Renewables Accelerating

By John Benson

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1. Introduction

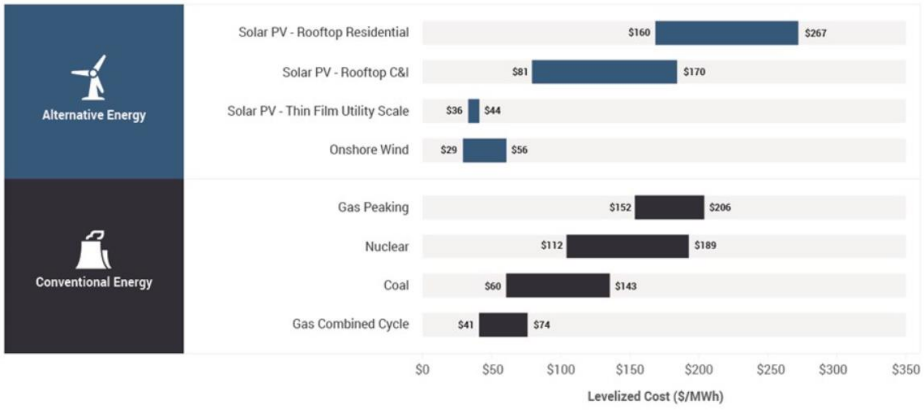
Last week's post was primarily on wind energy, focusing on future challenges and global large projects. This is linked below.

https://www.energycentral.com/c/cp/2020-wind-energy-update

This paper is primarily on U.S. photovoltaic (PV) and PV plus battery energy storage systems (BESS). Section 2 below is on recent news on wind, PV and PV+BESS economics, and specifically how their levelized cost of energy compares with other types of generation. Section 3 is on recent major PV+BESS and PV-only projects. It also includes some amazingly low power purchase agreement energy-pricing.

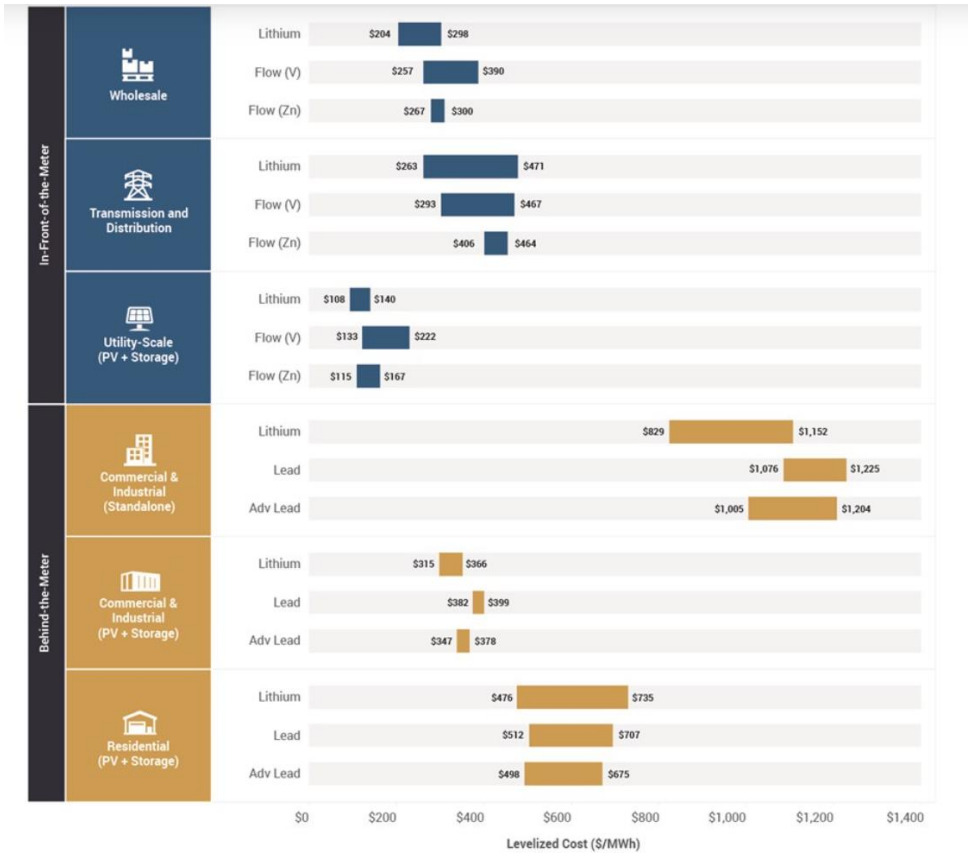
2. The Cost of Energy and Construction

There are many reasons to use renewables for our energy. However all of the altruistic or societal benefits fade into the background if the cost of renewables are lower than any other source. The calculus for the cost of energy for a particular generation type is complex, and the levelized cost of energy (LCOE) is only one metric for this, but when this metric becomes comparable for renewables and other sources, the end is near. Why? The cost of many renewables (read: wind, PV and BESS) are falling rapidly. Other sources: not so much. The chart below is from Lizards[1], a large financial advisory firm.

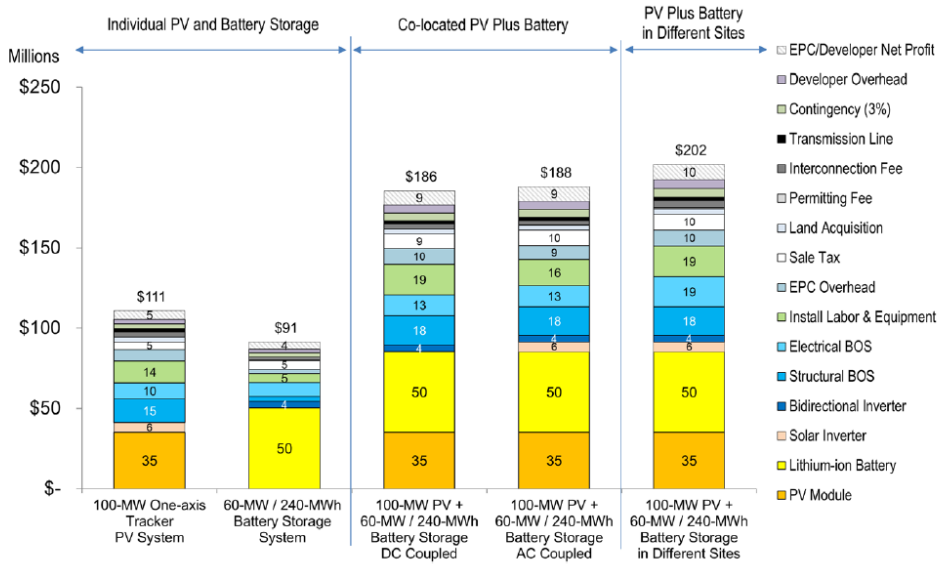


The referenced site contains much other information on this subject, including related metrics for battery energy storage (below). Note the chart below includes LCOE for PV plus BESS. Utility-scale PV plus lithium-ion BESS is $108 to $140 per MWh, which is competitive with coal, leaving gas-fired combined cycle as the only less expensive fossil-fueled option. Given the rapid decline in PV and BESS pricing lately, I would guess we are within a few years of new PV+BESS projects dropping below gas combined cycle. The other interesting thing about this chart is that flow batteries are nearly competitive with lithium-ion.

[1] Lizard's Levelized Cost of Energy and Levelized Cost of Storage 2018, Version 12.0, https://www.lazard.com/perspective/levelized-cost-of-energy-and-levelized-cost-of-storage-2018/



The chart below is referenced here,[2] and shows different configurations for a PV plus BESS. Note that the numbers are a year older than the Lizard numbers, and that these are engineering, procurement and construction (EPC) costs not LCOE.



[2] Ran Fu, Timothy Remo, and Robert Margolis, National Renewable Energy Laboratory, "2018 U.S. Utility-Scale Photovoltaics-Plus-Energy Storage System Costs Benchmark", https://www.nrel.gov/docs/fy19osti/71714.pdf

3. Recent Major PV + Storage Projects

Recent posts where I focused on PV + Storage are linked below, and I attempted to compare projects from the earlier posts to assure no duplicates make it into this paper.

Recent Developments in Storage, Wind and PV, September 2019: There were many more large PV wind and storage projects in the U.S. when I wrote this paper, and it reviewed those. Also there had been recent news that impacted the cost of BESS, and we started this paper with this subject.

https://www.energycentral.com/c/cp/recent-developments-storage-wind-and-pv

Photovoltaic plus Storage, February 2019: This was a two-part series. Part 1 was on new technologies for utility-scale PV, utility-scale BESS, PV plus BESS, and the evolution of their missions. Part 2 described recent major U.S. PV and BESS projects and some new twists on residential PV plus BESS.

https://www.energycentral.com/c/cp/photovoltaic-plus-storage-%E2%80%93-part-1-technology

https://www.energycentral.com/c/cp/photovoltaic-plus-storage-%E2%80%93-part-2-projects

The following projects are for large U.S. utility-scale PV+BESS or large PV-only.

3.1. Los Angeles Department of Power & Water (LADWP)

Note that there are two separate projects for this Utility. The developer for both is 8minute Solar Energy. The first is PV plus BESS and the second: PV with predictive software. At least part of the second project (Springbok 3) apparently also has BESS to allow use of the predictive software.

*"As the country's largest independent solar and storage power plant development company, 8minute will build a massive new state-of-the-art facility—**Eland Solar & Storage Center**—to serve the needs of the LADWP. Eland will deliver up to 400MW of clean energy to the grid while capable of storing up to 300MW/1200 MWh (megawatt hours), dispatchable for use when the sun is not shining, typically in the evening and night hours when the load is still high. Located just 70 miles north of Los Angeles close to California City on over 2,000 acres of barren, desert land, much of which was previously disturbed, Eland will be built in 2 phases starting operations in 2022 with full operational capabilities in 2023. The project will be the largest municipal photovoltaic operation in the world. Due to the partnership's unprecedented scale, 8minute is able to provide LADWP with the lowest solar energy prices on record in the U.S.: **less than 2 cents per kWh**."*[3]

"8minute Solar Energy has partnered with Doosan GridTech to develop an advanced energy software control solution for dispatching energy from advanced solar photovoltaic plus storage centers (PVS). [4]

*"The companies will utilize the new software first at the Springbok 3 Solar Farm, part of the **448 MW Springbok solar cluster** in Kern County, California, which was developed*

[3] Business Wire, "The City of Los Angeles Taps 8minute Solar for Game-Changing Clean Energy Project", November 06, 2019, https://www.businesswire.com/news/home/20191106006100/en/City-Los-Angeles-Taps-8minute-Solar-Game-Changing

[4] Business Wire, "8minute Solar Energy and Doosan GridTech Ink Deal to Develop Advanced Predictive Controls for Dispatchable Solar + Storage, https://www.businesswire.com/news/home/20191024005051/en/8minute-Solar-Energy-Doosan-GridTech-Ink-Deal

by 8minute and supplies enough clean energy for more than 152,000 households in Los Angeles. This partnership pairs Doosan's flexible software platform and energy storage expertise with 8minute's forward-thinking PVS dispatch approach to maximize asset value creation. The resulting control solution will improve PVS plant output predictability and unlock additional value streams for 8minute and its Springbok 3 off-taker, the Los Angeles Department of Power & Water (LADWP)…

"The enhanced Doosan Intelligent Controller used at the Springbok 3 site will uniquely combine several operating modes, such as active power smoothing and predictive active power response with coordinated charge and discharge, giving a smoother power output from the PVS system. The joint team will also develop PVS block strategies to provide contingency frequency support services on top of its baseline output. Additionally, active PV-only control will be initiated to more smoothly ramp the resource up and down based on solar forecasting without the need for an ESS."

3.2. East Bay Community Energy (EBCE)

EBCE is the community choice aggregator (CCA) for the area where I reside (Livermore). I have chosen to opt out of this organization, and I still buy my electric energy from PG&E (long story).

For people that are not familiar with CCAs: *"CCAs are local, not-for-profit, public agencies that take on the decision-making role about sources of energy for electricity generation. Once established, CCAs become the default service provider for the power mix delivered to customers. In a CCA service territory, the incumbent utility continues to own and maintain the transmission and distribution infrastructure, metering, and billing."*[5] There are two projects mentioned in the article excerpt below. One doesn't currently have storage but includes an option to add it later.

The East Bay Community Energy (EBCE) group a not-for-profit public agency that operates a Community Choice Energy Program for Alameda County in California has contracted two more major solar and battery storage projects that it describes as astoundingly low.[6]

The latest deal is an agreement to contract a total of 225MW of solar power capacity and 80MW/160MWh of battery storage, a deal that EBCE Nick Chaset says takes the company's total solar portfolio to an astoundingly low average cost of about ***$US22/MWh****.*

EBCE has a total portfolio of 550MW of new renewable energy generation and at least 137.5MW/390MWh of battery storage.

The two newest agreements include a 20-year agreement for 125MW of solar power and 80MW/160 MWh of battery storage from the sPower Solar + Storage Project in Southern California, developed by Salt Lake City-developer sPower.

[5] Wikipedia Article on Community Choice Aggregation, https://en.wikipedia.org/wiki/Community_Choice_Aggregation

[6] Energy Central, "California group contracts astoundingly low-cost solar and battery storage", October 4, 2019, https://www.energycentral.com/news/california-group-contracts-astoundingly-low-cost-solar-and-battery-storage?utm_medium=eNL&utm_campaign=DAILY_NEWS&utm_content=416684&utm_source=2019_10_08

ECBE is purchasing the entire output from the project as well as all renewable energy credits and resource adequacy. ECBE will also maintain full control over when to charge and discharge the battery.

A separate 15-year contract has been signed for 100MW of solar power and virtual storage from the Edwards Solar Project in Kern County that is being developed by San Diego-based Terra-Gen. The project has the option to install battery storage which ECBE will have the right to procure.

3.3. Ørsted West Texas

"Ørsted announced today that following final investment decision from its Board of Directors it has commenced construction on the company's first utility-scale solar plus battery storage project, the 460megawatt (MWac) Permian Energy Center. The facility is located in Andrews County, Texas, and will come online in mid-2021...[7]

"The Permian Energy Center will comprise 420MWac of solar PV and 40MWac of battery storage located on a 3,600-acre site alongside existing oil and gas installations and will supply growing West Texas demand for electricity. In a region synonymous with traditional energy production, the project underscores the increasing cost competitiveness of renewable energy.

"The solar modules for the Permian Energy Center will be supplied by Jinko Solar and JA Solar, the number one and number two global suppliers, respectively, in 2018.

"About MW Permian Energy Center

- *460MW combined solar plus battery storage facility*
- *Total project area: 3560 acres*
- *Number of solar panels to be installed: 1,300,000*
- *Projected daily output capacity: 420MWac, able to deliver power to 100,000 US homes*
- *Battery storage facility capacity: 40MWac, 1-hour*
- *Estimated number of jobs during peak construction: 300…"*

3.4. Salt River Project (SRP), AZ

Three projects are being built for SRP, two by NextEra, and one by sPower. The last (for Intel) appears to be PV-only.

"Phoenix-based community utility Salt River Project (SRP) is to build the largest solar-plus-storage project in the southwestern US state of Arizona, just as an historic coal plant is put to rest.[8]

"Two new solar and battery projects, to be owned and operated by subsidiaries of NextEra Energy Resources, will help the utility reduce emissions and tackle the summer peak load using the battery storage technology. The investment makes SRP one of the

[7] Ulrik Frøhlke, Orsted Press Release "Ørsted to build landmark solar & storage project", Nov 13, 2019, https://orsted.com/en/Media/Newsroom/News/2019/11/211915390980624

[8] Tom Kenning, PVTECH, "Phoenix summer peak load to be tackled with major solar-plus-storage project", Nov 19, 2019, https://www.pv-tech.org/news/phoenix-summer-peak-load-to-be-tackled-with-major-solar-plus-storage-projec

largest energy storage investors in the country and the firm claims that it is continuing 'aggressively pursuing renewable generation'.

"The Sonoran Energy Center will have a 250MW solar array charging a 1GWh energy storage system in Little Rainbow Valley, south of Buckeye. Meanwhile, the Storey Energy Center will include 88MW of solar alongside an energy storage system scheduled to be built south of Coolidge.

"Combined, the plants will generate enough solar energy to power approximately 100,000 homes.

"They were spurred on by SRP's target of investing in 1GW of large-scale solar by 2025. Furthermore, yesterday, SRP announced that it had permanently closed down the largest coal plant in the West, the 2,250MW Navajo Generating Station, as the technology started to come up short against the prices of other technologies such as power from natural-gas, or renewables such as solar.

"SRP GM and CEO and Mike Hummel said of the new clean energy projects: 'These plants will get SRP more than 60% toward our goal of adding 1,000 megawatts of new utility-scale, solar energy to its system by the end of fiscal year 2025.' "

SRP-Intel Project: *"Eloy, AZ—Salt River Project announced today a collaboration to invest in clean, green energy with zero emissions and provide 100 megawatts of solar generation to the growing Intel Chandler facility.*[9]

"As part of a commitment to invest in more renewable energy and reduce carbon emissions, SRP and Intel reached a 15-year agreement to provide energy from a solar plant that will be built in Eloy, Ariz. by sPower, an AES (NYSE: AES) and AIMCo company.

The solar plant will support Intel's Chandler Ocotillo Campus, one of its largest global, semiconductor manufacturing sites.

" 'We are excited this collaboration will drive new, additional solar facilities in Arizona,' said Marty Sedler, Intel's Director of Global Utilities and Infrastructure. 'This effort helps support our portfolio approach to use a greener and more sustainable energy supply. Intel will continue to look for additional innovative ways to provide a more sustainable electric supply, globally, in all locations where we operate.'

"This project contributes to SRP's 2035 goals, which include a commitment to reduce the amount of carbon dioxide emissions from power generation by 33 percent.

" 'An important part of meeting SRP's carbon objectives is to work with large customers to provide them with renewable energy solutions that also meet their sustainability goals,' said SRP General Manager and CEO Mike Hummel. 'This is a great example of how utilities and their business customers can work together to promote sustainability.'

"SRP is a community-based, not-for-profit public power utility and the largest provider of electricity in the greater Phoenix metropolitan area, serving more than 1 million customers."

[9] sPower Press Release, "SRP to Unveil 100-Megawatt Solar Project", Dec 3, 2018, https://www.spower.com/news/2018-12-03/

3.5. Anheuser-Busch, TX

Large corporations can also sign agreements for utility-scale PV projects, especially if they are committed to 100% renewables. The project below is apparently PV-only.

"Recurrent Energy, a subsidiary of Canadian Solar, has signed a 15-year power purchase agreement with beverage company Anheuser-Busch for 222MWac/310MWp of electricity from its Maplewood solar project. The deal is the seventh largest commercial and industrial PPA for solar energy in the world to date, according to Bloomberg New Energy Finance data. It is the U.S. beverage industry's largest single purchase of solar energy.[10]

"The Maplewood solar farm is located in Pecos County, in the Permian Basin of West Texas, near the towns of Fort Stockton and McCamey, and is slated to begin commercial operation in 2021. It consists of two projects—the 222MWac/310MWp Maplewood 1 and a 28MWac/40MWp Maplewood 2—spread across roughly 2,200 acres. During the construction phase, the two will create 400 to 500 construction jobs at peak activity. It is anticipated that Canadian Solar's high-efficiency poly modules will be used for the project. Upon completion, the two components of the solar farm are estimated to produce enough clean energy to power the equivalent of 62,000 homes.

"Simultaneously with the PPA agreement, Anheuser-Busch announced that, by 2021, its entire portfolio of beers will be brewed using 100 percent renewable electricity produced at various solar and wind parks."

3.6. Constellation, VA

The project below is apparently PV-only.

"BALTIMORE—Constellation has announced an agreement with three major commercial customers to power their operations with renewable energy. At 175 megawatts, this project is the largest of its kind for Constellation, an Exelon company.[11]

"Major commitments from Johns Hopkins University; McCormick & Company, a global leader in flavor that manufactures, markets and distributes flavorful products to the entire food industry; and the TJX Companies, Inc., a major off-price apparel and home fashion retailer, resulted in Constellation's agreement to purchase the renewable power and project-specific renewable energy certificates (RECs) from the Skipjack Solar Center. Skipjack Solar Center is a large new solar plant being developed in Charles City County, Va., on former working timber land. Expected to come online in 2021, the solar project is being built by sPower, an AES and AIMCO Company, and a national leader in the development, construction and operation of solar power facilities.

"The Johns Hopkins University Applied Physics Laboratory (which would initially purchase only project-specific RECs) also is a part of this deal, among other Johns Hopkins' campuses in Maryland and Washington, DC.

"To simplify the purchase, each of the three customers will use Constellation's Offsite Renewables (CORe) retail power product, which increases access to renewable energy

[10] Anca Gagiuc, Commercial Property Executive, "Canadian Solar Subsidiary Inks 222MW PPA", June 5, 2019, https://www.cpexecutive.com/post/canadian-solar-subsidiary-inks-222mw-ppa/

[11] SPower Press Release, "Constellation Signs 175 MW Solar Agreement to Supply an Aggregation of Three Commercial Customers", Sep 18, 2019, https://www.spower.com/news/2019-09-18/

for commercial customers by removing the significant hurdles that accompany traditional offsite power purchase agreements (PPAs). As part of this transaction, Constellation will purchase energy and RECs from the Skipjack Solar Center and will then sell the power and project-specific RECs to the customers.

"This collaboration with retail customers is the largest ever for Constellation. By combining the simplified contracting and aggregation process of CORe with the commitment and involvement from sustainability-minded companies such as these, Constellation is able to offer more customers access to the economic and sustainability benefits of large-scale, offsite renewable energy projects.

"The 15-year agreement, which begins in 2021, is part of Exelon's broader commitment to advance zero-carbon energy locally and nationally, address climate change and achieve a cleaner energy future."

3.7. Marin Clean Energy (MCE), California

Marin Clean Energy is a community choice aggregator (see section 3.2). PV-only.

"Salt Lake City, UT— sPower, an industry leader in solar and wind assets, working collaboratively with MCE, announced that they recently achieved commercial operations on a 130 MWdc solar project in Lancaster, California. The project, named Antelope Expansion 2, completed by sPower in December of 2018 will sell output to MCE under a long-term Power Purchase Agreement (PPA). While California is home to many large solar projects, this is the largest one completed to-date in California with a Community Choice Aggregator (CCA). CCAs broaden the potential for renewables by allowing cities and counties to bring customers together to leverage individual purchasing power within a defined jurisdiction.[12]

"Antelope Expansion 2 is the second solar facility where sPower and MCE have partnered to bring more solar on-line. This project provides meaningful benefits to the community, it produces enough electricity to power over 26,000 homes and eliminates over 217,000 metric tons of carbon dioxide annually. While under construction, this project provided meaningful economic benefits locally in the over 261,000 union labor hours worked from the Southern California Trade Unions, including Laborers Local 300, Operators Local 12, Ironworkers Local 433 & 416 and IBEW Local 11."

3.8. Spotsylvania County, VA

This project is apparently PV-only.

"Spotsylvania, VA—The Spotsylvania Board of Supervisors has approved three special use permits for sPower's proposed 500 megawatt (MW) solar project. The project will be built in phases over the next two years and will ultimately generate over $20 million in new tax revenue for Spotsylvania County. The project will create approximately 800 construction jobs and 35 full-time jobs.[13]

"sPower CEO, Ryan Creamer commented, 'sPower is beyond excited to get this final vote of approval. We are pleased with how hard our staff and the County Supervisors

[12] SPower Press Release, "sPower and MCE Complete Largest Operational CCA Solar Project in California", https://www.spower.com/news/2019-04-29/

[13] sPower Press Release, "sPower's 500 MW Solar Project to Become Among Largest in US", April 15, 2019, https://www.spower.com/news/2019-04-15/

have worked to create what will be a world class project that will be a source of pride for everyone in the County.' Mr. Creamer went on to say, 'We are also proud to be able to generate enough power with this project to supply the equivalent of approximately 111,000 homes and offset 340,000 tons of carbon dioxide emissions each year.'

" 'This is a landmark project for sPower, Spotsylvania and the Commonwealth of Virginia, which will bring hundreds of new jobs and new tech investment to the area,' said Daniel Menahem, Director, Solar Development for sPower. 'Over the last year we have worked closely with County staff, officials and citizens to ensure that this project fits well with the character and community of Spotsylvania.' "