

PV & Storage Mid-Summer 2023

By John Benson

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1. Introduction

My last post in this series was in late June, and it is described and linked below.

PV & Storage Early Summer 2023: This earlier post covered the following subjects:

Technology:

- *Major Advance in Flow Battery Architecture*
- *Ultra-Thin Film Photovoltaics Everywhere*
- *Rolling Hills PV*
- *Bifacial PV Panels on Tracking Systems?*
- *PVEL 2023 PV Module Reliability Scorecard*

Business:

- *CAISO plan supports 17GW of solar within a decade*
- *Enel New 3 GW Solar Panel and Cell Factory in the U.S.*
- *Tesla Battery Energy Storage Business*
- *Battery maker wins \$850M DOE loan to build US factory*

Projects:

- *Strata Clean Energy 1 GWh Scatter Wash BESS Project*
- *rPlus Energies to build solar project in Idaho Power system*
- *Apex adds 195 MW of solar and 400 MWh BESS in Texas*
- *400 MW BESS for Portland General Electric*
- *162 MWac Pachwáywit Fields solar for Portland GE Online*
- *Tesla project breaks ground, Arizona's largest project*

<https://energycentral.com/c/cp/pv-storage-early-summer-2023>

This post will cover the following subjects.

Technology:

- *Solar Forecasting Brings Reliability and Economic Savings*
- *American-Made Solar Prize Winners: Where Are They Now?*

- Putting Solar Energy Installation on Autopilot

Business:

- US-India joint venture will spend \$1.5B to build US solar factories
- Canadian Solar Announces U.S. Module Manufacturing Plant
- Solar4america Technology New HJT Solar Cell Factory in the US
- Storage Projects
- PV Projects and PV + Storage Projects

2. Technology

As I was looking for material for this section, I (re) discovered a rich vein of innovation ore in Energy.gov / Energy Efficiency and Renewable Energy / Solar Technologies Office information mine (a.k.a. Solar News, link below). I've been here before, but when I visited this time, I found a series of inspiring success stories, and these are below.

<https://www.energy.gov/eere/solar/listings/solar-news>

2.1. Solar Forecasting Brings Reliability and Economic Savings

Many of us start our morning by checking the weather forecast to prepare for the day ahead. But sometimes, the weather can change rapidly. Grid operators face similar challenges: they rely on forecasts to get a general idea of expected electricity demand, as well as how much renewable energy supply will be available to power the grid during a given timeframe.¹

For solar and wind energy, most grid operators rely on deterministic forecasting to predict the power they can supply a few days or hours in advance. In 2021, Texas electricity grid operator, Electric Reliability Council of Texas or ERCOT, started experimenting with a new forecasting method called probabilistic forecasting, which includes detailed information about solar forecast uncertainty. This was made possible by the research funded by the U.S. Department of Energy (DOE) Solar Energy Technologies Office (SETO) under the Solar Forecasting 2 Funding Program. By adopting the probabilistic forecasting method, ERCOT is better positioned to integrate more renewable energy generation with confidence and improved reliability.

With a \$1.7 million SETO award, the National Renewable Energy Laboratory (NREL) and Maxar developed advanced, data-driven probabilistic forecasting techniques that improve the accuracy of solar power generation forecasts through state-of-the-art predictive modeling and an in-depth understanding of power systems and markets. These forecasts predict how much solar energy will be produced during a variety of time frames, ranging from minutes, hours, days, and weeks ahead.

¹ Energy.gov / Energy Efficiency and Renewable Energy / Solar Energy Technologies Office, “Success Story—Novel Approach to Solar Forecasting Delivers Improved Reliability and Economic Savings for Texas Grid,” June 14, 2023, <https://www.energy.gov/eere/solar/articles/success-story-novel-approach-solar-forecasting-delivers-improved-reliability>

Maxar created these forecasts by using innovative approaches to quantify uncertainty and overcome the limitations in traditional weather models, while leveraging innovations in cloud computing. Produced on the fastest forecasting cadence Maxar offers, this probabilistic forecast information is delivered via application programming interface (API) and allows grid operators to more efficiently balance energy generation from solar, wind, and other sources while achieving economic savings and improved reliability.

To understand the real-world benefits of these new forecasting approaches, Maxar partnered with ERCOT to gain the end user's perspective on data and grid reliability requirements. ERCOT manages the flow of electric power to 26 million Texas customers, representing about 90 percent of the state's electric load. While ERCOT already used Maxar's standard forecast solutions for grid operations prior to the DOE project, the success of this project's efforts resulted in ERCOT having visibility into Maxar's probabilistic solar power forecasts on a sub-hourly basis in their operational systems. By integrating probabilistic solar forecasts into power system operations, ERCOT can integrate more solar power into its grid, reducing system operating costs, and improving overall grid reliability...

Author's comment: It took some digging, but I believe I found the Maxar application that the above expanded capabilities are probably built on. Go through the link below. Note from the above: "...ERCOT already used Maxar's standard forecast solutions..."

<https://www.maxar.com/products/weatherdesk>

2.2. American-Made Solar Prize Winners: Where Are They Now?

The American-Made Solar Prize (Solar Prize) is a multi-million-dollar competition designed to energize U.S. solar innovation by providing resources and support to entrepreneurs as they develop transformative technology ideas into concepts and then into early-stage prototypes ready for industry testing. Since launching in 2018, the Solar Prize has awarded \$19.6 million in cash prizes and other support to 140 teams, including 13 grand prize winners, over the course of six rounds. Learn about a few of our past winners and find out what they've been up to since participating in the competition...²

2.2.1. Round 1 - Phase3 Photovoltaics

Phase3 Photovoltaics (PV) began with a mission to bring rooftop solar energy to manufactured houses. The founders saw a gap in the solar market and an opportunity to expand access to solar energy and its benefits among lower income brackets. While competing in the Solar Prize, Phase3 PV conducted testing to see how the pre-installed solar panels fared during transport. Working with the Pacific Northwest National Laboratory, they developed a model neighborhood to investigate how these solar arrays can be leveraged by utilities to improve grid resilience. The Solar Prize was pivotal to Phase3 PV's success, reducing the amount of venture funding needed to get the business off the ground.

² Energy.gov / Energy Efficiency and Renewable Energy / Solar Energy Technologies Office, "Success Story—American-Made Solar Prize Winners: Where Are They Now?" June 12, 2023, <https://www.energy.gov/eere/solar/articles/success-story-american-made-solar-prize-winners-where-are-they-now>

Since winning the Solar Prize, Phase3 PV has been busy. The company was awarded more than \$1.2 million in the 2019 Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) funding program. They went on to work with a builder in Northern California and now have a 340-kilowatt multi-stage project with battery storage constructed. In addition to expanding its industry footprint with new customers, Phase3 PV is also working with Oak Ridge National Laboratory on a white paper and hopes to use it to help update the Housing and Urban Development code to include an index of solar best practices.

Author's comment: The page linked below contains some images of Phase3 PV past projects.

<https://www.phase3pv.com/past-projects>

2.2.2. Round 2 - Resilient Power Systems

Resilient Power Systems developed the Resilient Power Router, a hybrid inverter that enables interconnection between solar, storage, and other energy resources. It also integrates transformers and inverters into a single unit, helping to solve the national transformer supply shortage while reducing size and installation times by 90%. The Solar Prize allowed the company to work with the National Renewable Energy Laboratory (NREL) and Savannah River National Laboratory and the Savannah River National Laboratory on analysis and validation of their product, leading to a tenfold increase in orders and a doubling of staff.

Since winning the Solar Prize, Resilient Power Systems has received more than \$5 million from top tier investors like Amazon, sold more than \$15 million in transformers, and currently has six U.S. patents and another six pending.

Author's comment: I was not able to find any current information on Resilient Power Systems (RPS). I know that photovoltaic (PV) systems have been evolving from centralized inverters to micro-inverters. Enphase seems to be the leader in the micro-inverter market. It could be that RPS has partnered with one of the major micro-inverter firms. Based on the above text, they seem to have intellectual property (IP) for this technology, but "\$15 million" is very small potatoes for this market.

2.2.3. Round 3 - Wattch, Inc.

Wattch, Inc. developed a solar monitoring platform to help commercial PV plants increase operational efficiency. The platform has a universal dashboard that allows PV fleet owners and operators observe the performance of their systems, improves remote and automated diagnostics, and effectively models a plant's lifetime energy yield. The Solar Prize helped Wattch catalyze initial development of the product, hire its first team members, and establish legitimacy in the industry, elevating the company's visibility to prospects, investors, and future hires.

Since winning the Solar Prize, Wattch has worked to build out the functionality of its platform and expand the number of sites the platform can monitor. Wattch also raised \$3 million from prominent industry executives and venture capital funds and hired five additional employees to further its expansion. On average, an existing project that switches to Wattch will see a 21% performance improvement in the first three months. The platform is now being used to monitor and control nearly 1,000 sites in 14 states and 3 countries.

Author's comment: The above is basically a supervisory control and data acquisition (SCADA) system for PV projects and fleets of projects. Since I spent over 15 years in this technology (SCADA systems for electric utilities and related applications), I would guess that this will have a “standard application” core that will probably need to be substantially customized for each fleet manager, each systems network and each grid environment. Based on the above plus their web site (see below), it sounds like they are doing this.

Wattch has a minimal web site that is linked below.

<https://www.wattch.io/>

Note that there are several more recent rounds and winners, but it doesn't sound like they have had time to develop.

2.3. Putting Solar Energy Installation on Autopilot

I covered a similar technology to that described below a few months ago as part of a larger post. I went back and dug this out to make sure it was not the same firm (and it wasn't). Given the speed that utility-scale PV projects are ramping-up (and accelerating this ramp-up), I would guess that several firms will be offering similar technologies.

On a bright, sunny morning, a team of machines settles in for a day of work. Their location: the construction site for a large-scale solar power plant. Their task: to install rows upon rows of solar panels, which will soon generate clean energy to power American homes, businesses, and communities.³

While that may sound like an excerpt of science fiction, Terabase Energy⁴ received a \$1 million award in 2019 from the U.S. Department of Energy to develop a new field factory facility that brings automation to solar power plant installation. It uses robotic arms to lift heavy solar panels and connect them to solar trackers, saving time, energy, and ultimately, money.

The United States needs to increase its installed solar capacity to 1 terawatt by 2035 to achieve a 100% renewable power grid—that's 10 times the level today. Hitting that target will require lowering the costs of solar projects and scaling up installations to happen faster. Thanks in part to DOE investments, the cost of photovoltaic (PV) technologies continue to come down. But with large-scale solar projects, labor and installation costs have been going, and are expected to go, the other direction.

Terabase's solution, called Terafab, is transforming the traditionally manual processes of designing arrays, delivering modules, and installing them at the site. Terafab enables the completion of the module and trackers installation phase in half the time as traditional methods, thereby doubling productivity.

By automating the construction of large-scale plants, Terabase's goal is to enable faster, safer deployment. Terabase's technology can improve safety and efficiency of solar installation by allowing the machines to do the heavy lifting, while workers oversee the assembly line of construction.

³ Energy.gov / Energy Efficiency and Renewable Energy / Solar Energy Technologies Office, “Success Story—Putting Solar Energy Installation on Autopilot,” May 30, 2023,

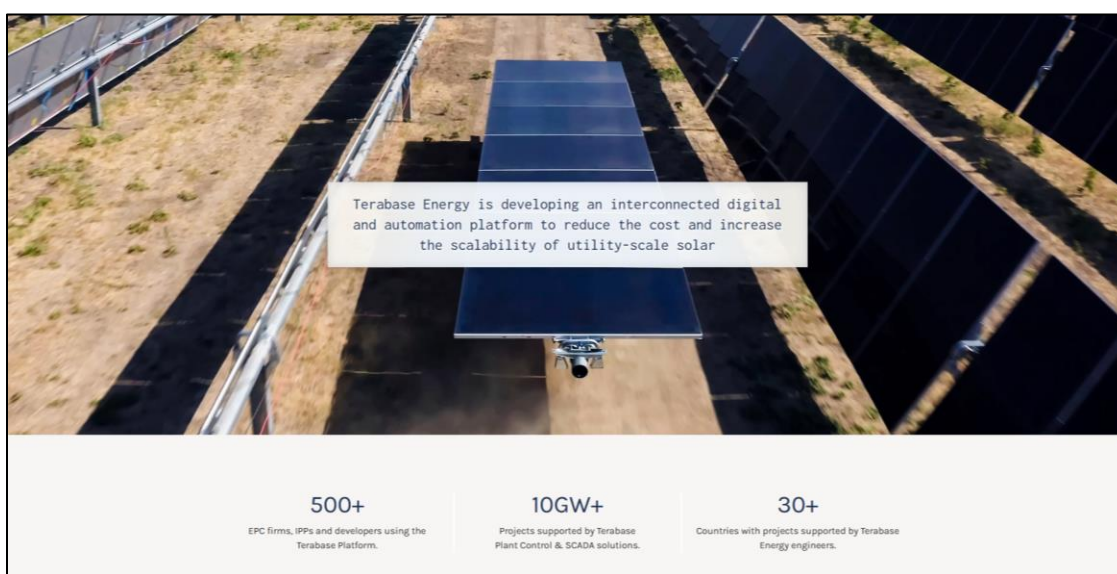
<https://www.energy.gov/eere/solar/articles/success-story-putting-solar-energy-installation-autopilot>

⁴ Terabase Energy, <https://www.terabase.energy/>

The project culminated with an open-field demonstration of solar plant construction in rural Texas in 2022, using the Terafab system to build 10 megawatts (MW) of a 400 MW site. The demonstration led to \$44 million in follow-on funding and an official launch announcement of its automated, digital field factory in the spring of 2023.

On top of that, Terabase received an additional \$1.5 million in DOE funding in 2020 to develop software that can mimic the operations of a factory, providing an overview of equipment deliveries, assembly, and other activities. When complete, this research and demonstration project will automate the distribution of solar power plant equipment to the installation location, bringing panels and trackers to the sites on smart transportation vehicles.

Author's comment: A link to the Terabase website is on the bottom of the previous page. This firm seems to be well-developed, and it is expanding beyond just automating PV project construction into modeling, SCADA and overall project management.



3. Business

3.1. US-India joint venture will spend \$1.5B to build US solar factories

New US-India joint venture VSK Energy has announced it will invest up to \$1.5 billion to develop a vertically integrated solar manufacturing operation in the US, and it's starting in Colorado.⁵

VSK Energy is made up of India-headquartered global solar module maker Vikram Solar and New York-based investors Phalanx Impact Partners and Das & Co.

The first of two planned projects is a \$250 million PV module factory in Brighton, Colorado). The new factory is expected to create over 900 direct jobs and over 200 construction jobs. VSK Energy expects the factory to come online in 2024 with an initial capacity of 2 gigawatts (GW) in PV modules and a planned expansion of up to 4 GW.

⁵ Michelle Lewis, Electrek, "A new US-India joint venture will spend \$1.5B to build US solar factories," Jun 23 2023, <https://electrek.co/2023/06/23/us-india-joint-venture-1-5b-us-solar-factories/>

The plan for the second stage is to complete VSK's vertical integration of the solar manufacturing process. It intends to develop a factory in a southern state to produce solar ingots, cells, and wafers with a planned annual capacity of 4 GW.

VSK Energy plans to invest up to \$1.25 billion in the new factory, which is expected to come online in 2025 following the evaluation and finalization of available federal, state, regional, and local incentives for the project. The new factory is expected to create over 1,500 direct jobs and over 1,000 construction jobs.

3.2. Canadian Solar Announces U.S. Module Manufacturing Plant

Canadian Solar Inc. headquartered in Guelph, Ontario, today announced that it is establishing a solar PV module production facility in Mesquite, Texas.⁶

Canadian Solar is building a state-of-the-art solar photovoltaic module manufacturing plant with an annual output of 5 GW, equivalent to approximately 20,000 high-power modules per day. The new facility represents an investment of over \$250 million and will create approximately 1,500 skilled jobs once it is fully ramped up. Production is expected to begin around the end of 2023. This will be Canadian Solar's first United States manufacturing facility, following its successful track record of production in Canada, China, Brazil, Thailand and Vietnam. In 2021, Canadian Solar relocated Recurrent Energy, its 17-year-old U.S. subsidiary, to Austin, spearheading the rapid growth of renewable energy in the Lone Star State as a solar and battery storage developer...

3.3. Solar4America Technology New HJT Solar Cell Factory in the US

SPI Energy Co., Ltd., a global renewable energy company and provider of solar, storage and electric vehicle (EV) solutions for business, residential, government, logistics and utility customers, today announced its wholly owned Solar4America subsidiary plans to begin manufacturing state-of-the-art N-type HJT solar cells in the United States.⁷

HJT leverages N-type monocrystalline silicon as a substratum, depositing silicon-based thin films with unique characteristics and transparent conductive films on the front and rear surfaces. By combining the benefits of crystalline silicon and amorphous silicon thin-film technologies, HJT technology offers excellent photo absorption, passivation effects as well as exceptional efficiency and performance. Key advantages of HJT solar cells include enhanced conversion efficiency, superior energy yield, reduced degradation rate, improved weak light performance, and adaptable to thinner wafers.

Solar4America plans to begin manufacturing HJT solar cells in the US by the end of 2024. The US-based facility will significantly expand Solar4America's manufacturing capabilities and capacity. With the introduction of HJT solar cells to its product portfolio, Solar4America aims to become one of the American leading providers of advanced photovoltaic (PV) solutions.

⁶ Canadian Solar Inc. "Canadian Solar Announces U.S. Module Manufacturing Facility in Mesquite, Texas," June 15, 2023, <https://www.prnewswire.com/news-releases/canadian-solar-announces-us-module-manufacturing-facility-in-mesquite-texas-301851796.html>

⁷ ACCESSWIRE· SPI Energy Co., Ltd. via Yahoo Finance, "SPI Energy's Solar4America Technology Announces N-Type Heterojunction Technology (HJT) Solar Cell Factory in the US," July 12, 2023, <https://finance.yahoo.com/news/spi-energy-solar4america-technology-announces-074500821.html>

Author's comment: For additional information on HJT Technology see the post referenced and described below, section 2.1.

***PV and Storage, Spring 2022:** The Technology & Business (Section 2) part of this paper updated to latest photovoltaic (PV) cell/module technologies, a possible revival of concentrated solar power from NREL, and possible extension of PV project lifetimes. As usual, the last part of this paper (section 3) covered recent large (100 MW per technology) PV and/or storage projects in the U.S.*

<https://energycentral.com/c/cp/pv-and-storage-spring-2022>

3.4. Storage Projects

3.4.1. SDGE

San Diego Gas & Electric has finished two energy storage facilities totaling 171 megawatts and 684 MWh in Fallbrook and Imperial Valley, it was announced Thursday.⁸

The two projects are the 131 MW Westside Canal Project and the Imperial Valley, and the 40 MW Fallbrook Project.

3.4.2. Cranberry Point Energy Storage Project, MA

*San Francisco-based developer Plus Power won two bids in the latest capacity auction held by the New England ISO, which operates the transmission grid and competitive power markets in six Northeastern states... a 150-megawatt/300-megawatt-hour system near a cranberry bog south of Boston, Massachusetts. The seven-year capacity contracts start in June 2024.*⁹

The Cranberry Point project in the town of Carver, just inland from Cape Cod, tackles several grid imperatives at once... It sits near a major substation, Keefe said, which allows for shipping its electricity out to the greater Boston area. It also happens to be "strategically located" in the same grid zone as the Mystic Generating Station, a legacy gas plant in Boston. Mystic dates back to World War II and had been kept open with out-of-market payments on the grounds that it could jeopardize grid reliability if it retired. But owner Exelon plans to shut down several generating units there...

This battery is also near the expected landing point for the cables that will deliver electricity from the forthcoming offshore wind projects Vineyard Wind and Mayflower Wind. Once that happens, the battery is poised to charge up on the cheap influx of clean power, in order to discharge during valuable peak hours.

⁸ Debbie L. Sklar, Times of San Diego, "SDG&E Completes Large Energy Storage Facilities in Fallbrook and Imperial Valley," July 7, 2023, <https://timesofsandiego.com/business/2023/07/06/sdge-completes-2-energy-storage-facilities-in-imperial-san-diego-counties/>

⁹ Julian Spector, Greentech Media, "Plus Power Breaks Open Market for Massive Batteries in New England," Feb 11, 2021, <https://www.greentechmedia.com/articles/read/plus-power-breaks-open-new-england-market-for-massive-batteries>

3.5. PV Projects and PV + Storage Projects

3.5.1. Toyota / Savion

Today, Toyota announced that it has agreed to offtake 100-megawatts (MW) of the electricity generated as part of renewable energy company Savion's Martin County Solar Project through a virtual power purchase agreement (VPPA). The project is converting the former Martiki Coal Mine, a brownfield site in Martin County, on the border of Kentucky and West Virginia, into a new, clean solar photovoltaic energy facility. Once an active coal mine on the top of a mountain that closed in the 1990s, the Martiki site has clear access to light from the sun, making it an ideal location for reclamation and the installation of solar photovoltaic panels for electricity generation. Construction on the project is anticipated to begin in mid-2023 and commercial operation is expected in 2024.¹⁰

The solar energy generation facility will be located on approximately 1,200 acres on the old Martiki mine site in Martin County, interconnecting with Kentucky Power's 138-kilovolt Inez Substation. When built, the project will create capacity of up to 200 megawatts and will produce enough energy to power the equivalent of more than 33,000 Kentucky homes.¹¹

3.5.2. San Juan 1

D. E. Shaw Renewable Investments (DESRI) today announced the San Juan 1 Project achieved financial close with its project lenders and initiated construction. San Juan 1 is a 200-megawatt (MWac) solar and 100 MWac battery storage facility adjacent to the former San Juan Generating Station in San Juan County, NM. The Project is a critical capacity replacement to the San Juan Generating Station, which was retired in 2022, and it will interconnect to the grid using existing infrastructure from the retired plant. San Juan 1 is the first phase of a larger project that is expected to deliver 400 MWac of clean power to the grid when fully developed and constructed.¹²

"DESRI is thrilled to announce the start of construction at San Juan 1. As a capacity replacement for a retired coal generator, the Project is an important part of New Mexico's transition to state of the art, cost-effective renewable energy, firmed by battery storage," said Thomas de Swardt, Chief Commercial Officer of DESRI. "We deeply appreciate the partnership of PNM, San Juan County, the San Juan Citizen's Alliance, the Project's lenders, and numerous other stakeholders and supporters in the community in achieving this milestone."

¹⁰ Aaron Fowles, Toyota News Release, "Reclaimed Kentucky Coal Mine Sees the Sun Shining on New Solar Power Purchase Agreement with Toyota," May 24, 2023, <https://www.prnewswire.com/news-releases/reclaimed-kentucky-coal-mine-sees-the-sun-shining-on-new-solar-power-purchase-agreement-with-toyota-301833045.html#:~:text=Today%2C%20Toyota%20announced%20that%20it%20has%20agreed%20to.Project%20through%20a%20virtual%20power%20purchase%20agreement%20%28VPPA%29>

¹¹ Savion Energy Press Release, "Martin County Solar Project to Advance – Savion's First Solar Project on a Reclaimed Coal Mine," Dec 9, 2021, <https://savionenergy.com/martin-county-solar-project-to-advance-savions-first-solar-project-on-a-reclaimed-coal-mine/>

¹² PR Newswire via Energy Central, July 11, 2023, https://energycentral.com/news/d-e-shaw-renewable-investments-announces-close-financing-and-start-construction-200mwac-san?utm_medium=eNL&utm_campaign=DAILY_NEWS&utm_content=416684&utm_source=2023_07_12

San Juan 1 is DESRI's third project in New Mexico and first project in San Juan County. The Project has a 20-year power purchase agreement with the Public Service Company of New Mexico (PNM) and will provide meaningful renewable energy to its customers while facilitating the company's efforts to have all electricity generation be emissions free by 2040. The facility is expected to generate enough clean energy to power approximately 52,400 homes each year, according to metrics provided by the Environmental Protection Agency. The Project is anticipated to commence operations in mid-2024. Photosol USA initially developed the project before selling it to DESRI in 2022.

SOLV Energy will serve as the engineering, procurement, and construction contractor for the solar and battery storage components, while EPC Services Company will construct the generation tie-line and project substation. Additionally, SOLV Energy will provide ongoing operations and maintenance services to the facility once operational.

3.5.3. RWE PPAs for 266 MW to Dominion Energy Virginia

This is a bit complex. First of all I don't include "distributed power" projects in this post. However, I do include transactions with multiple projects, none of which is over 100 MW (my lower limit for each transaction). If you look at the reference and text for the excerpt below you will see a maximum output that is greater than the output in the section heading above. This is because the transaction included a small amount of distributed power.

RWE, a leading renewable energy company, has signed eight long-term utility-scale PPAs with Dominion Energy Virginia for seven solar projects in the state totaling more than 300 megawatts (MW) capable of producing more than 750,000 megawatt hours of generation. As part of net-zero commitment, Dominion Energy plans to achieve net-zero greenhouse gas emissions by 2050.¹³

"We're invigorated by our ability to help Dominion move forward with a slate of projects in its home state of Virginia that reduces its carbon footprint and helps get the industry closer to achieving net zero," said Mark Noyes, CEO of RWE Clean Energy, a subsidiary of RWE AG. "As a company, we are well-positioned to leverage our vast experience to deliver the highest quality solar energy projects, optimizing costs, while providing tailor-made solutions to our customers."

The utility-scale project portfolio includes:

Pleasant Hill Solar: 20 MW project located in the City of Suffolk, VA, which came online in April.

Watlington Solar: 20 MW project located in Halifax County, VA, which came online in June.

Wythe County Solar: 75 MW project located in Wythe County, VA, which is in construction and is expected to be online in 2024.

Switchgrass Solar: 69 MW project located in Suffolk County, VA, which is in development.

¹³ Jen Villarreal, RWE, "RWE signs 300 MW PPAs to provide solar power to Dominion Energy Virginia," July 18, 2023, <https://www.rwe.com/en/press/rwe-clean-energy/2023-07-18-rwe-signs-300-mw-ppas-to-provide-solar-power-to-dominion-energy-virginia/>

360 Solar: 52 MW project located in Chesterfield County, VA, which is in development.

Groves Solar: 15 MW project located in Westmoreland County, VA, which is in development.

Harrisonburg Solar: 15 MW project located in Rockingham County, VA, which is in development.

Author's comment: I don't know where they got the "...750,000 megawatt hours..." figure in the above excerpt. If I had to guess, I would maybe say it is the maximum or average output in a day. I saw no mention of storage in this article.