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Energy Storage Market Current State and Trends

Ed Toppi, Vice President – Integrated Solutions

December 1, 2016

Agenda

- Overview of CES
- Where are we now?
  - Applications and growth projections
  - Where is the market participation by energy storage
  - Selected case studies of actual deployments
- Barriers to increased deployment
- Policy developments, initiatives, and other market trends
  - FERC – ***Recent NOPR in AD16-20 is a game changer!***
  - Regional market activity
  - Other market trends

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Customized Energy Solutions Company Overview

- **Customized Energy Solutions is at the forefront of competitive energy markets. Through consulting services and financial analysis, we enable competitive suppliers, technology providers, marketers, and utilities to prosper through change.**

- Founded in 1998
- Self-Funded Corporation
- Main Office: Philadelphia, PA with Regional Offices in CA, IN, NY, TX, VA, International Offices in Canada and India
- 100+ staff with diverse educations and experience in regulatory, transmission, generation, risk management, trading, consulting, demand side, load serving, operations and planning.
- We have won several awards over the past few years : The Inc. 500, Philadelphia 100 Hall of Fame, Brad Roberts Award for contributions to Energy Storage industry.

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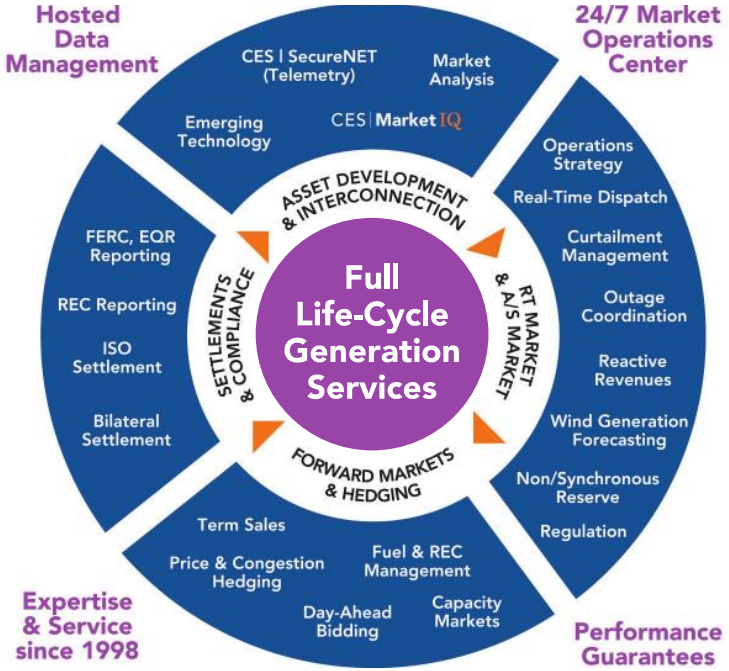
Since 1998, in every deregulated market, senior staff with real-world business experience….

RETAIL SERVICES

Enabling power and gas retailers' growth and profitability with end-to-end solutions through our state-of-the-art hosted software and service platform, CES | **BLUE**.

GENERATION SERVICES

Supporting the market entry and optimal operations of power generation with comprehensive hosted software and service solutions through CES | **GOLD**.



215.875.9440 / info@ces-ltd.com / www.ces-ltd.com

Analyze · Simplify · Implement

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CES Service Offerings

Consulting

- Feasibility Analysis
- Competitive Assessment
- Interconnection Studies
- Financial Analysis
- StorageIQ : Market Insights
- Project Finance Advisory

Data Acquisition & Scheduling

- Real-time Communication through SecureNet-RT
- UI Management
- Real-time Monitoring for energy and ancillary services
- Web-based reporting

Scheduling and Operations

- Registration / Accreditation
- Portfolio Management
- Bidding Strategies
- SOC management
- Settlements

CES assists clients from concept to market implementation

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Integrating Energy Storage Into Energy Markets

- CES Schedules Energy Storage Resources into the RTOs
  - 20 MW flywheel facility in NYISO: 3 years
  - 4 MW battery facility in PJM: 1 Year
  - 2 MW battery facility in PJM 1 Year
  - 4 MW battery facility in IESO 4 months
  - 2x 20 MWs Batteries in PJM – 8 months
  - 6 MW battery facility in PJM – 5 months
  - 20 MW battery in PJM – 4 months
  - 2 MW battery in ISO-NE – coming on line
- CES also provides telemetry to ~25 MWs of Telemetry for both in front and behind the meter storage resources in PJM

Also previously scheduled: 32 MW battery facility in PJM: 2 years and 8 MW battery facility in NYISO: 1.5 years

We offer bidding strategies, state of charge management, scheduling, and dispatch.

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Comprehensive Emerging Technology Services

- Markets & Regulatory
  - US Market Report on Storage
  - ISO/RTO storage activity reporting
- Modeling and Consulting
  - Price forecasts
  - Economic analysis and valuation
  - Optimization of product configuration
- Financial Advisory
  - Help secure funding
- Project Development
  - Site selection, interconnection
- Market Operations
  - Wholesale, DR, and Telemetry

Customized assists clients from concept to market implementation

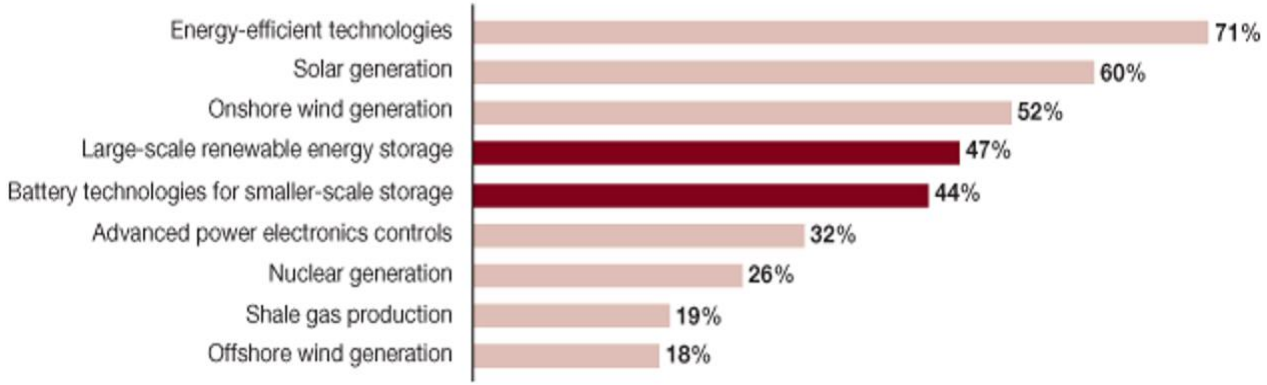
Where Are We Now?

- Energy Storage market is “growing by leaps and bounds” *
  - Opportunities for energy storage development are quickly opening across the country—and around the world
  - Projection estimates are being revised [upwards] every quarter
- Deployment of energy storage grew by > 250% in 2015
- 2016 on pace to be another record setting year
- More than 2 gigawatts of new energy storage announced in 2016 alone

❖ Interview with Matt Roberts, Executive Director, ESA

Energy storage technologies are expected to play a central role in the power industry.

Which of the following technologies do you expect to have the biggest impact on your “home market” by 2030?



Rated from 1–10, where 1 = no impact, 10 = very high impact. Scores 7–10 reported.
Source: 14th PwC Global Power & Utilities Survey

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Energy Storage Deployment

Energy storage deployments are forecast to grow tremendously in the next 4 years

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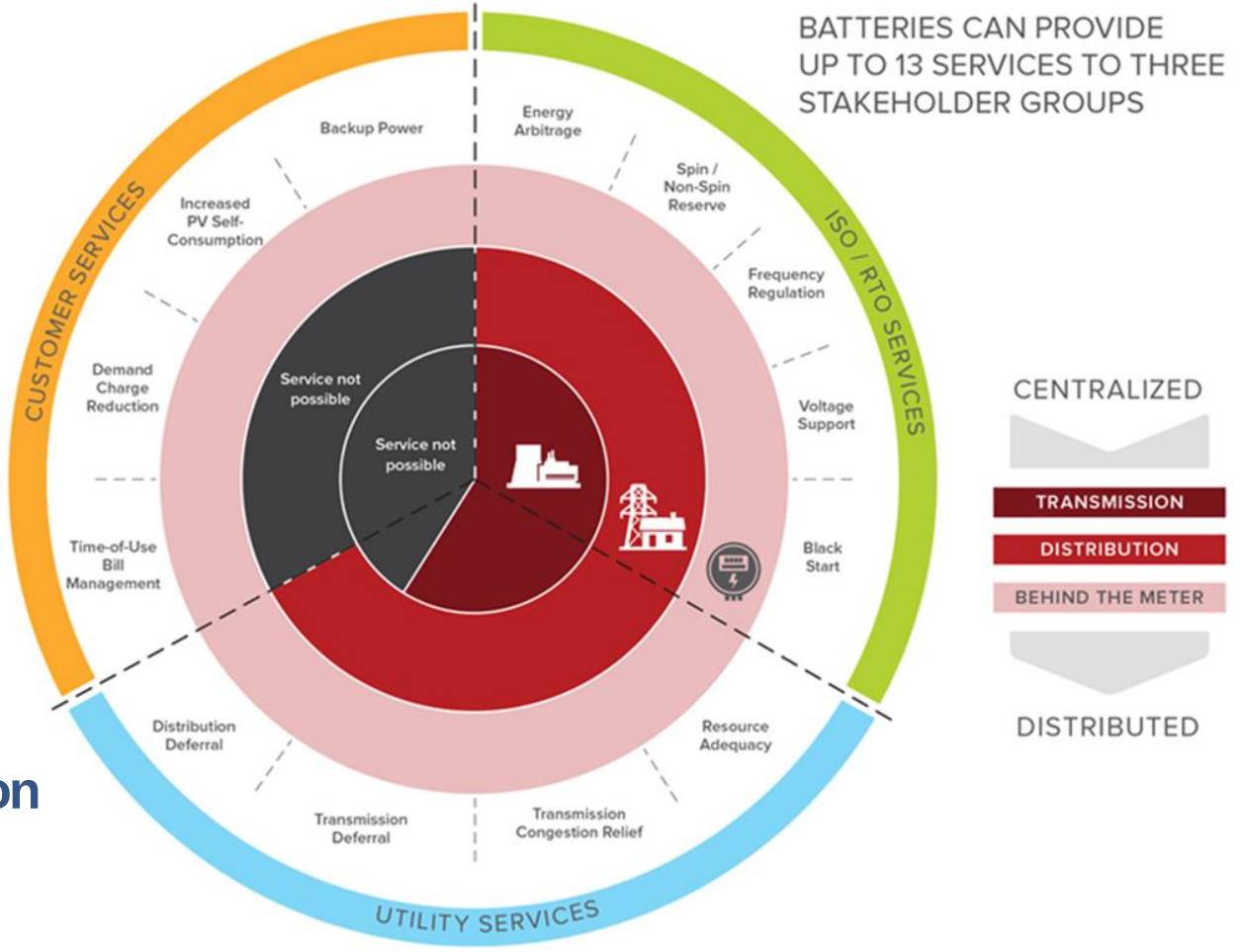
Drivers For Energy Storage

- Distribution system needs
- Renewables integration
- Reliability and resiliency
- Decreasing emissions
- Retail Bill Management
  - ✓ Energy arbitrage
  - ✓ Demand management
- Demand response participation



Source: http://www.rmi.org/electricity_battery_value

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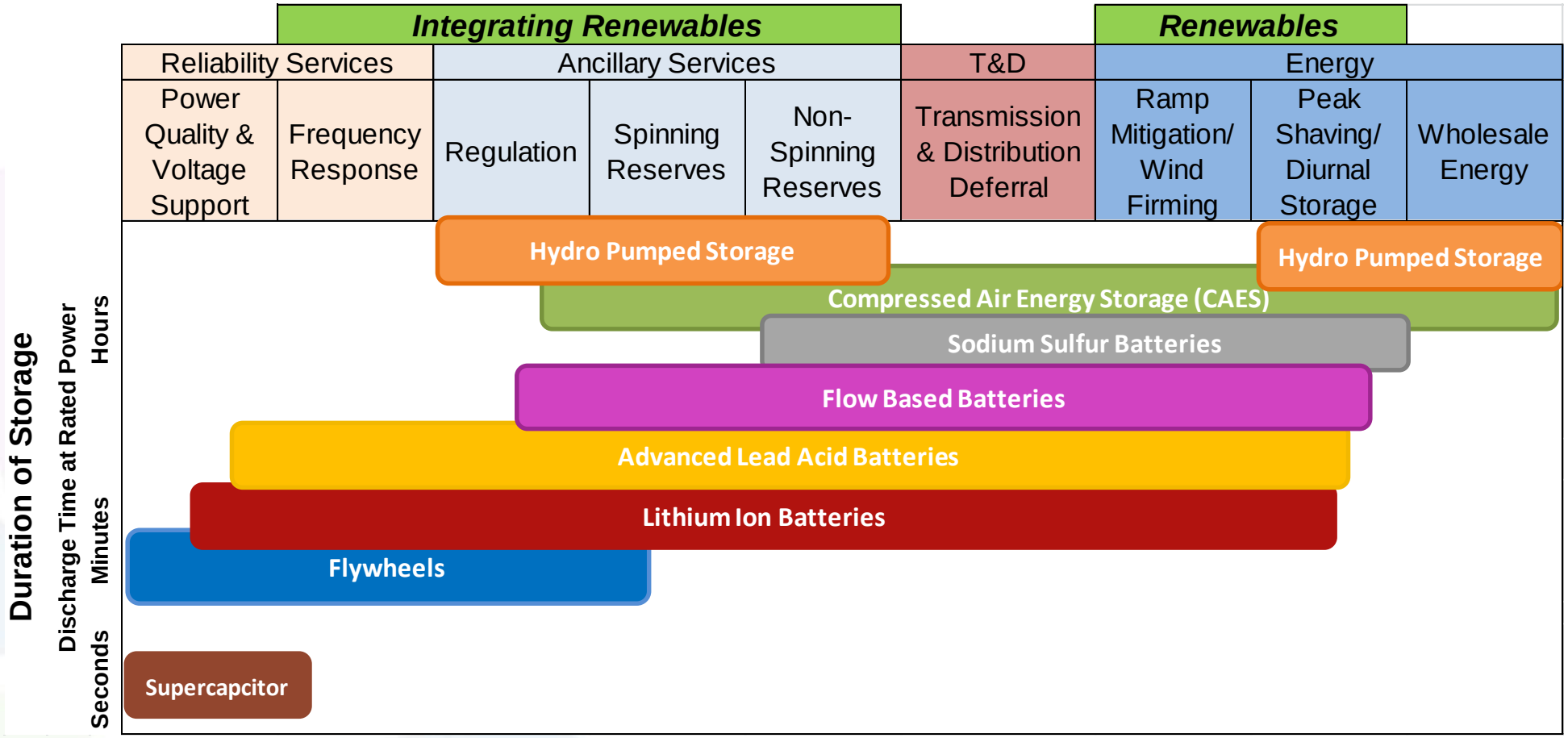
Mapping Storage Technologies



Of the advanced storage technologies, Lithium Ion Batteries have highest market share (33%) followed by Advanced Lead Acid (23%)

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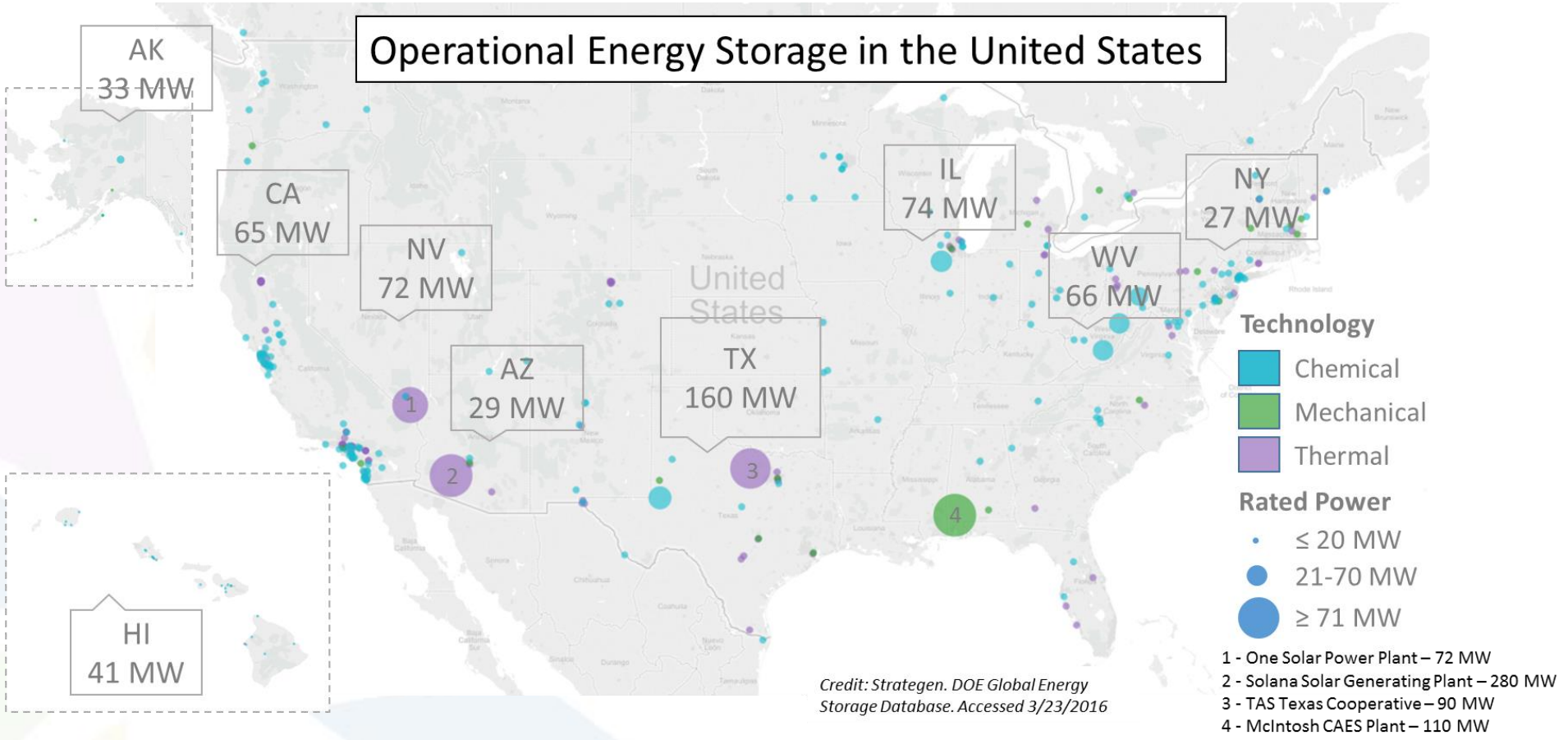
Storage Deployment



Energy storage has moved out of the research and development phase.
It is commercially viable and there are over **500 MW** operating throughout the US.

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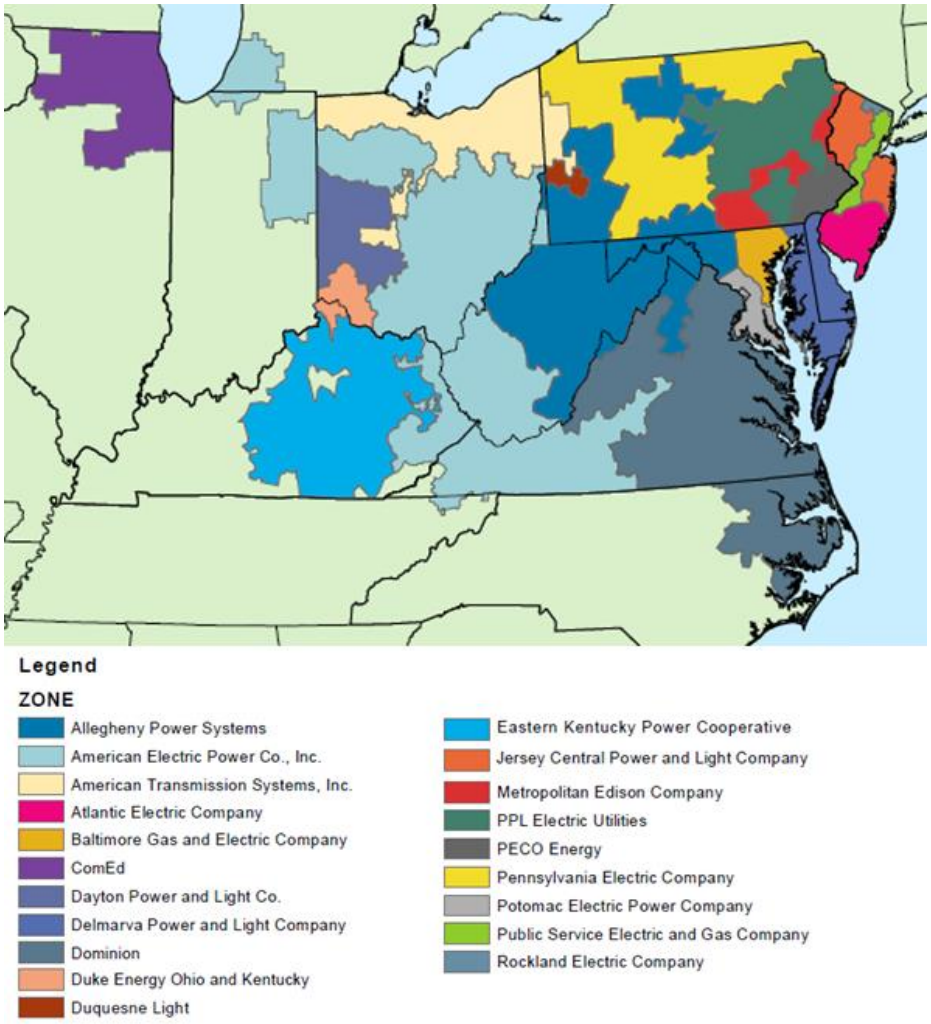
PJM ISO Region

- PJM ISO has seen high level of grid connected storage
  - ✓ First major advanced storage market in U.S.
  - ✓ “Land rush” to capitalize on “pay for performance” regulation market
  - ✓ ~300MW of advanced storage deployed
- Regulation prices have dropped as market has matured
  - ✓ $40/MWh in 2015 to $18/MWh
  - ✓ Market changes underway



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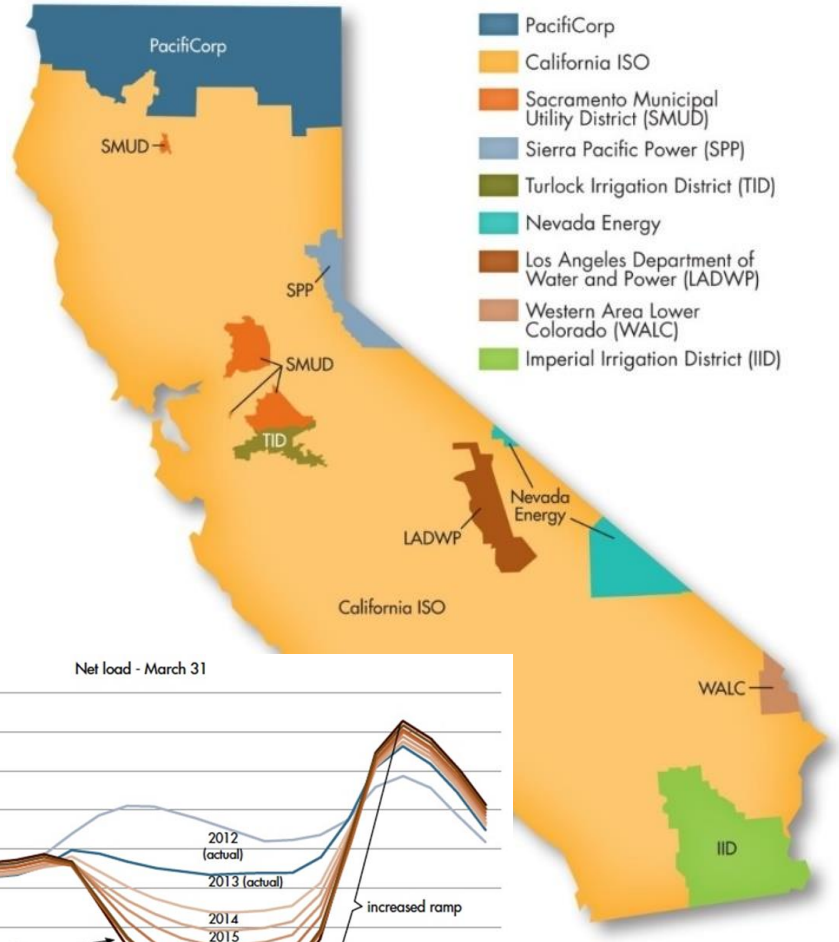
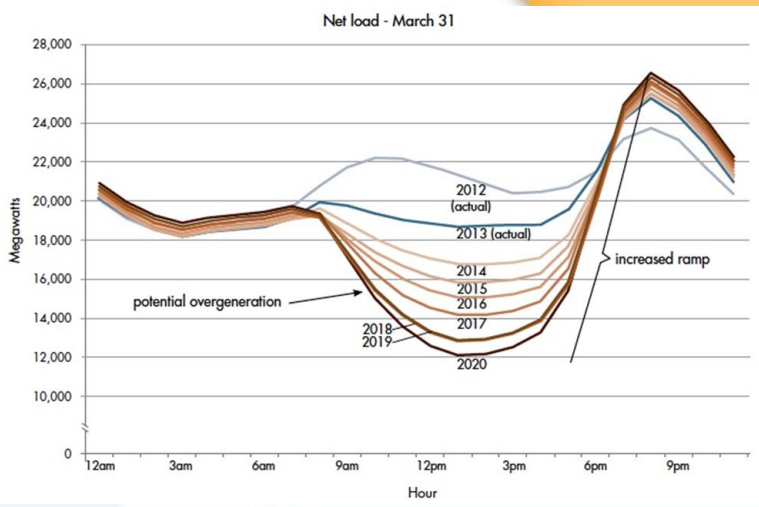
California

- California leading the way in broad ranging storage integration
  - ✓ 1.3 GW storage by 2020
  - ✓ Utility Distribution Resource Planning
  - ✓ SGIP and DRAM programs
- CAISO addressing pending issues
  - ✓ Ramping issues … “Duck Curve”
  - ✓ New market resource class… Non-Generator Resource (NGR)
  - ✓ New market participant class…Distributed Energy Resource Provider (DERP)





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California

- Utility procurement
  - ✓ As part of Long Term Procurement of Local Capacity
  - ✓ Preferred Resource Programs
  - ✓ To meet mandate targets
- Initial procurements proved successful
  - ✓ SCE procured 5X more storage than target in Local Capacity procurement
  - ✓ PGE received over 5,000MW of offers for 74MW of requested storage
- Thousands of MW of storage in the queue

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California

- Demand Response Auction Mechanism
  - ✓ Demand Response as Resource Adequacy
  - ✓ Behind the Meter storage enables participation
  - ✓ Enhanced value proposition of BTM storage
- Self Generation Incentive Program
  - ✓ Monetary incentive for installing distributed BTM generation
  - ✓ Energy storage systems qualify for incentive

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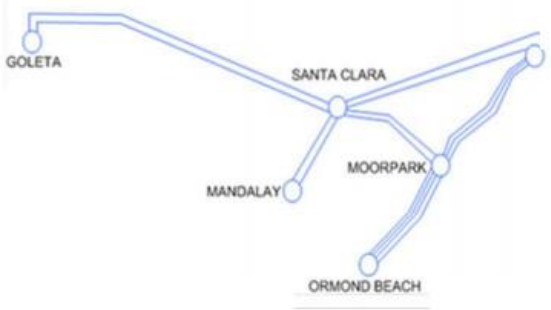
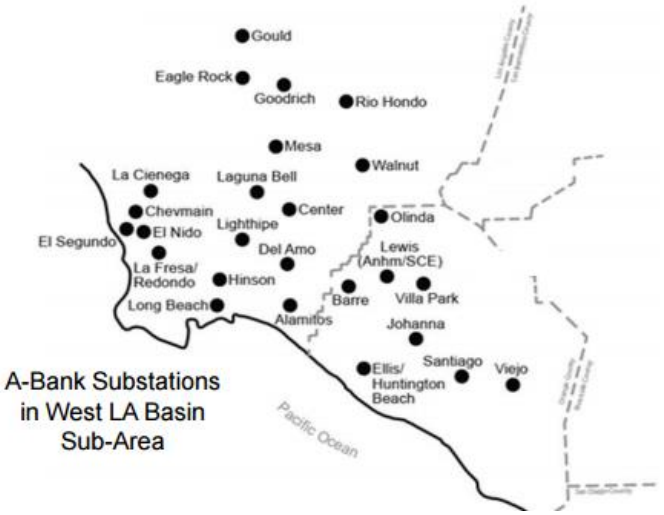
SCE Local Capacity Requirement

Problem Statement

Closure of the 2,200 MW San Onofre Nuclear Generating Station (SONGS) will greatly strain the system providing power to the region. Between 2020 and 2024, the loss of SONGS and expected growth of load in the region would create transmission constraints necessitating new supply resources to be built and associated transmission to support them.



A-Bank Substations in Moorpark Sub-Area



A-Bank Substations in West LA Basin Sub-Area

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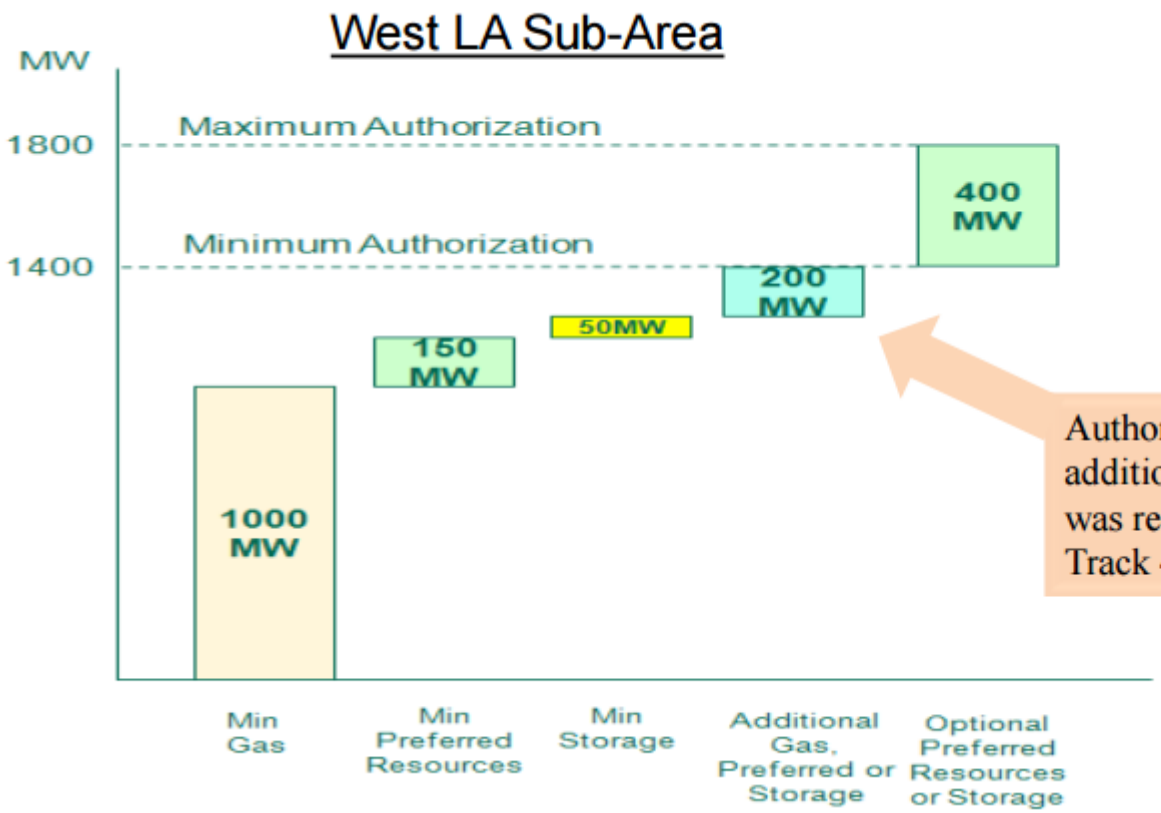
SCE LCR

Proposed Solution

Proposed solution to procure ~2,200MW of a mix of resources to provide the necessary capacity in the region



Moorpark Sub-Area:

- 215-290 MW in Ventura/Big Creek

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SCE LCR

- Request for Offers process conducted from late 2013 – late 2014
- Successful awards announced in November 2014

West LA Basin

Seller	Resource Type	MWs	Number of Contracts
NRG	Energy Efficiency	102.5	8
Onsite Energy Corporation	Energy Efficiency	11.0	11
Sterling Analytics LLC	Energy Efficiency	16.7	7
NRG	Demand Response	75.0	7
SunPower Corp.	Behind-the-Meter Renewable	44.0	4
Ice Energy Holdings, Inc.	Behind-the-Meter Thermal Energy Storage	25.6	16
Advanced Microgrid Solutions	Behind-the-Meter Battery Energy Storage	50.0	4
Stem	Behind-the-Meter Battery Energy Storage	85.0	2
AES	In-Front-of-Meter Battery Energy Storage	100.0	1
AES	Combined Cycle Gas Fired Generation	1284.0	2
Stanton Energy Reliability Center	Peaking Gas Fired Generation	98.0	1
	TOTAL:	1891.8	63

Over 250 MW storage procured vs target of 50MW

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Kaua'i Island Utility Cooperative

- KIUC and SolarCity entered agreement in September 2015 for first utility scale dispatchable solar project
- Designed to provide power from solar during evening hours 5 p.m. to 10 p.m.
- Solar output used to charge 13 MW / 52 MWh battery energy storage system for discharge during target hours
- Reduces KIUC reliance on diesel fired generation during evening hours at lower cost while reducing emissions
- Scheduled to be operational by December 2016

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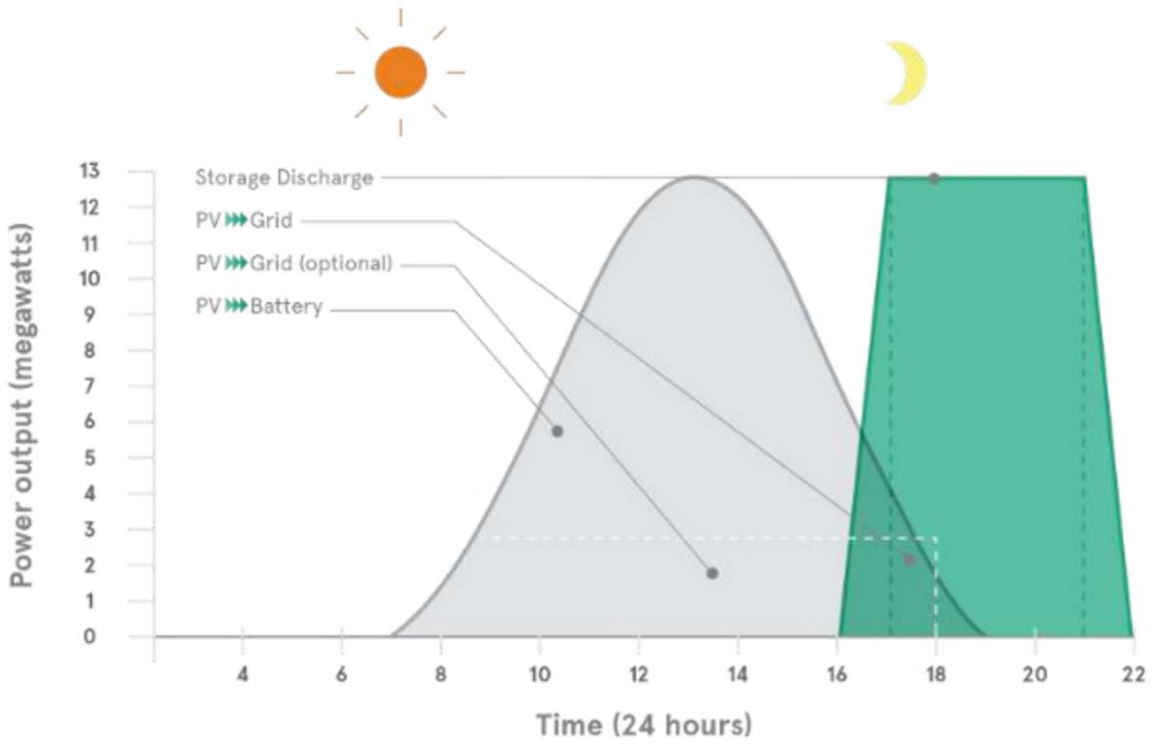
Kaua'i Island Utility Cooperative

Kauai Island Utility Cooperative



SolarCity

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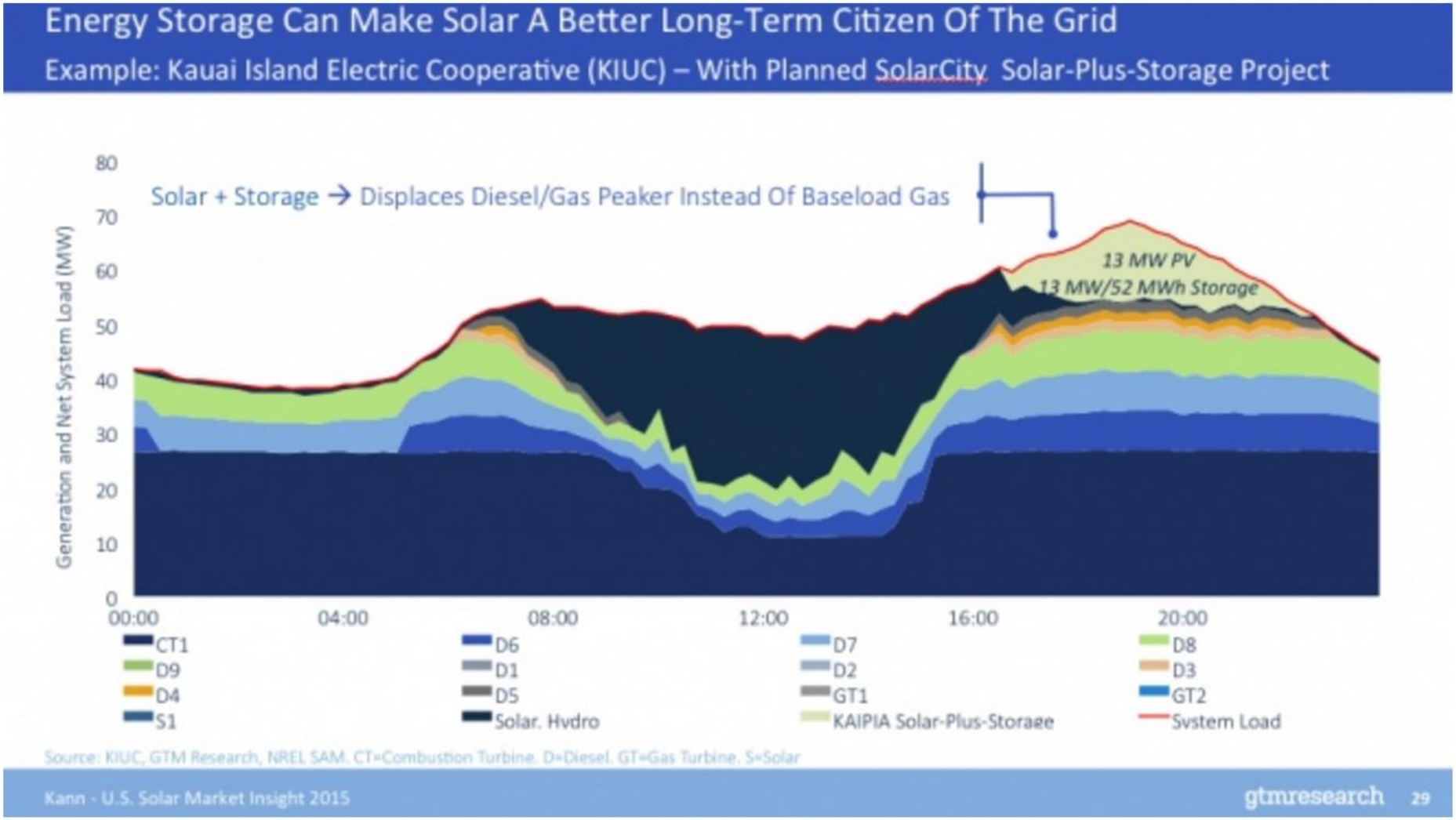
Kaua'i Island Utility Cooperative



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Aliso Canyon (CA)

- Natural gas leak at Aliso Canyon in Southern California will impact generation availability in the region
- SCE and SDG&E turned to alternative solution to offset natural gas constraint
  - ✓ Up to 50MW of Li Ion battery systems (2MW to 20MW in size)
  - ✓ Provide up to 4 hours of energy per day to meet peak demands
- Offered, selected and deployed within 2016
- Provide case study to not only alternative solutions but to speed of deployment

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Stafford Hill (VT)

- Green Mountain Power solar & storage project in Vermont
- 2MW of solar combined with 4MW battery storage
  - ✓ Resiliency and emergency shelter at local high school
  - ✓ Intermittency of solar
  - ✓ Demand management
- Part of "Energy City of the Future" project
- Storage recently used to avoid estimated $200,000 of future capacity costs [annual value could be replicated year over year]

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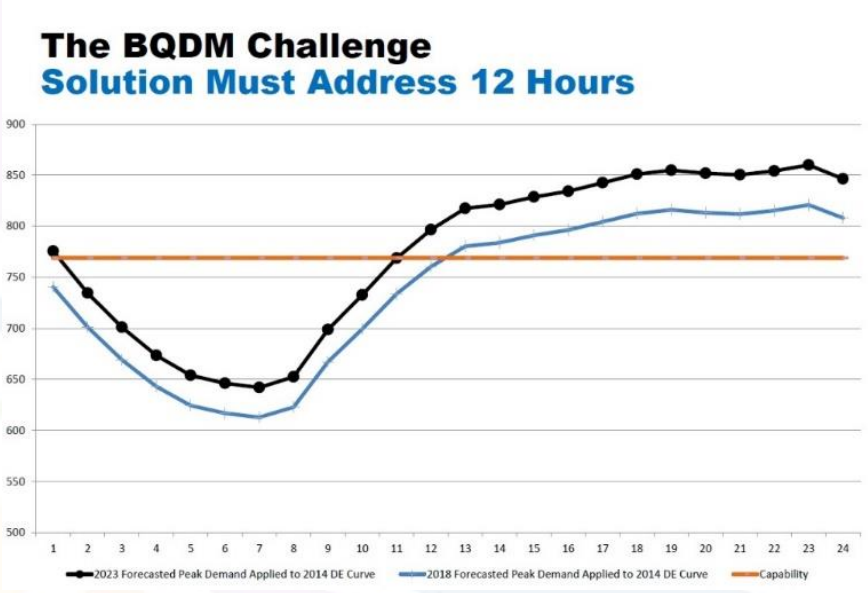
Brooklyn Queens Demand Management

Problem Statement

Increased customer electric demand growth in Brooklyn and Queens began overloading capabilities of the distribution system in 2013. ConEd forecasted that without some form of alleviation by 2018 the system will be overloaded by 69 MW above current capabilities for 40 - 48 hours during summer months. Traditional distribution system upgrades to alleviate the condition estimated at $1 billion before 2017.



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Brooklyn Queens Demand Management

Proposed Solution

Proposed alternative solution includes operational measures, new demand management program and other low cost utility side solutions specifically targeted at the growth pocket. The Program proposed combines ~52 MW of non-traditional solutions and 17 MW of traditional infrastructure investment

- **$200 million total expected investment in non-traditional solutions**
  - ✓ **$150 million to incentivize demand response amounting to approx. 41 MW**
  - ✓ **$50 million for 11 MW utility sided non-traditional solutions including grid connected battery**
- **The above non-traditional solutions combined with traditional infrastructure investment and load transfers estimated to defer the need for a new substation until 2026 or beyond**
- **Expectation for Net Present Value of project is $40 million; distribution expansion deferred until 2024**

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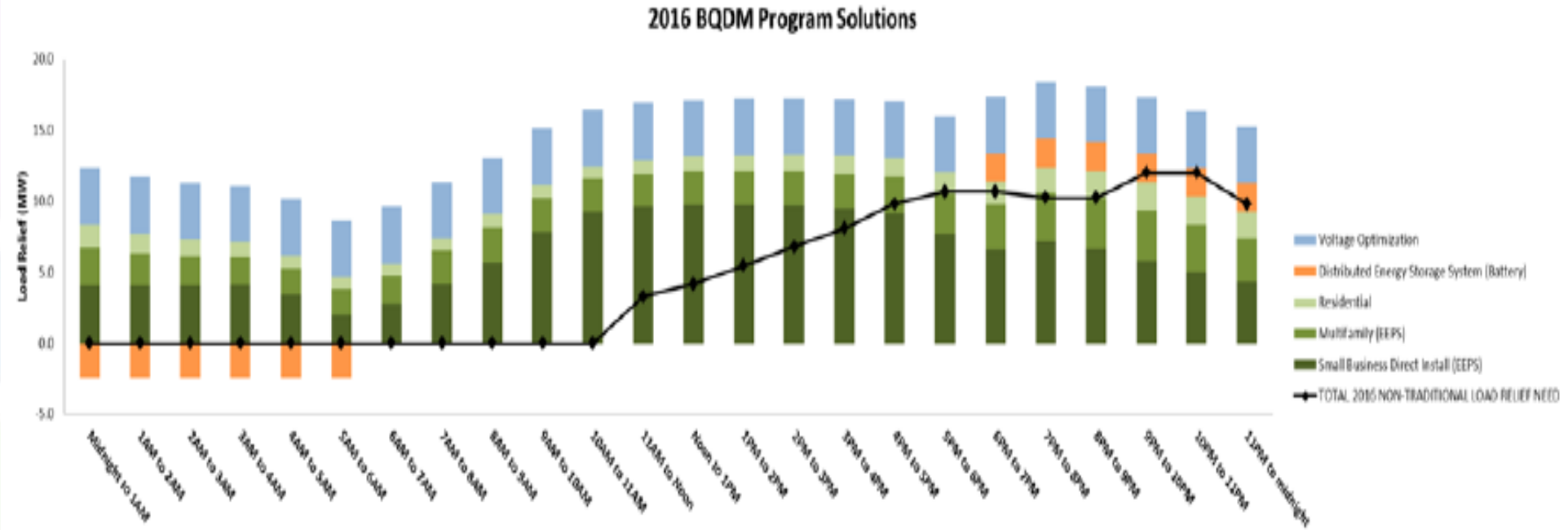
Brooklyn Queens Demand Management

Current Status

Efforts to date have provided sufficient relief to meet 2016 needs



Brooklyn Queens Demand Management

Non-traditional Solutions

Customer Sided

- Energy efficiency
- Demand response
- CHP deployment incentives
- Thermal storage

Utility Sided

- Distributed Energy Storage System (12MWh system|1MW/12hrs or 2MW/6 hrs)
- Voltage Optimization (7 MW)
- Utility sided PV (1 MW)
- Fuel cell (1 MW)

Brooklyn Queens Demand Management

Dynamic Resource Auction

- Conducted to obtain resources beyond 2016
- Targeted to B-Q area, replaces ConEd's Commercial System Relief Program for 2017/2018
- Demand Response products to provide 8 hours of relief (4pm to midnight) in two 4 hour blocks
- No restrictions on technologies or strategies to achieve curtailment
- Results
  - 22 MW of reductions by 2018
  - Offers included battery storage as well as more traditional DR methods

Barriers to Market Participation

- Regulations and market structures that account for storage system operating parameters
  - To be regulated is to be recognized
  - Advanced energy storage systems are not commonplace on the electric grid
  - Most markets, policy, and planning processes do not consider energy storage alongside other traditional assets
  - Could lead to less than optimal decision making
- Ensuring markets recognize the value energy storage can provide and compensate accordingly
  - Increased performance
  - Resiliency
  - Flexibility
  - Efficiency and environmental benefits

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FERC Policy Developments

- FERC actions that have promoted storage development
  - FERC Order 890 - Participation by non-generator resources in the RTO/ISO Ancillary Services markets; preventing undue discrimination and preference in transmission service
  - FERC Orders 719 and 745 - Improve DR in the wholesale power markets
  - FERC Order 755 - Pay for Performance Regulation
  - FERC Order 784 - Third-party provision of ancillary services and the accounting and financial reporting for new electric storage facilities”
  - FERC Order 794 - Frequency Response
- Recent NOPR in docket AD16-20 (November 2016)
  - **Requires ISOs to establish a participation model to accommodate energy storage**
  - Requires ISOs to define DER aggregators as a type of market participant

FERC NOPR in AD16-20

- Requires ISOs to establish a participation model specifically for energy storage
  - In most cases, to date, ISOs have attempted to fit storage into existing participation models
  - Limited participation to certain markets, e.g., regulation only
  - Arbitrary size requirements for participation
  - Behind the meter storage limited to participation as demand response
  - Addresses charging power costs
- Requires ISOs to define DER aggregators
  - To allow greater participation of distributed resources
  - Will define metering and communication requirements for aggregators
  - Locational aspects of aggregation
- Compliance filings due within six months of final rule with implementation 12 months after that

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Mid-Atlantic Region

- PJM ISO addressing expanded storage participation
  - Regulation market provided great opportunity but has matured
  - Stakeholder processes addressing
    - Capacity market participation
    - Broader role of Distributed Energy Resources
- NYISO addressing storage participation
  - 20MW participating in regulation market despite rules in place since 2009
  - Stakeholder initiatives underway to address
    - Rules clarification
    - Expanded market participation
    - DER participation

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Mid-Atlantic Region

- New York State
  - New York PRIZE program ($40 million to promote development of resiliency projects)
  - Reforming the Energy Vision (REV)
  - Storage key element in REV implementation
    - Distributed energy resources
    - Non-wires alternatives to distribution & transmission upgrades
- Other state level initiatives
  - New Jersey energy storage incentive program
  - Microgrid / resiliency initiatives in New Jersey and Maryland
  - Utility microgrid projects in Delaware, Pennsylvania, and Ohio

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West Region

- CAISO
  - Implemented Flexible Ramping product November 2016
  - Energy Storage and Distributed Energy Resource (ESDER) stakeholder initiative
    - Started in 2015 and continues in Phases (Phases I complete)
    - Addressing myriad issues associated with storage and DER, e.g., metering configuration, base line determination, multiple use scenarios, DR participation in regulation market
- Other state level initiatives
  - California utility storage RFOs to meet various needs; PGE 2016 RFO 11/30/16 for another 120MW storage (up to possibly 220MW)
  - CPUC Demand Response proceeding
  - Oregon storage mandate for utilities to have a minimum of 5MWh of storage by 2020
  - Arizona residential storage pilot program

New England Region

- Massachusetts taking the lead
  - Energy Storage Initiative - comprehensive study of the benefits and value of advanced storage in the state and $10 million ear marked for development of storage market
    - Quantified rate payer benefits > $2 billion
    - Several policy and program recommendations to incent deployment of energy storage and expansion of energy storage industry in the state
  - Omnibus Energy Legislation August 2016
    - Opens door for advanced energy storage mandates
    - Provides for inclusion of energy storage in SREC III program
  - Community Clean Energy Resiliency Initiative ($40 million to promote development of resiliency projects)

New England Region

- ISO-NE clarifying rules for storage participation
  - White paper on energy storage participation in March 2016
  - Alternative Technology Regulating Resource (ATRR) asset class
  - Participated in Massachusetts Energy Storage Initiative
- Vermont
  - Green Mountain Power Tesla PowerWall residential pilot
  - Green Mountain Power Stafford Hill (previous)

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Other Regions

- MISO
  - Implemented Stored Energy Resource asset to provide regulation in 2010
  - 0 MW of commercial, advanced energy storage in operation as of mid-2016
  - Storage initiative underway since January 2016, multi-year initiative to clarify and/or create new rules, improve interconnection process, and define various use categories
- ERCOT
  - Not FERC jurisdictional
  - Voted down Future Ancillary Services Market design
- SPP – Stakeholder initiative to consider Stored Energy Resource asset type underway

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General Market Trends

- Continued renewable generation penetration
- Above impact on Net Energy Metering policy
- Electrification of transportation
- General movement toward more distributed market
- Rise of the prosumer / transactive energy model
- Growing concerns over grid resiliency and reliability

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Distributed Energy Resources

THE OLD WAY

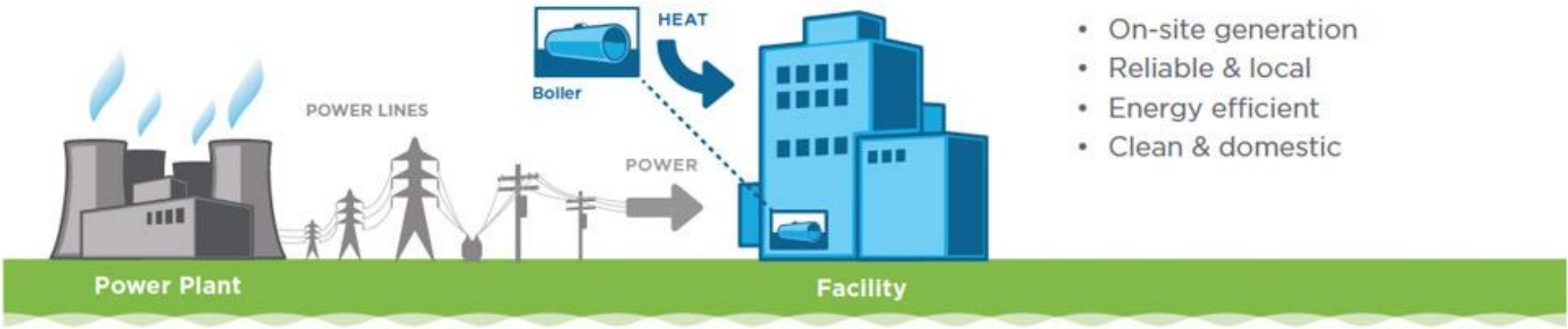
TRADITIONAL POWER PLANTS

- Grid dependence
- System inefficiencies
- Environmental impacts
- Pricing uncertainties

THE BETTER WAY

CHP SOLAR WHP BIOGAS

- On-site generation
- Reliable & local
- Energy efficient
- Clean & domestic



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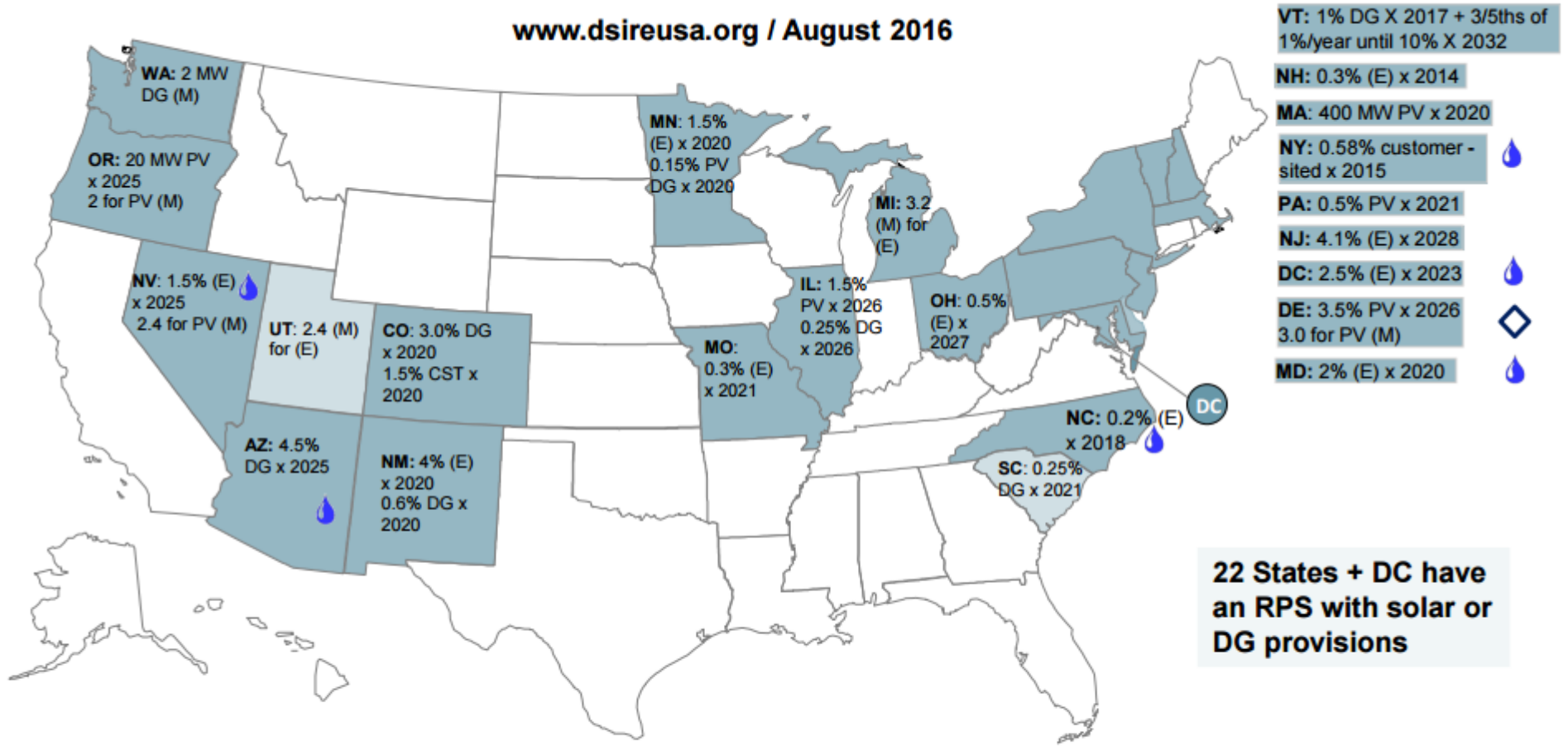
RPS with Solar or DG Provisions

Renewable Portfolio Standards (RPS) with Solar or Distributed Generation Provisions



22 States + DC have an RPS with solar or DG provisions

Renewable Portfolio Standard with solar/distributed generation (DG) provision

Renewable Portfolio Goal with solar/DG provision

(E): Solar Electric
PV: Solar Photovoltaic
DG: Distributed Generation
(M): Multipliers
(CST): Customer - Sited

Delaware allows certain fuel cell systems to qualify for the PV carve-out

Solar water heating counts toward solar/DG provision

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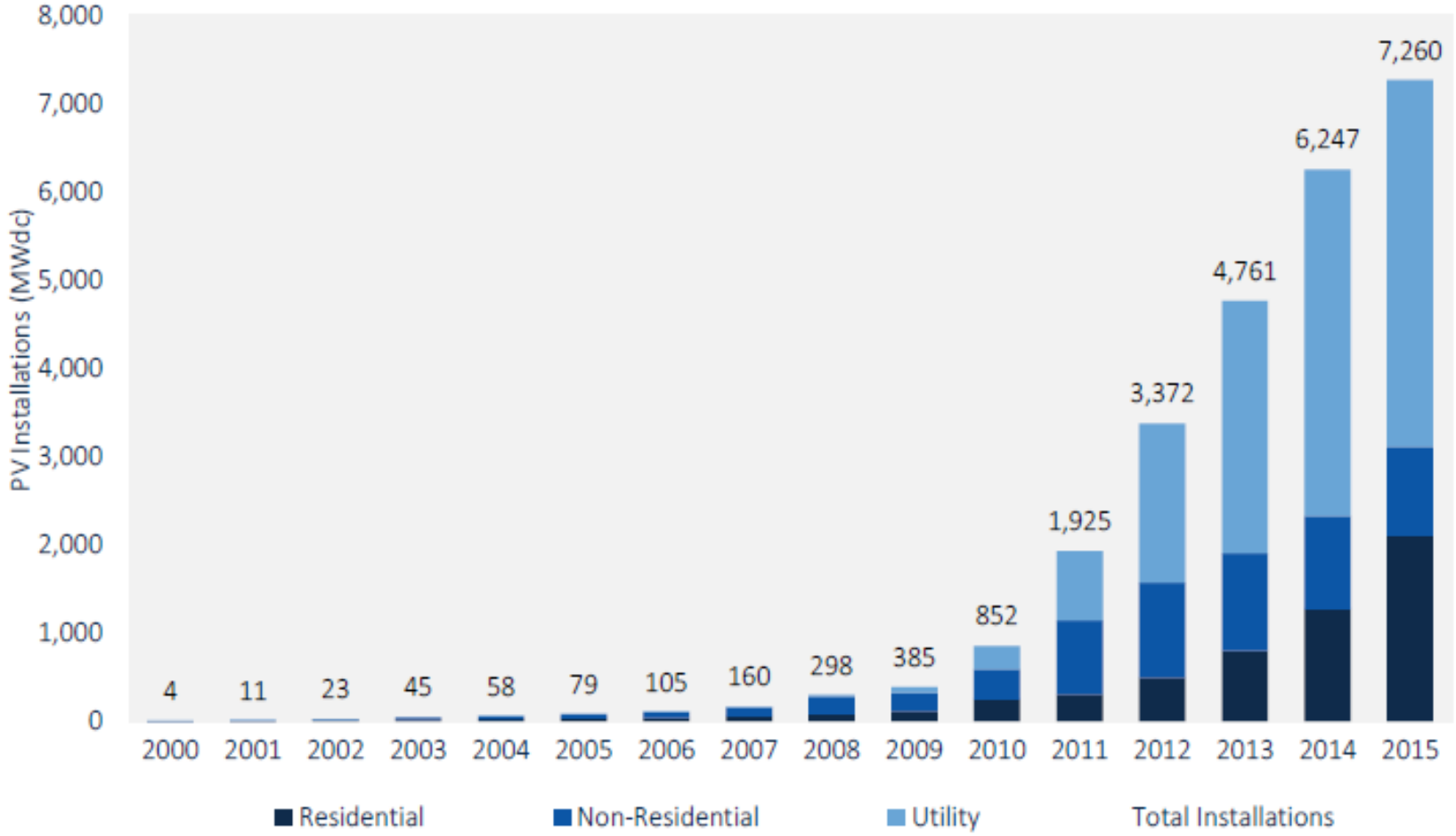
Solar PV Installations



Source: GTMResearch / Solar Energy Industry Association

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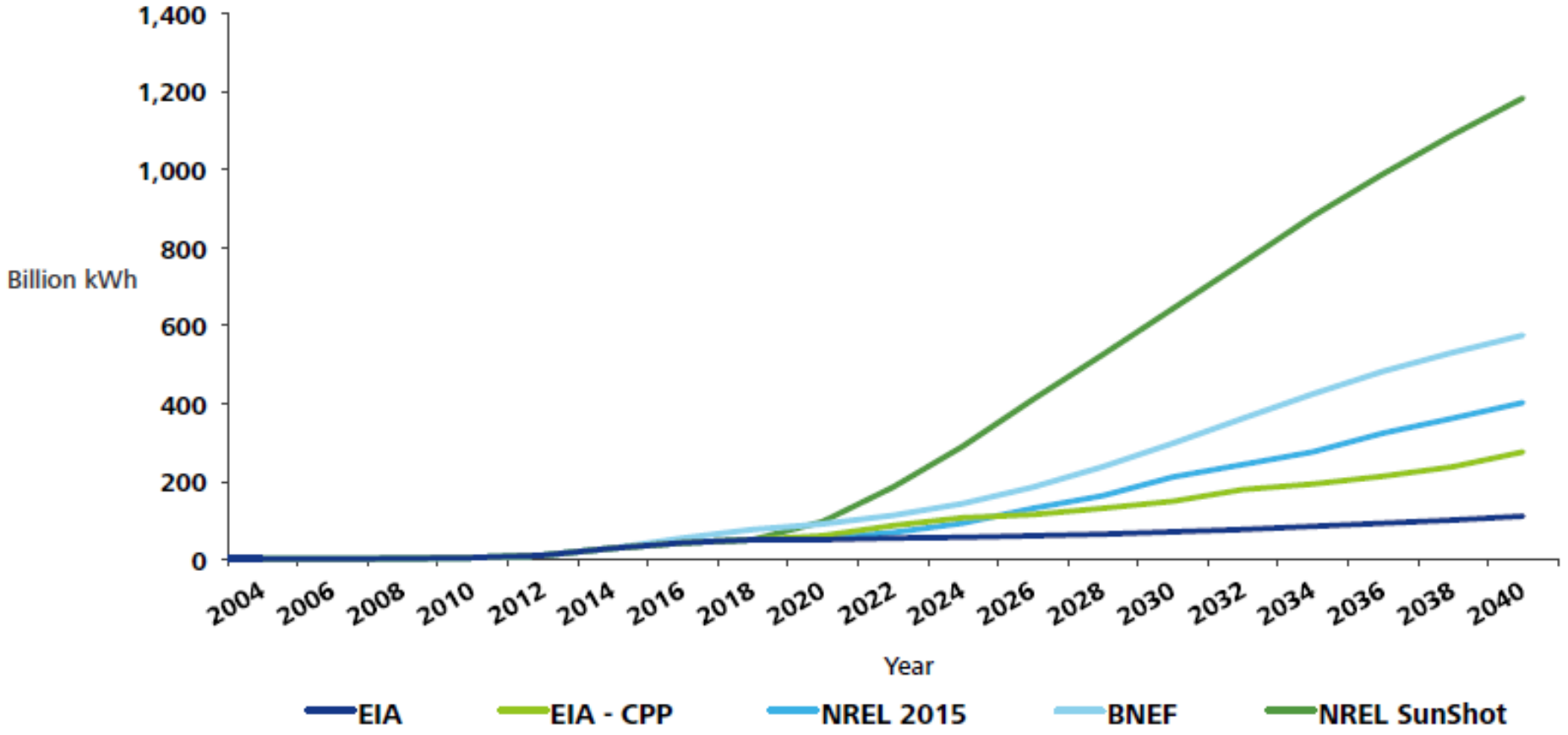
Distributed Solar Projected Growth



Source: EIA/NREL/Bloomberg

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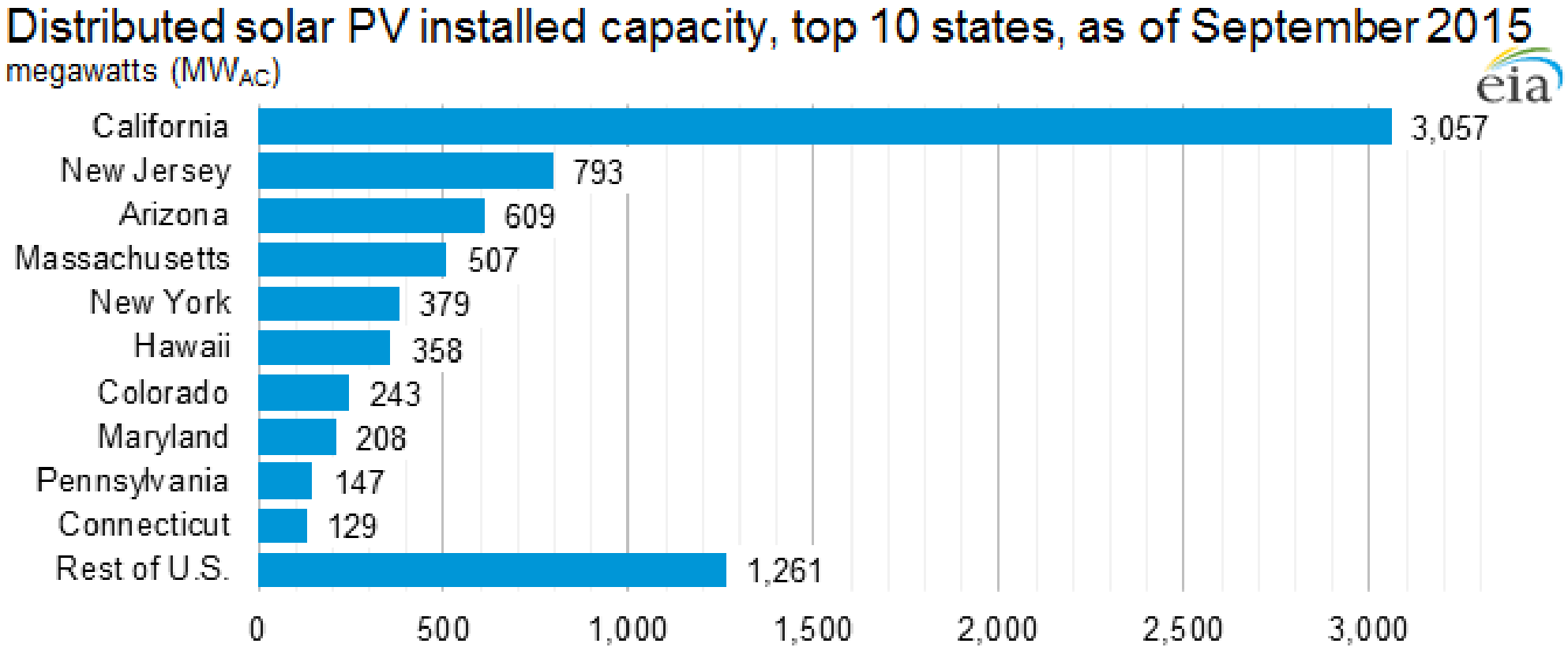
Distributed Solar Top States



Source: U.S. Energy Information Administration, *Electric Power Monthly*

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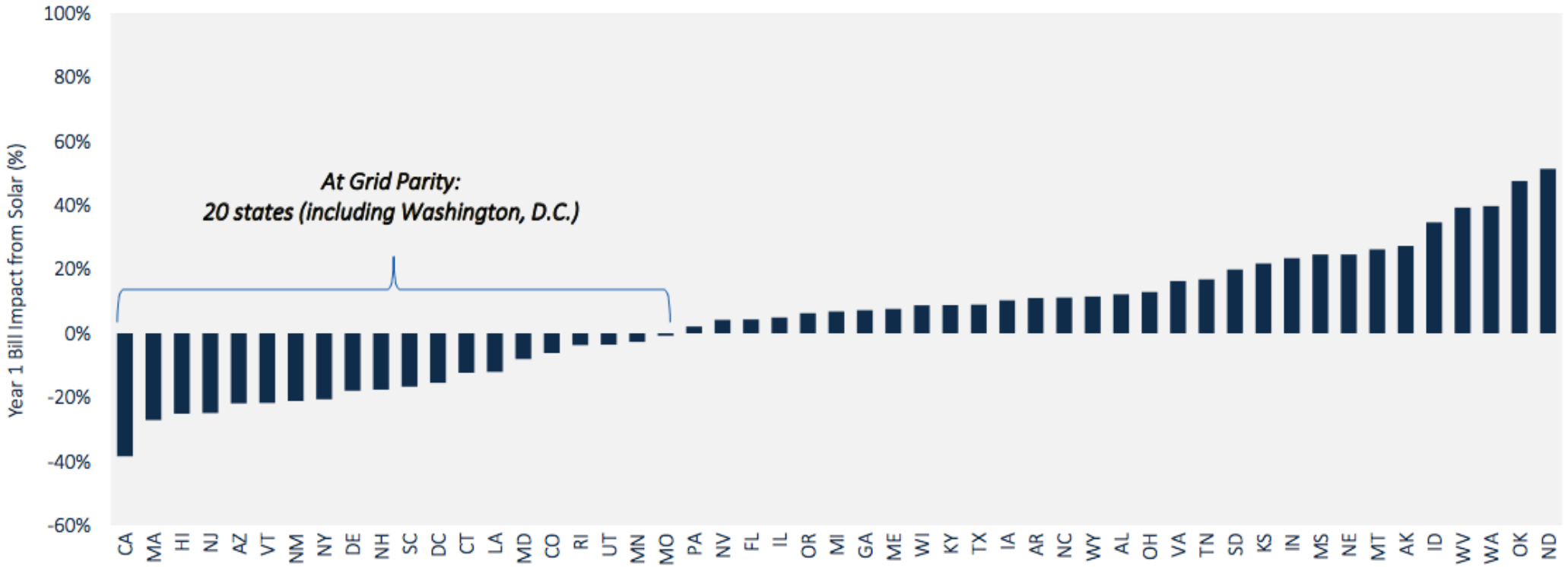
Solar Parity



Note: Grid parity metrics account for all NEM and rate reforms currently in effect for modeled utilities.

Source: GTMResearch

- 20 states currently at grid parity
- 42 states expected to reach parity by 2020

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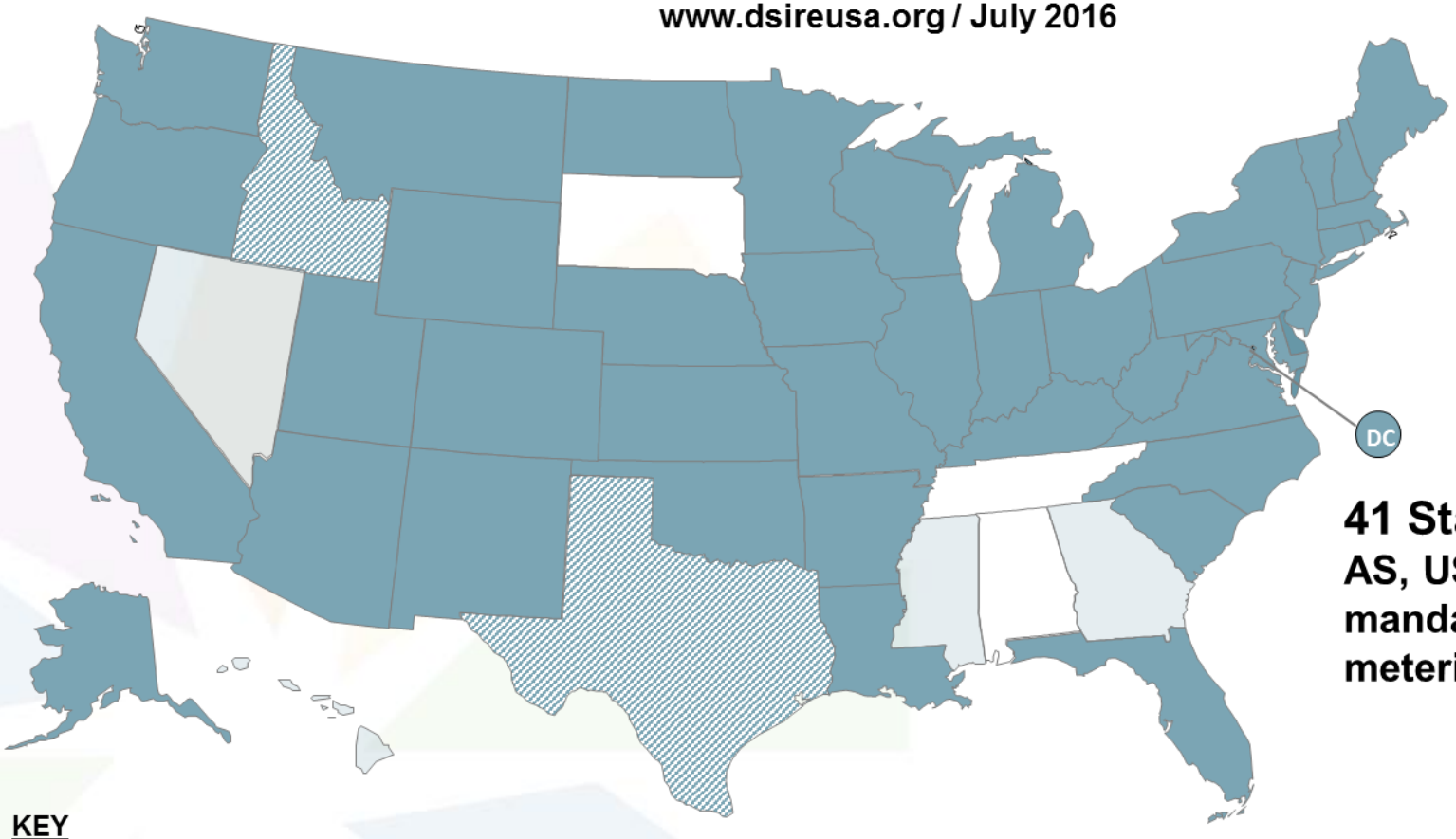
Net Energy Metering – Boon or Barrier?

Net Metering

www.dsireusa.org / July 2016



41 States + DC,
AS, USVI, & PR have mandatory net metering rules

KEY

- State-developed mandatory rules for certain utilities (41 states + DC+ 3 territories)
- No statewide mandatory rules, but some utilities allow net metering (2 states)
- Statewide distributed generation compensation rules other than net metering (4 states + 1 territory)

U.S. Territories:

AS PR
VI GU

Net Energy Metering – Boon or Barrier?

- Net Energy Metering has surely helped promote the development of behind the meter renewable resources
  - Gives customers control over bills
  - Creates jobs and private investment
  - Can benefit the grid
- Is NEM all positive
  - Hidden costs to ratepayers
  - Stymies new technology development
  - Disconnects presence of solar from retail supply

Net Energy Metering Tide Changing

- Though considered the lifeblood of solar in the U.S., many states are considering changes to their policy
- Most notably
  - October 2015 – HI closed NEM to new participants
  - December 2015 – NV reduced the buy back rate
  - January 2016 – CA PUC narrowly (3-2) passed NEM 2.0 upholding retail rates for buy back
- Half of all states considering changes to their NEM policies as caps are being neared or exceeded in many states

Customized Energy Solutions

One Door Closes, Another Opens

- Changes, reductions, or even elimination of Net Energy Metering poses a threat to distributed renewable
- Creates opportunity for more integrated behind the meter solutions
- What emerging technology stands to benefit most….

Energy Storage

Customized
Energy Solutions

Analyze · Simplify · Implement

THANK YOU!

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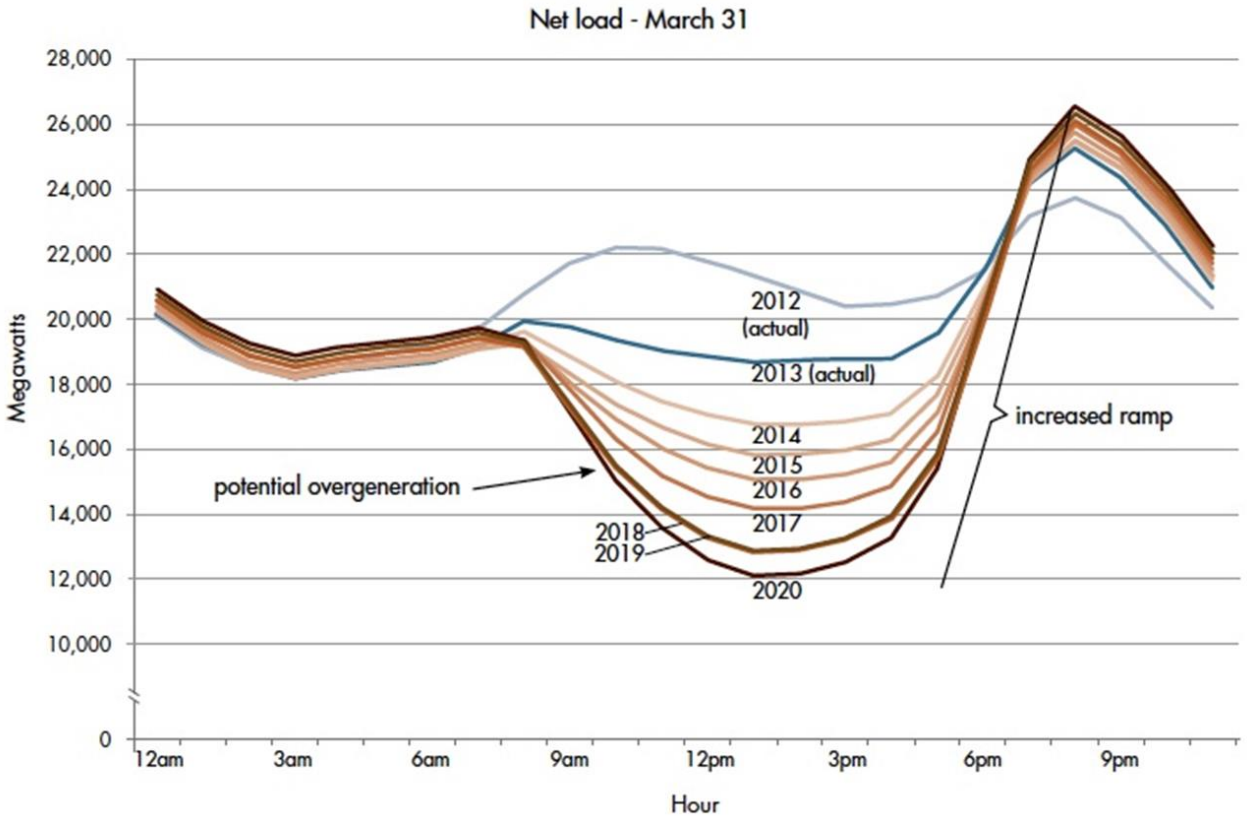
Customized Energy Solutions

Duck Curve

- Periods of lower load with high DER production can lead to over-generation
- Sharp ramps required to maintain load and generation in balance
- Requires flexible resources
  - ✓ Does current generation mix provide needed flexibility?
  - ✓ Are current market products adequate?
- Potential challenges to the natural gas supply



Source: CA