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Grid-Based Energy Storage Represents a \$200 Billion Opportunity

by: John Petersen

February 28, 2010 | about: [ALTI](#) / [AONE](#) / [AXPW.OB](#) / [BCON](#) / [CHP](#) / [ENS](#) / [HEV](#) / [MXWL](#) / [XIDE](#) / [ZBB](#)

A reader sent me a copy of an exhaustive new study titled "[Energy Storage for the Electricity Grid: Benefits and Market Potential Assessment Guide](#)" that was commissioned by the [DOE's Energy Storage Systems Program](#) and prepared by Jim Eyer and Garth Corey. I've been following the work in progress on this report since last summer and have eagerly awaited an opportunity to shift away from the over hyped electric vehicle market and focus instead on a far larger market where cost, performance and substantive business merit will be the only drivers. It looks like my time has finally come. For technology aficionados that want a detailed understanding of what the various grid-based storage applications are, the entire report (232 pages including appendices) is a must read. Over the next few weeks I'll try to extract some high-level technical and market data and translate that information into a form that will be useful to energy storage investors.

The Eyer-Corey Report identifies 17 discrete grid-based energy storage applications, discusses the performance requirements of each application and assesses the 10-year economic potential for each application. The Report also includes a great summary that condenses a couple hundred pages of detail into a single table.

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#	Benefit Type	Discharge Duration*		Capacity (Power: kW, MW)		Benefit (\$/kW)**		Potential (MW, 10 Years)		Economy (\$Million)†	
		Low	High	Low	High	Low	High	CA	U.S.	CA	U.S.
1	Electric Energy Timeshift	2	8	1 MW	500 MW	400	700	1,445	18,417	795	10,129
2	Electric Supply Capacity	4	6	1 MW	500 MW	359	710	1,445	18,417	772	9,838
3	Load Following	2	4	1 MW	500 MW	600	1,000	2,889	36,834	2,312	29,467
4	Area Regulation	15 min.	30 min.	1 MW	40 MW	785	2,010	80	1,012	112	1,415
5	Electric Supply Reserve Capacity	1	2	1 MW	500 MW	57	225	636	5,986	90	844
6	Voltage Support	15 min.	1	1 MW	10 MW	400		722	9,209	433	5,525
7	Transmission Support	2 sec.	5 sec.	10 MW	100 MW	192		1,084	13,813	208	2,646
8	Transmission Congestion Relief	3	6	1 MW	100 MW	31	141	2,889	36,834	248	3,168
9.1	T&D Upgrade Deferral 50th percentile††	3	6	250 kW	5 MW	481	687	386	4,986	226	2,912
9.2	T&D Upgrade Deferral 90th percentile††	3	6	250 kW	2 MW	759	1,079	77	997	71	916
10	Substation On-site Power	8	16	1.5 kW	5 kW	1,800	3,000	20	250	47	600
11	Time-of-use Energy Cost Management	4	6	1 kW	1 MW	1,226		5,038	64,228	6,177	78,743
12	Demand Charge Management	5	11	50 kW	10 MW	582		2,519	32,111	1,466	18,695
13	Electric Service Reliability	5 min.	1	0.2 kW	10 MW	359	978	722	9,209	483	6,154
14	Electric Service Power Quality	10 sec.	1 min.	0.2 kW	10 MW	359	978	722	9,209	483	6,154
15	Renewables Energy Timeshift	3	5	1 kW	500 MW	233	389	2,889	36,834	899	11,455
16	Renewables Capacity Firming	2	4	1 kW	500 MW	709	915	2,889	36,834	2,346	29,909
17.1	Wind Generation Grid Integration, Short Duration	10 sec.	15 min.	0.2 kW	500 MW	500	1,000	181	2,302	135	1,727
17.2	Wind Generation Grid Integration, Long Duration	1	6	0.2 kW	500 MW	100	782	1,445	18,417	637	8,122

*Hours unless indicated otherwise. min. = minutes. sec. = seconds.
†Life cycle, 10 years, 2.5% escalation, 10.0% discount rate.
**Based on potential (MW, 10 years) times average of low and high benefit (\$/kW).
†† Benefit for one year. However, storage could be used at more than one location at different times for similar benefits.

From an investor's perspective, the problem with the summary table is that it focuses on the needs of utilities instead of economic opportunities for storage device manufacturers. As a result, the summary table uses a range of discharge durations, a range of power capacities and a range of economic benefits per kW of nameplate power capacity. Since

investors typically think in terms of megawatt-hours of potential demand and economic benefit per kilowatt hour of storage, we have to take the Eyer-Corey calculations a couple of steps further to arrive at a simple translation that fits an investor's perspective.

In an effort to translate the summary table data into terms investors will understand, I've calculated an average discharge duration and an average economic benefit for each grid-scale application identified in the Report. I've then used those averages to calculate potential demand in MWH, economic benefit per kWh and revenue opportunity to manufacturers. I've also reordered the data based on declining economic benefit per kWh to highlight the inverse relationship between economic benefit per kWh and potential demand in MWH. If you're interested in more detail, I've posted a copy of my Excel spreadsheet [here](#).

I've discussed this methodology with Mr. Eyer and feel comfortable that my potential demand, economic benefit per kWh and revenue opportunity calculations are at least in the ballpark. Since we're dealing with averages of values that covered a wide range to start with, my numbers are best characterized as rough estimates, but they're certainly good enough for a first pass. The summary results of my calculations are set forth below.

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	Potential Demand (MWH)	Economic Benefit (per kWh)	Revenue Opportunity (millions)
7 Transmission Support	13	\$197,486	\$2,652
14 Electric Service Power Quality	90	\$68,760	\$6,156
17.1 Wind Generation Grid Integration, Short Duration	291	\$5,934	\$1,727
4 Area Regulation	380	\$3,727	\$1,414
13 Electric Service Reliability	4,988	\$1,234	\$6,156
6 Voltage Support	5,756	\$640	\$3,684
16 Renewables Capacity Firming	110,502	\$271	\$29,909
3 Load Following	110,502	\$267	\$29,467
11 Time-of-Use Energy Cost Management	321,140	\$245	\$78,744
9.2 T&D Upgrade Deferral 90th percentile††	4,487	\$204	\$916
10 Substation Onsite Power	3,000	\$200	\$600
9.1 T&D Upgrade Deferral 50th percentile	22,437	\$130	\$2,912
17.2 Wind Generation Grid Integration, Long Duration	64,460	\$126	\$8,122
1 Electric Energy Time-shift	92,085	\$110	\$10,129
2 Electric Supply Capacity	92,085	\$107	\$9,844
5 Electric Supply Reserve Capacity	8,979	\$94	\$844
15 Renewables Energy Time-Shift	147,336	\$78	\$11,455
12 Demand Charge Management	256,888	\$73	\$18,689
8 Transmission Congestion Relief	165,753	\$19	\$3,168
Total Cool Opportunity	5,762		\$18,105
Voltage Support	5,756		\$3,684
Total Cheap Opportunity	1,399,653		\$204,799

The color coding in the table represents my attempt to segregate economic benefit per kWh into cool technologies like flywheels, supercapacitors and lithium ion batteries, which are highlighted in blue, and cheap technologies like flow batteries, lead-acid batteries, compressed air and pumped hydro, which are highlighted in yellow.

Last summer I wrote about energy storage on the smart grid and said that in terms of potential demand, the market would be [99.45% Cheap and 0.55% Cool](#). Depending on how you want to classify the voltage support line that I've highlighted in orange, my estimate was either spot-on accurate or off by a half-point. Now that I can refer to a reasonable third-party estimate of storage system values, it's clear that revenue opportunities in smart grid storage will be about 90% cheap, 8% cool and 2% in-between. Any way you cut it, the substantial bulk of the revenue opportunity for energy storage on the smart grid will flow to companies that manufacture objectively cheap storage solutions. There will be meaningful niche markets in the \$1 billion to \$6 billion range for cool technologies like flywheels, supercapacitors and lithium ion batteries, but those niche markets will pale in comparison to the immense opportunities for cheap energy storage technologies.

The following table provides summary information on the pure play energy storage companies I track that are actively working on storage applications for the smart grid. To keep things as simple as possible I've used the same color coding to segregate their planned product offerings into objectively cool technologies and objectively cheap technologies.

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Name	Symbol	Price	Mkt. Cap	Price/Sales
AI23 Systems	AONE	\$16.59	\$1,700.4	18.9
EnerI Inc	HEV	\$4.28	\$518.4	17.3
Maxwell Technologies	MXWL	\$14.33	\$375.0	3.8
Altair Nanotechnologies	ALTI	\$0.73	\$77.0	21.0
Beacon Power	BCON	\$0.38	\$49.3	72.6
Energys	ENS	\$23.23	\$1,121.3	0.7
Exide Technologies	XIDE	\$5.75	\$434.6	0.2
Axion Power	AXPW.OB	\$1.15	\$87.1	51.1
C&D Technologies	CHP	\$1.62	\$42.6	0.1
ZBB Energy	ZBB	\$1.14	\$14.6	8.4

For several years the market has been enthralled with gee-whiz energy storage technologies and references to potential markets that represent billions of dollars in potential for highly specialized niche applications like frequency regulation. In the process, investors have lost perspective on the question of how the niche applications fit into the overall market. This dynamic has led to inflated expectations for companies that are developing cool emerging technologies and unrecognized value in companies that manufacture the cheap established technologies that will do the yeoman's share of the heavy lifting for the smart grid. Unless I'm way off the mark, that dynamic will shift very rapidly, as outsized revenue gains begin accruing to manufacturers of cheap solutions.

When I started writing this blog I believed energy storage would become a major investment trend over the next few years because cost efficient storage systems can reduce waste while enhancing the reliability of most alternative energy technologies. Since then, the fundamental market drivers have developed faster than I imagined and what I initially described as a rising tide is rapidly becoming a full-blown investment tsunami. While rising tides lift all boats, the critical points for investors to remember are:

- Percentage gains in the stock market are largely dependent on entry price and it's easier to bag a double or triple in a cheap stock than it is to get the same result in an expensive stock;
- While it's all well and good to look a decade down the road and dream of a brighter future, America has pressing energy storage needs that require solutions today;
- In America we get up in the morning, we go to work and we solve our problems using the tools that we have in our toolbox, however we remain ready to embrace new tools as they are developed, perfected and proven; and
- Successful investing requires diligent monitoring to adjust portfolio positions to a rapidly changing market and technical landscape, and emerging technologies that are not ready for prime time, but will be someday.

Disclosure: Author is a former director of Axion Power International ([AXPW.OB](#)) and has a large long position in its stock. He also has small long positions in Energys ([ENS](#)), Exide ([XIDE](#)), C&D Technologies ([CHP](#)) and ZBB Energy ([ZBB](#)).

About the author: [John Petersen](#)



John L. Petersen, Esq. is a U.S. lawyer based in Switzerland who works as a partner in the law firm of Fefer Petersen & Cie (<http://www.ipo-law.com>) and represents North American, European and Asian clients, principally in the energy and alternative energy sectors. His international practice... [More](#)

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