Deploying Energy Storage: Economics, Regulations and Technology

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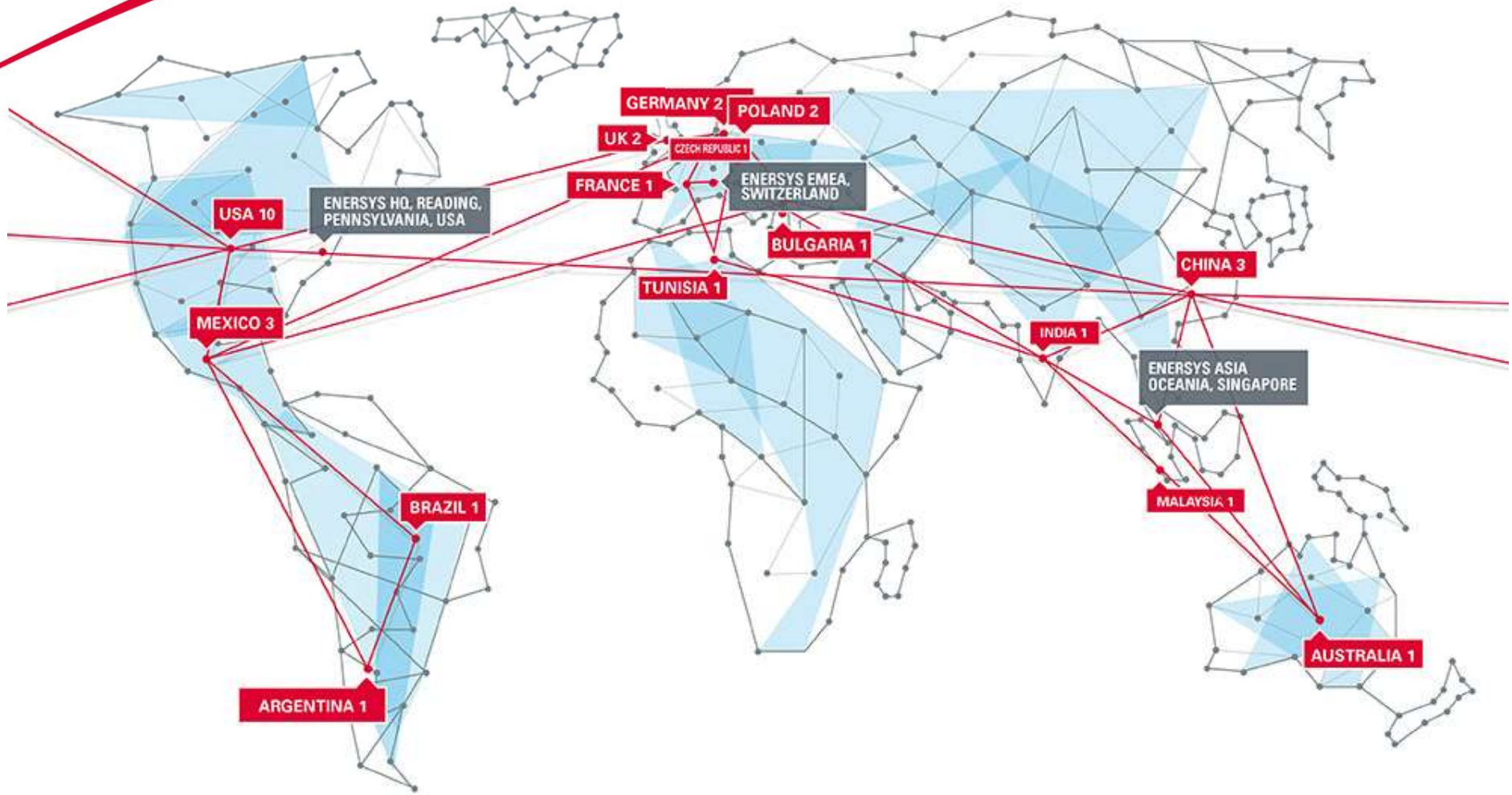
Deploying Energy Storage: Economics, Regulations and Technology

- EnerSys introduction
- Energy storage systems economics
- Energy storage system project example (economic analysis, system components and regulatory costs)


EnerSys
Power/Full Solutions
GLOBAL
LEADER
in stored energy solutions for industrial applications
motive power | reserve power | aerospace & defense


EnerSys
Power/Full Solutions
approximately
9,400
employees worldwide

EnerSys®
Power/Full Solutions



Motive Power – Electric Forklift Batteries

- Low maintenance battery
- Longer topping up intervals (4/8/13/20 weeks)

- More power, longer lifetime
- Ideal for very heavy duty applications
- Opportunity charges*

- TPPL (thin plate pure lead) technology
- Extra fast charges
- Opportunity charges*

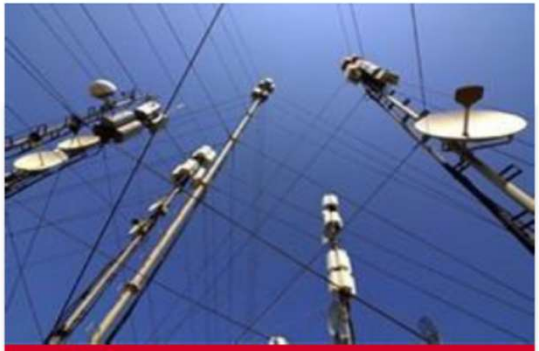
Reserve Power – Mission Critical Power on Standby

Industrial UPS*

- Oil & Gas
- Switchgear
- Distribution Substations
- Industrial Substations
- Process Industries
- Railways & Metros
- Air Transport

Standard UPS*

- Datacenters
- Power Quality
- IT Systems
- Banking & Finance
- Process Industries
- Healthcare



Telecom

EnerSys provides optimized solutions to reduce your energy consumption and promote the longest battery life.

*Uninterruptable power supply

Aerospace & Defense

Air: Civil and military aviation

- Lead-Acid & Ni-Cd technologies, OEM, MOD and aftermarket

Land: Storage and management

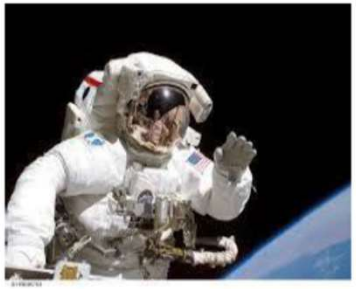
- Thin Plate Pure Lead (TPPL) technology and management systems
- OEM and replacement
- Dominant supplier

Sea: Submarine batteries

- Flooded Lead Acid, TPPL, OEM and replacement
- Next generation product development
- Dominant Supplier

Lithium Ion Applications

Space



Medical

Defense

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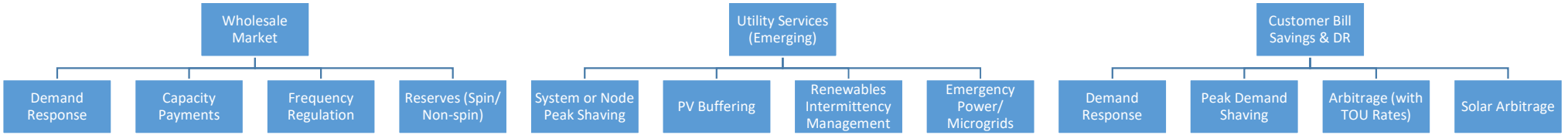
Energy Storage Revenue Streams



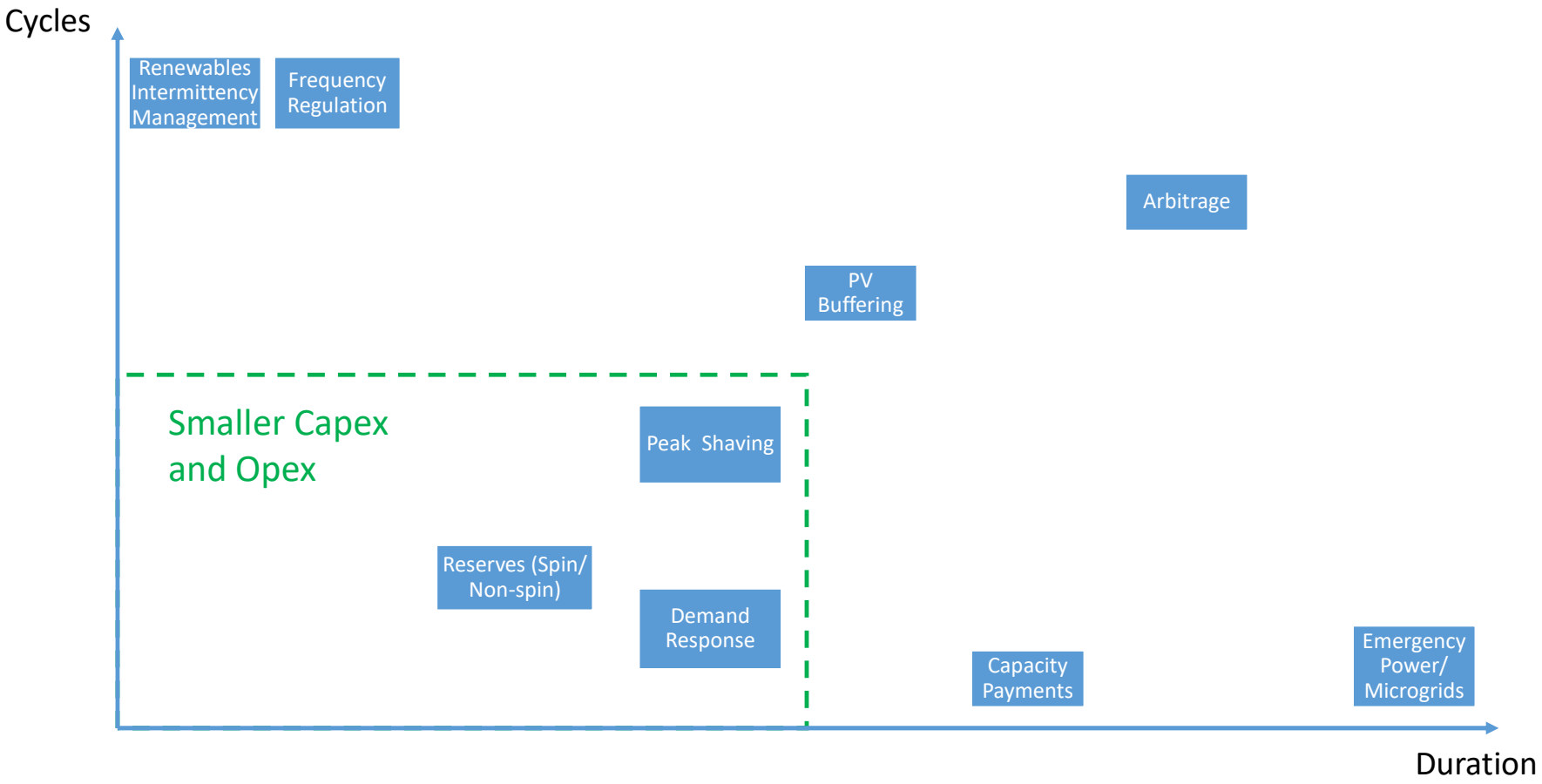
- Metering requirements
- Performance penalties
- Price fluctuations
- Market saturation
- Frequency regulation high cycles
- Minimum size requirements

- Subject to regulatory approval
- Minimum size requirements
- Metering requirements
- Cyber security requirements
- Renewables intermittency management high cycles

- Straightforward revenue stream
- Relatively stable electricity and solar tariffs
- Established demand response programs
- Demand response and peak shaving value stacking rarely conflict
- TOU* rates not common

*Time of use

Energy Storage Revenue Streams

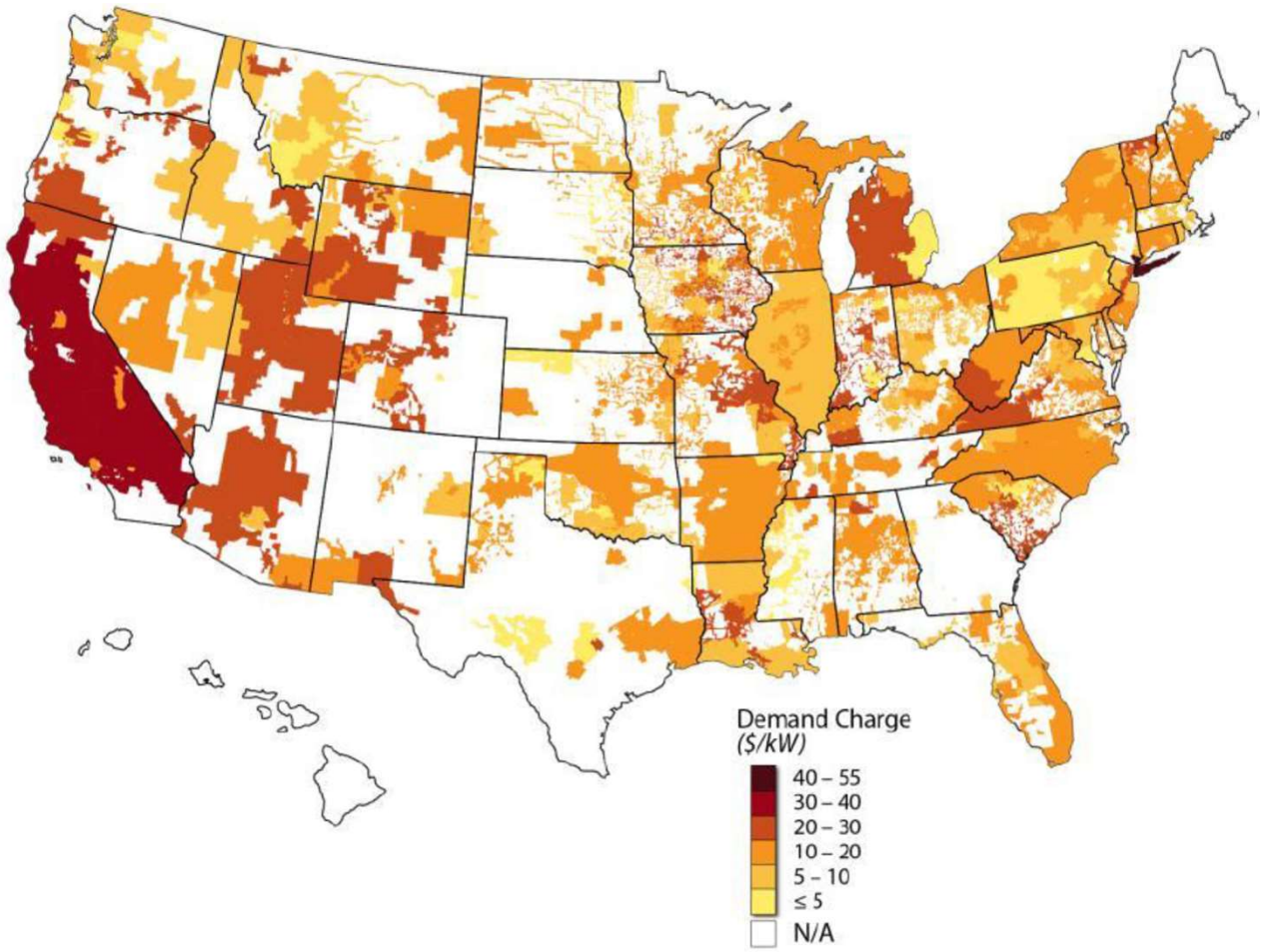


Energy Storage Project Economics

Key Factors

- Bill savings and/or grid service payment
- Utility incentives
- Tax incentives
- Tax impact
- Capital cost
- Commissioning cost
- O&M costs

Peak Demand Charges

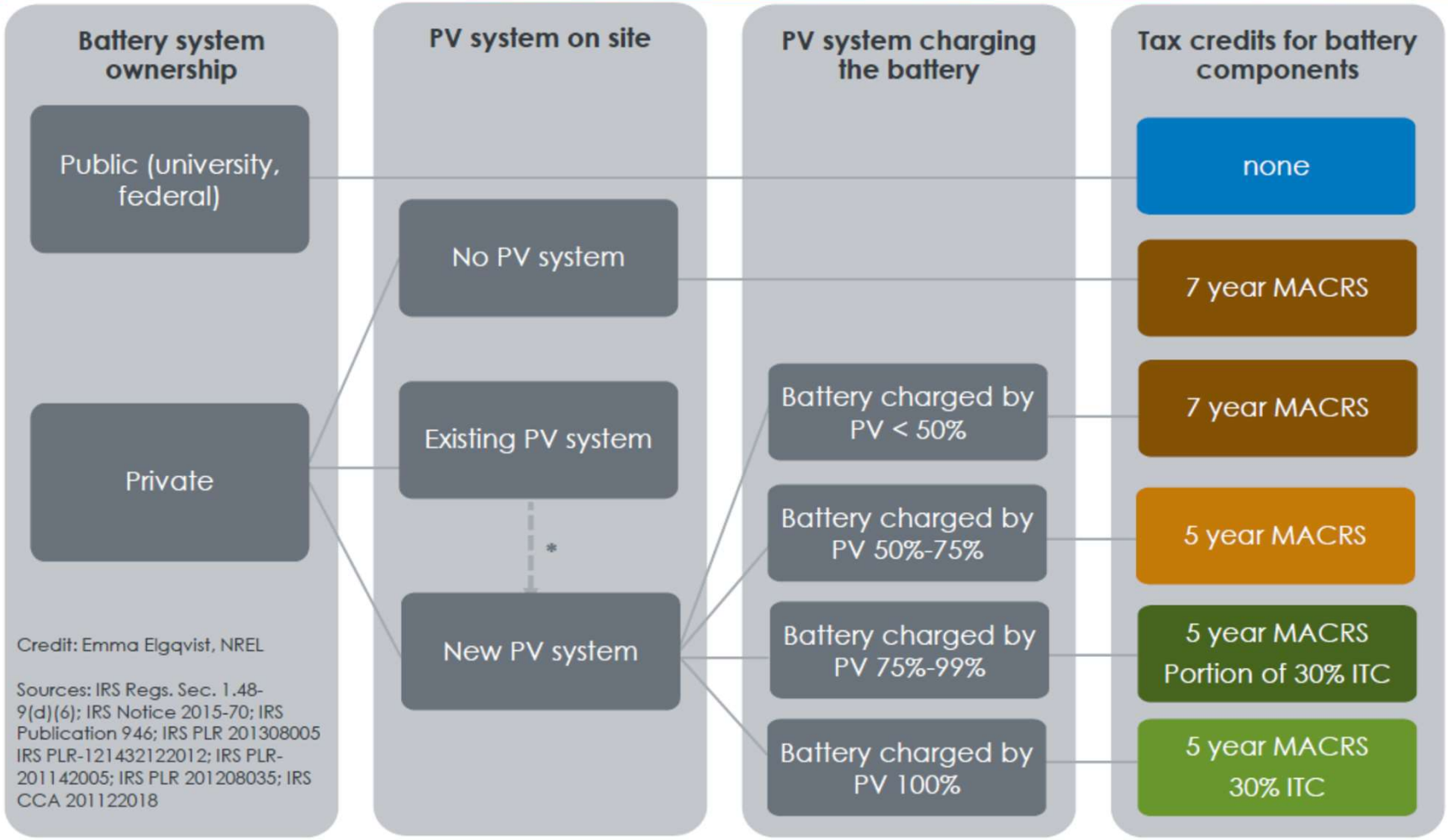


Source: Utility Rate Database, visualization by National Renewable Energy Laboratory (NREL)

Energy Storage Key Incentives

- Utility Capex incentives
  - ConEdison DMP ($1,350/kW)
  - SMUD $200/kW
- Solar associated benefits (ITC and 5-year bonus MACRS)
  - ITC 30% Capex credit if battery charged by solar only (pro-rated down to 75% of solar charging). Must remove utility incentive when calculating Capex for tax credit purposes. Reduced by 4% per year from 2020 until down to 10% in 2024
  - 5-year bonus MACRS allows accelerated up front depreciation benefits. New tax law increases depreciation in 1st year to 100% up from 50%

Energy Storage Solar Associated Tax Incentives



Source: National Renewable Energy Laboratory (NREL)

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ESS Project Example

- Large commercial campus in New York
- Existing solar installation
- Peak demand charges (~$25 for peak summer months, ~$11 for off peak months)
- NYISO demand response payments

NYISO SCR $/kW

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
$3.20	$1.86	$1.09	$0.95	$11.62	$10.75	$10.34	$10.13	$10.04	$9.85	$3.22	$3.13

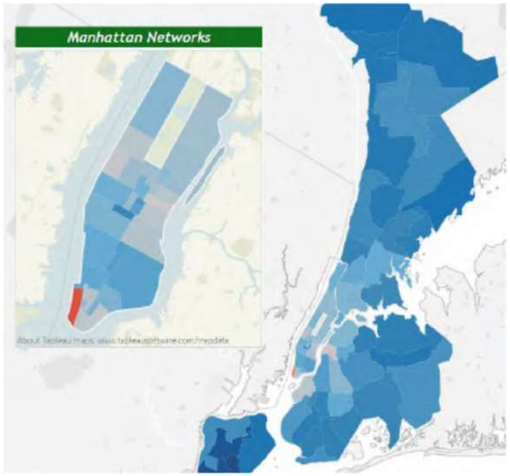
- ConEdison demand response payment ($6/kW monthly reservation fee, $0.5/kWh energy compensation payment during events)
- $1,350/kW utility incentive payment
- 30% solar ITC (assumes 100% solar charging)
- 5-year bonus MACRS depreciation schedule

	1	2	3	4	5	6	7	8
5-year MACRS	20.00%	32.00%	19.20%	11.50%	11.50%	5.80%	0.00%	0.00%
5-year Bonus MACRS	50.00%	20.00%	12.00%	7.19%	7.19%	3.63%	0.00%	0.00%
7-year MACRS	14.30%	24.50%	17.50%	12.50%	8.90%	8.90%	8.90%	4.50%

ConEdison Demand Response

Distribution Load Relief Program – 2 Hr Notification Program

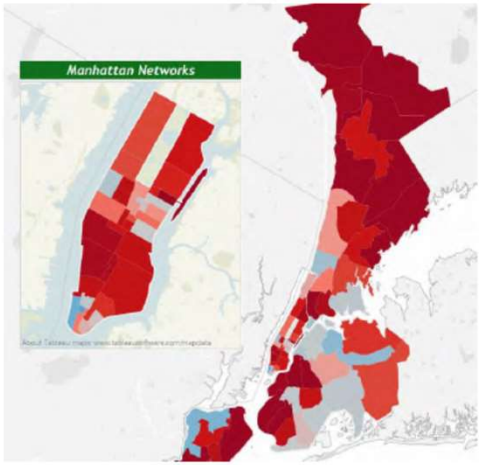
- Called on a network basis for contingencies



- Premium paid for 10 networks with higher need for demand response ("Tier 2" networks)

Commercial System Relief Program – 21 Hr Notification Program

- Called for network peak shaving



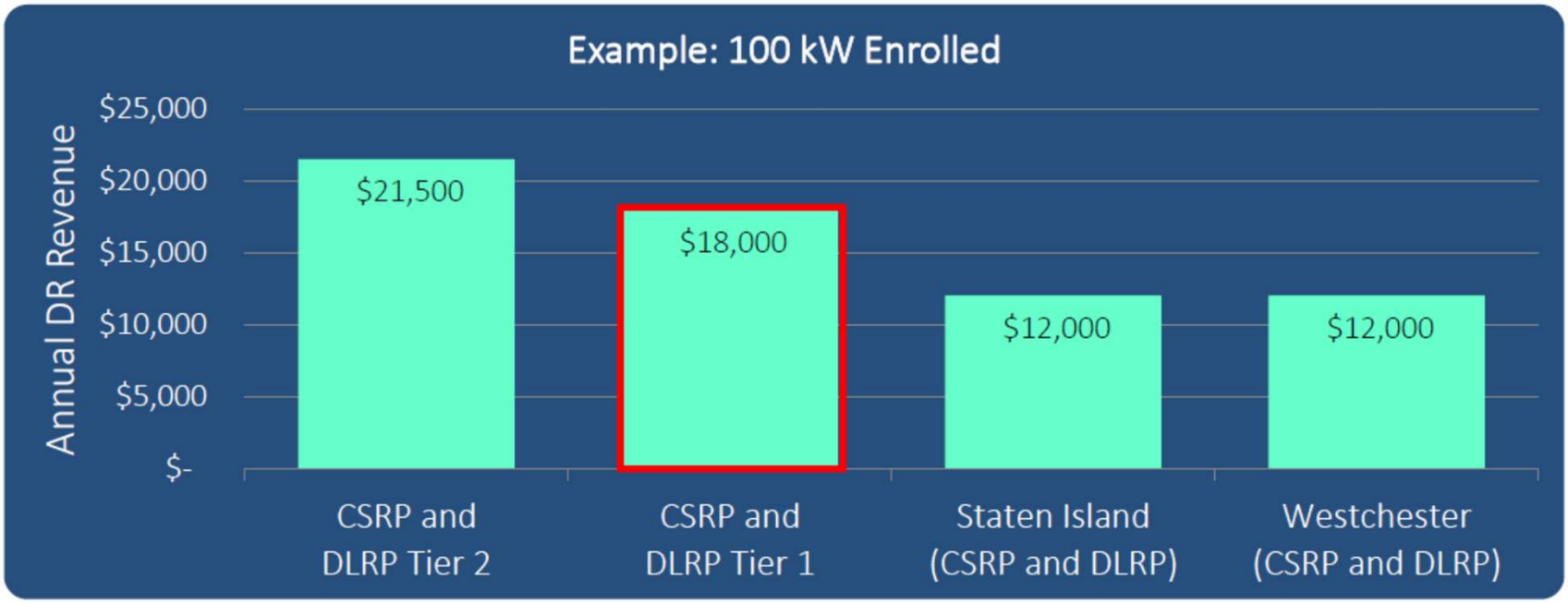
- 4 call windows to coincide with network peaks
- 3 events per year expected on average

Source: ConEdison Demand Response Forum

ConEdison Demand Response

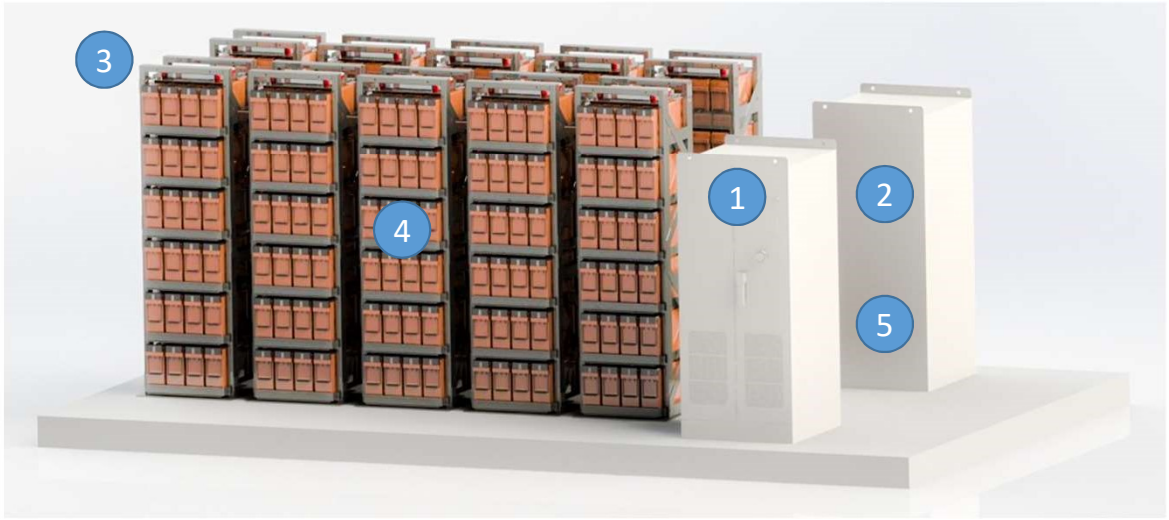
Reservation Rates ($/kW-month)	CSRP	CSRP in Westchester/ Staten Island	DLRP Tier 1	DLRP Tier 2
	$18	$6	$18	$25

Performance Rates ($/kWh)	All Reservation	Voluntary
	$1	$3



Source: ConEdison Demand Response Forum

ESS Project Example – ESS System Overview



1. Bi-directional PCS (air-cooled)
2. Energy Storage Controller
3. Energy Storage Indoor Racking
4. EnerSys VRLA TPPL Batteries (designed for extended cycle life)
5. Battery Monitoring System for Block Measurements & Functional Safety

System Specifications

- TPPL VRLA batteries
- 50-250 kW
- 50kWh modular blocks
- 480 VDC nominal
- 480 VAC nominal
- ESS controller to manage charge and discharge profile, peak shaving and operation modes
- SOC estimation, capacity and remaining charge time and energy forecasting based on load and solar forecasts
- Optimal peak shaving and mission profile analysis tool
- Data storage, trending and analysis. Cloud connectivity

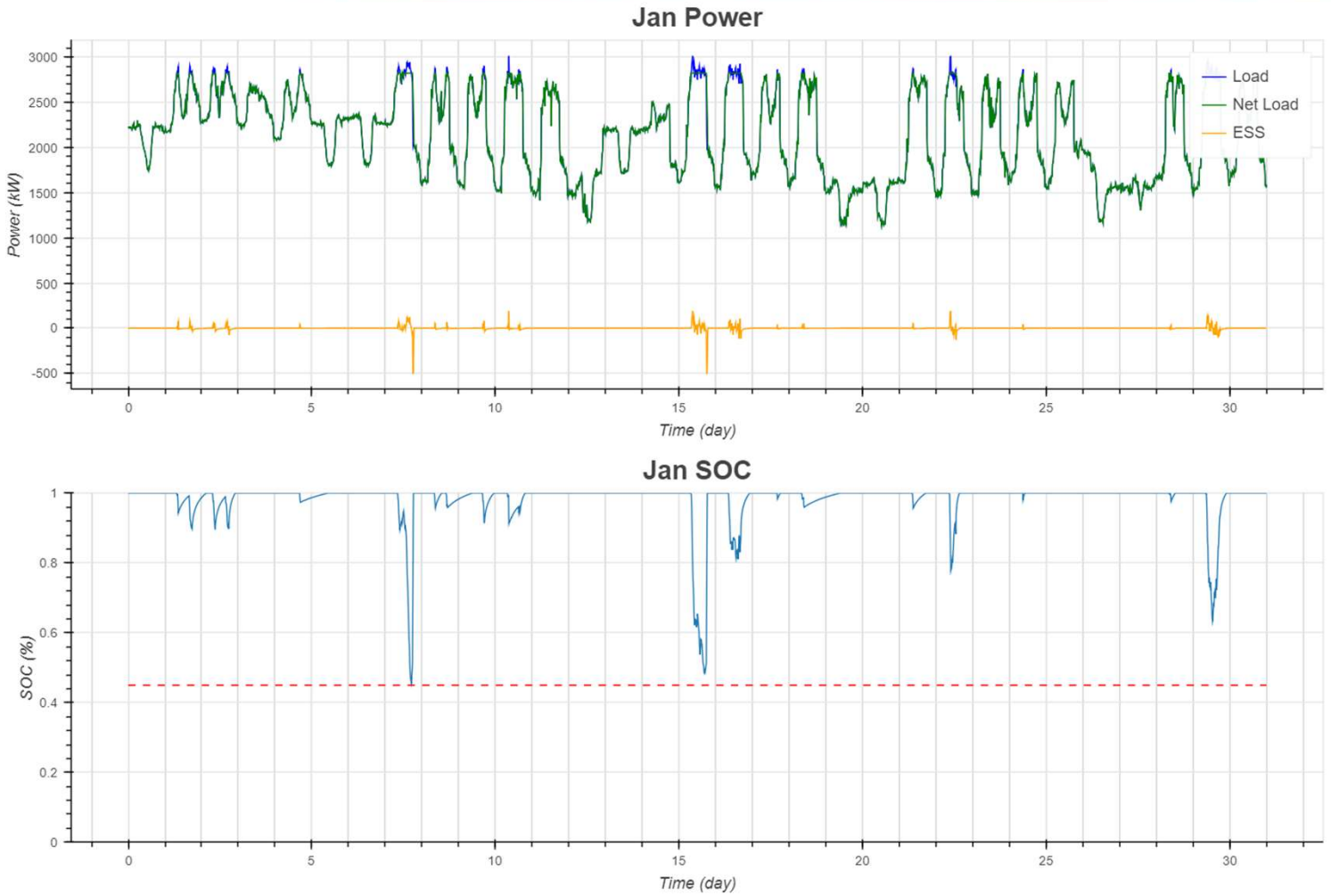
ESS Project Example – ESS System Overview

ESS Project Example – Regulatory Cost Considerations

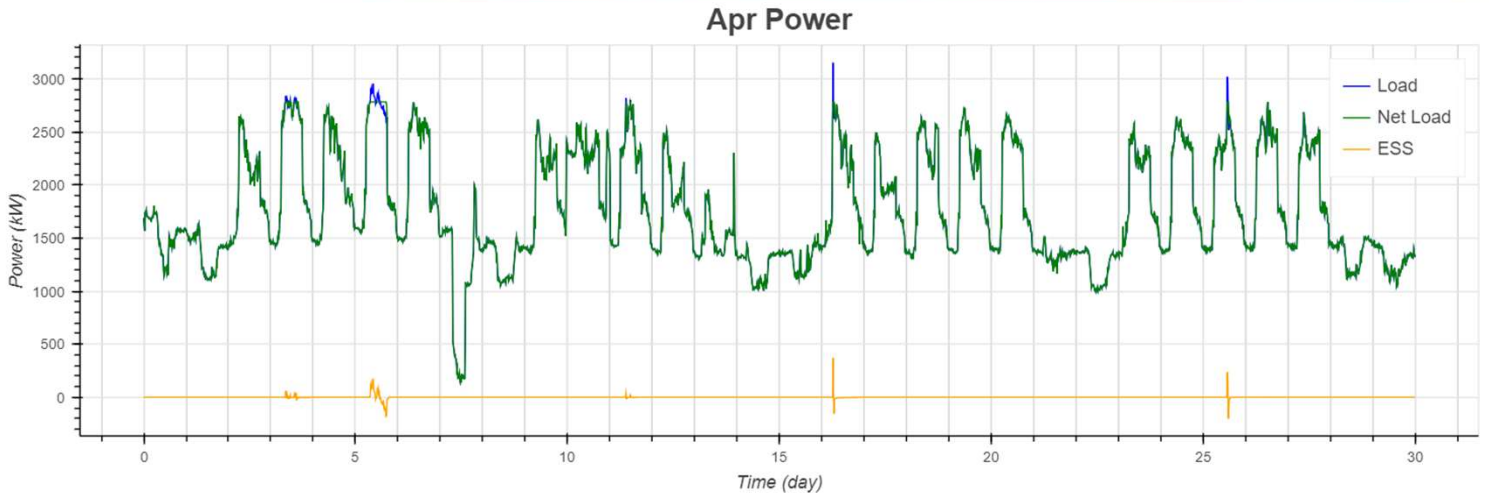
Category	Outdoor Lithium	Indoor VRLA	Impact
Footprint restrictions	Individual containers may not exceed 53’ x 8.6’ x 9.6’	Any installations over 600 kWh must have fire barrier between them	Installation size restrictions
Distance restrictions	Minimum of 10' from: Lot lines, public ways, buildings (and air intakes or openings such as doors and windows), stored combustible material, hazardous material, high piled stock, other exposure hazards, means of egress, and required exits unless AHJ approves line of protection or UL 9540A demonstrates this limit is not required for safety	Shall be at least 10 feet away from any flammable or combustible material	Limitations on which buildings can install an ESS
Rooftop restrictions	1-Installation and building must comply with NYC fire code 504.4 requirements on distance from frontage space of the building, access signs and markings, rooftop access landings, rooftop clear path, rooftop clear path protection, rooftop clearances and rooftop conduits and piping 2-Rooftop material under system must be noncombustible, extending at least 5 ft. from system perimeter 3-If installed on dunnage, dunnage must have a fire rating of 1 hour rating for medium size systems and 2 hour rating for large size systems	N/A	1-Installation size restrictions 2-Limitations on which buildings can install an ESS
System encasement specification	Enclosure must be made out of non-combustible material	Room must have fire barrier around enclosure	System cost
Fire protection system	Specified based on UL9540A testing. If rooftop installation and water-based system required, drawing of sprinkler system, with FDNY access to Fire Department Connection serving system at grade level shall be provided	If already existing in the room and deemed sufficient by FDNY, no additional requirements	System cost
Monitoring and alarms	If dedicated system for fire supression is installed, a central station connection shall be required	If relying on room smoke alarms and fire supression, no additional requirements aside from hydrogen alarms	System cost
Rooftop structural analysis	Analysis demonstrating rooftop is structurally capable of handling all anticipated loads.	N/A	Project cost
Sealing requirements	N/A	Duct, wall and floor penetrations in close proximity to ESS shall be sealed to prevent fire or smoke spread	Project cost

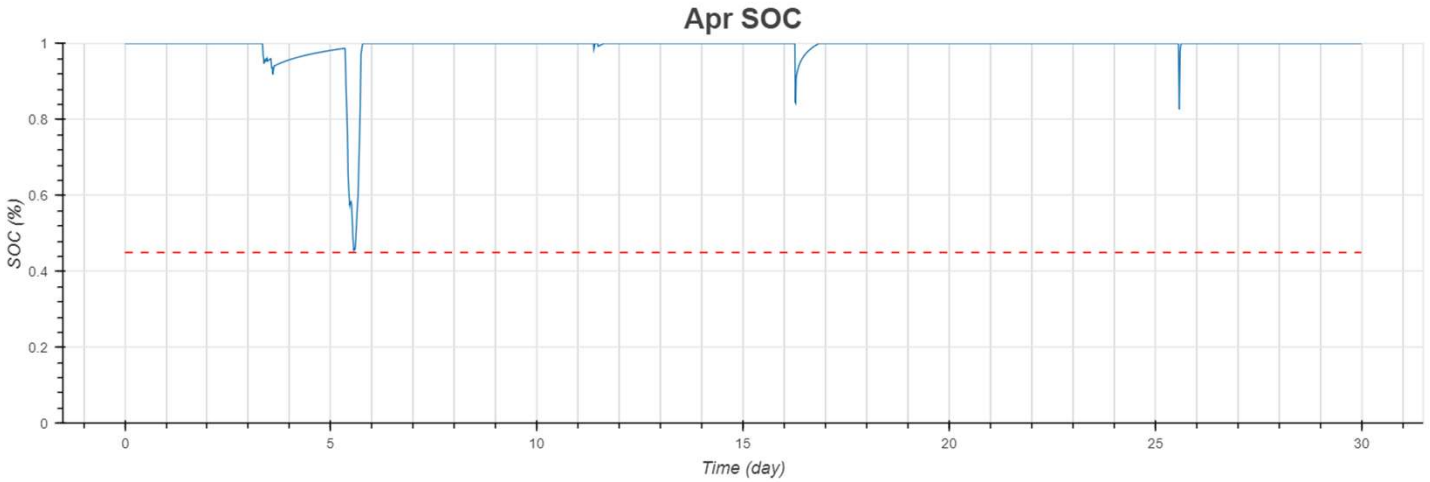
Additionally, all systems must comply with UL 1973 and 9540 and provide fire test data in accordance with UL9540A

Estimating Peak Shaving Savings - 250kW/600kWh ESS

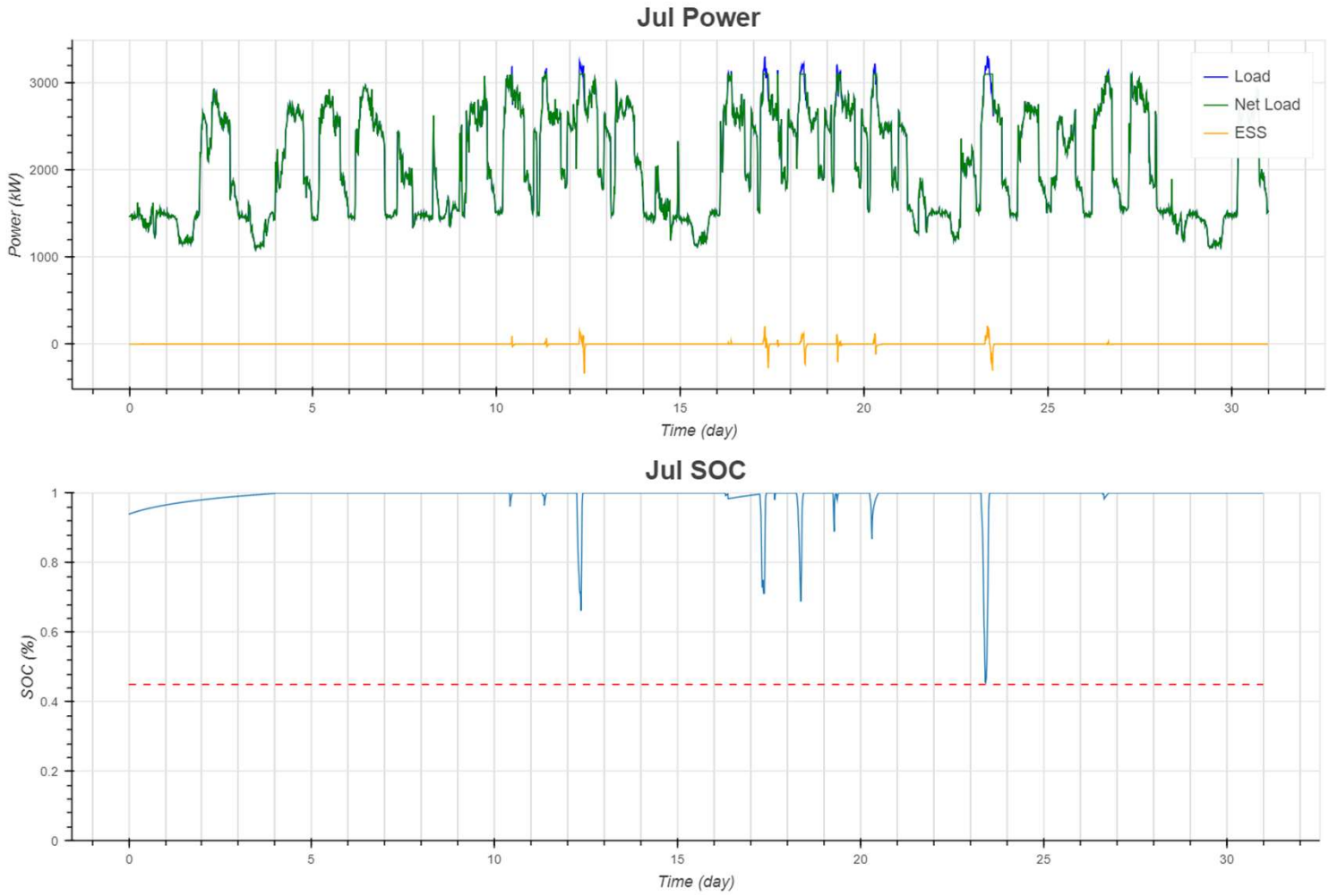


Peak Shaving April – 250kW/600kWh ESS

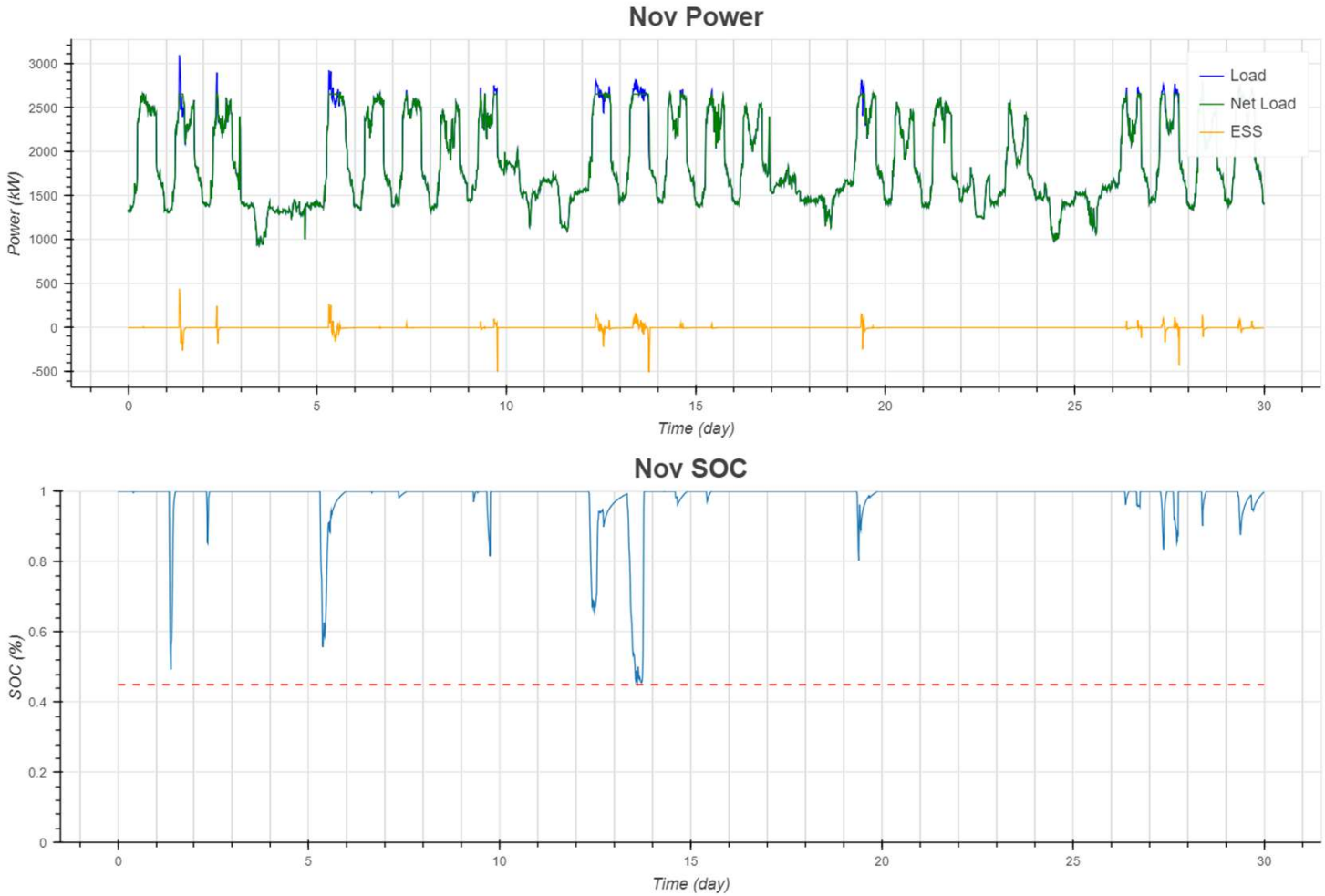




Peak Shaving July – 250kW/600kWh ESS

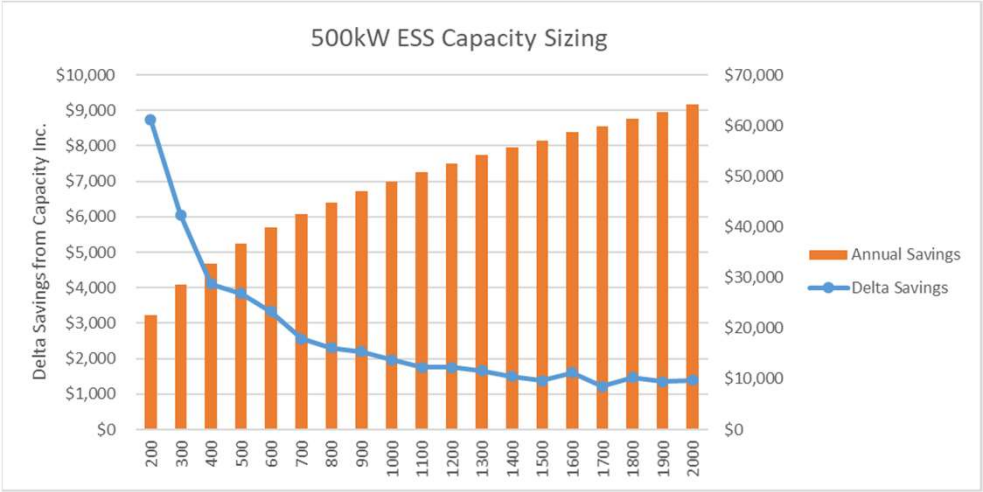


Peak Shaving November – 250kW/600kWh ESS



Peak Shaving Analysis

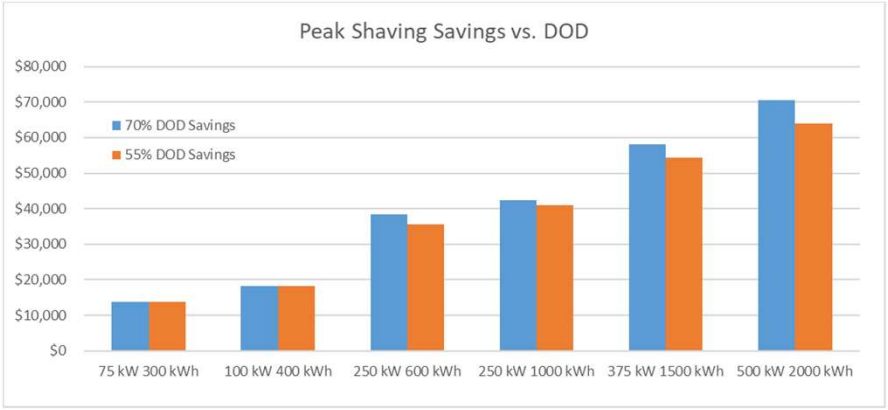
- Low usage application due to the nature of the load profile (low load on weekends, statistically significantly higher load on one or two days a week, relatively low load factor)
- For peak shaving alone, incremental savings begin to diminish at ~500 kWh
- Larger than 500 kW inverter does not result in additional value

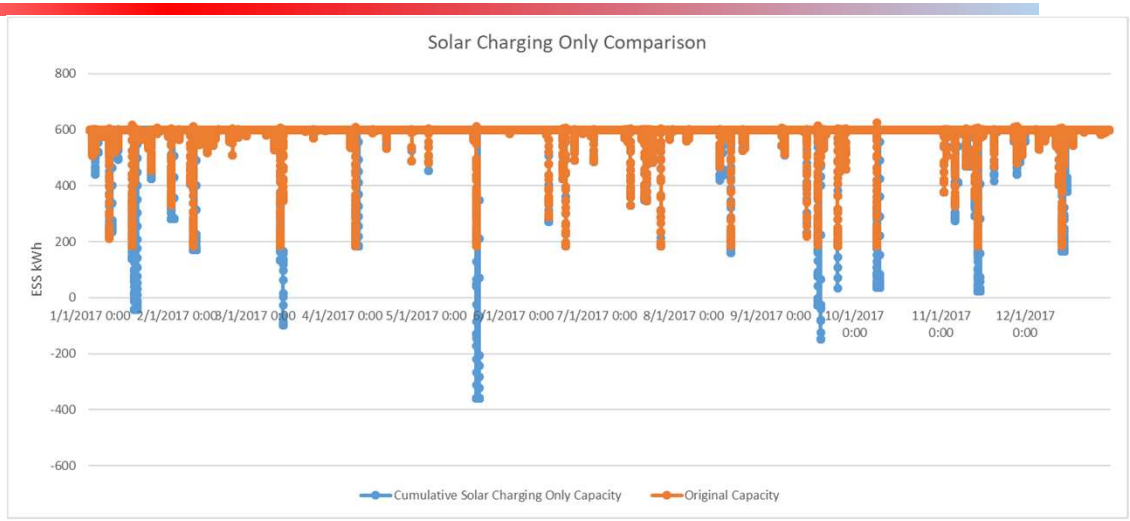


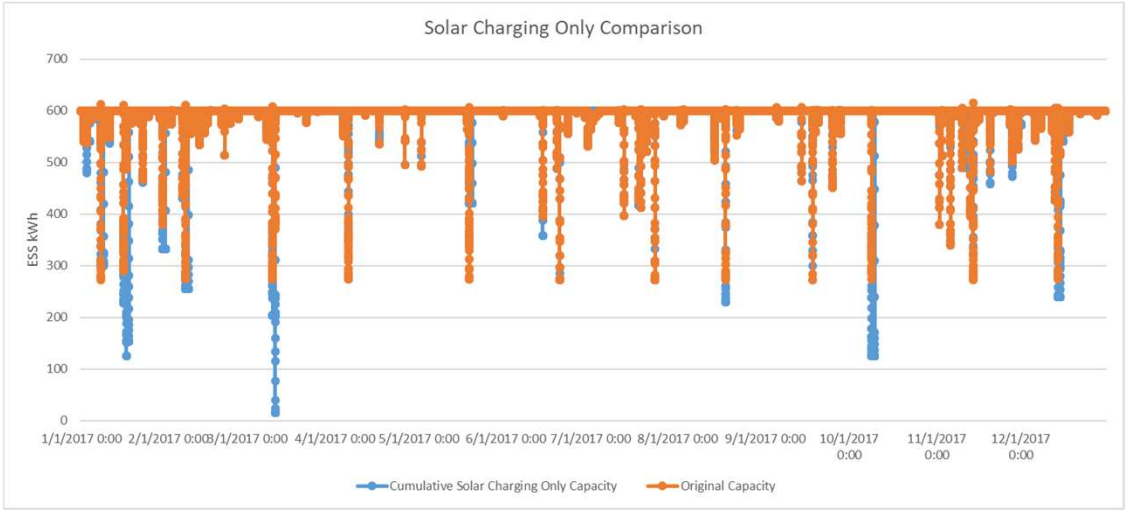
Peak Shaving Depth of Discharge & Solar ITC Verification

Discussion Points

- Deeper discharge results in lower cycle life
- Savings begin to make an impact at ~600 kWh and/or 500 kW
- For 600 kWh and below systems, 70% DOD would impact ability to fully claim solar ITC







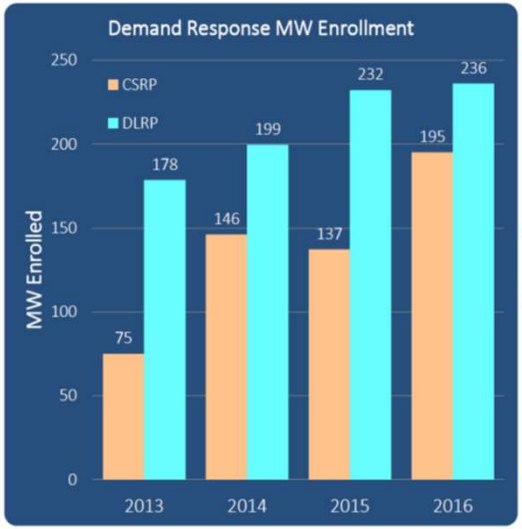
Example Project Pro-forma Results

Assuming Solar Enables ITC & 5-year bonus MACRs

Assuming no ITC and 7-year MACRs

- Curve driven by fixed costs (inverter and commissioning/site prep). Jump in costs over 500 kW (requires two inverters + additional installation costs) and 1 MW (requires three inverters + additional installation costs
- Solar associated tax benefits significantly improve project economics though higher demand charge savings can compensate for solar savings

Other Discussion Points – Value Stacking



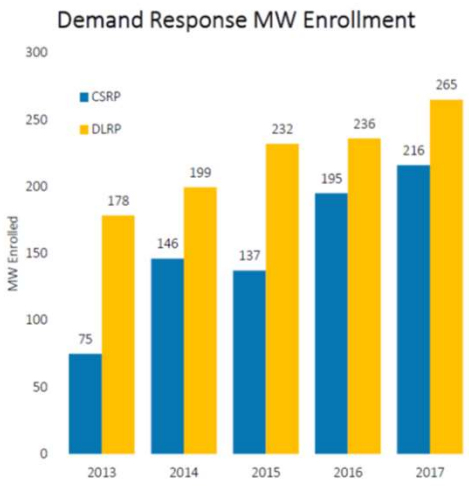
DLRP

- 2% increase in MW enrollment over 2015
- 48% increase in operationally available MW over 2015
- 27 events* across 8 networks
  - *Does not include test event

CSRP

- 43% increase in MW enrollment over 2015
- 19% increase in operationally available MW over 2015
- 4 events*
  - *No test, 11am-3pm not called on 8/12

2016 ConEdison DR Summary**



- CSRP
- 11% increase in MW enrolled since 2016
- 0 events called

- DLRP
- 12% increase in MW enrolled since 2016
- 6 events across 2 networks

2017 ConEdison DR Summary**

Peak shaving and demand response value stacking very possible without too much concern about loss of peak shaving revenue due to battery capacity loss for demand response discharge due to scarcity of DR events and tests*

* Only two test CSRP events per zone in 2017 for one hour duration

** Source: ConEdison Demand Response Forum

Other Discussion Points - Role of Technology in Improving ESS Economics

- Alternative lithium ion materials with the same or improved power density (overcome supply scarcity) at lower cost
- Improve cell and module inherent fire safety to reduce regulatory imposed safety system costs
- Enhanced accurate storage capacity and performance forecasting to assist with accurate value stacking prediction for increased confidence in project economics
- Enhanced performance and cycle life tolerance in higher temperature

Thank You – Questions?

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