20 years to be introduced to the market, which complements the four procured ancillary services ERCOT currently uses: Regulation Up, Regulation Down, Responsive Reserve Service and Non-Spin Reserve Service.

Similarly in CAISO the following types of ancillary services are traded in ISO markets: regulation up, regulation down, spinning reserve and non-spinning reserve.

In a report issued 7 July, CAISO said that battery storage capacity grew from about 500MW in 2020 to 5,000MW in May 2023 in its balancing area. This rapid buildout has coincided with a change in battery behaviour from primarily providing ancillary services to performing energy arbitrage. Batteries provide over half of CAISO's regulation up and regulation down requirements, but the ISO noted that the percentage of total battery storage capacity being scheduled for ancillary services has decreased as batteries have transitioned to providing more energy during the net peak hours.

The latest Department of Market Monitoring (DMM) report for CAISO noted that bid cost recovery payments for batteries are increasing significantly more than the total amount of battery capacity. Bid cost recovery payments for batteries increased from about US\$3.6 million in 2021 (or 2% of bid cost recovery payment) to over US\$30 million (or 12%) in 2022. Revenues for batteries from bid cost recovery payments have increased from about US\$3.60/kW in 2021 to almost US\$10/kW in 2022. In



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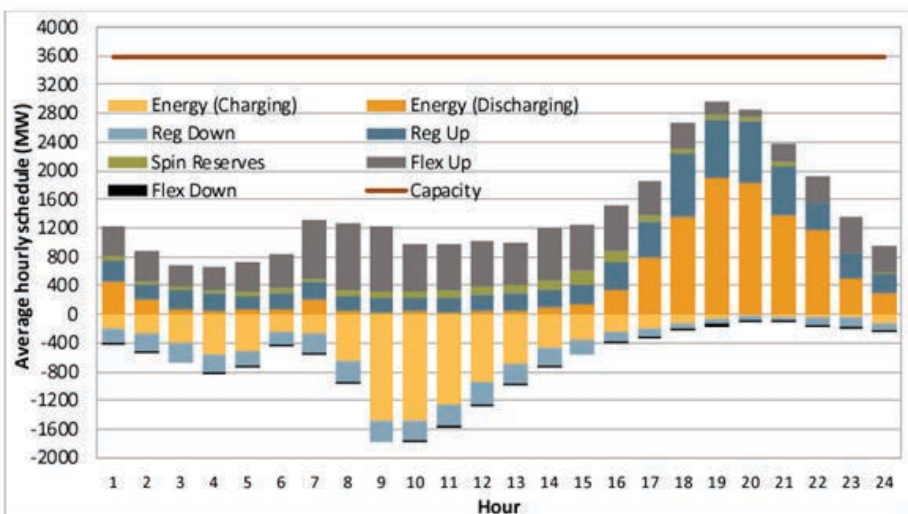
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Source: CAISO

2022 battery resources received 10% of all bid cost recovery, while accounting for about 5% of capacity in the CAISO market. According to CAISO, these payments represent about 7.6% of net market revenue for batteries.

DMM continues to recommend that the ISO begin to develop revisions to bid cost recovery rules. These were primarily designed for traditional gas generating units, which have significant start-up and minimum load costs, minimum run times, and various other physical operating constraints. While batteries do have some special operating constraints, they are not subject to the various costs and constraints of gas units around which bid cost recovery rules have been designed.

Similar trends are being seen in ERCOT resulting in some interesting price interactions with the Real Time market. According to a recent publication by S&P Global, Texas accounted for nearly 70% of grid battery additions in the US in the first three quarters of 2023, resulting in a total capacity of 3,300MW.

Though initially viewed as a stop-gap for intermittent power or an ancillary service to maintain grid integrity, batteries have a much broader potential. Because of their fast response times, batteries are ideal for providing services used to balance very short-term differences in supply and demand, such as frequency regulation and flexible ramping product.

In addition, batteries can moderate the extremes in daily price swings through arbitrage, by increasing demand for renewables during the very

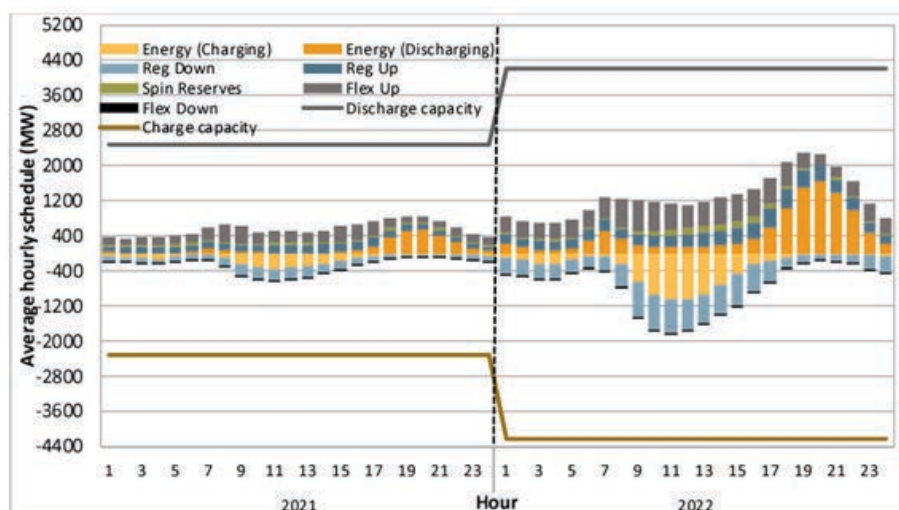
**CAISO average hourly battery schedules (August 31 – September 9, 2022)**

low-priced hours of the day and increasing supply in the evening to bring prices down. This was demonstrated during the recent heatwaves.

#### Changing revenue streams

Battery storage is the fastest growing type of resource in the CAISO market. As of 1 May 2023, Non-Generator Resources (NGR) batteries make up 7.6% of CAISO's nameplate capacity. In addition, the majority of projects waiting to connect to the grid contain a battery component and at the beginning of May, the interconnection queue included nearly 127GW of planned capacity, 46% of which was from batteries.

**Figure 7 : CAISO average hourly battery schedules (2021-2022)**



Source: CAISO

Initially, batteries favoured providing ancillary services, especially frequency regulation, because it allows them to avoid deep charging and discharging cycles which cause rapid cell degradation. In the last two years, regulation services offered by batteries have increased significantly. But more recently the largest revenue category comes from the day-ahead market.

During the September 2022 heat wave, batteries tended to offer a large portion of both their upward and downward capacity into the market. Batteries provided 2.4% of generation for the CAISO balancing area in hours ending 17 to 21 from 31 August to 9 September. Net market revenue for batteries during the 10-day 2022 summer heat wave totalled nearly US\$78 million, about 20% of all market revenue for batteries in 2022, but this was driven in part by the high energy prices during the period. The percentage difference between average heat wave schedules and average 2022 schedules was significant.

During the 2023 heatwaves we have seen a similar trend. ERCOT has continued to see maximum load records exceeded on an almost weekly basis. Despite this, renewable generation has ensured a relatively stable summer in ERCOT. With the latest demand record set on 31 July, in tandem a new maximum level of storage capacity was delivered to the system, during the evening peak period where while demand remained high and solar generation fell away with the setting sun, storage delivered just over 1GW of energy into the system.



Source: CAISO

Hour	Energy (Charging)	Energy (Discharging)	Reg Down	Reg Up
16	6%	-0.7%	-79%	-0.4%
17	13%	37%	-74%	4%
18	45%	33%	-76%	100%
19	64%	26%	-61%	102%
20	12%	12%	-48%	137%
21	161%	-1%	-65%	119%

Indeed this type of combination of high demand, high renewable energy coupled with storage to meet peak demand has occurred throughout June and July, with significant price spikes occurring in the energy market only when wind has been particularly low, generally below 5GW.

July's market conditions present a good snapshot of how the market will play out in the future, where the system is heavily reliant on a combination of renewable energy and battery storage, and can cope admirably provided both are there in sufficient levels, but where market volatility can play out in real time as weather driven generation sources ramp up or down intermittently.

As was evident in June and July, the

system becomes stressed and prices can rise dramatically (as the market is designed to do) when supply is in danger of not meeting demand. In such cases Real Time market prices reached in excess of US\$3,000/MWh. This is where storage can excel and return previously stored excess solar and wind generation to the grid.

To study battery performance, GridBeyond models revenues under stochastic (mainly weather driven) conditions. Analysis shows that storage assets participating in energy and ancillary markets during these extreme load summer months increase income by more than 5x over off-season months.

Indeed with GridBeyond's forecasting

### Percentage difference between average heat wave schedules and average 2022 schedules in CAISO

and optimisation algorithms, a battery storage system trading across DA and RT energy markets as well as ancillary services markets revenues of around 70% of perfect foresight are achievable. In addition a margin uplift of 30-40% above a reserve market-only strategy is observed. The below charts consider the gross marginal income over a 10 year horizon in both ERCOT and CAISO for a 2-hour and 1-hour battery respectively.

Prices are expected to decline as the markets saturate with increased battery penetration, however in the long-term, revenue from wholesale arbitrage is expected to make up a larger proportion of a battery's gross margins. Wholesale margins make a small contribution for a 1-hour battery entering the market in 2024 and ancillary services will be the dominant revenue stream supporting the project until wholesale price volatility increases towards the end of the decade. Battery revenues range between US\$100-240/kW/year over the forecast horizon as energy arbitrage becomes a larger portion of the total income.

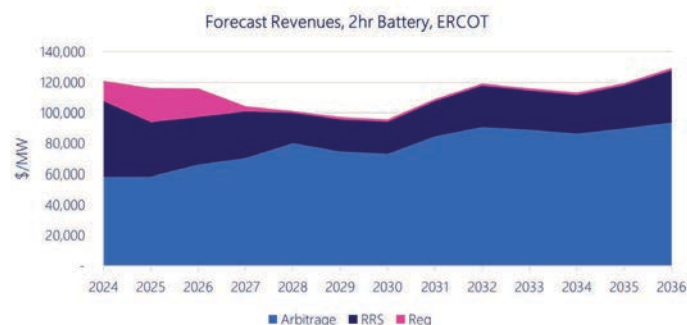
### Building capabilities to optimise performance

Battery operations can be complex and require a new way of working to participate in volatile and evolving markets. In order to optimise operations, battery operators need to invest in advancing existing capabilities and acquiring new ones. These capabilities expose commercial and operations teams to real-time markets, operations and proprietary data to make trading and operations decisions and to maximise value.

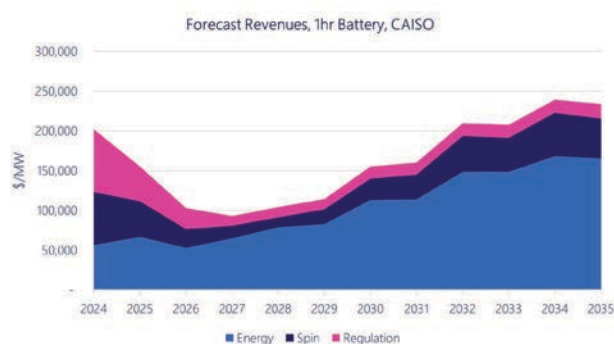
As utility-scale battery development continues in ERCOT, the role storage plays will likely change as it did in CAISO. The integration of large amounts of battery storage poses new challenges and opportunities, as battery technology is fundamentally different from that of more traditional power generators like gas and hydroelectric resources.

**Top: Forecast revenues – 2hr battery storage system in Texas; Bottom: Forecast revenues - 1hr battery in CAISO**

Source: GridBeyond



Source: GridBeyond



### Author

Wayne Muncaster is VP North America at GridBeyond, provider of a technology platform for managing distributed and flexible energy resources. With over 20 years' experience in the energy sector, Wayne has seen the energy landscape change significantly and is ideally placed to provide advice and education on this complex market. Wayne is a regular industry speaker and advocate for enhanced energy services and demand-side response.



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# Mitigating energy storage's unique natural catastrophe risk with insurance

**Battery Risk** | Battery storage plays an important role in adding resilience to energy networks. But it should also be remembered that natural catastrophes can affect BESS resources too, writes Ross Kiddie of bespoke battery insurance company Altelium.

**N**atural catastrophe (nat cat) planning and risk assessment is different for battery energy storage compared to renewables such as wind and PV solar because it involves a chemical reaction.

Every battery cell contains a cathode, anode and an electrolyte through which the ions flow when the battery is charged and discharged. Because we're dealing with chemistry, not physics, there is always the potential risk (albeit a small one) of a thermal runaway in a lithium-ion battery if design conditions aren't maintained. Thermal runaway will produce an uncontrolled release of heat and energy, and this will produce fire and toxic fumes.

Writing for Energy-Storage.news earlier this year, my colleague Charley Grimston highlighted the increased risk when wind turbines are located at less-than-ideal sites. In the article 'Comparing the path to maturity and insurance's role in the battery storage and wind turbine markets' he describes how in the early days of wind turbines, fire was quite a common occurrence caused by the blades rotating the wrong way, or rotating too fast and causing a nacelle fire. Natural catastrophes also caused turbines to fall over, but the resulting damage is not on the same scale as is possible with a battery energy storage fire caused by a chemical reaction.

The most damaging potential element in a nat cat situation for batteries is water, and especially saltwater which has been described as a 'death sentence' for batteries. Saltwater corrodes and subsequently can cause short circuits which can lead to thermal runaway.

However, no one should think that because a nat cat event is taking place,



Credit: Harmony Energy

energy storage isn't taking place there too. In Texas for example, because of load constraints, reliability issues and the way the independent electricity system ERCOT is structured, there is a very high need for battery storage. But there is also a very high probability of a nat cat event such as hurricanes and flooding.

Texas' ERCOT market had around 2GW of batteries online in Q1 this year, but is set to soar to 8GW by the end of 2023. The nat cat risk hasn't stopped development. Where there is a need for storage, nat cat can typically be addressed with the right planning and design.

## Standards a work in progress in many regions

As my colleague, Paul Markham, Power & Energy Risk Engineer, confirms: "It is a question of ensuring developments are structurally developed to withstand wind or hurricane risk, and where there is a flood risk, that the batteries' enclosures are adequately IP rated and are built on a raised platform or raised concrete structure."

**Harmony Energy's 196MWh Pillswood BESS in East Yorkshire, UK, was built on a raised platform to mitigate the risk of water damage in the flood-prone region.**

Standards established by the National Fire Protection Agency (NFPA) in the US are considered the gold standard for design in this respect. While work is underway in the UK to develop an equivalent, at present in the UK and Europe there is no standard to compare with it.

At Altelium we were recently asked to review the development of a new battery energy storage development, to assess standards of design and planning with reference to NFPA 855. The scope of the standard is defined by the NFPA below:

*The standard applies to the design, construction, installation, commissioning, operation, maintenance, and decommissioning of stationary energy storage systems (ESS), including mobile and portable ESS installed in a stationary situation and the storage of lithium metal or lithium-ion batteries.*

*Energy generation equipment – even if it is tied to the ESS – is not covered under the scope. An example of this is a solar energy farm that feeds ESS on the same property. The solar generation and collection equipment are not governed by this*

standard. NFPA 850 and 855 or other relevant standards should be applied for the design, construction, installation, commissioning, operation, and maintenance of generation facilities.

Together with UL 9540 Energy Storage System (ESS), these two standards guide insurers in assessing preparedness and mitigation of nat cat risk.

There are many battery energy storage projects today undergoing approval and construction to address these standards in the US and UK. For example, one is being built in Scotland on a raised plinth to address tidal water, the 'worst' risk because it is saltwater.

### All energy resources carry risks

The US Electric Power Research Institute (EPRI) keeps a database of stationary energy storage failure events, with publicly available data. Beginning from 2019, it has tracked over 50 utility-scale battery failures that have occurred over the last four years. The incidents represent a 1% to 2% failure rate across 12.5GW hours of lithium-ion energy storage worldwide. Two events in Korea are believed to have been preceded by heavy rain and thunderstorms, where water may have gotten into the building or container. However, it is not always possible in every case to identify Root Cause Analysis (RCA) and the majority are not believed to have been the result of nat cat.

Some events have included loss of life and life-changing injuries to first responders and the risk cannot be underestimated. But it can and should be seen in context: risks are not unique to storing electricity.

The US National Research Council (NRC) found in a study around a decade ago that some storage systems, albeit not energy storage systems, such as carbon capture and storage, are more likely than fracking to trigger nat cat in the form of earthquakes.

Other energy storage systems being explored such as compressed air energy storage in depleted natural gas reservoirs can potentially cause detonations initiated via a shock making an earthquake nat cat a risk.

Writing in the Scientific American, Paul Denholm, a senior energy analyst at the National Renewable Energy Laboratory says: "Fossil fuels are technically forms of stored energy, pose plenty of problems in their extraction, refining, distribution, and delivery.

"We basically have grandfathered these risk factors. Gasoline catches on fire all the

time. Electrical energy storage systems aren't inherently riskier than petroleum or natural gas, but their risks are different."

Battery fires are a particular concern because they can occur several days after an initial thermal runaway event and consequent 'original' fire. Battery cells contain energy within themselves, called 'stranded energy' and this means they can reignite days after the fire has been put out. But again, awareness of this means it should be prepared for, and where it is not, insurance will be not offered and the project is highly unlikely to proceed.

In this respect insurance and especially nat cat modelling plays a key part in providing both environmental and financial protection.

According to the NOAA (National Oceanic and Atmospheric Administration), the US alone has sustained 355 weather and climate disasters since 1980 where overall damages/costs reached or exceeded US\$1 billion (including CPI adjustment to 2023). The total cost of these 355 events exceeds US\$2.540 trillion.

### Modelling risks with software

In the battery storage and renewable energy industry we see this trend having a worldwide affect that insurers and reinsurers need to understand and model to assist with making informed decisions.

Nat cat software modelling programmes offer several benefits and can function as a valuable tool when looking at battery energy storage sites. They provide insights into the potential impact of catastrophes such as hurricanes, earthquakes, floods, wildfires, and other events.

When it comes to battery storage, natural catastrophe modelling tools can be valuable in several ways:

1. **Improved risk assessment:** these tools help battery storage facility engineers, owners, operators, banks, and insurers understand the vulnerability of their assets to different types of natural catastrophes. By analysing historical data, climate patterns, and geographical

vulnerability to natural disasters. This might include implementing structural reinforcements, relocating facilities away from high-risk areas, or investing in early warning systems and emergency response plans.

3. **Insurance and risk transfer:** catastrophe modelling tools assist insurance companies in assessing the potential losses associated with insuring BESS facilities against natural disasters. These models provide insurers with a statistical and scientific input for help determining premiums, coverage limits, and deductibles, ensuring that the costs align with the risks involved. We see best results when CAT models are combined with deterministic assessments, site reviews, BESS owner and operating conversations and loss histories.

4. **Transparency and data accuracy:** all models that depend on large data sets are sensitive to uncertainty driven by poor quality or missing data. The major providers of CAT modelling tools used for energy and battery storage systems all have recognised the issue of quality of data and have created their own proprietary algorithms to reduce poor quality and to represent that they are providing the most accurate level of results.

As climate change intensifies, the frequency of natural catastrophes will increase and the insurance industry will need to adapt quickly to these exposures for renewable energy and battery storage. The use of modelling software to help them adapt is not the only tool needed by risk engineers, however, it is recognised as a critical tool in their toolbox.

Where battery energy storage developments have the correct facilities to address the risk of flooding or other nat cat, insurance costs would not be exorbitantly high and a good insurance rate can be secured with the correct mitigations in place. In this respect, insurance plays a key role in supporting the transition to clean energy and addressing climate change issues. ■

### Author

Ross Kiddie is North America general manager at Altelium, an insurtech business that offers insurance for batteries driven by real-time, AI-powered data analytics. Ross specialises in the integration of battery storage technologies to support grid resource for resiliency and reliability. An electrical engineer by training, he has nearly 30 years experience working with utility companies, clean energy technology companies, renewable energy/storage entities and energy consumers. His experience ranges from risk assessment and due diligence, insurance, grid modernisation, energy efficiency programmes, distributed energy resources, electrification, energy engineering to software solutions and national policy objectives.



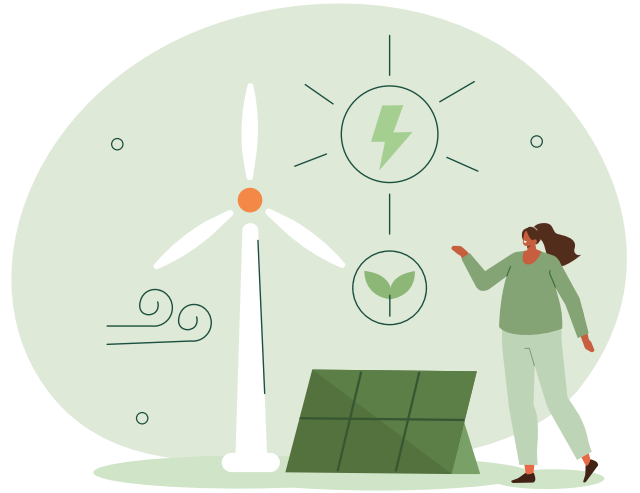


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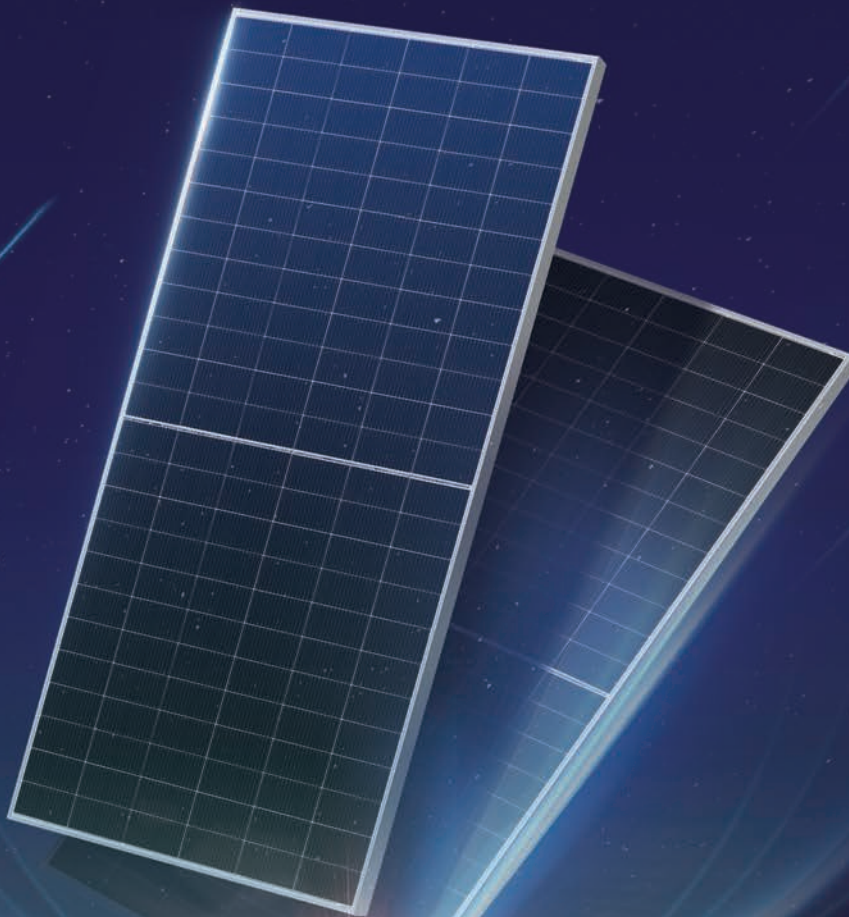
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