

US Solar & Alternative Energy

The Real Battery Storage Opportunity

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We see real interest for batteries – in the C&I and utility markets

Following the much discussed TSLA launch of their residential battery product, we dug into the economics of storage in the context of both utility-scale and C&I solutions. We emphasize the residential economics look particularly poor when compared to generator alternatives, but alternatively emphasize an improving opportunity to install batteries in utility-scale, and more notably C&I contexts under which incumbent utilities already charge high fixed tariffs. While capacity payments largely remain uneconomic for storage today (highest consistent prices in NYC though does come close today), we see the opportunity as tiering to the C&I opportunity where fixed charges can be even higher in discrete circumstances as well as into the existing utility-scale procurements.

It's all about the fixed tariffs and capacity charges

In sharp contrast to the economics of solar, when net metering and high variable rates dictate the economics du jour of this resource, the complement exists for Storage. In this instance, the higher the fixed charge – particularly the peak demand charge/capacity market, the more appealing the product. With many utilities typically fixing their demand charges predicated off peak load, consumers at all sizes tend to be highly incentivized to reduce their peak where possible (fixed portion of C&I bills remain in ~35-40% range).

Storage is similar to solar, circa a decade ago...

We see the opportunity around storage as eerily familiar with solar a decade ago, both in terms of the rapid pace of the cost trajectory through the near-term as well as in the context of its properties to offset utility-bills. We see solar and storage as direct complements tackling the volumetric and fixed components of the utility bill. While we're clearly not calling for customers to disconnect en masse (far from that given disparate reliability products), it certainly chips away at another meaningful value proposition.

What's the cost? Looking at ~\$400/KWh by ~2018

Many of the latest RFPs appear to be pricing in the \$350-450/kWh range (reflecting inverters, etc but ex-transformer), substantially lower than systems of late in the \$500-700/kWh ballpark. With most systems contemplated to shift peak load (~at 4-hours), this translates to an all-in cost of ~\$1,500/kW. This is ~60% below TSLA's resi costs.

Who's the real winner here? Solar Devcos and YieldCos

Taking the same playbook from recent years around solar deployment, we suspect independent renewable developers will all diversify their offerings to include battery development efforts to both medium-scale C&I customers, as well as offer grid-scale solutions. It's the very same customers who are likely to engage on cost reduction efforts via storage that the IPPs have engaged with previously. For instance, we see the recent trend to diversify into wind from solar as illustrative of this willingness to expand. We see storage as a further complementary asset class, ultimately expanding the eligible asset class for drop-downs. While AES is the clear market leader in battery deployment, we suspect others will quickly emerge (NRG, SUNE, etc). Specifically, we suspect SUNE will be among the first serious adopters.

Feeding the beast? Storage offers another avenue for YieldCo growth

While still quite modest in terms of total addressable market (TAM) today at ~1.2GW in California and <1GW in PJM, we see a near-term total deployment opportunity as being in the ~\$3 Bn range through ~2019. We suspect much of this, particularly given its contracted nature for non-ancillary products, will end up in the hands of YieldCos. The question remains whether customers will opt to pursue the same 20-year leasing model for batteries as have for solar panels rather than purchasing systems outright.

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Finding opportunities requires digging through utility rate tariffs

While much of the opportunity requires understanding the 'net demand charge' opportunity, we emphasize the real potential gap in the value equation is between the peak demand charge (predicated on annual peak usage) and the max load charge (predicated on daily peak usage). In speaking with developers, there appears to be economic value propositions across several markets, including CA. We suspect it is this angle that could drive the most interest in storage across many other utility territories. We look for growing focus on this angle of the bill in coming months.

Near-term, it's all about short-duration opportunities via Ancillaries

The most economic opportunity remains the Frequency Response market. In PJM it's the Reg D – Ancillary Services market. We see compensation as exceptionally attractive and see the bulk of near-term development activity oriented towards capturing this ~\$100/kW-yr revenue opportunity off a short duration (and cheap) ~30min-1 hour battery. We emphasize batteries largely scale linearly, suggesting shorter-duration batteries are the 'most' incremental today. While largely limited to the PJM market today, we suspect others will soon follow their lead (ERCOT?). We suspect this market would well become quickly saturated with a meaningful reduction in overall compensation.

Getting both energy and capacity compensation: Holy grail

We note some discussion in the industry around tapping multiple revenue streams for interconnected batteries. We suspect improving tariffs from power markets will continue to make such compensation possible for both the DR-like attributes in reducing peak during emergency events alongside compensation for energy and ancillary benefits provided. We suspect much of this focus will eventually mesh into the wider question of Demand Response compensation.

Meshing the Demand Response market into the storage opportunity

An alternative path to think of storage market penetration is effectively bidding into existing Demand Response regimes like that in PJM. While the number of hours of DR required is a critical question (4-7hours), this is likely to gain much more attention. PJM for instances requires 6-hours of reduction to qualify as a Demand Response product, making it relatively uneconomic. In California, the product procured thus far has been ~4-hours (at least in the initial SCE solicitation). In the case of instance, APS has indicated it was seeking up to 7-hours in its own RFO.

So where are the primary markets for DG and Utility-scale storage?

The key markets to track are California, New York, and Hawaii aside the PJM in terms of utility-scale opportunities; AZ's two smaller utilities have also recently explored grid-scale storage at the urging of the ACC. We continue to see the California IOUs as crucial in pushing forward economics and scale on the subject.

Warranties are very much key in developing technology

We continue to note a discrepancy in the market place among developers seeing a wide variety of products available in the Lithium Ion (LiOn) space. We emphasize those without warranties are not financeable. We remind investors that systems are typically designed to last ~10-years, with batteries swapped out with the existing balance of system infrastructure kept in place. We emphasize among the cheapest developers of batteries today (BYD) has among the weakest warranty options.

Software is the key – particularly with DG focus

A pervasive focus among all the storage developers we have spoken with remains the need for software integration, particularly for behind-the-meter solutions. Knowing when to reduce consumption in an effort to mitigate annual peak demand charges remains a multi-faceted challenge. We suspect those with the best software could well prove the 'best' storage developers in this nascent marketplace.

Other avenues – Defense sector is another key angle

With the defense sector as already having been a voracious consumer of solar products to reduce their dependency on the grid, batteries appear a similarly attractive solution to improve resiliency of these sites. Stay tuned for meaningful customer orders here too.

What is the latest TSLA announcement? Focuses on residential offering

Tesla and SolarCity two are partnering to offer an installed battery at \$7,140 for a 10Wh system to new customers (\$5k with a 9-year lease); this would imply a ~\$700/kWh, a meaningful premium to more mid-and-large scale opportunities. TSLA pins the price of the battery-only residential system (ex-inverter, etc) at \$3,500 for a 10kWh system (~\$350/KWh).

Looking at the flipside: Resi product is thoroughly uneconomic

When compared to conventional backup generators that range in price from \$2,000-\$3,000 for an 8kW machine, TSLA's residential offering does not compete. Additionally, gas powered generators are much more reliable and have incrementally longer run times. Conversely--the Powerpack, TSLA/SCTY's commercial offering goes for a fully loaded install cost of ~\$50,000 for a 100kWh system, and is economic specifically in urban markets with high demand charges. The Powerpack can be used for peak shaving, charging during off-peak hours and discharging during peak hours, curtailing peak demand. We emphasize residential battery systems will not take off as long as residential rates are meaningfully oriented towards volumetric consumption rather than fixed charges.

What are the Economics of Large-Scale Storage?

We illustrate economics of C&I via storage mini-model

We include a basic model below for a 20-year battery system, reflecting several scenarios of specific demand charges at a 4-hour peak load displacement. While these are quite high at \$10/kW-mo+, they indicate in urban markets (such as NYC, from which these prices are derived), they can indeed make some economic sense. We suspect economics illustrated here can be complemented with further energy and ancillary market revenues, to provide better than just improvements in the demand charge reduction

We see storage economics as working with high fixed charges under 2018 cost curves

Figure 1: Comparing the IRRs under different demand charges

Time Period (Years)	Demand Charge (\$/kW)	IRR	Total System Cost (\$/kWh)
20	\$9.41	-3%	\$400
20	\$12.41	2%	\$400
20	\$15.95	7%	\$400
20	\$17.62	9%	\$400
20	\$20.17	12%	\$400

Source: UBS estimates

Proving Out Just How Poor Resi Economics Remain

Residential offering is cheaper than competing batteries...

TSLA/ SCTY's residential backup offering, the 10kW product that can be tethered to numerous additional batteries, runs at \$3,500 for the battery alone, and the installed cost with BoS equipment and labor totals \$7,140. A 10kWh system can also be leased for \$5,000 for a 9 year contract. Bottom line, this appears meaningfully cheaper than what many had contemplated a residential system could cost, but remains well outside of the context

...But backup thermal generators still provide more value/ reliability

In the example below, we attempt to compare a TSLA 10kWh system and an 8kW natural gas generator. An 8kW conventional NG generator is in the lowest kW

range that you can purchase for a residential stationary system. Comparatively, TSLA is offering a 10kWh battery as their residential backup system.

With a cost of \$7,140, and a continuous output of 2kW, it is significantly more expensive than a NG generator, installed at ~\$4,400 and having a continuous output of 8kW— and a theoretically unlimited continuous run time (contingent on the availability of the fuel source). The fuel cost over a 9-year span will run the total to ~\$5,300, assuming flat NG pricing. TSLA's lease product will run for \$5,000 over 9 years, which is cheaper than the 8kW generator, but with much less generator capacity.

TSLA backup product isn't competitive in the current market

The underlying conclusion here is that comparing a stationary fuel generator to TSLA's battery backup unit isn't apples-to-apples; fuel generators are much more reliable, can handle significantly longer run times, and are cheaper from an ownership perspective. As a backup option, we see TSLA's offering as more of a luxury item for homeowners not concerned with reliability or long-term power outages. For individuals with PV systems, the TSLA product can offer some hedging against outages, at a higher cost than competing products. The product may be an attempt to offload some of the large fleet of Panasonic batteries the company has in stock, but we look for more value and innovation from future offerings coming out of the giga-factory.

TSLA's 10kW backup storage system is not cost or output-competitive with incumbent generator offerings

How extreme of a residential backup are customers looking for?

Perhaps a true 'backup' context, customers would desire to leverage batteries to address a lack of fuel, because presumably an extended electrical outage has limited the ability for regional suppliers to provide constant diesel or natural gas. Bottom line, we see the simple answer here as maintaining an adequate inventory of fuel to address.

Figure 2: TSLA 10kWh Backup

Battery Size (kWh)	10
Battery Price (\$/kWh)	\$350
Total Battery Price	\$3,500
Total Installed Cost (\$/kWh)	\$714
Total Storage System Installed Cost	\$7,140
Total Cost over 9 Years (Own)	\$7,140
Total Lease Price (\$/10kWh)	\$5,000
Continuous Run Time	5 Hours
Continuous Output (kW)	2

Source: TSLA, UBS Estimates

Figure 3: NG Generator 8kW Backup

Generator Size (kW)	8
Generator Price (\$/kW)	\$ 275
Total Generator Cost	\$ 2,200
Total Installed Generator Price (\$/kW)	\$ 550
Total Installed Generator Cost	\$ 4,400
Fuel Type	Natural Gas
Fuel Consumption	169 ft ³ /hr
Fuel Cost (\$/ft ³)	\$ 0.011
Fuel Consumed/ Year (ft ³)	8,619
Fuel Cost/ Year	\$ 95
Total Cost Over 9 years	\$ 5,253
Continuous Run Time	Unlimited
Continuous Output (kW)	8

Source: GE, EIA, Eaton, UBS Estimates

Statement of Risk

Risks for Utilities and Independent Power Producers (IPPs) primarily relate to volatile commodity prices for power, natural gas, and coal. Risks to IPPs also stem from load variability, and operational risk in running these facilities. Rising coal and, to a certain extent, uranium prices could pressure margins as the fuel hedges roll off Competitive Integrations. Further, IPPs face declining revenues as in the money power and gas hedges roll off. Other non-regulated risks include weather and for some, foreign currency risk, which again must be diligently accounted in the company's risk management operations. Major external factors, which affect our valuation, are environmental risks. Environmental capex could escalate if stricter emission standards are implemented. We believe a nuclear accident or a change in the Nuclear Regulatory Commission/Environment Protection Agency regulations could have a negative impact on our estimates. Risks for regulated utilities include the uncertainty around the composition of state regulatory Commissions, adverse regulatory changes, unfavorable weather conditions, variance from normal population growth, and changes in customer mix. Changes in macroeconomic factors will affect customer additions/subtractions and usage patterns.

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