

# When solar meets storage

**Colocation** | Solar and energy storage were described by Elon Musk as going together “like peanut butter and jelly”. Andy Colthorpe meets some of the players creating this winning combination in the US.



Image: Recurrent Energy.

**F**irst, some quick stats: out of 10GW of battery storage additions planned for deployment in US utility service areas over the next two years —around 60% — is paired with solar, according to figures from the US Energy Information Administration (EIA) released in March.

Solar-plus-storage is becoming a massive part of the renewable energy market in the US. In Vol.28 of this journal, Lawrence Berkeley National Laboratory (Berkeley Lab) researcher Will Gorman noted that as of the end of 2020, there was about a gigawatt of solar-plus-storage in operation at 70 sites.

Then, utility interconnection queues, Berkeley Lab found 160GW of solar PV being developed that was paired with batteries. Of course, not all of this will be built by a long shot and certainly given the challenges of securing interconnection some of it may not be built for several years, but clearly a lot will.

If you haven't read Gorman's article, we'd urge you to go back and do so. Among the fascinating insights is the assertion that hybrid resources — pairing energy storage with solar or wind (or both) — isn't always the best solution versus standalone.

The high value of a grid intercon-

nection point that the renewable and batteries can use, as well as the federal investment tax credit (ITC) incentive which applies to solar-plus-storage but not to standalone storage, are strong drivers for the phenomenal growth in interest in hybridisation.

But of course, in many cases solar-plus-storage does work very well indeed — among Elon Musk's many pronouncements was a then-famous 2016 quote that the pairing is like “peanut butter and jelly”.

We spoke with four companies that are putting that metaphorical sandwich together in the field. Broadly speaking, they are active in two scales of solar-plus-storage: very large utility-scale power plants and smaller distributed generation projects.

Lucas Moller is head of energy storage at Recurrent Energy, the US-based developer subsidiary of Canadian Solar. Recurrent develops large-scale plants, including Slate in California: 300MW PV with 140.25MW/561MWh of BESS, which the company sold to Goldman Sachs and came online in March.

Jamal Burki is president and Joonki Song VP of marketing and supply chain management at IHI Terrasun Solutions. The full lifecycle services provider for solar-plus-storage is a subsidiary of

Japanese conglomerate IHI, currently working on the US\$1.2 billion Gemini project in Nevada for developer Primergy.

Mark Frigo is VP for energy storage at Nexamp. Known as a leader in US community solar, based on the East Coast, the company is developing a wave of solar-plus-storage projects at a more distributed level in key markets like Massachusetts.

Mary Cauwels is VP of product marketing at smart energy storage technology and services provider Stem Inc. From a background delivering behind-the-meter batteries — and solar — for commercial and industrial (C&I) customers, Stem Inc is now also in energy storage procurement, integration and operations for distributed level solar-plus-storage, both in front of and behind-the-meter.

## Recurrent Energy - Lucas Moller

“Solar-plus-storage for us to date in terms of executed projects is all California, is the case for most of the market. But, fundamentally, we look at all solar projects in our portfolio as potentially solar-plus-storage. That's just our perspective on how we do project development and plan for future market demands — not today's demands,” Lucas Moller says.

While it seems like solar-plus-storage has sprung up in California almost overnight, in fact it was developers like Recurrent taking that perspective early on which has made it so. Moller refers to Slate, the “star project of sorts”.

Slate was conceived as a solar-plus-storage project from 2015 when interconnection plans were drafted up. Even further back, interconnection requests for solar projects filed by the developer in 2014 included storage.

That “first flag planted” highlighted that the areas large solar projects were being developed in would have enough variable solar generation to need storage to shift energy into later hours sooner rather than later. While the economics didn't pencil out for solar-plus-storage then, Recurrent knew they would before long.

**Slate solar-plus-storage in California, which includes over 560MWh of battery alongside 300MW of PV.**

Image: IHI Terrasun Solutions.



**An IHI Terrasun solar-plus-storage project.**

"We look at all solar projects as solar-plus-storage projects. As it pertains to California, and [more broadly] the Desert Southwest US, there's no such thing as a solar-only project anymore. There is pretty much a fundamental need to add storage to every project to make it economically viable."

In other words, the value of solar-plus-storage is directly associated with the degree of solar penetration.

"The reference, of course, is the duck curve, which is fundamentally driving value in energy shifting. That is creating necessity for storage, but further than that, it's saying any marginal solar that comes online needs to effectively ameliorate the very low or sometimes negative value of midday energy. So, we don't want to create a new power plant that is primarily going to be stranded out there injecting low value power in the middle of the day if it's a standalone PV asset.

For the buyers in these markets, whether it's a regulated market like Arizona or an open market in California, the value of that midday energy is so low in every marginal megawatt of renewable power that when you buy a new plant, you want it to be associated with the ability to shift and not be exposed to that low value in the middle of the day."

#### **IHI Terrasun - Jamal Burki and Joonki Song**

"Four years back, if you did a 50MWh project, you would do a big press release and hold an event. With Gemini, a 1.4GWh, DC-coupled, solar-plus-storage, solar-only charging project, it's really a milestone project that we're working with Primergy on," Jamal Burki says.

IHI Terrasun is also involved with some of the smaller, distributed generation projects — including a recently

completed project in New England ISO territory for Nexamp — and while these are worthy of celebration in their own way, solar-plus-storage on the sheer scale of Gemini, which charges from 690Mwac/966MWdc of PV, shows "how the industry has really come together," Burki says.

The four-hour duration BESS at Gemini will provide solar time shifting, taking cleanly generated power into the evening peak. Joonki Song says Gemini and projects like it show that the combination of solar and storage creates dispatchable power plants.

They may not be 24/7 power plants, but they combine the two technologies to "provide consistent power from when the sun rises and capture energy when the solar generation is higher than the inverter limit and then smooth out in the afternoon".

Conversely, another large-scale project IHI Terrasun is working on, Leeward in California (72MW of PV with 36MW/144MWh BESS), is AC-coupled.

"It's really more of a peak shaving and interconnect firming application and the customer is also planning to use that for voltage regulation," Burki says.

The differences in applications drive the decision to AC-couple or DC-couple: solar-plus-storage projects intended to provide a lot of ancillary services and grid stability will be AC-coupled, while DC-coupling is better suited for doing a lot of solar shifting.

Meanwhile, in terms of technology and system design solar-plus-storage is broadly speaking more complex than standalone energy storage.

"If you have standalone energy storage, the controls are relatively simplistic. You have a signal coming in for charging the batteries from the grid, and a signal coming in for discharging it, so the controls piece is relatively straightforward," Jamal Burki says.

Standalone storage's two main use cases are to provide either short-term peak reduction or ancillary services, or both. As alluded to by Joonki Song, solar-plus-storage plays more of a power plant role, but of course, the batteries there can also provide other applications.

While standalone and solar-plus share some complexities around making sure batteries are healthy, state-of-charge management is in place and so on, for DC-coupled projects in particular, there is also a "lot of technology that needs

to go in" to ensure solar PV otherwise clipped during times when generation goes above that inverter limit is captured efficiently.

The market continues to evolve and Burki says "tremendous improvement" is being seen in the technologies, in batteries, but perhaps even more so in inverters. All of the Tier 1 inverter companies are already providing AC-coupled and growing numbers are adding DC-coupling too.

Over the last three years, IHI Terrasun has doubled down on developing solar-plus-storage controls and monitoring for DC-coupled systems and partnered with two inverter companies to bring solutions to market.

Where previously a solar-plus-storage project was more like two separate systems operating side by side, integrated controls create "green power plants": "so you can start to think in those terms — a dispatchable renewable solar power plant," Burki says.

"We see that trend continuing and growing."

#### **Nexamp - Mark Frigo**

"If you're in solar, you have to be in energy storage. They go together, like Yin and Yang," Mark Frigo says.

Nexamp has been around since 2007 and started ramping up its energy storage efforts two or three years ago, to the point where it now has 140MW of distributed solar-plus-storage or standalone storage in construction or in operations, largely in the northeastern US.

When asked if there may be a 'one size fits all' solution for US solar-plus-storage, the answer is "an emphatic no," because depending on which state your projects are in and what opportunities they will target, the batteries can be solving different problems, Frigo says.

For instance, two Nexamp projects recently brought online in Massachusetts and paired with Nexamp community solar PV installations have four distinct revenues associated with them.

"One, they're part of a state programme called Solar Massachusetts Renewable Target (SMART). Two, they're part of [another] state programme called Clean Peak. Three, they are a capacity resource and they are also a frequency regulation resource for the independent system operator, ISO New England."

Elsewhere in New York, another project





Image: Stem Inc.

is being developed for a utility as a non-wires alternative to building out transmission and distribution infrastructure. It's still paired with solar, but the energy storage's main use case is to mitigate a substation overload in the utility's service territory.

As Frigo describes it, there are only a handful of US states that have put in place incentives and programmes to move forward the progress of clean energy development and associated energy storage, Massachusetts, New York and California being prime examples.

Outside of those leading regions, in the US market, there are generally two major drivers for solar-plus-storage. One is the ITC, which can lower the capex cost of the equipment by up to 30%.

Storage is eligible for the ITC if colocated with solar generation and charged at least 75% to 100% of the time from that PV annually. The closer to 100% you get, the closer to that full ITC capex reduction you get.

"The reason for that is simple. The ITC is meant for renewable generation and if instead of charging from the solar, you charge from the grid, you have no idea of where that power is coming from," Frigo says.

The other option is in creating what Nexamp calls "a shaped product", adjusting the shape of the solar generation curve to meet demand when most valuable, typically in the early evenings and at other peak demand times. By adding storage, instead of giving a customer a take-as-is type of power purchase agreement (PPA), generation is provided at different times based on the customer need.

Frigo argues that the ITC should

be extended to standalone storage, for instances where pairing with solar doesn't necessarily make sense. However he also acknowledges that with batteries as a relatively new phenomenon on the grid, these things take time to move through regulatory and political steps. That includes solar-plus-storage as much as it does standalone.

#### Stem Inc - Mary Cauwels

Focusing on Massachusetts, which targets net zero emissions by 2050, Stem Inc's Mary Cauwels explains how the state uses the SMART programme in service of that goal.

SMART pays a per kilowatt-hour rate for all solar production for a 20-year term. Recently the administration of Governor Charlie Baker doubled its target to 3.2GW. It incentivises the addition of battery storage with state-provided funds, paid by the utility to the project owner.

Massachusetts' Clean Peak Energy Standard meanwhile incentivises clean energy tech that supplies electricity or reduces grid demand during seasonal peak demand periods, as established by the state's Department of Energy Resources (DOER).

For Stem Inc, as a California headquartered tech company, it was a question of building on its experience of delivering solar-plus-storage in its home market for behind-the-meter commercial and industrial (C&I) customers and adapting those offerings for a market which is characterised by more complex — but rewarding — use cases.

That meant configuring the company's Athena artificial intelligence-driven software platform and bidding

**"This is what our planet needs," Mary Cauwels says.**

algorithms to tackle applications that earn those four distinct revenue streams that Nexamp's Mark Frigo referred to.

"We're optimising charging the battery from the solar and then dispatching the solar, dispatching the batteries' stored energy to the market, as appropriate, into the different value streams: for the wholesale market in ancillary services and forward capacity markets at the right time, so we can capture the full value of the solar," Cauwels says.

Cauwels offers a simple revenue breakout of a solar-plus-storage system operating in Massachusetts.

"We're seeing about 34% of the revenues coming from the energy market. About 27% coming from forward capacity markets, 15% coming from real time reserves, 12% coming from clean peaks, and about 12% coming from frequency regulation. There's a really interesting kind of spread across all these different value streams that solar-plus-storage is able to participate in."

In the near term, Stem Inc sees a bright future opening up in Connecticut, where regulators want 580MW of a 1,000MW energy storage deployment target by 2030 coming from aggregated behind-the-meter systems. Hawaii will continue to be a hotbed of solar-plus-storage as it has for years, pushed on in particular by Hawaiian Electric's Battery Bonus incentive programme which just got extended.

All of this pushes in the right direction. Cauwels says it is important to recognise how far the clean energy movement has come with just solar alone in the past, and how much more will be done now energy storage has hit the mainstream.

In the last five to 10 years, without energy storage a lot of excess solar energy was generated and wasted, meaning fossil fuels were used to meet peak demand. With energy storage, more clean energy can be absorbed, injected into the grid and add more flexibility as more and more renewable energy is integrated into the networks.

"This really helps shift loads better, absorb more low cost clean energy, during optimal times and really discharge energy, when more expensive greenhouse gas emitting conventional resources would have otherwise been used," Cauwels says.

"This is what our planet needs. This is the purpose of what wind and solar are all about and storage is one of the answers to bringing that intermittent resource into play more responsibly." ■