Better Buildings Residential Network Peer Exchange Call Series:

The Next Frontier: Energy Storage and Batteries

March 28, 2019

Agenda and Ground Rules

- Agenda Review and Ground Rules
- Opening Poll
- Residential Network Overview and Upcoming Call Schedule
- Featured Speakers:
  - **Scott Sklar,** The Stella Group
  - **Brett Simon,** Wood Mackenzie
  - **Renée Guillory**, Arizona Public Service
- Open Discussion
- Closing Poll and Announcements

Ground Rules:

1. **Sales of services and commercial messages are not appropriate** during Peer Exchange Calls.
2. Calls are a safe place for discussion; **please do not attribute information to individuals** on the call.

The views expressed by speakers are their own, and do not reflect those of the Dept. of Energy.

Better Buildings Residential Network

Join the Network

Member Benefits:

- Recognition in media and publications
- Speaking opportunities
- Updates on latest trends
- Voluntary member initiatives
- Solution Center guided tours

Commitment:

- Members only need to provide *one number*: their organization's number of residential energy upgrades per year, or equivalent.

Upcoming calls:

- April 11th: What's Keeping Energy Experts Up at Night? Technical Problems That Need to Be Solved
- April 25th: Getting Smarter Every Day: Leveraging Smart Home Technologies to Advance Home Performance Projects
- May 9th: Residential Energy Efficiency in a World of Funding Constraints

Peer Exchange Call summaries are posted on the Better Buildings website a few weeks after the call

For more information or to join, for no cost, email bbresidentialnetwork@ee.doe.gov, or go to energy.gov/eere/bbrn & click Join

Scott Sklar
The Stella Group

U.S. DEPARTMENT OF ENERGY

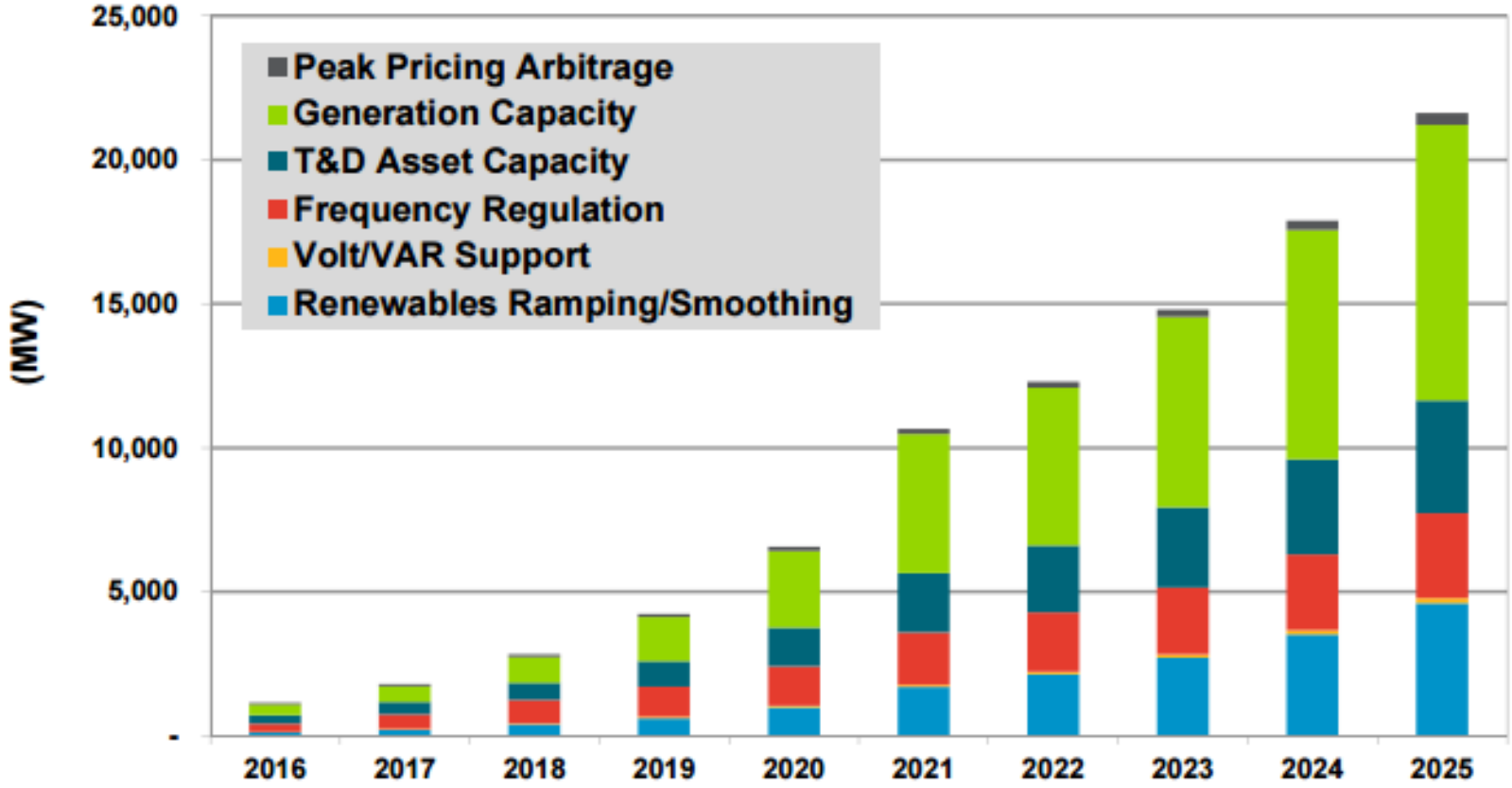
The Stella Group, Ltd.

The Stella Group, Ltd.. is a strategic technology optimization and policy firm for clean distributed energy users and companies which include advanced batteries and controls, energy efficiency, fuel cells, geoexchange, heat engines, microhydropower (including tidal and wave), modular biomass, photovoltaics, small wind, and solar thermal (including CSP, daylighting, water heating, industrial preheat, building air-conditioning, and electric power generation). Scott Sklar serves as Steering Committee Chair of the Sustainable Energy Coalition, composed of the renewable and energy efficiency associations, national environmental groups, and analytical groups, and sits on the national Boards of Directors of the non-profit Business Council for Sustainable Energy and The Solar Foundation, teaches two unique interdisciplinary sustainable energy course at The George Washington University, Scott Sklar was awarded the prestigious The Charles Greely Abbot Award by the American Solar Energy Society (ASES) and on April 26, 2014 was awarded the Green Patriot Award by George Mason University in Virginia, and serves on the US Department of Commerce Renewable Energy & Energy Efficiency Advisory Committee, term ending June 2020.

The Stella Group, Ltd. 706 North Ivy Street, Arlington, VA 22201

703-522-3049 www.TheStellaGroupLtd.com solarsklar@aol.com

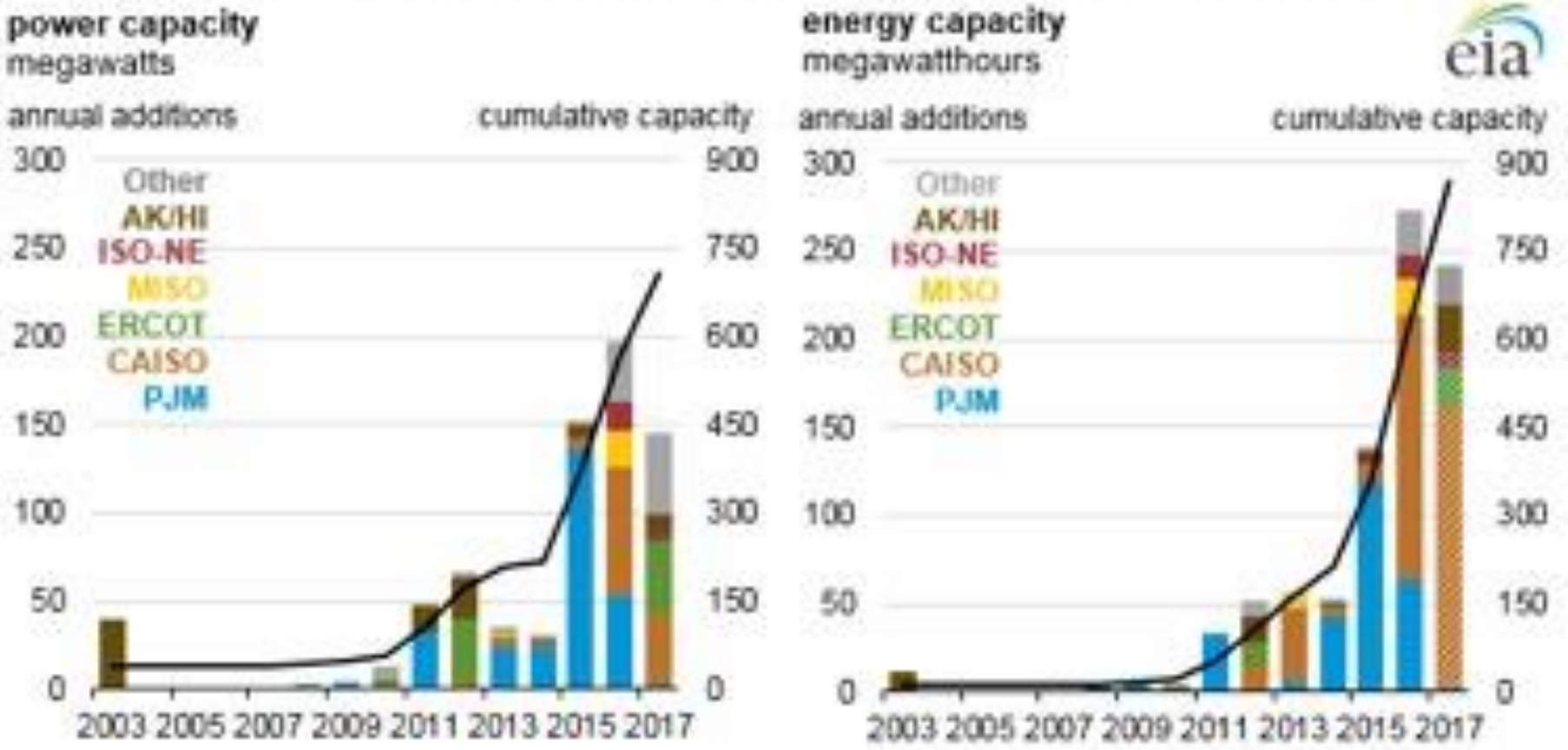
Chart 1.1 Installed ESGAS Power Capacity by Application, World Markets: 2016-2025



(Source: Navigant Research)

http://www.utilitydive.com/news/ferc-proposed-storage-rulemaking-draws-familiar-concerns-over-jurisdiction/437022/

Figure ES1. U.S. large-scale battery storage capacity by region (2003–2017)



RMI Report Finds Renewables, Storage Reaching Cost Parity:
UtilityDive.com, by Herman K. Trabish, June 11, 2018

https://www.utilitydive.com/news/end-of-the-gas-rush-renewables-storage-reaching-cost-parity-report-fin/524840

A report released by the nonprofit Rocky Mountain Institute, "The Economics of Clean Energy Portfolios," shows that emerging mixes of renewable energy, storage, and other distributed energy resources may soon be more cost effective than natural gas plants in most regions. RMI's modeling shows the portfolio of renewables, batteries, demand response and energy efficiency can replace natural gas plants and save ratepayers money. The problem is that developers engaged in a "rush to gas" have already planned $110 billion in gas plant investments by 2025. That trend could lock in $1 trillion in costs to the U.S. power sector by 2030 if it continues and make it more difficult for renewables and batteries to get a foothold in the market. The gas rush will likely continue if regulators and lawmakers do not provide new incentives and market rules to encourage battery storage and demand management, which will provide crucial flexibility in emerging clean energy portfolios.

RESILIENCY and RELIABILITY

RESILIENCY

Resiliency encompasses consequences to the electricity system and other critical infrastructure from high-impact external events whose likelihood was historically low, but is now increasing.

RELIABILITY

Maximize electric power 24 hour operations – Minimize outages

Reliability is generally measured in terms of the system average duration and frequency of outages (SAIDI and SAIFI), with different permutations based on whether the system average or customer average is more important to the reliability regulator.

System Average Interruption Frequency Index (SAIFI)

SAIFI is the average number of sustained interruptions per consumer during the year. It is the ratio of the annual number of interruptions to the number of consumers.

SAIFI = (Total number of sustained interruptions in a year) / (Total number of consumers)

System Average Interruption Duration Index (SAIDI)

SAIDI is the average duration of interruptions per consumers during the year. It is the ratio of the annual duration of interruptions (sustained) to the number of consumers. If duration is specified in minutes, SAIDI is given as consumer minutes.

SAIDI = Total duration of sustained interruptions in a year / total number of consumers

SKLAR THESIS

BATTERY STORAGE MAKES ABSOLUTE ECONOMIC SENSE IF YOU CAN OFFSET THREE COST AREAS:

1. OFFSETTING EQUIPMENT DAMAGE AND REPLACEMENT COSTS FOR ELECTRIC POWER QUALITY EQUIPMENT ADDRESSING: SURGES, SAGS, and TRANSIENTS

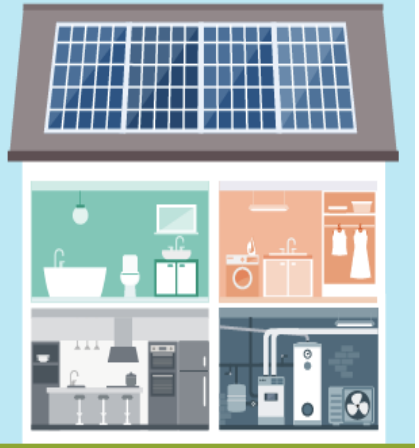
2. PROVIDING ABSOLUTE ELECRIC POWER RELIABILITY FOR A SUBSET OF THE ELECTRIC LOAD – CRITICAL FUNCTIONS (ie. dedicated to a series of sub-circuits)

3. ARBITRAGING LOWER ELECTRIC RATES TO OFFSET HIGHER RATES and DEMAND CHARGE REDUCTION

The Solar Plus Home

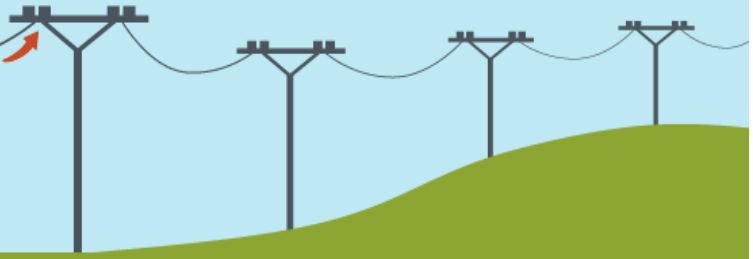
Solar panels generate energy during the day, when most homeowners are not home

There are a number of controllable appliances, like hot water heaters and air conditioners, that can be used to store energy during the day



With the addition of EVs and batteries, even more of that energy can be stored

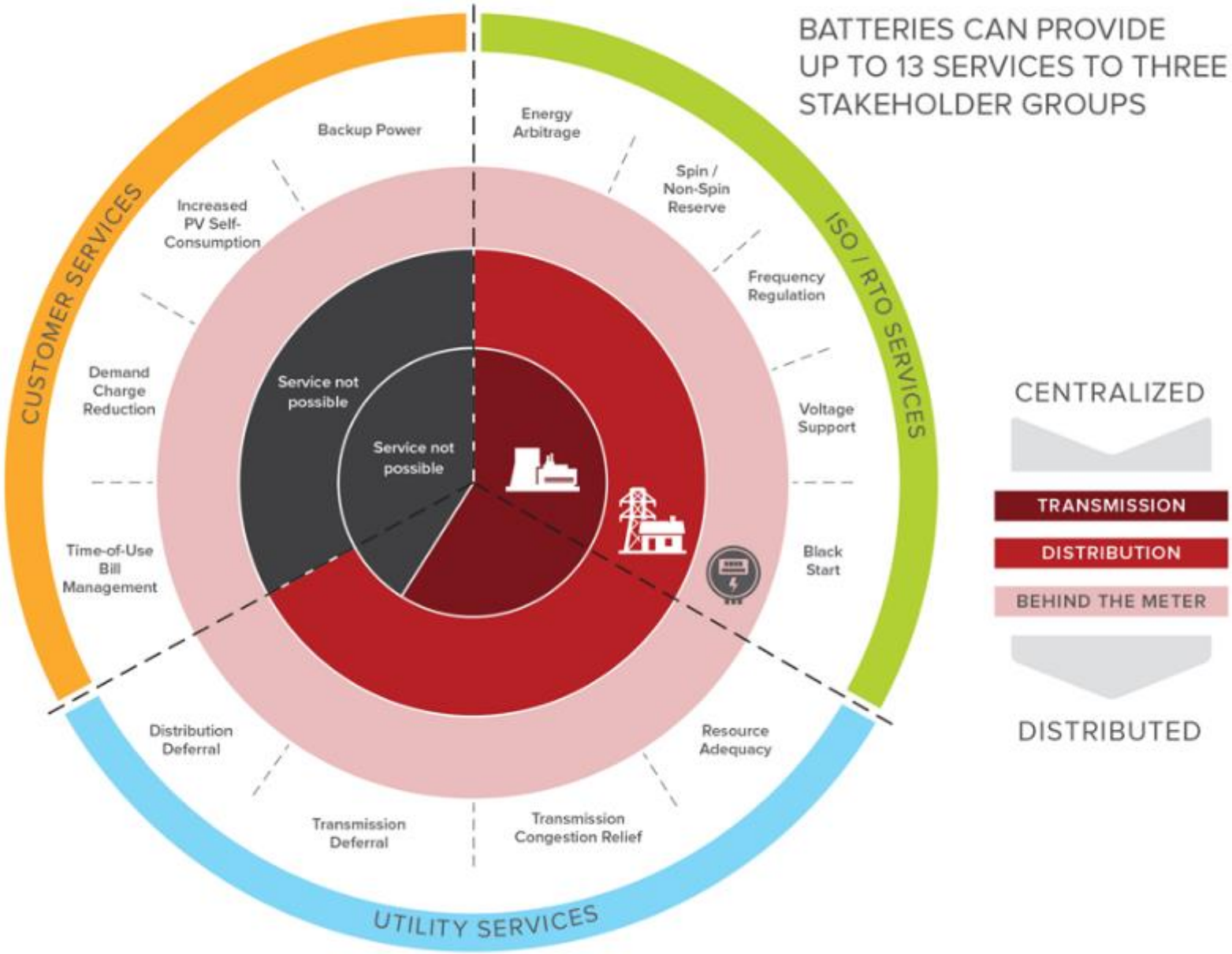
Solar Plus looks at how more energy can be used in the home, which helps utilities better manage the grid



EAST SIDE

NET ZERO BUILDING #126
WASHINTON NAVY YARD (NAVFAC)

Mitigated 63,000kWh of electricity


BATTERIES CAN PROVIDE UP TO 13 SERVICES TO THREE STAKEHOLDER GROUPS
CUSTOMER SERVICES
ISO / RTO SERVICES
UTILITY SERVICES
Backup Power
Energy Arbitrage
Spin / Non-Spin Reserve
Frequency Regulation
Voltage Support
Black Start
Resource Adequacy
Transmission Congestion Relief
Transmission Deferral
Distribution Deferral
Time-of-Use Bill Management
Demand Charge Reduction
Increased PV Self-Consumption
Service not possible
Service not possible
CENTRALIZED
TRANSMISSION
DISTRIBUTION
BEHIND THE METER
DISTRIBUTED

Energy Storage Power Conversion Systems Becoming a 'Crowded Market': Energy Storage News, by Andy Colthorpe, July 18, 2018

https://www.energy-storage.news/news/navigant-energy-storage-pcs-becoming-a-crowded-market

The market for power conversion systems (PCS) used in energy storage is becoming "increasingly crowded" with competitors, while the diverse field of players will contribute to "rapid technological innovations and price reductions," according to Navigant Research. Renewable energy sources producing DC power, such as solar PV, and variable AC (wind), use PCS to convert their energy to regulated AC power which can be grid-integrated, thus, "PCS enable the utilization of renewables, storage, and microgrids on a large scale". While North America is likely to see a higher capacity of energy storage installations in the next few years, all world regions are expected to see significant PCS growth over the 10-year forecast period.

Battery Storage, Smart Grid, and Energy Efficiency Companies Bring in $2.8 Billion in VC Funding in 2018:
North American Clean Energy, January 21, 2019

http://www.nacleanenergy.com/articles/33415/battery-storage-smart-grid-and-energy-efficiency-companies-bring-in-2-8-billion-in-vc-funding-in-2018

According to Mercom Capital Group, $2.8 billion was raised by Battery Storage, Smart Grid, and Energy Efficiency companies in 2018, an increase from the $1.5 billion raised in 2017. In 2018, VC funding into Battery Storage companies increased by 19 percent to $850 million in 49 deals compared to $714 million raised in 30 deals in 2017. Total corporate funding, including debt and public market financing, increased to $1.3 billion in 2018 compared to $890 million in 2017. Lithium-ion based battery technology companies received the most funding with $236 million. Smart Grid companies raised $530 million in VC funding in 29 deals in 2018, a 26 percent increase compared to the $422 million raised in 45 deals in 2017. VC funding for Energy Efficiency companies jumped to $1.5 billion in 23 deals in 2018 compared to $384 million in 38 deals in 2017. Total corporate funding, including debt and public market financing, reached more than $1.7 billion in 2018, compared to $3.3 billion in 2017.

The U.S. Department of Energy's National Renewable Energy Laboratory and Clean Energy Group (CEG) have released the first comprehensive public analysis detailing the potential size of the commercial behind-the-meter battery storage market in the United States. NREL analyzed over 10,000 utility tariffs in 48 states, finding that more than five million of the 18 million commercial customers across the country may be able to cost-effectively reduce their utility bills with battery storage technologies. (September 2017)

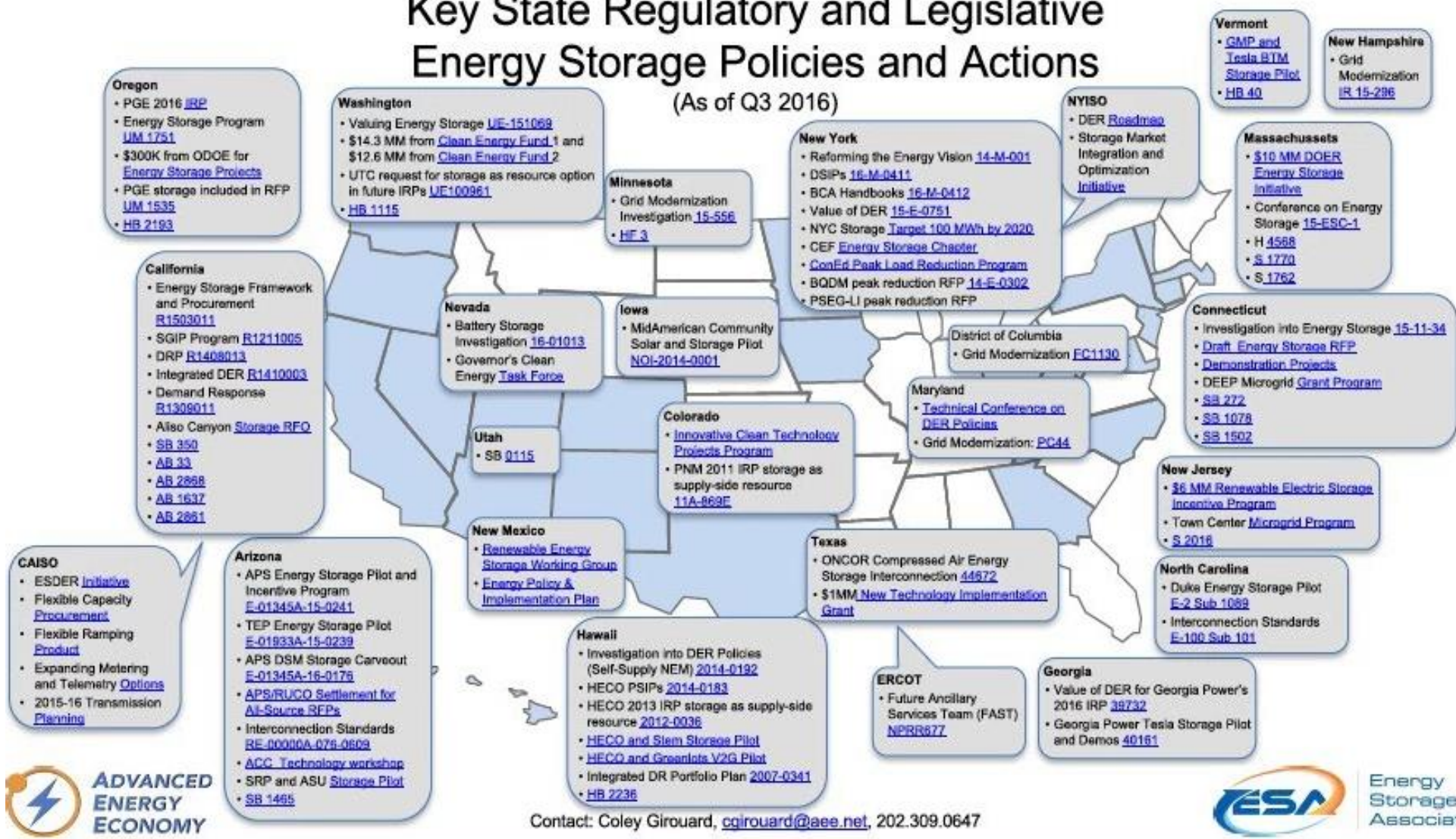
These findings, grouped by utility service territory and state and illustrated in a series of maps and tables, are presented in NREL and CEG's white paper, Identifying Potential Markets for Behind-the-Meter Battery Energy Storage: A Survey of U.S. Demand Charges, available at this link:

(http://www.cleanegroup.org/ceg-resources/resource/NREL-demand-charges-storage-market/)

The researchers looked at the number of commercial customers eligible for utility rate tariffs that included demand charges of $15 or more per kilowatt, an industry benchmark for identifying economic opportunities for behind-the-meter storage and they concluded that nearly five million customers were at or above this demand charge threshold, accounting for over 25 percent of commercial customers in the United States. This represents a substantial market opportunity for behind-the-meter battery storage, which can be installed to control peak demand and lower electricity bills by reducing demand charges.

Key State Regulatory and Legislative Energy Storage Policies and Actions

(As of Q3 2016)

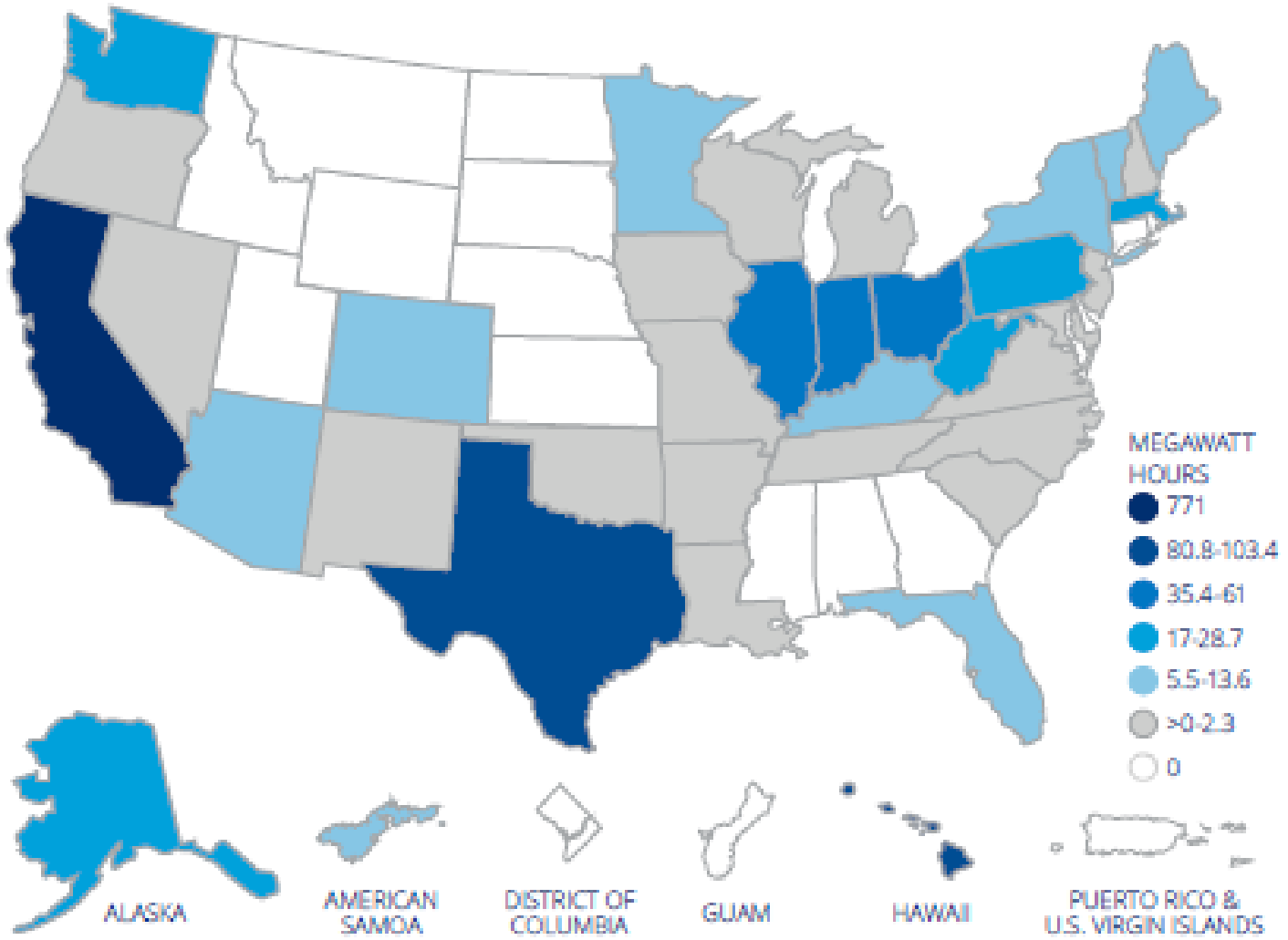


Contact: Coley Girouard, cgirouard@aee.net, 202.309.0647

ADVANCED ENERGY ECONOMY

ESA Energy Storage Associa

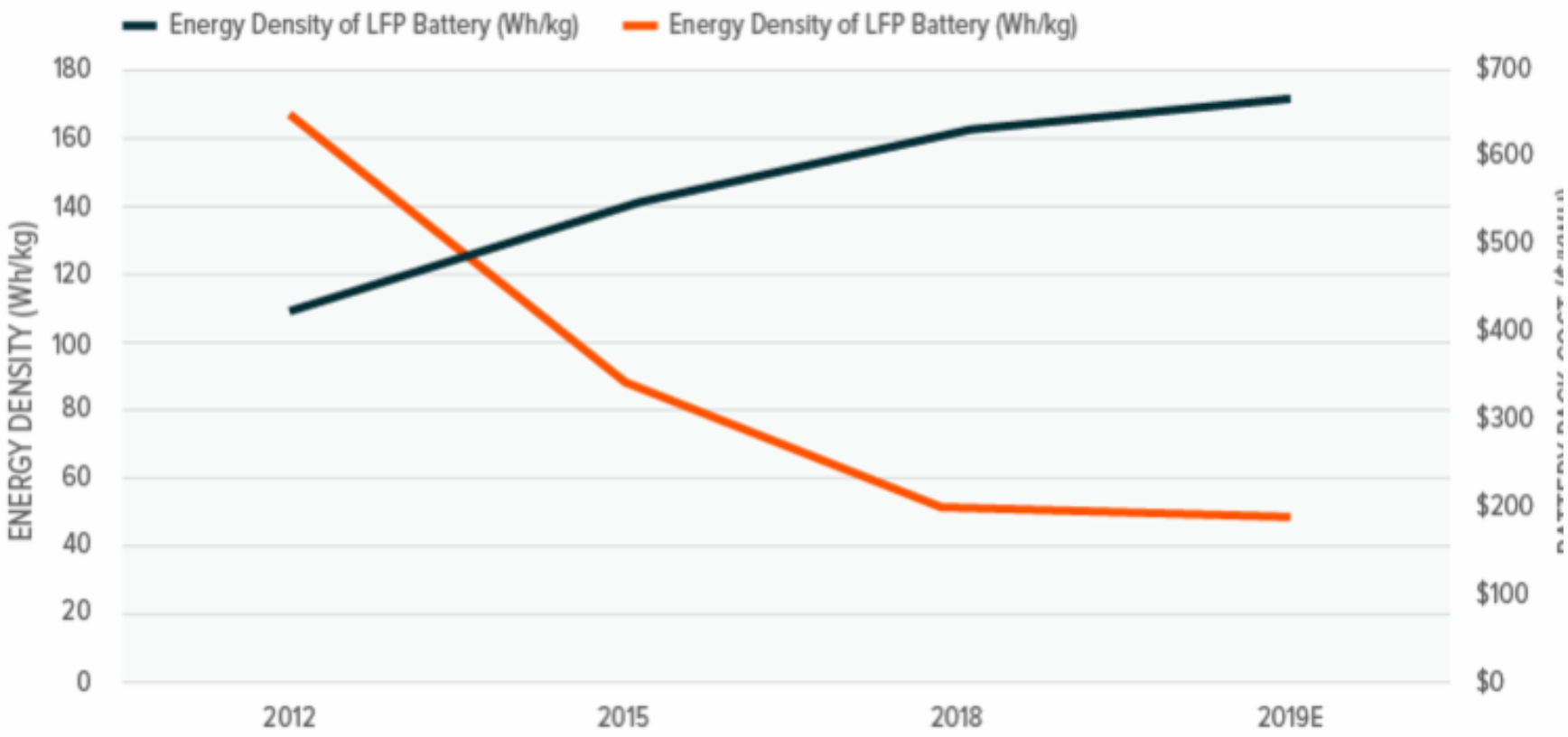
CUMULATIVE ENERGY STORAGE DEPLOYMENT (MWH)



Smart Electric Power Alliance, 2018

BATTERY IMPROVEMENTS OVER TIME

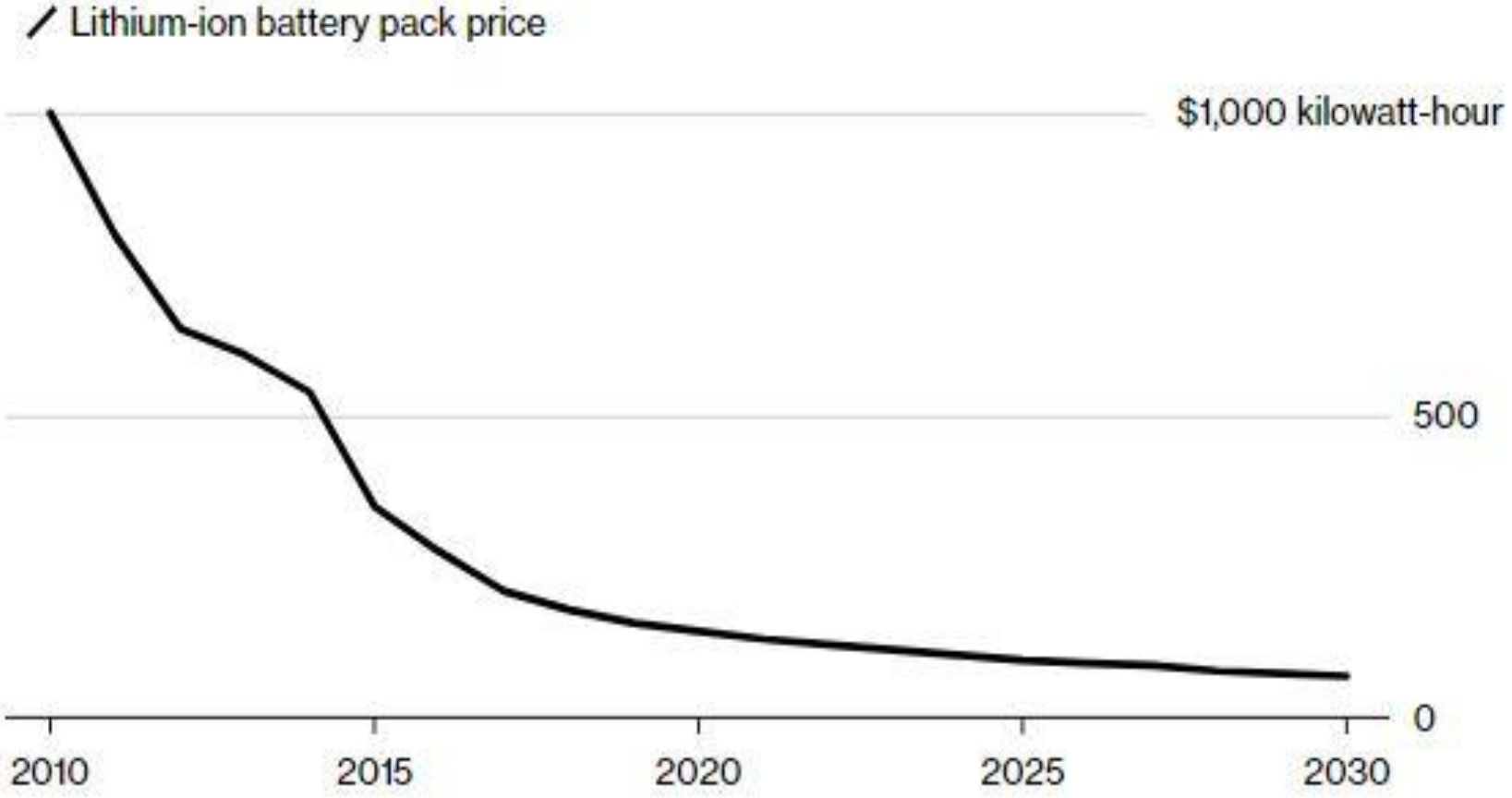
Source: BYD, Bloomberg NEF, CairnERA



2/2019

Cheaper Batteries

Costs are expected to drop in half by 2025 as production ramps up



Source: Bloomberg NEF

Note: Prices starting in 2018 are forecasts

MARYLAND ....System Specs | 402.3 kW
System Production | 515,790 kWh annually
Environmental Benefits | Offsets CO_2 from 41,168 gallons of gasoline annually

The Konterra Solar Microgrid project in Laurel, Maryland is one of the nation's first commercial scale solar grid-interactive battery storage systems. A true game changer for the solar PV industry, the Konterra Solar Microgrid project was developed through a partnership with Konterra Realty, Standard Solar Inc. (SSI), the Maryland Energy Administration (MEA), and Solar Grid Storage (SGS). The project consists of a 402.3kW solar canopy, a 300kwh commercial scale back-up battery system, and two electric vehicle charging stations with infrastructure for four additional stations. This innovative clean energy generation technology produces 515,790kWh annually and offers new benefits such as battery back-up against grid outages, which provides solar powered energy for critical loads.

Note: Standard Solar (MD) is adding storage to a nearly 4 MW project recently completed at Fort Indiantown Gap near Harrisburg PA. 2/2019

https://www.standardsolar.com/about-us/projects/konterra-solar-microgrid-project

Five years ago, a mere 0.34 GW of energy storage could be found globally. Fast forward and the market is expecting 6 GW to be installed in 2017 alone. Globally, analysts expect the energy storage market to grow 47 percent in 2017 over 2016 installations.

Study Finds It Could Be Cost Competitive with Standalone PV Installations by 2020

A recent NREL technical report examines the benefit of a battery energy storage system (BESS) when paired with a utility-scale solar photovoltaic (PV) system. The report examines both separately installed systems and systems that integrate the PV and BESS components to work together. Although the current high price of batteries causes all combinations with a BESS to have a lower benefit-to-cost ratio than a PV system alone, the best-performing choice is a direct-current system where the BESS is used only to store solar energy, thus qualifying the system for the investment tax credit. The report, titled *Evaluating the Technical and Economic Performance of PV Plus Storage Power Plants* by NREL's Paul Denholm, Josh Eichman, and Robert Margolis, also looks to the near future and finds that by 2020, a BESS will likely yield significant additional net benefits to PV developer. The report, which is summarized in a slide deck**,** was covered by Utility Dive and Greentech Media.

http://www.renewableenergyworld.com/articles/print/volume-20/issue-5/features/energy-storage/a-brief-history-of-utility-scale-energy-storage.html
cmpid=enlrew_energy_storage_news_2017-09-21&email_address=SOLARSKLAR@AOL.COM&eid=291124330&bid=1872394

Early adopters of fuel cells are driven by the need for uninterrupted, high quality power.

Power Disruption Events per Month

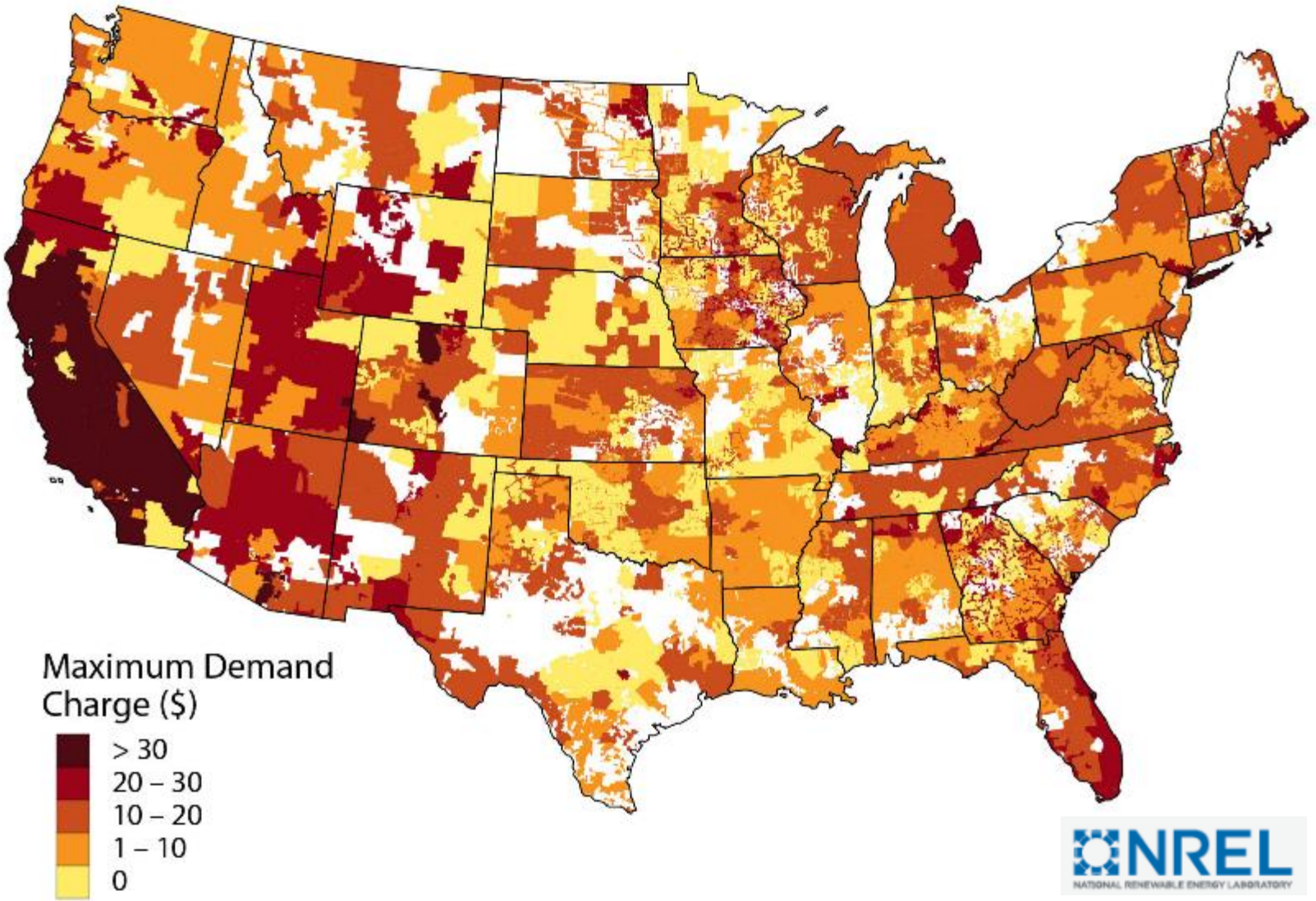
Event	Median	Average	Worst
Interruptions	1.0	1.3	10.0
Sags / undervoltages	4.1	27.9	1,660
Swells / overvoltages	3.4	13.9	1,450
Transients	15.7	63.5	1,166

Source: Duke Power, Sandia National Laboratories

- Power disruptions may cause sensitive equipment to fail.
- As a result, organizations face potential for significant losses – lost data, lost materials, lost productivity, and lost income – as well as risks to public safety.
- A study by Sandia National Laboratories estimates losses from power disruptions at more than $150 billion per year in the U.S.
- In response, more and more organizations are turning to on-site generation to boost power availability.

Nexus Associates, Inc.

Figure 2. Maximum demand charge rates by utility service territory.



Demand Charges Can Vary Widely, Even Within the Same State

Table 3.
Top 10 States with the Most Commercial Customers Estimated to be Eligible for Utility Rates that Include Demand Charges of **$20**/kW or Higher

	Number of Customers Eligible for Demand Charge >$20/kW
California	1,081,000
New York	648,000
Georgia	216,000
Michigan	205,000
Massachusetts	180,000
Kentucky	41,000
New Mexico	24,000
Alabama	23,000
Texas	23,000
Iowa	23,000

http://www.cleanegroup.org/wp-content/uploads/NREL_BatteryStorage_2017.pdf

Demand Charge Savings from Commercial Solar

Authors:
Naïm R. Darghouth; Galen L. Barbose; Andrew D. Mills; Ryan H. Wiser;
Pieter Gagnon; Lori Bird

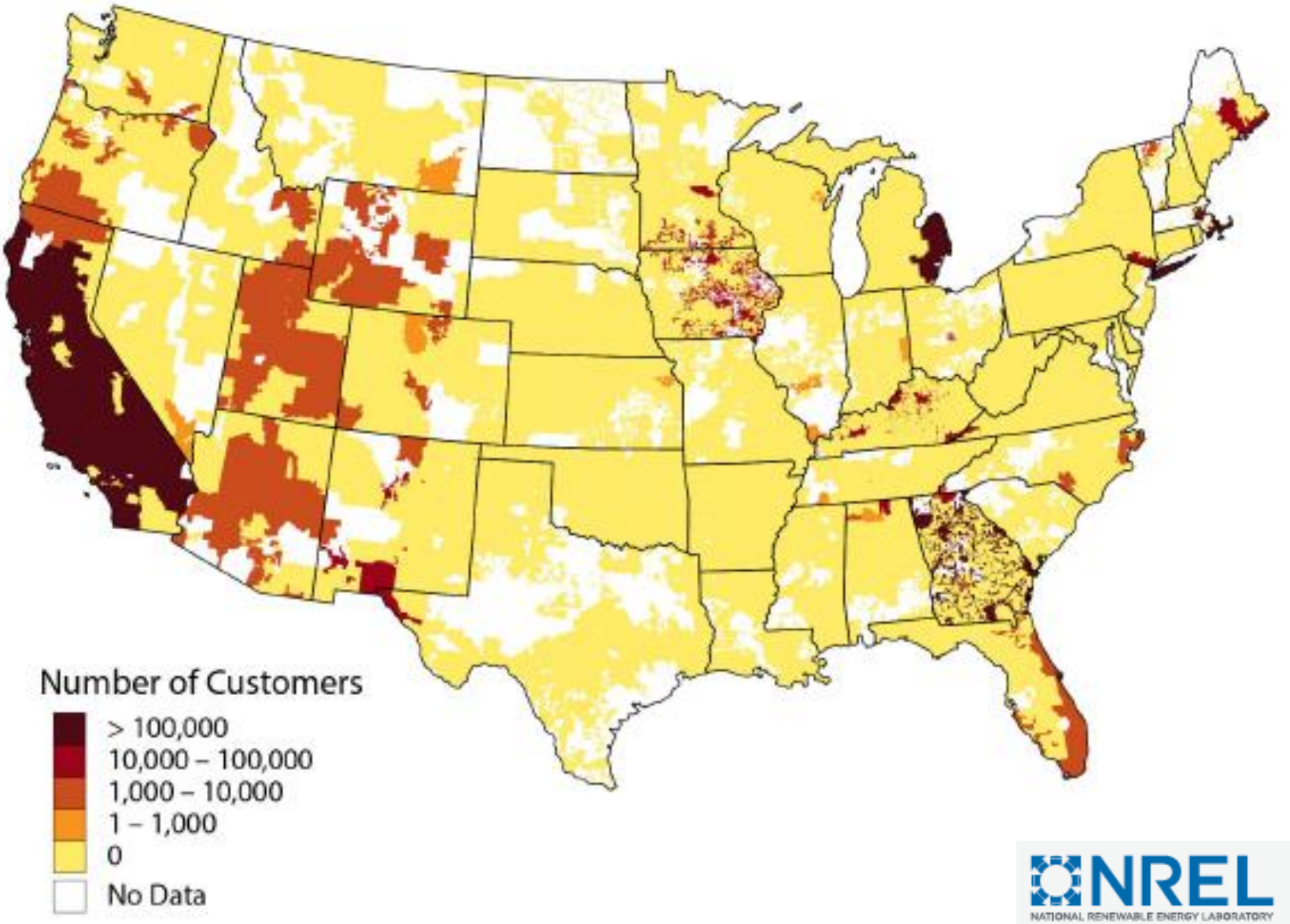
Date Published:
07/2017

Abstract: Commercial retail electricity rates commonly include a demand charge component, based on some measure of the customer's peak demand. Customer-sited solar PV can potentially reduce demand charges, but the magnitude of these savings can be difficult to predict, given variations in demand charge designs, customer loads, and PV generation profiles. Moreover, depending on the circumstances, demand charges from solar may or may not align well with associated utility cost savings.

Lawrence Berkeley National Laboratory (Berkeley Lab) and the National Renewable Energy Laboratory (NREL) are collaborating in a series of studies to understand how solar PV can reduce demand charge levels for a variety of customer types and demand charges designs. Previous work focused on residential customs with solar. This study, instead, focuses on commercial customers and seeks to understand the extent and conditions under which rooftop can solar reduce commercial demand charges. To answer these questions, we simulate demand charge savings for a broad range of commercial customer types, demand charge designs, locations, and PV system characteristics. This particular analysis does not include storage, but a subsequent analysis in this series will evaluate demand charge savings for commercial customers with solar and storage.

https://emp.lbl.gov/sites/default/files/comdemandcharge-execsummary.pdf
https://emp.lbl.gov/sites/default/files/comdemandcharge-briefing.pdf

Figure 4. Estimated number of commercial electricity customers who can subscribe to tariffs with demand charge in excess of $20/kW.



Maryland's Governor Hogan has signed into law a state income tax credit for specific costs related to energy storage systems installed between January 1, 2018 and December 1, 2022. Systems eligible for the credit are systems that are used to store electrical, mechanical, chemical or thermal energy that was once electrical energy to be used as electrical energy at another time or in a process that would offset electrical use at peak times of electrical use.

The credit applies to both residential and commercial installation. The credit for residential installation is $5,000.00. The credit for commercial installation is the lesser of $75,000.00 or 30% of the cost of the system.

There is a $750,000.00 aggregate cap statewide for the credit, and a taxpayer that wants to utilize the credit must obtain a credit certificate from the Maryland Energy Administration prior to taking the credit. Also, the credit must be taken in the year of the installation, is not subject to a carry forward and cannot exceed the state tax due for that year. The credit is granted on a "first come – first served" basis. The Comptroller is responsible for the promulgation of regulations in relation to the credit.

http://www.jdsupra.com/legalnews/maryland-new-tax-credit-for-energy-22613/

Battery Storage Accelerates Puerto Rico's Transition to a Distributed Energy Grid:

Navigant Research, by Ricardo Rodriquez, August 24, 2018

https://www.navigantresearch.com/news-and-views/battery-storage-accelerates-puerto-ricos-transition-to-a-distributed-energy-grid

The Puerto Rico Public-Private Partnerships Authority and the Puerto Rico Electric Power Authority (PREPA) recently issued a Request for Qualifications (RFQ) for utility scale energy storage projects. The proposal seeks to add nearly 200 MWh of batteries, enough to supply 5% of the island's peak electricity demand, as it rebuilds in the wake of Hurricane Maria. The RFQ calls for 10 20 MW/20 MWh battery electric storage systems to interconnect to 10 115 kV switchyards owned by PREPA. At an estimated cost of $3.8 million each, these systems must also have the flexibility and modularity to expand to 40 MW/160 MWh should the initial rollout prove successful. It is expected that this project will provide net savings of $8 million to $12 million per substation.

Massachusetts targets 200 MWh of energy storage by 2020

By

Krysti Shallenberger June 30, 2017

Dive Brief:

Massachusetts must procure 200 MWh of energy storage by January 1, 2020, according to new targets set by the state Department of Energy Resources Friday.

The agency allocated $10 million in funding for demonstration projects and will evaluate the whether storage resources should be allowed to participate in the Alternative Portfolio Standard.

Massachusetts released its highly-anticipated energy storage target a day before its July 1 deadline. The target aims to help the state reach its renewable energy goals including procuring 1,600 MW of offshore wind.

“As the Commonwealth continues to make unparalleled investments in renewable energy, energy storage technologies have the potential to play an integral role in effectively deploying these new resources,” said Gov. Charlie Baker (R) in a statement.

While the number is considerably less than the potential 600 MW, it's still significant for a state with a relatively nascent energy storage market.

SOURCE: http://www.utilitydive.com/news/massachusetts-targets-200-mwh-of-energy-storage-by-2020/446281/

Standardized Interconnections

- 49 States allow DG under IEEE consensus standards which has allowed smart battery banks like the GridPoint 3.6 kw in my VA office building (installed 2006)

- This unit was the first standardized battery bank with charge controller, inverter, dc disconnect and microprocessor w/ modem in top of unit; and 8 250 amp hour AGM batteries in bottom of unit.

- PV and Wind connect to the upper left side of this unit.

ENGION SENTRY

SYSTEM

Function	automatic back-up emergency power, off-grid
Output power (continuous)*	6.8 kW
Overload 30 min / 60 s*	8.5 kW / 12 kW
Input / output voltage AC	120 V
Nominal battery capacity	9.2 kWh / 13.8 kWh / 18.4 kWh
Dimensions (W x H x D) in inches	23.6 x 72.8 x 23.6

INVERTER

Maximum output current 60 s (rms)	102 A (120 V)
Output frequency	60 Hz
Input voltage range DC	42 – 64 V (48 V nominal)
Maximum input current DC	180 A
Maximum output charge current DC	140 A

BATTERY

Electrochemistry of cell	valve Regulated Lead Acid (VRLA)
Design life	10 years
Battery voltage	48 V nominal (4 x 12 V)
Battery capacity C10	192 Ah / 288 Ah / 384 Ah (8 / 12 / 16 batteries)
Dimensions (W x H x D) in inches	4.3 x 9.4 x 20.1 (each 12 V battery)
Weight	75 lbs (each 12 V battery)

SOLAR CHARGE CONTROLLER**

Max. PV array voltage (operating)	140 V
Max. PV array open circuit voltage	150 V including temperature correction factor
Max. charge current	60 A

VARTA Storage GmbH
Emil-Eigner-Straße 1
86720 Nördlingen
Germany

Powerwall comes in 10 kWh weekly cycle and 7 kWh daily cycle models. Both are guaranteed for ten years and are sufficient to power most homes during peak evening hours. Multiple batteries may be installed together for homes with greater energy need, up to 90 kWh total for the 10 kWh battery and 63 kWh total for the 7 kWh battery. (Tesla)

40.7 MW of energy storage was deployed in Q2 2015, a nine-fold increase from Q2 2014, and six-fold increase from Q1 2015. Behind-the-meter market continued its strong showing of previous quarters, and grew over eleven times from same period last year.

http://files.ctctcdn.com/1fb72c5e001/5e784b5b-74ee-4031-88b0-c2ea937bf943.pdf

sonnen

Sonnen's mission is to provide clean and affordable energy for all. As the first mainstream grid tied residential energy storage company in the world and with 24,000 sonnenBatterie systems installed worldwide, sonnen is a proven global leader in intelligent energy management solutions. The all-in-one sonnenBatterie smart energy storage solution easily integrates with new and existing solar installations to help homes manage their energy throughout the day-saving money, providing backup power, and maximizing the effective use of solar power day and night. Sonnen has won several awards for its energy innovations, including the 2017 Zayed Future Energy Prize, MIT's Technology Review's 50 Smartest Companies in 2016, Global Cleantech 100 for 2015-2017

LG rolled out new battery products at the 2018 Solar Power International Conference this week in California: a 5 kW AC-coupled system for homes where solar panels are already installed and a 7.6 kW DC-coupled system for new installations. (9/26/2018)

https://www.utilitydive.com/news/as-residential-energy-storage-booms-lg-enters-market-with-expandable-batte/533123/

2018-03-21 - With its modular design, ABB’s new solar inverter with energy storage capability, REACT 2, provides a capacity of up to 12 kWh, increasing electric self-sufficiency of homes.

http://www.abb.com/cawp/seitp202/B2A53C2AB2AFE7F6C125825700315D59.aspx

Distributed Energy Storage System L1000 In-Building

Manage energy use, cut costs and provide backup power for a building, campus or enterprise with the L1000 In-Building Distributed Energy Storage System from Johnson Controls. We combine world-class battery technology, in-depth buildings expertise and intelligent controls to deliver the solution that performs best with your specific building systems. Controls go beyond the battery to optimize whole-building performance and simplify participation in energy markets. Adaptive algorithms and premium battery composition help realize the lowest total lifecycle cost.

'clean' installation of the Darfon 12kW Lithium battery system with 7.5kW PV in Moorefield, W VA

Ben Glenzer Solar Solutions For All

http://solarsolutionsforall.com/projects--customer-testimonials.html


NUVATION BMS™
System status
Stack Voltage
42.0 V
Stack Current
0.57 A
100%
System statistics
cell voltage
cell temperature
NUVATION
ENGINEERING

RECENT ENERGY STORAGE STUDIES

CALIFORNIA
http://www.cpuc.ca.gov/NR/rdonlyres/1110403D-85B2-4FDB-B927-5F2EE9507FCA/0/Storage_CostEffectivenessReport_EPRI.pdf

TEXAS
http://www.brattle.com/system/news/pdfs/000/000/749/original/The_Value_of_Distributed_Electricity_Storage_in_Texas.pdf

FERC – DG
The potential benefits of distributed generation and rate ...
https://www.ferc.gov/legal/fed-sta/exp-study.pdf

THE POTENTIAL BENEFITS OF DISTRIBUTED GENERATION AND RATE-RELATED ISSUES THAT MAY IMPEDE THEIR EXPANSION
A STUDY PURSUANT TO SECTION 1817 OF THE ENERGY POLICY ACT OF 2005

THERE ARE NO DUMB QUESTIONS !!!

SCOTT SKLAR

solarsklar@aol.com

Key Points

- Battery storage combined with solar panels can make sense in a variety of circumstances
- Where reliability of electric service is a priority, storage allows homeowners to mitigate the risks of disruption or substandard electric quality
- The battery market is burgeoning, with many off-the-shelf solutions available from leading manufacturers

Brett Simon
Wood Mackenzie

U.S. DEPARTMENT OF ENERGY

2018

The Year of Residential Storage

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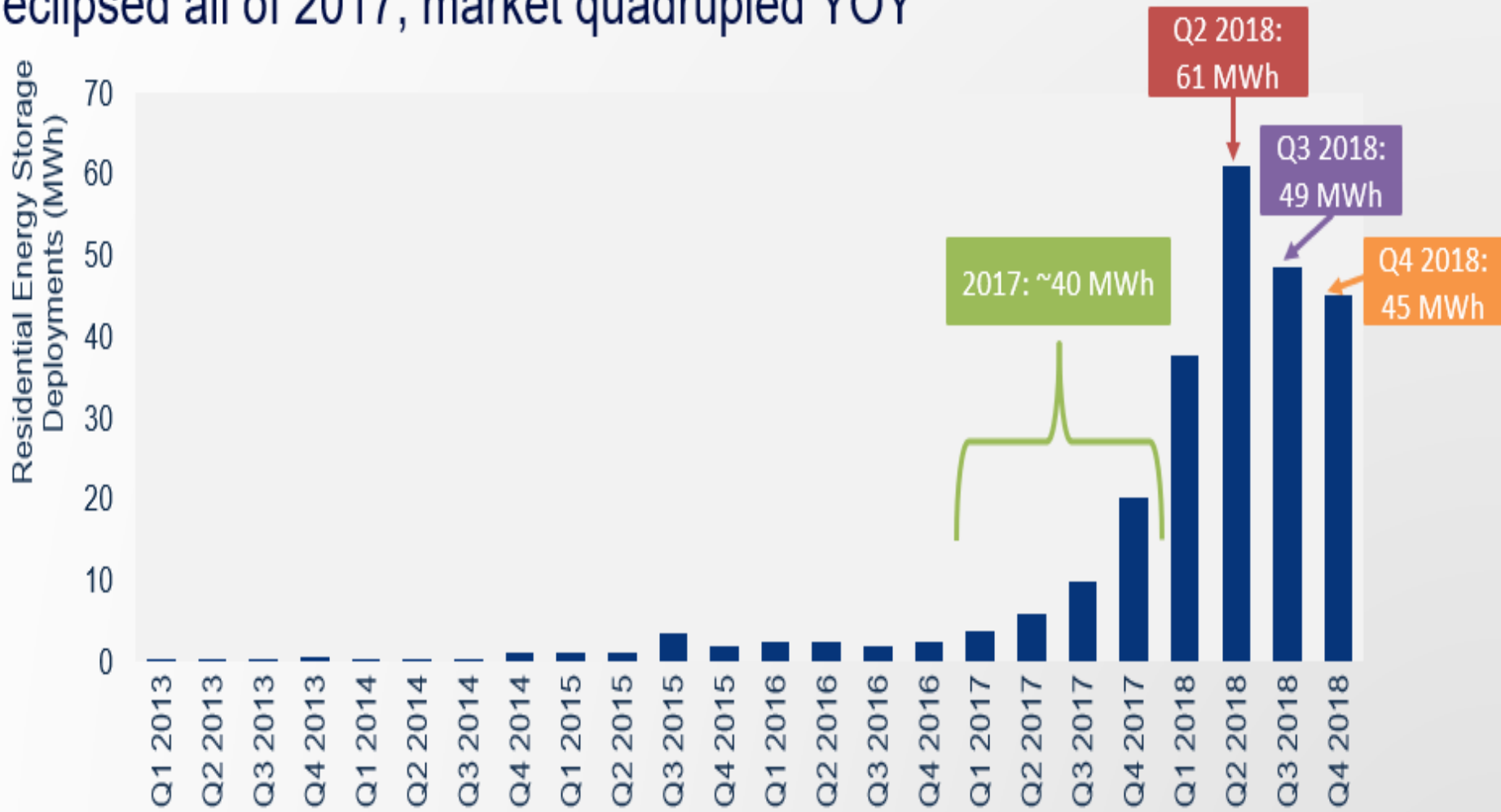
Wood Mackenzie
POWER & RENEWABLES

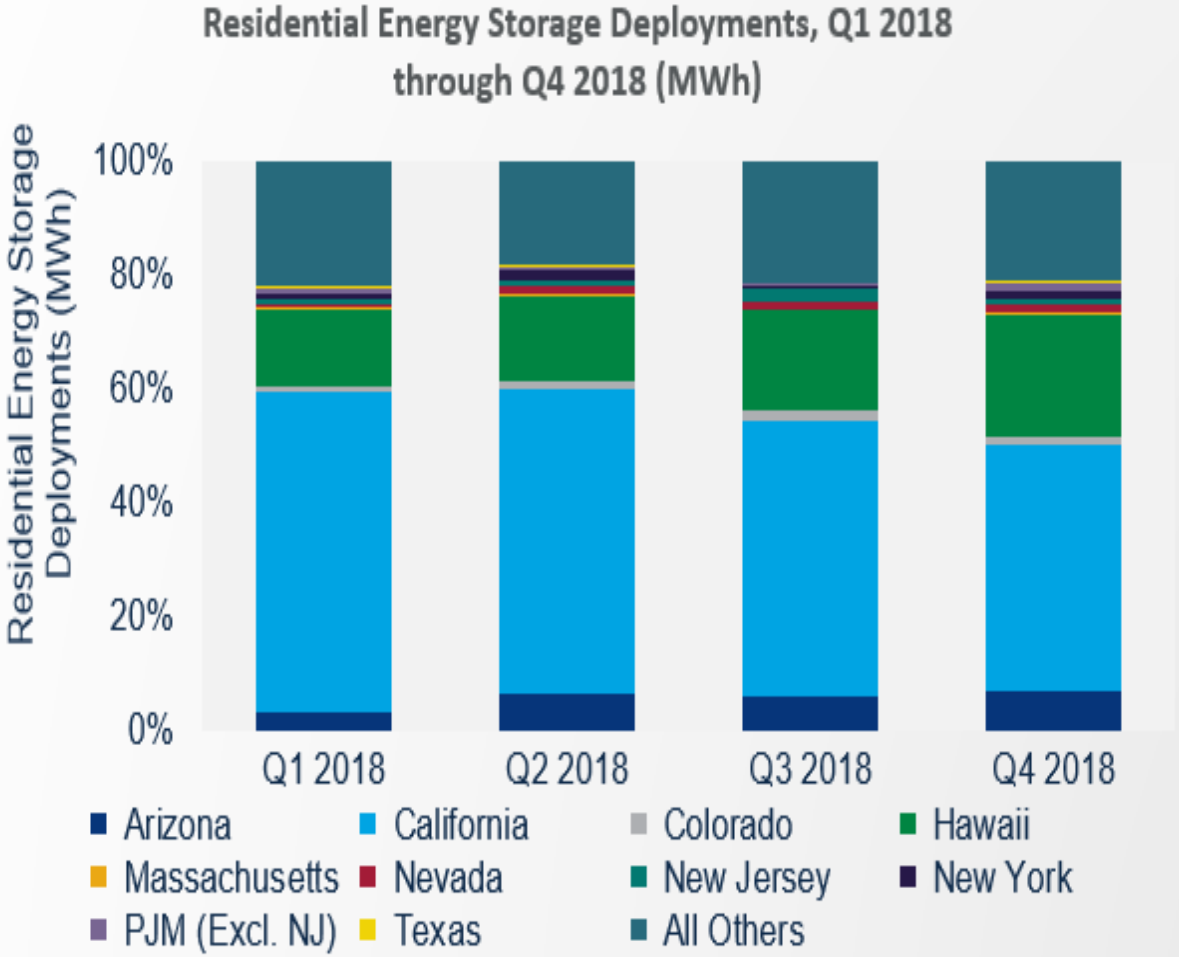
Massive year-over-year growth: individual quarters in 2018 eclipsed all of 2017, market quadrupled YOY



Source: Wood Mackenzie Power & Renewables / ESA *U.S. Energy Storage Monitor*

California and Hawaii continue to rule residential market

Account for 67% of all MWh deployed from Q1 2018 through Q4 2018



Drivers

- Incentives
- Changing NEM rules
- Shifting tariff structures
- Backup power
- General customer demand and installer upsell

Source: Wood Mackenzie Power & Renewables / ESA *U.S. Energy Storage Monitor*

…But storage is expanding beyond California and Hawaii!

Settlement incentive in SRP territory, APS pilots and storage rewards program

Xcel Energy pilot under 2019/2020 Demand Side Mgmt. Plan

JEA storage incentive, proposals for resilience support

MEA storage incentive

SMART incentive

Liberty Utilities Pilot

Storage Roadmap: Bridge Incentive, Pilot Programs

Green Mountain Power Pilot

Source: Wood Mackenzie Power & Renewables

Case Study 1: In New Hampshire, Liberty Utilities' proposes program to leverage residential storage to cut peak demand

Grid services the next frontier for residential storage

Phase 1 – Utility-owned

200

If program goes well…

300 additional

Customer pays either $2,433 upfront or $25/month

Phase 2 – 3rd party

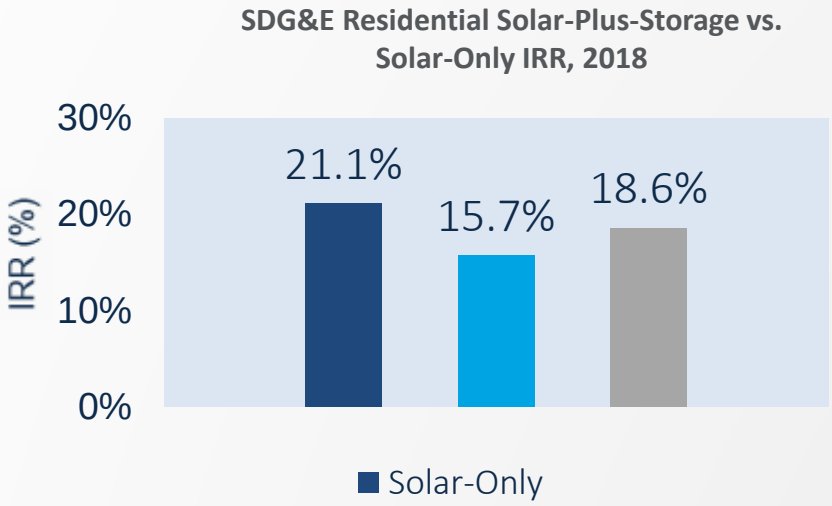
500

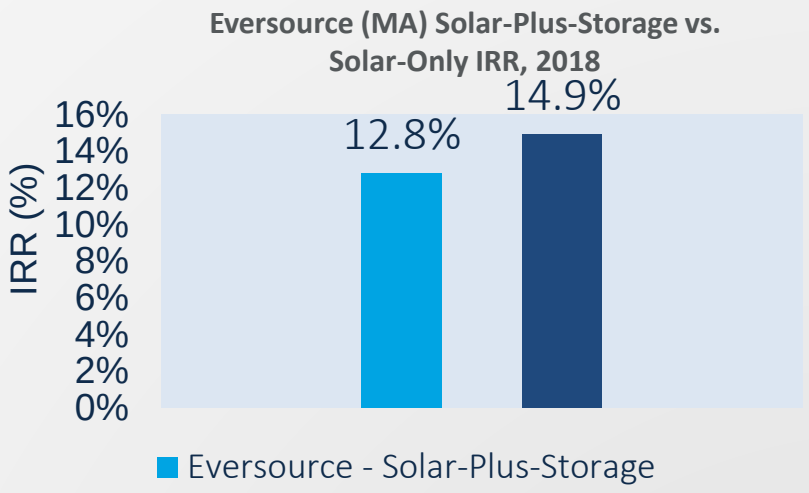
BYOD program, aggregators rewarded for peak demand reduction (value/mechanism TBD)

Liberty Utilities estimated savings: ~$693,000/year (based on 5 MW of storage)

Source: Wood Mackenzie Power & Renewables

Case Study 2: Residential solar-plus-storage economics already competing with solar-only economics in California and Massachusetts

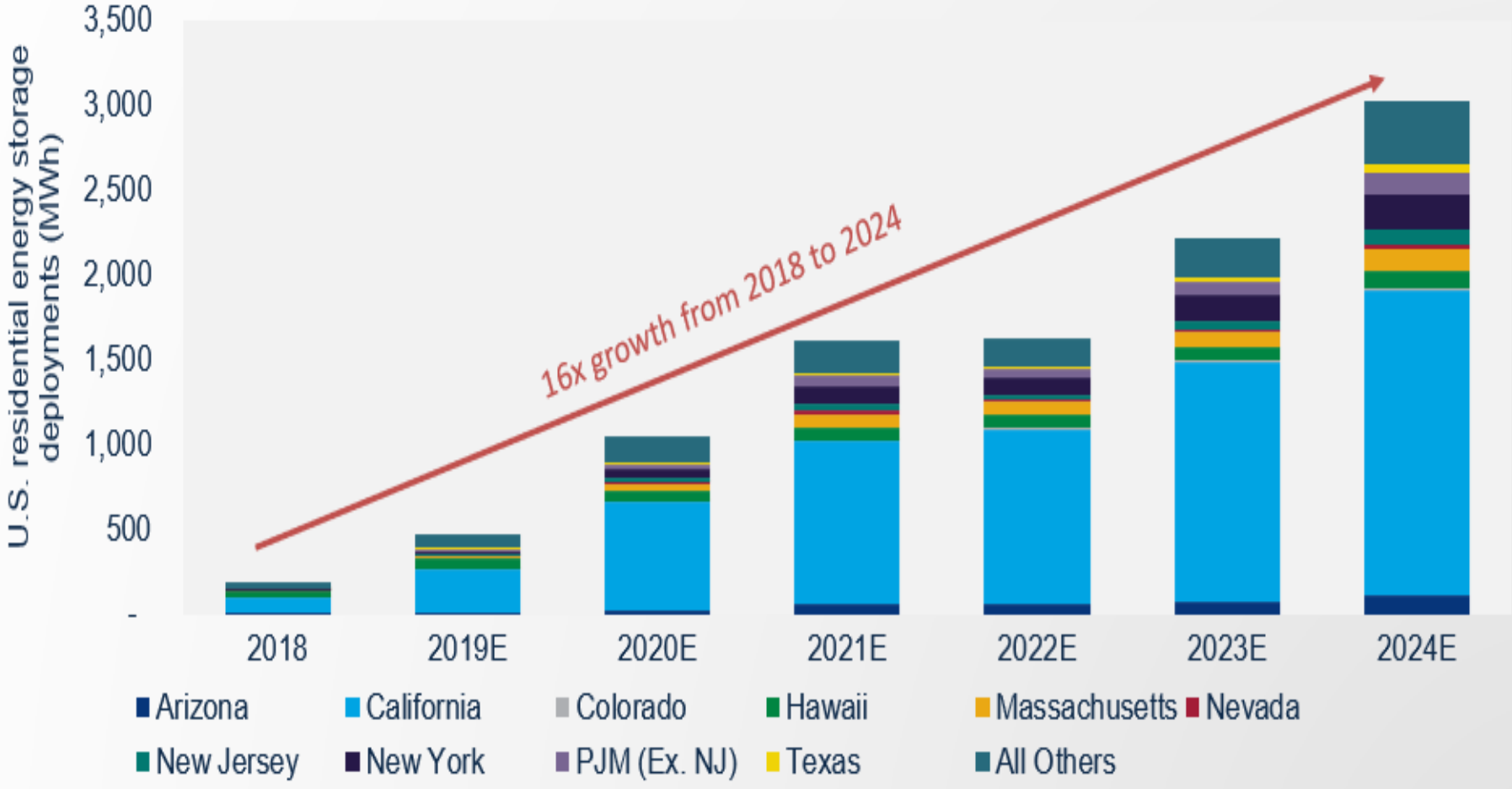




Note: assumes 5 kW/13.5 kWh storage system, 10 kW solar system, $217/kWh battery cost, $1,223/kW storage BOS cost, $2.91/W solar system cost. SGIP incentive for CA of $0.35/Wh capex. MA SMART incentive of $0.54 per exported kWh.

Source: Wood Mackenzie Power & Renewables *Residential Solar-Plus-Storage Economic Analysis 2018*

Residential market grows to 3 GWh annually by 2023



Source: Wood Mackenzie Power & Renewables / ESA *U.S. Energy Storage Monitor*

Thank You!

Questions?

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POWER & RENEWABLES

Key Points

- Residential energy storage capacity is expanding at a rapid annual rate
- California and Hawaii continue to lead the way, but other states are seeing healthy adoption trends
- Utilities are increasingly more aware of how fostering residential energy storage capabilities can address peak-demand concerns

Renee Guillory
Arizona Public Service

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APS Rewards Programs:

A (Mostly) Residential Demand Response, Energy Storage, and Load Management Initiative

Renée Guillory, PMP
Rewards Initiative Project Manager
and
APS Customer Technology Energy Innovation Program Consultant

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Rewards Initiative Genesis

- Strategic amendments to APS' 2016-17 DSM plans
- Demand response, energy storage, load management
- Aligned with operational needs
- Aligned with APS' time-of-use and demand rates
- Approved by Arizona Corporation Commission decisions 76314 and 76313

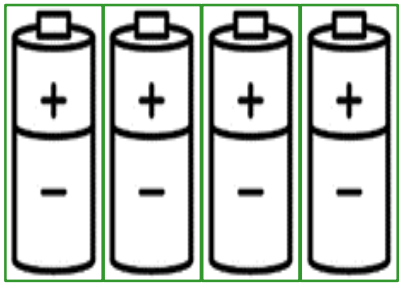
Rewards Initiative Program Scope

~6000
Smart Thermostats

(13,000 by YE2019)

200
80-gallon Water Heaters
+
on targeted feeders

40
7.2 kW / 19.4kWh Residential Batteries
+
on targeted feeders

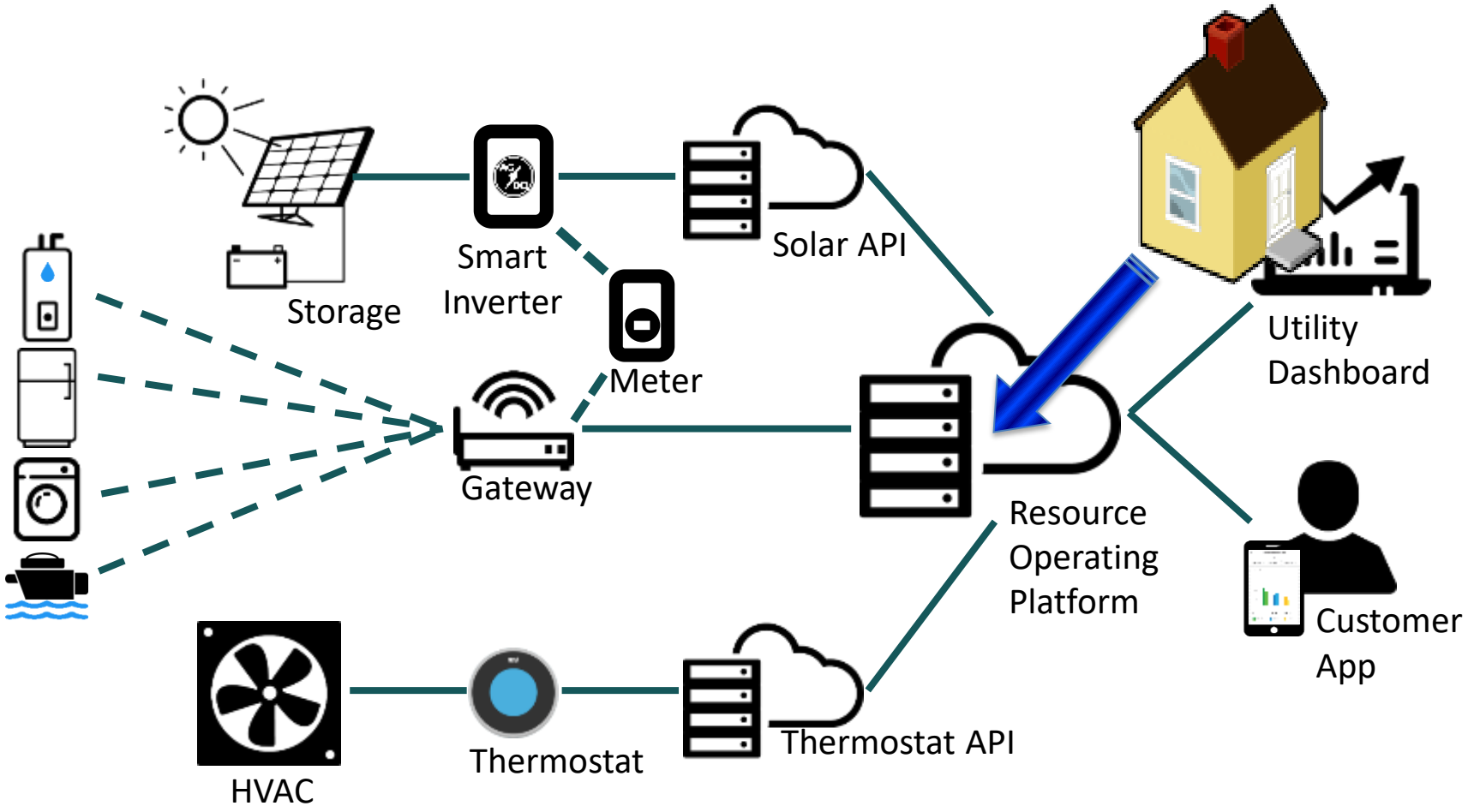


~4
100-200 kW Intermediate Batteries
+
on targeted feeders

Where Are We Now?

- ✓ Device cybersecurity & operations testing complete
- ✓ Fleets under development
- ✓ Integrations with the Resource Operating Platform proceeding
- ✓ Developing future DERMS roadmap

Future state: Technology Ecosystem



Questions?

Key Points

- APS successfully implemented a program to place energy storage in targeted homes
- Results were promising, with utility stakeholders and homeowners being quite satisfied
- Initial successes have prompted APS to begin plans to explore a larger implementation of residential storage options

Explore the Residential Program Solution Center

Resources to help improve your program and reach energy efficiency targets:

- Handbooks - explain *why* and *how* to implement specific stages of a program.
- Quick Answers - provide answers and resources for common questions.
- Proven Practices posts - include lessons learned, examples, and helpful tips from successful programs.
- Technology Solutions NEW! - present resources on advanced technologies, **HVAC** & **Heat Pump Water Heaters**, including installation guidance, marketing strategies, & potential savings.

https://rpsc.energy.gov

Thank You!

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Please send any follow-up questions or future call topic ideas to:
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