PV and BESS, Early 2022

By John Benson

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1. Introduction

This year I will try to post these "PV (photovoltaic) and BESS (battery energy storage systems)" reports frequently enough to where I can get them each into a single post (in 2021 I did a total of six posts). I will also try to make the first part of each post (in this case Section 2) on any technology or business development and the last part will cover major projects (in this case section 3).

This year I will use the following criteria for what constitutes a major project:

PV-only: larger than 100 MW output

BESS-only: larger than 100 MW output

Combined PV and BESS – larger than 100 MW for either source

I will also be a bit flexible in the above numbers, depending how important a given project is for a state or region. Each major project will continue to be added to the database of major PV / BESS projects that I started in 2021 (this database also helps me avoid double-entries).

2. Technology & Business

2.1. Material-Tools

The revolution brought about by PV and BESS in electric generation and storage is primarily a revolution in the understanding in the way the materials behave when solar energy irradiates them (PV) and when they store and release electricity (BESS). However, this revolution, at its foundation, is about the tools scientists and engineers use to measure and model these materials. Thus the following described tool should be very important to future advances in storage systems using NMC Lithium Ion batteries.

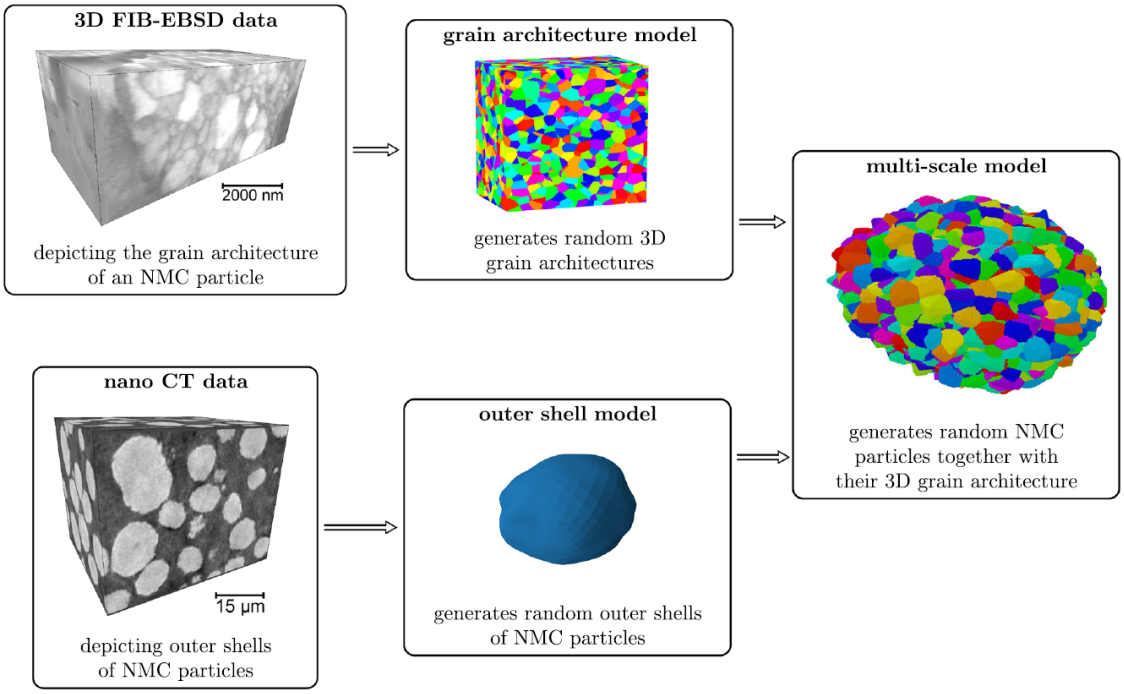
Accurately capturing the architecture of single lithium-ion electrode particles is necessary for understanding their performance limitations and degradation mechanisms through multi-physics modeling. Information is drawn from multimodal microscopy techniques to artificially generate $LiNi_{0.5}Mn_{0.3}Co_{0.2}O_2$ particles with full sub-particle grain detail.[1]

The design of electrode architectures is known to significantly influence the rate performance and energy density of electrodes but it is not well understood how the architecture of single particles influences their performance. For example, the most widely used positive electrode in Li-ion batteries consists of $LiNi_{1-x-y}Mn_yCo_xO_2$ (NMC) particles of various relationship between the quantities of reactants and products before, during, and following chemical reactions. The majority of NMC electrodes consist of

[1] Orkun Furat, & Lukas Petrich, Ulm University, Germany; Donal P. Finegan, Francois Usseglio-Viretta and Kandler Smith, NREL Colorado, et al, "Artificial generation of representative single Li-ion electrode particle architectures from microscopy data," June, 2021, https://www.nature.com/articles/s41524-021-00567-9

polycrystalline particles where each grain within the particle facilitates transport of Li along 2D planes. When each grain is oriented randomly relative to its neighbor, one can envisage a sub-particle flow-paths where Li travels along the 2D plane of one grain and changes direction as it enters and travels along the 2D plane of the next grain, and so on as the particle continues to combine with lithium (lithiate) or separate from lithium (delithiate). Expansion or contraction of the layered crystal structure of NMC occurs when the grains lithiate or delithiate. This expansion and contraction can lead to sub-particle mechanical strains, particle cracking and accelerated capacity fade. Furthermore, the shape, arrangement and orientation of grains have been shown to greatly affect the rate capability of the electrode, where particles with grains oriented with exposed edge facets that transport Li radially inward, display superior rate performance, and longer life.

In this paper, we combine two kinds of well-described 3D models which represent NMC particles on different length scales to obtain a multi-scale model for both the outer shell and grain architecture of NMC particles. This workflow is visualized in Fig. 1.



2.2. U.S. Corporations Critical Role in Renewables

There are two organizations, a web-site and a yearly report that monitors the world's largest corporations that are committed to renewable development:

RE100 is the global corporate renewable energy initiative bringing together hundreds of large and ambitious businesses committed to 100% renewable electricity. Led by the Climate Group and in partnership with CDP, our mission is to accelerate change towards zero carbon grids at scale.[2]

[2] RE100, About us, https://www.there100.org/about-us

Companies in the commercial and industrial sector account for around half of the world's end-of-use of electricity. We're switching this demand to renewable electricity.

Climate Group: *Our mission is to drive climate action. Fast.*[3]

Our goal is a world of net zero carbon emissions by 2050, with greater prosperity for all.

We focus on systems with the highest emissions and where our networks have the greatest opportunity to drive change.

We do this by building large and influential networks and holding organizations accountable, turning their commitments into action. We share what we achieve together to show more organizations what they could do.

Carbon Disclosure Project: *CDP is a not-for-profit charity that runs the global disclosure system for investors, companies, cities, states and regions to manage their environmental impacts. Over the past 20 years we have created a system that has resulted in unparalleled engagement on environmental issues worldwide.*[4]

The remainder of this subsection will cover some highlights from the "RE100 annual disclosure report 2021." This report can be downloaded from the site referenced here.[5]

The International Energy Agency (IEA) estimates that roughly a quarter of greenhouse gas emissions result from power generation and that companies account for about half of global electricity consumption. Companies therefore have a significant role to play in the decarburization of electricity through leveraging their demand for renewable electricity.

In 2021, renewable electricity growth continued to demonstrate resilience despite global supply chain shocks, and high commodity and manufacturing costs. 2021 set a record for capacity additions in renewable electricity, 60% of which was in solar PV, growing its capacity additions by 17%...

Private sector companies taking action on climate change are leaders. RE100 is a global leadership initiative to accelerate the decarbonization of electricity by committing large and influential companies to set targets to source 100% of their electricity renewably. This report presents findings from RE100's 2021 disclosure cycle and explores these leaders' performance and impact in sourcing renewable electricity. It captures 315 members (at the time of publication, RE100 has 349 members) with an aggregated electricity consumption of 340 TWh – greater than the United Kingdom's…

2.2.1. Key Findings:

RE100 members' momentum in sourcing renewable electricity is continuing to grow. 45% of reported electricity consumption by RE100 members is now renewable, up from 41% in the 2020 annual disclosure report.

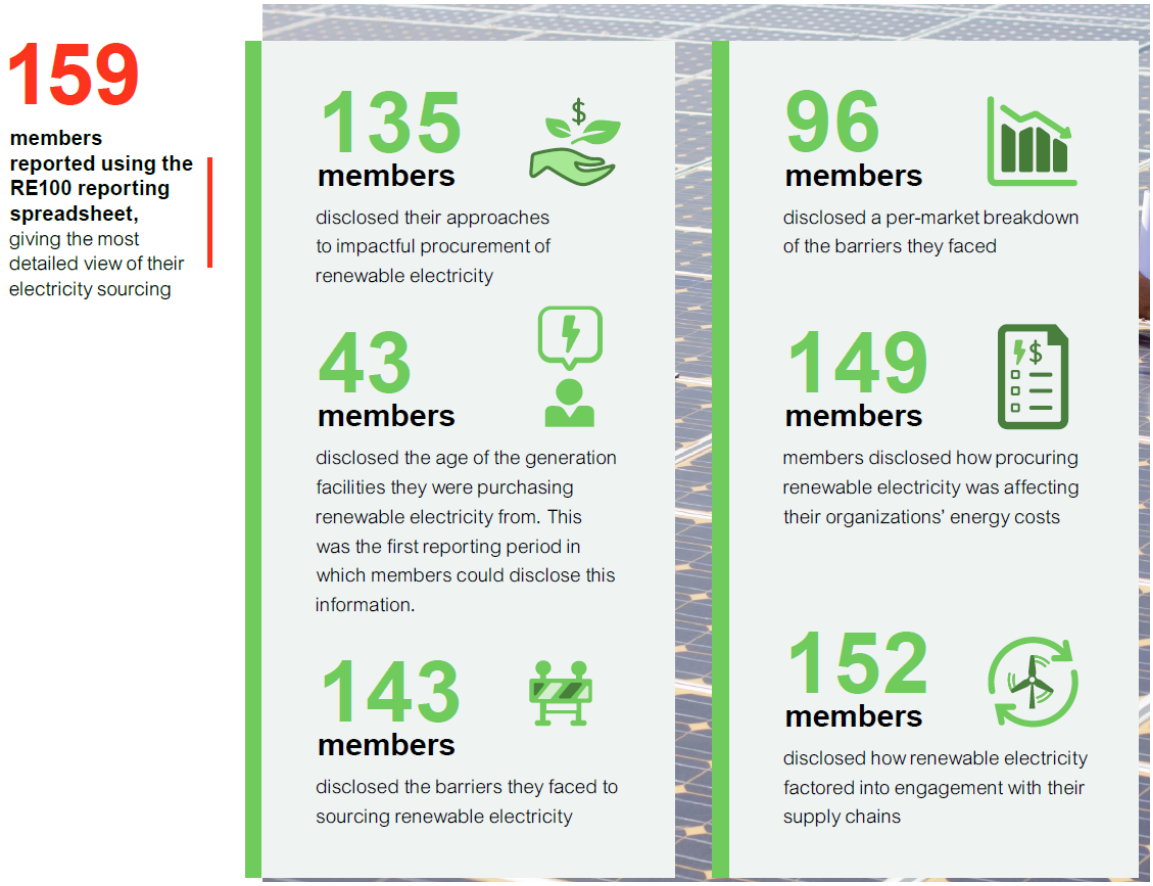
Members are sourcing more of their renewable electricity through Power Purchase Agreements (PPAs) than ever before. 28% of reported procurement of renewable electricity is done through PPAs, up from 26% in the 2020 report. New disclosures in 2021 suggest that RE100 members sourcing through PPAs are directly responsible for

[3] https://www.theclimategroup.org/
[4] https://www.cdp.net/en
[5] https://www.there100.org/

bringing new renewable electricity capacity to grids: PPAs are strongly associated with facilities less than two years old.

> **TABLE 2:** BREAKDOWN OF THE REGIONS RE100 MEMBERS ARE HEADQUARTERED IN

	2020	2019	2018	2017	2016	2015
Region	**Number of members**					
Europe	124	111	95	77	65	46
Asia-Pacific	102	68	54	26	9	5
North America	89	82	71	53	42	31



2.2.2. Selected U.S. Companys' Reports

Adobe: Joined RE-100 in 2015. Target for 100% renewables is 2035, Attained 46% RE in 2020, 33% RE in 2019.

Alphabet: Joined RE-100 in 2015. Target for 100% renewables was 2017, Attained 100% RE in 2020, 100% RE in 2019.

American Express: Joined RE-100 in 2020. Target for 100% renewables was 2018, Attained 100% RE in 2020, 100% RE in 2019.

Apple: Joined RE-100 in 2016. Target for 100% renewables was 2020, Attained 100% RE in 2020, 100% RE in 2019.

Bank of America: Joined RE-100 in 2016. Target for 100% renewables was 2020, Attained 100% RE in 2020, 100% RE in 2019.

Citigroup: Joined RE-100 in 2017. Target for 100% renewables was 2020, Attained 91% RE in 2020, 46% RE in 2019.

Dell Technologies: Joined RE-100 in 2019. Target for 100% renewables is 2040, Attained 54% RE in 2020, 45% RE in 2019.

Facebook: Joined RE-100 in 2016. Target for 100% renewables was 2020, Attained 100% RE in 2020, 87% RE in 2019.

General Motors: Joined RE-100 in 2016. Target for 100% renewables is 2035, Attained 24% RE in 2020, 22% RE in 2019.

Intel Corporation: Joined RE-100 in 2020. Target for 100% renewables is 2030, Attained 81% RE in 2020, 79% RE in 2019.

Microsoft: Joined RE-100 in 2015. Target for 100% renewables is 2030, Attained 100% RE in 2020, 100% RE in 2019.

PepsiCo: Joined RE-100 in 2020. Target for 100% renewables is 2030, Attained 52% RE in 2020, 10% RE in 2019.

Salesforce: Joined RE-100 in 2015. Target for 100% renewables is 2022, Attained 73% RE in 2020, 59% RE in 2019.

Wal-Mart: Joined RE-100 in 2015. Target for 100% renewables is 2025, Attained 15% RE in 2020, 9% RE in 2019.

Wells Fargo: Joined RE-100 in 2016. Target for 100% renewables is 2020, Attained 100% RE in 2020, 100% RE in 2019.

3. Projects

Enel Green Power North America has begun operating two new clean power plants, including its first renewables-plus-storage hybrid project.

The 181 MW **Lily solar + storage project**, located east of Dallas, is the company's first hybrid project in North America that integrates a renewable energy plant with utility-scale battery storage. The project includes 55 MW DC of battery storage, part of Enel's installation of around 600 MW of new storage capacity on the Texas power grid by 2022. Enel also began operations of the 140 MW Rockhaven wind farm in Oklahoma. This project was completed in 2021.

https://solarindustrymag.com/enel-green-power-begins-operations-for-texas-solar-storage-project

EDP Renovaveis SA, the Portuguese arm of EDP Renewables, announced that it has sold an 80% equity stake in the 200 MW **Riverstart Solar project** to Toronto-based investment firm Connor Clark & Lunn Infrastructure.

Hoosier Energy Rural Electric Cooperative, which buys power on behalf of 18 electric cooperatives in Indiana and Illinois, signed a contract in early 2018 to buy power from the 200 MW project. Riverstart is being developed in Randolph County, right near the Ohio border. EDP Renewables is building the project and expects to have it online in 2022, delayed after an initial expected start date in 2021.

https://pv-magazine-usa.com/2022/01/03/edp-renewables-sells-stake-in-200-mw-solar-project-to-connor-clark-lunn/

Doral Renewables LLC ("Doral") announced today that it has acquired **Brenneman Solar Project** from AVANGRID, Inc. The Project is a nominal 150 MWac utility-scale solar photovoltaic development project in Macon County, GA.

The Project is located in the Southeastern Electric Reliability Council (SERC) energy market, one of the fastest growing areas in the United States in terms of solar power generation potential. The Project has secured almost 1,600 acres under long term leases with local landowners and has a signed interconnection agreement with Georgia Power.

Construction is in progress on this project.

https://www.businesswire.com/news/home/20211221005567/en/

Oberon I & II Solar PV Park is a 500MW solar PV power project. It is planned in California. The project is currently in financed stage. It will be developed in single phase. The project construction is likely to commence in 2022 and is expected to enter into commercial operation in 2023.

The project is being developed and currently owned by Intersect Power.

https://www.power-technology.com/marketdata/oberon-i-ii-solar-pv-park-us/

Canadian Solar Inc. announced its wholly owned subsidiary, Recurrent Energy, LLC completed a purchase and sale agreement with Appalachian Power for Recurrent's **Firefly Energy solar project** located in Pittsylvania County, Virginia. Firefly Energy is expected to be operational in the 2nd quarter of 2024.

Firefly Energy has a capacity of 150 MWac, Appalachian Power's largest solar energy acquisition to date. Once completed Firefly Energy will help the utility meet its clean energy requirements under the Virginia Clean Economy Act (VCEA).

https://pv-magazine-usa.com/2022/01/05/appalachian-power-purchases-firefly-energy-solar-project-in-virginia/

Solar Developer Innovative Solar Solutions (ISS) seeks to offload **IS206**, a 300 MW project, and **IS416** a 180 MW project.

The larger of the two, IS206, is sited on 2305 acres in Jones County, Texas and totals 300 MW in capacity. The project has an estimated commercial operation date of Q1 2023. The project has undergone initial design and equipment selection, has acquired all utility interconnection request documentation and required attachments.

The 180 MW project is in Castro County, Texas, and has an estimated commercial operation date of April 20, 2023.

https://pv-magazine-usa.com/2022/01/04/acquisition-sought-for-four-texas-solar-projects-with-690-mw-combined-capacity/

Tesla recently uploaded a video introducing its latest energy storage project in Angleton, Texas. Tesla installed 81 Megapacks in Angleton totaling 200 MWh of energy.

According to Tesla, the Megapack storage project will allow Angleton to participate in the energy storage market and support the Texas grid during outages. Tesla's video reminded people of the Texas Big Freeze in February 2021, when parts of the state lost power for three days. With Angleton's Megapack project, Tesla can help support the grid in Texas during events like the Big Freeze.

Based on official documents from Angleton obtained by Teslarati, the 81 Megapack project started with a proposal submission in 2019. The proposal described a **"Gambit" Energy Storage Park Project**. In March 2021—after the Big Freeze—Bloomberg reported that Tesla registered a subsidiary named Gambit Energy Storage LLC that planned to quietly build more than a 100 MW energy storage project in Angleton, Texas.

https://www.teslarati.com/tesla-angleton-megapack-big-freeze-preparations/

https://houston.culturemap.com/news/innovation/01-14-22-tesla-megapacks-angleton-texas-ercot/

The Ohio Power Siting Board announced it will hold a public hearing on March 14 regarding **Harvey Solar Project**, LLC's proposal to construct an up to 350 MW solar project in Licking County, just east of Columbus.

The project is being developed by Harvey Solar Project, LLC, a subsidiary of Open Road Renewables. Project will start construction in late 2022 and be completed in 12 to 18 months.

https://www.harveysolar.com/

The 135 MW **Conway Solar project**, located near Happy, Arkansas includes a $533 million multi-project financing package. The developer is Lightsource bp. The off-taker is Conway Corp.

https://pv-magazine-usa.com/2022/01/12/lightsource-bp-closes-financing-on-135-mw-solar-project-in-arkansas-and-345-mw-solar-project-in-louisiana/

In late December, Lightsource bp closed on a $376 million multi-project financing package and mobilized construction on its 293 MW **Sun Mountain solar project** in Pueblo, Colorado, and its 173 MW **Bellflower Solar project** in Indiana.

Lightsource bp will build, own and operate the Colorado solar facility and deliver the energy it generates to Xcel Energy under a long-term power purchase agreement. The solar project is Lightsource bp's second in Pueblo, representing cumulatively almost 600 MW of solar capacity. This project will be completed in 2022.

The Bellflower Solar project is about 40 miles east of Indianapolis in Henry and Rush Counties. A power purchase agreement with Verizon Communications Inc. was announced in early 2021. This project will be completed in 2022.

https://www.renewableenergyworld.com/news/lightsource-bp-lines-up-financing-for-480-mw-of-solar-capacity/

Green Power EMC, the renewable energy supplier for 38 Georgia Electric Membership Corporations (EMCs), and Silicon Ranch announced that the companies have come to terms on an agreement to develop a 252 MW portfolio of solar projects, all set to be located in Georgia.

The capacity is set to come across three separate installations, all of which Silicon Ranch will fund, construct, own, operate, and maintain, while Green Power EMC will purchase all the energy and environmental attributes generated by the facilities on behalf of its member cooperatives.

Snipesville III is expected to be the first project in the portfolio to reach commercial operation, a 107 MW slated for construction in Jeff Davis County, west of Savannah. Construction is expected to commence later this year, and the facility is scheduled to be operational by mid-2023.

https://pv-magazine-usa.com/2022/01/13/green-power-emc-silicon-ranch-announce-252-mw-georgia-solar-portfolio/

Renewables developer and operator Leeward Renewable Energy has signed power purchase agreements (PPAs) with telecom company Verizon for a portfolio of under-development solar projects.

PV projects included in the deal are the 200MW ***Horizon Solar*** *installation, on which construction is due to begin in September in Frio County, Texas, and be completed by the end of 2023, and the 160MW* ***White Wing Ranch Solar farm*** *in Yuma County, Arizona, which is expected to be fully constructed before July 2024. Both projects will feature thin-film modules from First Solar.*

https://www.pv-tech.org/leeward-renewable-energy-signs-ppas-with-verizon-for-360mw-of-solar/