Energy Storage Systems (ESS) Market Outlook 2019

The Hickory Group, LLC
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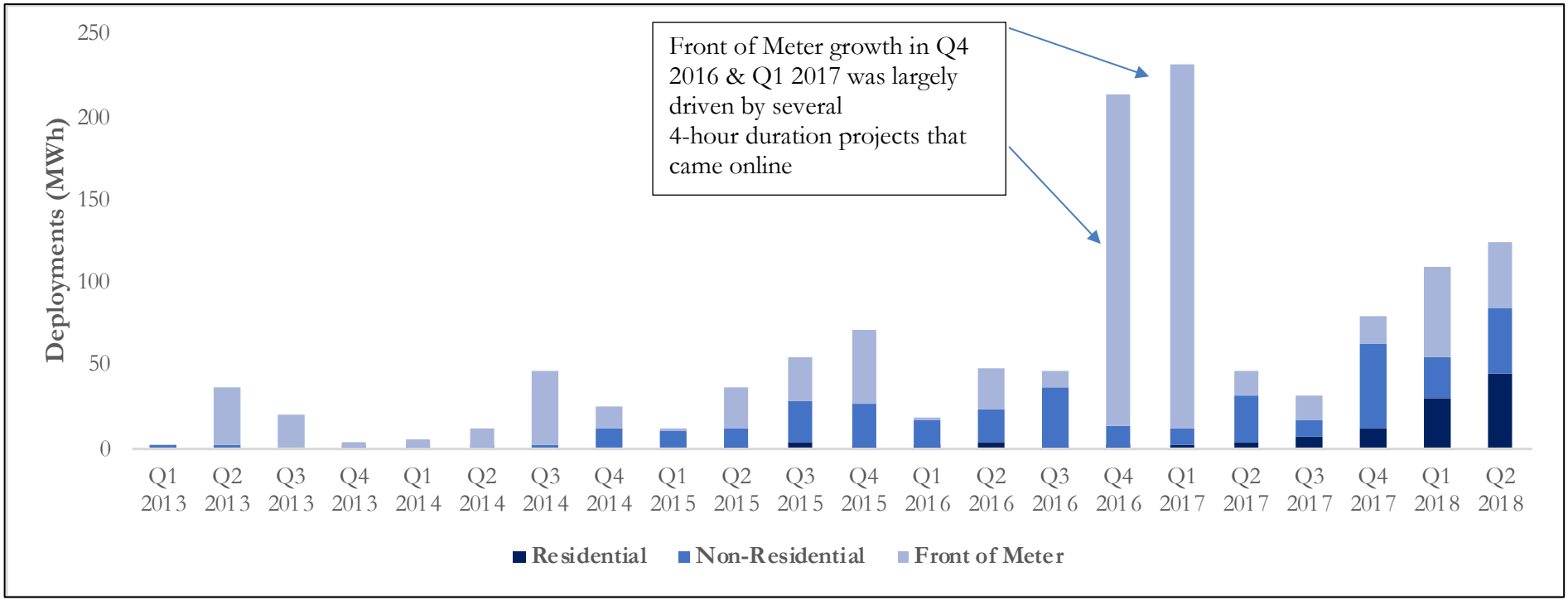
Energy Storage: Alternative Energy's Next Growth Industry

By storing clean power in a battery, people and utilities alike can use that power at night when the sun isn't shining, withstand power outages that are growing in frequency, keep the grid stable during times of high usage, and make 100% renewable, clean energy achievable.

- The global energy storage market is set to draw in $1.2Trn investment by 2040 and the cost of batteries is also set to significantly decrease
- Until recently the energy storage technology was prohibitively expensive and did not make economic sense for many participants across many alternative energy verticals. What Companies are beginning to do is create a mainstream market for energy storage, like they've done for solar PV as the economics are following a similar trajectory as solar PV
- Analysts project that the U.S. energy storage market will reach well over $500Mm in sales this year

Exhibit 1

Historical U.S. Quarterly Energy Storage Deployments by Segmen:t Q1 2013 – Q2 2018 (MWh)



Source: GTM Research

1. Front of Meter refers to energy storage interconnected on distribution or transmission networks or in connection with a generation asset.

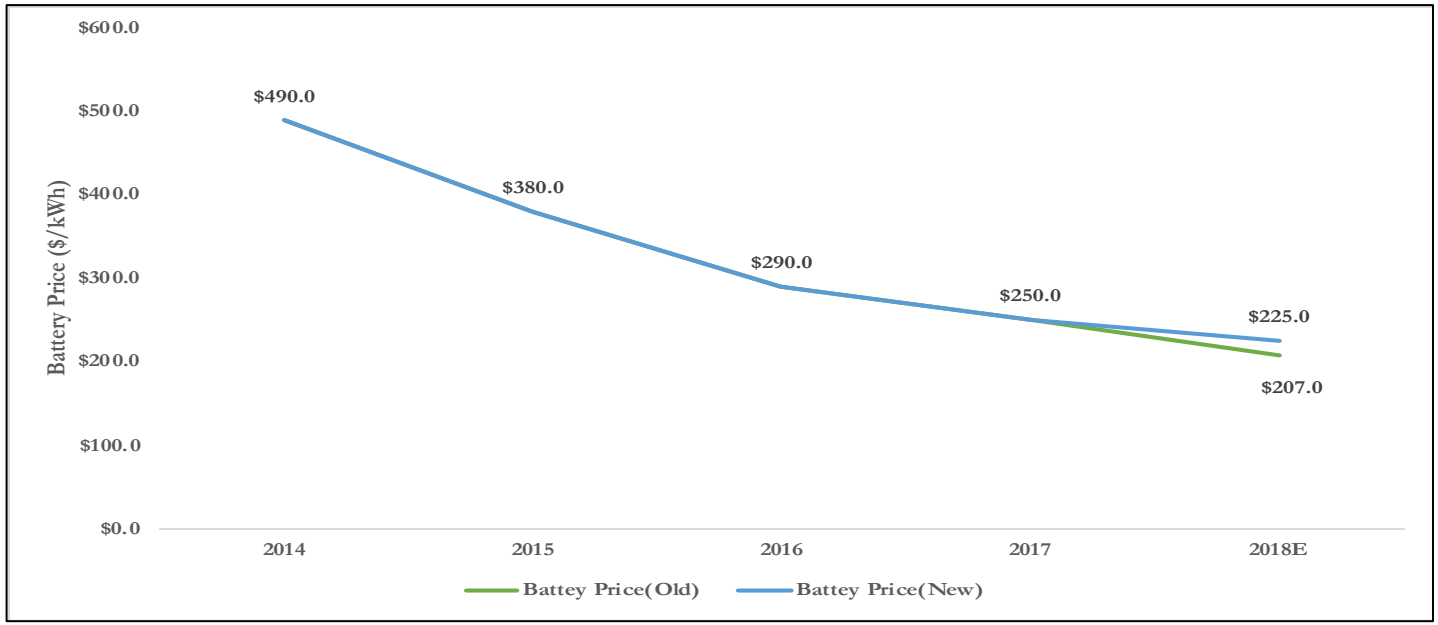
Energy Storage: Increasing Economic Feasibility

The steep decrease in prices in the past few years is in part due to technological improvements as well as economies of scale. However, fierce competition between the major manufacturers has been instrumental in bringing down prices.

- Over the past 5 years the cost per kilowatt hour of Lithium Ion (Li-ion) batteries has dropped c. 65%. This reduction in the price of Li-ion batteries is one of the key reasons for the substantial growth in the energy storage industry
- So far Tesla has been the leader in reducing the costs of their Lithium Ion battery. The reason for this is twofold. They participate in two industries where Li-Ion batteries are certainly needed for both solar and electric vehicles (EV's) and they were one of the first entrants into the market. It is well known that Tesla has the highest production volume and lowest cost of Li-ion batteries in the world, but more detailed figures on these costs only emerge occasionally
- The graphic below depicts the drastic decline in costs of Li-ion batteries over the past few years and demonstrates the increasing economic feasibility of batteries for both EV's and alternative energy such as solar and wind power

Exhibit 2

Lithium-Ion Battery Prices: 2014A-2018E ($/kWh)



Source: GTM Research

"We think at the cell level probably we can do better than $100/kWh (a significant discount to costs achieved by peers) maybe later this year ... depending upon [stable] commodity prices" **Elon Musk, CEO of Tesla**

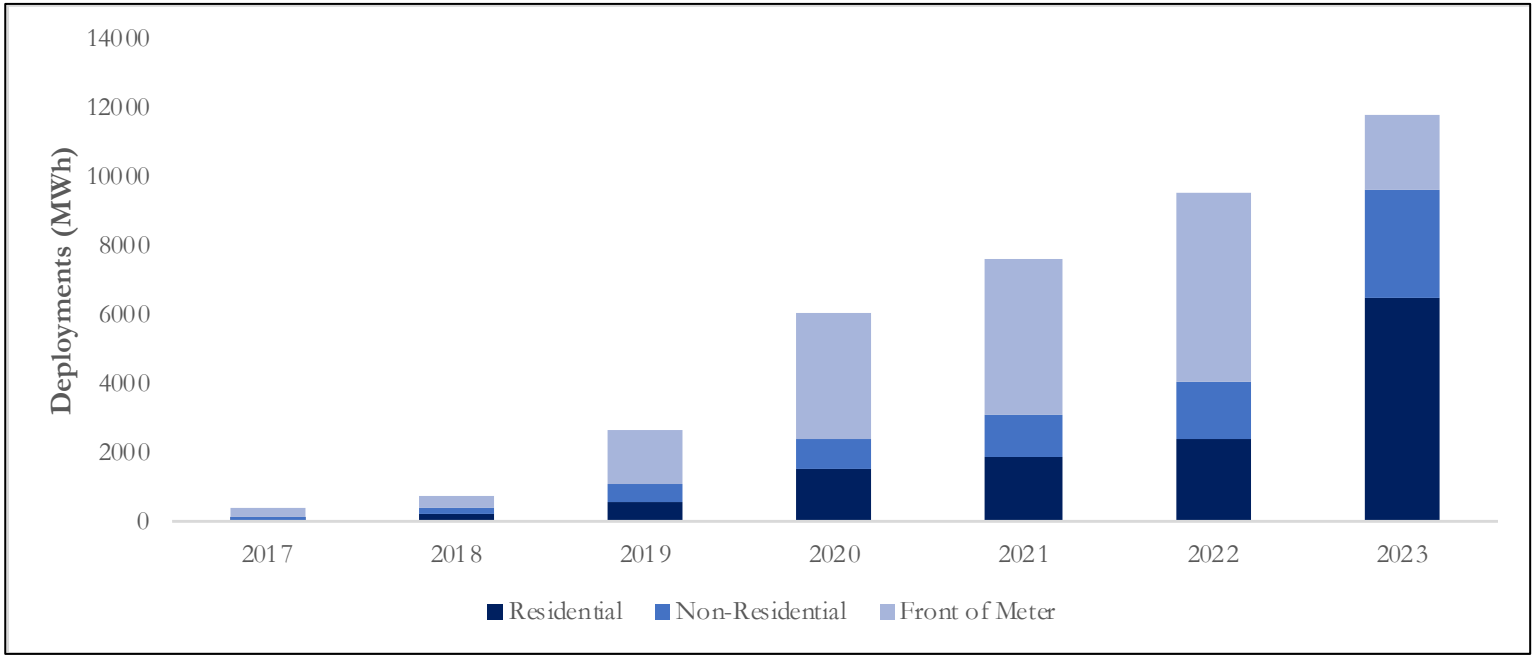
Energy Storage: Residential Storage, A Key Growth Sub Sector

The headline for residential energy storage growth during Q2 2018 is just as significant as the 9X growth in Q1 2018. Although this time the overall market growth was 200%, a new "non-emergency" peak volume of installations, and relatively strong contributions from all three sectors

- The residential market has shown the most consistent growth of the three sectors, with positive quarter-over-quarter numbers since the beginning of 2017 – cumulatively experiencing 60.6% quarterly growth. In fact, during this quarter residential was the leading sector in both MW and MWh installed. Customers' increased interest in self-consumption and grid resilience are main factors driving this growth in the near-term
- However, supply chain issues have and may still weigh on the growth of the industry. Researchers estimated that over the next 15 years, there will likely be enough raw materials available to meet lithium-ion battery demand. But if ESS companies don't work out supply chain issues, production could slow down. Cobalt which is also used in iPhones is most vulnerable to potential supply chain issues

Exhibit 3

US Annual Energy Storage Deployment Forecast: 2018E-2023E (MWh)



Source: GTM Research

"The industry is bullish about continued state action designed to ensure fair and equal access for storage to the grid and markets.. As barriers to storage are removed in state markets, we will likely see new state names on the leaderboards for residential, non-residential, and front-of-the-meter deployments." **Kelly Speakes-Backman, CEO of the Energy Storage**

Energy Storage: Technology Innovation

Energy storage systems (ESS) provide a wide array of technological approaches to managing and storing the global power supply. To help understand the diverse approaches being deployed around the world, THG has divided energy storage technologies into six main categories:

- **Solid State Batteries** - a range of electrochemical storage solutions, including advanced chemistry batteries and capacitors
- **Flow Batteries** - batteries where the energy is stored directly in the electrolyte solution for longer cycle life, and quick response times
- **Flywheels** - mechanical devices that harness rotational energy to deliver instantaneous electricity
- **Compressed Air Energy Storage** - utilizing compressed air to create a potent energy reserve
- **Thermal** - capturing heat and cold to create energy on demand
- **Pumped Hydro-Power** - creating large-scale reservoirs of energy with water

Below are energy storage technologies that we see shaping the energy storage industry at present and also into the future.

Technology	Pioneering Company	Description	Pros & Cons
Lithium-Ion	TESLA	The term "lithium-ion" refers not to a single electrochemical couple but to a wide array of different chemistries, all of which are characterized by the transfer of lithium ions between the electrodes during the charge and discharge reactions. Li-ion cells do not contain metallic lithium; rather, the ions are inserted into the structure of other materials, such as lithiated metal oxides or phosphates in the positive electrode (cathode) and carbon (typically graphite) or lithium titanate in the negative (anode).	**Pros:** High energy density, Low Self-discharge, No requirement for priming, Low maintenance, Variety of types available, Ability to generate high current **Cons:** Protection required, Ageing, Transportation restrictions, Cost of materials, Immature technology (constantly changing and evolving)
Flywheel Energy Storage Systems (FESS)	ABB	Flywheel energy storage functions by accelerating a rotor to high speed and maintaining the power as rotating energy. When that energy is drawn from the system, the flywheel rotational speed is reduced and accelerated when energy is reintroduced. Most advanced flywheel systems are designed high-strength composite rotors suspended by magnetic bearings, and when power is introduced, the can spin up to 20,000 to 50,000 RPMs	**Pros:** Facilitates effective utilization of intermittent renewable sources, Can be combined into smart integrated energy system, Reduces need for increased peak generation capacity, Enhances grid reliability, Allows renewable and fossil source to integrate, Declining costs **Cons:** Energy lost in "round trip" inefficiencies, Additional cost and complexity, Additional infrastructure and space requirements
Redox Flow Battery	VIONX ENERGY	Redox flow batteries (fuel cell), which replace solid electrodes with energy-dense electrolytic compounds (hydrogen-lithium bromate, bromine-hydrogen, organic, etc.) separated by a membrane that charge and discharge as the liquids circulate in their own respective space. Ion exchange occurs through the membrane separator when the electrolytes undergo reduction and oxidation (redox)	**Pros:** Economical, Low vulnerability means to store electrical energy at grid scale, Greater design flexibility, Allows a combination of any storage capacity with any power output capacity, Long service life, Not subject charge/discharge cycle **Cons:** Takes up significantly more space thus not suitable for EV's, Higher upfront cost, Comparably low efficiency of 75% to 80%

Energy Storage: Top Trends for 2019 & Beyond

	Trend	Comments
1	**Energy Storage-as-a-Service(ESaaS) is Becoming a Key Service Model**	ESaaS simply refers to a combination of an advanced energy storage system, an energy management system, and a service contract which can deliver value to a customer by providing power more economically. The model of ESaaS is being replicated elsewhere to generate steady returns for investors. With energy storage opportunities previously avoided by investors due to the complexity surrounding cash flow, ESaaS is a promising development which may attract institutional capital and further grow the industry.
2	**Utilities are Primed to Partner With / Acquire ESS Companies**	The Energy Storage industry in 2017 had a phenomenal year in terms of mergers and acquisitions, with utility and energy companies such as Enel and Agrekko making large acquisitions. In 2018, this trend continued to grow. In H1 2018 there were a total of eight Energy Storage M&A transactions, compared to two transactions in 1H 2017. There were four Energy Storage M&A transactions in Q2 2018.
3	**State and Federal Incentives**	At the federal level, the 30% Investment Tax Credit remains available for energy storage, provided it is coupled with renewable generation. However, increasingly states are introducing measures to promote and support the growing energy storage industry. While 29 states and the District of Columbia currently have Renewable Portfolio Standards (RPS), a growing number of states are also instituting standalone targets and mandates for energy storage procurement. Currently these states include California Massachusetts, Nevada, Oregon, Arizona, and New York. We see this list only getting larger.
4	**Lithium-ion Becoming the Technology of Choice for Solar**	For solar panels, Li-ion battery-powered energy storage is the technology of choice today. The growth of the EV market has contributed to greatly improving this technology over the past few years. As a result, the prices for Lithium-based batteries have been steadily declining by 8% on an annual basis. As it stands, Li-ion batteries comprise c. 99% of the energy storage market share.
5	**Opportunities for Financing Battery Storage on a Project Basis are Increasing**	The improvements in the business model and clearer metrics for revenue/cost of energy storage systems, are providing a renewed focus on project financing for energy storage deals. According to Moody's, an energy storage project that has a long-term contract with a creditworthy counterparty "provides a lower risk profile from a revenue and cash-flow generation perspective than one using a merchant revenue model." As the industry experiments per-project basis, expect to see a clearer structure for project financing in the energy storage space.
6	**Levelized Cost of Storage (LCOS) is Emerging as a Popular Revenue Metric**	The commonly accepted method for predicting revenue is levelized cost of electricity (LCOE) most prominently championed by Lazard. However, this model does not factor energy storage technology into account. LCOS measures the efficiency of energy storage systems in the grid that now handles c. 85% of renewable energy after adding storage. The LCOS formula calculates the cost of storing electricity in energy storage systems and divides that number by the retail price of electricity stored. LCOS has only been in existence for the past few years, and this new metric will continue to evolve and provide a standard metric of providing better insights to the financing sources
7	**Ethical Sourcing is Increasingly Critical for Battery Materials**	While Li-ion battery is the dominant technology used in energy storage systems, many worry about the harmful consequences when procuring the materials to produce same. Li-ion battery containing cobalt is not only hazardous to the environment due to its toxic nature, but, like diamonds, is also found and mined in a select "conflict areas" around the world where human rights are often violated. Moving forward, the industry will either look at alternative solutions for batteries or take caution in selecting their suppliers.

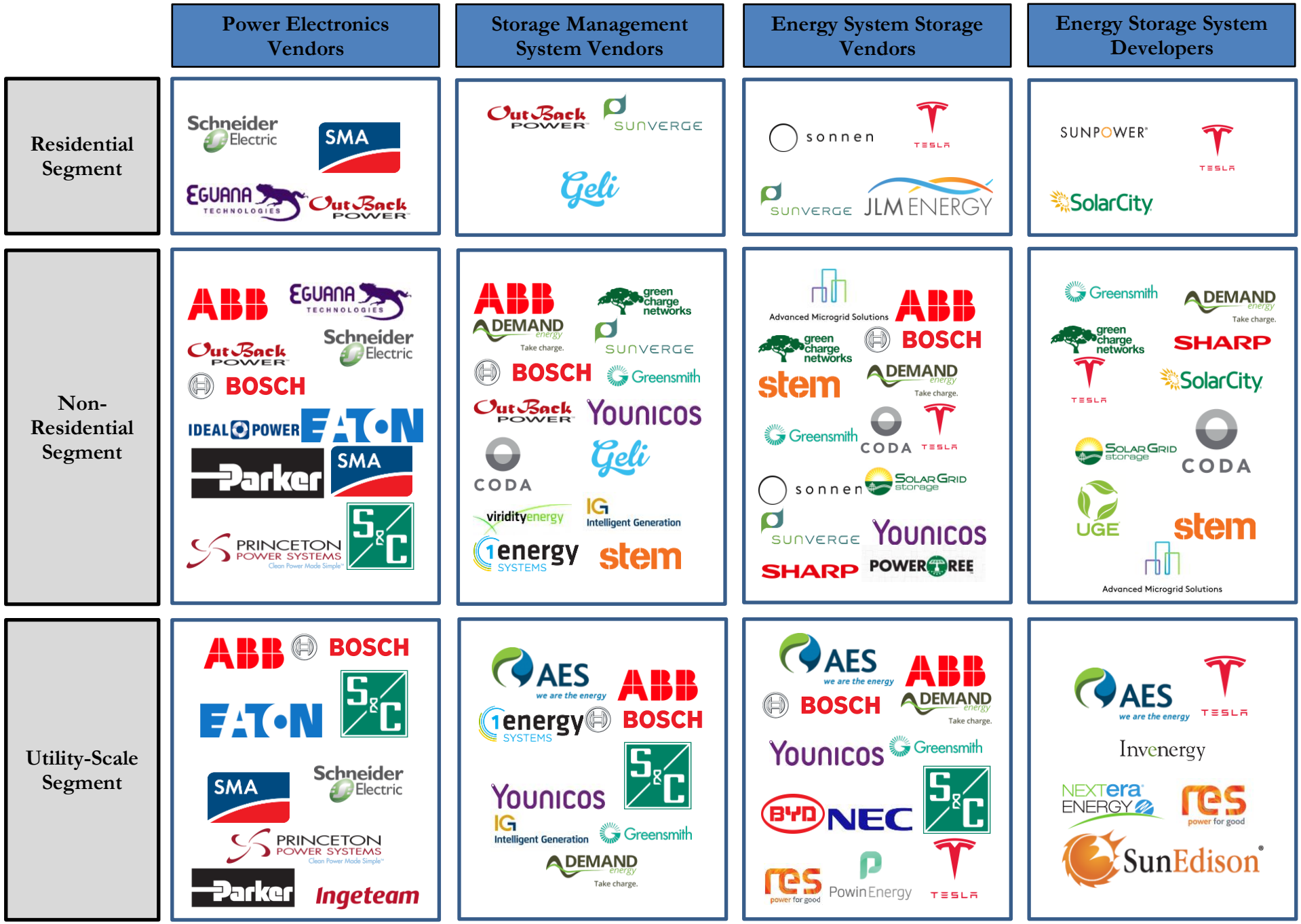
Energy Storage: Recent M&A Activity

Funding for Battery Storage companies in the first 9 months of 2018 was 39 percent higher that the previous year with $783Mm raised compared to the same time period in 2017 at which time funding had reached $563Mm

- Lithium based battery companies received the most funding with $211Mm. Below is a list of the top deals in the ESS industry from 2017/18

Company	Year Completed	Country	Funding Type	Amount ($Mm)	Investors
Greensmith	2017	USA	Acquisition	$170	Wartsila
stem	2018	USA	Series D	$80	Activate Capital
ionic MATERIALS	2018	USA	Series C	$65	Dyson, Samsung, A123, Hitachi, Renault, Nissan, Mitsubishi
Younicos	2017	USA	Acquisition	$52	Agrekko
durapower	2018	Singapore	Undisclosed	$40	Banpu Infinergy Company, K-IX Ace
BATTERY ENERGY STORAGE SOLUTIONS LTD	2018	United Kingdom	Undisclosed	$39	Santander Corporate & Commercial
solid energy	2018	USA	Series C	$34	Undisclosed
24m	2018	USA	Series D	$22	Kyocera Group, Itochu, North Bridge Venture Partners
Geli	2018	USA	Series C	$5	17 Undisclosed Investors
DEMAND energy Take charge.	2017	USA	Acquisition	Undisclosed	ENEL

Energy Storage: Companies to Watch



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