SMART Series

The energy storage revolution in NC
RTCC SMART Series
The Energy Storage Revolution in NC
Mission
Accelerate the cleantech economy through collaboration and partnerships which promote innovation and sector growth
Board of Directors

- ABB
- Duke Energy
- Field2Base
- Itron
- PowerSecure
- RTI International
- SAS
- Schneider Electric
- Sensus
Paul Quinlan
Clean Tech Manager
SMART Series: The Energy Storage Revolution in North Carolina

March 31, 2017
Pumped hydropower storage projects account for roughly 97% of installed energy storage capacity in the US.

Source: Bloomberg New Energy Finance, 2017 Sustainable Energy in America
While several battery storage technologies exist, lithium-ion batteries have dominated the market in recent years.

Source: Bloomberg New Energy Finance, 2017 Sustainable Energy in America
Battery Storage Markets

US Announced and Commissioned Energy Storage projects, as of December 2016 (MW)

- OR: 5MWh procurement target by 2020 for PGE and PacificCorp
- WA: $14.3m grant for storage projects
- IN: 20MW AES Indiana project first project in MISO
- PJM: 265MW+ operational for frequency regulation
- VT: 4.3MW installed in microgrid projects
- MA: DOER agrees to have an energy storage mandate
- NY: Brooklyn-Queens Demand Management contracts storage for distribution deferral
- CA: 1.3GW storage mandate by 2020
- AZ: TEP awarded two 10MW projects, APS develops two 2MW projects
- NC: Duke Energy commits to develop at least 5MW
- FL: FPL BMW second life Miami energy storage pilot

Note: Does not include underground compressed air energy storage, pumped hydro, or lead-acid batteries for non-grid applications.

Source: Bloomberg New Energy Finance, 2017 Sustainable Energy in America

Battery storage has gained an early footing in California and PJM Interconnection.
Battery Storage Benefits

Potential Services:
- Energy arbitrage
- Spin / non-spin reserve
- Frequency regulations
- Voltage support
- Black start
- Resource adequacy
- Transmission congestion relief
- Transmission deferral
- Distribution deferral
- TOU bill management
- Demand charge reduction
- Increased PV self-consumption
- Backup power

Batteries can provide up to 13 services to three stakeholder groups.

Source: Rocky Mountain Institute, The Economics of Battery Storage
A crucial component of the value of storage is its ability to support multiple applications—and thus value streams—at the same time.
The majority of the state is outside of an organized wholesale markets. Vertically integrated investor-owned utilities serve the majority of electric customers in North Carolina.
NCSEA’s Energy Storage Work

Research Triangle Cleantech Cluster * March 31, 2017
Outline

• Why Energy Storage, Why Now?

• Energy Storage Working Group
  – Goals
  – Composition & Timeline
  – Accomplishments & Challenges

• Interim Conclusions Based on Work
Why Energy Storage Now?

Five main reasons:

– The amount of renewables deployed in NC;

– The economic development benefits of storage;

– Cost of storage technologies have declined appreciably; and,

– Performance of energy storage technologies has improved dramatically.
Goals of NCSEA’s Storage Working Group

1. Determine how to deploy energy storage in North Carolina (& then other SE states);

2. Develop guidance that allows energy storage to be utilized for all of its possible purposes; and,

3. Determine any outstanding considerations that impact energy storage deployment in North Carolina.
Working Group Composition

1. IOUs: Duke Energy, Dominion

2. Rural electric cooperatives

3. Energy storage developers, providers & consultants — Alevo, stem, ABB, Trane, Eaton, AES,

4. Financial actors — Live Oak Bank

5. Educational institutions — NCSU, FREEDM Center, UNC Charlotte, EPIC Center, NCSU, NC Clean Energy Technology Center

6. State agencies — NC Department of Environmental Quality, NC Utilities Commission, Public Staff

7. Advocates/Non-Profits — Southern Alliance for Clean Energy, E4 Carolinas
Timeline & Discussions

• Timeline
  – Began in April 2016
  – Held six meetings and numerous subcommittees

• Discussions
  – Uncovered the complicated nature of energy storage deployment, including how to value services, markets, and appropriate use.
  – Which challenges to energy storage apply to various applications and how energy storage may alleviate challenges to NC’s grid.
Significant Challenges for Utility Scale Storage

• Three main ones:
  – No regulatory and policy clarity on the role of energy storage in long-term planning (*a regulatory barrier*);
  – The difficulty of measuring and monetizing the values provided by energy storage in the market (*a financial barrier*); and,
  – A lack of market designs and business models (*a market barrier*).
Importance of Energy Storage Study

WG concluded a study should focus on answers to four questions:

1. What is the feasibility of energy storage in North Carolina?
2. What can energy storage do that is not being done today?
3. What would the economic potential or impact be in North Carolina?
4. What policies would be needed or impacted by coordinated energy storage deployment?

Note: Current legislative bill with NC House Speaker’s staff has a storage study provision in it.
Remaining Challenges & Interim Conclusions

• Energy storage still is not appropriately valued in the market for all of the services it provides:
  – Renewables integration;
  – Peak load shaving;
  – Emergency response;
  – Grid stability; and,
  – Energy cost reduction such as avoided transmission and distribution costs.

• Traditional utility planning tools (IRPs) do not value storage since they are based on overall generation demand and supply.
PowerSecure At A Glance

1,100+ Employees; Headquartered in Wake Forest, NC

Wholly Owned Subsidiary of Southern Company (NYSE : SO)

2GW of Installed Distributed Generation / Microgrid Capacity

2016 Revenue

$400+mm

98%+ Dispatch Reliability

Over 1,500 Interconnections supporting over 200 different utility programs

1,000+ Customers Served

Target Zero Safety

0.63 EMR / 2.23 TIR
PowerSecure Product & Services Portfolio
Stretches Across The Grid

- Energy Storage
- Microgrid
- Solar
- Distributed Generation
- Energy Efficiency
- Utility Infrastructure
- Generation
- Step-Up Substation
- Transmission
- Step-Down Substation
- Distribution
- Consumption

PowerSecure
Key Elements of PowerSecure Offering

Distributed Infrastructure

- IDG Solution; manufacturers, installs and operates turnkey (Natural Gas, Diesel) generation
- Energy Storage design, integration and operation
- Fuel Cell; 50-250kW low emission uninterruptable generation with supplemental storage add-on
- Proprietary Switchgear design & manufacturing
- Solar EPCm, O&M and asset ownership (Commercial & Utility Scale)
- Microgrids providing grid parallel and islanding capability utilizing one or more generation forms

Energy Services

- Specialty LED Lighting fixtures for high-end retail and freezer/refrigerated case markets
- Efficiency and facility upgrades focused on supporting major ESCO, utilities and retailers
  (mechanical, electrical, lighting retrofit, water and building envelop)

Utility Infrastructure

- Grid Infrastructure construction, repair and maintenance / Substations / Storm restoration
- Design, engineering and consulting for grid infrastructure, utility operations and resource planning, regulatory consulting, cyber-security and NERC-CIP compliance
A multi-national company with its manufacturing hub in Concord, N.C.

Ground Breaking Li-Ion Technology
The first inorganic Lithium-Ion battery, developed over a decade, non-flammable, with up to 10 times the cycle life of conventional Lithium-Ion batteries

Alevo Energy
Vertically Integrated Manufacturing
Electrolyte manufacturing, battery manufacturing, GridBank™ ESS assembly, systems integration, and project development

Alevo Analytics
Proprietary Grid Analytics
Actionable business intelligence regarding where and how to deploy energy storage solutions to make the biggest impact on the grid
Alevo Batteries vs Other Batteries

Alevo Battery Technology provides unique characteristics never before seen in Lithium-Ion batteries

Alevo Battery Technology
Inorganic Lithium-Ion Battery

- **NON-FLAMMABLE**
  Independent sources have confirmed that inorganic electrolyte cannot be ignited. ⁴

- **STABLE, PREDICTABLE**
  Inorganic chemistry remains stable over time. Behavior highly predictable. ²

- **HIGH POWER**
  High concentration of lithium-ions. Electrolyte has 10X higher conductivity than organic systems. ³

- **STABLE RESISTANCE**
  High stability of electrolyte leads to stable resistance over use and time – cells retain their high power capability even after 50,000 cycles. ⁴

Other Battery Competitors
Organic Lithium-Ion Battery

- **HIGHLY FLAMMABLE**
  Organic electrolytes are hydrocarbon based which makes them inherently flammable. Many failure modes can lead to ignition.

- **UNSTABLE, UNPREDICTABLE**
  Inherent reactivity of organic materials means that chemistry changes over time. Unpredictable.

- **LOW POWER**
  Only low concentration of lithium ions. Electrolyte has low conductivity.

- **INCREASING RESISTANCE**
  Degradation of electrolyte over time leads to increasing resistance and loss of power capability.

¹ Verified by Prof. Walter van Schalkwijk
², ³, ⁴ ABT laboratories, externally validated by Walter van Schalkwijk, PhD, University of Washington
# Alevo GridBank Enclosure Configuration

Non-flammable, highly durable and high power chemistry

### Alevo GridBank Enclosure Configuration

<table>
<thead>
<tr>
<th>Component</th>
<th>Quantity</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>14,080 Cells</td>
<td>8 cells per module</td>
<td></td>
</tr>
<tr>
<td>1,760 Modules</td>
<td>4 modules per tray</td>
<td></td>
</tr>
<tr>
<td>440 Trays</td>
<td>2 trays per shelf</td>
<td></td>
</tr>
<tr>
<td>220 shelves</td>
<td>10 shelves per rack</td>
<td></td>
</tr>
<tr>
<td>22 racks per GridBank</td>
<td>Totaling: 2MW / 1 MWh</td>
<td></td>
</tr>
</tbody>
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**GridBank pictured with Parker Hannifin Inverter**
21st Century Manufacturing

I  Electrode Manufacturing
Anode and Cathode Electrode consists of mixing, coating, blanking, and welding.

II  Cell & Module Assembly
Sorted and stacked electrodes are brought upstairs to cell and module assembly. This station is made up of 7 major steps.

III  Module Fill
During the fill process, each cell in the module is filled with Alevolyte.

IV  Formation & Aging
Formation & Aging is a 7 step process that takes 2 weeks to complete.

V  Tray Assembly
Four modules are secured and wired to tray and prepared for GridBank assembly.

VI  GridBank Assembly
Completed parts are installed into empty GridBanks.

Alevo employs over 200 at its Concord manufacturing plant.
Alevo plans to hire 200 more employees and invest $300 million over next five years.
Energy Storage Use Cases

- **Bulk Power**
  - Time Shifting Energy
  - Frequency Regulation
  - Voltage Support

- **Grid Services (T&D)**
  - Resource Adequacy
  - Power Quality

- **Customer Services (Behind the Meter)**
  - Peak Shaving
  - Backup Power

Control and Convenience

Deferred Investment

Higher Power Plant Efficiency
Upcoming Events

April 12 – Cleantech Connect Career Fair
Upcoming Events

April 20 – Future Cities & Cleantech Networking Event
Upcoming Events

June 6: Meet the Investors (Cleantech Venture Capital Event)
Upcoming Events

June 26-28 – Smart Cities Connect Delegation
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