Smart Grid Advanced Metering Annual Implementation Progress Report

ATTACHMENT 4

Industry & Customer Research: Non-Utility Owned Storage Units

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Non-Utility Owned Storage Units

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Industry & Customer Research: Non-Utility Owned Storage Units

December 31, 2013

Executive Summary

Project objective: To understand the market for third party non-utility storage companies within ComEd's territory

Project Impetus

- Comply with directive from EIMA to meet metrics around system reliability and customer benefits
- It is uncertain how many customers have end-use storage solutions, who these customers are, and what Comed can do to better serve any customers with storage solutions

Project Tasks

- Perform market and industry assessment of third party non-utility storage companies as a whole and specific within ComEd territory.
- Conduct detailed primary research on third party non-utility storage companies.
- Develop stakeholder communication package to present key findings from research.

Key Takeaways

- Energy storage solutions for end-use customers are beginning to gain market adoption in the US amongst large C&I segments, but only in geographies with specific storage regulatory incentives and/or specialized use cases (high peak demand prices, need for uninterruptible power, etc.)
- At scale, end-use energy storage devices might affect how ComEd serves its customers, but significant market adoption isn't expected to occur before 2020.

Key Findings

- Energy storage technologies **do not have a presence in ComEd's service territory** largely due to economics
  - Cost of storage still outweighs benefits
  - No state/local incentives for energy storage
- Additional impediments to growth:
  - Use and business cases of technologies are not always well understood
- Energy storage companies are mostly **targeting large C&I customers**
  - Economics of storage for residential customers are even less attractive than those for larger customers
- Storage unlikely to penetrate ComEd market by **2020** because:
  - Unlikely **regulatory mandates** supporting energy storage
  - **Significant cost reductions** and/or changes to power market fundamentals

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Methodology, Approach, & Timeline

Perform Storage Industry Assessment 10/28/2013 – 11/1/2013	Detailed Primary Research and Analysis 11/4/2013 – 11/22/2013	Communicate Findings December 2013
Perform Market & Industry Assessment	**Primary Research and Analysis**	**Develop Stakeholder Communication Package**
Confirm ComEd objectives / mobilize team • Identify specific aspects of Electrical Storage Systems that are of importance • Gather details on ComEd service territory **Assess Industry / Market:** • Identify key industry trends • Map energy storage technology options • Understand industry regulations and incentives • Determine market size and growth potential	**Prepare Primary Research:** • Identification of vendors • Develop primary research approach / questions **Conduct Primary Research** • Interview manufacturers and installers • Synthesize findings from industry / market scans, secondary customer research, and primary research to identify key elements of storage implementation	**Stakeholder Buy-In:** • Detailed review of identified findings with key stakeholders • Key discussion points include approach followed, analysis methodology and key findings **Final Messaging** • Updating the findings based, in line with discussions with key stakeholders. • Organize and ready findings for legal / regulatory compliance

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There are energy storage applications across the entire electric grid value chain, but this report focuses only on non-utility third party vendors

Generation & System-Level Applications	**Wholesale Energy Services**	Utility-scale storage systems for bidding into energy capacity and ancillary services markets
	Renewable Integration	Utility-scale storage providing renewables time shifting, load and ancillary services for grid integration
T&D System Applications	**Stationary Storage for T&D Support**	Systems for T&D system support, improving T&D system utilization factor, and T&D capital deferral
	Transportable Storage for T&D Support	Transportable storage systems for T&D system support and T&D deferral at multiple sites as needed
	Distributed Energy Storage Systems	Centrally managed modular systems providing increased customer reliability, grid T&D support and potentially ancillary services
End-Use Applications	**ESCO Aggregated Systems**	Residential-customer-sited storage aggregated and centrally managed to provide distribution system benefits
	C&I Power Quality and Reliability	Systems to reduce TOU energy charges, participate in Demand Response programs and/or demand charges for C&I customers
	Home Energy Management	Systems to shift retail load to reduce TOU energy and demand charges and/or participate in Demand Response program
	Home Backup	Systems for backup power for home offices with high reliability value

Across technologies, large commercial and industrial companies tend to be primary customers

Technology	Features	Customers
Flywheel	High cycling technology Power dense	Rail systems High power applications
Isothermal compressed air	Large scale mega-watt Scalable and easily distributed Renewable energy savings	Large industrial companies Power producers and utilities
Zinc air	Affordable price point Designed to last over longer period of time	Utilities Independent power producers Large C&I customers Military bases Residential (long term)
Capacitor	Maximizing energy usage Protection of devices	Industrial companies
Lead Acid	Grid energy storage proprietor Battery use in case of grid failure	Telecommunication Large C&I Residential (long term)
Lithium Ion	Grid storage or telecomm	Telecomm and cable Home (solar) storage applications Commercial

Unclear which technology type or respective company will emerge as a market leader…

Utility-Scale

Commercial-Scale

- Flywheel
- Compressed Air
- Lead Acid
- Flow
- Zinc-Air
- Aqueous Hybrid-Ion
- Lithium-Ion

Beacon POWER

LightSail Energy

ecoult energy storage solutions

PRIMUS POWER

EnerVault Launching a Clean & Secure Energy Future

eos Powering the Dawn of Energy Storage

AQUION ENERGY

A123 SYSTEMS

NEC

MITSUBISHI

- No single technology winner…yet
- Companies looking for new revenue streams for batteries developed for transportation
- Competition for federal funding and grants to commercialize new technologies (e.g. ARPA-E)
- Consolidation occurring as new promising technologies are introduced
- Unable to monetize value for all potential applications

Each energy storage technology has unique strengths and weaknesses in cost, response time, flexibility, and longevity

Different technologies are suited for different end use applications, making the market fragmented.

● = Good

◑ = Medium

○ = Poor

	Sodium Sulfur	Lead Acid	Advanced Lead Acid	Lithium Ion	Zinc- Air	Vanadium Redox (Flow)
Low capital cost/ kWh	○	○	◑	○	◑	○
Large volume of energy storage capacity	●	○	○	○	●	●
Long life (high # of life cycles)	◑	○	◑	◑	◑	◑
Quick response time (milliseconds)	●	●	●	●	◑	◑
Flexible to locate (in cities)	○	◑	◑	◑	◑	◑
Low O&M costs	◑	◑	◑	◑	◑	◑
In commercial production	●	●	◑	◑	○	○

Source: eoS website

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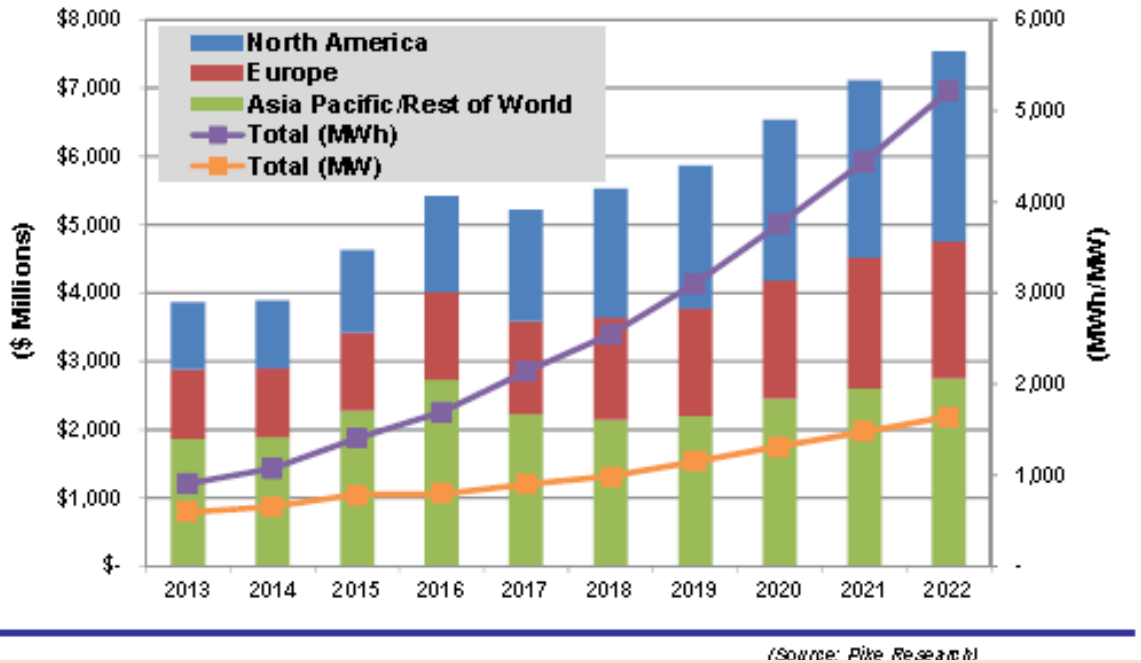
Energy Storage Market Growth Projection

The market for energy storage is poised to grow over the next decade, but mostly in regions with incentives and expensive power markets.

Chart 1.1 Energy Storage in Commercial Buildings Revenue and Capacity by Region, World Markets: 2013-2022



(Source: Pike Research)

Total global capacity of commercial building energy storage systems will grow from 900MWh in 2012 to >5000 MWh in 2022 (8.6% CAGR over next 10 years) according to Pike Research. Installations within the United States are occurring primarily in states with energy storage mandates such as California, New York, and Hawaii.

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This growth, however, is contingent on technology costs and ability to monetize numerous applications

It is very difficult to value an energy storage system today due to the range of technologies and costs, the ambiguity of possible revenue streams, and the changing regulatory environment. There are, however, a few key indicators to watch, including:

Energy Prices	Increased volatility and wholesale costs will improve the economics
Renewable Integration	As penetration increases so do the challenges of managing the grid with significant intermittent power. Energy storage will be necessary.
Regulations and Market Structure	Must enable the monetization of all energy storage applications across the value chain
Distributed PV Penetration	Storage systems will help overcome the challenges of integrating solar PV into distribution systems
Technology Costs	Cost reductions for batteries will occur as energy storage solutions scale, both in the transportation and electricity sectors

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A range of energy storage vendors were interviewed to assess the existing market and current demand

- Conducted interviews with 10 vendors:[1]
  - Kinetic Traction Systems – flywheel power for energy storage and rail traction systems
  - Redflow Limited – developer and manufacturer of zinc-bromide flow batteries
  - SustainX – isothermal compressed air energy storage company
  - Eos – zinc battery aims to provide low-cost energy storage solutions for electric utilities
  - Illinois Capacitor[2] – manufacturer of miniature capacitors for electronics, lighting, energy, and other markets
  - Ecoult – advanced lead-acid battery technology solution
  - ZBB Energy Corporation – manufacturer of modular Zinc-Bromide batteries used for energy storage
  - Silent Power – energy storage powered by high-frequency micro-transformer
  - Aquion Energy – aqueous hybrid ion technology powered energy storage
  - A123 Systems – advanced technology lithium-ion battery packs
- Primary interview objectives:
  - Understand vendor's **target geography** and customer
  - Determine **number of installations** in ComEd footprint
  - Estimate **sales** in other US markets
  - Gather other market information from vendors

[1] Larger description of interviewees in appendix
[2] Additional information in appendix

The Illinois market for energy storage has yet to be tapped

- Energy Storage within ComEd Territory
  - Of the 10 vendors interviewed, **only 1 has sold energy storage** units in Illinois/ComEd territory
    - ZBB Energy Storage – project with the Illinois Institute of Technology as a beneficiary of DOE grant
      - Illinois Institute of Technology was the grant recipient from the DOE to purchase energy storage
      - ZBB was the selected bidder to provide a 250 kW / 500 kWh ES system
  - All vendors mentioned **barriers to entry in ComEd territory** including:
    - Lack of consumer demand
    - Lack of financial incentives at state and/or local level
- Customer insight:
  - Customers within Illinois are **primarily large industrial companies** or utility focused
  - Following global trends, customers tend to buy energy storage for industrial and commercial purposes as opposed to residential

Third Party Non-Utility Vendors Interviewed

Company	Technology	Headquarters	Illinois Sales
Illinois Capacitor	Capacitor	Lincolnwood, IL	Yes
ZBB Energy Corporation	Zinc Bromine	Menomonee Falls, WI	Yes
Ecoult	Lead Acid	Sydney, Australia	None
Silent Power	High-frequency microtransformer	Baxter, MN	None
Aquion Energy	Aqueous Hybrid-Ion	Pittsburgh, PA	None

Third Party Non-Utility Vendors Interviewed

Company	Technology	Headquarters	Illinois Sales
Kinetic Traction Systems	Flywheel	Chatsworth, CA	None
Redflow Limited	Zinc-Bromide Flow Battery Module	Brisbane, Australia	None
SustainX	Isothermal compressed air	Seabrook, NH	None
Eos	Zinc Air	New York, NY	None
A123 Systems	Lithium Ion	Waltham, MA	None

Known energy storage installations for residential customers in ComEd territory is currently limited to the ComEd smart home case.

- On May 17, 2013 ComEd selected four customers as the winners of the Smart Home Showcase from a group of photo applications and essays
- Each winner received a smart home makeover worth $45,000
- The makeover included Whirlpool smart appliances, electricity-generating solar panels and battery storage equipment, a Nest learning thermostat, and an in-home display to monitor household electricity.
- The winners shared their experience with the smart home makeover and the impact the smart home technologies made

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Over time, we expect to see an increase in demand for energy storage.

- Drivers that could influence adoption within ComEd territory:
  - Demand for stabilization of the grid
    - Energy **storage provides shock absorber for grid** and can keep faults from transferring around grids
  - Incentives
    - **Government grants** for energy storage demonstrations which are then enhanced by actions of regulators who recognize the benefits of energy storage and believe that it can contribute greater value than fossil fuel generation
    - Movement towards maximizing **efficiency and cleanliness of fossil fuel** generation
    - Change in regulatory framework and opportunities in frequency regulation market
    - California State Mandate
    - Incentives in Illinois
      - Currently 0% of interviewed vendors have conducted business in Illinois
      - Lack of government or state incentives causes lack of demand in ComEd territory
  - Older technologies that are better understood are more readily accepted as an alternative power source
    - Maturity of industry and technology of capacitors is cited as a large factor for their continued growth and sales
    - Enhanced view in the Western world for greater energy security
  - **Decrease in cost** relative to fossil fuel generation

However, there are still several factors inhibiting an immediate increase in demand in the market.

- Growth tends to be inhibited by:
  - Energy efficiency / other demand side management
  - Persistently **low power prices**
  - Most battery technologies and energy **storage technologies** remain **too expensive** to be cost effective or profitable
  - Difficult environment for raising capital necessary for expansion
    - Many energy storage companies are start ups facing resource challenges
    - Some are still in **their pre commercial phase** and have not yet brought a product to market
  - Market is **relatively new** and technologies do not have past history
    - Benefits may be understood but technology has not been implemented before, leading to a chicken and egg scenario in terms of sales and growth
    - Utility companies tend to be **more cost sensitive** as they do not always have the ability to build energy storage into rates
    - Pay for performance packages boost energy storage
      - Under pay-for-performance plans, grid operators implement pricing structures that pay faster-ramping resources a higher price for their service
      - Speed and accuracy is considered when utilities purchase regulation service for transmission
  - **Highly fragmented market** with no distinguished leader/leading technology creates marketing hurdles

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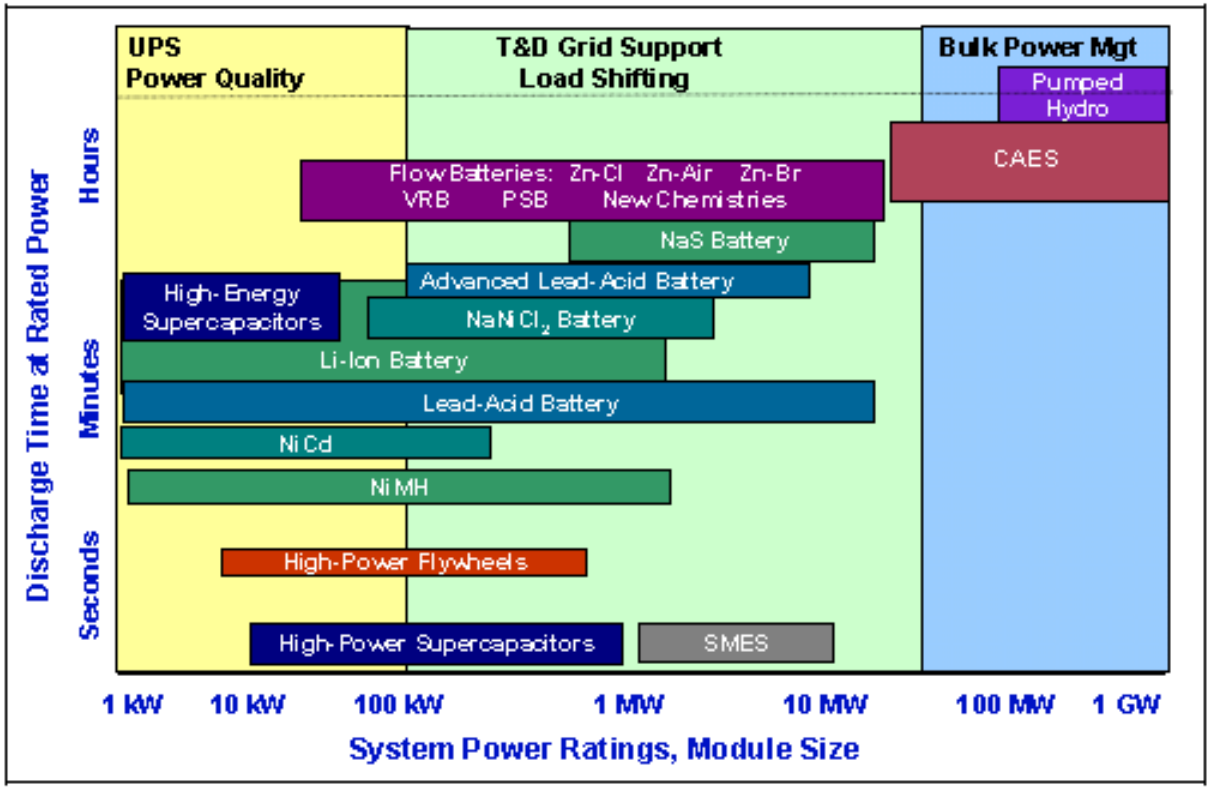
Various energy storage technologies suit different applications throughout the value chain

Currently energy storage has been primarily limited to industrial, commercial, and utility businesses, with limited offerings for residential consumers due to demand and price point.



High energy and high capacity supercapacitors, lithium ion batteries, lead acid batteries, Nickel Cadmium, and Nickel Metal Hydride batteries are all potential solutions for distributed applications

Source: EPRI

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List of Vendors Contacted

- Interviewed:
  - Kinetic Traction Systems
  - RedFlow
  - SustainX
  - Eos
  - Illinois Capacitor
  - Ecoult
  - ZBB
  - Silent Power
  - Aquion
  - A123
- No Response:
  - Electrosynthesis
  - EnerDel
  - EnerVault
  - Greensmith
  - Ice Bear
  - Ioxus
  - Mad Dash
  - Magnetic Coil Manufacturing
  - PCM
  - Powerthru
  - Primus Power
  - Stem
  - Viridity
  - Xtreme Power
- Other:
  - Hydrogenics (would not release information due to proprietary nature)
  - Amonix (not a manufacturer or designer)
  - Beacon Power (currently in talks with Exelon)
  - Lightsail Energy (still in development phase)

Kinetic Traction Systems (1/2)

- Start-up company targeting global market
- Flywheel Energy Storage High cycling technology (a lot of charge/discharge per hour) well suited for electrified rail systems
  - Very power dense – able to move a lot of energy quickly but does not store a lot of energy
    - Charge/discharge for 25 seconds, can do that 40-45 times an hour
    - Only store 1.5 kw energy in a usable fashion
  - High power requirements good for trains and subways or other high power applications
  - Also doing some work with grid stability/microgrid
- A lot of interface with rail systems – benefits are well understood but technology has not been implemented
- Main targets:
  - Direct to transit (Chicago Transit, LA Metro) as energy storage supplier
    - Chicago transit recently upgraded trains to be able to regenerate and break energy – they are investing, but still 10-15 years behind LA Metro/Philadelphia transit systems
    - A lot of transit agencies have secured a grant (electric utility grant) – fair amount of funding which allowed them to upgrade their info structure
    - Worked with Philadelphia
  - OEM (ex: Siemens)
    - Think would be more successful in selling to an OEM

Kinetic Traction Systems (2/2)

- Limited in marketing – trade shows, qualification testing with Bombardier (check spelling) test track – installed small system and tested for a year and a half, demonstrated commercialization of technology in a real world test track – quite successful (press release led to activities)
  - In China/Korea – seems to be a prerequisite for in-country testing/qualification before any commercial sales
  - In North America – a lot of traction/customers from other projects, due to name recognition
- Growth inhibited by
  - Energy storage/efficiency
  - Cheap electricity prices in the state – as prices go up, pay back of flywheel equipment will be better
    - Currently product is relatively high priced – cost reduction path, in a few years can offer product 1/3 price of what it is today
    - Plan on cost reduction and volume increase in action
    - Investment has been key – worked about 2 years to secure additional funding
      - Still trying to attract investors
      - Gone through 60-80 investment companies/banks (expressed difficulty in securing investment)
  - North America seems to be investing little in transit investment, conservative business (chief engineers not inclinced to look into new technologies)
- Chicago Transit is a ComEd customer, Kinetic Traction has had a lot of interface but no sales with Chicago Transit
  - From an energy conservation perspective, ComEd services Chicago Transit77

Redflow

- RedFlow is focused on developing the battery and handing it to system integrators to develop products which incorporate the battery
  - Do not actually have any systems for sale in the US that would fit ComEd's description, but help American companies develop those products
  - Australian based
- Systems installed in 60 residential households in Australia – behind the meter, utility wanted to control storage devices along with smart meters/solar panels/other infrastructure for their research
  - Sent 5 residential units to the US
  - Goal is to have version of behind the meter storage in US
- Value proposition for residential not quite there in the US – initially, not expecting large demand
- Currently do not have a battery in Illinois
- Cite small tech start up company/international as a challenge
- Number of barriers to introducing products into US
- Do not have financial resources to do everything they would like to do
- Contract managing factory – in order to make transition company from R&D company to manufacturing company, big change and management challenge
  - Typical "start-up" and "new technology company" problems
  - Challenge in finding partners (system integrators)

SustainX (1/2)

- Target geography: international global business, primary hotspots are 1. Asia (China, Japan, Korea), 2. Europe, 3. USA
- Large scale product focused on large utilities, independent power producers, large industrial users
  - Core product 3 MW of power
  - Targeting Consortiums in Asia
  - Reaches targets primarily through strategic introductions
- Differentiator: large scale mega-watt, more scalable, more distributed than conventional hydro or compressed air, capable of expansion
  - Focused on middle ground – 10-50 mw range, differentiate by large scale mega watt, multi hour
- Illinois Overview: In terms of major utility partners or customers, have not yet sold
  - Have had smaller component suppliers that may have had sales
  - Capable of expansion into Illinois but currently not active in Illinois
- Targeted benefits: renewable energy savings, peak demand savings, integration of renewables
  - Large industrials: energy savings
  - Power producers/utilities: 1. Integration of renewables (firming up wind/solar, providing schedulable products that can be more easily integrated into constrained grid regions with limited transmission), 2. Substituting for traditional transition – putting storage in regions
    - Energy + capital

SustainX (2/2)

- Roadblocks:
  - Market is relatively new
  - Applications aren't well understood
  - Value is not well understood
  - Technology not well understood
    - Use proven mechanical components – utilities are comfortable with/used to dealing with
- System has new innovations, but at its core is proven technology vs. more novel battery technologies (no past history)
  - Proven materials and components
- Are aware of initiatives and rebates
- Partnerships: GE is strategic investor
  - Funding: backed by VC, PE, and equity funding from strategic investors (GE is one)
  - Company is 6 years old

Eos (1/2)

- Novel grid scale battery system that can be deployed on the grid and behind the meter on customer's premise
  - Development of technology that addresses fundamental requirements in the marketplace
    - Cost – most battery technologies/energy storage technologies have been too expensive to be cost effective or profitable
    - Working to bring a product to market $160/kw/hr for DC battery systems (does not include power electronics or invertor required to integrate battery to electric grid or behind the meter)- believe this is a compelling and interesting price point because believe around $300/kw/hour the battery is becoming competitive with the incumbent solutions used on the grid today
    - Capital cost is not the only consideration – also care about longevity which has historically been a limitation
    - Technology is designed to last 10,000 cycles (30 years) – able to advertise costs over longer period of time, more economically viable offering for customer
    - Round trip efficiency of 75%
- Grid-scale product – discharge 1 mega watt for 6 hours
  - Where we are in this process: pre commercial, do not have a large system battery being tested in the field, but have R&D headquarters that have tested some modules (basic building block of larger grid scale battery)
  - Go to market strategy based on in depth collaboration with several large utilities and energy service providers: Genesis Program
- Genesis Program: work hand in hand with partners to evaluate business case around technology and target application
  - Work to schedule pilot demonstration projects
  - Ultimately aim to deploy large numbers of batteries

Eos (2/2)

- Target market: utilities, independent power producers, end use customers - large commercial and industrial customers, military bases, different operations that could use this technology
  - Even residential – less of a focus in the near term, but are having conversations with partners to bring smaller product to residential market
  - Not prepared to provide marketing and distribution required for such a product, trying to develop the right partnerships
- Currently have 8 participants in Genesis program, include: NRG, NL, National Grid
- Not in ComEd territory, but have had several conversations with Exelon who expressed interest
  - Have not specifically spoken with ComEd, could be interesting customer
- Potential benefits: energy storage for provision of targeted or provisional capacity.
  - Energy storage can be installed much more quickly
  - Behind the meter analog of application – install battery behind the meter, reduce demand charges
- Market is opening up :
  - California mandate – 1.325 GW energy storage over next 5 years, commercial tendered, administered by California higher use, interesting opportunities
  - New York – LIPA (Long Island Power Authority) 1.6 GW energy in combination
  - Technology can offer more compelling price point and longevity – see increasing interest from both utilities and behind the meter customers

Illinois Capacitor (1/2)

- In business since 1935 – produce multiple price capacitors: main product lines are aluminum electrolytic, film capacitors, super capacitors (EDLC capacitors), ultra capacitors
- More industrial in terms of end user – do not specifically target utility companies
- Capacitor is an energy storage device – it used in all different kinds of applications
  - If you plug it into a wall, you use a capacitor
  - Energy harvesting – also looking at wind and solar for EDLC modules which are big energy storage devices that take a lot of energy and store it/give it up when demand is needed. Mostly helping with batteries right now
- Sales in Illinois – no specific number, but at least 6 unique companies (customers). Segments:
  - 1 – military
  - 2-3 heavy equipment
  - 1 – makes equipment for utilities
- Do not do consumer products, primary customers are:
  - Solar power – powering motors to change the angles or mirrors
  - Emergency lighting – powering strobe lights
  - Hair removal products, UPS systems, smart meters
- Price ranges from a couple pennies/part up to $2000/part

Illinois Capacitor (2/2)

- Filtering – AC to DC conversion
  - Maximizing energy usage
  - Protection of devices
- Growth
  - "Necessary component" – system can't work without it
  - Inexpensive protection circuit in many cases
  - $4-5 capacitor can protect $1300 device from damage
    - System reliability
  - Energy backup – alternative power source
    - Multiple benefits to capacitor – all depends on the specific needs of a customer
- Capacitor is one of the oldest components in an electronic – one of the oldest established industries
  - Maturity of industry cited in large factor for growth/sales
  - Not necessarily cutting edge, "new" technology other than the fact that different types of capacitors are being developed
  - It is a known commodity
  - One of the oldest forms of energy storage
- Growth has been stable – not tied to one industry, diversity is an advantage
  - ComEd would need really large, industrial capacitors, not exactly offered by Illinois Capacitor

Ecoult

- Address all markets with products
- As a grid energy storage proprietor, most work to date larger systems
- Market as it is developing doing work in smaller systems
- Have products suitable all the way down to residential
  - Most work is large big work scale
  - Anticipate commercial/industrial scale will be next market, then residential
- Parent company has work in Illinois
  - Nearest grid scale energy storage is in Pennsylvania at the moment – large system in PKM grid
  - Well throughout Illinois but do not have specific grid trail energy storage
- Battery use – telecommunication in case grid fails
  - Main customer segment
    - Large scale commercial and industrial
  - Cost: depends on what you are doing with them
- Market encouraged by 1) government grants to see out demonstrations, market then enhanced by actions of regulators who recognized energy storage would contribute greater value than fossil fuel generation
- Ultrabattery – lead acid battery technology

ZBB

- Lithium ion technology – not necessarily new
- Growth spurred by increase in market awareness, changing regulatory framework, and an enhanced view in the Western world for greater energy security – distributed energy resources – idea and market opportunity that has really only gelled in the past 12-24 months
  - Energy storage as a commercial scale end user is something company has been waiting for
  - Expecting utilities to own assets, now seeing end user market gaining traction in next 2-4 years in US
  - Have put dice on table with distributed ownership/types of products exclusively
- Asia – ZBB has launched strategic partnerships where there are people on the ground we work with – have established joint development agreements/joint ventures – do see markets there both utility owned and end user projects
- Do not see market mechanisms in Canada
- Right now commercially – only markets where we see storage having definitive end market users – “islands” of US – Caribbean, Hawaiian, Alaskan – communities, Long Island, California market (“Power island”
- 1 project in Illinois – Illinois Institute of Technology (beneficiary of DOE grant)
- Value Proposition
  - Need for energy security/energy reliability
  - Rebate/credit program (California/Hawaii have state level credits)

Silent Power

- Based in Minnesota, a lot of activity is there due to location and proximity
  - Actively involved in CA – a lot of initiatives in place for energy storage or conservation
  - Have not done any work in Illinois
  - Product is behind the meter – customer is primarily utility and property owners
- Primary benefits: energy savings and demand management
- Growth heavily dependent on federal and state incentives – energy storage is such a new industry
- All vendors need to get more volume and deployment to bring the cost down
  - Cost is major barrier to expansion currently
  - Energy storage is a new concept and a different way of thinking for most people
    - A lot of education needs to occur
    - These devices have multiple or simultaneous benefits – matter of quantifying all of those benefits
- Price dependent on battery chemistry

Aquion

- Global product – targeting primarily two big buckets: developing microgrids and developing large scale grid installations
- No projects in Illinois – have not seen a significant demand, but added caveat that it may still exist
- Mandate for renewable energy is primary factor that drives demand for energy storage
  - Solar panel prices are decreasing rapidly (80-90% drop in the last 5 years, and continue to see a decline year over year, while price of diesel increases)
  - In locations where cost of using diesel is high, cost of using solar/energy storage is lower
  - Demand for grid scale is largely regulatory – higher levels of policy shifts demand
    - California: increase in adoption of renewables
    - Long Island: need for additional capacity, difficult to build new coal/gas capacity on Long Island
- Unique value – long lasting and low cost –very abuse tolerant, does not get damaged in extremely hot/cold environments
  - A bit safer, lower balance of system costs
  - Cites as safer than traditional battery technologies
- Siemens purchased a shipment of grid batteries in October 2013

A123 (1/3)

- In 2007 launched an effort to create a grid storage project, deployed first systems project in 2008
  - Deploy over 100 MW storage on grid between various continents – Asia, N America, S America, Europe
    - Deployments in China, Japan, Spain, England
      - Largest in terms of installed base around the world for grid storage applications
      - Everything designed for 1) Safety and 2) Security and 3) efficiency and performance
- Focus on providing grid storage and working at smaller systems for telecomm (more third world countries), cable, home (solar) storage applications
  - Business is strictly energy storage for the grid or smaller applications for home, solar, wind
  - Home solar is just beginning to develop – haven't deployed anything yet, just started talking to solar developers
  - Strictly grid storage or telecomm
- Here in the US – opportunities in frequency regulation market (PJM in particular, has been very forward looking how they pay for regulation)
  - In South America – have a reserve market. If you own power plant, have to reserve 4% for grid market – installed battery systems, installed plants at 100%, if they need reserves, use battery reserves to fulfill requirements
  - China – stabilizing power coming out of wind farms
  - Europe – basic grid stabilization stuff, building at utility level vs. energy storage level

A123 (2/3)

- US seems to be ahead of the rest of the world more power type applications (frequency regulation, renewables integration), in deploying longer duration energy storage the rest of the world is developing
  - More cost sensitive here in the US – do not have the ability in most areas to build storage into rates
- Have not done anything in Illinois – do not believe anyone else has other than some very small test systems
  - There is a large project currently under development, no contract – good sized storage project (cannot discuss)
    - Illinois isn't behind the curve, but companies that have deployed storage so far have deployed in other states
    - CA very forward looking
    - PJM does not have large presence in Illinois, most storage deployed other than CA has been in PJM Iso
      - Multitude of grid operators across country (PJM, Miso (Mid continental iso), CA Iso, etc) – PJM is the first to get the pay for performance package
- Energy arbitrage – purchase and sell energy once a day, costs have not come down enough yet

A123 (3/3)

- Why companies aren't buying – Cost and how you deal with storage is still trying to be defined – is it a transmission product, distribution/generation product? Can't classify energy storage, don't know how to charge for it
  - Coal, power lines easier to classify
  - Storage plays a role in all things – transmission, distribution, generation, load source
  - Defining applications – competitors have issues with accidents/fires – fear that battery storage is dangerous
- Growth:
  - Mandates trying to get away from fossil fuel generation – maximize efficiency and cleanliness of it 2
  - If you can run coal plant at 100% much cleaner than at 95 or 90%
  - Government mandate clearly driving it
  - Remove storage from discussion of green energy
    - Storage stands on its own because the grid is inherently unstable – mass generation to use, when batch gets out of balance
    - Energy storage provides shock absorber for grid – provides more when necessary, absorbs when there is too much
    - Can keep faults from transferring around grids – last big black outs, energy storage would stabilize
    - Green energy is a lightning rod for arguments and discussion
  - Renewables integration – renewables inherently intermittent (wind isn't always blowing, sun isn't always shining) – add instability to grids
    - In the end, real main driver is: stabilization of grid, whether through mandates, giant shock absorber, or stabilization of the grid