Energy Storage Technology Advancement Partnership (ESTAP) Webinar

State of the U.S. Energy Storage Industry: 2019 Year in Review

Hosted by
Todd Olinsky-Paul, Project Director, CESA

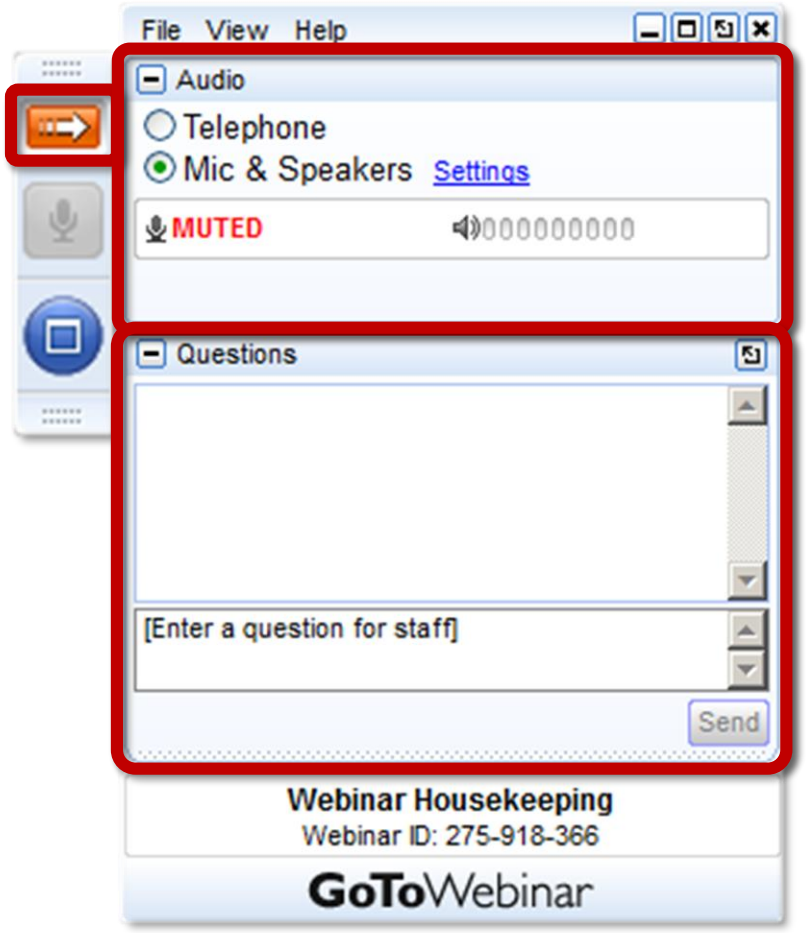
February 6, 2020

U.S. DEPARTMENT OF ENERGY

Sandia National Laboratories

CleanEnergy States Alliance

Housekeeping



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Energy Storage Technology Advancement Partnership (ESTAP) (bit.ly/ESTAP)

ESTAP is supported by the U.S. Department of Energy Office of Electricity and Sandia National Laboratories, and is managed by CESA.

ESTAP Key Activities:

1. Disseminate information to stakeholders

   - ESTAP listserv >5,000 members
   - Webinars, conferences, information updates, surveys.

2. Facilitate public/private partnerships to support joint federal/state energy storage demonstration project deployment

3. Support state energy storage efforts with technical, policy and program assistance

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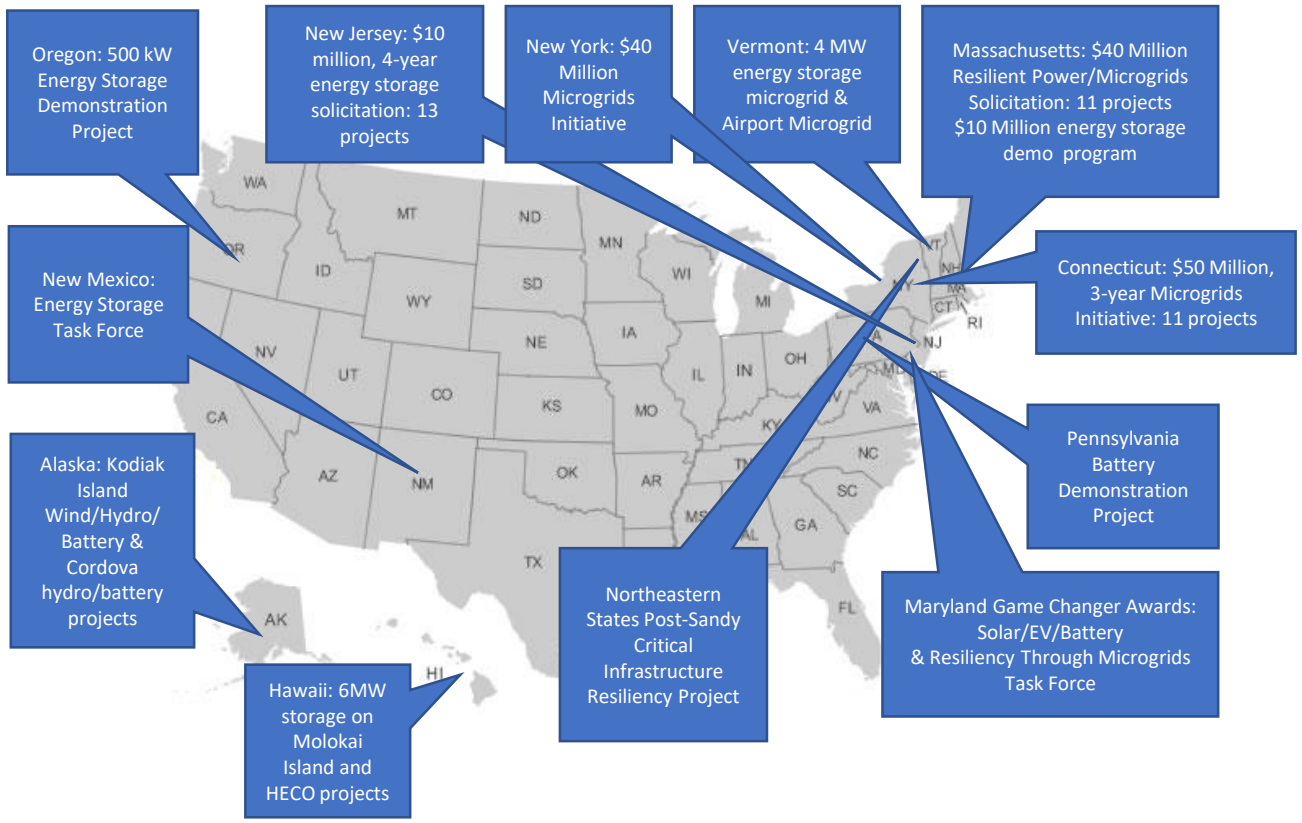
ESTAP Project Locations:



Webinar Speakers

Dr. Imre Gyuk
Director, Energy Storage Research, U.S. Department of Energy

Dan Finn-Foley
Head of Energy Storage, Wood Mackenzie Power & Renewables

Todd Olinsky-Paul
Project Director, Clean Energy States Alliance (moderator)

Grid Scale Energy Storage: 3 Recent DOE Projects

IMRE GYUK, DIRECTOR,
ENERGY STORAGE RESEARCH, DOE-OE

Sterling, MA: Microgrid/Storage Project

Sterling Municipal Light Department.

$1.5M Grant from MA Community Clean Energy Resiliency Initiative (Dept. of Energy Resources). Further Funding fromDOE/Sandia.

2MW/2hr storage with existing 3.4 MW PV to provide resiliency for Police HQ and Dispatch Center. Li-ion batteries provided by NEC.

Sterling, MA, October 2016

Sterling, MA, December 2016

2016 Dec. till **2017** Nov.
Actual Savings:

- Arbitrage $11,731
- Monthly Peaks $143,447
- Annual Peak $240,660
- Total $395,839

Sean Hamilton

Chart: Carina Kaainoa

April 2019: 1 million Avoided Cost!

Visitors: Germany, Switzerland, Denmark, Sweden, England, Ireland, Australia, Japan, Malaysia, Taiwan, Brazil, Chile, …. Thailand

Cordova, Alaska, Municipal System

Cordoba, Grid Isolated

6MW Run of RiverHydro Power

Total Generating Capacity:

6MW + 1.25MW Hydro; 2x 1MW Diesel

0.5MW Deflected as Spinning Reserve

Hydro: $0.06/kW; Diesel: $0.60/kW

Ribbon Cutting with Sen. Murkowski

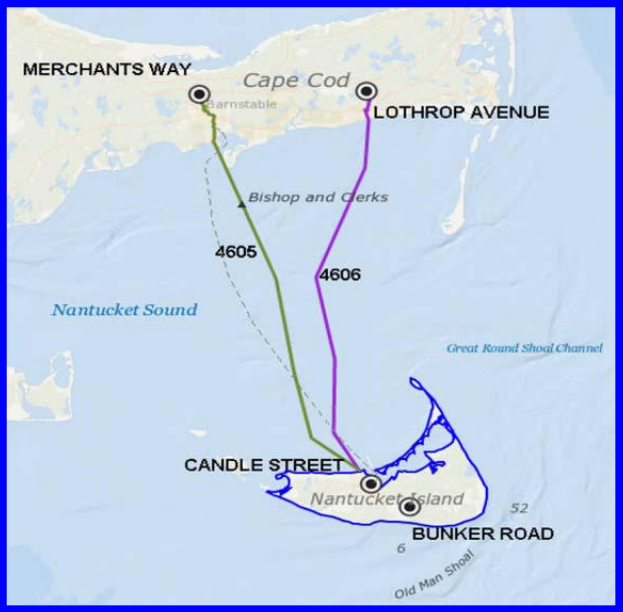
1 MW / 1 hr Li-ion Storage

Commissioned June 7, 2019

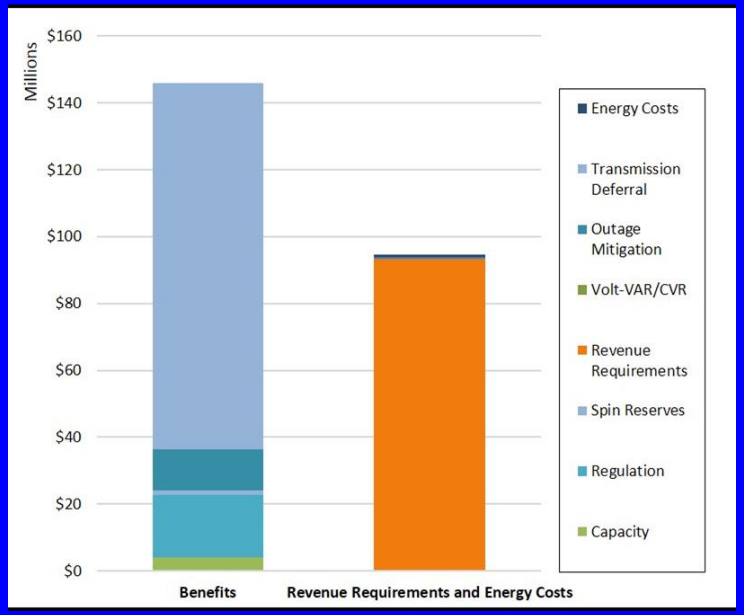
- Frequency Regulation
- Load following
- Emergency Supply

Thanksgiving, Nov. 2019
2 days: 4hrs diesel vs. 48 hrs
$10,000 in savings

Nantucket – National Grid, Tesla, PNNL/DOE



71 MW Submarine Cables



Analytics: Balducci et al. PNNL

$110 million Deferral Value + $36 million Operational Benefits

Installation: 6MW/8hr Storage + 6-10 MW Generator to yield required 91MW Peaking Capacity

PNNL evaluated technical and financial benefits of energy storage:

- Financial benefits of ES
- Technical impact on distribution system
- Control strategies to maximize financial benefits while achieving resiliency goals.

Ribbon Cutting: Oct. 8, 2019. Return on Investment: 1.55

In addition to transmission deferral, other potential economic benefits could include:

- ISO-NE demand response program participation
- ISO-NE ancillary service markets
- ISO-NE forward capacity and reserve markets
- Energy arbitrage, Outage mitigation

U.S. Energy storage market overview

Dan Finn-Foley
Head of Energy Storage
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Wood Mackenzie

About Wood Mackenzie

We provide commercial insight and access to our experts leveraging our integrated proprietary metals, energy and renewables research platform

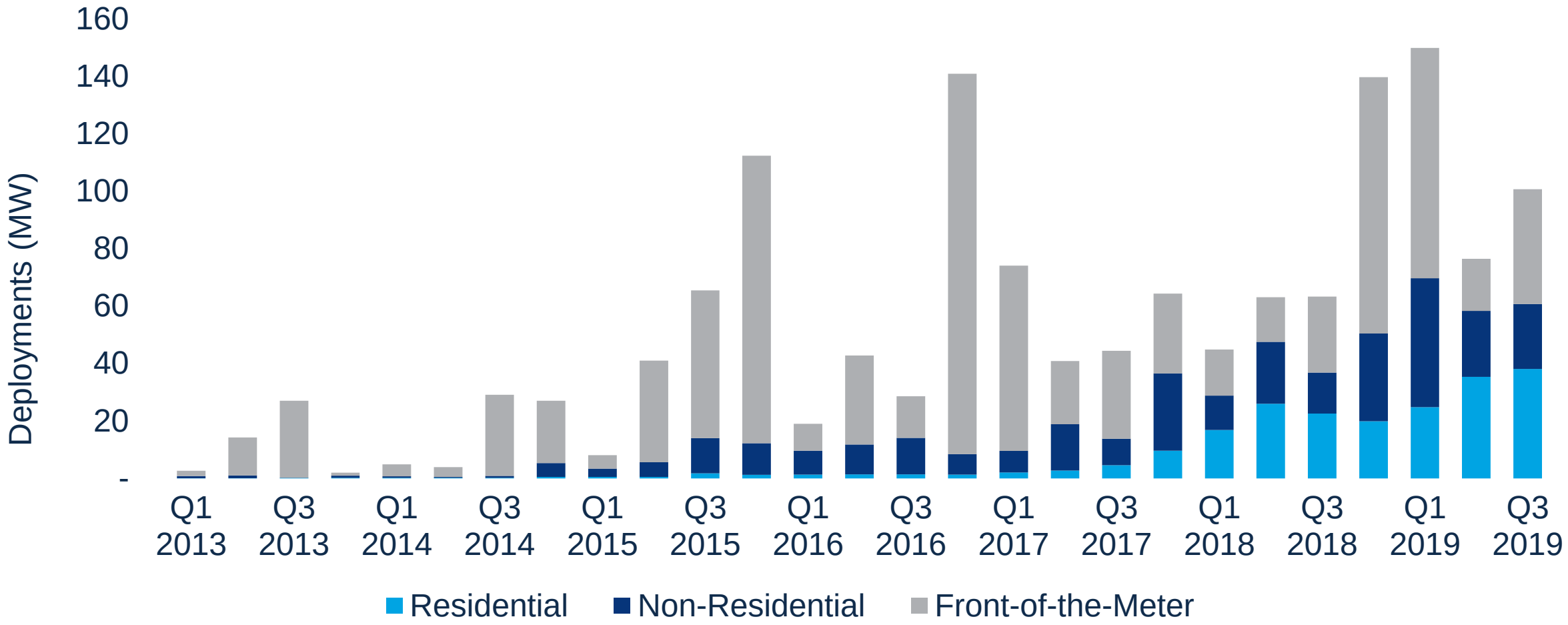
Wood Mackenzie is ideally positioned to support consumers, producers and financers of the new energy economy.

- Acquisition of MAKE and Greentech Media (GTM)
- Leaders in renewables, EV demand and grid-connected storage
- Over 500 sector-dedicated analysts and consultants globally, including 75 specifically to power and renewables
- Located close to clients and industry contacts

1. Deployment trends

U.S. Q3 2019 deployments up 32% quarter-over-quarter

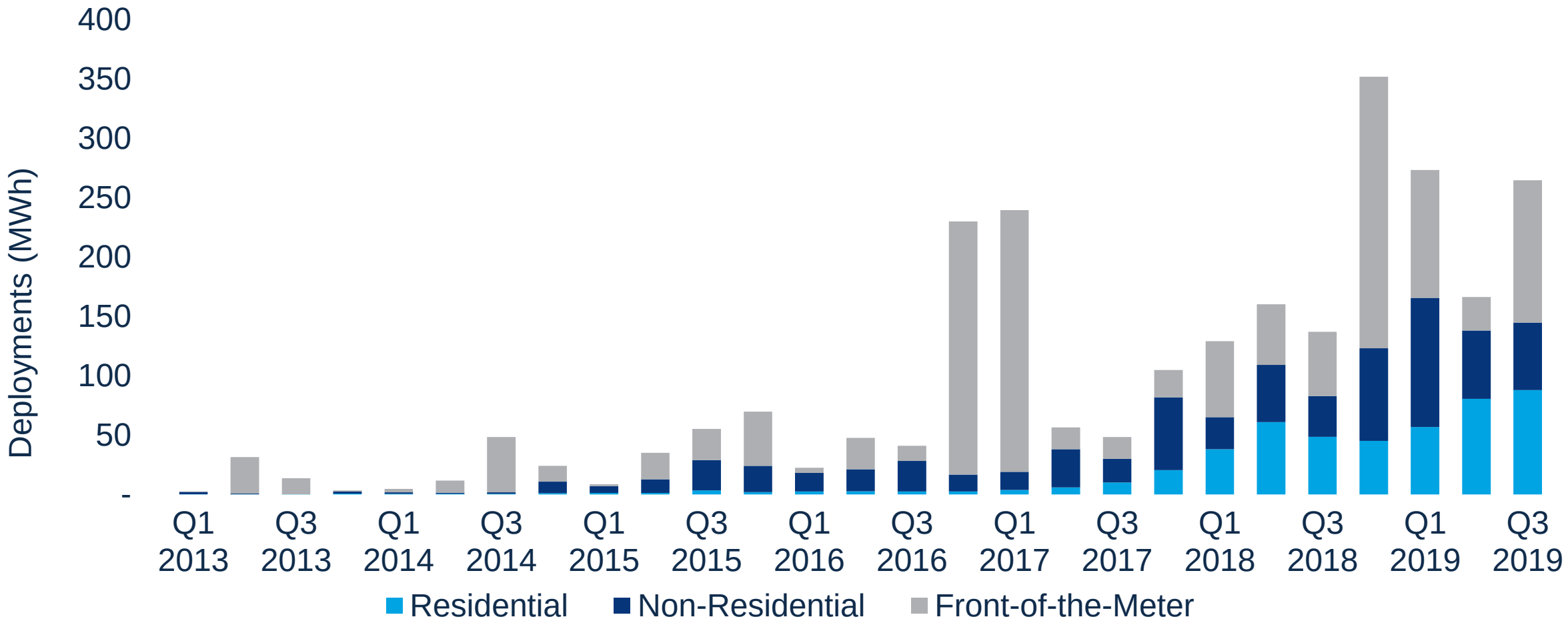
Rebounding front-of-the-meter segment helps push market higher; behind-the-meter market roughly flat QOQ



Source: Wood Mackenzie Power & Renewables

In Q3 2019, megawatt-hours deployed increased by 59%

Market grew 93% year-over-year



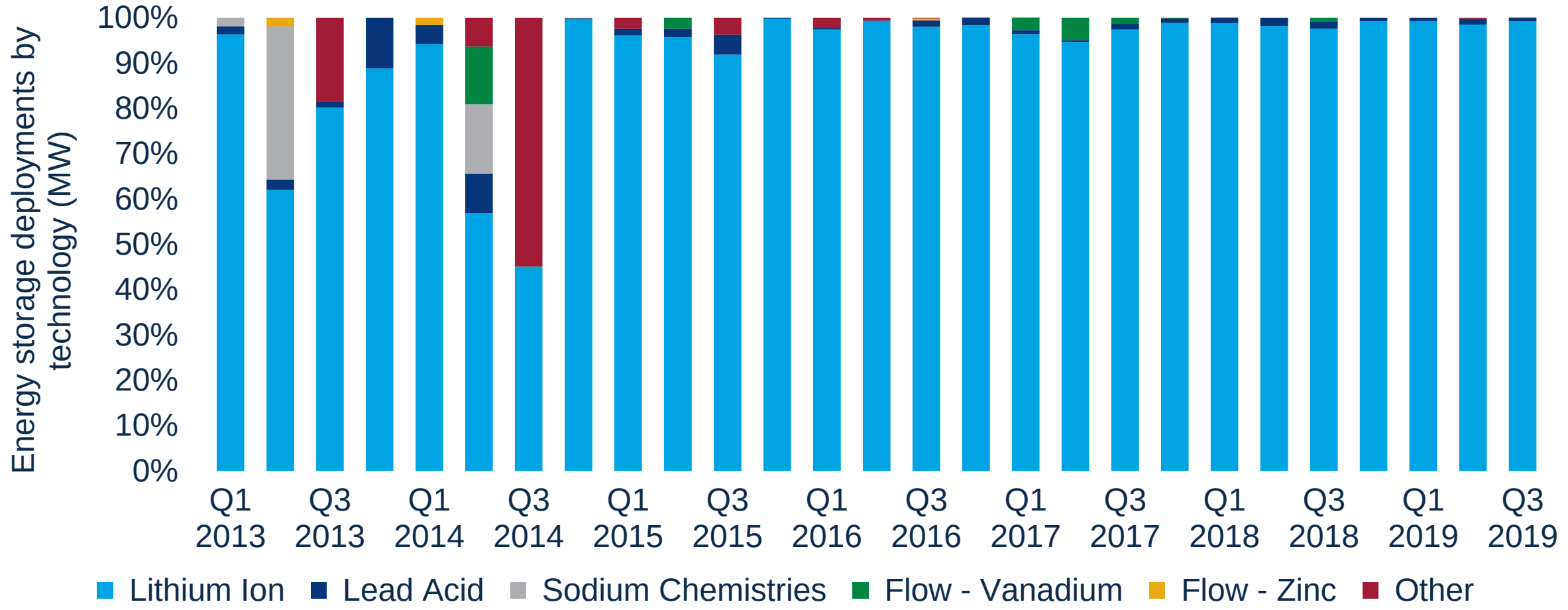
Source: Wood Mackenzie Power & Renewables

2. Technology and system price trends

Lithium-ion still dominates the market, accounting for 99.2% share in Q3 2019

Lead-acid hovers around 0.8%; a single vanadium flow battery project in Q3 accounts for roughly 0.01% share

Quarterly energy storage deployment share by technology (MW %)

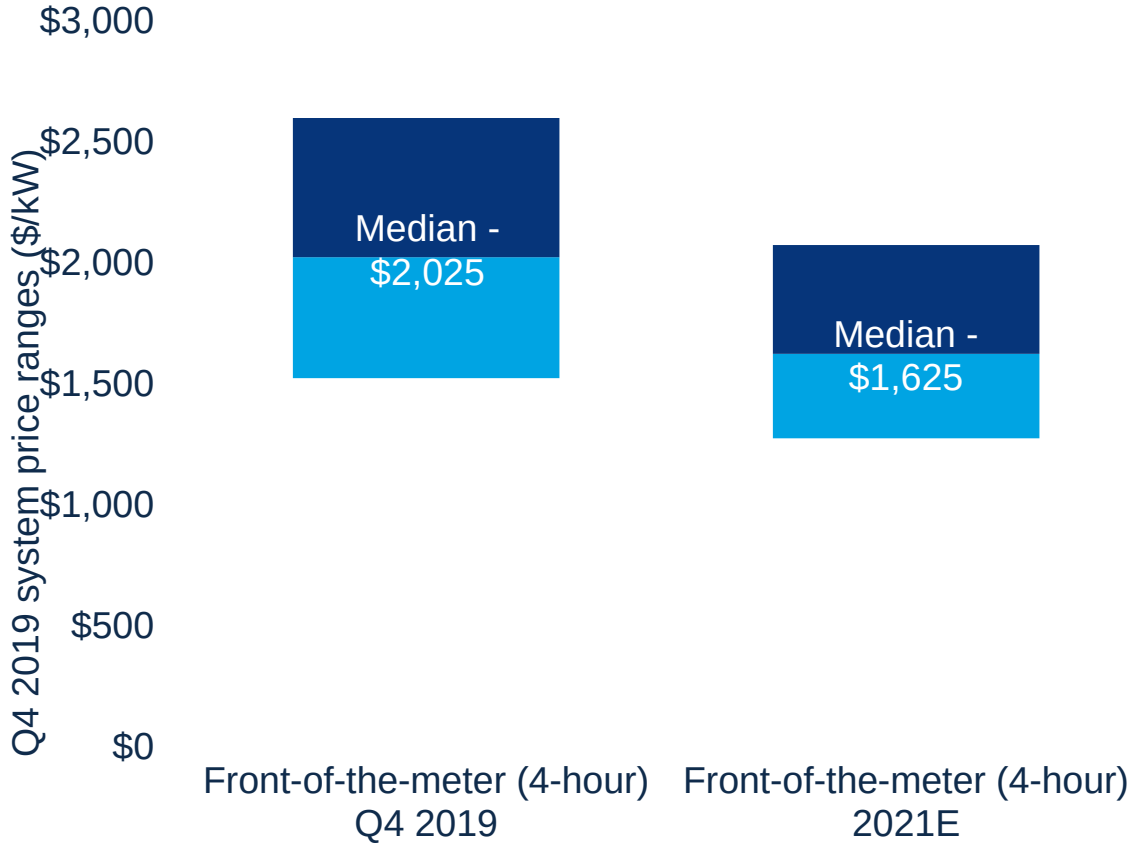


* “Other” includes flywheel and unidentified energy storage technologies.

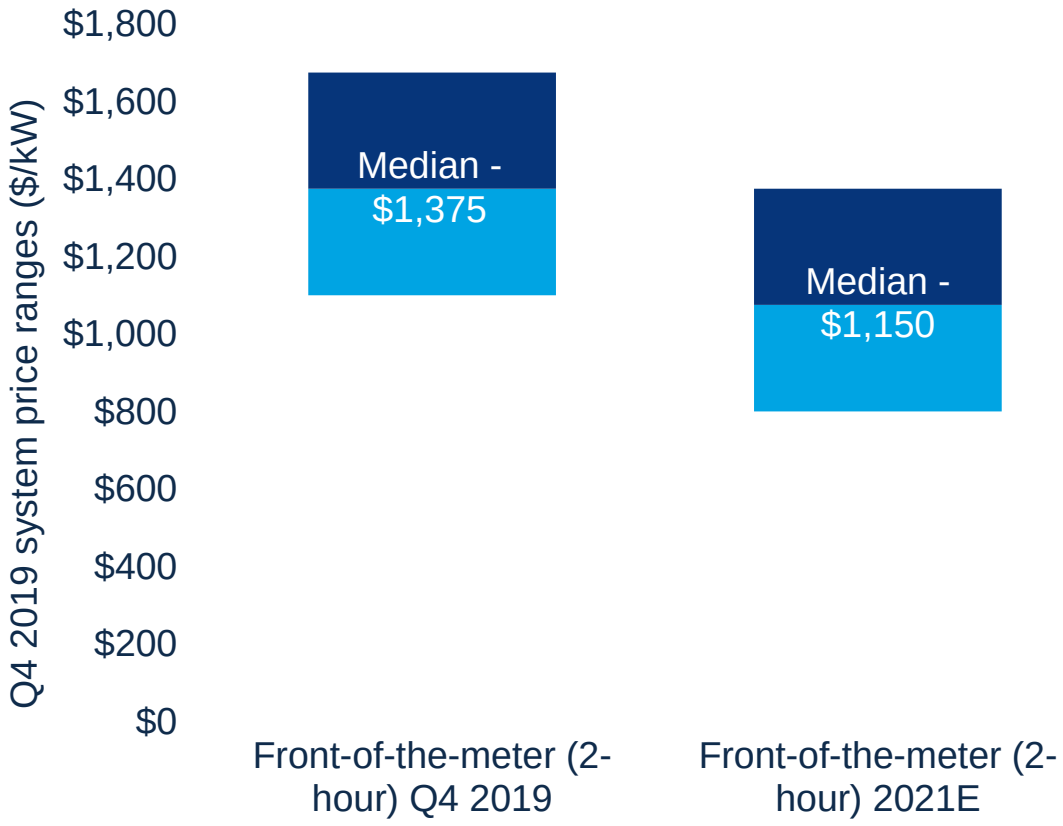
Source: Wood Mackenzie Power & Renewables

Prices of long- and medium-duration FTM systems set to decline more than 15% by 2021

Price trends for front-of-the-meter fully installed systems, Q4 2019 and 2021E, 4-hour ($/kW)



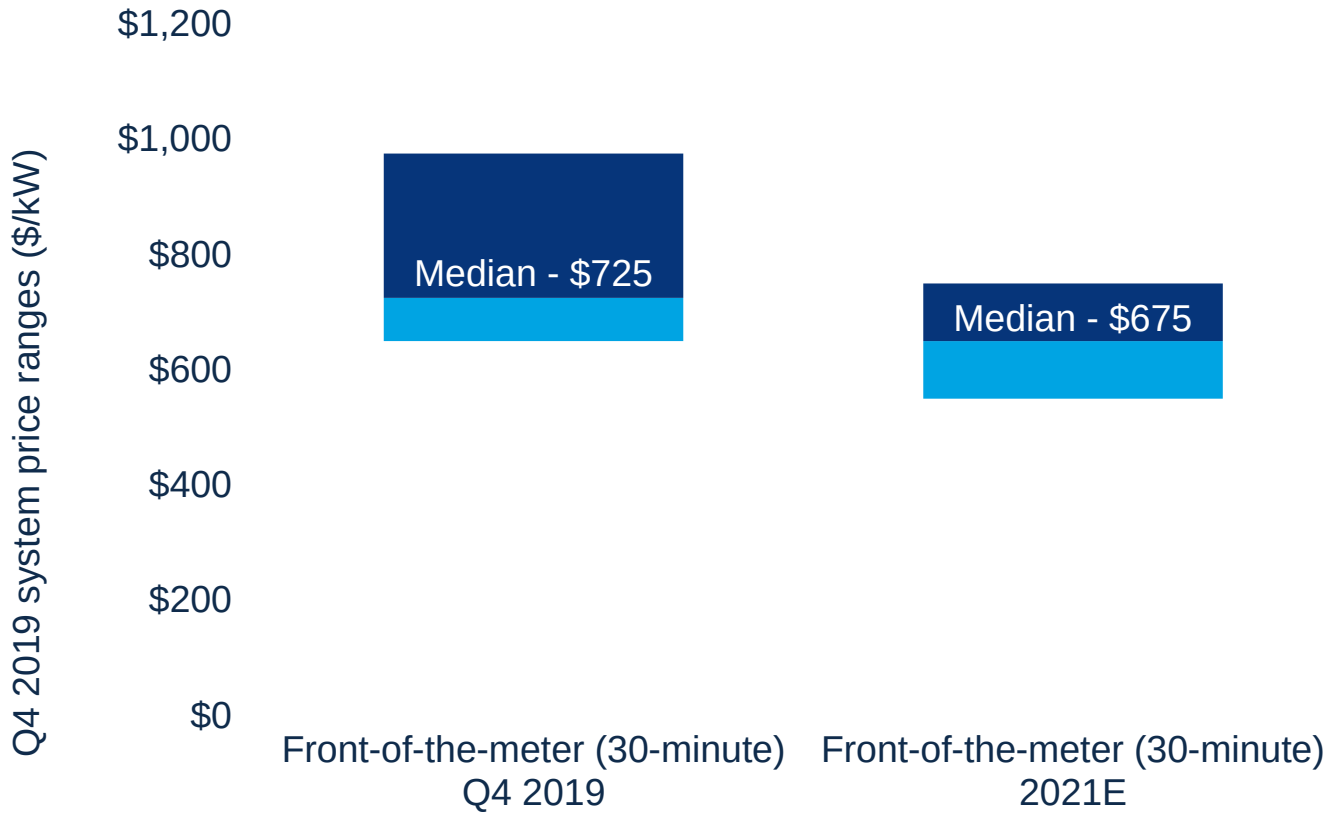
Price trends for front-of-the-meter fully installed systems, Q4 2019 and 2021E, 2-hour ($/kW)



Note: The prices shown in charts are for fully installed systems including interconnection
Source: Wood Mackenzie Power & Renewables

Short-duration FTM system prices expected to decline by 10% over the next two years

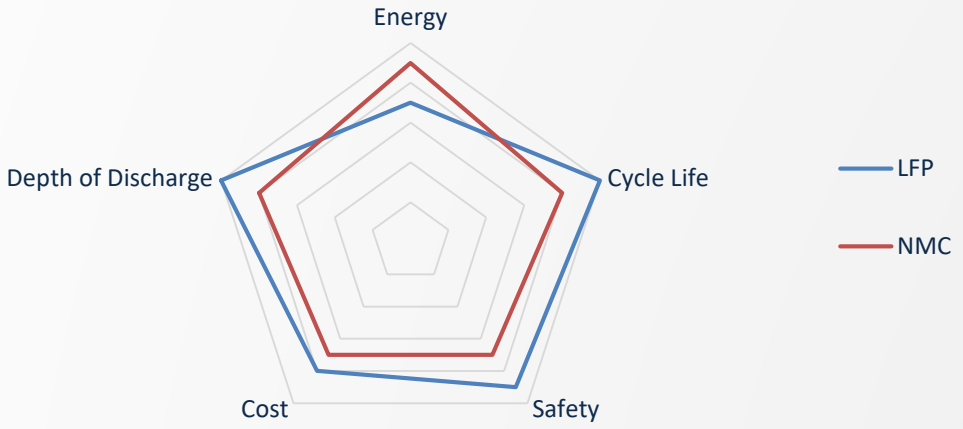
Price trends for front-of-the-meter fully installed systems, Q4 2019 and 2021E, 30-min. ($/kW)

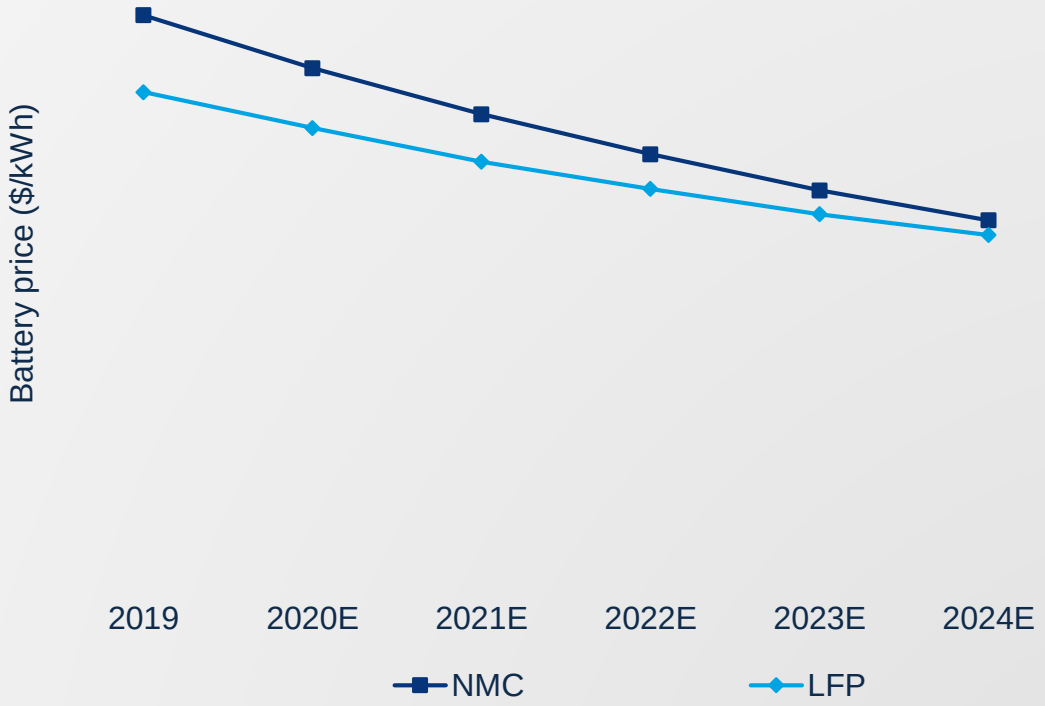


Note: The prices in the chart are for fully installed systems including interconnection
Source: Wood Mackenzie Power & Renewables

Changing battery chemistry will drive down battery prices

2018 was the year of NMC shortage, but LFP is here to stay

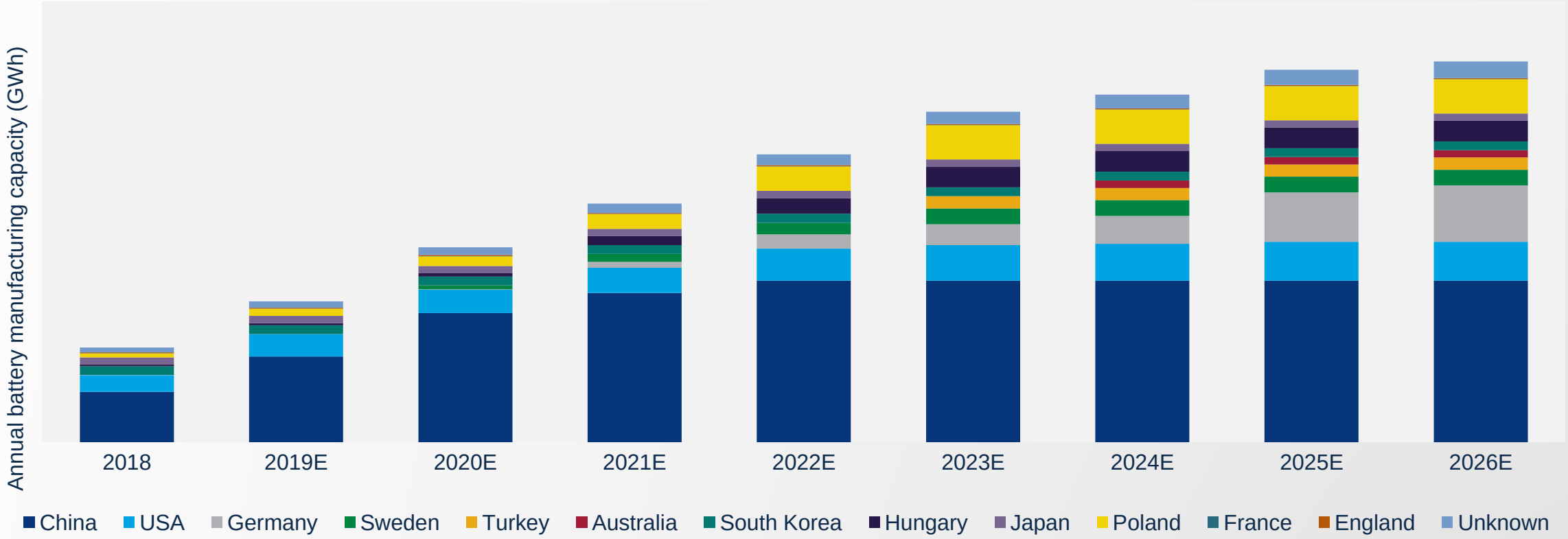




Source: Wood Mackenzie

Source: Wood Mackenzie Power & Renewables

Global battery manufacturing scale-up will drive down battery prices in the future



Source: Wood Mackenzie

3. Market drivers and outlook

Front-of-the-meter policy and market developments, Q3 2019

PacifiCorp

PacifiCorp's 2019 integrated resource plan calls for dramatic increases in planned solar and storage compared to 2017's version. It impacts multiple states in the utility's Northwest U.S. service territory.

California

California Public Utilities Commission ordered 2-3 GW of new resources to meet capacity shortfall anticipated in Southern California. CPUC approved 95 MW of storage procurements to provide local capacity requirements for utility SCE.

Texas

Grid operator **ERCOT** established Battery Energy Storage Task Force.

Hawaii

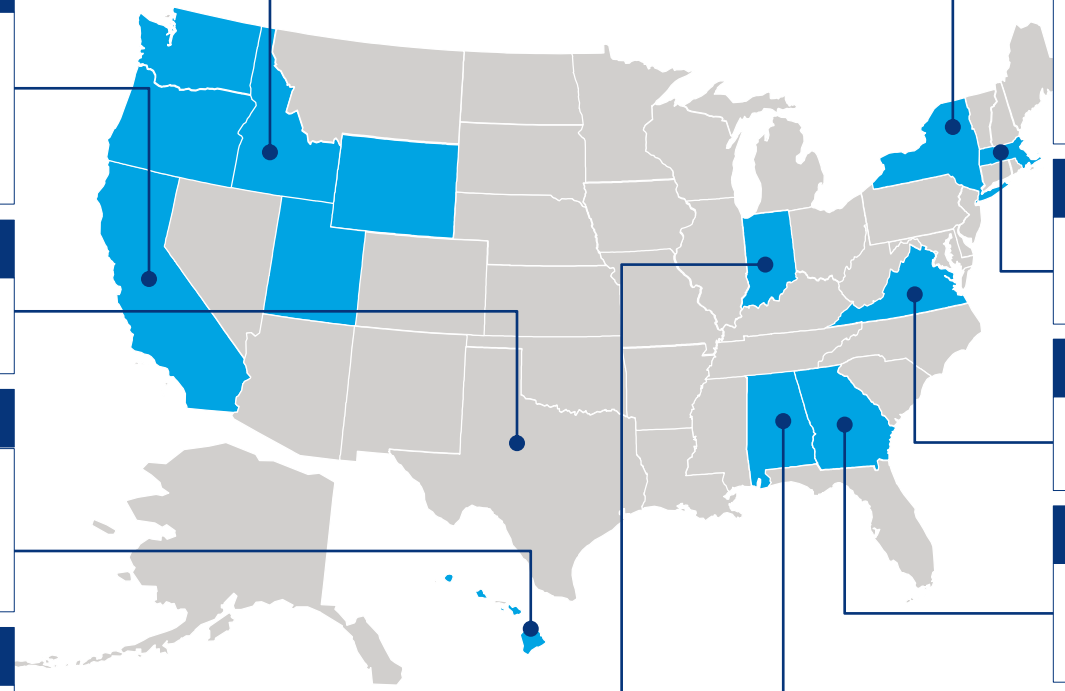
Utility **HECO's** Phase II renewables request for proposals includes targeted procurement of resources, including storage, to replace retiring fossil fuel plants.

Federal

The **U.S. Senate** introduced a bill to create a distributed energy opportunity board for the purpose of streamlining DER permitting. An amended BEST act was also passed in the U.S. Senate. Additional tariffs were placed in Chinese lithium-ion batteries.

FERC

The **Federal Energy Regulatory Commission** approved storage participation rules for grid operators PJM and SPP under Order 841 and opened a proceeding examining capacity qualifications.



Indiana

Northern Indiana Public Service Company released an RFP for 2,300 MW of solar and solar-plus-storage resource, among others.

New York

New York Fire Prevention and Building Code Council and the **New York Department of State** issued an emergency rulemaking concerning storage permitting in New York, followed by a finalized change to the fire prevention and building code. **FDNY's** outdoor storage permitting rules went into effect on 1 October 2019. **The NY Public Service Commission** approved plans for a 316 MW battery system to replace existing combustion turbines. Additional financing available through the **Green Bank.**

Massachusetts

The **Department of Energy Resources** proposed changes to the SMART program as part of a review process.

Virginia

Dominion released an RFP for new capacity resources.

Georgia

Georgia Power signed a PPA for a 40 MW/80 MWh system for 2021 delivery.

Alabama

Alabama Power submitted plans for five power-purchase agreements for solar-plus-storage systems.

Source: Wood Mackenzie Power & Renewables

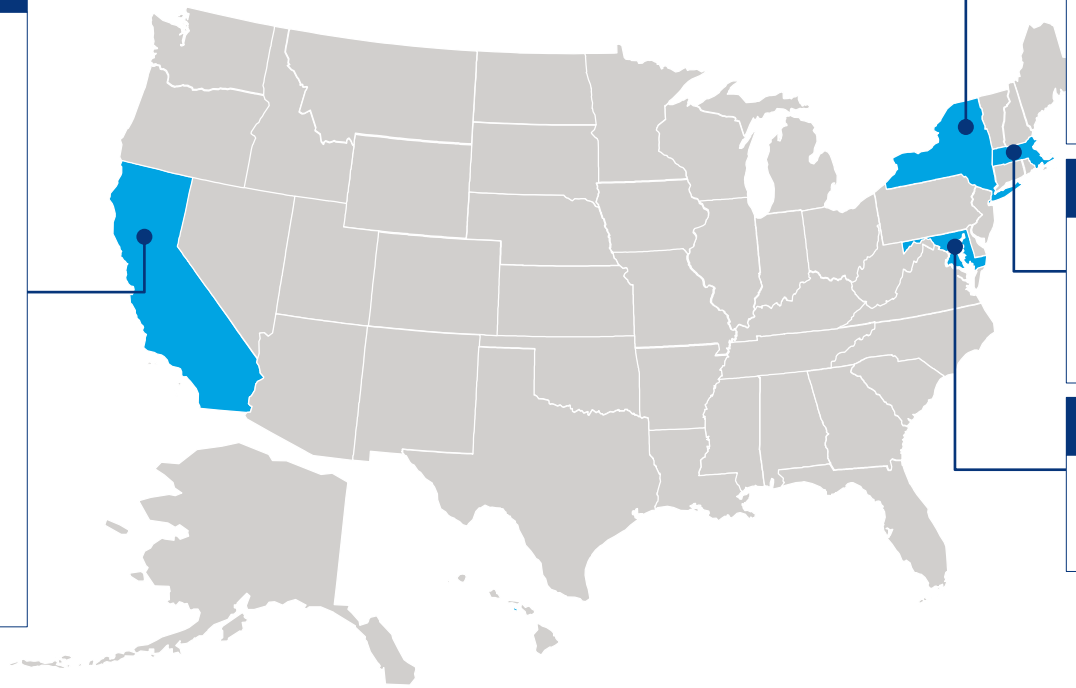
Behind-the-meter policy and market developments, Q3 2019

Federal

The **U.S. Senate** introduced a bill to create a distributed energy opportunity board for the purpose of streamlining DER permitting.

California

The **California Public Utilities Commission** revised the Self-Generation Incentive Program to include additional funding for systems supporting low-income communities and customers with resilience needs; it also denied a petition to remove mandatory time-of-use rates from residents of affordable multifamily housing enrolled in virtual net energy metering programs and approved 95 MW of storage procurements to provide local capacity requirements for utility SCE. **East Bay Community Energy, Peninsula Clean Energy, Silicon Valley Clean Energy and Silicon Valley Power** issued a joint RFP to procure 32.7 MW of BTM storage to support resource adequacy and customer resilience. The **City of San Jose** issued a grid resiliency replacement memorandum.



New York

New York Fire Prevention and Building Code Council and the **New York Department of State** issued an emergency rulemaking concerning storage permitting in New York, followed by a finalized change to the fire prevention and building code. **FDNY's** outdoor storage permitting rules went into effect on 1 October 2019. **NYSERDA** added a fourth block to the retail incentive program under the bridge incentive.

Massachusetts

DOER proposed changes to the SMART program as part of a review. The **Massachusetts fire code** was amended to add storage provisions more in line with recent National Fire Protection Association rules.

Maryland

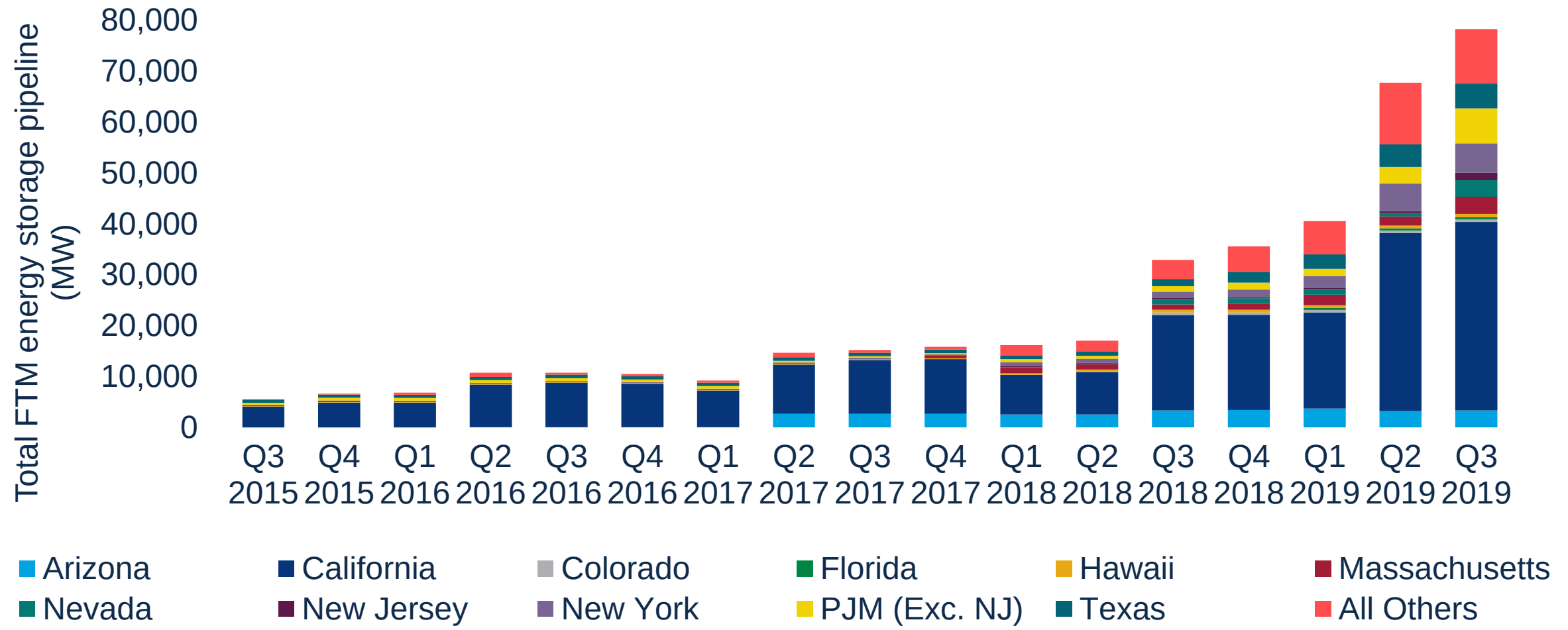
Maryland Public Service Commission approved new energy storage interconnection standards.

Source: Wood Mackenzie Power & Renewables

Total FTM pipeline grows to 78 GW led by PJM and Massachusetts

This represents a 15% increase to the pipeline QOQ and a 2.4x growth YOY

U.S. front-of-the-meter energy storage pipeline by market, Q3 2015-Q3 2019 (MW)

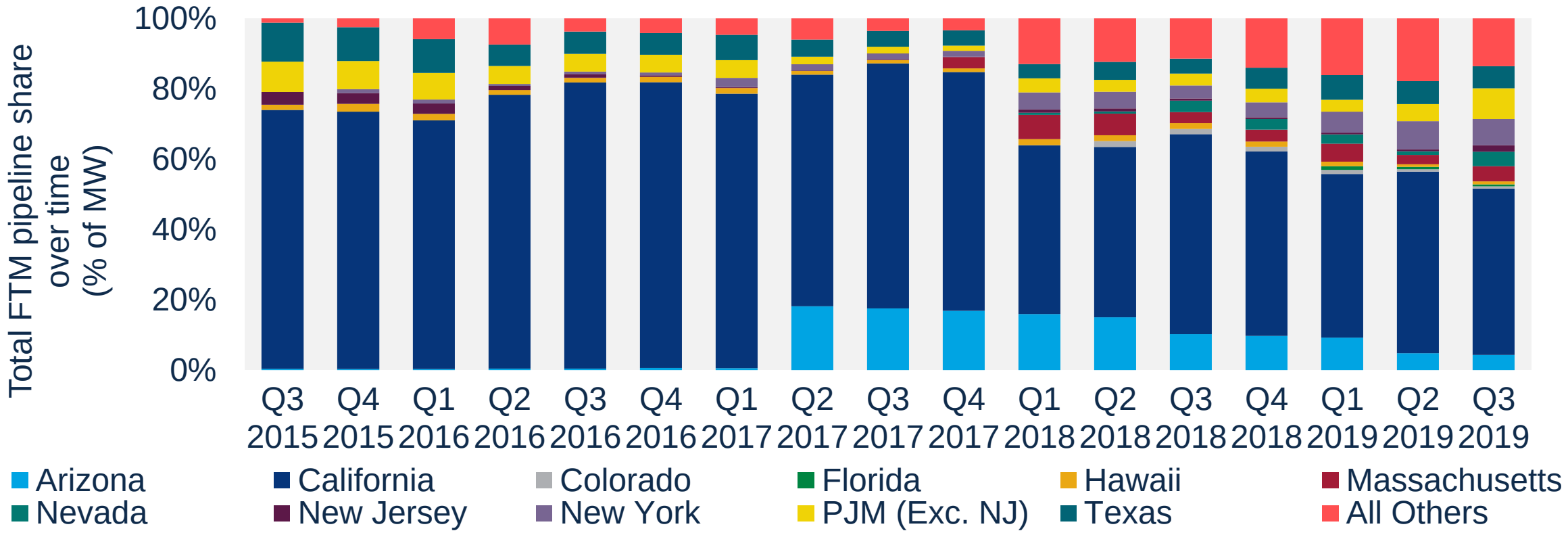


Source: Wood Mackenzie Power & Renewables

Total FTM pipeline grows to 78 GW led by PJM and Massachusetts (cont.)

This represents a 15% increase to the pipeline QOQ and a 2.4x growth YOY

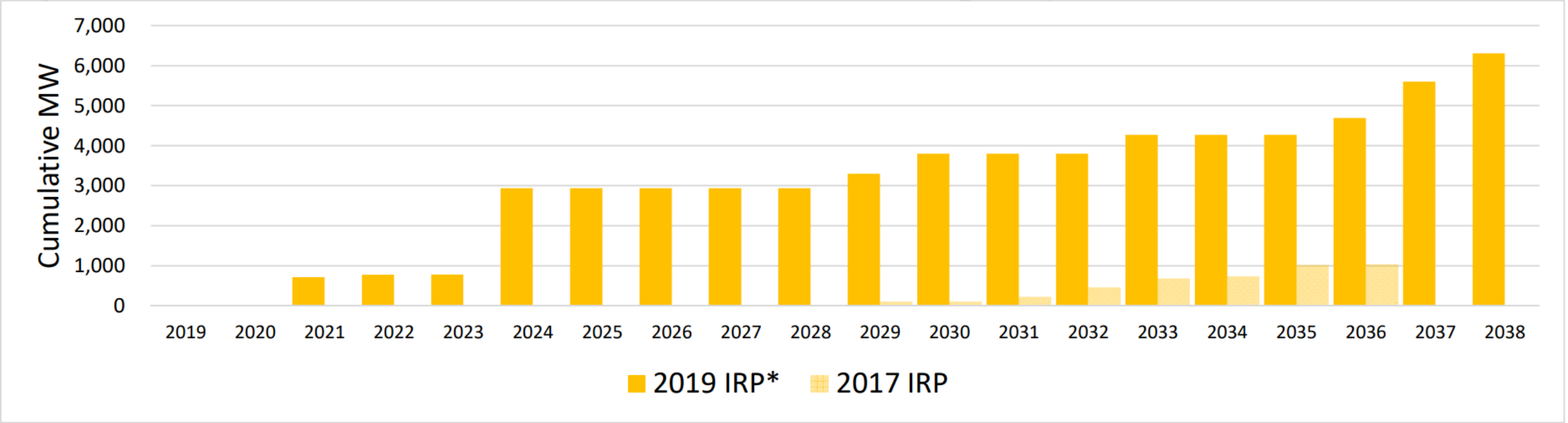
U.S. front-of-the-meter energy storage pipeline market share, Q3 2015-Q3 2019 (%)



Source: Wood Mackenzie Power & Renewables

Case study – Pacificorp integrated resource plan, 2017 vs. 2019

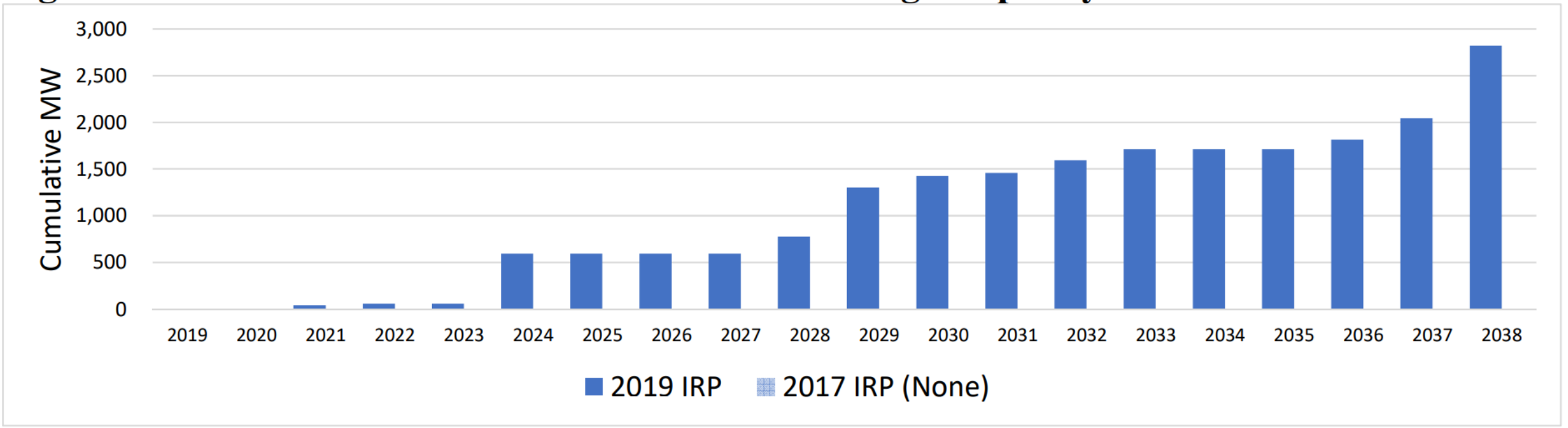
Figure 1.3 – 2019 IRP Preferred Portfolio New Solar Capacity*



Source: Pacificorp IRP

Case study – Pacificorp integrated resource plan, 2017 vs. 2019

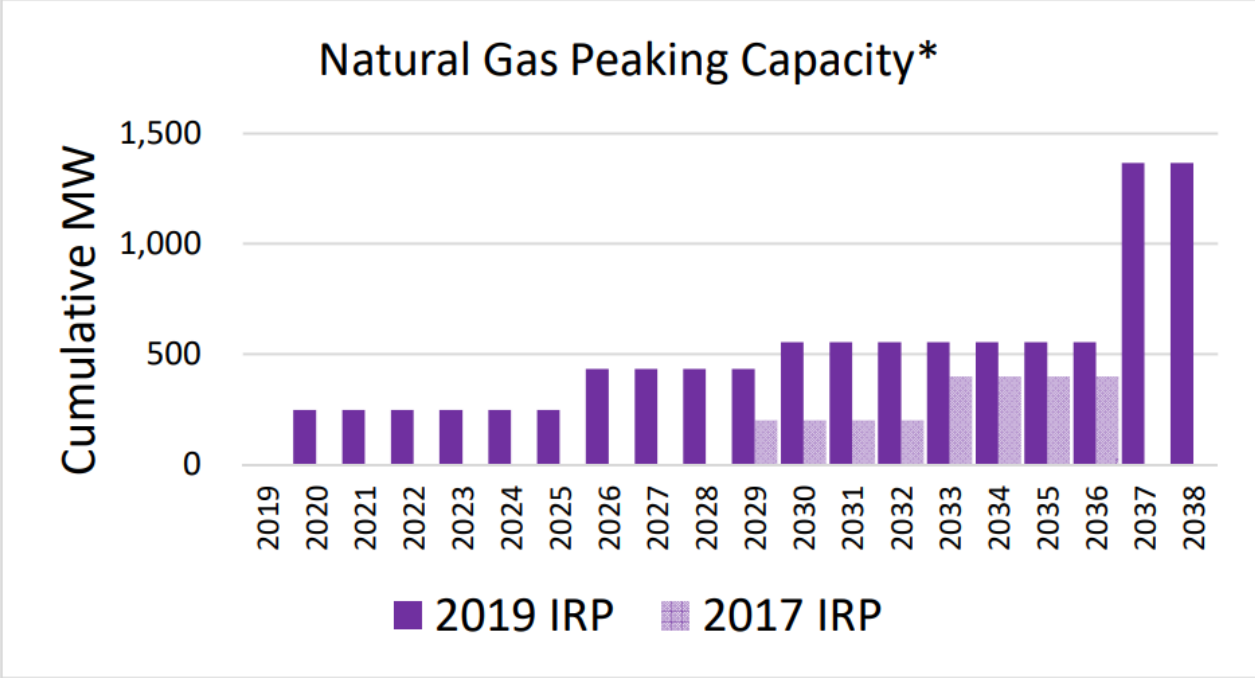
Figure 1.5 – 2019 IRP Preferred Portfolio New Storage Capacity

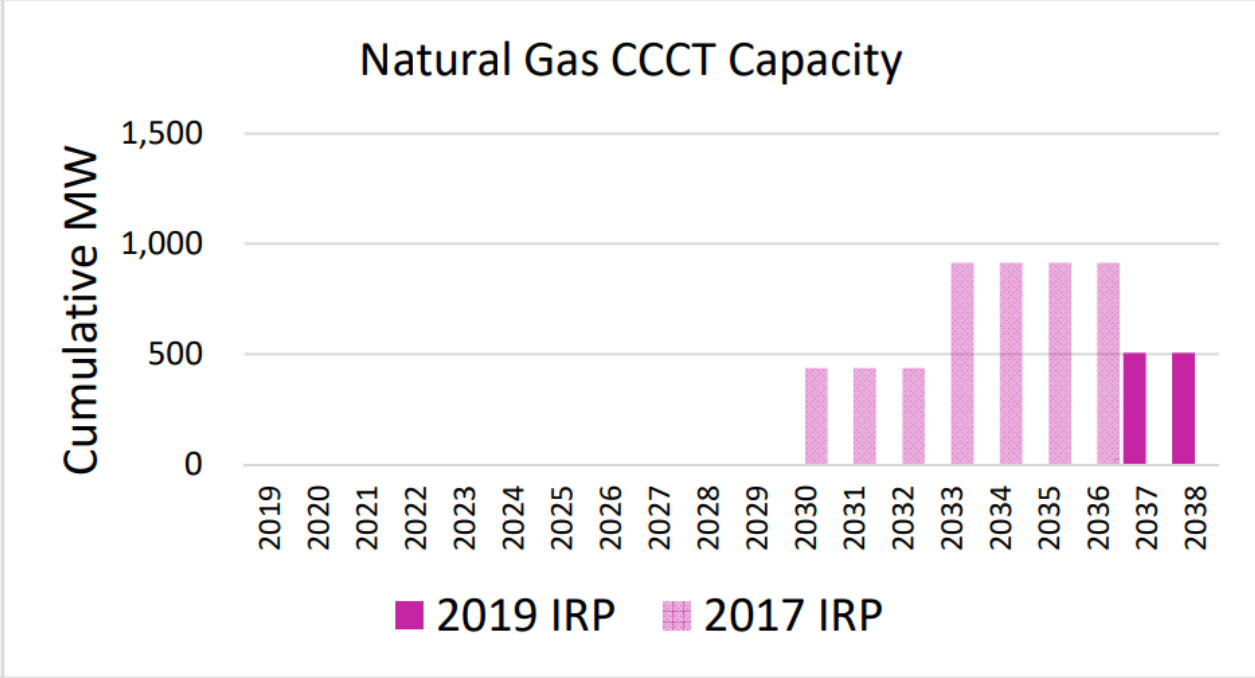


Source: Pacificorp IRP

Case study – Pacificorp integrated resource plan, 2017 vs. 2019

Figure 1.10 – 2019 IRP Preferred Portfolio Natural Gas Peaking and Combined Cycle Capacity*





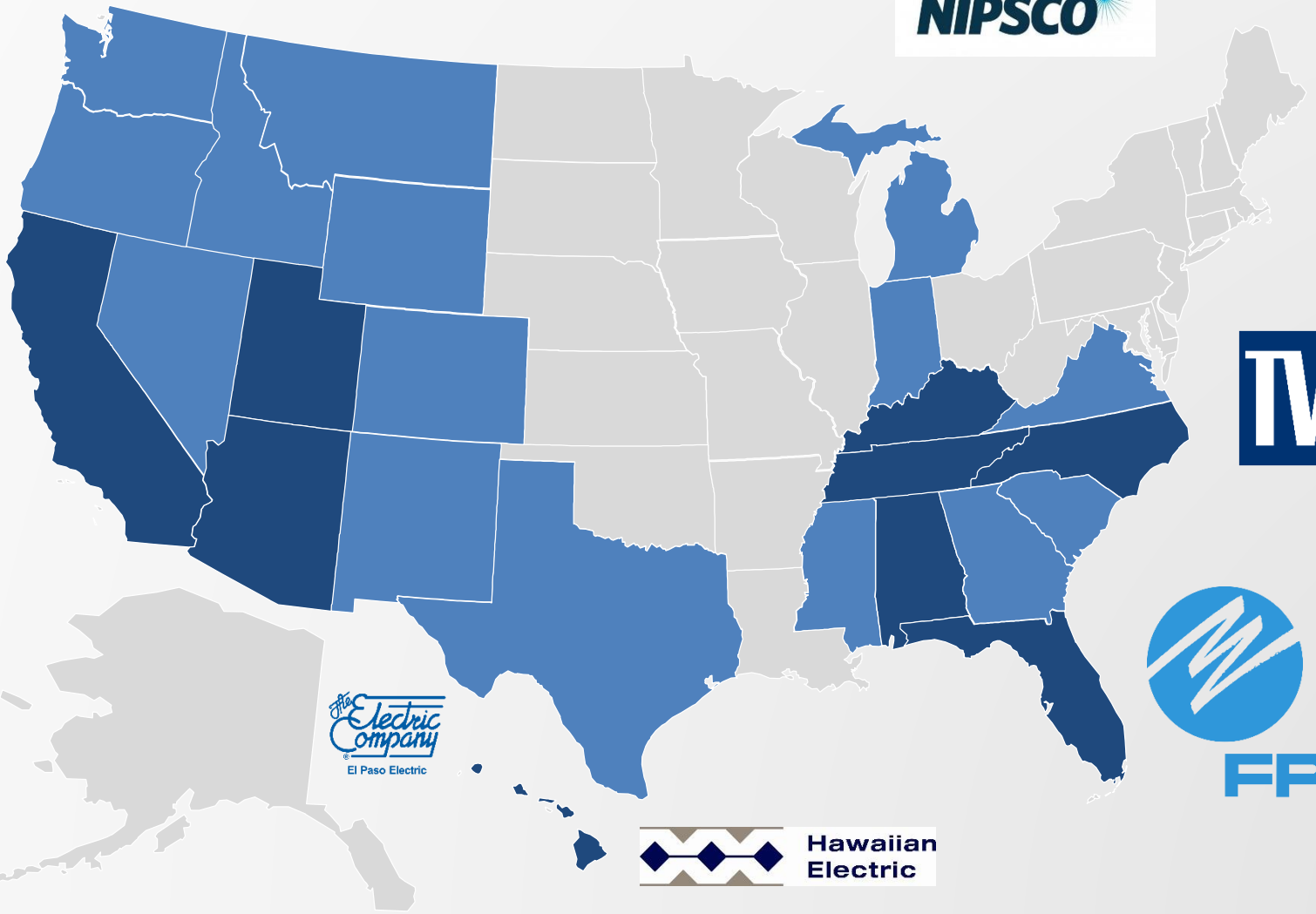
* Note: 2019 IRP natural gas peaking capacity includes the conversion of Naughton Unit 3 to natural gas in 2020 (247 MW).

Source: Pacificorp IRP

U.S. energy storage market – integrated resource plans

> 300 MW

> 0 MW

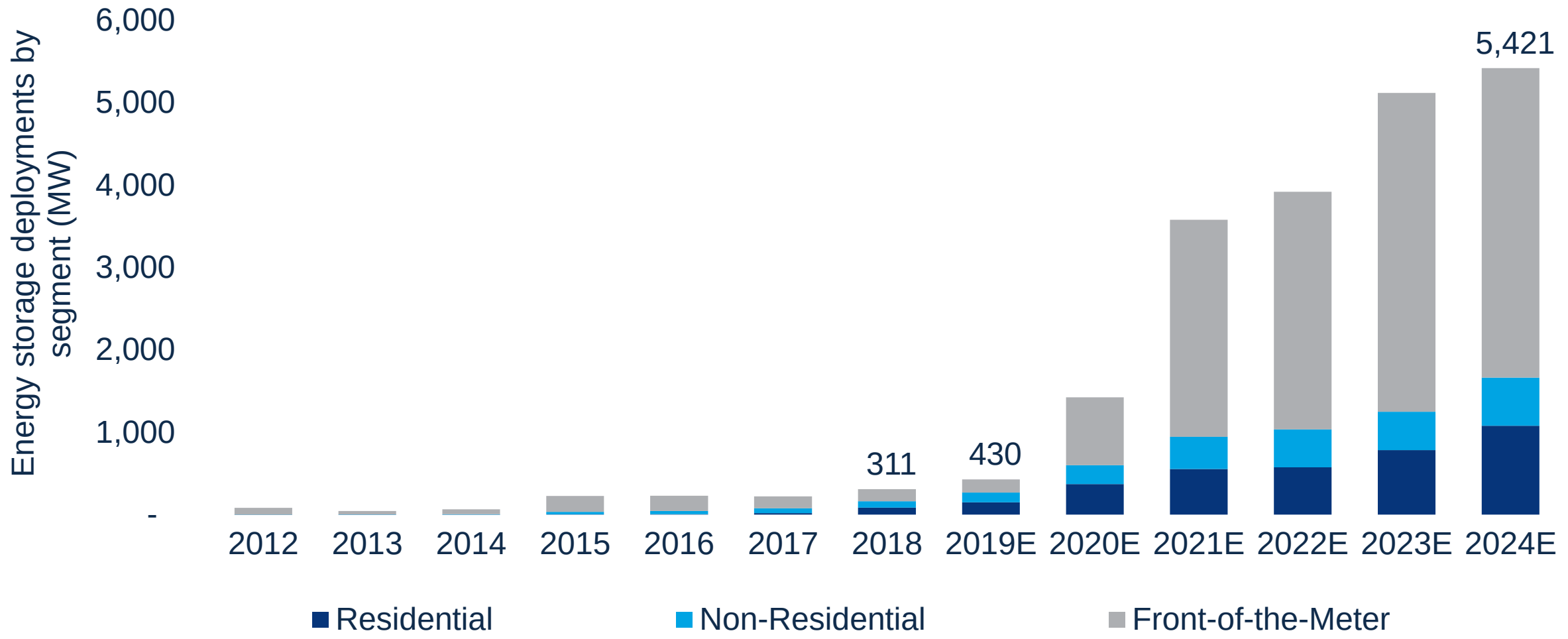


Note – state storage mandate-based procurement planning excluded

U.S. energy storage annual deployments will reach 5.4 GW by 2024

A shift in utility planning and procurement priorities will drive FTM deployments higher

U.S. energy storage annual deployment forecast, 2012-2024E (MW)

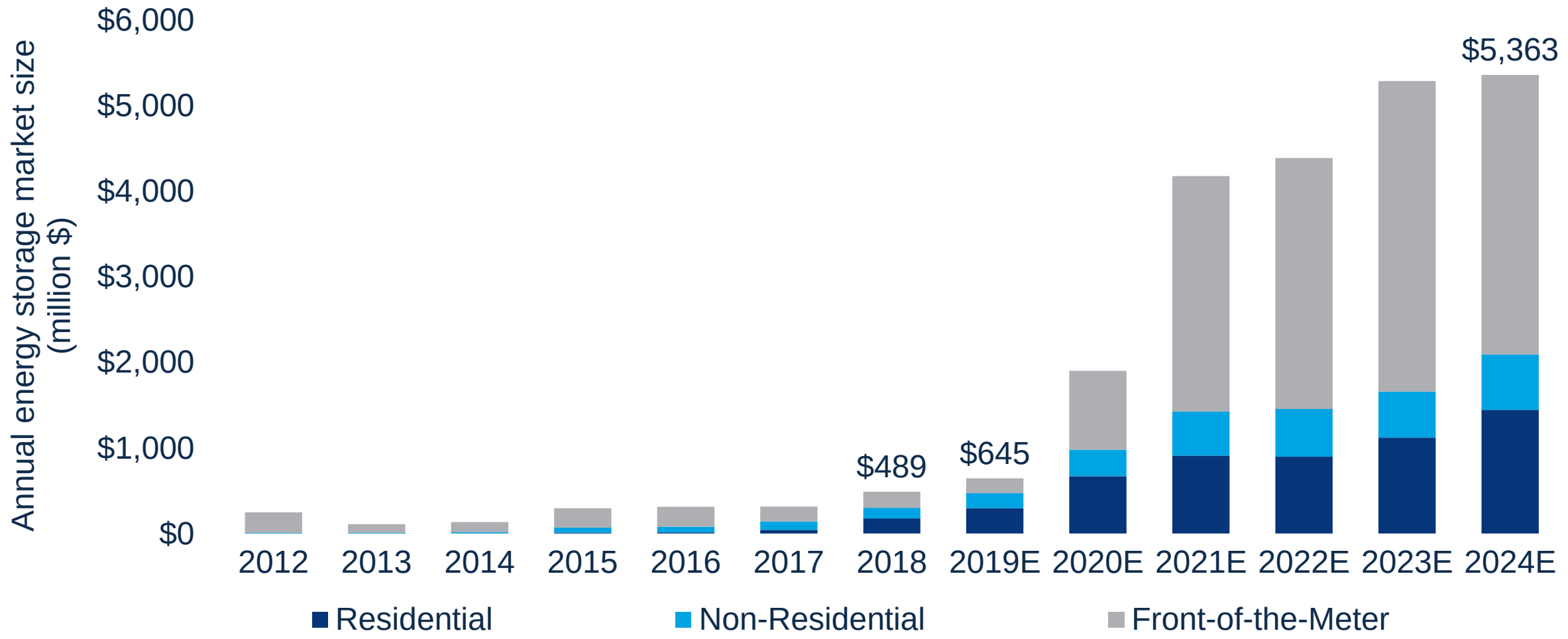


Source: Wood Mackenzie Power & Renewables

U.S. energy storage will be a $5.4 billion market in 2024

Annual value will surge to almost $2 billion in 2020 before more than doubling again to $4.2 billion in 2021

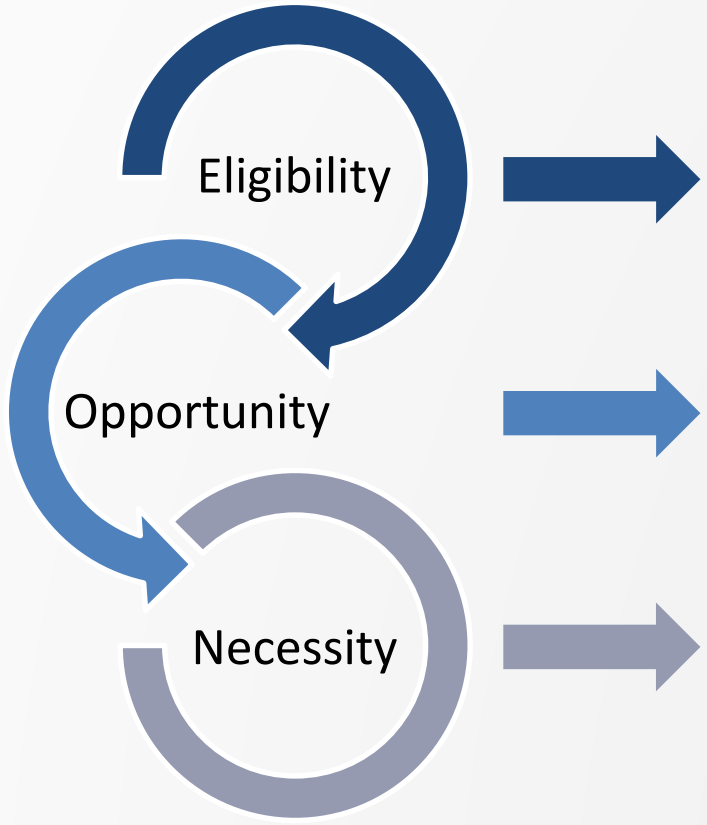
U.S. annual energy storage market size, 2012-2024E (million $)



Source: Wood Mackenzie Power & Renewables. Note: Market size is reported as energy storage system deployment revenue (product of deployments and installed system prices).

Opportunity and strategy surrounding energy storage shifts dramatically as the market moves from capturing value to the necessity of flexibility

Adaptation -> Transition -> Transformation



Adapt to new market forces (2020 – 2024)
• Capture early market, establish scale • Diversify or specialize markets and offerings? • Establish supply chain amid growing competition
Transition technology to new system needs (2025 – 2035)
• Commercialize investments in next-gen storage technology • Scale solutions to needs, ensure flexibility of offerings • Expand into new markets, out-compete
Transform the way electricity is delivered (2036 – 2050)
• Decentralization • Deep decarbonization • Disrupt at the grid edge

Thank you for attending our webinar

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Upcoming Webinar

Soleil Lofts: The Largest Solar+Storage Virtual Power Plant in the Country
Wednesday, February 12, 1-2 pm ET

With 5.2 megawatts of solar and 12.6 megawatt-hours of battery storage, a new 600-unit housing development in Herriman, Utah, about 25 miles south of Salt Lake City, is being developed as the largest solar virtual power plant in the country.

Read more and register at: www.cesa.org/webinars