Joint Staff Subcommittees on Rate Design and Energy Resources and the Environment
BEHIND THE METER RESIDENTIAL

Deployment of 10MW/27MWHs of Tesla PW2.0 by summer 2019

- 2000 units.
- Fully subscribed. Deployments on track.

Filing to make BTM Storage a tariffed Program

- Replace fossil backup generators.
- Existing PV owners.
- Low Income, Life Support customers.
- T&D Project Deferral/Elimination.
- Reliability challenged locations.
GMP BTM Storage Pilots

GMP Personal Reliability

- Tesla Powerwall 2.0

Device

GMP Bring Your Own Device

- SolarEdge StorEdge Inverter-compatible

Device Ownership

- Customer

Customer Pricing

- $15/mth or $1500 up front
- built into Customer pricing

Customer Benefit

- from their supplier
- GMP bill credit based on device size ($14-$36/mth range)
STORAGE IN ACTION

- Halloween 2017: New England experienced the equivalent of Category 1 hurricane
- GMP customers in our BTM Storage program were able to ride through the outage duration, some as long as 3 days
RESILIENCY AND CUSTOMER SAVINGS

RELIABILITY THAT PAYS FOR ITSELF

Battery Power (kW)

Zoom: 1d 3d 1m 1y All

From: Jan 15, 2018 To: Jan 16, 2018

Battery Power (kW)

10:00 12:00 14:00 16:00 18:00 20:00 22:00 02:00 04:00 06:00 08:00
Joint Staff Subcommittees on Rate Design and Energy Resources and the Environment
2018 NARUC Annual Meeting

Maximizing BTM Storage Value

Jim Baak
Senior Manager for Regulatory Affairs, West
Jim.Baak@stem.com
November 11, 2018
Stem Overview

Stem operates the world’s smartest and largest digital energy storage network.

**High Caliber Global Investors**

- ANGELNO GROUP
- MITSUI & CO., LTD.
- IBERDROLA
- GE
- RWE
- MITHRIL
- Constellation
- Activate Capital
- TOTAL
- Ontario Teachers' Pension Plan

**Founded:** 2009
**Headquarters:** Millbrae, CA
**Employees:** 150+
**Operations In:** CA, HI, NY, TX, MA, Japan, ONT
**Pipeline & Installed:** 900+ sites, 250+ MWh
**Installed:** 400+ sites, 3.5M+ device hours
**8 utility contracts:** 350 MWh
**Project Finance:** $650 MM

**Distinguished Honors & Awards**

- Greentech Media: 2018 Grid Edge Innovation Award
- SEPA Power Player 2017: Innovative Partner of the Year
Stem’s Solution Components

Athena™ Artificial Intelligence
Automatically controls when energy storage charges and discharges to optimize timing, maximize savings, and create virtual power plants.

Energy Storage Systems
Modular options for all facility sizes and locations. Batteries from leading global manufacturers.

Small indoor 18 kW modules

Medium indoor 132 kW modules

Large outdoor
Scalable from 100 kW to 5+ MW
Stem’s network of storage systems can be dispatched as a “Virtual Power Plants” for utilities and grid operators.

Cloud-based AI software automatically optimizes each system to help the customer and the grid at the same time.

Machine learning and big data processing allow software to learn from each event and grow smarter.
Multiple Use Applications
Customer - Sited Storage = Range of Values

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

Source: Rocky Mountain Institute
The Economics of Battery Energy Storage, Oct 2015
Only BTM Storage is capable of providing Customer Value and Grid Value.

Categories of Multiple Use Applications:
- Time Differentiated
- Capacity Differentiated
- Market Differentiated

Need to determine incremental value.
Case Study: Demand Charge Mgmt & Local Capacity

- Promote LCR program
- Educate customers on benefits
- Customer satisfaction

- Capacity and energy payments for performance
- Support customer acquisition
- $0 money down
- Load management
- Automated bill savings

- VPP of 85 MW of firm, local, dispatchable capacity
- Fatigue-less Resource Adequacy resource
- Performance based contract
- Energy storage system subscription payment

Athena™ Artificial Intelligence
Automatically controls energy storage charge/discharge to optimize timing, maximize savings, and create VPPs.
DR Event + Demand Charge Savings (Single Customer)

SCE Demand Response Event
5 – 8 pm

Charging against a setpoint

Discharge for demand charge management

Discharge for DR event

Post DR event charging
VPP: Aggregated Dispatch (Multiple Customers)
Storage & PV (Multiple DERs)

Storage Firms Solar
Demand Cost Reduction

Storage Reduces Shoulder Peaks
(and may enhance peak reduction)
Demand Cost Reduction

Solar Delivers Lower Cost/kWh
Energy Cost Reduction

Solar May be Allowed to Net Export
Export Credits/Payments

Storage May Enable Self Consumption
Increased PV Sizing in Non-Export Scenarios

AND
OR
Rate Design
Rate Design Principles for DER

- In General, Avoid Resource-Specific Tariffs
- Dynamic Pricing Options
  - Temporally (TOU, RTP, etc.)
  - Locationally (LMP, Options Tariffs, etc.)
- Separate tariffs for services (versus consumption)
  - Energy, Capacity, Ancillary Services (Voltage/Frequency Support)
- Move from Non-Coincident Peak Demand to Coincident Peak
  - Coincident with either system or distribution circuit peak
  - Daily Demand Charges (DER as Non-Wires Alternatives)
Additional Considerations: Distribution Planning & Non-Wires Alternatives
Unlocking Full Value of Storage/DER Requires Paradigm Shift

- Ability to maximize customer & grid value hinges on access to markets
- Traditional resource & grid planning only sees DER as load-modifiers
- New approach to grid planning treats DER as resources that can be leveraged to provide customer & grid value
- To unlock full potential of any 3rd party DER, including energy storage, requires re-imagining the regulatory framework
  - Performance Based Regulation may be a first step in that direction
CA’s Distributed Resources Planning (DRP) Approach

- DRP – Planning for the Grid
  - Integration/Hosting Capacity Analysis – where, what & how much?
  - Locational Net Benefits Analysis
  - Distribution Deferral Opportunities/Non-Wires Alternatives
- Integration of DER (IDER) – Sourcing Strategies
  - Focus has so far been IOU procurement
- Utility Grid Modernization
  - Balance IOU investments with 3rd Party DER sourcing
  - Need to avoid over-investment / stranded investments
Utility Investments vs. 3rd Party DER Sourcing

- Moving from utility capital investments to 3rd party software + services sourcing
- DER Sourcing Options:
  - Procurement
  - Pricing/Tariffs
  - Programs
  - Market Mechanisms
- No “one-size-fits-all” approach – different needs/timing require different solutions
Additional Background Slides
The Stem Energy Platform – Athena

- Real-time telemetry and multiple external data services stream information to Stem's predictive analytics and optimization engine.
- Stem's machine learning algorithms optimize the asset's operations to deliver value for customers.
- Provides grid assets for the utility's needs.

### The Stem Energy Platform

<table>
<thead>
<tr>
<th>Partner Integration Layer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Services &amp; Access Management</td>
</tr>
<tr>
<td>Dispatch Scheduler</td>
</tr>
<tr>
<td>Optimization Engine</td>
</tr>
<tr>
<td>Solution Engine</td>
</tr>
<tr>
<td>Forecasting</td>
</tr>
<tr>
<td>Tariff Modeling &amp; Rating</td>
</tr>
<tr>
<td>Configuration Management</td>
</tr>
<tr>
<td>Real-Time Monitoring</td>
</tr>
<tr>
<td>Classification</td>
</tr>
<tr>
<td>Anomaly Detection</td>
</tr>
<tr>
<td>Data Persistence</td>
</tr>
</tbody>
</table>

**Partnership Integration:**

- **Real-time telemetry and event data**
- **Real-time supervisory and operational control signals**

**Data Acquisition & Cleansing:**

- **Utility & Grid Control Systems**
- **SMART Meter Data**
- **Local Weather Data**
- **Grid Connection Data**

**Utility Tariff & Rates**

**Market & Price Data**

© 2018 Confidential
• Stem is currently monetizing 7 of the 13 energy storage value streams as identified by the Rocky Mountain Institute in their report “The Economics of Battery Energy Storage”

• In the future, Stem intends to co-optimize and stack these revenue streams as well as expand the scope of available offerings and services

• Only behind-the-meter solutions can address all 13 value streams
Joint Staff Subcommittees on Rate Design and Energy Resources and the Environment
HOW CAN BTM STORAGE CUSTOMERS PARTICIPATE IN MULTIPLE SERVICES IN ORDER TO CAPTURE VALUE?

NARUC
NOVEMBER 11, 2018

Lon Huber
Head of NA Retail Regulatory Offering
Navigant has assisted developers, vendors, utilities, investors, and government in developing energy storage strategies and implementing projects.

<table>
<thead>
<tr>
<th>COMMERCIAL STRATEGY</th>
<th>PROJECT STRATEGY</th>
</tr>
</thead>
<tbody>
<tr>
<td>MARKET RESEARCH</td>
<td>OPPORTUNITY ASSESSMENT</td>
</tr>
<tr>
<td>Develop syndicated reports + custom research.</td>
<td>Identify opportunities and assess feasibility.</td>
</tr>
<tr>
<td>ENERGY STORAGE 101</td>
<td>TECHNOLOGY PROCUREMENT</td>
</tr>
<tr>
<td>Deliver workshops and educational materials.</td>
<td>Support both ESS buyers and sellers.</td>
</tr>
<tr>
<td>GO-TO-MARKET STRATEGY</td>
<td>PROJECT DUE DILIGENCE</td>
</tr>
<tr>
<td>Strategy and business plan development</td>
<td>Advise investors on opportunities and risks.</td>
</tr>
<tr>
<td>M&amp;A STRATEGY + DUE DILIGENCE</td>
<td>PILOT / DEMONSTRATION SUPPORT</td>
</tr>
<tr>
<td>Identify and evaluate potential targets.</td>
<td>Develop M&amp;V strategy and evaluate results.</td>
</tr>
</tbody>
</table>

MODELING
Develop and run tools to quantify technical and economic viability of projects, programs, and businesses.
During the next 5-15 years, Navigant expects massive disruption across the entire energy value chain that will affect a broad set of stakeholders.

Policymakers, energy companies and utilities must respond to market pressures by developing innovative business models. Although policy and regulatory reform is an important driver of transformation – customer choice, disruptors, and technology innovation are relentless instigators of market change.

As technology hardware costs decline, Navigant anticipates the annual worldwide revenue from energy storage for renewables integration will exceed $23 billion by 2026, with utility-scale and residential applications expected to show the strongest growth.
ECONOMIC NECESSITY

• Energy storage serves many applications – which vary from region to region
• Two pathways:
  1. **Dedicated, single use case**: Single use storage application tend not to pencil on one use case, this will change as deployment accelerates price declines for Li-ion.
  2. **Multi-use case/value stacking**: Most storage deployments in the US have relied on some form of value stacking

**Key Energy Storage Applications**

<table>
<thead>
<tr>
<th>Spinning and non-spin Reserves</th>
<th>Distribution Asset Optimization</th>
<th>RE Energy Shifting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hosting capacity</td>
<td>Transmission Asset Optimization</td>
<td>RE Ramping/Smoothing</td>
</tr>
<tr>
<td>Capacity</td>
<td>Frequency Regulation</td>
<td>Demand charge reduction</td>
</tr>
<tr>
<td>Energy arbitrage</td>
<td>Voltage/VAR Support</td>
<td>Backup power and reliability</td>
</tr>
</tbody>
</table>
STORAGE IS DIFFERENT

- Flow Battery
- Sodium Sulfur Battery
- Compressed Air
- Pumped Hydro Storage
- Advanced Lead-Acid Battery
- Lithium Ion Battery
- Flywheel
- Ultracapacitor

AVG. DISCHARGE DURATION

- < 15 min.
- 4 hrs. or Less
- 8 + hrs.

AVG. POWER CAPACITY PER PROJECT

10 kW 1 MW 1 GW
MOST RATE DESIGNS ARE TOO DUMB

• Like using a Swiss Army knife to open a bag of potato chips
ISO NE Rate Allocation Visualization (not to scale)

Transmission (RNS/LNS)

Capacity

Energy and AS

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Residential Rate design

Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec

0 1 2 3 4 5 6 7 8 9
BETTER WAY

• Proper price signals should be available as an option
  - Expect dynamic price signals or dispatch calls
• But don’t expect mass adoption of advanced rates
• Utilities and third parties need to be involved
SNAPSHOT OF RESIDENTIAL ADVANCED DER RATES (SMART HOME RATES)

*Proposed or soon to be proposed

Source: Lon Huber, Strategen Consulting
### NY REV SMART HOME RATE PILOT:

<table>
<thead>
<tr>
<th></th>
<th>ConEdison</th>
<th>Orange &amp; Rockland</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Supply Charge</strong></td>
<td>$ / kWh Hourly NYISO LMP Zones H, I, J</td>
<td>$ / kWh Hourly NYISO LMP Zones G</td>
</tr>
<tr>
<td><strong>Embedded Delivery Charge (12pm-8pm)</strong></td>
<td>$1.10 / max daily kW</td>
<td>$0.88 / max daily kW</td>
</tr>
<tr>
<td><strong>Coincident Event</strong></td>
<td>Incremental to daily demand charge; 24-hr advance notice for events; hours vary by event</td>
<td>Generation $11.34 / max event kW</td>
</tr>
<tr>
<td></td>
<td>Transmission $1.15 / max event kW</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Distribution $4.61 / max event kW</td>
<td></td>
</tr>
<tr>
<td><strong>Monthly Customer Charge</strong></td>
<td>$15.76</td>
<td>$15.76</td>
</tr>
<tr>
<td><strong>Adjustments and Surcharges</strong></td>
<td>$ / kWh; includes System Benefit Charge, MAC, RDM, etc.</td>
<td>$ / kWh; includes System Benefit Charge, MAC, RDM, etc.</td>
</tr>
</tbody>
</table>
Is New Hampshire on the verge of battery energy storage history?

The only question left to be settled is a big one: Should utilities own behind-the-meter batteries?

A small investor-owned utility in New Hampshire may be on the verge of regulatory approval for one of the most ambitious U.S. tests yet of utility-owned, customer-sited battery energy storage systems.

In the process, regulators and stakeholders of the DE 17-189
NEW HAMPSHIRE BATTERY PILOT

- Balance between status quo and true cost of service rates
  - Volumetric TOU with utility dispatch to 12CP and 1 CP price signals

- Use cases:
  - Transmission allocation avoidance
  - TOU arbitrage
  - Non wires alternative
  - Backup power

- Goal is to avoid intra-service territory cost shifts and double counting

- ROE adder based on forecast accuracy

- Proposal to allow third party aggregators to perform dispatch and include solar energy
  - Maybe shared savings
LON HUBER
Director
928.380.5540
Lon.Huber@navigant.com
Navigant has undertaken >75 projects related to energy storage for utilities, developers, manufacturers and policy makers in the last 10 years

Navigant has conducted market entry strategy, market forecasting, M&A support, due diligence, modelling and technology studies

Our Market Intelligence analysts regularly publish white papers, syndicated reports, and blogs. Since 2017, we published 25 syndicated reports related to energy storage and batteries

We regularly speak at industry events on energy storage

We have dedicated research services covering grid tied energy storage; distributed energy storage; and advanced battery innovations

We produce multiple reports on energy storage technologies and business models which provide in-depth examinations of utility integration strategies, policy and regulatory factors, business and financing models, and a detailed view of the key industry players

Through our consulting project work and through our Market Intelligence primary research, we have established relationships with stakeholders throughout the industry

Our Market Intelligence team executes over 200 industry interviews per year

Navigant is active in or has working relationships with all of the major energy storage industry associations such as: the U.S. Energy Storage Association (ESA) and the European Association for the Storage of Energy (EASE)
### Making the Case for Energy Storage

<table>
<thead>
<tr>
<th>Navigant Offerings</th>
<th>What We Do</th>
</tr>
</thead>
</table>
| Develop Business Case      | ✓ Assess technical and market potential  
                             | ✓ Define demonstration goals and objectives  
                             | ✓ Conduct initial cost benefit analysis  
                             | ✓ Develop use cases                                                         |
| Procurement                | ✓ Develop procurement options and strategy  
                             | ✓ Develop solicitation documentation (RFP/RFQ) and appendices (technical, protocols)  
                             | ✓ Administer solicitation process or augment existing Utility evaluation teams |
| Demonstration Planning     | ✓ Specify equipment capabilities to support use cases  
                             | ✓ Solicit project partners and vendors  
                             | ✓ Create monitoring and testing plan  
                             | ✓ Identify target customer types                                             |
| Project Execution          | ✓ Oversee equipment installation and commissioning  
                             | ✓ Manage project schedule and budget  
                             | ✓ Document lessons learned                                                    |
| Data Collection & Hosting  | ✓ Collect high resolution data  
                             | ✓ Support online database hosting                                              |
| EM&V                       | ✓ Analyze project data to verify performance  
                             | ✓ Project impacts of wider deployment  
                             | ✓ Write demonstration reports                                                 |
| Regulatory Support         | ✓ Define use cases and initial hypothesis for utility ownership  
                             | ✓ Analyze pilot results and assess costs and benefits  
                             | ✓ Write report using pilot results to prove hypothesis  
                             | ✓ Map out what other utilities have done and lessons learned  
                             | ✓ Support regulatory filings  
                             | ✓ Serve as expert witness                                                    |
BRING YOUR OWN BATTERY (BYOB) AND V-DER RATES

- BYOB or BYOD - Third party aggregators and utility partnerships
  - Green Mountain Power
  - Liberty - New Hampshire (ROE adder based on forecast accuracy)
  - PSEG Long Island
- V-DER rates – LMP and cost of service linked rates
- More sophisticated standby rates:

<table>
<thead>
<tr>
<th>Typical Commercial Utility Bill</th>
<th>Standby- Con Edison Rider Q</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Supply- Flat Rate</strong></td>
<td><strong>Supply- Day-Ahead Hourly</strong></td>
</tr>
<tr>
<td>Delivery</td>
<td><strong>Delivery</strong></td>
</tr>
<tr>
<td>Customer Charge (Fixed)</td>
<td>Customer Charge (Fixed)</td>
</tr>
<tr>
<td>Energy Charge</td>
<td>Contract Demand (Fixed)</td>
</tr>
<tr>
<td><strong>Demand Charge</strong></td>
<td>(Based on Historic Peak)</td>
</tr>
<tr>
<td>(based on highest peak in the billing period)</td>
<td>Demand Charge</td>
</tr>
<tr>
<td>Monthly Adjustments</td>
<td>Daily Period 8 am to 10 PM (M-F)</td>
</tr>
<tr>
<td>Taxes</td>
<td>Locational 4 hour period based on Substation Peak</td>
</tr>
<tr>
<td>C/kWH</td>
<td>Monthly Adjustments</td>
</tr>
<tr>
<td>$</td>
<td>C/kWH</td>
</tr>
<tr>
<td><strong>Taxes</strong></td>
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