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Tapping the Water–Energy Nexus

130th NARUC Annual Meeting and Education Conference

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

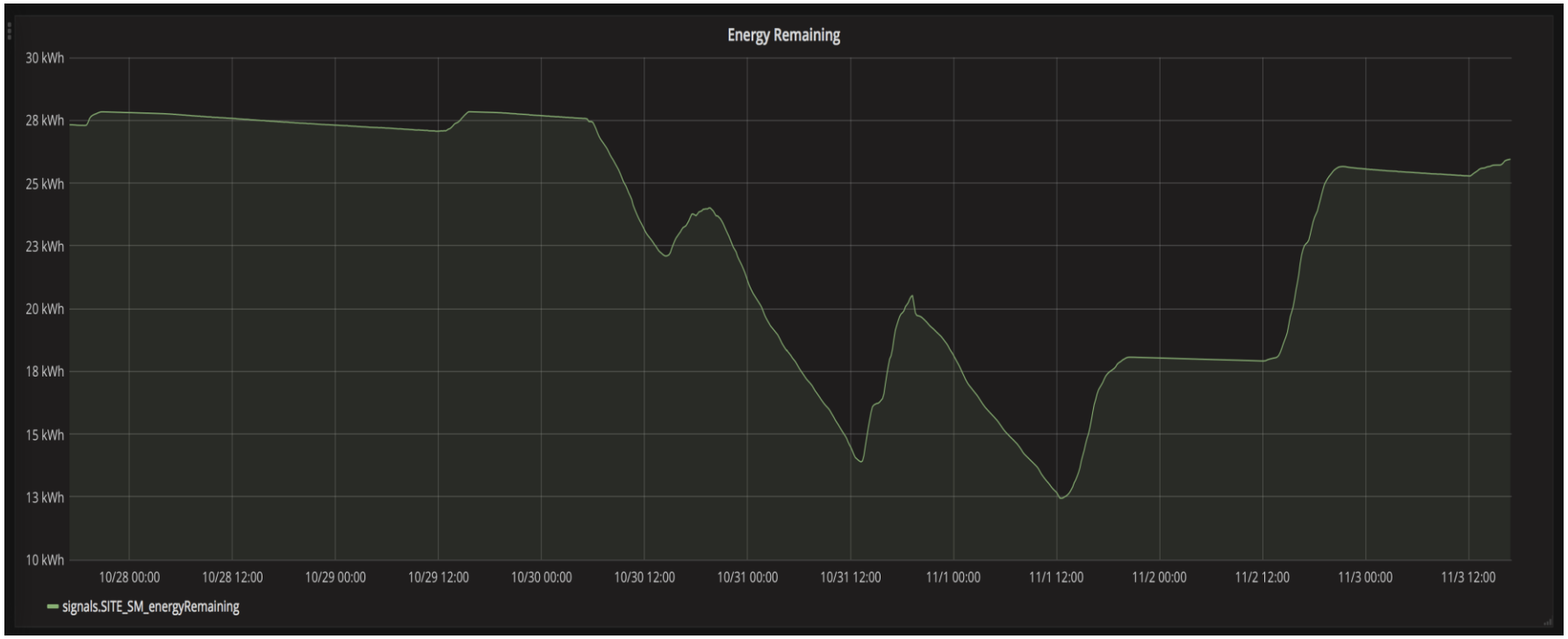
- Replace fossil backup generators.
- Existing PV owners.
- Low Income, Life Support customers.
- T&D Project Deferral/Elimination.
- Reliability challenged locations.

GMP BTM Storage Pilots

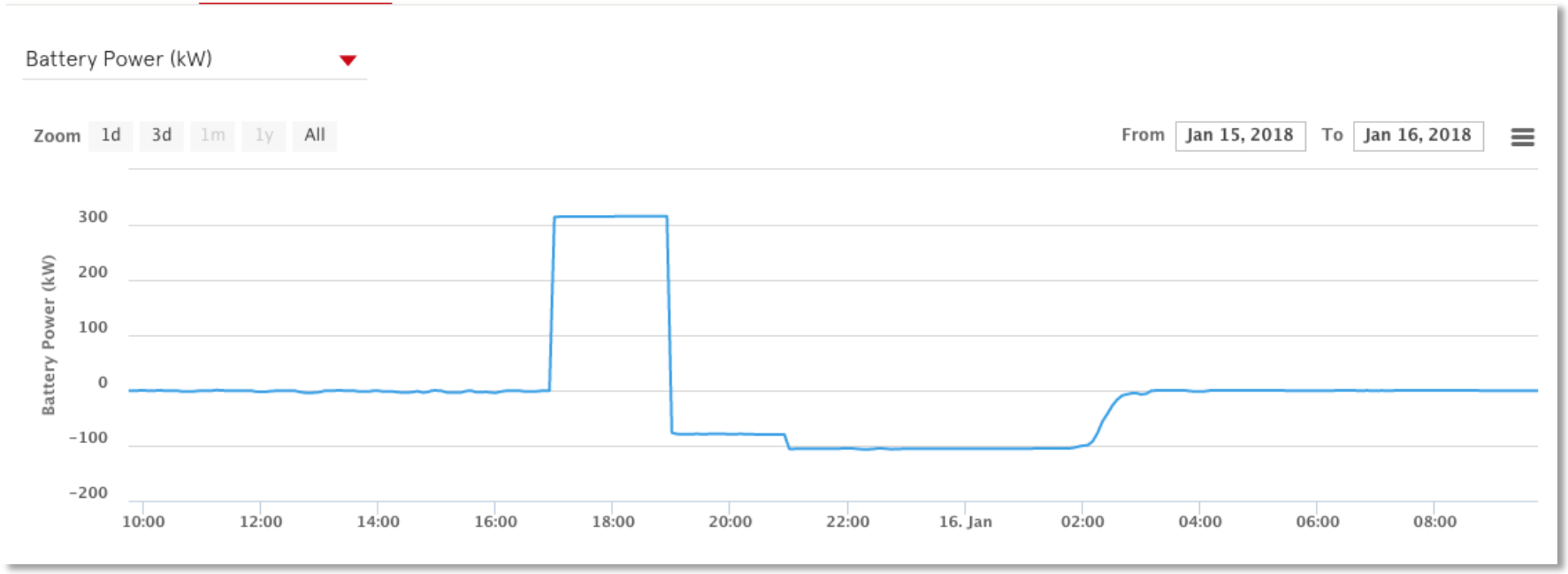
GMP Personal Reliability		GMP Bring Your Own Device
Tesla Powerwall 2.0	***Device***	SolarEdge StorEdge Inverter-compatible
GMP	***Device Ownership***	Customer
$15/mth or $1500 up front	***Customer Pricing***	from their supplier
built into Customer pricing	***Customer Benefit***	GMP bill credit based 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



RELIABILITY THAT PAYS FOR ITSELF



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2018 NARUC Annual Meeting

Maximizing BTM Storage Value

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

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Energy Superintelligence™

Stem Overview

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

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**

High Caliber Global Investors

GE, RWE, MITHRIL, Constellation. An Exelon Company, ANGELENO GROUP, MITSUI & CO., LTD., IBERDROLA, stem, ACTIVATE capital, TOTAL, ONTARIO TEACHERS' PENSION PLAN

Distinguished Honors & Awards

Greentech Media: 2018 Grid Edge Innovation Award
SEPA Power Player 2017: Innovative Partner of the Year

WORLD ECONOMIC FORUM, ENERGY EXCELERATOR, 2018 Global Cleantech 100 TOP 100 COMPANY, Bloomberg NEW ENERGY PIONEER 2018 WINNER, SEPA POWER PLAYERS, GRID EDGE innovation AWARD WINNER

Stem's Solution Components

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Athena™ Artificial Intelligence

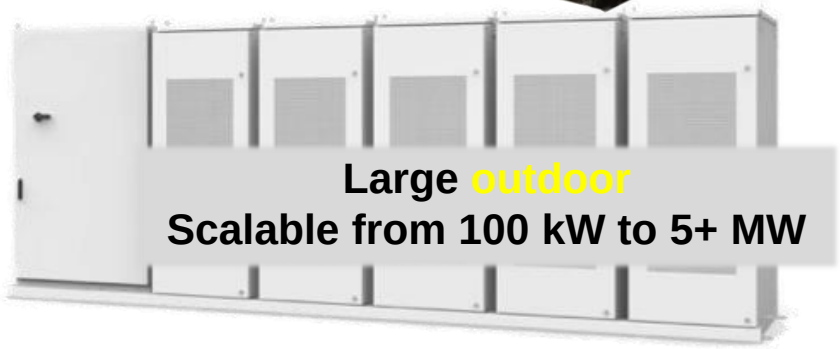
Automatically controls when energy storage charges and discharges to optimize timing, maximize savings, and create virtual power plants.

Energy Storage Systems

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

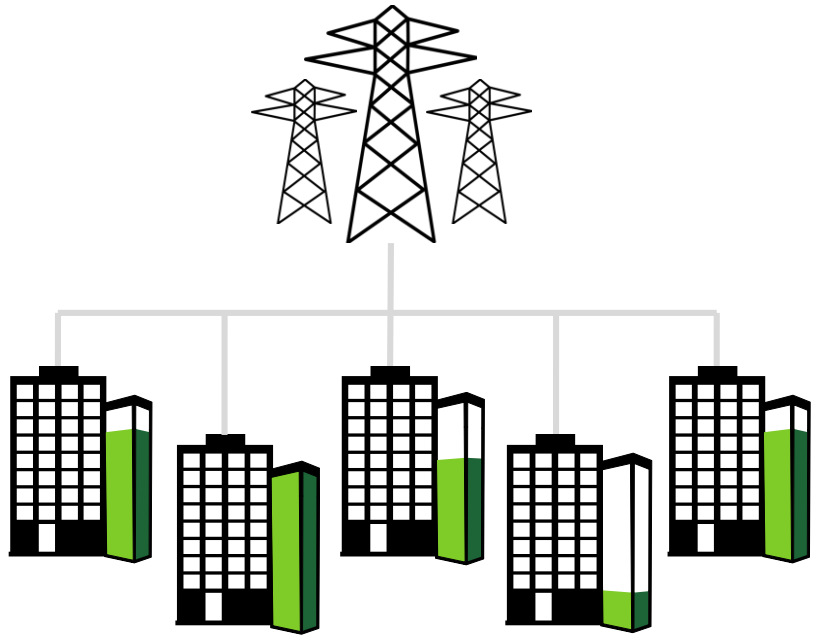
Medium indoor
132 kW modules

Small indoor
18 kW modules



Large outdoor
Scalable from 100 kW to 5+ MW

Stem's Virtual Power Plants



Energy Superintelligence™

- 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

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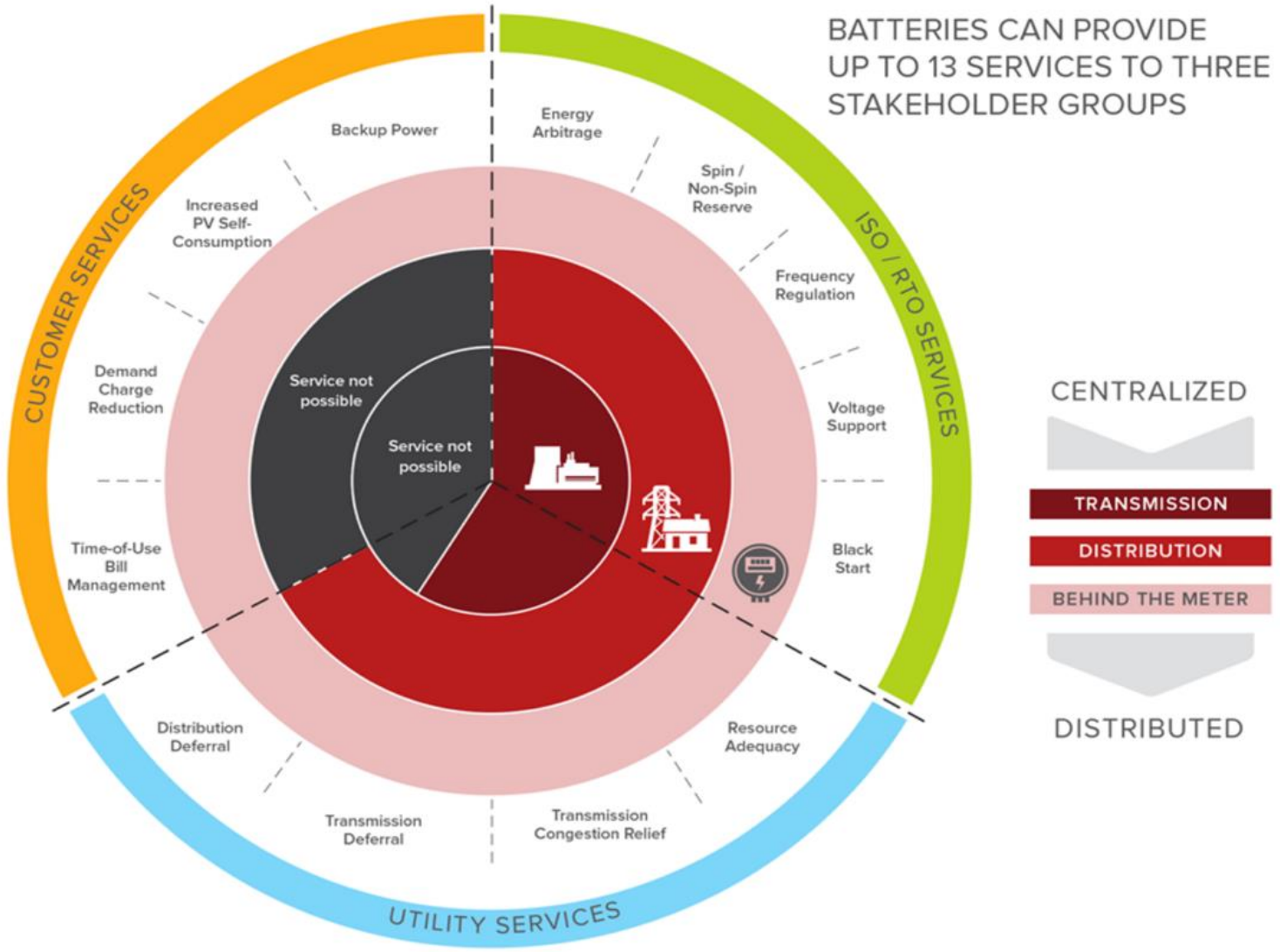
Customer - Sited Storage = Range of Values



Source:
Rocky Mountain Institute
The Economics of Battery Energy Storage, Oct 2015

Value - Stacking for BTM Storage

- 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

SOUTHERN CALIFORNIA EDISON®
An *EDISON INTERNATIONAL*® Company

- 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

Athena™ Artificial Intelligence
Automatically controls energy storage charge/discharge to optimize timing, maximize savings, and create VPPs.

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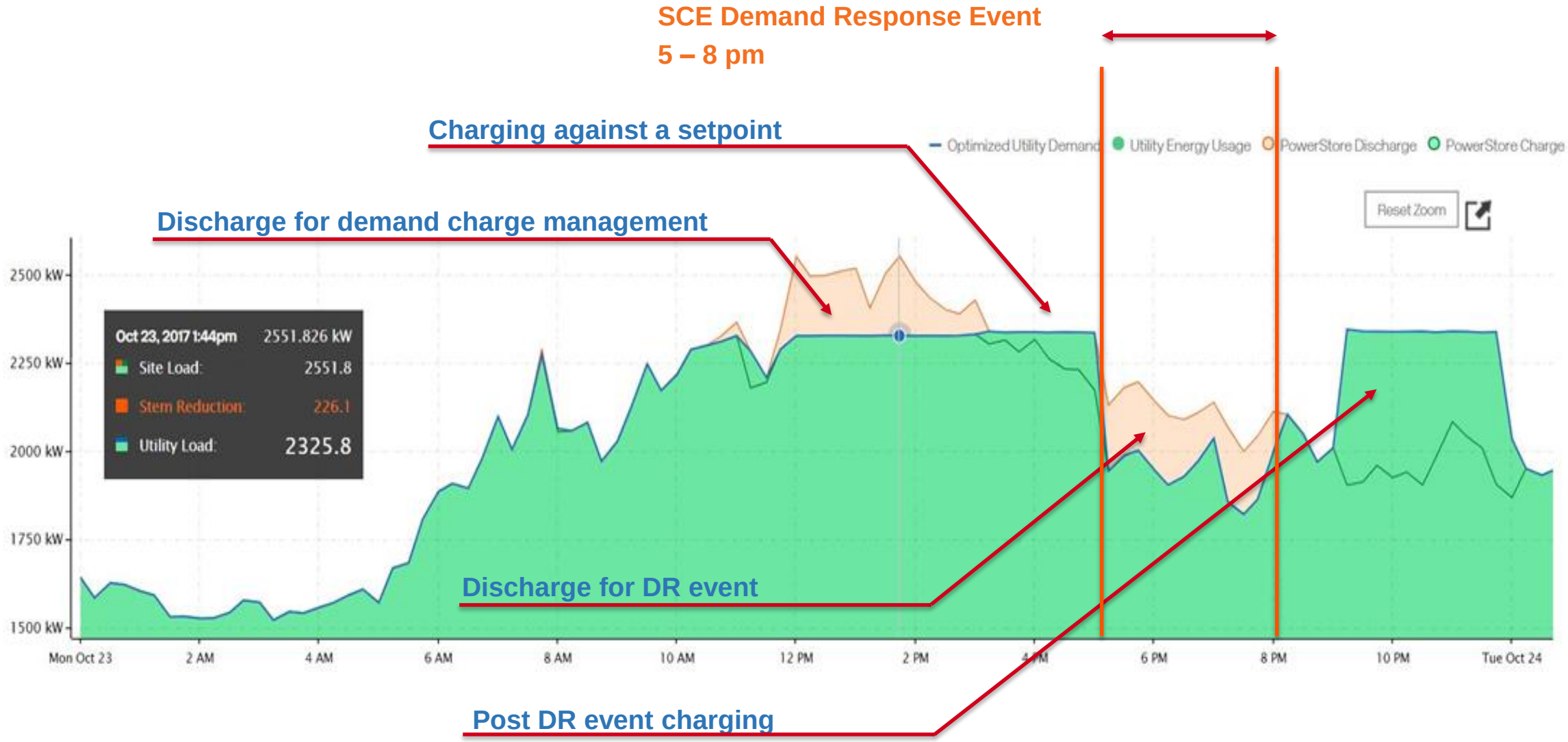
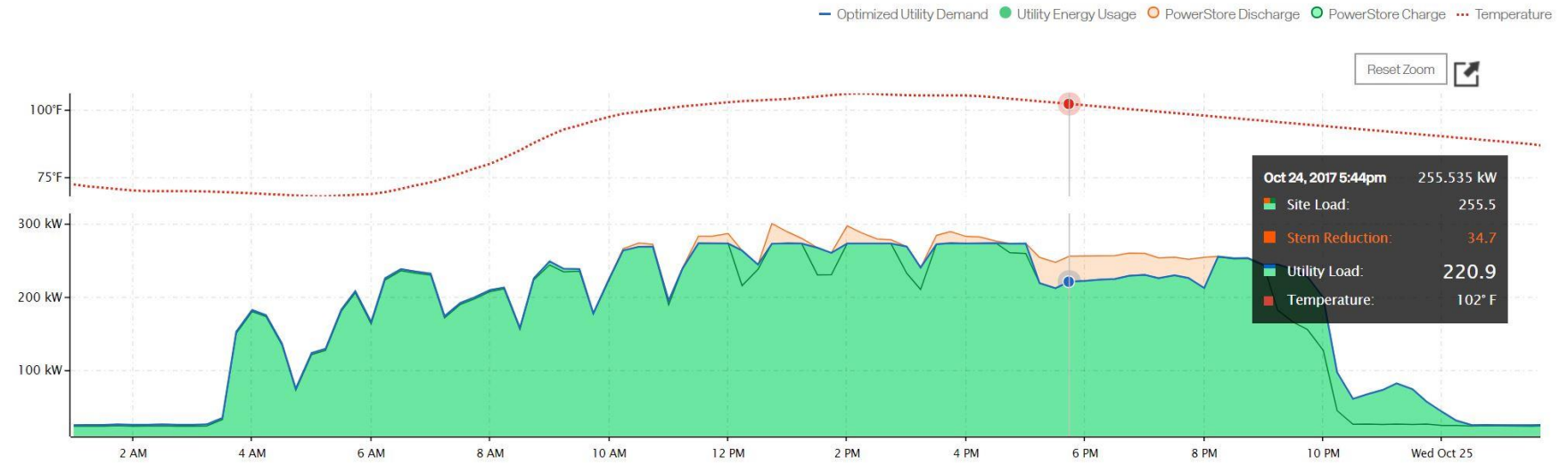
- VPP of 85 MW of firm, local, dispatchable capacity
- Fatigue-less Resource Adequacy resource
- Performance based contract

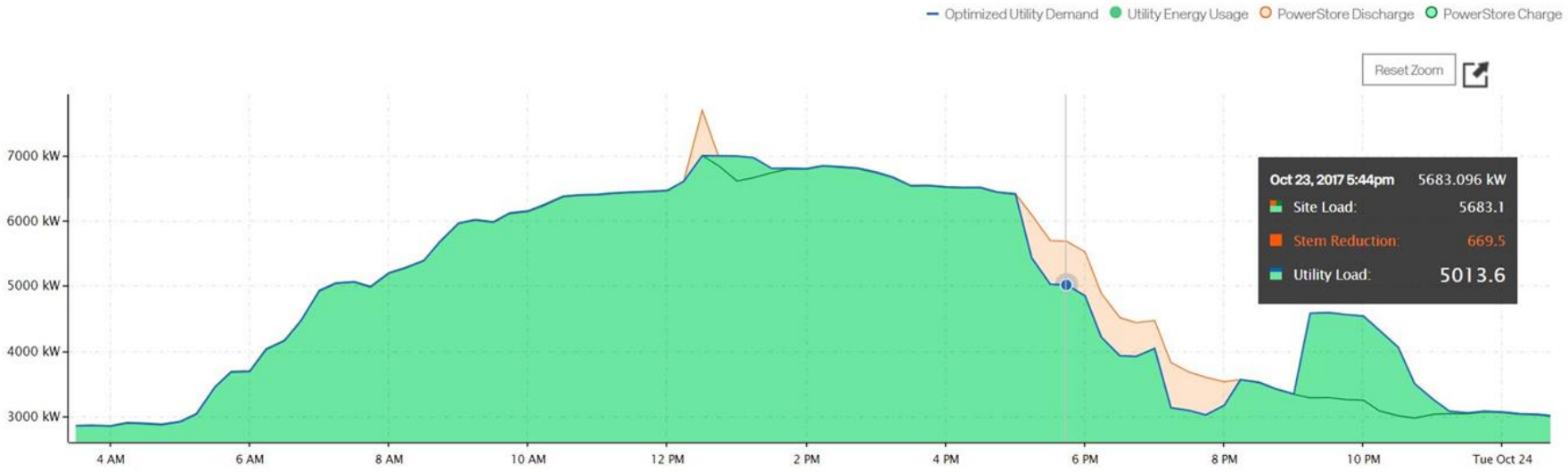
- Energy storage system subscription payment

DR Event + Demand Charge Savings (Single Customer)

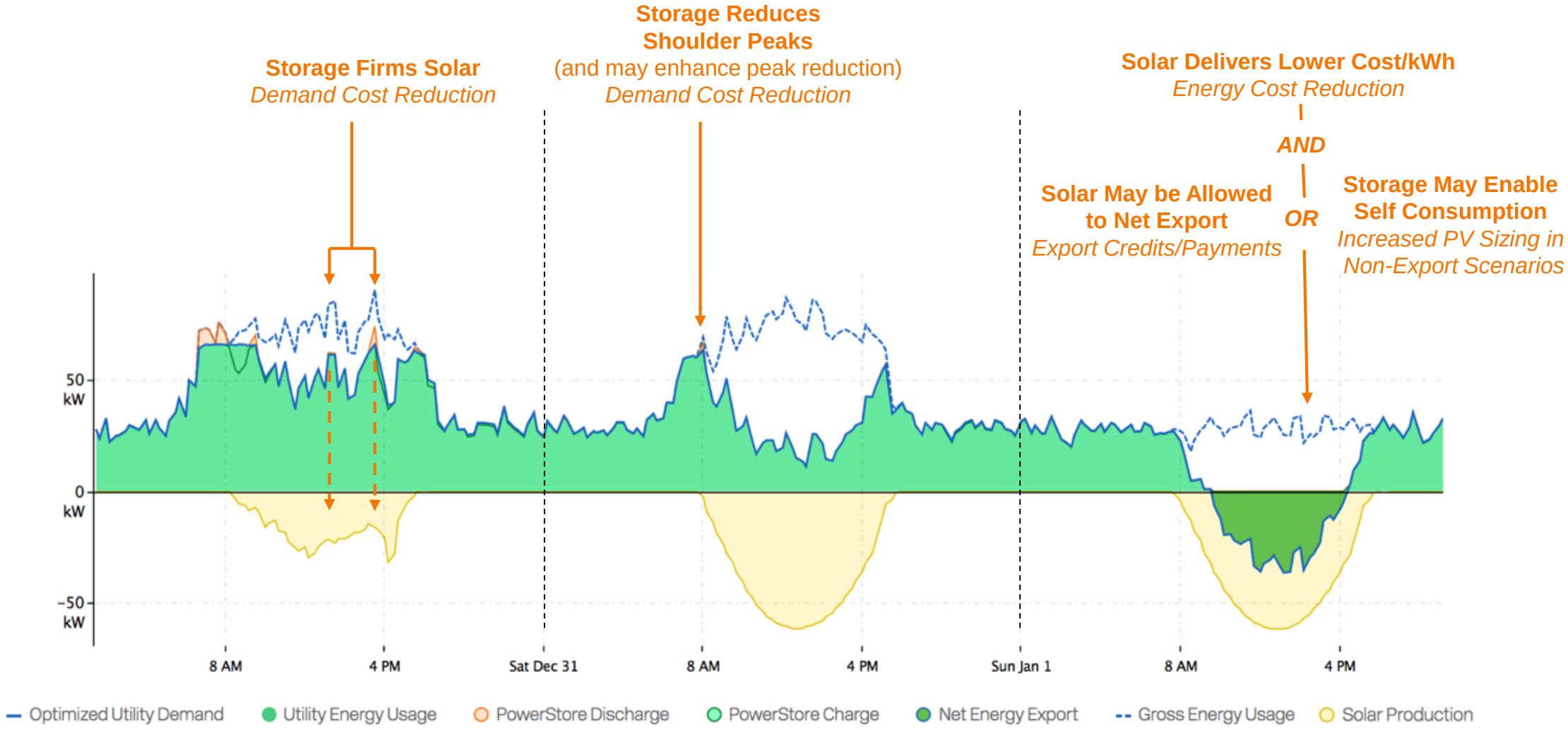


VPP: Aggregated Dispatch (Multiple Customers)





Storage & PV (Multiple DERs)



Rate Design

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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

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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

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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

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PARTNER INTEGRATION LAYER			
DATA SERVICES & ACCESS MANAGEMENT	DISPATCH SCHEDULER		VPP FORECASTING
	OPTIMIZATION ENGINE		MODELING & SIMULATIONS
BATTERY & ASSET OPTIMIZATION	SOLUTION ENGINE		
	FORECASTING	TARIFF MODELING & RATING	
CONFIGURATION MANAGEMENT	REAL-TIME MONITORING	CLASSIFICATION	ANOMALY DETECTION
		DATA PERSISTENCE	
DATA ACQUISITION & CLEANSING			

UTILITY & GRID CONTROL SYSTEMS

REAL-TIME TELEMETRY AND EVENT DATA

REAL-TIME SUPERVISORY AND OPERATIONAL CONTROL SIGNALS

UTILITY TARIFF & RATES

MARKET & PRICE DATA

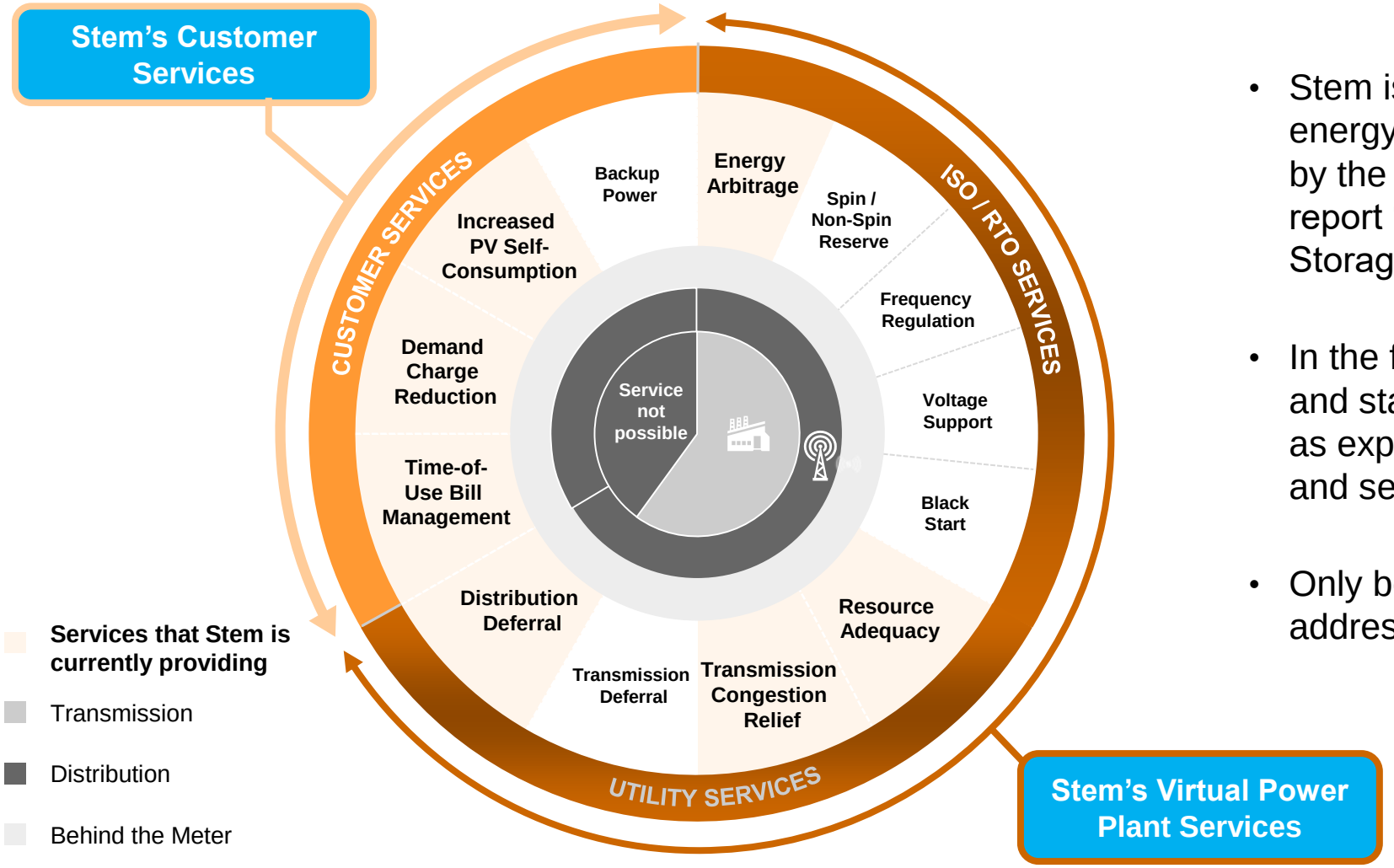
01234

SMART METER DATA

LOCAL WEATHER DATA

GRID CONNECTION DATA

AI-driven optimization of customer & grid benefits



- 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

Source: Rocky Mountain Institute.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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

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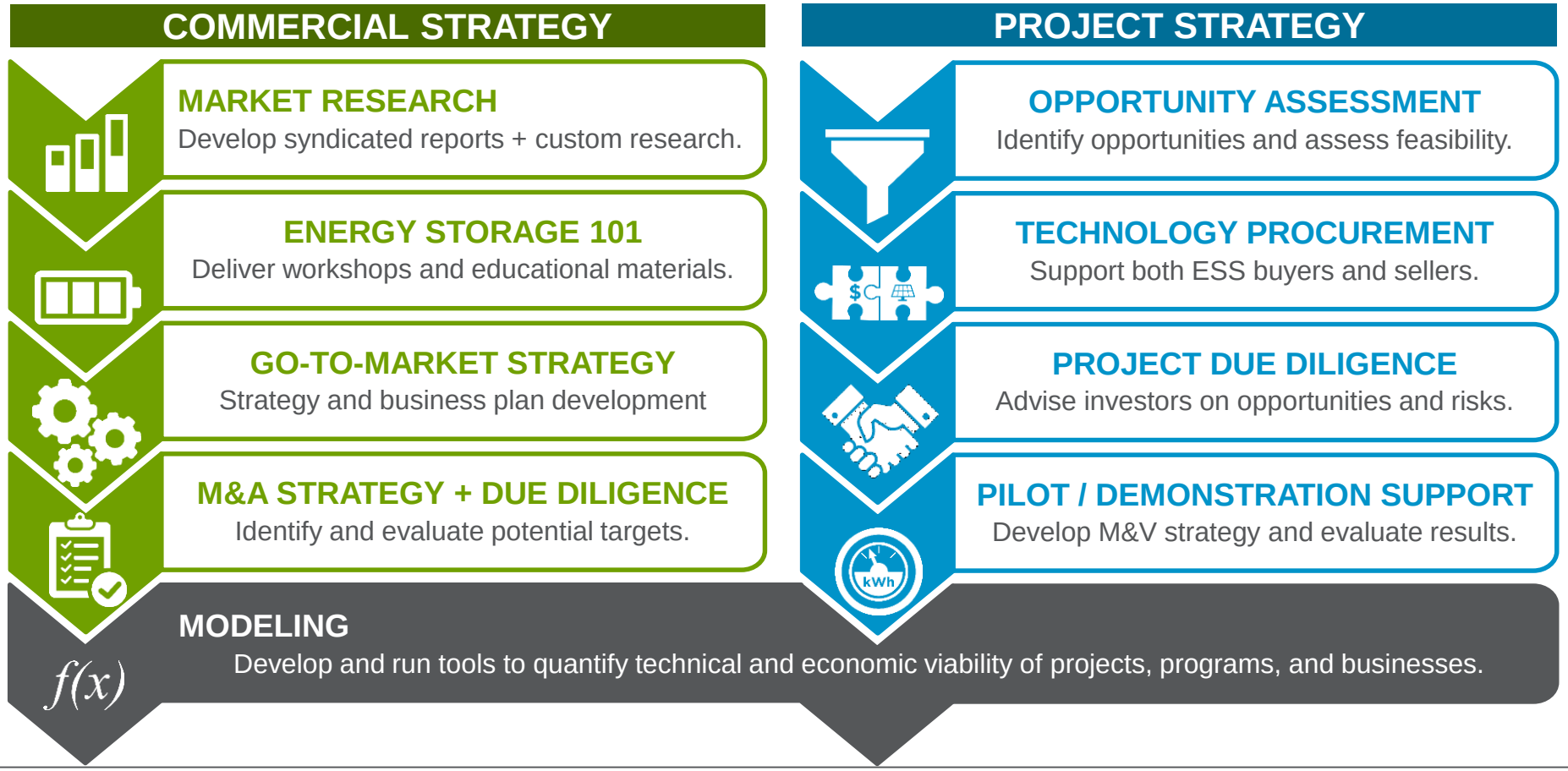
NAVIGANT STORAGE CAPABILITIES & EXPERIENCE

Navigant has assisted developers, vendors, utilities, investors, and government in developing energy storage strategies and implementing projects.



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DISRUPTION CREATES OPPORTUNITY

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.

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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

Spinning and non-spin Reserves	Distribution Asset Optimization	RE Energy Shifting
Hosting capacity	Transmission Asset Optimization	RE Ramping/Smoothing
Capacity	Frequency Regulation	Demand charge reduction
Energy arbitrage	Voltage/VAR Support	Backup power and reliability

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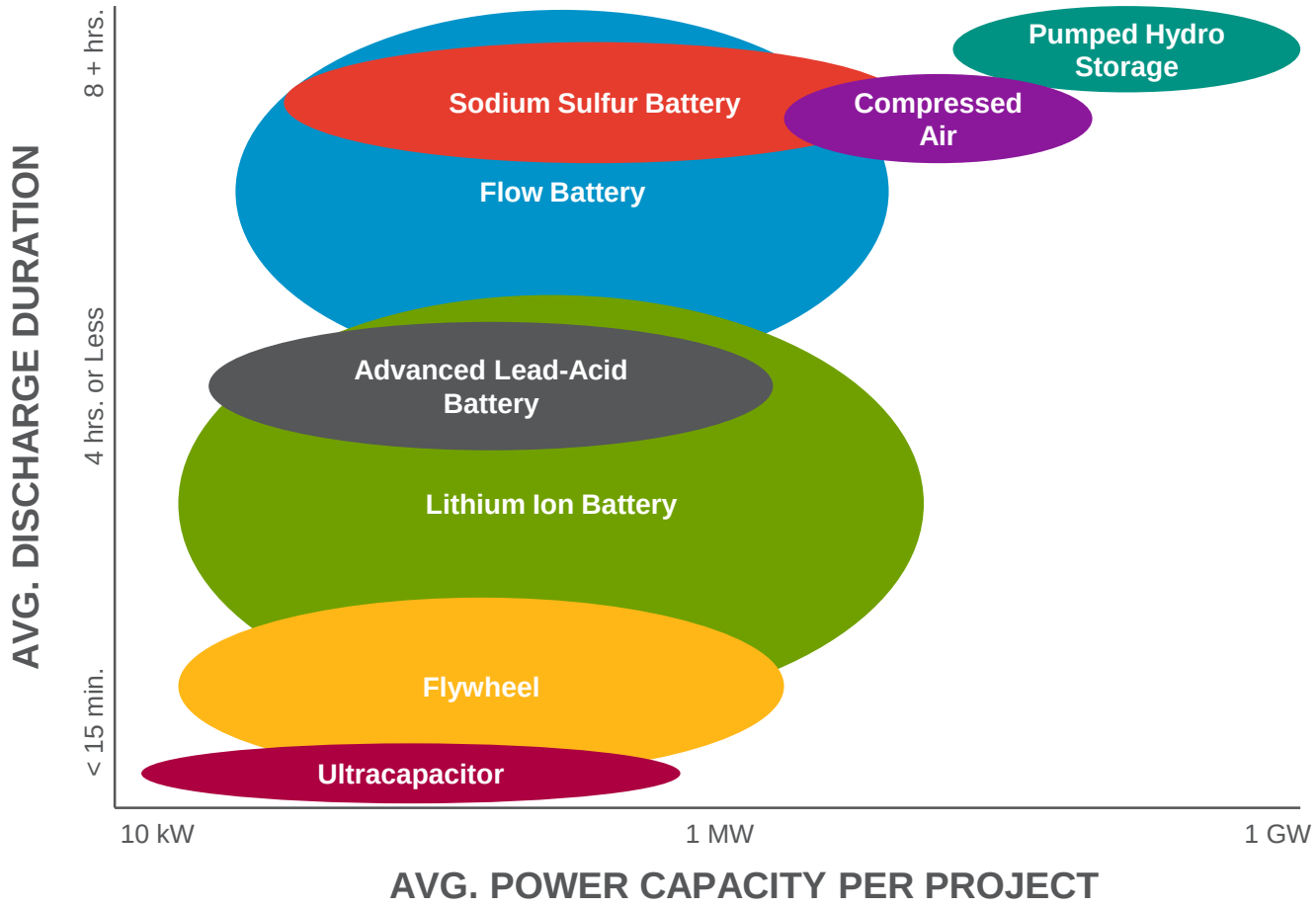
STORAGE IS DIFFERENT



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MOST RATE DESIGNS ARE TOO DUMB

- Like using a Swiss Army knife to open a bag of potato chips

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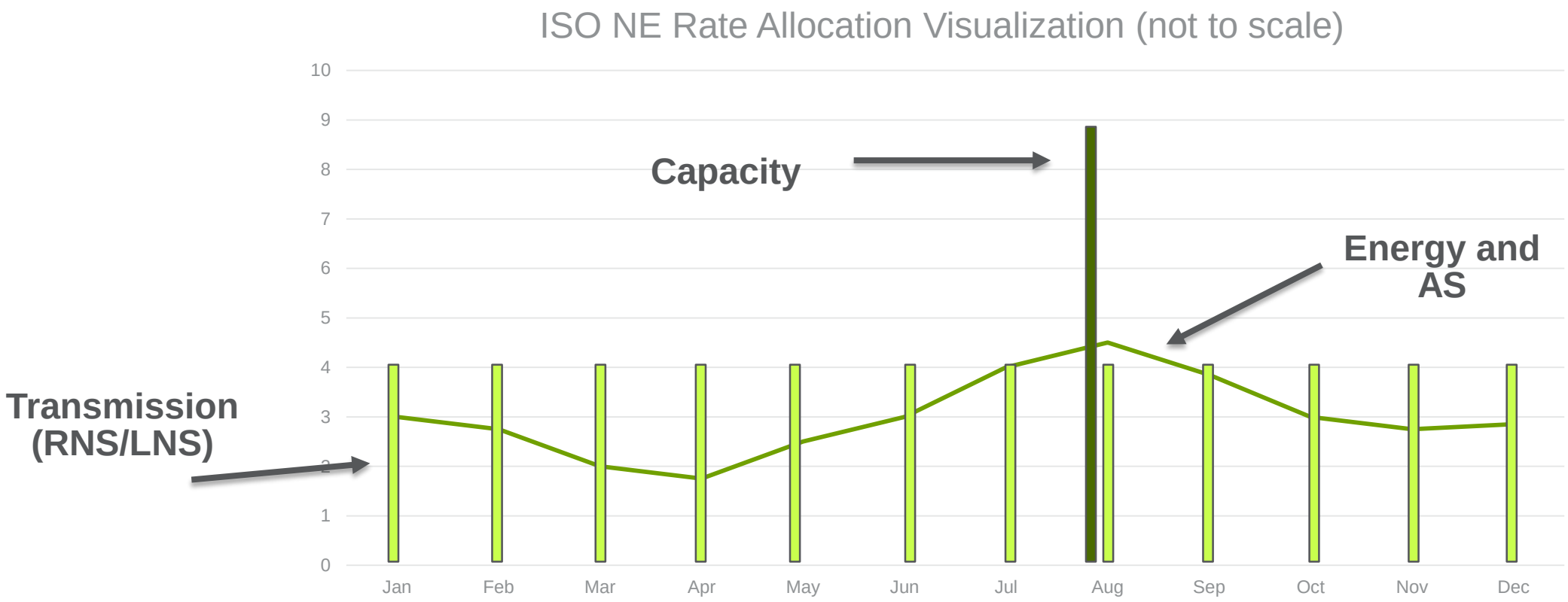
REAL LIFE



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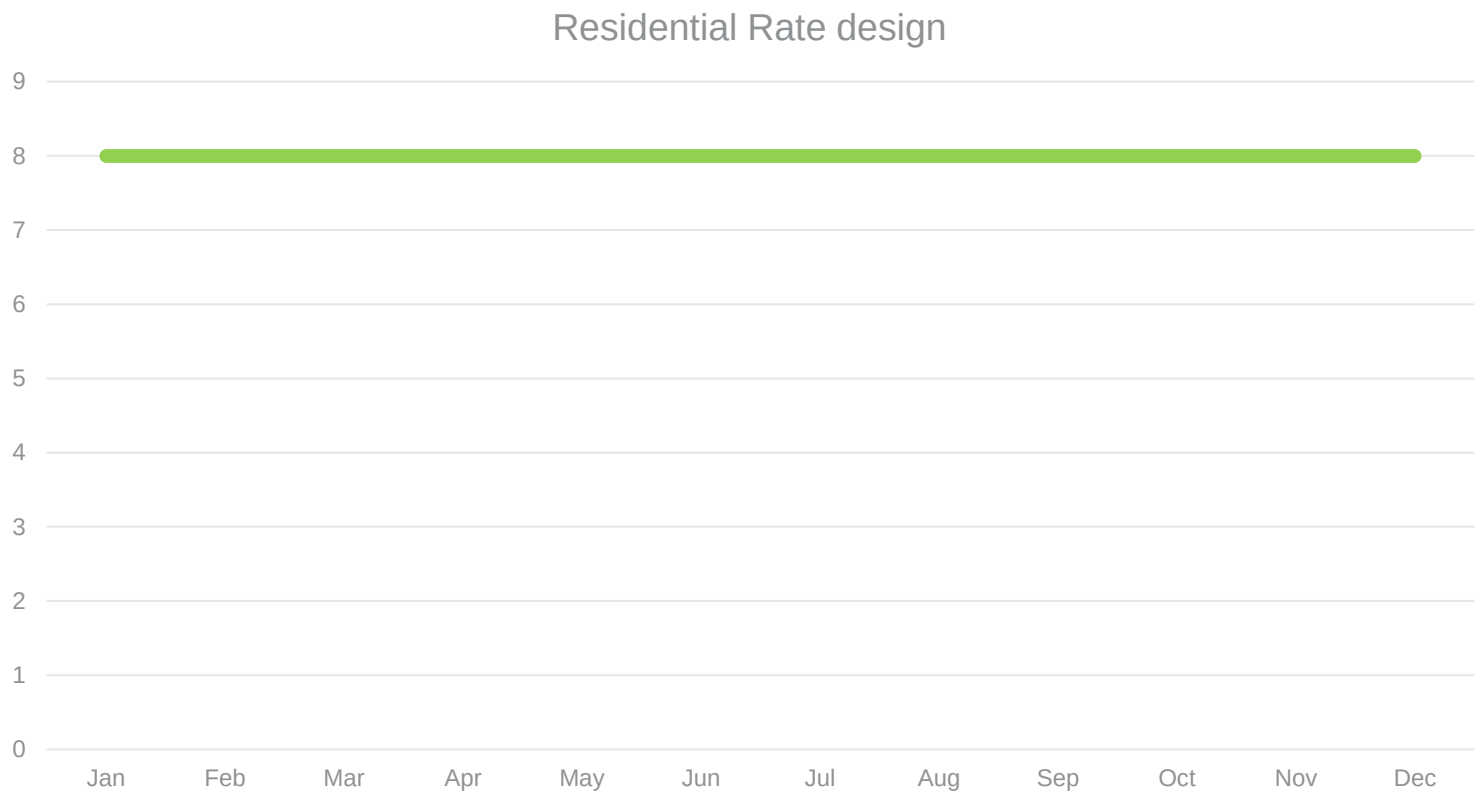
RESIDENTIAL RATE DESIGN



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

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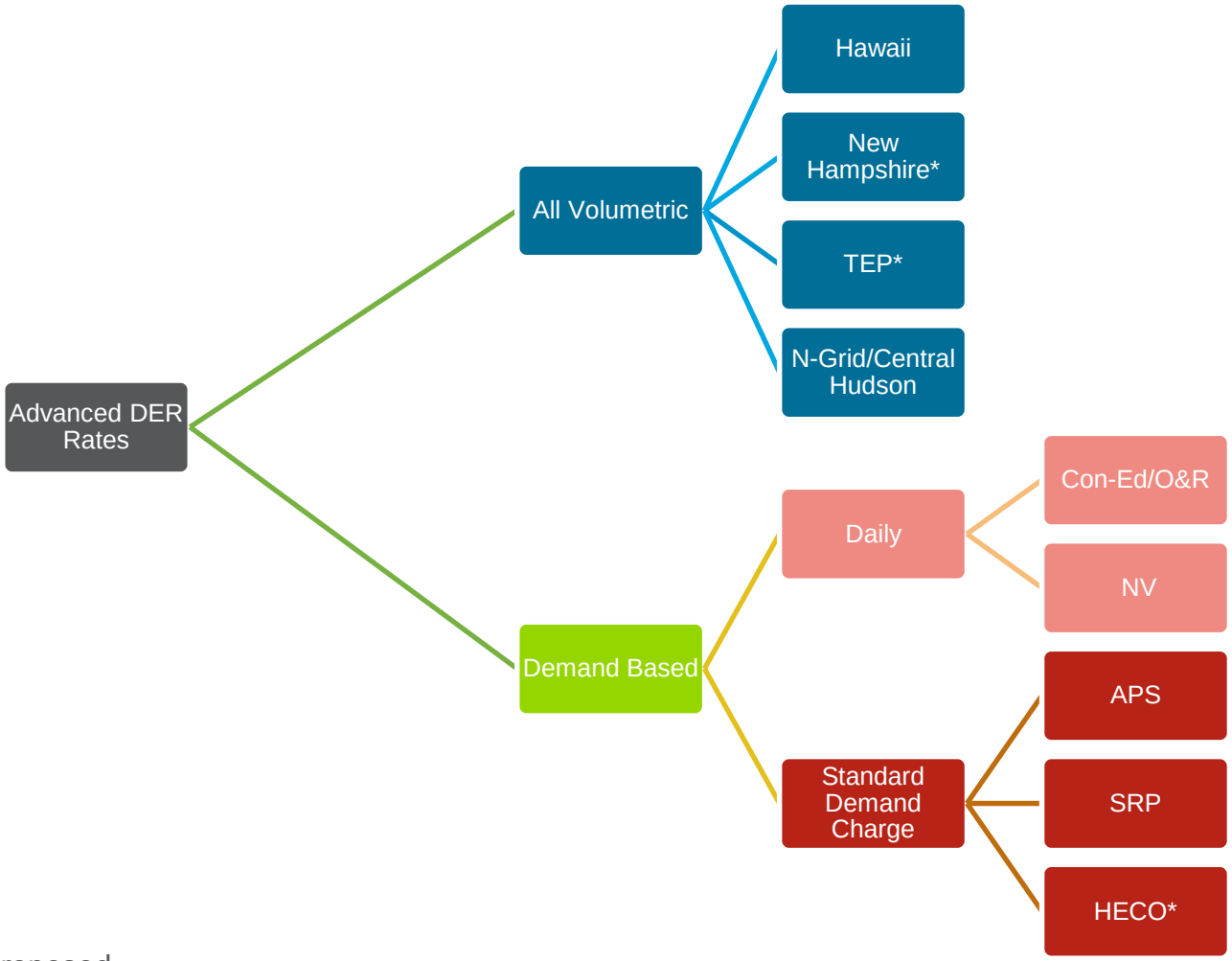
SNAPSHOT OF RESIDENTIAL ADVANCED DER RATES (SMART HOME RATES)



*Proposed or soon to be proposed

Source: Lon Huber, Strategen Consulting

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NY REV SMART HOME RATE PILOT:

ConEdison		
Supply Charge		$ / kWh Hourly NYISO LMP Zones H, I, J
Embedded Delivery Charge (12pm-8pm)		$1.10 / max daily kW
Coincident Event Incremental to daily demand charge; 24-hr advance notice for events; hours vary by event	Generation	$11.34 / max event kW
	Transmission	$1.15 / max event kW
	Distribution	$4.61 / max event kW
Monthly Customer Charge		$15.76
Adjustments and Surcharges		$ / kWh; includes System Benefit Charge, MAC, RDM, etc.

Orange & Rockland		
Supply Charge		$ / kWh Hourly NYISO LMP Zones G
Embedded Delivery Charge (12pm-8pm)		$0.88 / max daily kW
Coincident Event Incremental to daily demand charge; 24 hr advance notice for events; hours vary by event	Generation	$7.70 / max event kW
	Transmission	$0.95 / max event kW
	Distribution	$3.77/ max event kW
Monthly Customer Charge		$15.76
Adjustments and Surcharges		$ / kWh; includes System Benefit Charge, MAC, RDM, etc.

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LIBERTY UTILITY IN NEW HAMPSHIRE

DEEP DIVE

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?

AUTHOR

Herman K. Trabish

PUBLISHED

June 19, 2018

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

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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

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CONTACTS

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Lon.Huber@navigant.com

NAVIGANT

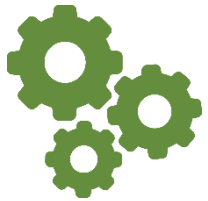
WHY NAVIGANT?

Practical Experience

- 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

Thought Leadership

- 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



Industry Relationships

- 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)

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MAKING THE CASE FOR ENERGY STORAGE

Navigant Offerings	What We Do
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

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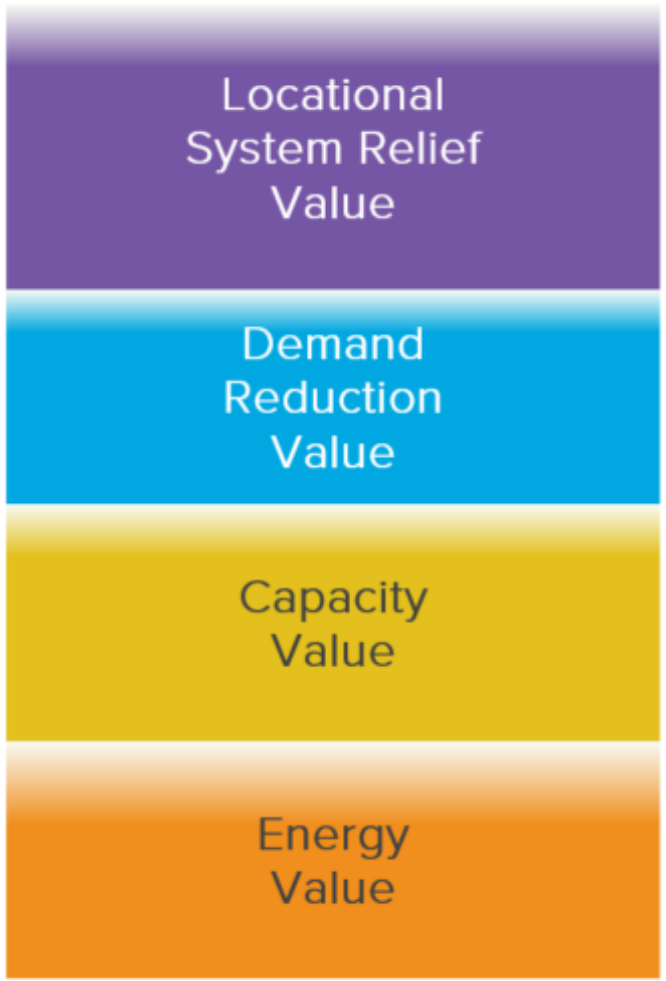
BRING YOUR OWN BATTERY (BYOB) AND V-DER RATES

- 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:

Typical Commercial Utility Bill	
Supply- Flat Rate	¢/kWH
Delivery	
Customer Charge (Fixed)	$
Energy Charge	¢/kWH
Demand Charge (based on highest peak in the billing period)	$/ kW
Monthly Adjustments	¢/kWH
Taxes	$

Standby- Con Edison Rider Q	
Supply- Day-Ahead Hourly	¢/kWH/H
Delivery	
Customer Charge (Fixed)	$
Contract Demand (Fixed- Based on Historic Peak)	$/kW
Demand Charge Daily Period 8 am to 10 PM (M-F) Locational 4 hour period based on Substation Peak	$/ kW
Monthly Adjustments	¢/kWH
Taxes	$



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