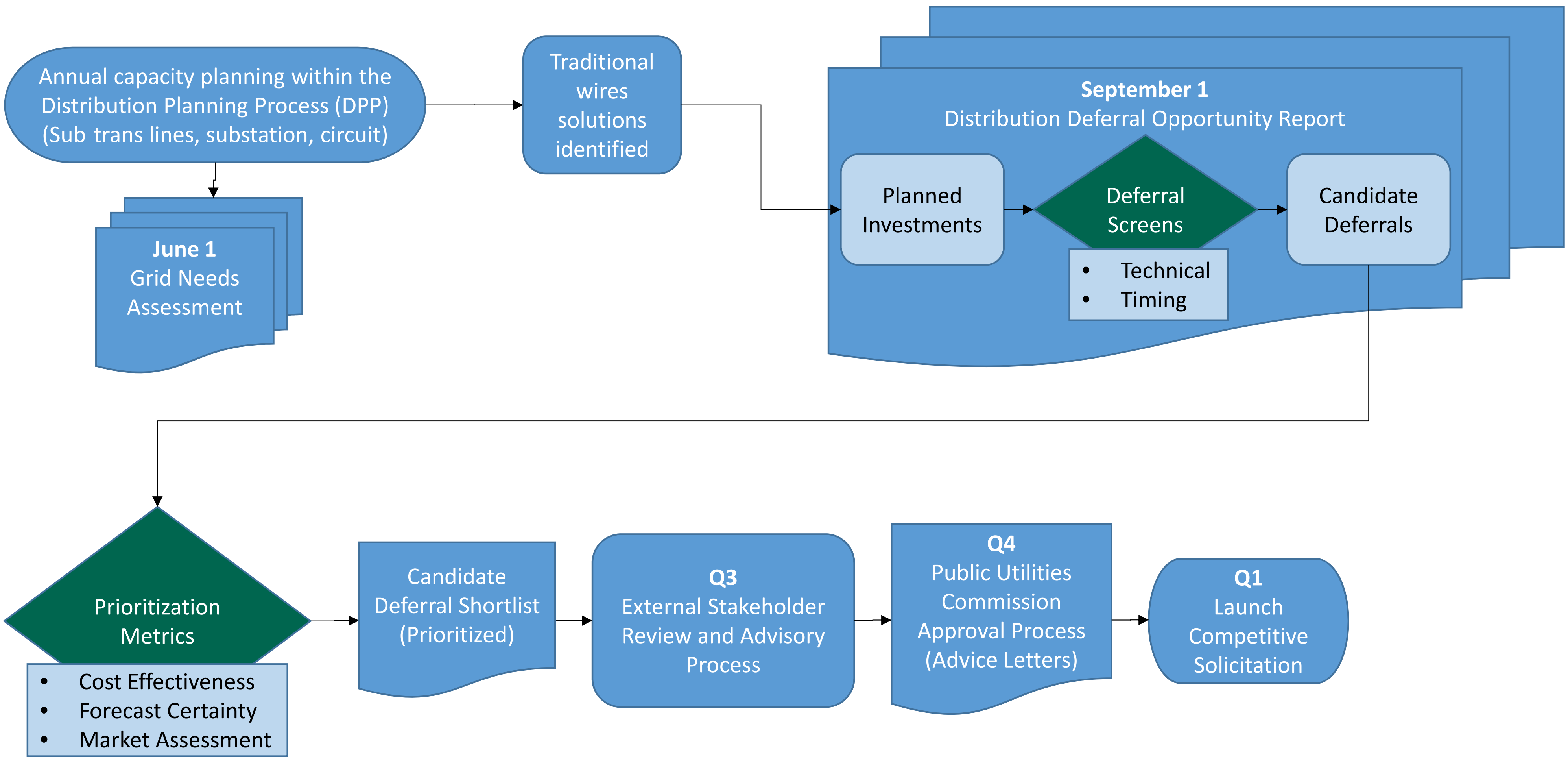
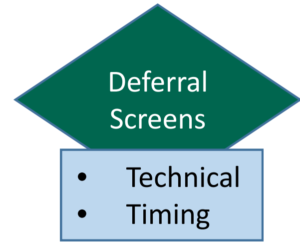
Selecting Deferral Projects, DER Operational Requirements, and Smart Inverters to Meet Grid Services

March 26, 2019

Distribution Investment Deferral Process



Initial Deferral Screens



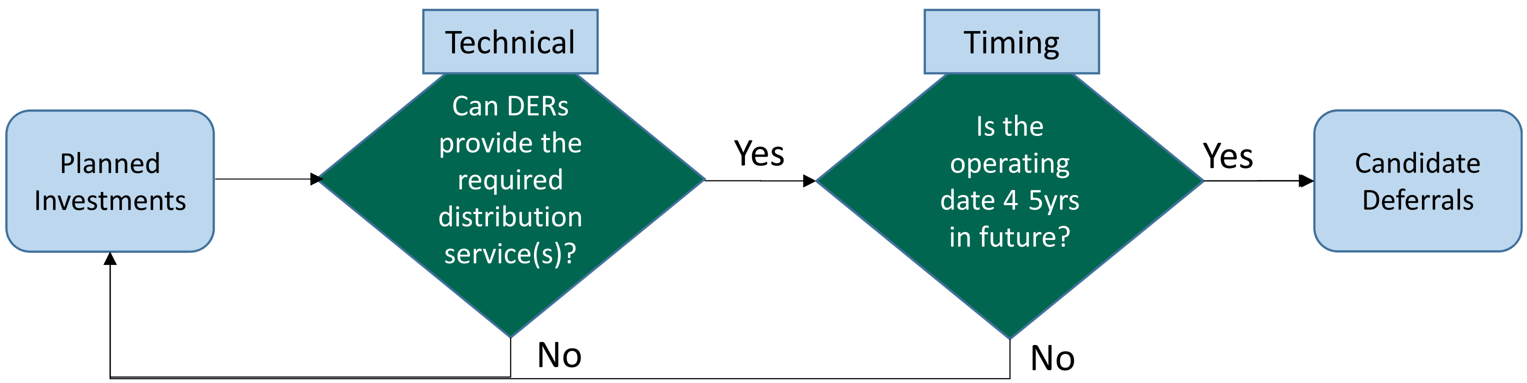
Projects in SCE's Planned Investments list will be considered Candidate Deferral opportunities if they satisfy the following deferral screens:

Technical Screen

- Identifies whether a DER solution can provide the distribution service(s) required: capacity, reactive power (VAR), voltage, reliability (back-tie), resiliency (microgrid)

Timing Screen

- Ensures sufficient time to evaluate, procure, deploy, and begin commercial operation of a DER solution prior to the projected need (4 – 5 years in the future)
- Consider timing of Solicitation, Interconnection Processes, Commission Approvals, Contingency Plans in case DER process unsuccessful



SCE 2018 Prioritization Metrics

Cost Effectiveness → Forecast Certainty → Market Assessment

Metric	High Priority	Low Priority
Cost Effectiveness	**Higher cost-per-MWh** of traditional capital projects	**Lower cost-per-MWh** of traditional capital projects
Forecast Certainty	• **Nearer-term** needs • **Less** historical **volatility** with load growth driving project need and required in-service date	• **Longer-term** needs • **More** historical **volatility** with load growth driving project need and required in-service date
Market Assessment	Integration (Hosting) Capacity within project footprint provides **sufficient opportunity** to defer need	Integration (Hosting) Capacity within project footprint is **insufficient** to defer need

- $\boldsymbol{Cost\ Effectiveness}\ (CE) = \dfrac{Cost\ of\ Traditional\ Solution}{Maximum\ 10\ Year\ Energy\ Need}$
- **Forecast Certainty** seeks to evaluate the volatility of the driver, the scope of the affected assets, and the timeframe of the needs
- **Market Assessment** reviewed distribution feeders and substations with higher ability to accept generation will be considered better candidates while those with less ability to accept increased generation will be ranked lower

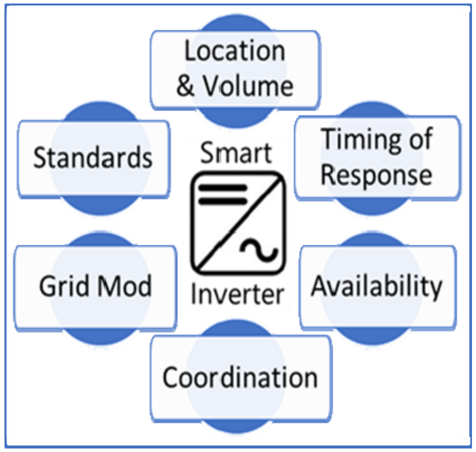
Smart Inverter Whitepaper

Energy for What's Ahead[SM]

SOUTHERN CALIFORNIA EDISON®

The structure of the white paper outlines the following six (6) key messages

1. **Location and volume of Smart Inverter-enabled DERs on the distribution grid is important**
   - For most distribution grid services, the distribution system will require location-specific services to address specific system constraints or needs. Significant distribution service needs that require investment do not exist everywhere.



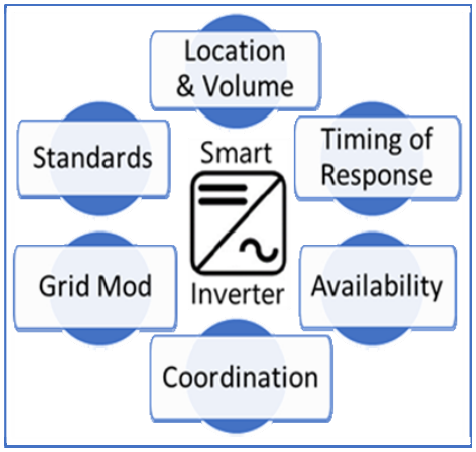
2. **Timing of Smart Inverter-enabled DER response should align with distribution grid need**
   - The distribution system has dynamic needs that can occur at various times within a day, month, or season which customer-sited DER is not currently coordinated

3. **Availability and assurance of Smart Inverter-enabled DERs to provide grid response is needed**
   - For Smart Inverter-enabled DERs to successfully provide distribution services, they must be readily available to provide distribution services with a comparable level of certainty as traditional utility "wires" infrastructure.

<u>The structure of the white paper outlines the following six (6) key messages</u>

4. Coordination between the utility and DERs or DER aggregators is important

- Smart Inverter-enabled DERs and their data must be visible and available to the utility and/or aggregator for these resources to be fully utilized by the Distribution Operator.
- Standardization is necessary between utilities and DER providers to ensure instructions are received, interpreted and executed consistently by different aggregators.



5. Grid modernization initiatives are necessary for Smart Inverter-enabled DERs to provide distribution grid services beyond autonomous Smart Inverter functions

- Utility operational capabilities and systems that automatically analyze grid conditions, determine optimized solutions, and communicate signals to aggregators and DER assets are needed to enhance the value of DERs to the grid and required to utilize DERs for distribution reliability

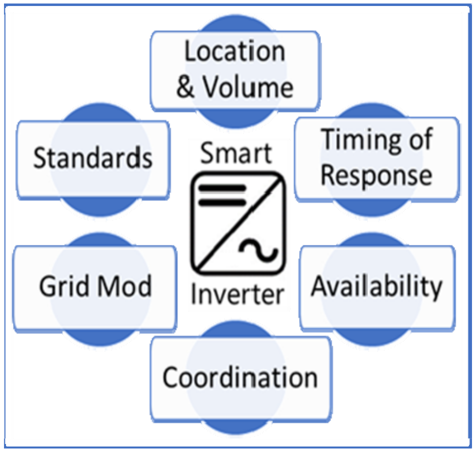
The structure of the white paper outlines the following six (6) key messages

6. Unified standards, comprehensive testing and certification, and training for DER installers are needed to ensure consistent Smart Inverter operation, communication and cybersecurity

- Separate standards for certifying and testing different Smart Inverter functions have created additional complexity for manufacturers in getting Rule 21-compliant SIs to market and for Nationally Recognized Testing Laboratories (NRTLs) to certify SIs.

- Manufacturers should standardize Smart Inverter feature names and user interfaces and improve documentation to facilitate proper configuration during field installation.

- Cybersecurity standards must be adopted by the industry and integrated into relevant communication standards for Smart Inverter interconnection. Existing methods to ensure end-to-end cybersecurity between the utility and Smart Inverter-enabled DERs need significant improvement.



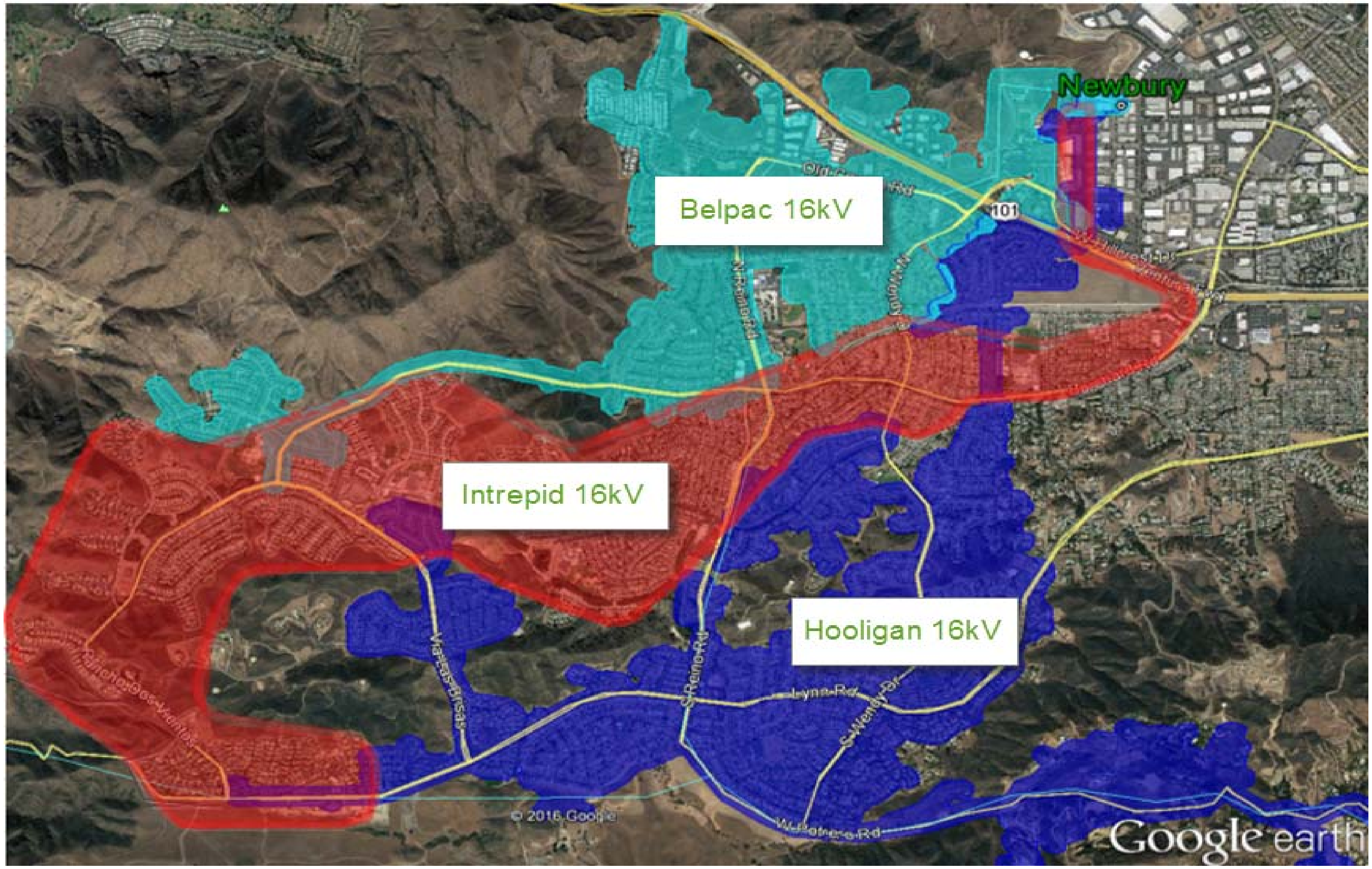
Enabling Smart Inverters for Distribution Grid Services:
https://www.pge.com/pge_global/common/pdfs/about-pge/environment/what-we-are-doing/electric-program-investment-charge/Joint-IOU-SI-White-Paper.pdf

Underlying Technical and Operational Requirements

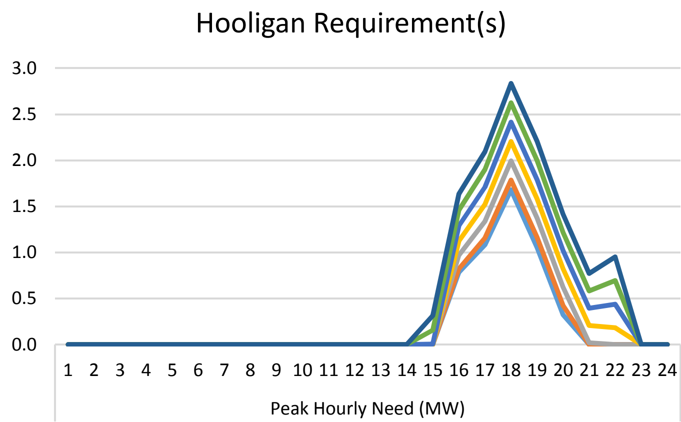
Energy for What's Ahead[SM]

SOUTHERN CALIFORNIA EDISON®

Aerial View: Newbury 66/16kV Substation & Circuit(s)



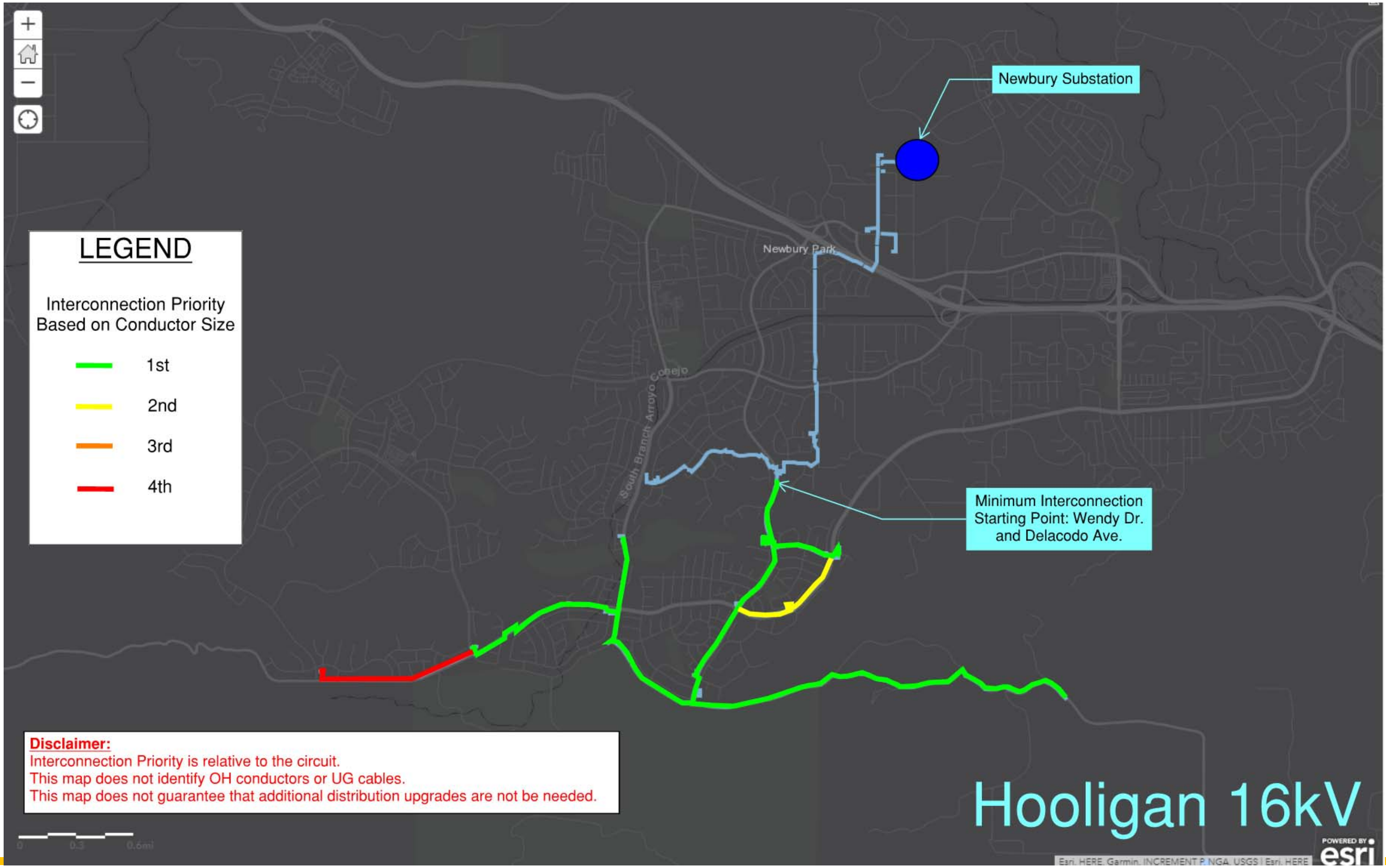
DER Attribute Requirements: Newbury 66/16kV



Year	Capacity (MW)	Energy Need (MWH)	Time of Year	Monthly Frequency	Yearly Frequency
2020	1.68	4.92	Summer	10	25
2021	1.79	5.35	Summer	10	25
2022	2.00	6.32	Summer	10	25
2023	2.21	7.65	Summer	15	40
2024	2.42	9.07	Summer	15	40
2025	2.63	10.64	Summer	15	40
2026	2.84	12.22	Summer	15	40

Year	Peak Hourly Need (MW)																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
2020	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.8**	**1.1**	**1.7**	**1.1**	**0.3**	0.0	0.0	0.0	0.0
2021	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.8**	**1.2**	**1.8**	**1.2**	**0.4**	0.0	0.0	0.0	0.0
2022	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**1.0**	**1.3**	**2.0**	**1.4**	**0.6**	0.0	0.0	0.0	0.0
2023	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**1.1**	**1.5**	**2.2**	**1.6**	**0.8**	**0.2**	**0.2**	0.0	0.0
2024	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**1.3**	**1.7**	**2.4**	**1.8**	**1.0**	**0.4**	**0.4**	0.0	0.0
2025	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.2**	**1.5**	**1.9**	**2.6**	**2.0**	**1.2**	**0.6**	**0.7**	0.0	0.0
2026	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.3**	**1.6**	**2.1**	**2.8**	**2.2**	**1.4**	**0.8**	**1.0**	0.0	0.0

- One (1) new circuit out of Newbury 66/16 Substation is planned to relieve three (3) circuits out of Newbury 66/16: Belpac 16kV, Hooligan 16kV, and Intrepid 16kV


Newbury Substation
LEGEND
Interconnection Priority
Based on Conductor Size
1st
2nd
3rd
4th
Newbury Park
Minimum Interconnection
Starting Point: Wendy Dr.
and Delacodo Ave.
Disclaimer:
Interconnection Priority is relative to the circuit.
This map does not identify OH conductors or UG cables.
This map does not guarantee that additional distribution upgrades are not be needed.
Hooligan 16kV
POWERED BY esri

AMS

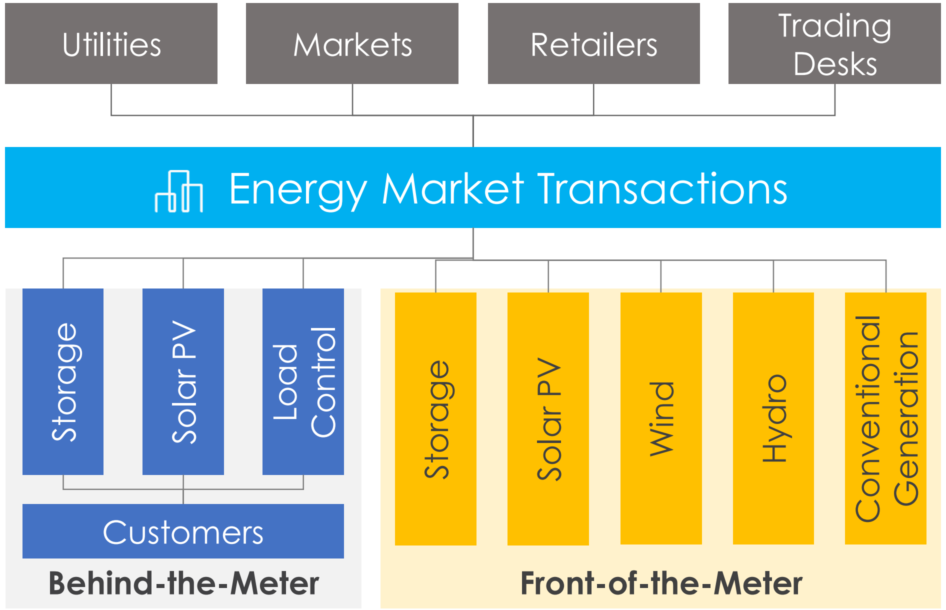
HECO

March 26, 2019

AMS – Company Description

AMS is a SaaS company with an A.I. software platform that uses deep learning algorithms to enable optimized trading of complex energy assets in wholesale energy markets

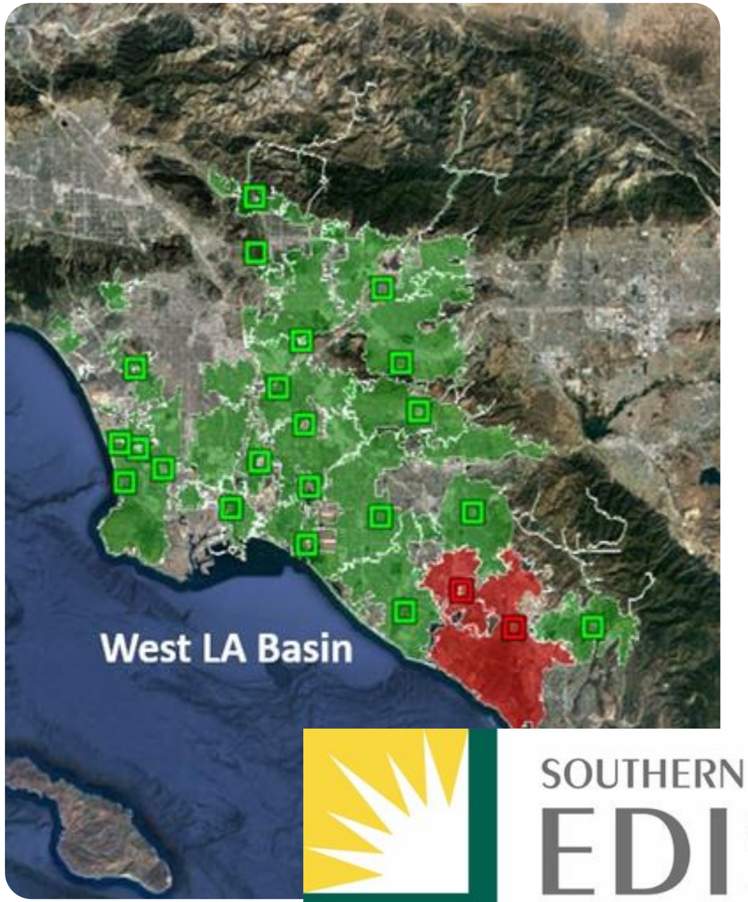
Founded	Headquarters	Employees	Equity Capital Raised	Project Capital
2013	San Francisco	80	$52.7 M	$200 M



The AMS Platform can optimize hardware from any manufacturer owned by any party

SCE Grid Modernization Project

Groundbreaking 2.2 GW Modernization Project



SOUTHERN CALIFORNIA EDISON®

An EDISON INTERNATIONAL® Company

SCE Grid Modernization Project

1. Closure of San Onofre Plant stressing grid
2. AMS selected out of 3,000 participants for BTM
3. AMS focused on providing fleet optimization and grid services

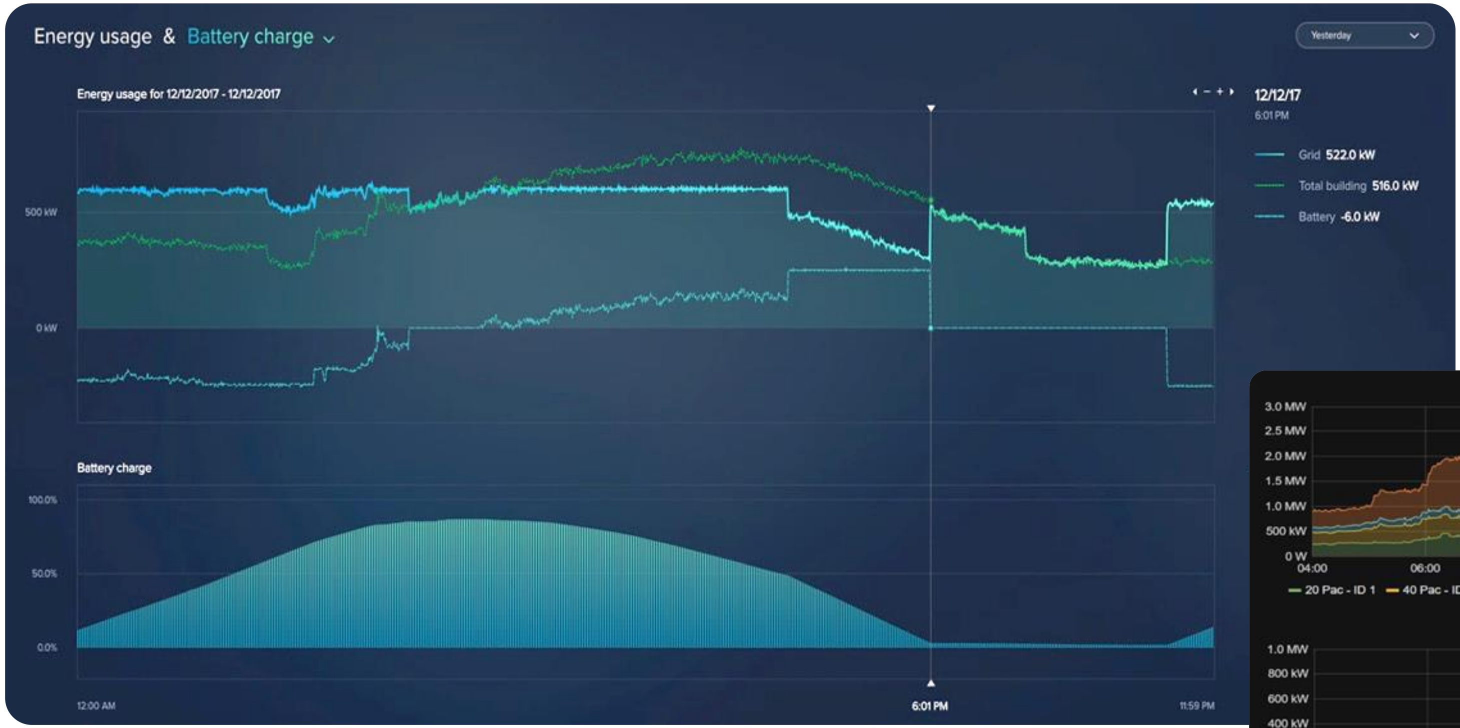
Local Capacity Requirement (LCR)

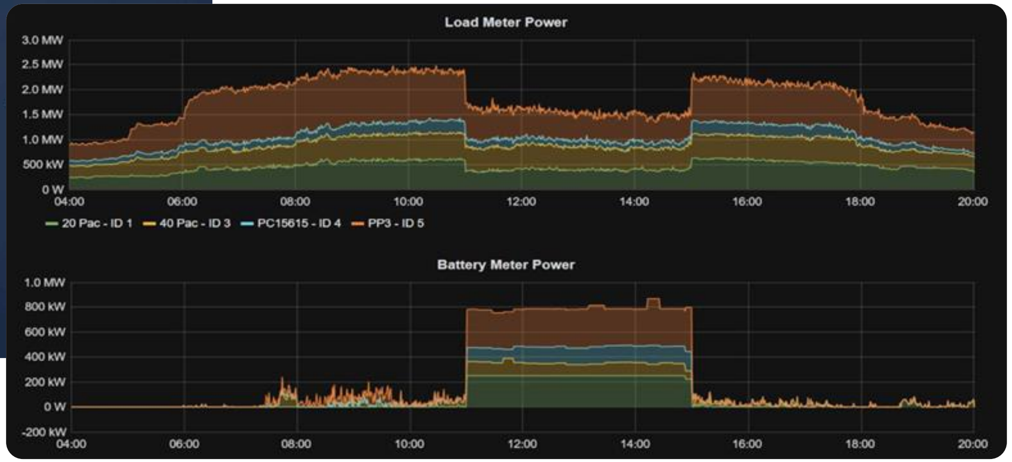
1. Instant, remote, dispatchable energy to SCE
2. **AMS awarded 50 MW LCR contract**

Distributed Energy Resource Optimization Platform

Host Client Portal

Distributed energy resource platform that combines advanced analytics with continuous optimization, delivering maximum financial performance from distributed energy resource portfolios, from both retail revenue streams and grid services.

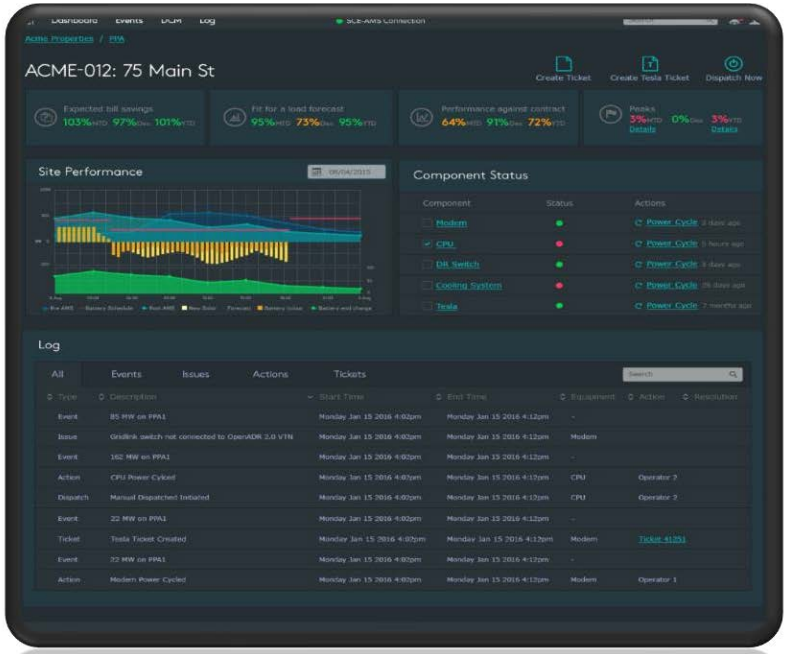




Distributed Energy Resource Optimization Platform

Network Operations Center (NOC)

AMS' NOC and NOC operators use best-in-class Armada™ software to optimize and monitor assets 24/7



- Early detection of issues and escalation protocols
- Responds to event-based utility programs
- Monitors and ensures optimal DCM performance
- Remotely controls batteries and conducts manual overrides
- Automatically creates service tickets as needed

AMS VPP Shatters World Record – Delivering 2 GWh of Grid Services

MARCH 2019

AMS' virtual power plant project in Southern California has hit major milestone, **breaking an industry record and delivering over 2 GWh of grid services** to the California Independent System Operator (CAISO) in its first year of operation.

EOY 2019

AMS will continue building out the virtual power plant through the end of 2019 for a total portfolio of:

- 27 Customers
- 91 Sites
- Total 62 MW / 352 MWh

LCR Lessons Learned

- **Things that worked well**
  - Very robust market response to utility solicitation
  - Market participants were very engaged throughout the process
  - Structure of solicitation resulted in Innovative product offerings
  - Although time consuming, flexibility to negotiate one-off contracts was critical to the success
- **Challenges**
  - Lack of clarity on how the new products would be treated under existing tariffs or market rules
    - Requires significant collaboration between supplier and utility (and CAISO)
  - Lack of clarity on how the existing interconnection process would work for energy storage
    - Requires close coordination between procurement team and T&D employees working on interconnections
  - Process created customer confusion with many developers offering competing solutions
    - Requires significant upfront customer education and perhaps a more customer friendly procurement process
  - Lack of transparency on where relative value of asset on the grid at one location vs another
    - Suggest providing a heat map or LNBA up front so developers know where to focus their effort
  - Accounting concerns created challenges for the utility
    - Spend time up front thinking about contract implications and draft contracts that avoid lease treatment

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AMS



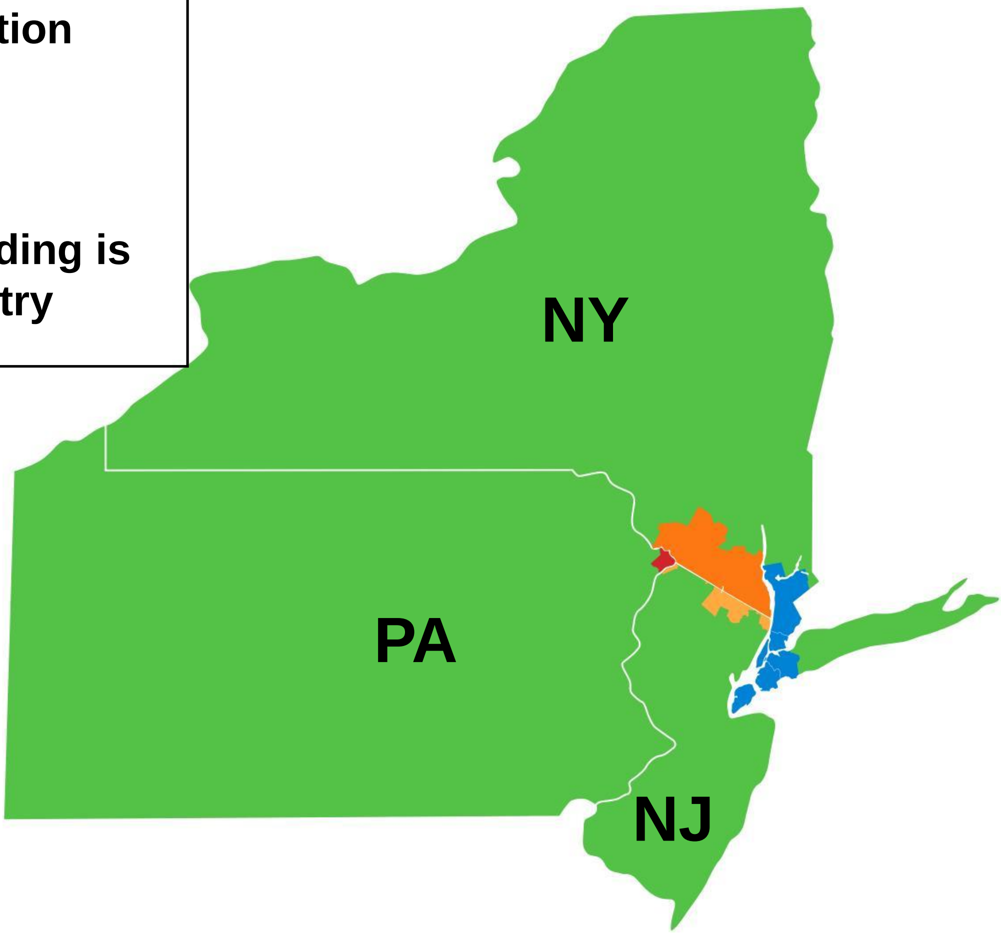
Con Edison Distribution Planning and the use of NWS

March 26th, 2019

Overview
Consolidated Edison (NYC + Westchester)

Features of NY regulation:

- **Focus on Transmission and Distribution**
  - Divested generation in mid-1990's
- **Collaborative process**
- **Reforming the Energy Vision proceeding is at the forefront of the evolving industry**



CECONY
- **3.4 million electric customers**
- **1.1 million gas customers**
- **1,700 steam customers**

O&R
- **0.3 million electric customers**
- **0.1 million gas customers**

2018 DSIP Overview – Steady Progress

Highlighting achievements and planning for future success

Significant DER growth

- Doubling of solar since Jan 2016 with 650 MWAC expected by 2023
- Ramp-up of storage, EE, CHP
- **50 MW NWS + > 100 MW IN RFPs**

Grid modernization

- Phased investment in foundational and enabling technologies
- Evolution of capabilities in line with grid and market needs

Implementation of DSP capabilities

- capacity maps
- Improved interconnection process and incorporation of storage
- More granular load/DER forecasting
- **Formalized NW identification**
- More detailed and comprehensive hosting

Expanded data sharing

- Implementation of GBC Phase I with Phase II by end of 2018
- Published 8,760 load forecasts
- Better data visualization and downloadable files

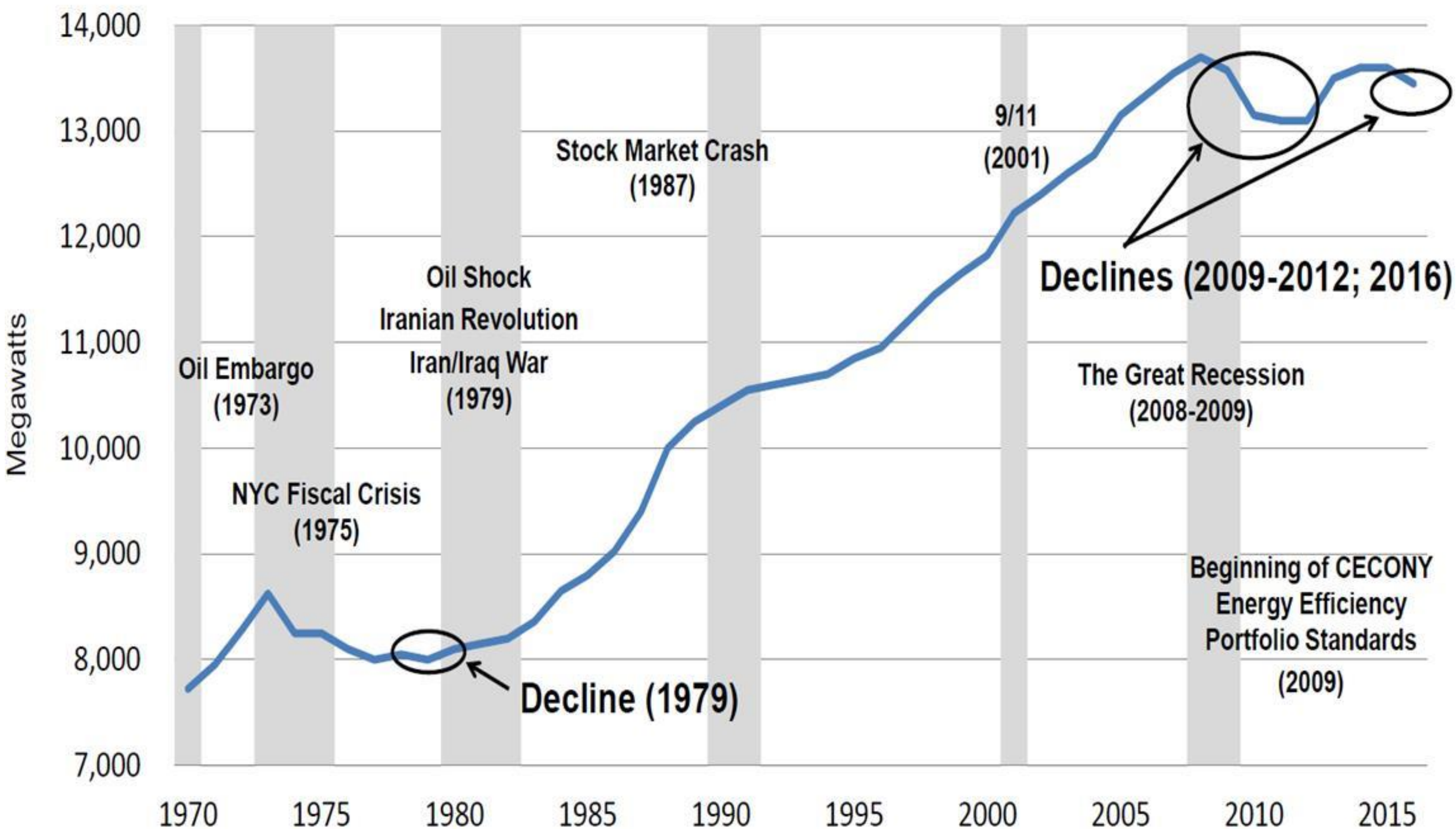
Enhanced customer engagement

- AMI-enabled tools to educate and engage customers
- Demonstration projects to test new outreach strategies

Continued market enablement

- **More NW solicitations**
- Access to VDER and innovative pricing
- Coordination with NYISO to enable value stacking
- EV and storage facilitation

CECONY Electric System Historical Peak Demand



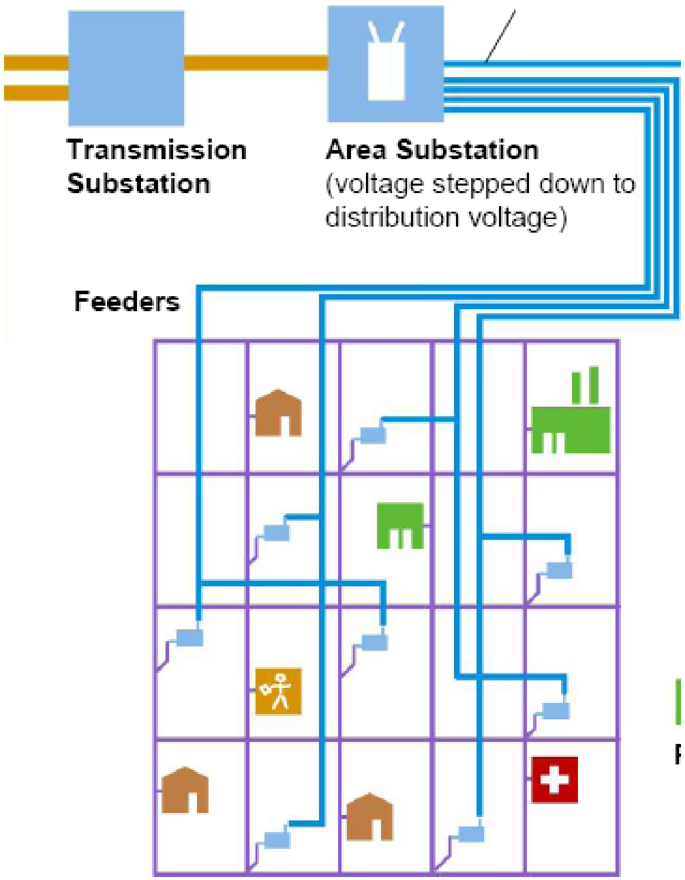
NWS is another tool to provide granular load following optionality – ESPECIALLY IF LOAD DECREASES

Acceptable for consistent growth

Provides optionality

...Other benefits of NWS may include customer contribution and capacity reductions that migrate upstream

NWS as both a customer choice and a utility tool is another resource to help defer, complement or avoid traditional builds

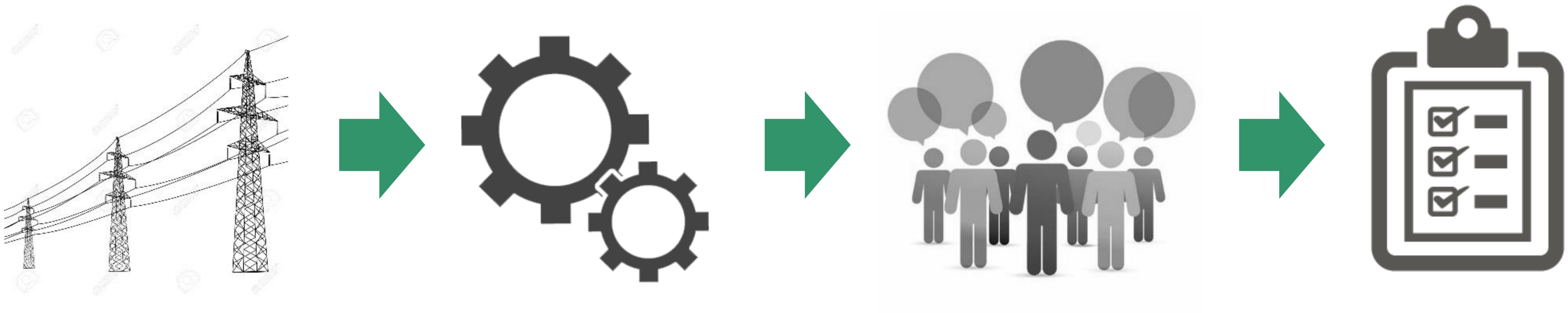


	Traditional Solutions
Area Station	New Substation
	Add or Upgrade components (transformers)
	Reconfigure NW (existing headroom)
	Increase equipment cooling (water spray)
Feeder Growth	New Feeder
	De-load feeder
	Upgrade section(s)
Secondary Growth	New or Upgrade Transformer(s)
	Reinforce mains

	REV/DER Solutions
Utility Sided Solutions	Energy Storage
	Voltage/VAR Optimization
	Microgrids
Customer Sided Solutions	Demand Response
	Energy Efficiency
	CHP
	Solar & Wind
	Energy Storage

Suitability Criteria for NWS

NWA suitability criteria lays solid foundation for the success of NWA solicitation and BCA evaluation.



Identify System Needs → **NWA Suitability** → **Competitive Solicitation** → **BCA Evaluation & Procurement**

Suitability Criteria for NWAs

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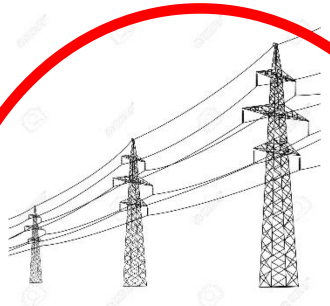


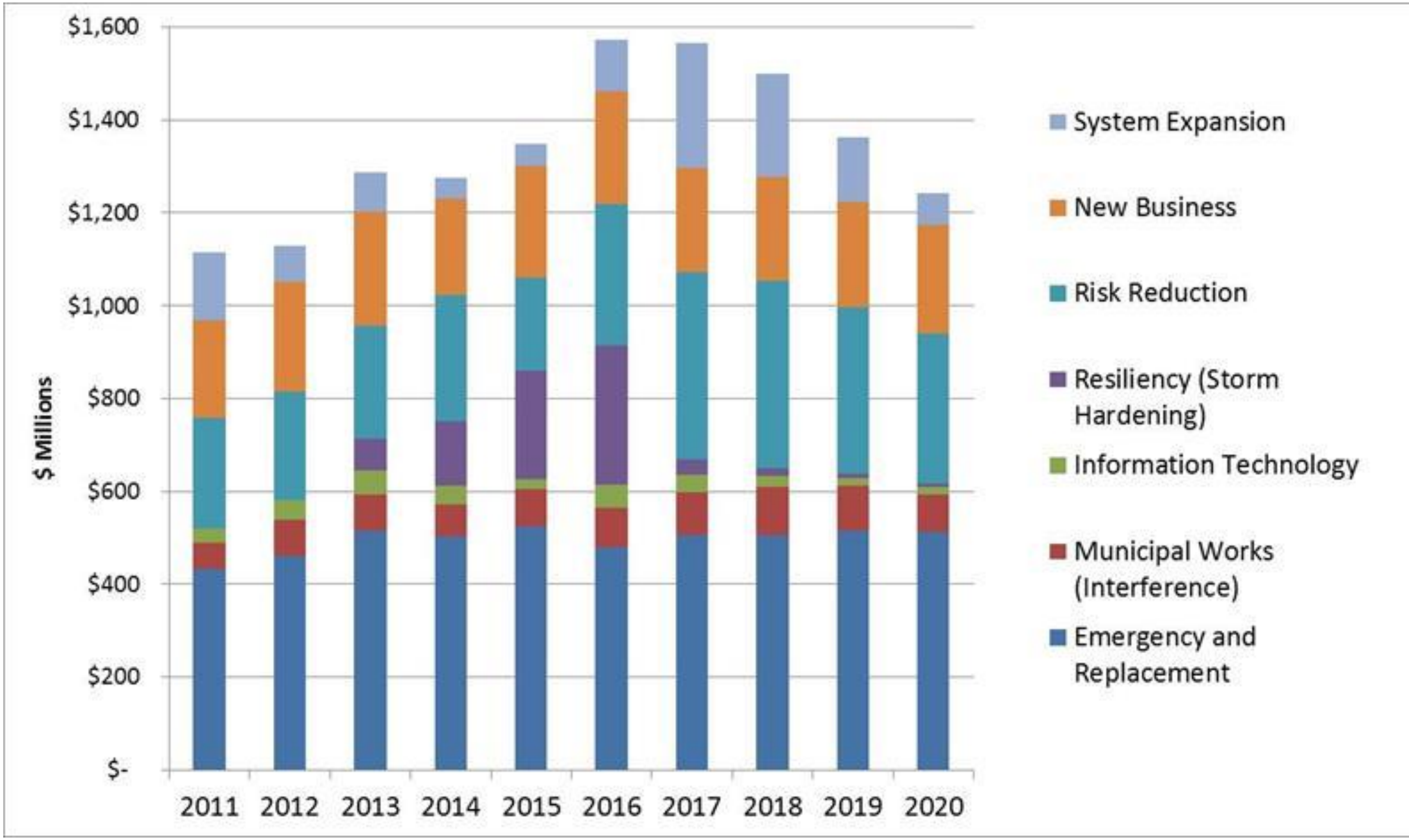
Identify System Needs

NWA Suitability

Competitive Solicitation

BCA Evaluation & Procurement

Target NWS for System Expansion at Substation



Source: Con Edison Distributed System Implementation Plan (DSIP), June 30, 2016

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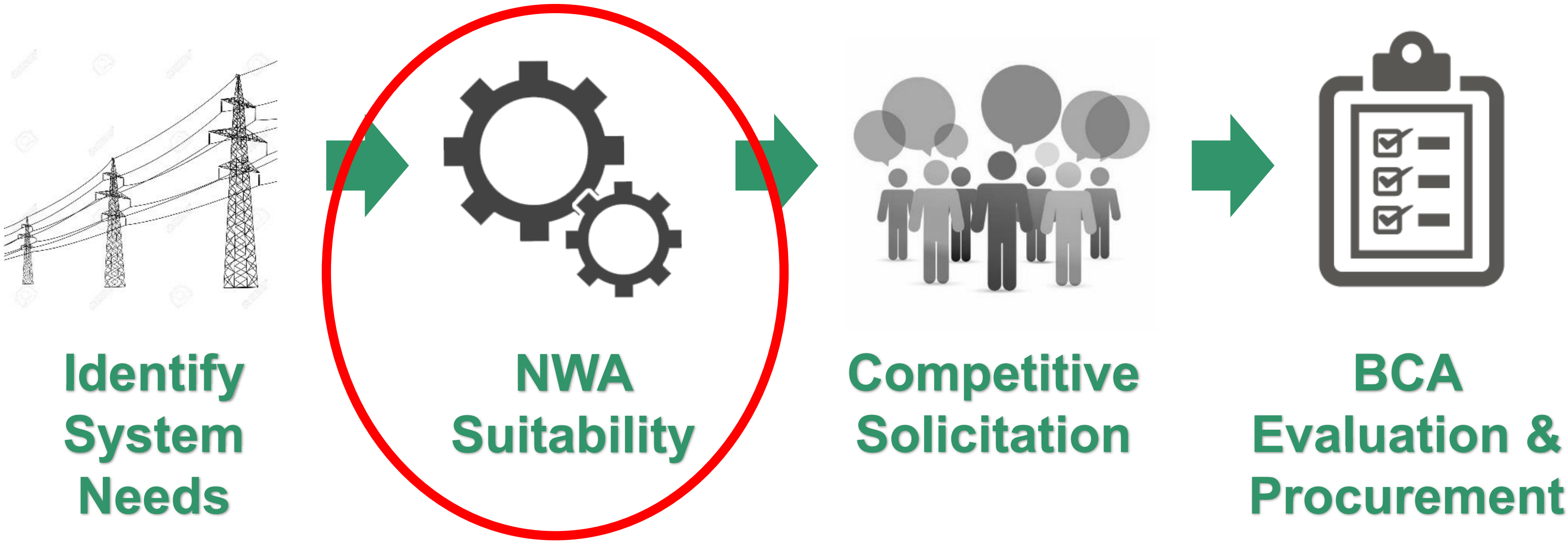
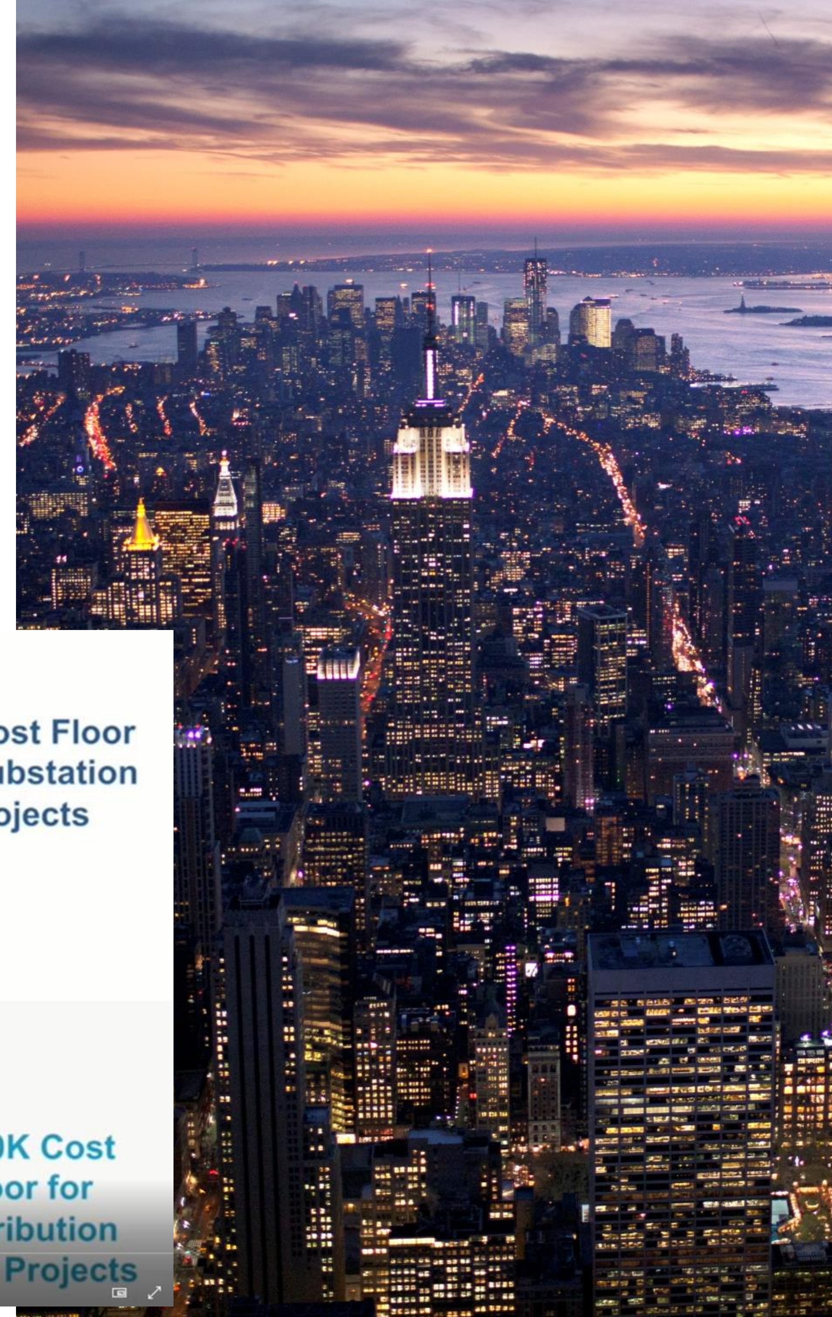


Non-Wires Solutions (NWS)

- Stakeholder collaboration provided suitability criteria
- NYS Benefit Cost Analysis (BCA) handbook describes BCA methodology
- Con Edison has identified and put out RFP for 7 projects in addition to BQDM and BQDM extension



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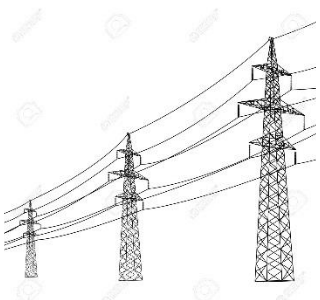

Identify System Needs

NWA Suitability

Competitive Solicitation

BCA Evaluation & Procurement

WWW.CONED.COM/NONWIRES

https://www.coned.com/en/business-partners/business-opportunities/non-wires-solutions

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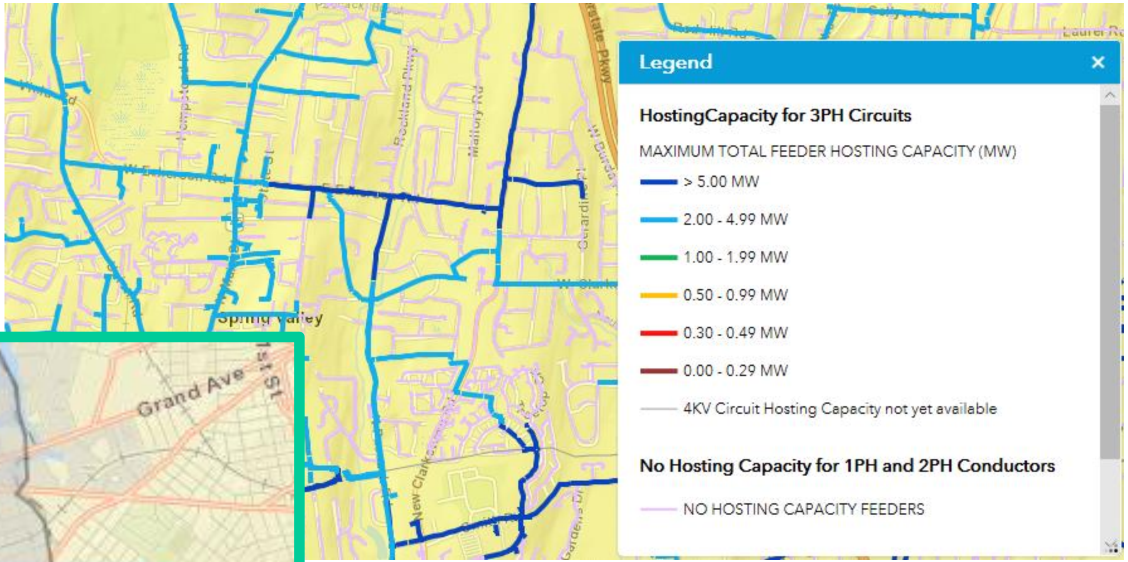
Feedback

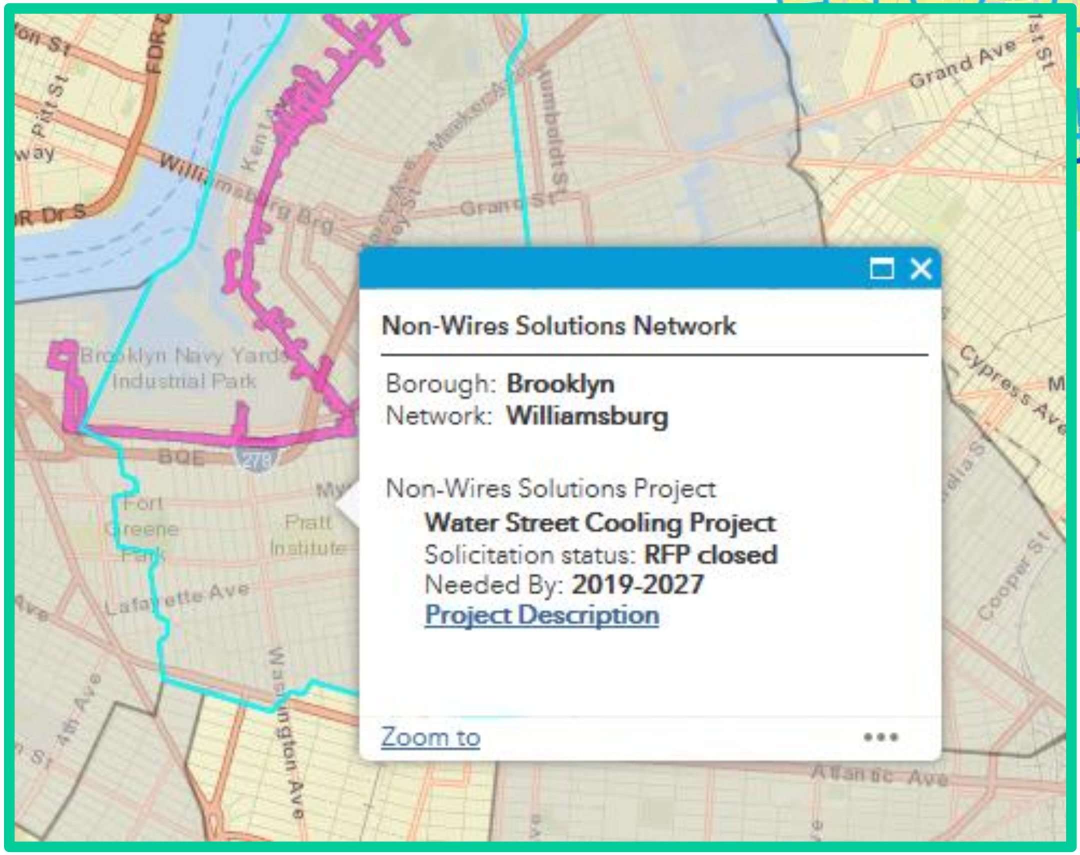
Current Opportunities

Projects	Current Status	Documents
Primary Feeder Relief - Chelsea	RFP in development Project Description available	Project Description
Parkchester No. 1 Cooling Project	RFP in development Project Description available	Project Description
Newtown Transformer Installation Project	No longer accepting proposals	RFP
Primary Feeder Relief - Williamsburg	No longer accepting proposals	RFP
Water Street Cooling Project	No longer accepting proposals	RFP
Plymouth Street Cooling Project	No longer accepting proposals	RFP
Primary Feeder Relief - Columbus Circle	No longer accepting proposals	RFP
Load Transfer W 42st	No longer accepting proposals	RFP

Hosting Capacity Maps Also Display NWS



NWS Layer



BQDM: System Expansion Project: Brooklyn-Queens Demand Management Program

Deferral of $1 billion in traditional network upgrades with distributed solutions

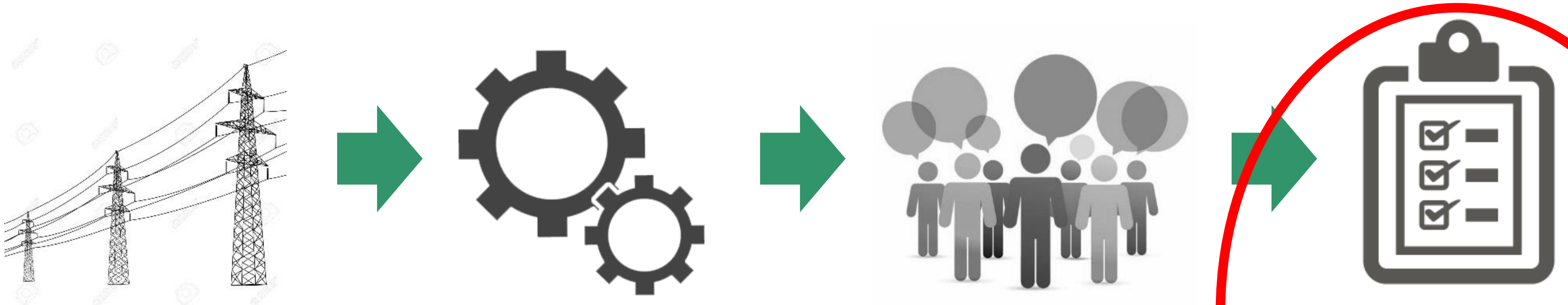
- Identify Target Area
- Identify load curve (BQDM was a long duration, night peaking network)
- For substations, the effective DER contribution can be located anywhere within the foot print

Lessons Learned from Solicitations

- Bidder screening
- Contractual milestones
- Contractual incentives/penalties
- Descriptive (but not prescriptive) RFP
- Measurement and Verification

Suitability Criteria for NWAs

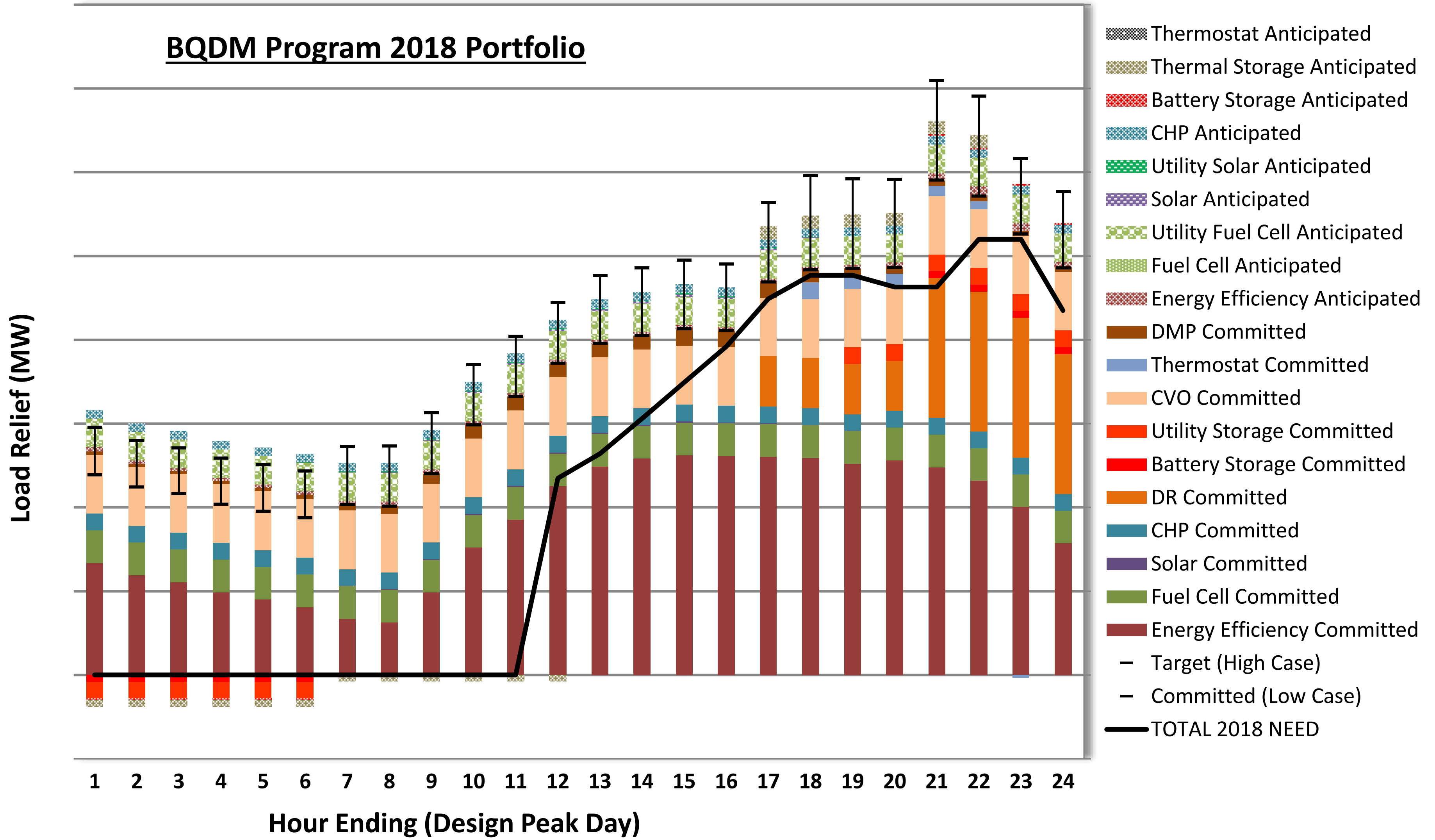
NWA suitability criteria lays solid foundation for the success of NWA solicitation and BCA evaluation.



Identify System Needs → NWA Suitability → Competitive Solicitation → BCA Evaluation & Procurement

BQDM 2018 ILLUSTRATIVE PORTFOLIO
Summer 2018 Outlook

ACRONYMS
DR – Demand Response
CHP – Combined Heat and Power
DMP – Demand Management Program
CVO – Conservation Voltage Optimization
C&I – Commercial and Industrial



Portfolio Development focuses on Societal Benefits while considering bill impact

- New York State Benefit Cost Analysis Handbook
  - Specifies SCT approach
  - Identifies benefits including carbon (~$24/MWh plus escalation)
- DER offerings are significantly varied
  - Energy Efficiency can include adders to existing programs
  - Resources like generation may have carbon benefits plus energy benefits
- Multiple portfolio approaches are reviewed

Closing thoughts and next Steps

- Integrating NWS into the planning process has actually been the easiest step
- Providing the proper incentives to everyone is key
  - Regulated asset treatment for NWS (earn rate base)
  - Shared savings 70% customer/30% utility
  - Targeted customers benefit from offset capital costs + O&M savings
  - All customers benefit from deferred system needs
- We will continue developing our NWS approach
  - Water Street and Plymouth Street has 2019 need
  - Other NWS discussed in rate case testimony

Enel X
HECO NWA

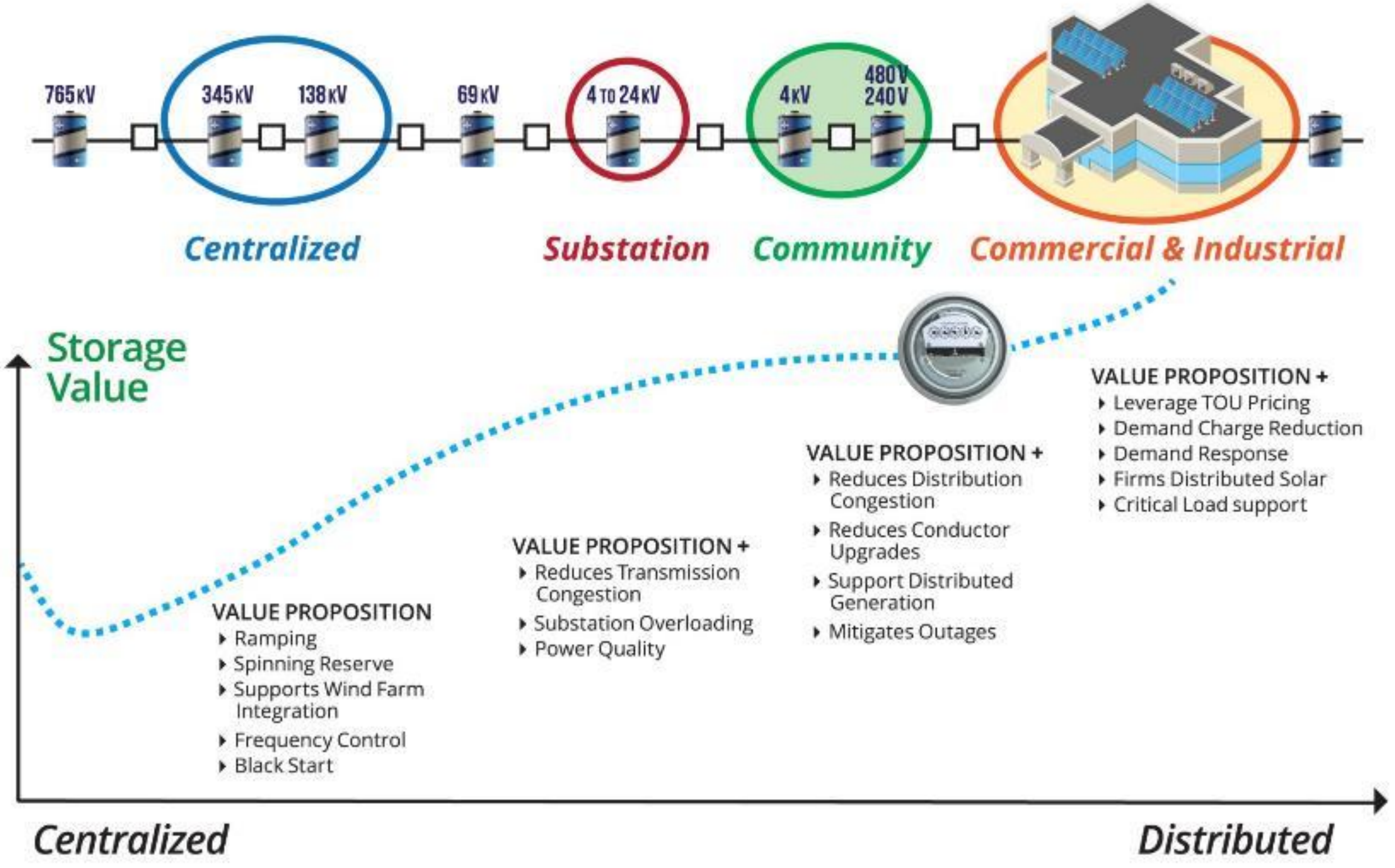
Doug Staker
Vice President, Utility Business Development
Flexibility Solutions
Enel X

Industry Perspective

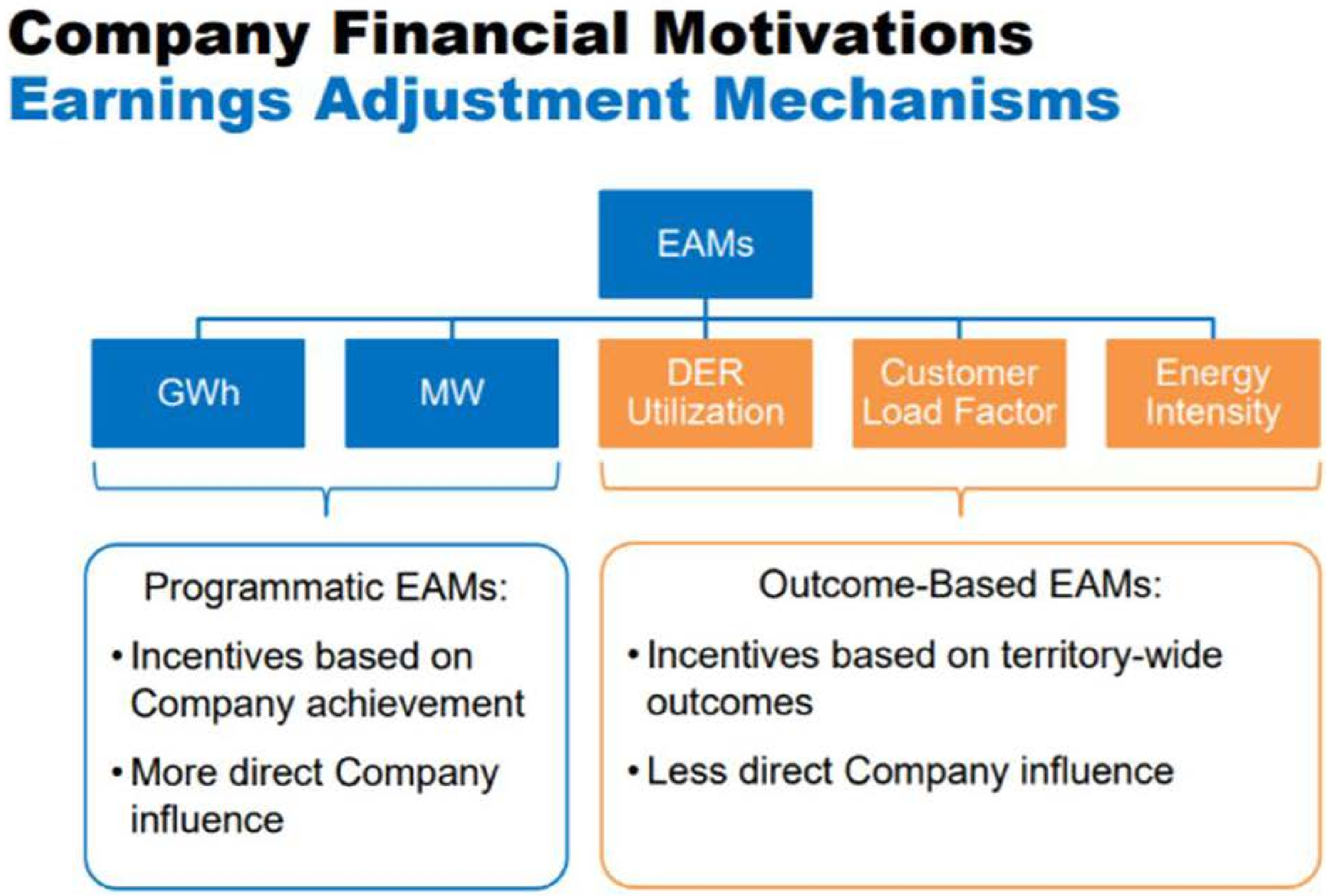
"The electric industry is in a period of momentous change. The innovative potential of the digital economy has not yet been accommodated within the electric distribution system.
Information technology, electronic controls, distributed generation, and energy storage are advancing faster than the ability of utilities and regulators to adopt them, or to adapt to them.
At the same time, electricity demands of the digital economy are increasingly expressed in terms of reliability, choice, value, and security."

Opening Paragraph:
ORDER ADOPTING REGULATORY POLICY FRAMEWORK AND IMPLEMENTATION PLAN
New York Public Service Commission- February 26, 2015

Locational Value of Storage



PSC-Con Edison Performance Based Rates



Specific Programs

- BQDM-Brooklyn Queens Demand Management
- NWA-Non Wire Alternatives
- DMP II- Demand Management Program.

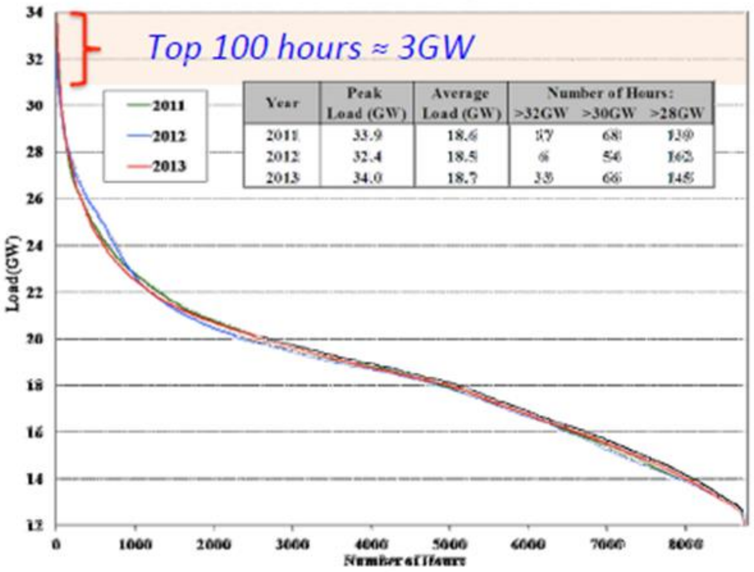
Load Duration Curve

enel x

Trapped Value in Peak Demand

"If, for example, the 100 hours of greatest peak demand were flattened, long term avoided capacity and energy savings would range between $1.2 billion and $1.7 billion per year."
-NY PSC Order Adopting Regulatory Policy Framework and Implementation Plan [REV], 2/26/15

NY ISO Load Duration Curves, 2011 -2013

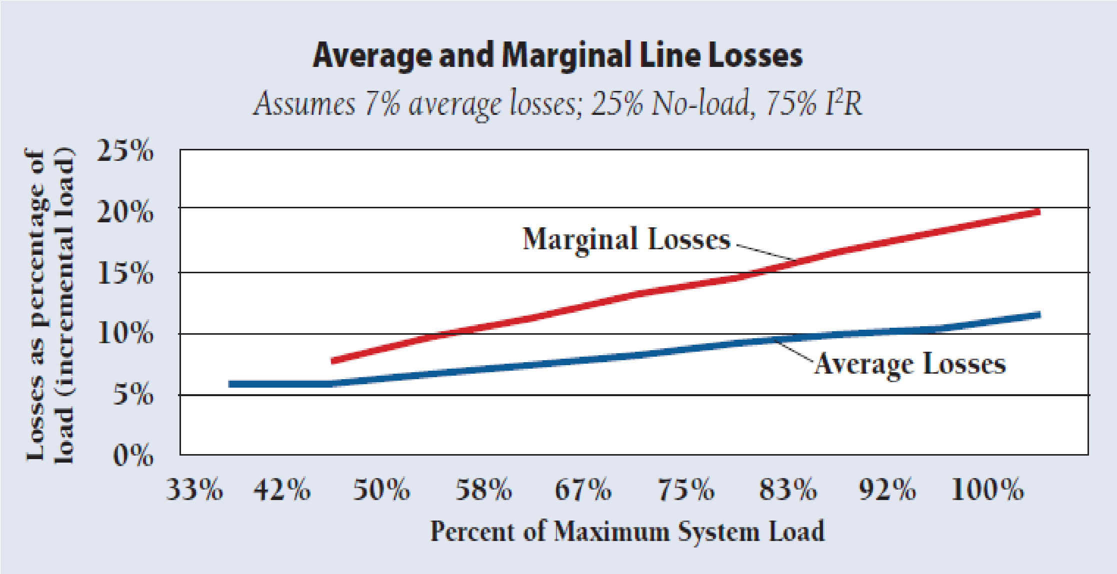


Source: 2013 NYISO SOM Report, Potomac Economics.

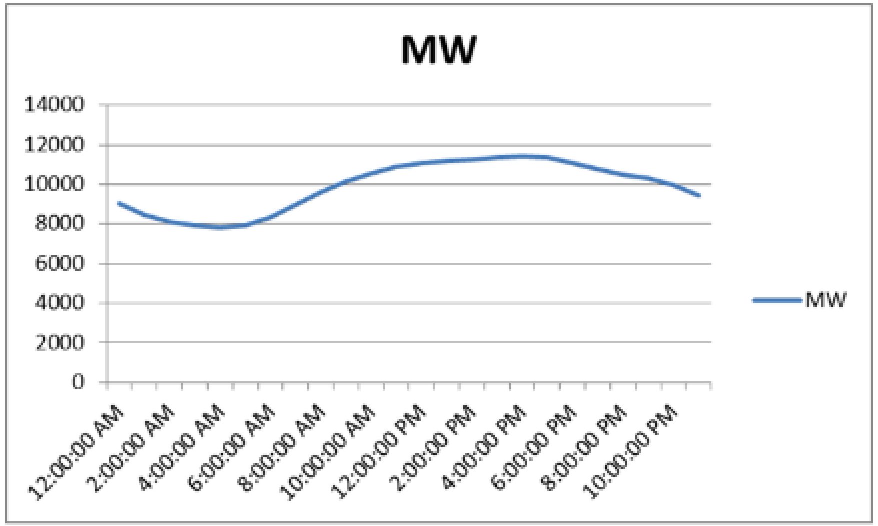
Cost of NYS Peak Demand	
Top 100 hours = 3 GW statewide *(1.4 GW NYC alone)*	
Low Average @ $1.2 billion	High Average @$1.7 billion
$400 / kW	**$567 / kW**
$0.40 / kWh	**$0.57 / kWh**

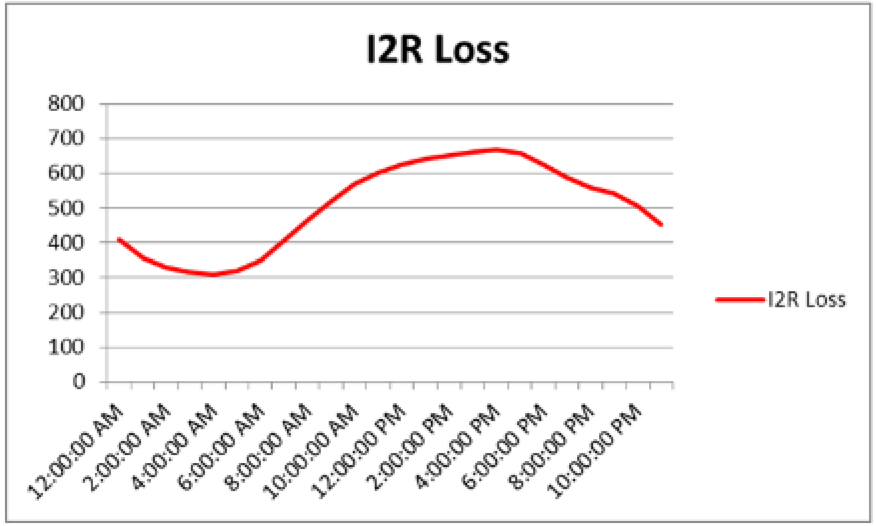
Time Variable Distribution "Cost"

Marginal Line losses are exponential and are dynamic based on the I^2R Losses. Average losses are measured over an extended time period overlook the benefits of load reduction at Peak periods.



Graph Courtesy of the Regulatory Assistance Project

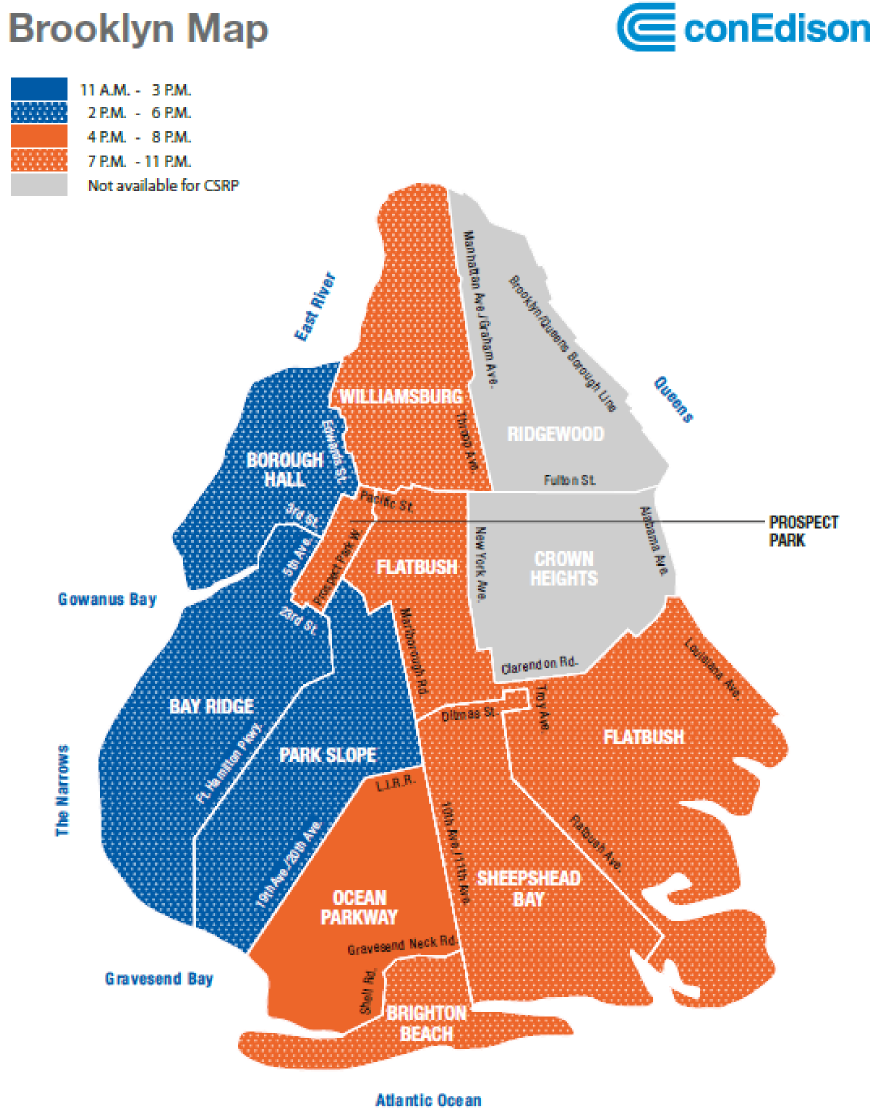




Con Ed Brooklyn Locational Peak Periods

- Borough Hall ,Bay Ridge & Park Slope
  2 PM to 6 PM
- Ocean Parkway
  4 PM to 8 PM
- Willamsburg, Prospect Park,Flatbush, Sheepshead Bay, Brighton Beach
  7 PM to 11 PM
- Ridgewood & Crown Heights

  BQDM Non Wires Solution
  8 to 12 PM



Rate Evolution

We can't build a digital power grid based on an analog rate design

Monthly

Electricity you used during this 32 day billing period from Jan 20, 2017 to Feb 21, 2017
Rate: EI12 Multiple Dwelling Heating

We measure your electricity by how many kilowatt hours (KWh) you use. One KWh will light a 100 watt bulb for 10 hours. The meter multiplier is the factor by which the meter difference is multiplied to determine your usage. Demand or kW is the highest amount of electric usage in any half hour during the bill period. Reactive-Power charges are measured in excess kVar above 95% power factor. Your total electricity use is the sum of the usage from your various meters as shown in the meter detail section of your bill starting on page 3.

Total electricity use	**334,400 kWh**	**2177.76 kW**
On peak energy (Mon-Fri 8am -10pm)	156,404 kWh	
Off peak energy (Mon-Fri 10pm - 8am)	177,996 kWh	
G & T demand (Mon-Fri 8am - 6pm)	2057.28 kW	
Primary demand (Mon-Fri 8am - 10pm)	2177.76 kW	
Secondary demand (all hours, all days)	2177.76 kW	
Billable kVar		0.00

Daily

PERIOD 1: MON - FRI 7 PM - 11 PM			PERIOD 2: MON - FRI 10 AM - 12 AM (S) 8 AM - 10 PM (	
NET DAILY DEMAND kW	STANDBY	MAC	NET DAILY DEMAND kW	STANDBY
-	$0.00	$0.00	-	$0.00
-	$0.00	$0.00	-	$0.00
198.2	$179.15	$0.00	414.7	$425.48
232.3	$209.98	$0.00	471.8	$484.07
349.4	$315.82	$0.00	540.4	$554.45
180.9	$163.52	$0.00	420.9	$431.84
233.7	$211.24	$0.00	469.4	$481.60

Hourly

Zonal Prices

Name PTID	00:00 EST	01:00 EST	02:00 EST	03:00 EST	04:00 EST	05:00 EST	06:00 EST	07:00 EST
CAPITL 61757	30.93	28.22	28.33	27.87	29.04	31.44	38.11	43.67
	2.42	2.24	2.27	2.23	2.37	2.52	2.98	3.49
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CENTRL 61754	29.02	26.45	26.46	26.13	27.20	29.68	36.18	41.10
	0.51	0.47	0.39	0.49	0.53	0.75	1.05	0.92
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

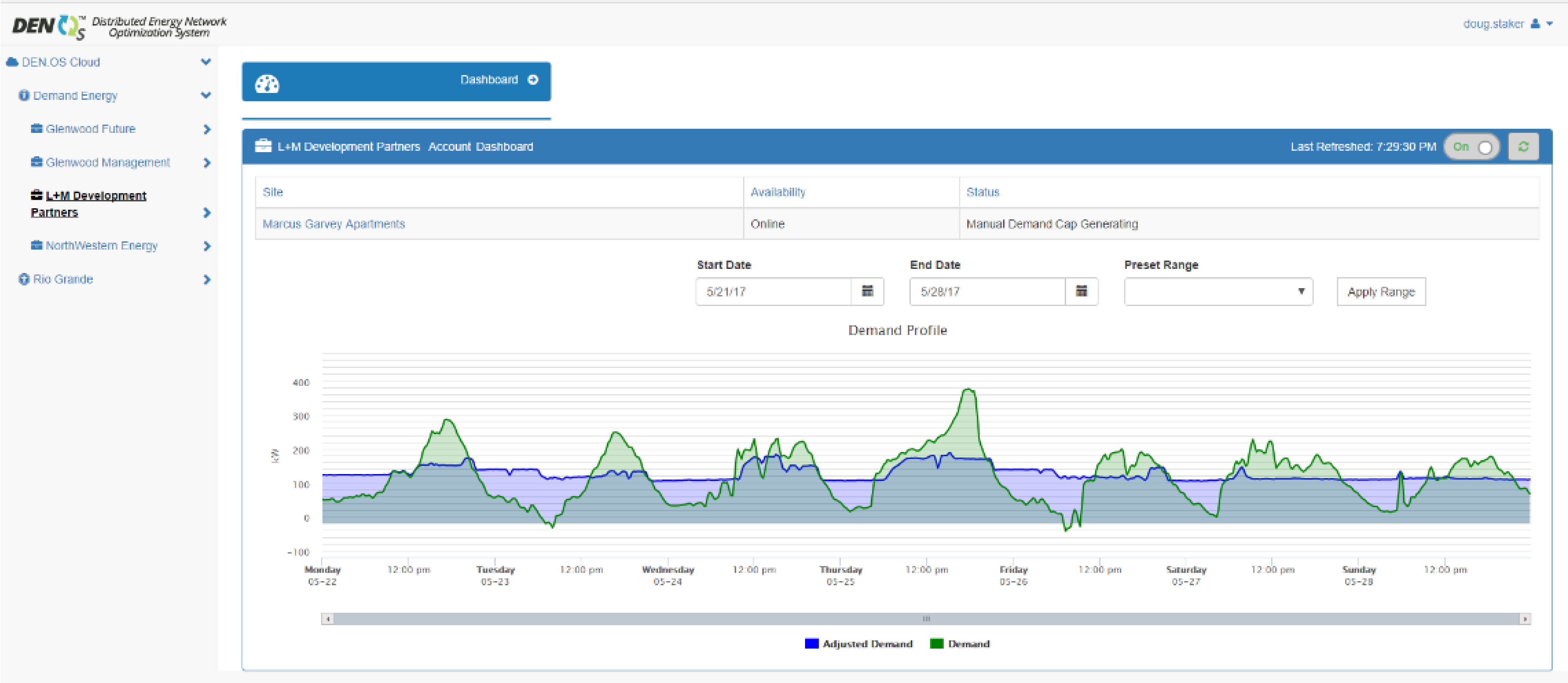
A Move to Daily Demand Charges

Convert from a monthly structure to a daily structure with TOU Locational value

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	$

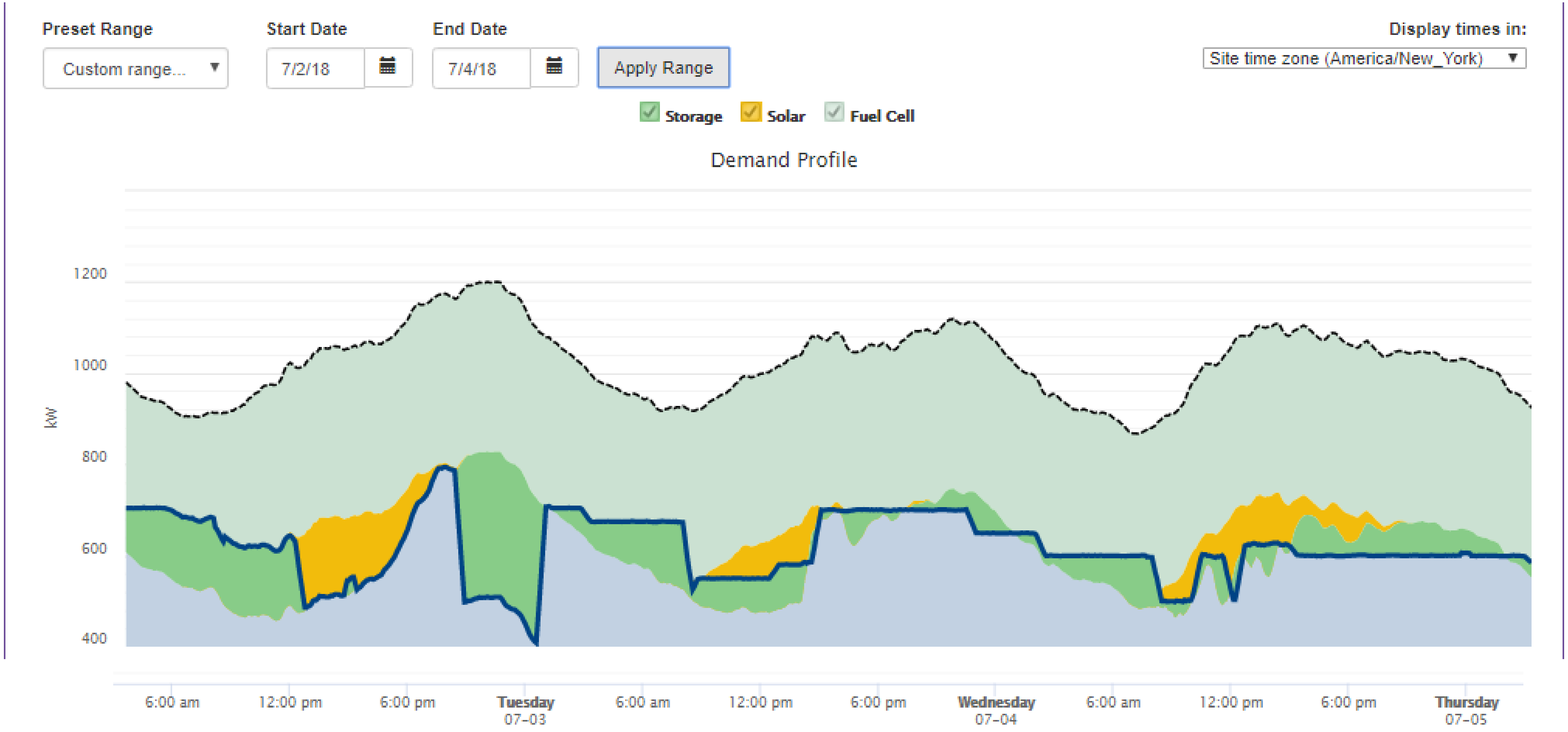
Standby- Con Edison Rider Q	
Supply- Day-Ahead Hourly	₵/kWH/H
Delivery	
Customer Charge (Fixed)	$
Contract Demand (Fixed- Based on Historic Peak)	$/kW
Demand Charge Daily Period 8 am to 10 PM (M-F) Locational 4 hour period based on Substation Peak	$/kW
Monthly Adjustments	₵/kWH
Taxes	$

Demand Charge Management

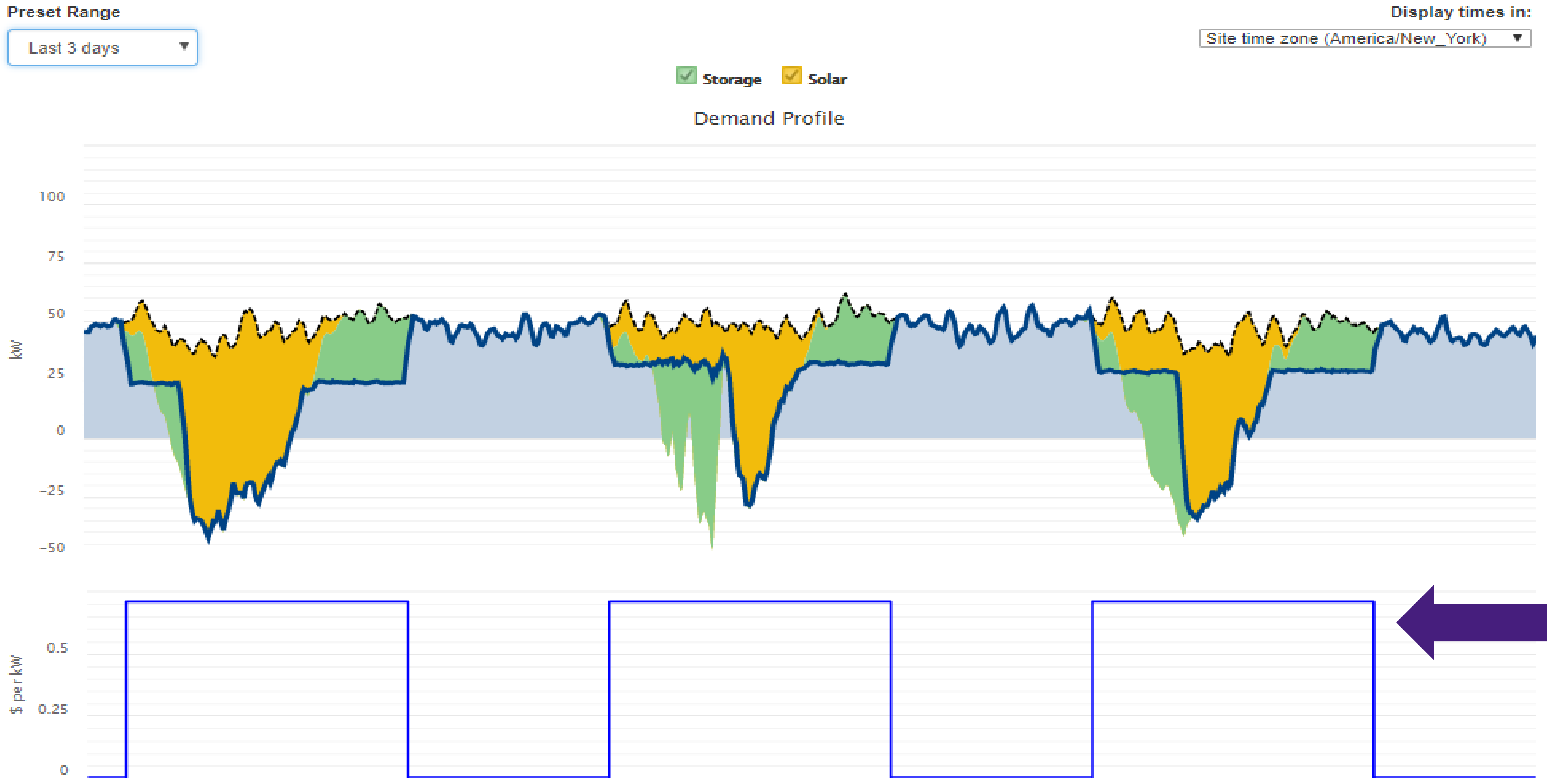


Load shaping for improving grid performance and lower energy costs

BQDM Load Reduction



Load Shaping Example-
Briar Hill, Bronx NY



Blue Line- Load as seen by the utility

Yellow Shade- Load Reduced by solar

Green Shade-
Below the line, storage of excess solar
Above the line, load reduced by Storage

Standby Daily Demand pricing
8 am to 10 pm

Thank you

Doug Staker
Vice President, Utility Business Development
Flexibility Solutions
EnerNOC, an Enel Group Company

Hawaii Energy Connection Demonstration Phase Project for Provision of Grid Services Using Demand-Side Resources

IGP Soft Launch Presentation
March 26th 2019

Presented by:
Chris DeBone
Managing Partner
Hawaii Energy Connection

HAWAII ENERGY CONNECTION™
sustainable energy solutions

LOCALLY OWNED. NATIONALLY RECOGNIZED

Hawaii Energy Connection LLC
99-1350 Koaha Place
Aiea HI 96701

Project overview

The purpose of the Demonstration Projects was to identify and mitigate potential technology, operational, and market risks associated with the delivery of the specified grid services.

To help the Companies and Respondents better understand the true costs associated with the delivery of the grid services via the aggregation of customer-sited devices.

There were 3 grid services targeted for these demonstration projects:

1) **Regulation**
2) **Fast Frequency Response (FFR)**
3) **Capacity / Load Shift**

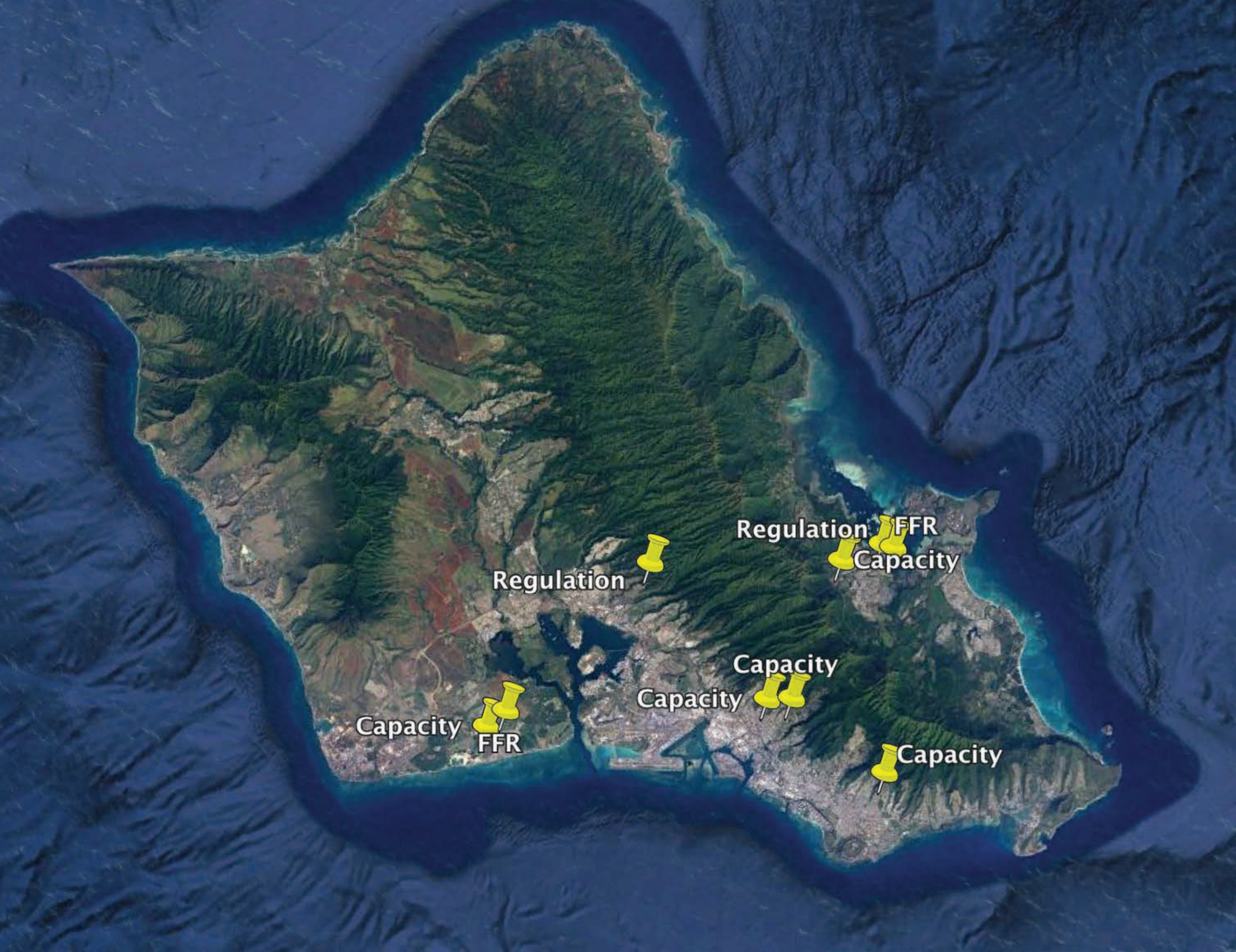
Hawaii Energy Connection (HEC) offered systems in all 3 project areas utilizing E-Gear's Energy Management Controller (EMC) and Battery Energy Storage System (BESS) in the residential segment.

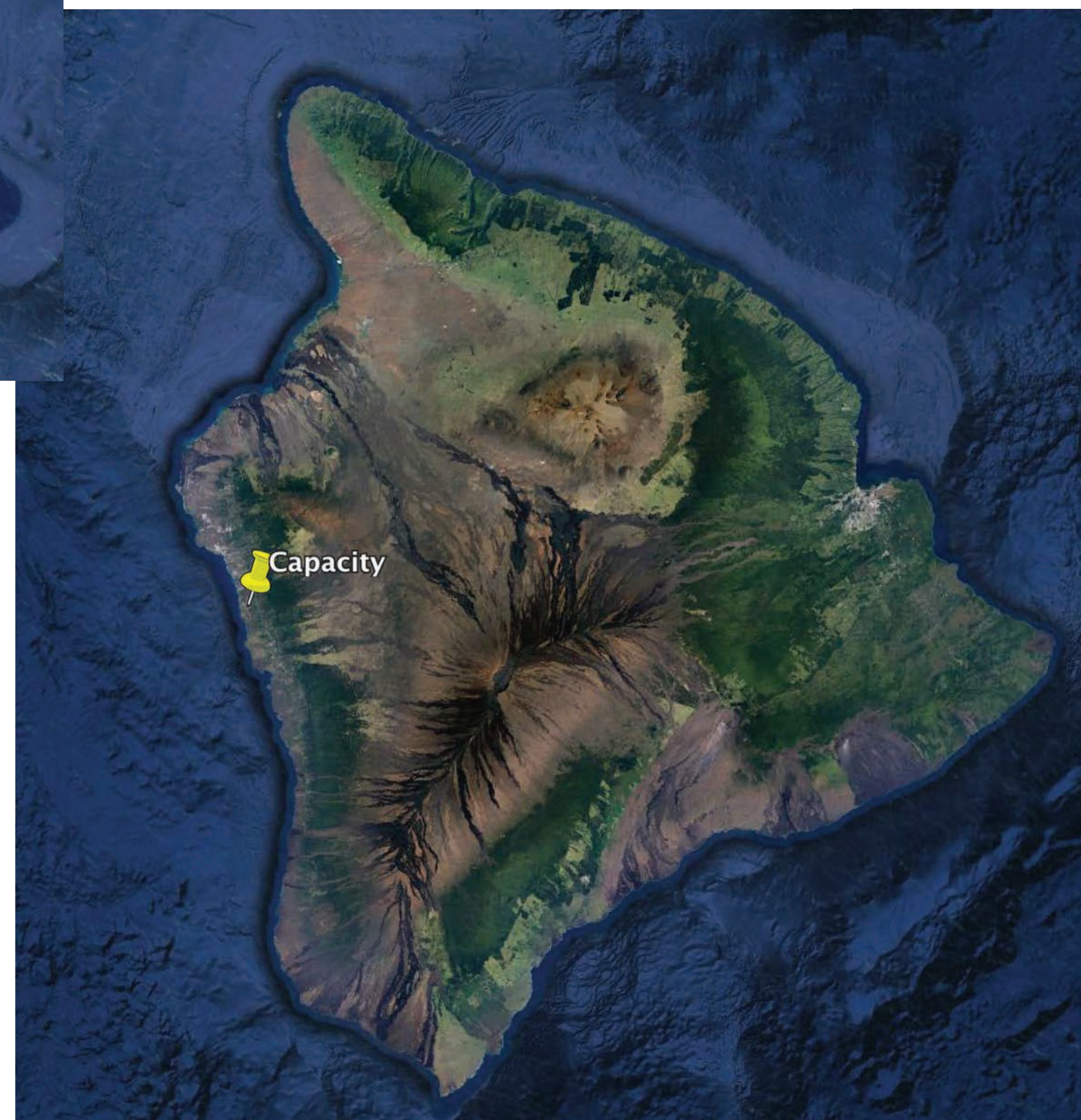
Regulating Reserves Participant Locations	Tariff	Power Capacity	Energy Capacity
Aiea, Oahu	Net Energy Metering	5 kWh	12.8 kWh
Kaneohe, Oahu	Customer Grid Supply		
		10 kW Total	32 kWh Total

FFR Participant Locations	Tariff	Power Capacity	Energy Capacity
Kaneohe, Oahu	Customer Grid Supply	5 kW	12.8 kWh
Ewa Beach, Oahu	Customer Grid Supply	5 kW	19.2 kWh
		10 kW Total	32 kWh Total

Capacity / Load Shift Participant Locations	Tariff	Power Capacity	Energy Capacity
Honolulu, Oahu	Net Energy Metering		12.8 kWh
Kailua-Kona, Hawaii	Customer Grid Supply	2.5 kW	19.2 kWh
Ewa Beach, Oahu	Customer Grid Supply	2.5 kW	19.2 kWh
Kaneohe, Oahu	Customer Self Supply	2.5 kW	19.2 kWh
Honolulu, Oahu	Customer Self Supply	2.5 kW	19.2 kWh
Honolulu, Oahu	Customer Self Supply	2.5 kW	19.2 kWh
		15 kW Total	108.8 kWh Total

Locational diversity of pilot participants

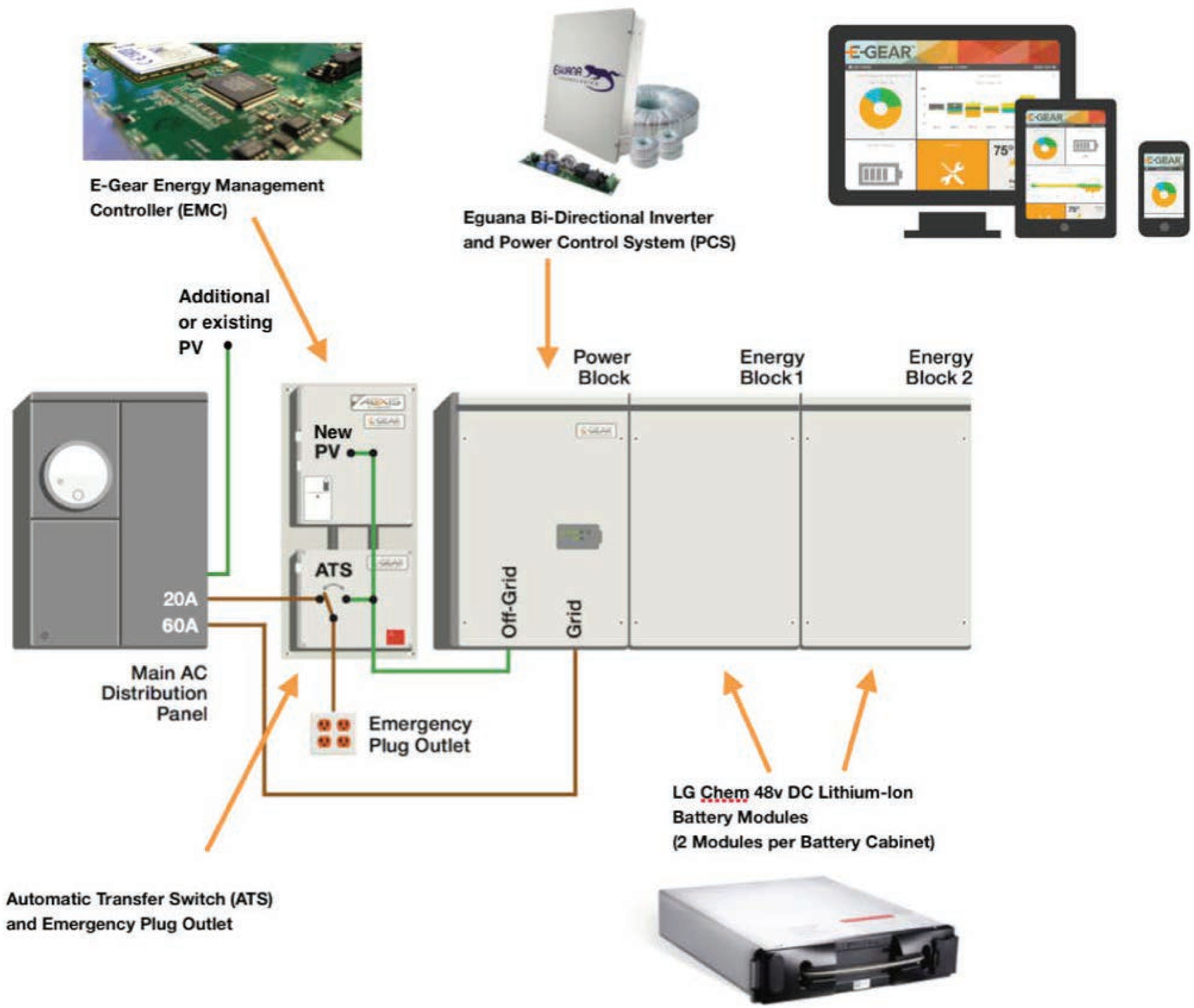




9 Participants island of Oahu

1 Participant island of Hawaii

Description of enabling technology employed



Project 1: Regulating Reserves

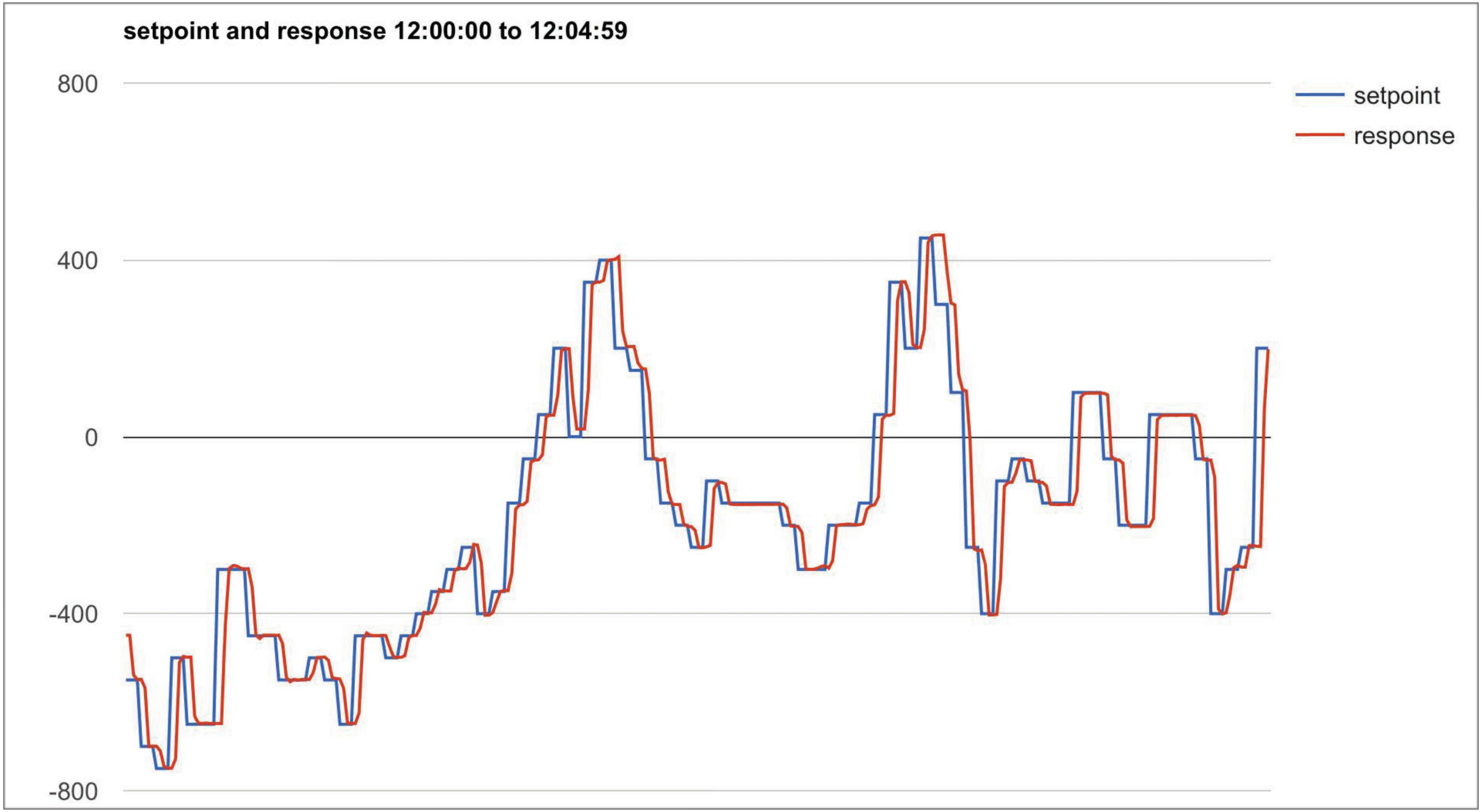
Regulation Reserves are maintained to respond to supply/demand imbalances over short time frames, typically on the order of one to several seconds. Resources that provide Regulation Reserves adjust their generation or load levels in response to automatic generation control (AGC) signals provided by the system operator.

Phase 1 – Initial Flat File Testing

Initial testing was based on a sample “flat file” supplied by Hawaiian Electric. A sample of the setpoint signal file is shown below. An event was run for a 2 hour portion of the supplied 24-hour resource file at the HEC BESS demonstration center located in Aiea, Oahu.

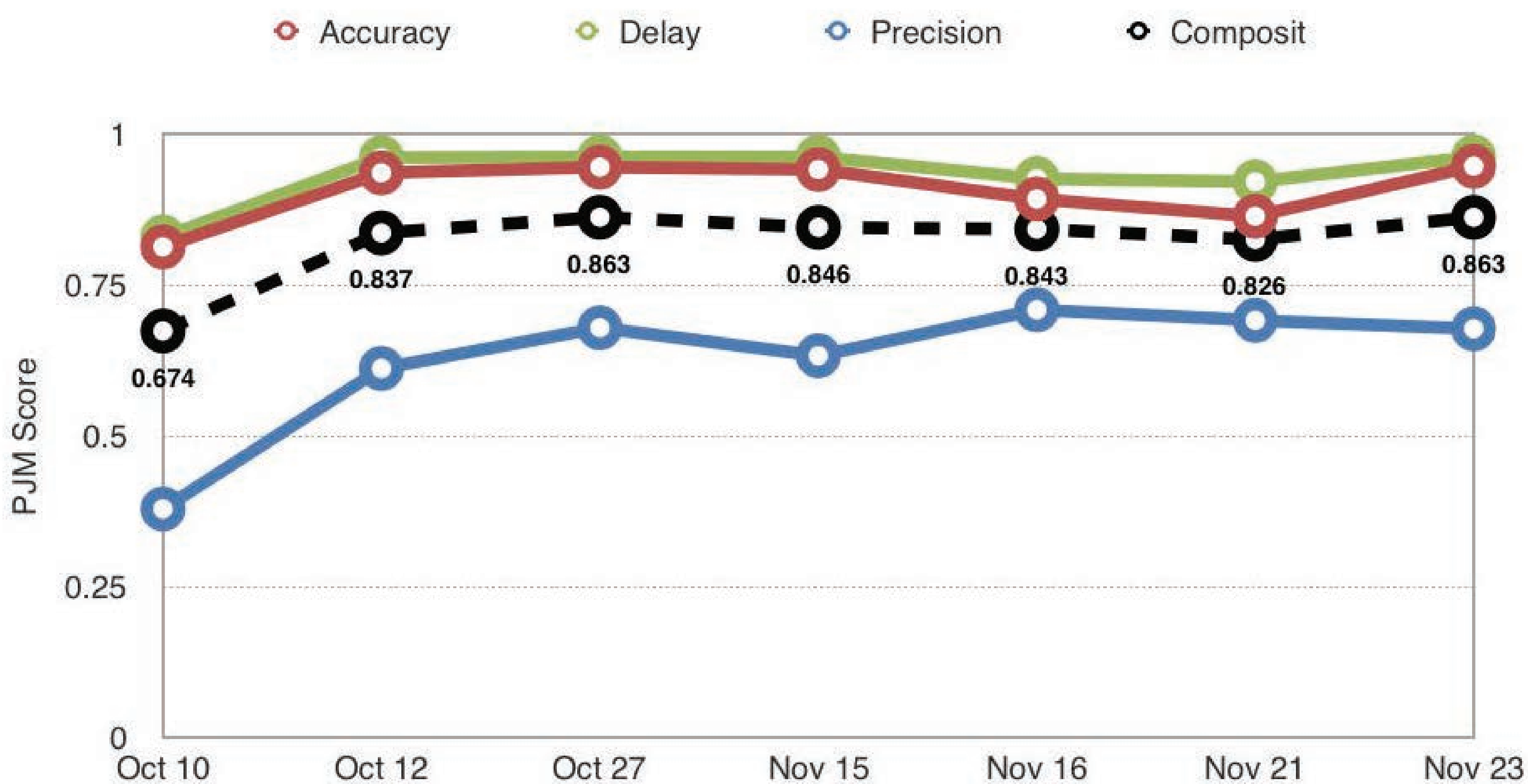
	A	B	C
1	time	setpoint	response
2	5/3/17 12:00:00	550	448.536
3	5/3/17 12:00:01	550	448.824
4	5/3/17 12:00:02	550	538.533
5	5/3/17 12:00:03	550	549.502
6	5/3/17 12:00:04	700	548.28
7	5/3/17 12:00:05	700	568.033
8	5/3/17 12:00:06	700	700.457
9	5/3/17 12:00:07	700	699.543
10	5/3/17 12:00:08	750	699.627
11	5/3/17 12:00:09	750	710.156
12	5/3/17 12:00:10	750	745.917
13	5/3/17 12:00:11	750	749.039

Phase 2A – Performance Verification - Lab Tests



Phase 2B – Performance Verification - Field Tests

	Test #1	Test #2	Test #3	Test #4	Test #5	Test #6	Test #7
Composit	0.674	0.8365	0.8626	0.8458	0.8429	0.8258	0.8625
Accuracy	0.8135	0.9362	0.9458	0.9418	0.8929	0.8643	0.9473
Delay	0.8296	0.9615	0.9625	0.9625	0.9267	0.9214	0.9625
Precision	0.3789	0.6119	0.6794	0.6329	0.7091	0.6917	0.6776
Date	Oct 10	Oct 12	Oct 27	Nov 15	Nov 16	Nov 21	Nov 23



Project 2:
Fast Frequency Response (FFR)

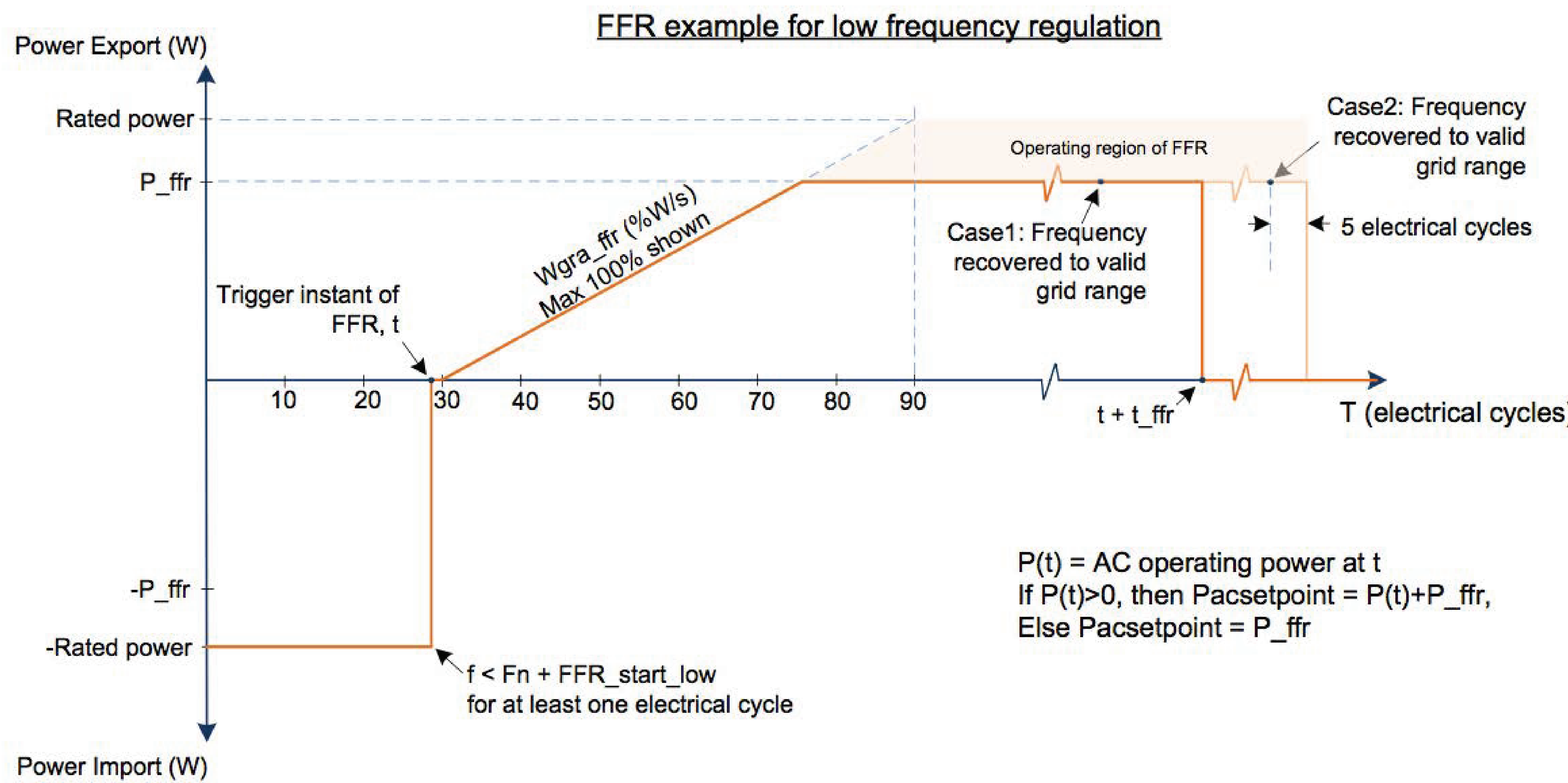
Fast Frequency Response ("FFR") is needed to reduce the rate of change of frequency ("RoCoF") to help stabilize system frequency immediately following a sudden loss of generation or load.

FFR Program Parameters

Using the aggregated controls available through the E-Gear PowerTools interface, participating DER's were programmed with an initial set of program parameters. <u>We tested for under frequency events only.</u>

FFR parameters	
Power Ramp (%W/sec.)	Percentage absolute AC Watts ramp rate of rated PCS power for increase in operating power in both directions (export and import)
Power Level (W)	Minimum delta rise in operating power in AC watts for FFR function. Used for both low frequency and high frequency regulation
Min. Active Time (min.)	Minimum time that AC battery will operating in FFR mode even if the frequency recovers. The function can be deactivated at any time by EMC
Start Frequency Low (Hz)	Deviation value from nominal frequency that determines the frequency low trigger point to start FFR
Start Frequency High (Hz)	Deviation value from nominal frequency that determines the frequency high trigger point to start FFR (will be disable)

Project Program Parameters

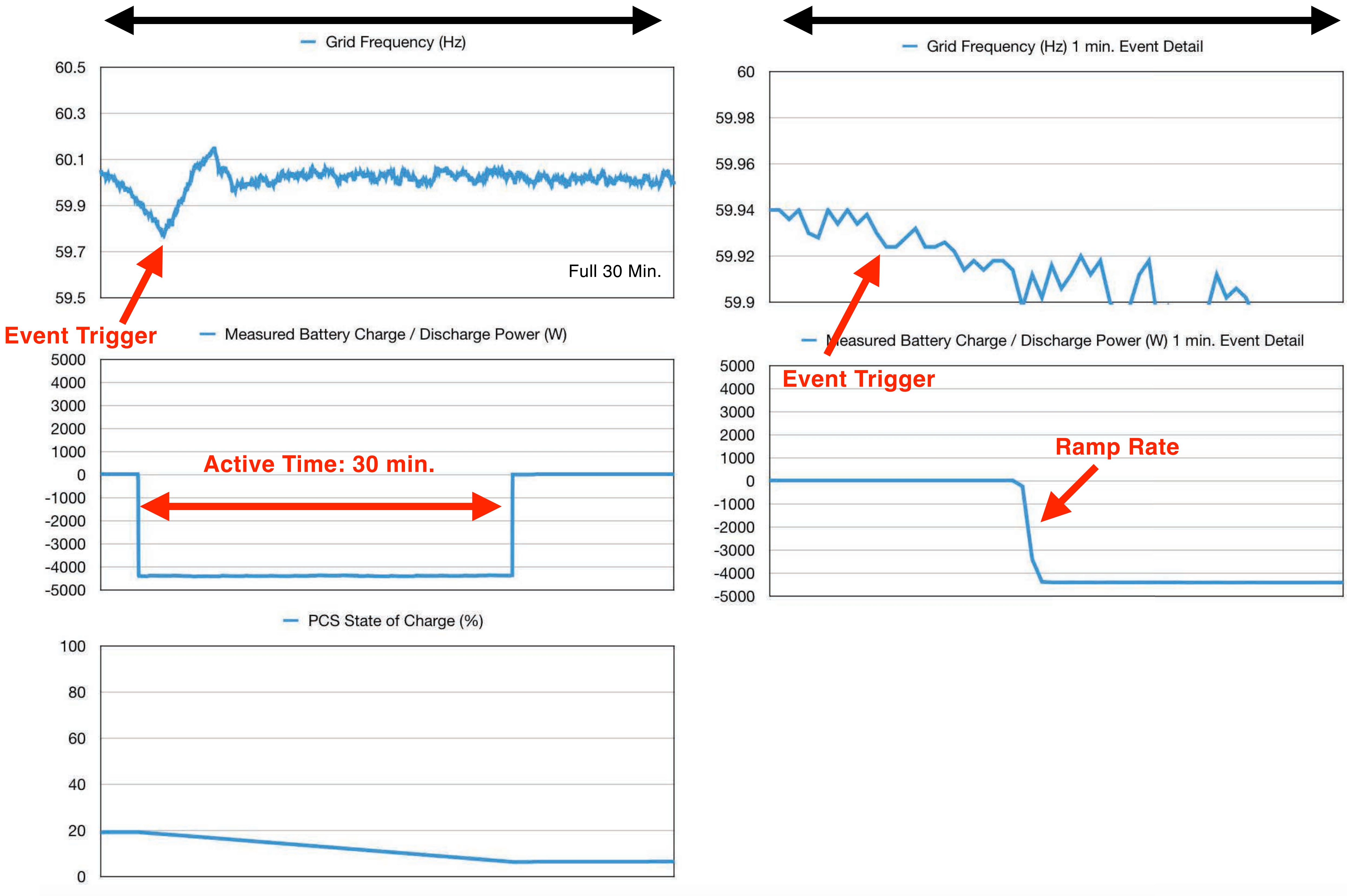


Power Ramp (%W/sec.): 100
Power Level (W): 4,500
Min. Active Time (min.): 30
Start Frequency Low (Hz): 59.9 (Minimum setting)
Start Frequency High (Hz): (Disabled)

FFR Live Event #1

FFR Live Event #2

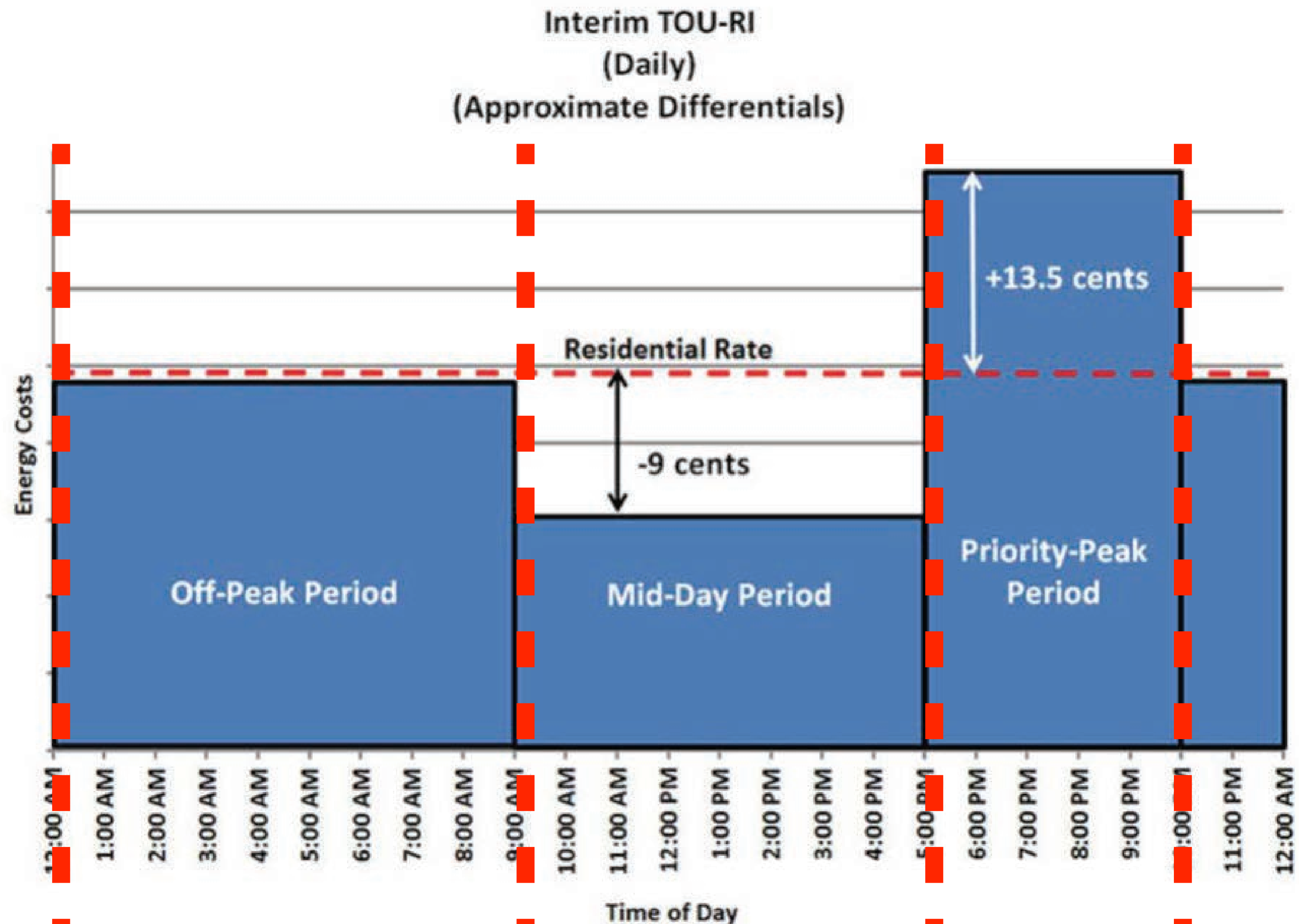
45 Minute Window | **1 min. Event Detail**

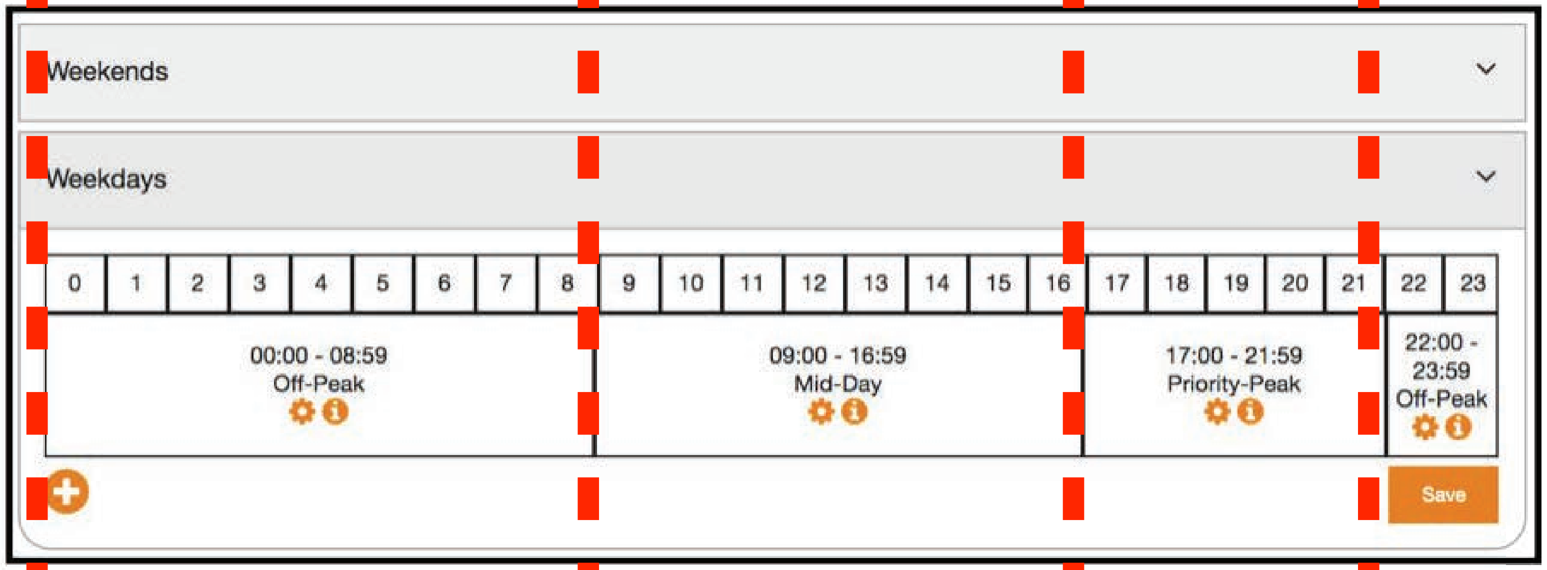


Project 3:
Capacity and Load Shift

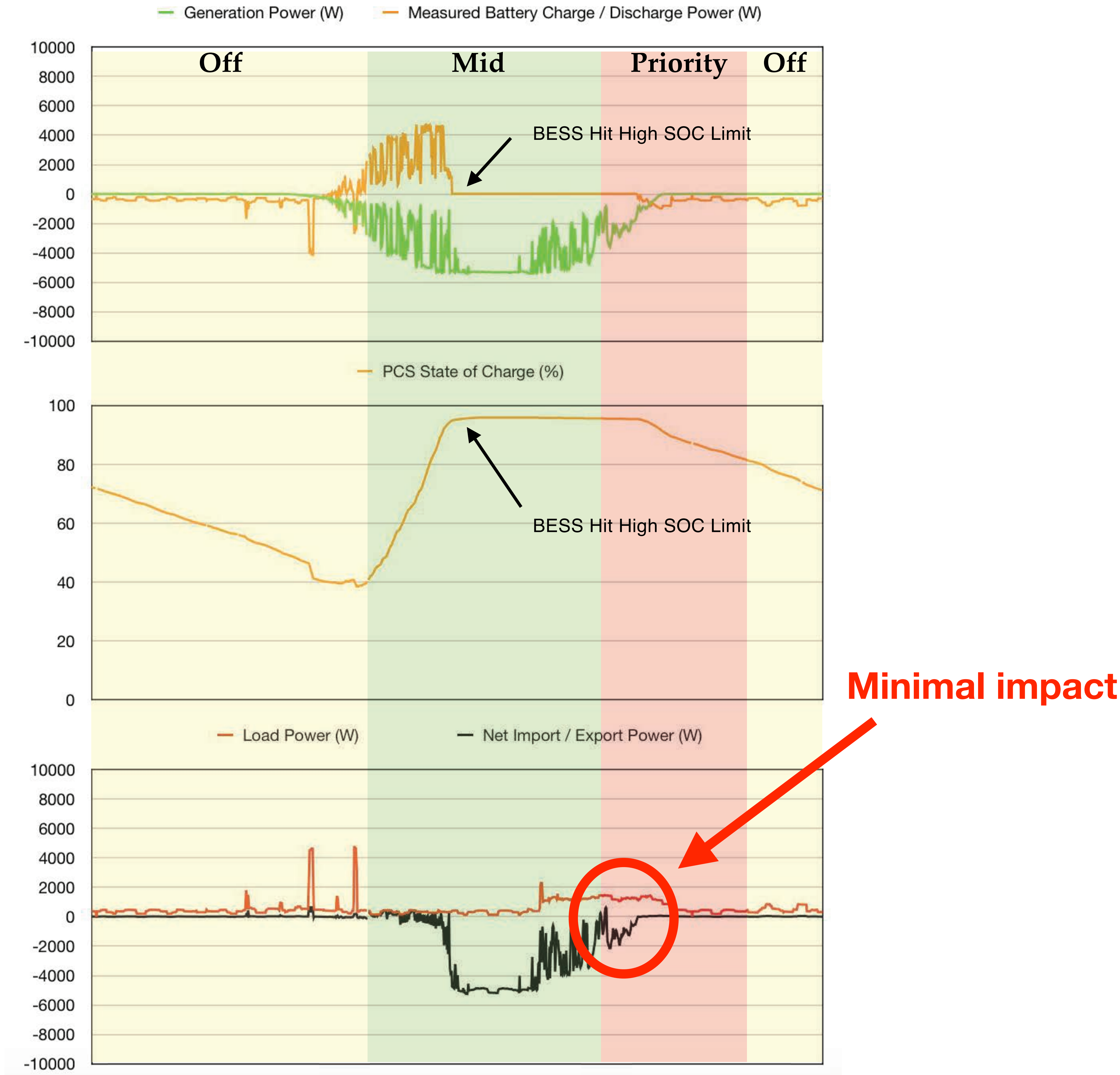
Capacity can be derived from either generation resources or controlled load. Capacity for dispatch-able generation is defined as the MW rating of the unit. Capacity for variable generation is defined as the amount of capacity that can be assured in the next four hours of the resource.

Initial TOU Test Plan

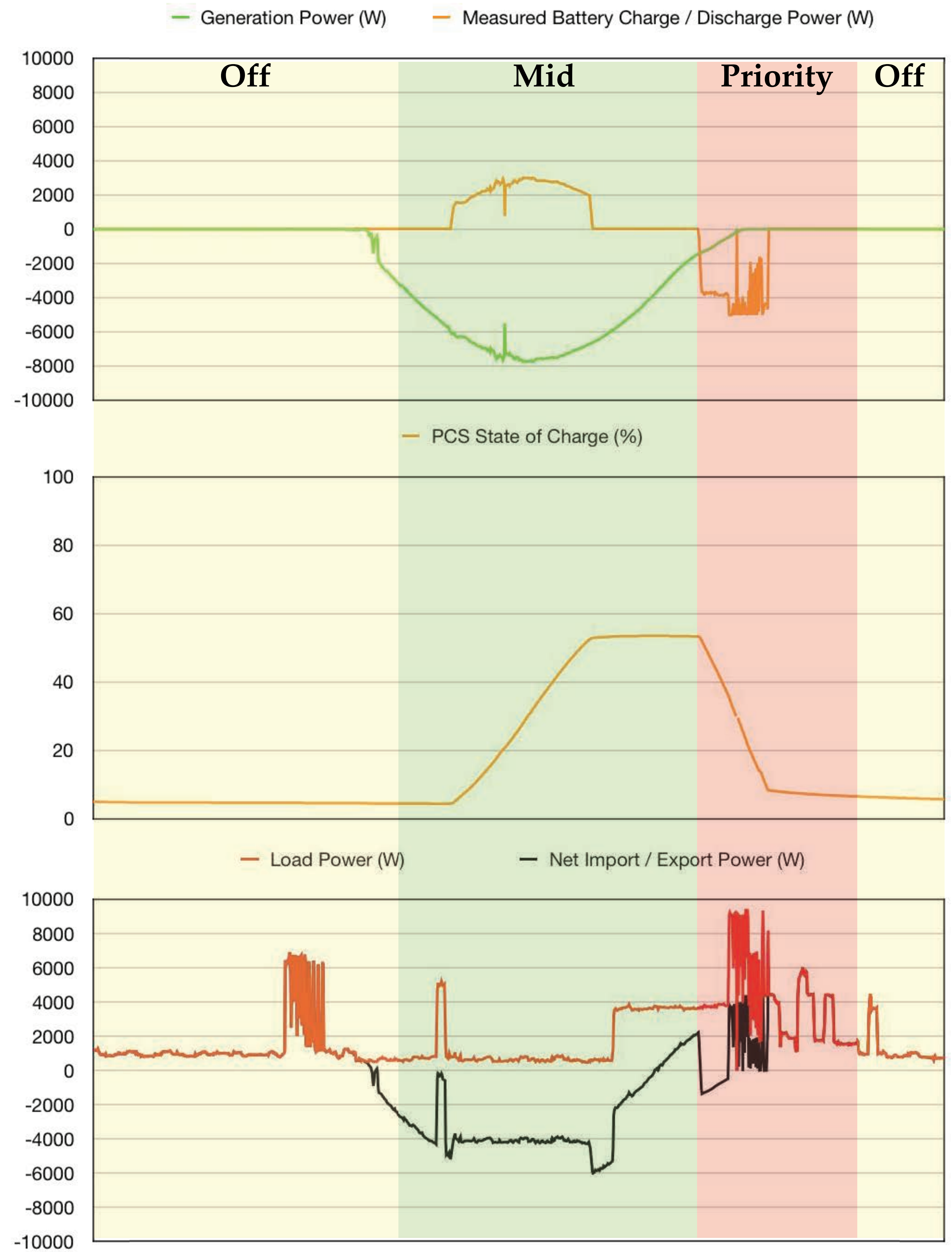




Default Solar Self-Supply vs. TOU



Alternate Scheme (PowerLock)



Lessons Learned

Lessons Learned

As a general lesson learned, customer internet is not a reliable source due to intermittent bandwidth limitations and the fact that customers have control over their equipment (passwords, routers, modems, extenders, etc…). This issue is very critical for successful deployment of assets participating in grid services.

Solid communication and security to grid edge devices is key. Based on data captured during this pilot program, under a live grid services program, devices will need to be configured to have redundant communication pathways.

The inherent nature of most reserve grid services do not provide a defined schedule and must be available 24/7. Therefore, the asset must be available at the time of an unexpected event to 1) perform for the system operator and 2) to back up the commitment by the aggregator and minimize performance penalties.

Participants were more engaged with the online interface once they signed up under a program and would check it on a regular basis.

Mahalo

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kumukit™
PV Solar Electricity

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Powerblocks

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PV Solar Water Heating

APS DER and Non Wires Alternative

HECO IGP Soft Launch

Daniel Haughton, Scott Bordenkircher

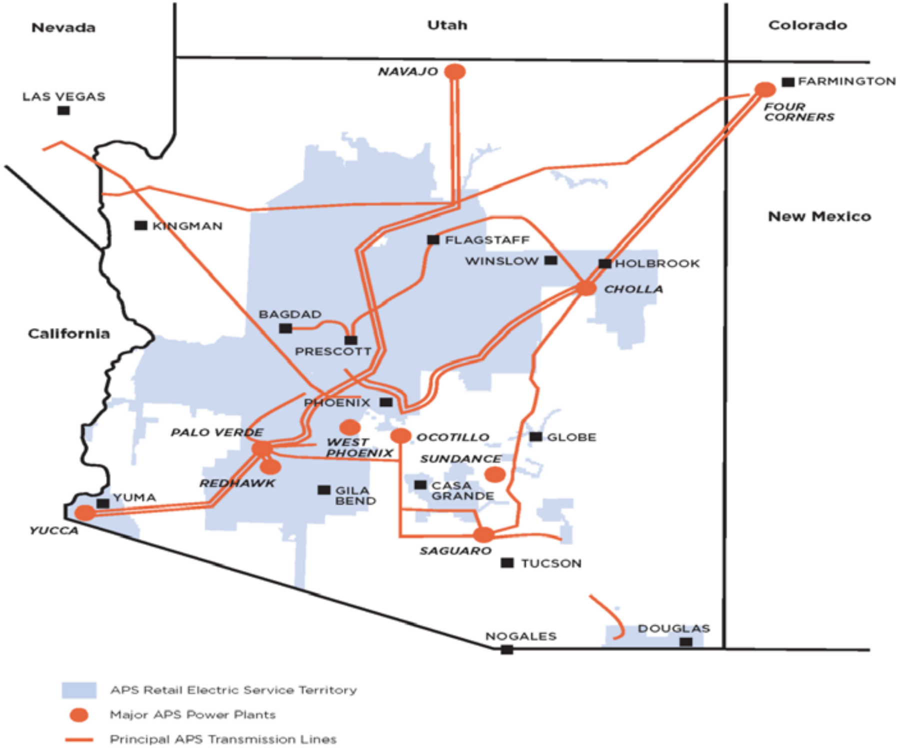
03/26/2019

Content Overview

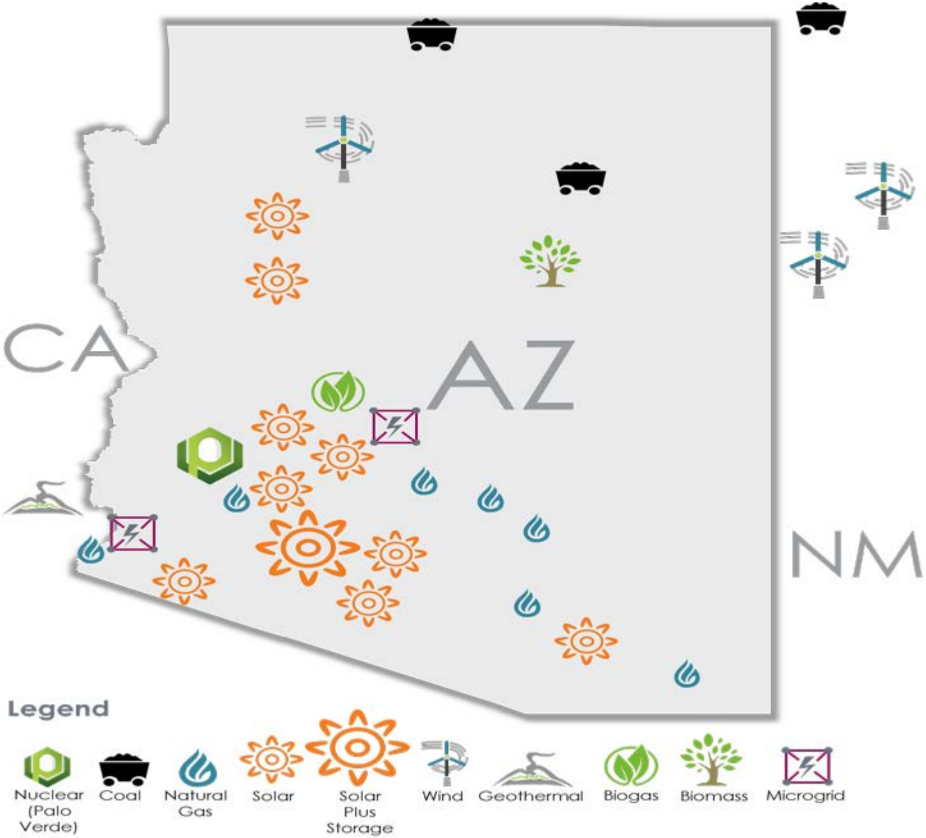
- APS Overview
- APS DER Profile
- DER Integration Projects
- Energy Storage and NWA Projects

APS Service Territory

- 11 of Arizona's 15 counties
- 34,646 square mile service area
- 1.2 M meters, 2.7 M people
- Over 35,000 transmission and distribution line miles
- 430 substations; 300,000 transformers; over 550,000 poles and structures
- Operating voltages 500, 345, 230, 115, 69, 21, 12.47 kV
- System Peak Load 7,350MW



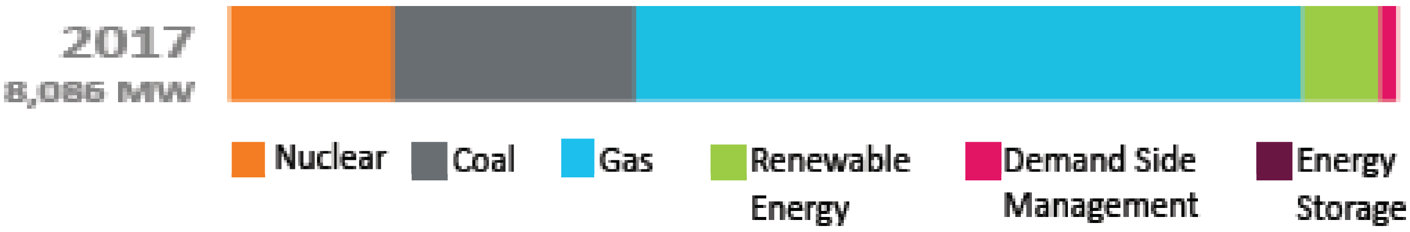
APS Resource Diversity

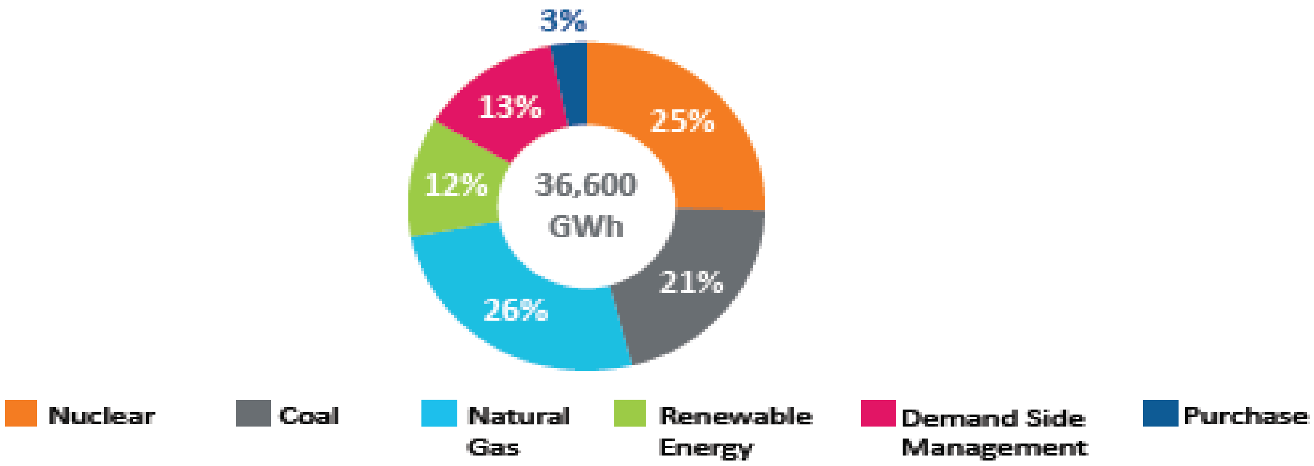


- Renewable energy resources are the second largest piece of the APS system
- 50% Carbon-Free Fleet

2018 Resources (MWs)

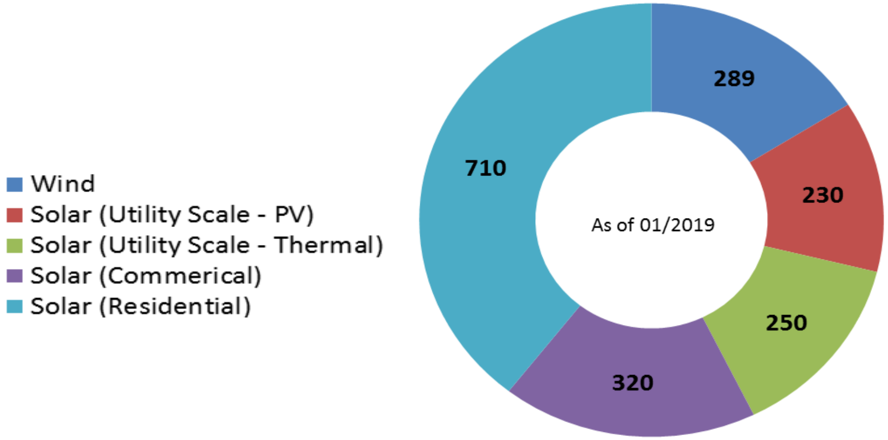
	NAMEPLATE CAPACITY
Nuclear	1,146
Coal	1,672
Natural Gas	4,959
Microgrid/ESS (Quick Start)	34
Renewables	1,838
Customer-Based DSM	854
TOTAL	**10,503**

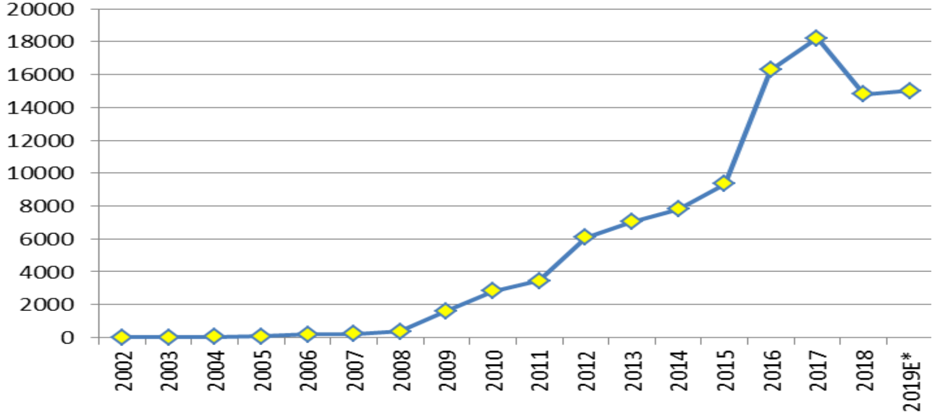

2017
8,086 MW
Nuclear
Coal
Gas
Renewable Energy
Demand Side Management
Energy Storage


3%
13%
25%
12%
36,600 GWh
21%
26%
Nuclear
Coal
Natural Gas
Renewable Energy
Demand Side Management
Purchase

APS Renewable and DER Profile

- Renewable profile
  - 769 MW utility scale solar and wind
  - 1030 MW customer owned solar
    - Average 1400 applications/mo.
- Energy storage
  - Solana (solar thermal)
    - 250 MW
  - Battery energy storage (utility scale)
    - 8 MW/12 MWh
  - Battery energy storage (residential)
- Anticipated DER Forecast*
  - 4100 MW by 2032
  - Most from customer DER





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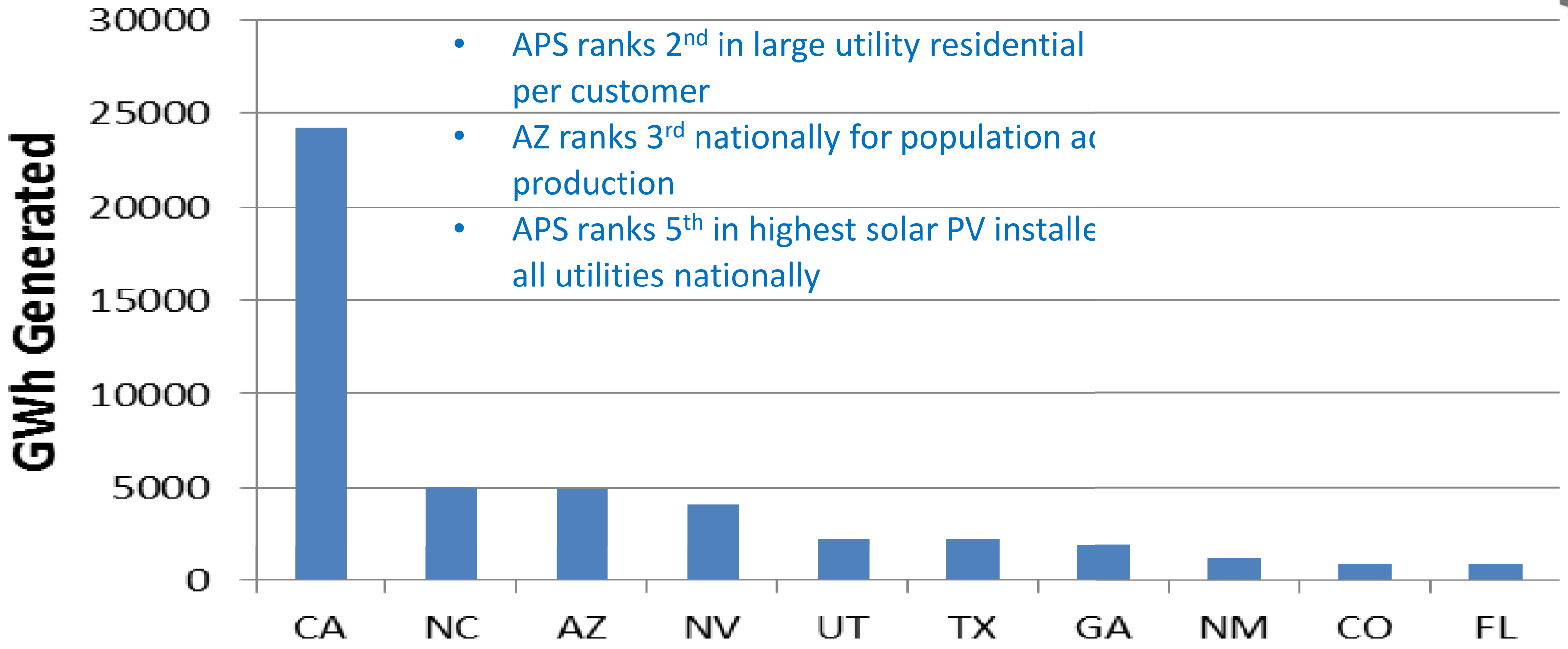
Energy Information Administration Statistics

- APS ranks 2nd in large utility residential per customer
- AZ ranks 3rd nationally for population ac production
- APS ranks 5th in highest solar PV installe all utilities nationally



https://www.eia.gov/electricity/data/state/

Punkin Center Non-Wires-Alternative

- Use Case
  - Distribution line reconductor deferral
  - Over 20 miles of small wire
  - Remote region
  - 21 kV, 174 A limitation

Feeder Characteristics

- Long, radial, small-wire circuit
- Low forecasted load growth
- Load concentrated at end of line
- Primary residential loads
- Multiple stages of voltage regulation – VVO circuit

Lessons Learned

- Procurement
  - Understand and define specific requirements
  - Size, duration, configuration, validation, testing
  - Long-term sustainable solutions required
- Planning
  - Robust studies and analysis required
  - New technologies present unanticipated challenges
- Operations
  - The battery is a useful asset when operational
  - Plan to operate thru abnormal and emergency condition, with loss of grid, and loss of NWA solution

APS Solar Partner Program with EPRI

- Phase 1 - initiated 11/2014
  - 10 MW, 1600 residential customers
  - External Advisory Council
- Rooftop solar PV
  - Residential systems (4-8 kW)
  - West-facing, with advanced inverters
  - 20 year contract
  - APS controls inverters (grid side of meter)
- Centralized communications and control
  - Utility communications, control, and central dispatch
- Phase 1 EPRI Report 05/2017
  - Product ID: 3002011316

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Solar Partner Program Lessons Learned

aps

Planning & Operations

- Feeder demand reduction from aggregated systems (5-8 %)
- West-facing coincident to system needs (66 vs 20 %)
- No negative VVO impacts
- No transformer or customer demand reduction

Advanced Inverters

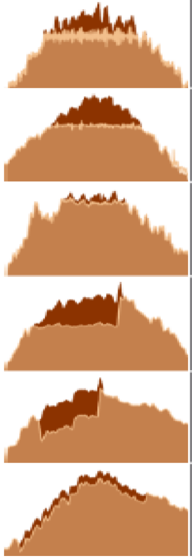
- Respond to commands
- Ideal settings vary by feeder (Volt/VAR, PF, unity)
- Aggressive voltage settings caused no kW curtailment
- Secondary voltage impact dominates

Interoperability & Communications

- Need for standards and protocols (nascent industry)
- Inverters do not talk at night (solar PV)
- Interaction with VVO seen but managed
- Tradeoffs abound – thoughtful consideration required

Solar Partner Program Lessons Learned

- Phase 2 – initiated 01/2017
  - BESS (2MW/2MWh), 2 feeders
  - Interoperability with VVO and advanced inverters
- Phase 2 [EPRI Report]11/2018
  - Product ID: 3002014455



ASSET PROTECTION	Decrease in Power Above Peak (%)	<- As a Ratio (kW/kW)	Peak Energy Deferral (%)	<- As a Ratio (kWh/ kWh)	Date Observed (Feeder)
Measurement-based – Sufficient Capacity, High Ramp Rate	77%	519/676	96%	780/813	8/24/2017 (Feeder A)
Measurement-based – Sufficient Capacity, Low Ramp Rate	84%	599/714	99%	706/712	2/22/2018 (Feeder A)
Measurement-based – Lighter Load	91%	165/181	99%	118/119	8/20/2017 (Feeder B)
Measurement-based – Insufficient Capacity	7%	68/957	71%	1663/2349	8/24/2017 (Feeder B)
Scheduled Dispatch – High Discharge Limit	31%	354/1148	48%	652/1256	10/26/2017 (Feeder B)
Scheduled Dispatch – Low Discharge Limit	40%	349/869	60%	668/1109	10/14/2017 (Feeder B)

Using AI to Unlock Energy Storage Value for Grid Services

HECO Grid Services Workshop

March 26, 2019

Jim Baak, Senior Manager for Regulatory Affairs, West
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stem
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
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 · Bloomberg WINNER · SEPA POWER PLAYERS · GRID EDGE innovation AWARD WINNER

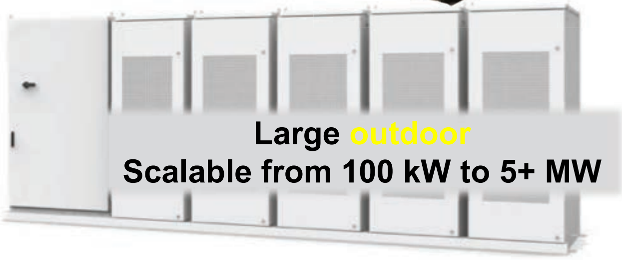
Stem’s Solution Components

Athena™ Artificial Intelligence

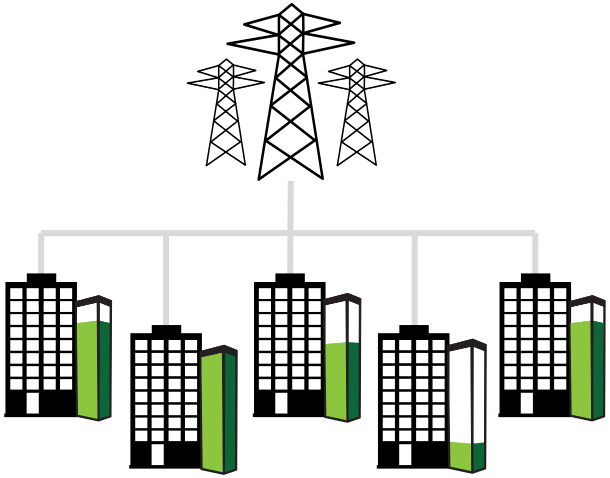
Automatically controls when energy storage charges and discharges to optimize timing, maximize savings, and create virtual power plants.

Energy Storage Systems

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



Virtual Power Plants

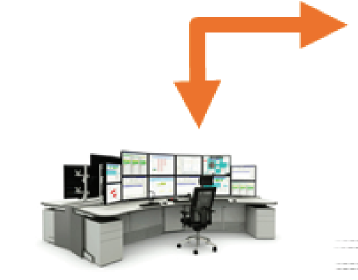


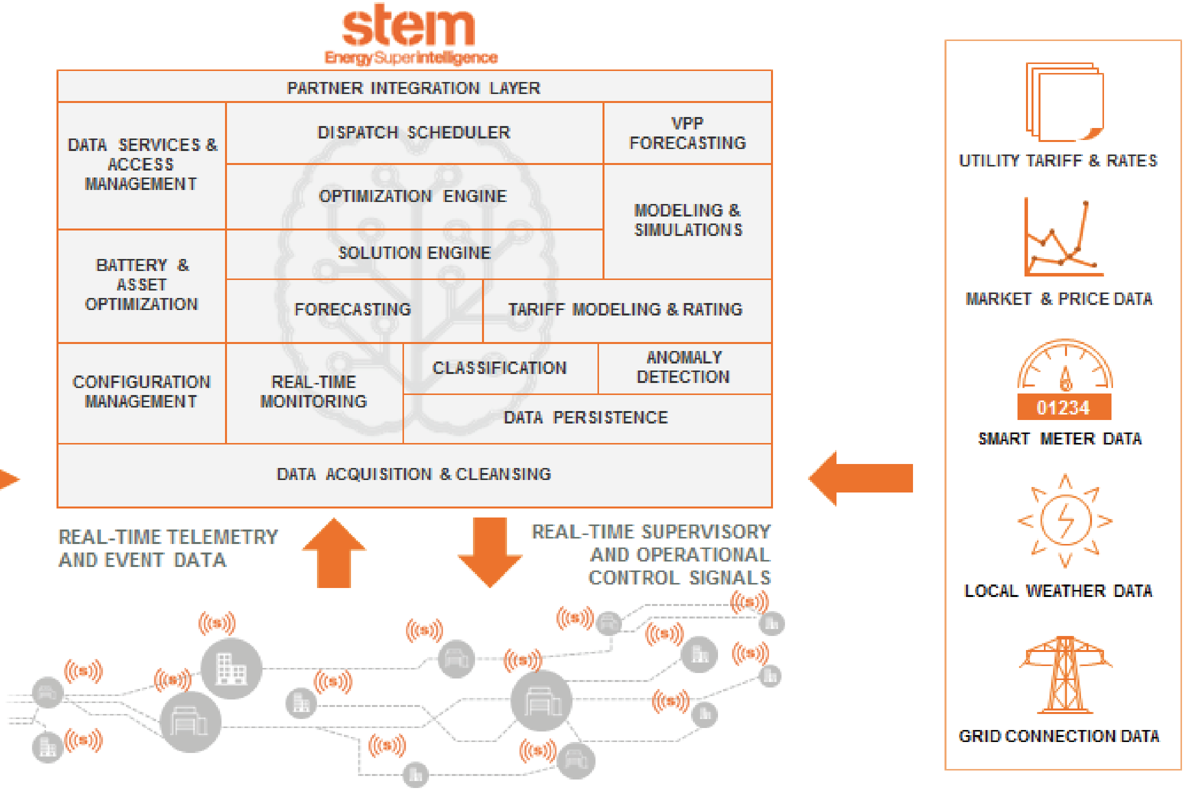
Energy Superintelligence™

- 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

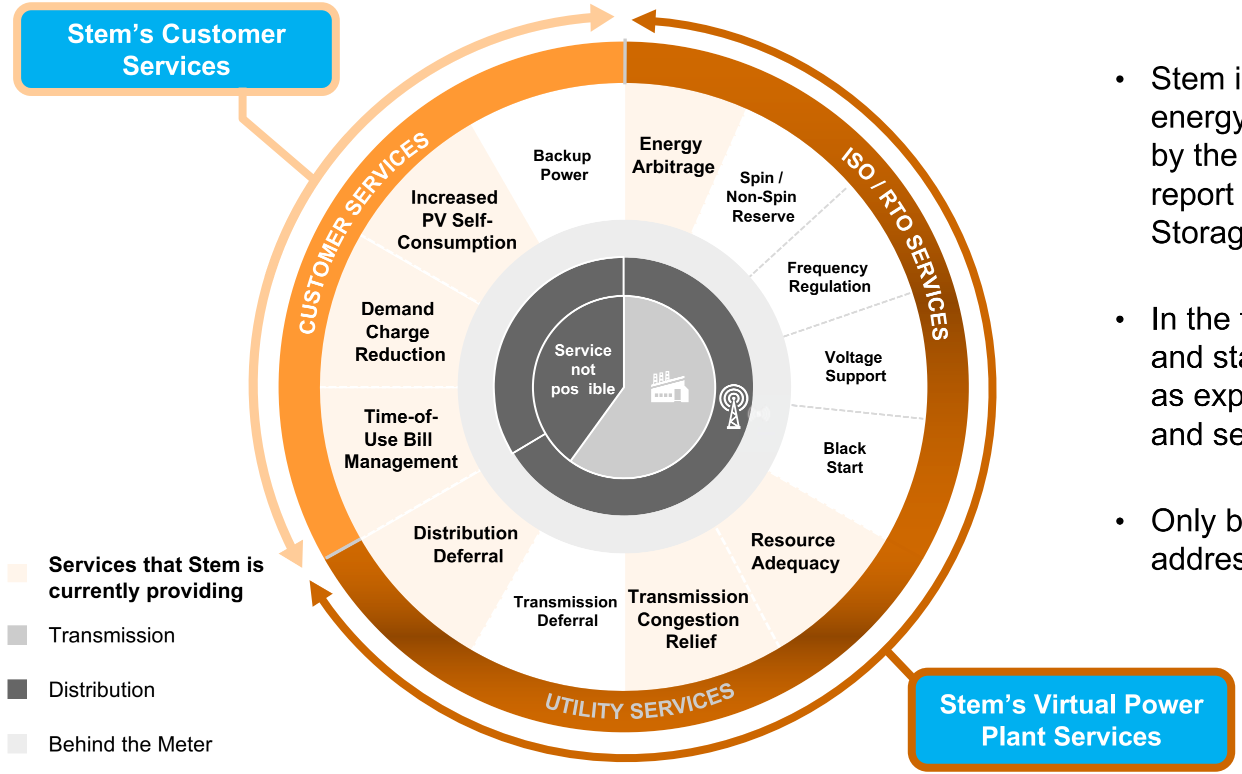
The Stem Energy Platform – Athena

- 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





AI-driven optimization of customer & grid benefits

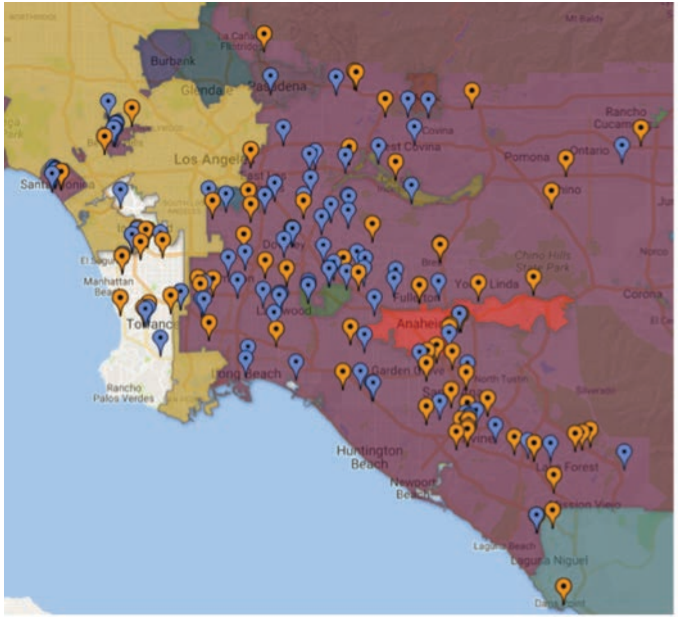


- Stem is currently monetizing 7 of the 13 energy storage value streams as identified by the Rocky Mountain Institute in their report "The Economics of Battery Energy Storage"
- In the future, Stem intends to co-optimize and stack these revenue streams as well as expand the scope of available offerings and services
- Only behind-the-meter solutions can address all 13 value streams

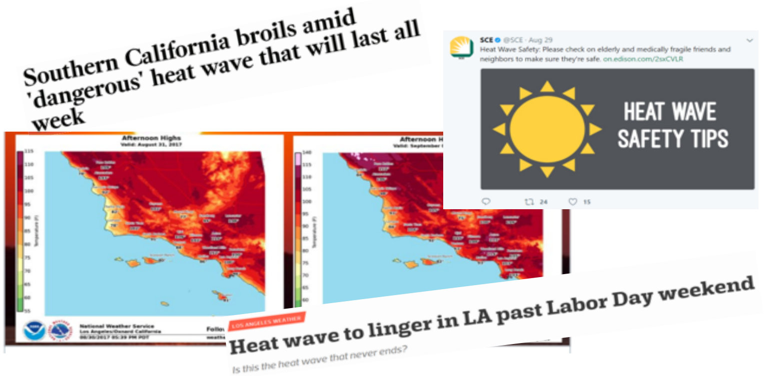
Source: Rocky Mountain Institute.

Stem's Current Grid Services Offerings

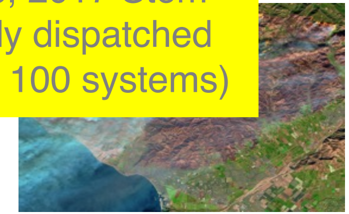
- **Local Capacity Requirements**
  - 20-min RT dispatch
- **Demand Response Auction Mechanism (DRAM)**
  - Aggregated DR bid into DA and 5-min RT markets
  - System, local and/or flexible Resource Adequacy
- **Retail Demand Response**
  - Reliability and peak capacity
  - Event-based responses
- **Distribution Deferral**
  - Stand-alone storage or portfolios of DER to meet grid deferral needs



In 2017 CA Grid Needed Flexibility, Fast Response



On August 28, 2017 Stem simultaneously dispatched 14 VPPs (over 100 systems)



Dec. 5 wildfires in Ventura County, Calif. (Joshua Stevens/NASA Earth Observatory)

Current Active Notice(s)

Southern CA Region TRANSMISSION EMERGENCY Notice [201702312]

The California ISO hereby issues a Southern CA Region TRANSMISSION EMERGENCY Notice effective 12/08/2017 00:00 through 12/11/2017 23:59 based on conditions as of 12/10/2017 07:37.

Reason:
Local transmission emergency in Ventura County area.

Reliability and Resilience Needs

> Unprecedented heat waves

> Ongoing wildfires disrupting transmission

> Southern CA gas supplies

Stem's VPPs are working

> Contract for SCE local capacity

> Wholesale market since 2014

> 1,000+ dispatches over 3 years

> Hundreds of real-time market calls – no manual intervention

"That's awesome. Wish all "DR" would respond like this!" – CAISO Staff

Win-Win-Win Partnerships With Customer and Utility

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.

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

- Energy storage system subscription payment

Lessons Learned – Grid Services RFOs

- Information is key
  - Good data on loads, load shapes, grid needs, hosting capacity, forecasted growth, etc. is essential to successful performance
- Contracts need to be longer term (> 1-2 years)
  - Shorter-term contracts make it difficult to sign up customers and harder to finance, negatively impacting economics
  - Prefer 10-year contracts, which correspond to many incentive program requirements
- Reasonable & consistent performance measurement & evaluation
  - Evaluate performance against capacity deployed versus contracted capacity to account for permitting and construction delays beyond the developer's control
- Common-sense rules for dual participation/incrementality
  - Focus on providing appropriate compensation for the value of services provided

Lessons Learned (Cont'd)

- Reasonable metering and interconnection requirements
  - Consistent treatment for energy storage across RFOs/IOUs
  - Length of time it takes to interconnect
  - Don't treat non-export like export
- Avoid baselines wherever possible
  - Baselines are more difficult for storage due to the variability of customer loads
  - Prefer direct metering with an MGO
- Fire/Building code restrictions
  - Significantly limits potential size of resource portfolio
- Think outside the box
  - Evaluate portfolios of DERs rather than just individual resources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Residential Solar+Storage for Non-Wire Alternatives

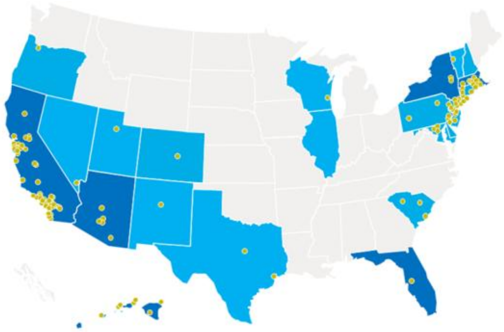
Nathan Wyeth
March 2019

Sunrun Overview

Who We Are

- Formed in 2007 and headquartered in San Francisco, CA, Sunrun pioneered the residential solar service product
- Largest residential solar, storage, home energy services company, with more than 233,000 customers
- Sunrun has deployed 1.6GW of residential solar and currently operates in 23 states, plus DC and Puerto Rico
- In 2017, Sunrun expanded its offering to battery storage (installed over 5,000 units to date) and is the leading residential grid services provider
- In 2019, Sunrun won a bid to provide 20MW of capacity from home solar and battery systems to ISO New England beginning in 2022 – a first for residential resources

Market Coverage



Value to customer

- **Save on electricity**
- **Little or no upfront cost**
- **Backup power, no fuel or pollution**
- **Bill management**

Value to the Grid

- **Peak capacity**
- **Resiliency**
- **Dispatchable Virtual Power plant**
- **Ancillary Services**

Key Points

Based on engagement with non-wires procurements in New York, California and elsewhere, Sunrun highlights the following key factors for maximizing NWA success with residential storage.

1. Residential storage can be a fully dispatchable resource for distribution capacity and other distribution services.

2. For residential-heavy distribution infrastructure, solar+storage delivers high potential per home

3. Solar paired with storage can serve long-duration needs

4. Sharing high quality, data-oriented view of grid need facilitates high quality, best fit solutions

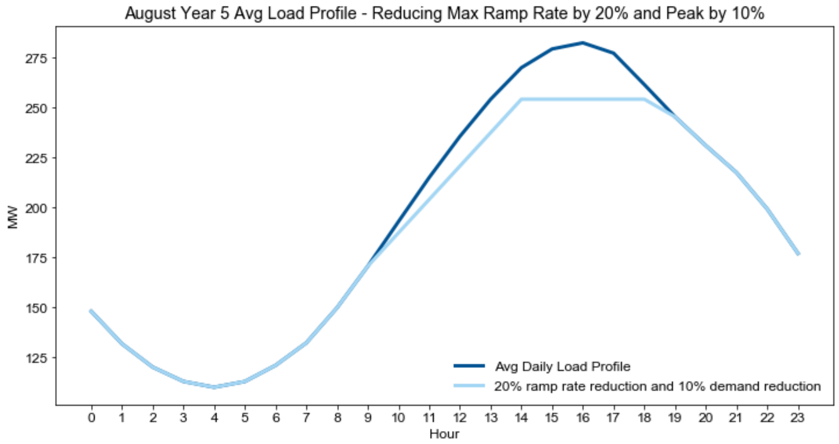
5. Demand for residential solar+storage creates a growing fleet available for utilization for distribution value as needs arise

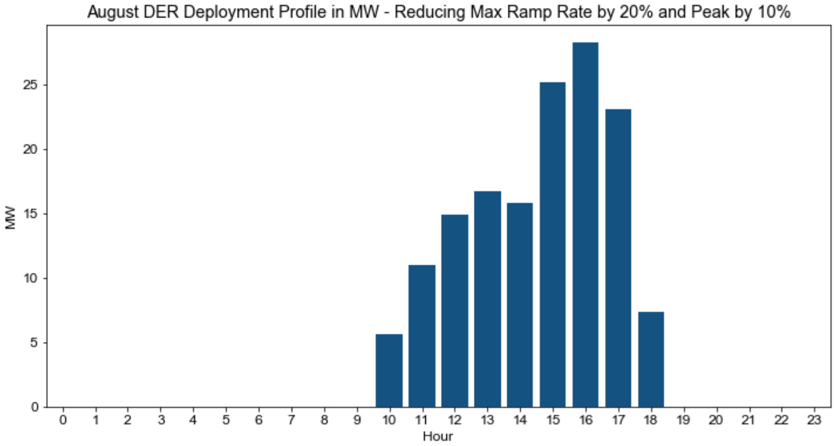
6. For optimal results:
    - *Enroll / engage assets at point of sale as they are deployed*
    - *Keep it simple and seamless for customers even as grid needs evolve*
    - *Leverage aggregators to manage complexity.*
    - *Work through existing customer relationships to de*epen technology deployment

Residential storage can be fully dispatchable

Residential batteries can be managed to deliver a fully shapeable profile for impact on net load. (In this case, ramp rate reduction and peak shaving)

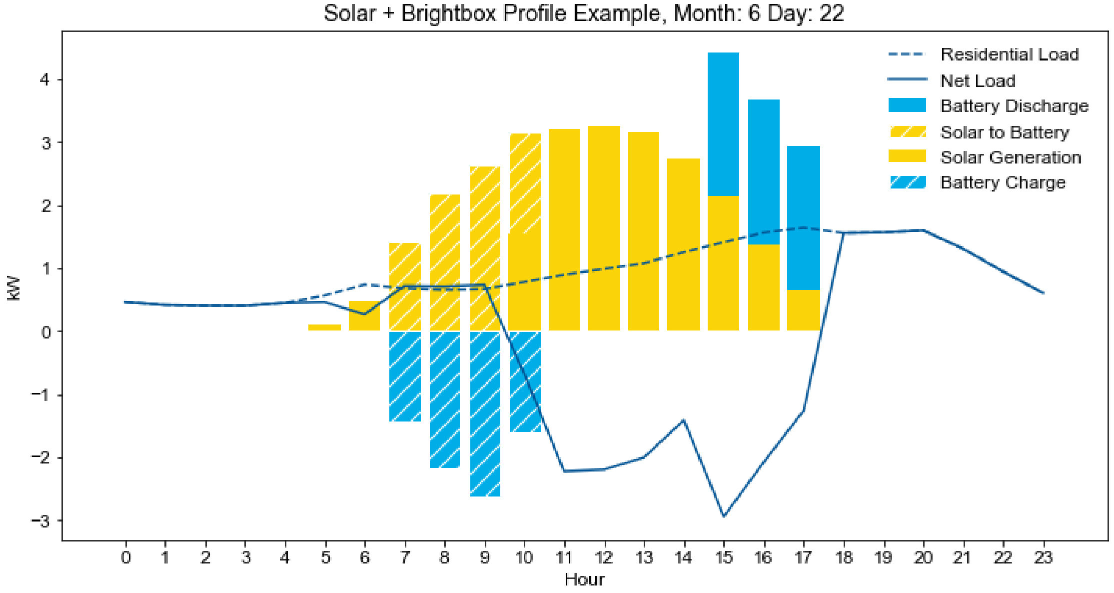
An aggregator can deliver a desired overall outcome by delivering asset-level dispatch. Pricing signals need not be translated with this granularity to a customer level.





Solar+storage delivers large impact per home

Storage sized to manage solar self-consumption results in 18+ kWh today; with future battery cost declines, sizing has room to grow. Depending on distribution capacity need duration, net difference between non-solar+storage home and solar+storage could be 5+ kW / home or more.

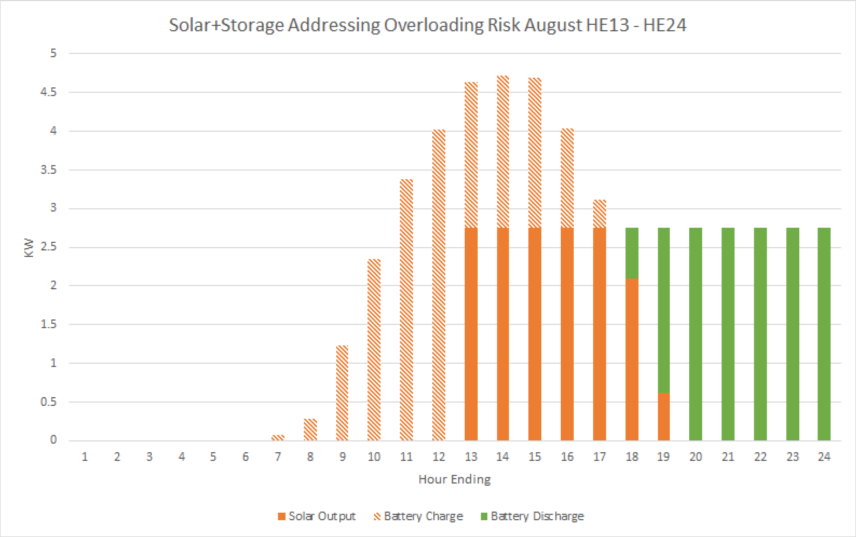


Passive solar + dispatchable battery is a long-duration solution

- Siting generation within constrained areas helps address long-duration needs. Midday needs are supported by passive PV generation, while storage shifts shifts generation to cover hours outside solar production.

- Rooftop solar can be sited within dense, constrained areas and solar and battery sizing can address varying duration needs.

- *Local generation supports battery charging when even “charging window” to draw power from outside constrained area is limited i.e. solar exports from BTM, if “capturable” by other storage within constrained area, can have value even outside target hours.*



A 7kW solar array in Honolulu directly reduces load starting 12:00 and charges 18.8 kWh of storage @ 88% RTE to provide 2.75 kW load reduction through 24:00

Data-rich communication of needs enables smart responses

- ***Leverage utility knowledge of customers & load characteristics***
  BTM approaches require canvassing a broad customer base for potential. Data on # of meters by customer class is the starting point - additional detail is helpful.

- ***Share 8760 data for smartest design of solutions with variable resources***
  Annual peak day need may not be only factor

- ***Accurate and granular maps enable planning***
  GIS shapefiles enable overlay with other mapping tools and market datasets.

- ***Show drivers of load forecasts***
  BTM solutions deploy in direct relationship to load. If we understand what you're expecting will show up (e.g. new homes, EVs, added cooling load, etc), we can consider how to meet with specific solutions.

- ***Descriptions of grid topography***
  The more clear the description of the grid, the better developers can propose customized solutions to balance across substations, address contingencies, etc. not just solve for X MWs.

Data-rich communication of needs enables smart responses

Hour by hour MWh need enables dispatch modeling

Even better: “8760” view of needs over seasons

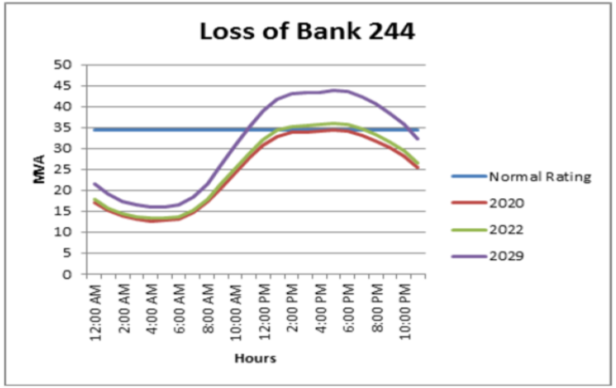
Need 3: Intrepid 16 kV																														
Year	Capacity (MW)	Energy Need (MWH)	Time of Year*	Monthly Frequency	Yearly Frequency	Year	Peak Hourly Need (MW)																							
							1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
2020	0.7	1.4	Summer	5	15	2020	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.2	0.7	0.6	-	-	-	-
2021	0.86	2.2	Summer	5	15	2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3	0.9	0.8	0.2	-	-	-
2022	1.1	3.0	Summer	5	15	2022	-	-	-	-	-	-	-	-	-	-	-	-	-	-	[illegible]	-	-	0.4	1.1	1.1	0.4	-	-	-
2023	1.3	3.8	Summer	5	15	2023	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5	1.3	1.3	0.7	0.1	-	-
2024	1.5	4.8	Summer	5	15	2024	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.7	1.5	1.5	0.9	0.3	-	-
2025	1.7	6.0	Summer	5	15	2025	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.8	1.7	1.7	1.1	0.6	0.2	-
2026	1.9	7.5	Summer	5	15	2026	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.0	1.9	1.9	1.3	0.9	0.6	-

Annual MW need + visual interpretation of graph prevents certainty of modeling

Table 3: Required Load Reduction and Hours of Need for Bank 244 Contingency

Loss of Bank 244										
Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Total MW Reduction	0.08	0.84	1.67	2.57	3.54	4.59	5.71	6.91	8.20	9.58
Days of Need in a Year	3	4	4	7	12	18	23	26	33	38
Hours of need based on load profile	4p.m. to 5p.m.	2p.m. to 6p.m.	1p.m. to 7p.m.	1p.m. to 7p.m.	1p.m. to 8p.m.	12p.m. to 8p.m.	12p.m. to 9p.m.	12p.m. to 9p.m.	12p.m. to 10p.m.	11a.m. to 10p.m.

Figure 3: Typical Peak Day Load Profiles for Bank 244 Contingency



Growing fleet of solar+storage is an opportunity today

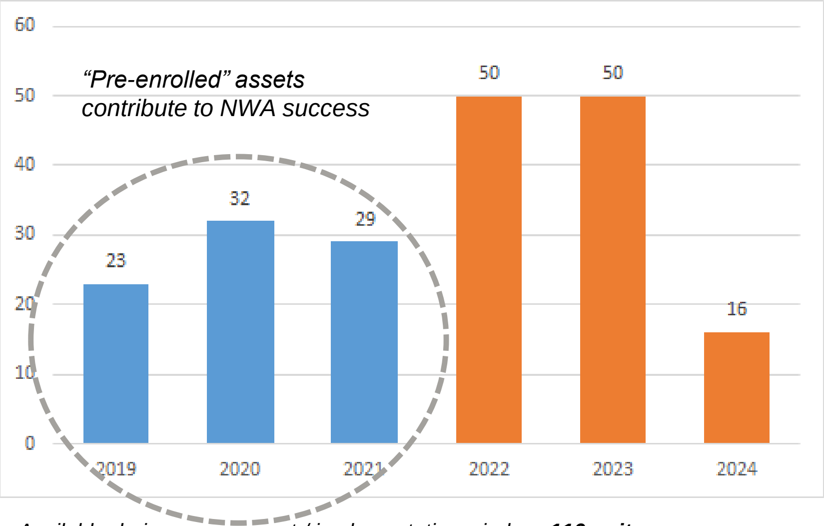
- Deployment of prospective resources for distribution capacity services is happening on an ongoing basis - act ahead of time with a programmatic approach with customer (pre-)enrollment to increase NWA success
- This simplifies marketing and customer education for mass market, avoiding “one pitch on one side of the street and a different pitch on the other side of the street”
- Can provide a framework to enable utility / developer collaboration for initial customer engagement and seamless, “evergreen” structure for customer engagement around ongoing distribution and other needs.

*For a hypothetical circuit, in 2021 a potential **1MW** overloading scenario is identified in the summer of 2024. This can be met by **200 homes** with storage delivering **5 kW** of battery discharge load over 3 hours.*

*If a 12-month procurement results in deployment starting in Q1 2022 - Q2 2024, **116 units** are deployed and the need is not addressed.*

*If an programmatic enrollment approach is initiated in 2019, an additional **84 units** are available for utilization for distribution capacity services. This reaches the threshold of **200 units** total.*

Illustrative Circuit - Residential Solar+Storage Deployment by Year



*Available during procurement / implementation window: **116 units***
*Available via programmatic approach + targeted density after need identified: **200 units***

To achieve success:

1. **Enroll / engage assets at point of sale as they are deployed**
   The time to engage assets for future distribution is as far in advance of grid needs as possible - i.e. now. Creating a structure that can layer on customer tariffs and around which DER customer value proposition can be built, enables context specific details to be filled in if / when needed. Point of sale is the time to establish this - not 1, 3, or 10 years later.

1. **Keep it simple and seamless for customers even as grid needs evolve.**
   Residential customers are open to sharing use of assets for grid and community benefit if they understand how they also benefit. Nothing kills this openness faster than complexity that customers struggle to understand. A simple customer value structure should be “evergreen” to accommodate sequential and stacked services.

1. **Coordinate for customer engagement & leverage aggregators to manage complexity.**
   Residential assets’ responses to distribution needs can be guaranteed, and the overlay with existing customer tariffs managed, by aggregators who enroll customers in programs and manage DERs. Doing so in partnership with the utility facilitates the targeted deployment sought.

2. **Work through existing customer relationships to deepen technology deployment.**
   Solar+storage is the beginning, not the end, of distribution services potential. Coordinate with aggregators to add technology (EV charging (G2V -> V2G), water heating, etc.) into this equation.

IGP SOFT LAUNCH

Best Practices for NWS RFPs and Contracting

March 26, 2019

Jason Prince
Rocky Mountain Institute

Summary of key findings

RFP design and processes are critical for success

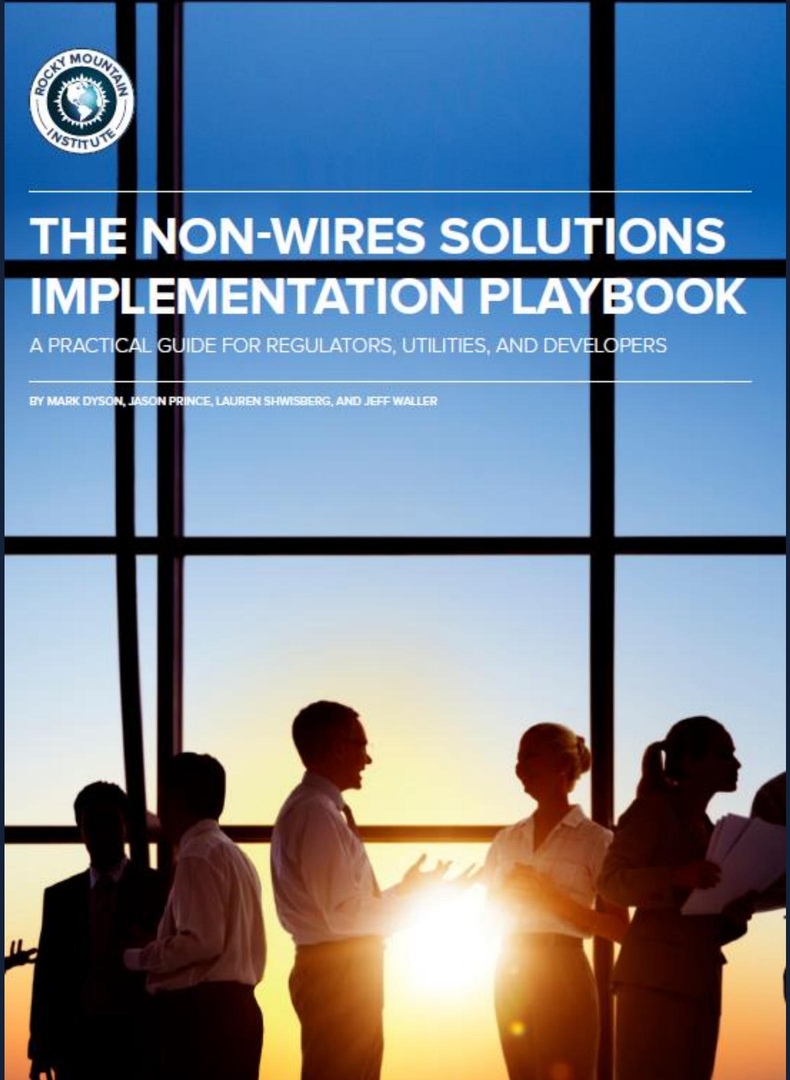
- RFPs should maximize technically acceptable, cost-effective bids
- Developer feedback can help prevent ‘garbage RFP out, garbage responses in’

Existing contract templates can be adapted for NWS

- Utilities have a long history contracting for third-party services
- Standard contract clauses should be adjusted to better suit the NWS context

RMI’s NWS Playbook provides procurement guidelines

- The Playbook contains best practices distilled from 65+ interviews
- It includes guidelines for RFP development and contracting considerations

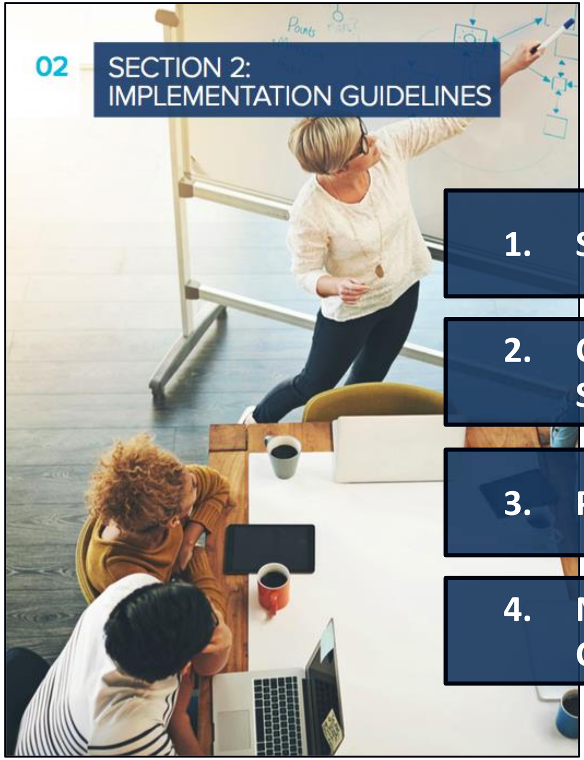


The Non-Wires Solutions Implementation Playbook

A practical guide for regulators, utilities, and developers

Playbook contains best practices and practical guidelines

1. Establish a supportive regulatory environment
2. Integrate NWS within standard utility operating procedures
3. Employ a holistic process for NWS procurement



1. Screening Criteria
2. Competitive Solicitation Processes
3. Proposal Evaluation
4. NWS Contracting Considerations

How to make a NWS RFP the best it can be?

RFP feedback loops can help animate the NWS marketplace

Process Enhancements

- Engage stakeholders before, during, and after RFP
- Consider the role that 3rd parties can play as solution integrators or procurement managers

Technical Approaches

- Provide data-rich needs descriptions
- Elaborate solution performance attributes
- Provide clear evaluation criteria
- Allow for participation in wholesale markets
- Include pro forma contracts

Received a compelling bid, now what?

Standardizing contract terms will help scale the NWS market

Category:	Key Risks:	Mitigation Strategies:
1. Dispatchability	• Control of assets • Limited account visibility	• **Pay-for-priority utilization rights** • **Maintain operational parameters**
2. Payment	• Fixed • Variable	• **Performance guarantees** • **Aligned incentives**
3. Performance	• Termination • Maintenance • Multiple Accounts	• **Metrics on rolling basis** • **Portfolio flexibility**
4. Construction	• Milestones • IE certification	• **Pay-for-delay** • **Representative designs**

Thank you!

Questions?

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