

U.S. Energy Storage: 2015 Year in Review

Ravi Manghani

Senior Energy Storage Analyst

manghani@gtmresearch.com

March 2016

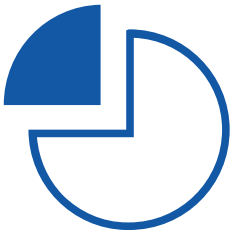
gtmresearch

About Greentech Media



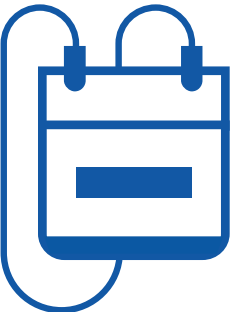
News/Online

Greentech Media delivers business-to-business news, analysis and events at the forefront of the global energy transformation. Our coverage area extends across the clean energy industry with a focus on solar power and the electric utility market's evolution. Greentech Media's industry-leading coverage is provided by a team of analysts from our market intelligence arm, GTM Research, as well as our world-class journalists and global network of expert contributors.



Research

GTM Research is the market analysis and consulting arm of Greentech Media. GTM Research is comprised of analysts covering solar, grid edge, and energy storage markets. Our analysts combine diverse backgrounds in energy, environmental, emerging technology, information technology and strategic consulting sectors. This diverse team provides critical and timely market analysis in the form of research reports, consulting, and data subscription services.



Event

Greentech Media and GTM Research experts come together to produce all of Greentech Media's industry conferences throughout the year. These summits provide a platform for our latest market intelligence and draw together the industry influencers from organizations across the value chain.

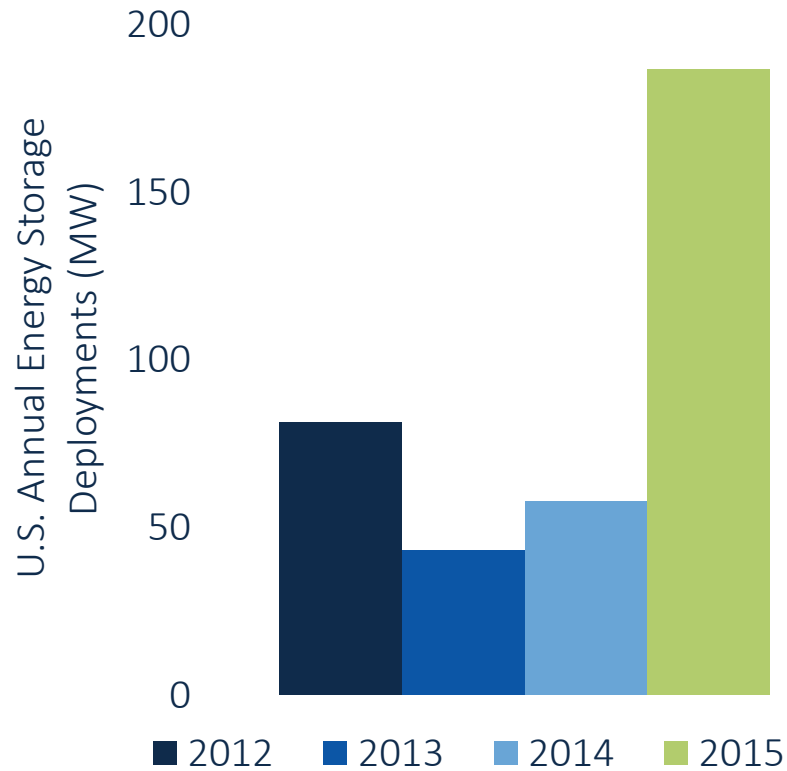
Contents

1. Deployment Trends	3
<hr/>	
2. Market Drivers	8
<hr/>	
3. Outlook	22
<hr/>	

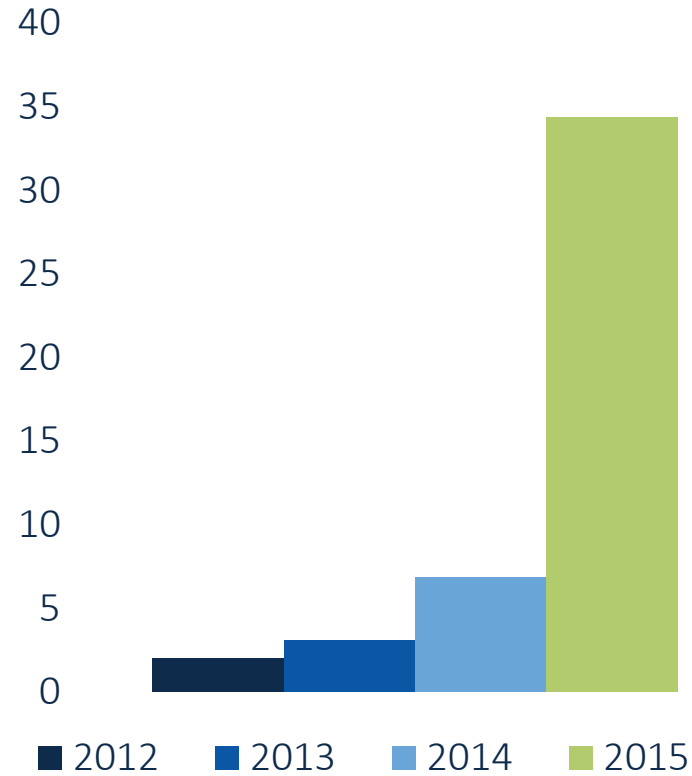
1. Deployment Trends

A Record Year for U.S. Energy Storage Market With 221 MW of Deployments

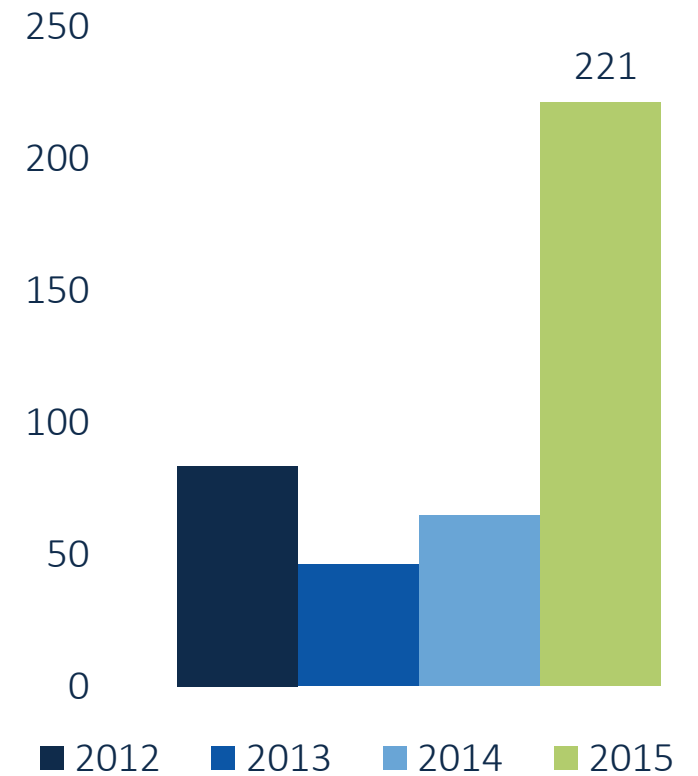
Front of the Meter



Behind the Meter

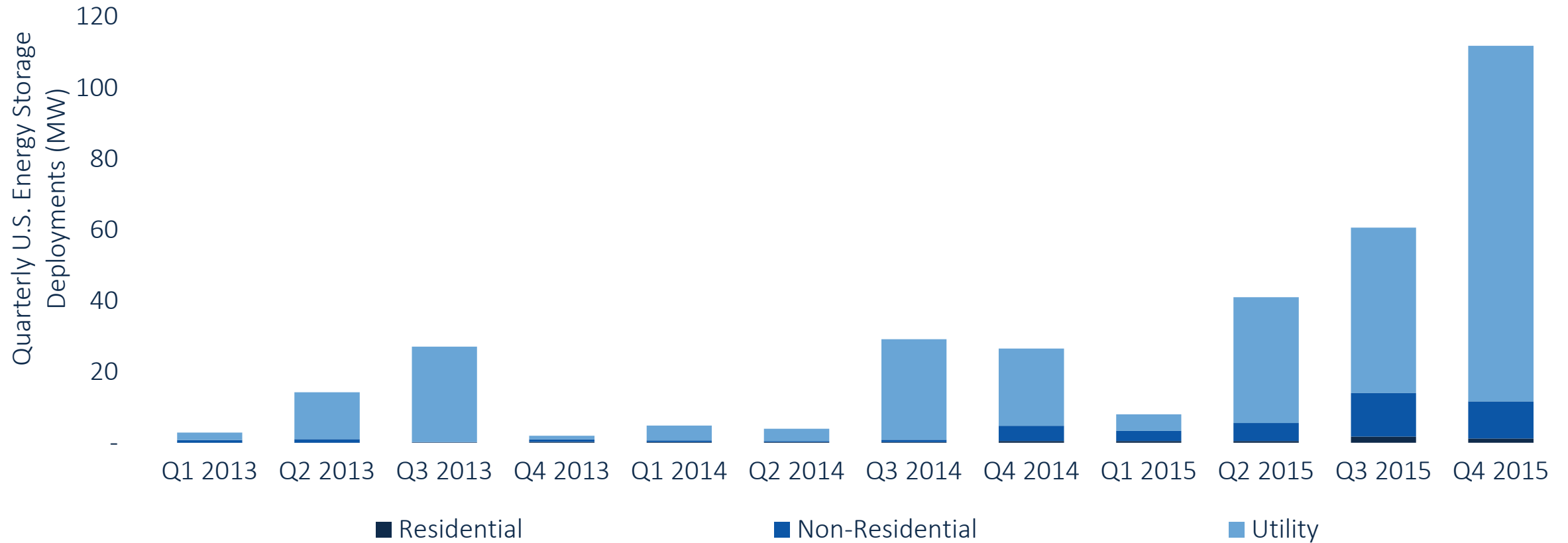


Total



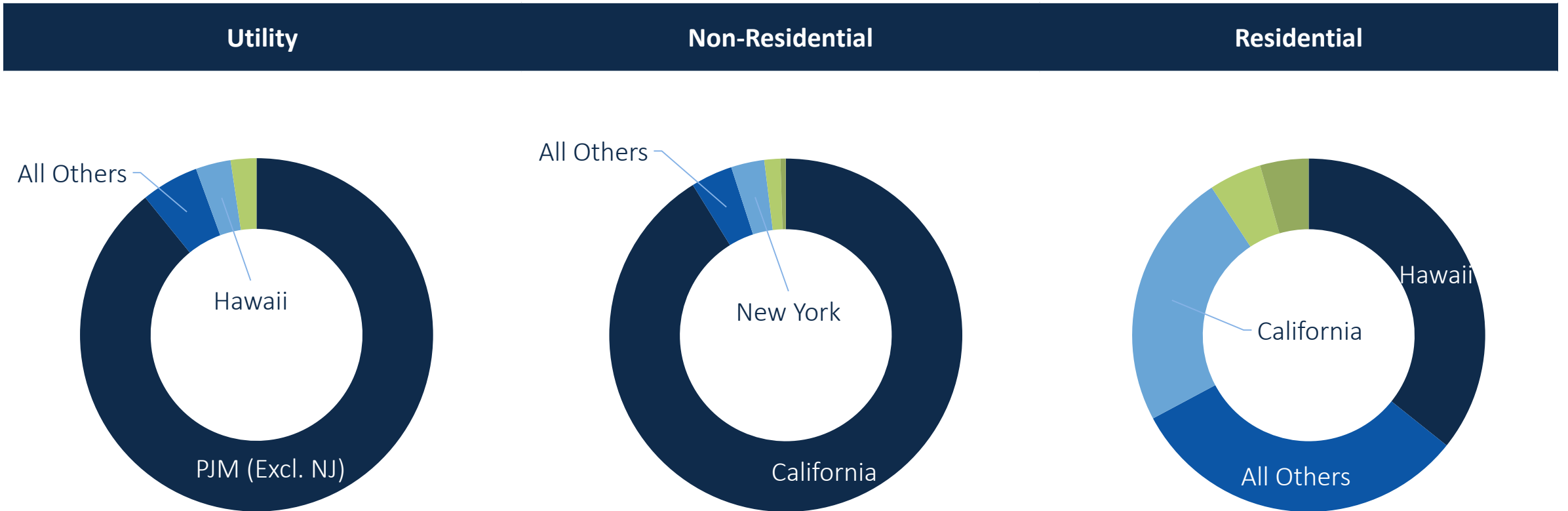
Source: GTM Research/ESA U.S. Energy Storage Monitor 2015 Year in Review

U.S. Deployed More Energy Storage in Fourth Quarter of 2015 Than Previous Two Years



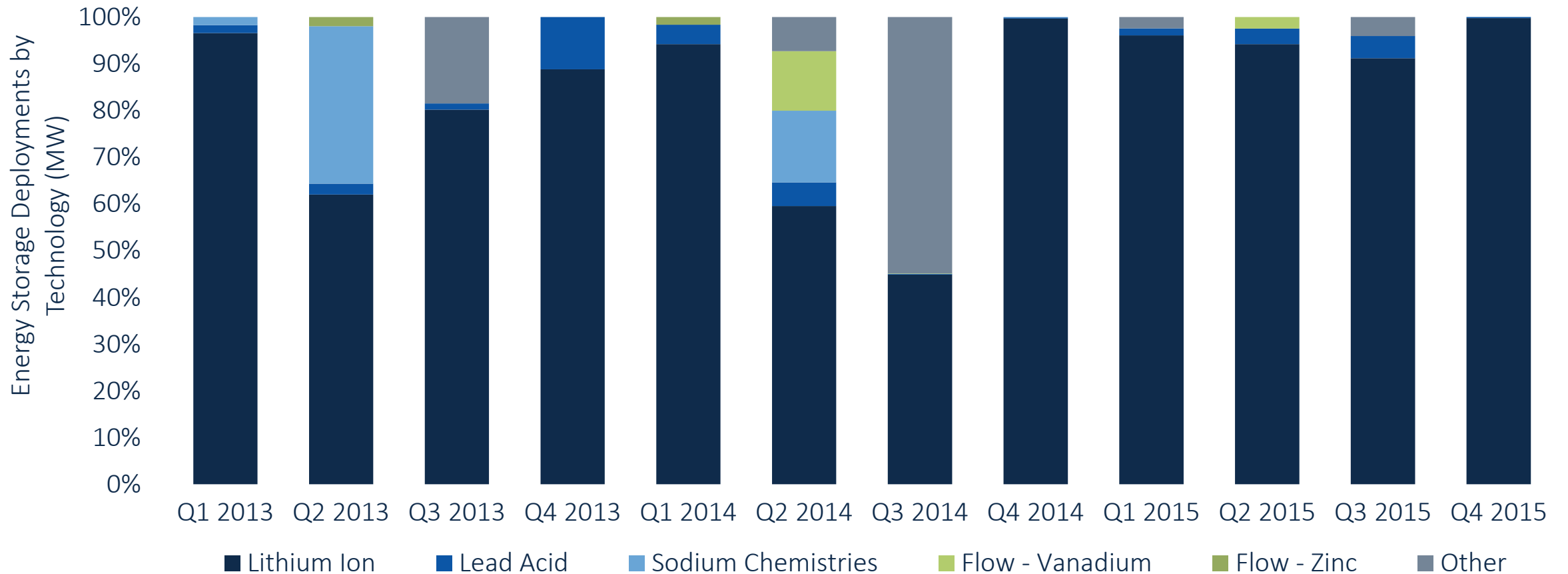
Source: GTM Research/ESA U.S. Energy Storage Monitor 2015 Year in Review

PJM (Excl. NJ), California and Hawaii Led Utility, Non-Residential, and Residential Segments in 2015



Source: GTM Research/ESA U.S. Energy Storage Monitor 2015 Year in Review. *GTM Research is currently monitoring seven individual markets. Complete coverage of all markets is available in the full report.

Lithium-Ion Technologies Made Up 96% of 2015 Deployments (MW)



Source: GTM Research/ESA U.S. Energy Storage Monitor 2015 Year in Review. Other includes flywheel and unreported energy storage technologies

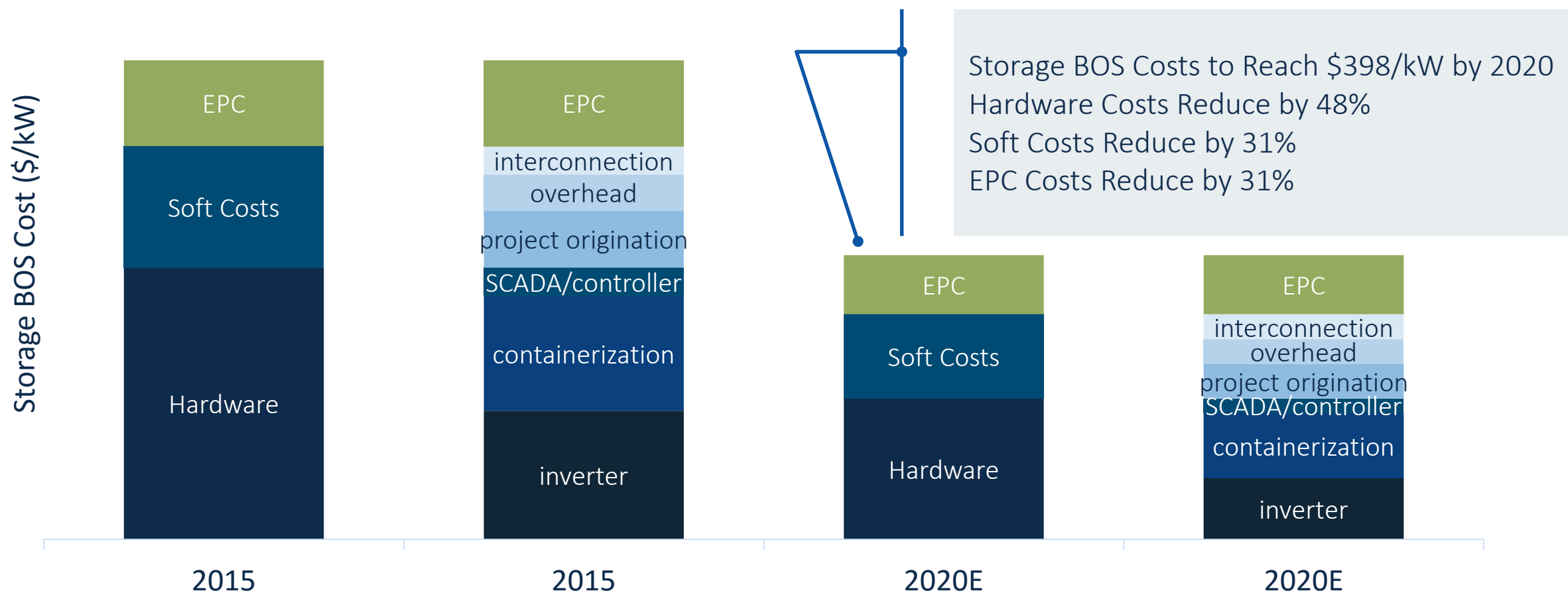
2. Market Drivers

Five Biggest Themes of 2015 and Beyond

Five Key Storage Market Drivers in 2015

- #1** System Cost Reductions Continue at Rapid Pace
- #2** Wholesale Markets' Structures Develop to Include Storage
- #3** Strong Renewables Growth Bolsters Storage Growth
- #4** Storage Mandates and All-Source RFOs Become a Commonplace
- #5** Storage Emerges As a Viable Technology for Grid Services

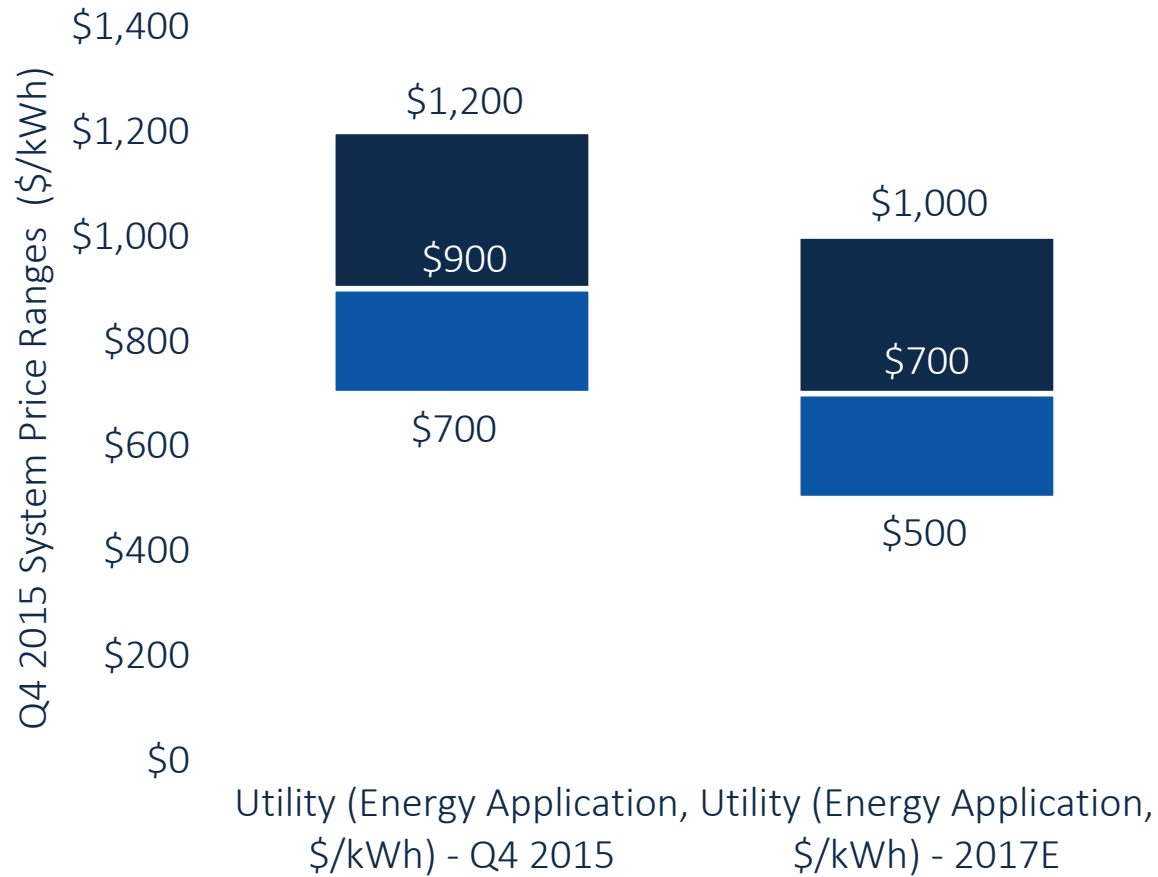
1) 41% Storage BOS Costs Reduction by 2020; Reach Below \$400/kW



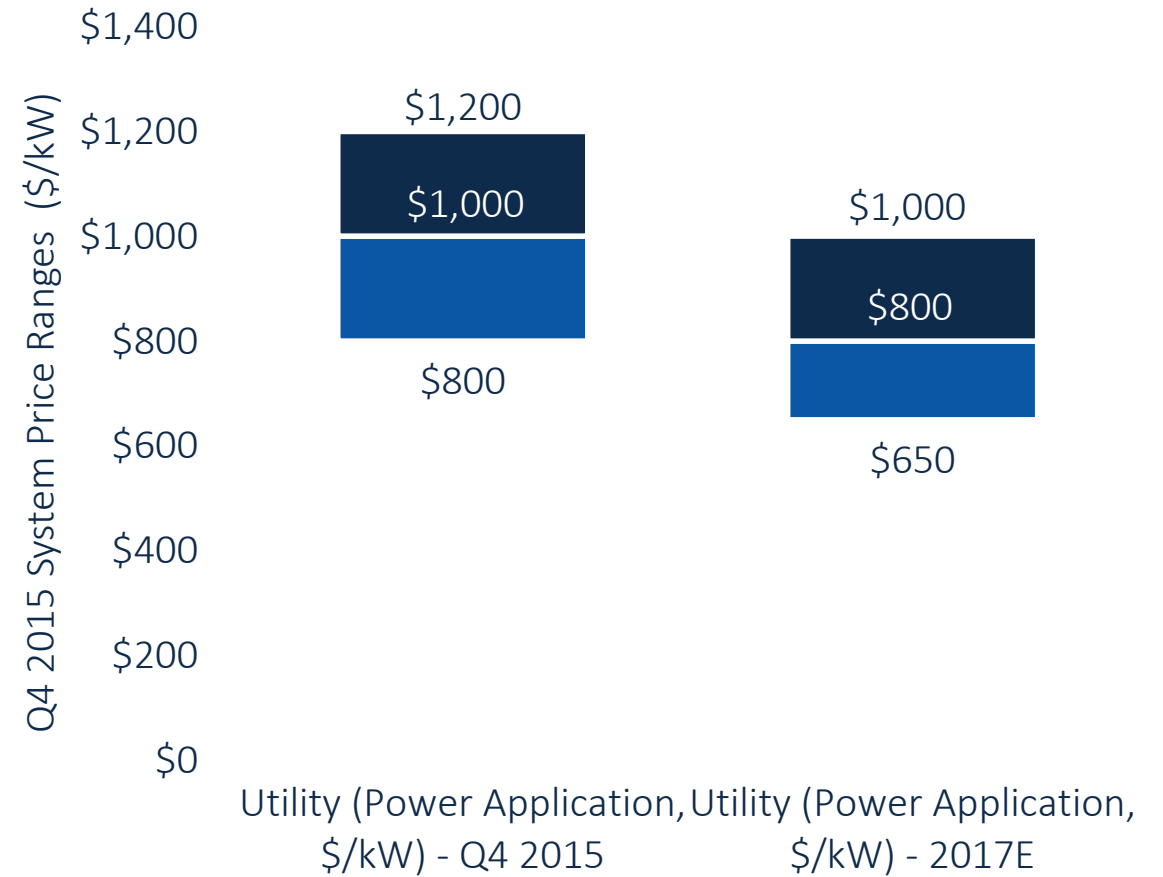
Source: GTM 'Grid-Scale Energy Storage Balance of Systems 2015-2020: Architectures, Costs and Players'

1) Front-of-Meter System Prices Expected to Drop 20% over Next Two Years

Utility-Scale Price Trends Q4 2015, Energy Applications – 2 Hours (\$/kWh)

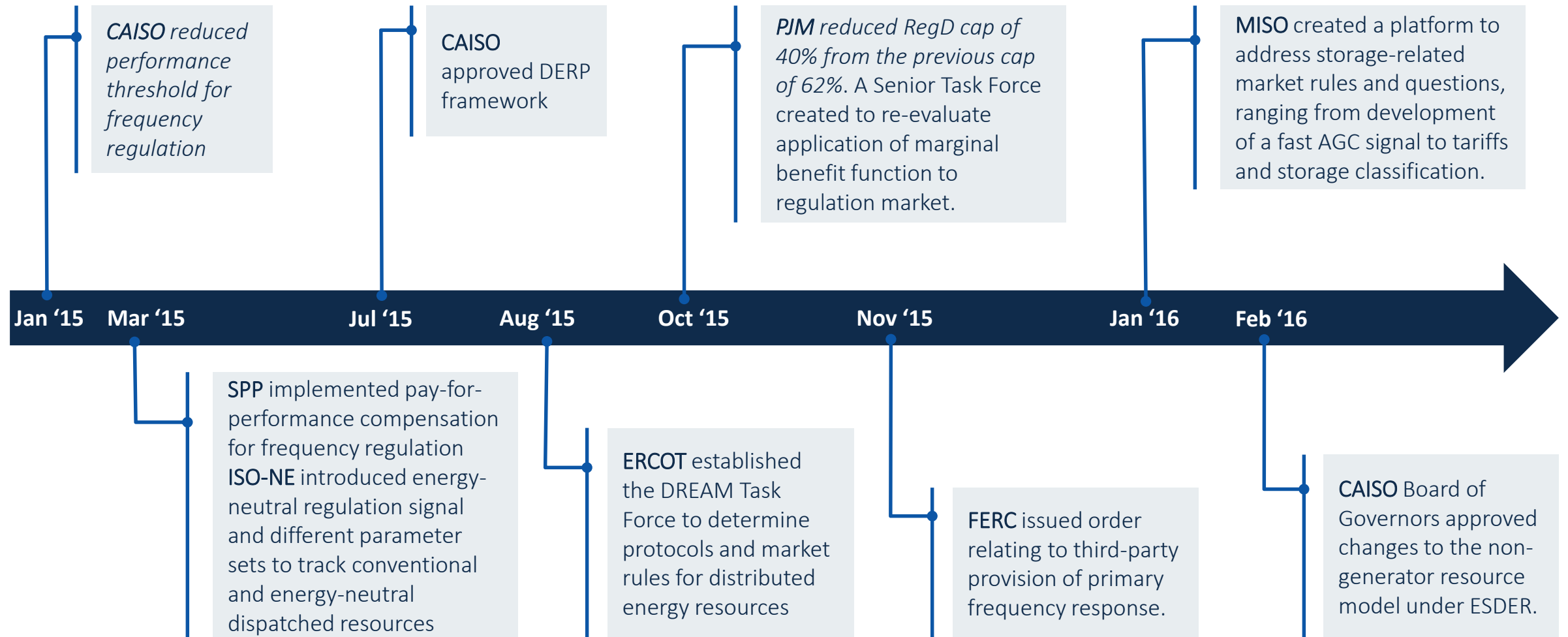


Utility-Scale Price Trends Q4 2015, Power Applications (\$/kW)



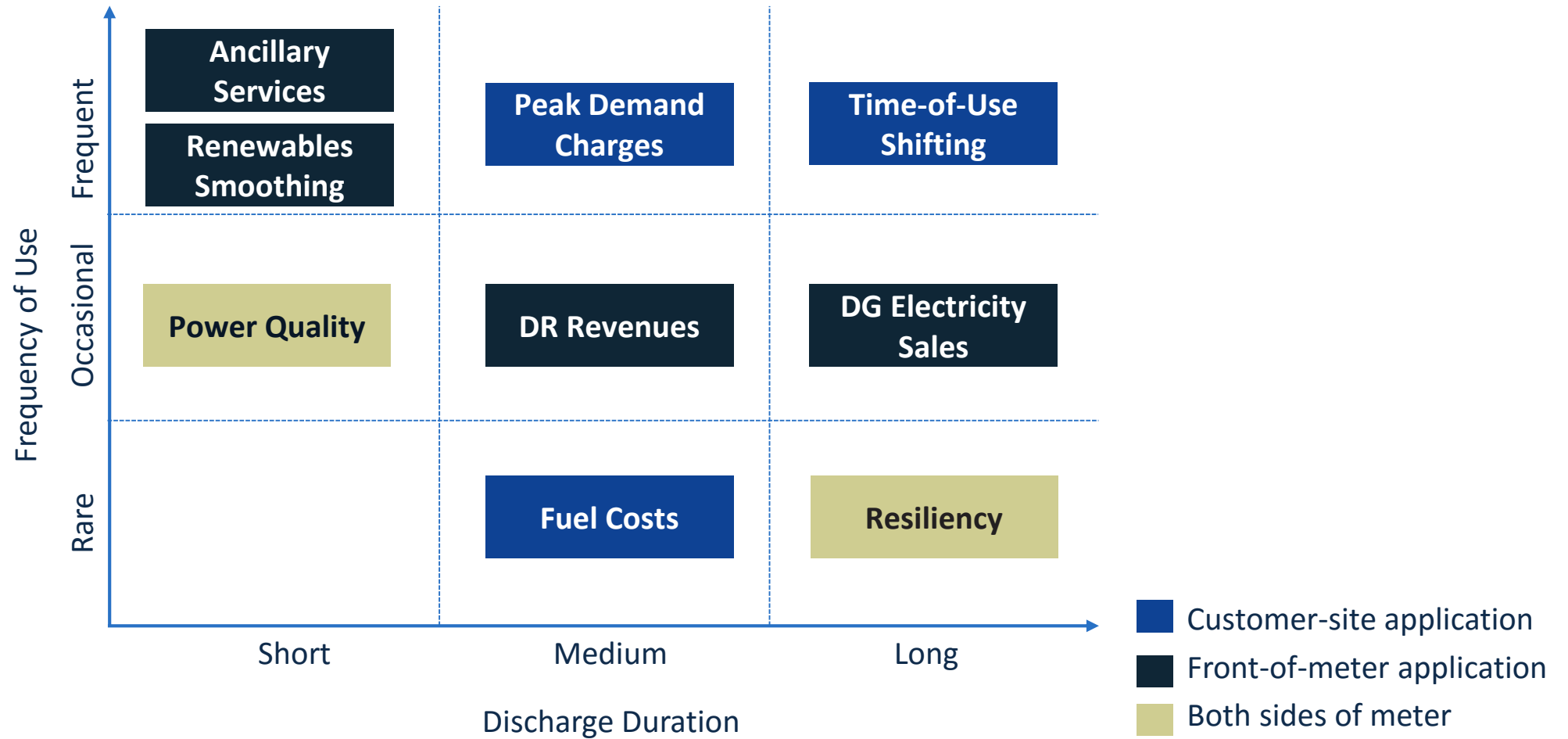
Source: GTM Research/ESA U.S. Energy Storage Monitor 2015 Year in Review

2) Wholesale Markets' Structures Evolving to Include Storage



Source: GTM Research/ESA U.S. Energy Storage Monitor

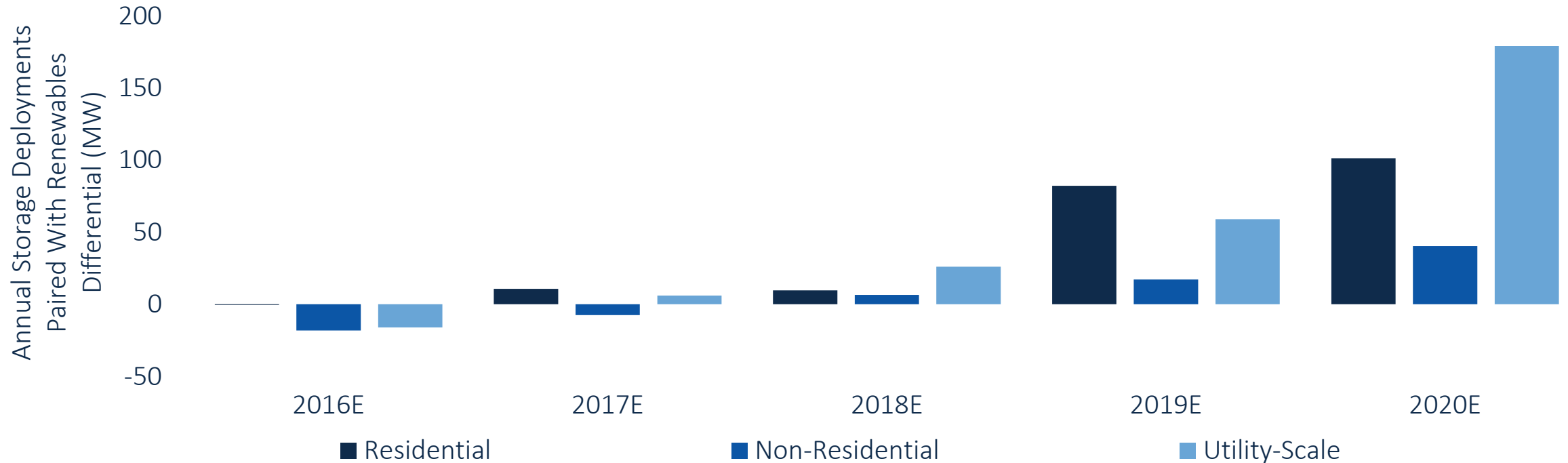
3) Solar-Plus-Storage Benefits Vary in Duration and Frequency



Source: GTM Research

3) Tax Credit Extension to Spur Further Growth in Storage Paired With Renewables

U.S. Storage Deployment Paired With Renewables Differential Vs. No Extension

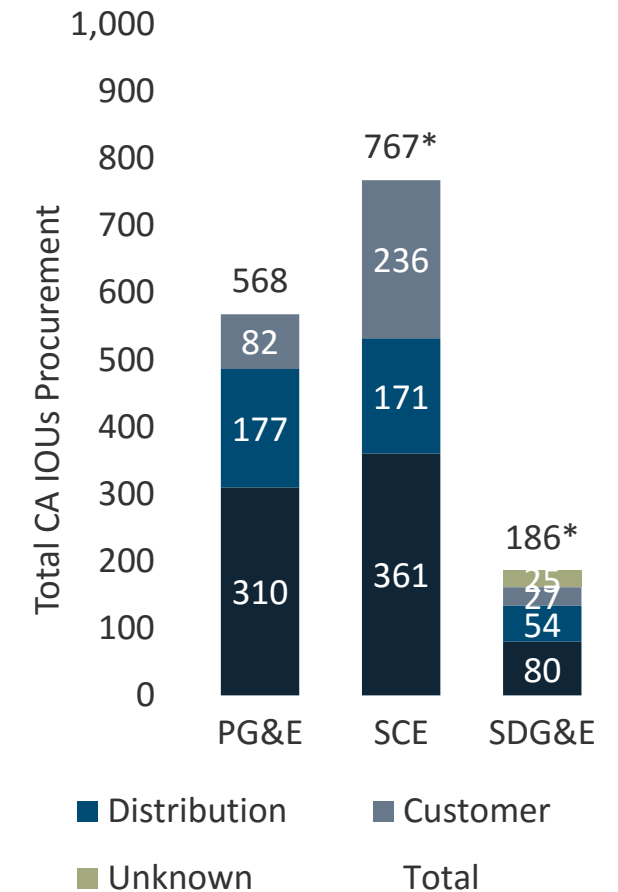


Compared to the non-ITC scenario, GTM Research expects an additional 0.5 GW of storage paired with renewables from 2016-2020, a 33% increase compared to a scenario with no tax credit extension.

Source: GTM Research/ESA U.S. Energy Storage Monitor 2015 Year in Review




4) California IOUs Started Procurement toward AB 2514 in 2014

Point of Interconnection	2014 Original	2014 Adjusted	2016	2018	2020	Total
Southern California Edison						
Transmission	50	0	65	85	110	310
Distribution	30	16.3	40	50	65	185
Customer	10	0	15	25	35	85
Subtotal SCE	90	16.3	120	160	210	580
Pacific Gas & Electric						
Transmission	50	50	65	85	110	310
Distribution	30	21.5	40	50	65	185
Customer	10	6.5	15	25	35	85
Subtotal PG&E	90	78	120	160	210	580
San Diego Gas & Electric						
Transmission	10	10	15	22	33	80
Distribution	7	6	10	15	23	55
Customer	3	0	5	8	14	30
Subtotal SDG&E	20	16	30	45	70	165
Total, All Three Utilities	200	110.3	270	365	490	1,325



for a minimum of 25 MW, maximum set at 800 MW

4) Progress by California IOUs for 2014 Energy Storage Procurements Under AB 2514

Utility	2014 Proposed Target	Actual Procurements	Timeline
	50 MW transmission 24 MW distribution	7 projects totaling 75 MW selected in December 2015	First projects expected to be on-line by May 2017
	16.3 MW distribution (Plus Local Capacity Requirement procurement)	2 projects totaling 16.3 MW selected in September 2015	Projects can start as early as January 1, 2017; must be interconnected by December 1, 2024
	10 MW transmission, 6 MW distribution (Plus Local Capacity Requirement procurement)	12 MW solicited through LCR RFO. 4 MW sought through distribution deferral RFP, but elected not to procure any storage through the RFP.	Project can be on-line as early as 2017, interconnection required by January 1, 2022

Source: GTM Research/ESA U.S. Energy Storage Monitor 2015 Year in Review

4) Other Notable Utility Procurements from New York to Guam!

Oregon

Oregon DOE and U.S. DOE awarded \$295,000 under Electrical Energy Storage Demonstration Project RFP.

Colorado

PSC Colorado/Xcel Energy submitted two storage project proposals under the Innovative Clean Technologies program.

Arizona

APS issued an all-source RFP to procure between 400 MW and 600 MW of capacity resources by 2020. TEP selected two 10 MW storage projects under REST

Guam

Guam Power Authority is soliciting bids for up to 40 MW of energy storage.

New York

PSEG Long Island amended its South Fork Resources RFP and issued a New Renewable Capacity and Energy RFP. Con Edison and Orange and Rockland issued a Grid-Scale Energy Storage RFI.

Texas

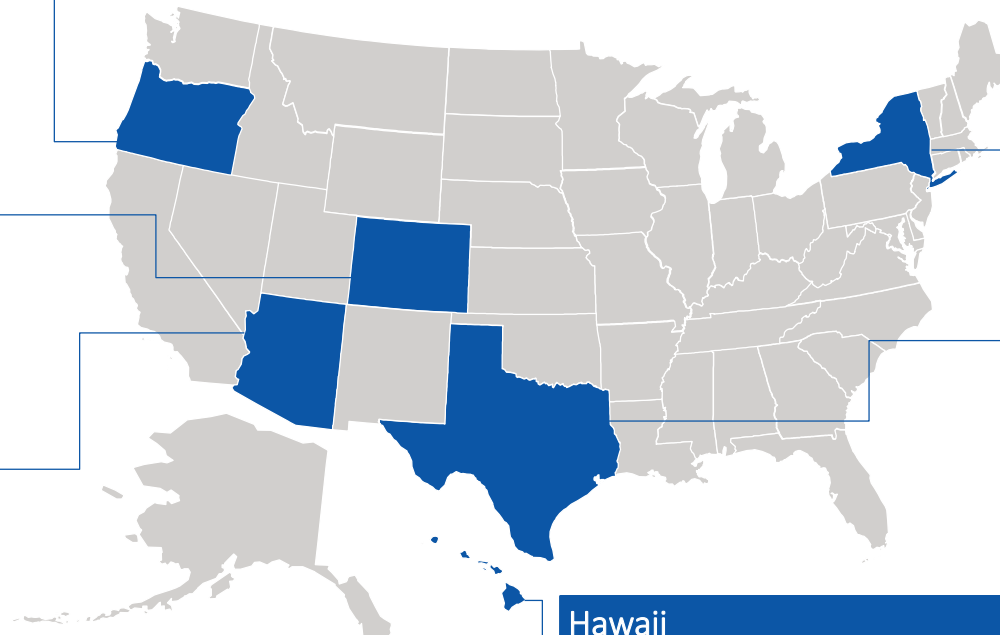
Austin Energy issued an RFI to solicit information on energy storage technology.

Hawaii

KIUC entered in a 20-year PPA with SolarCity for power from a 13 MW/52 MWh lithium-ion storage system

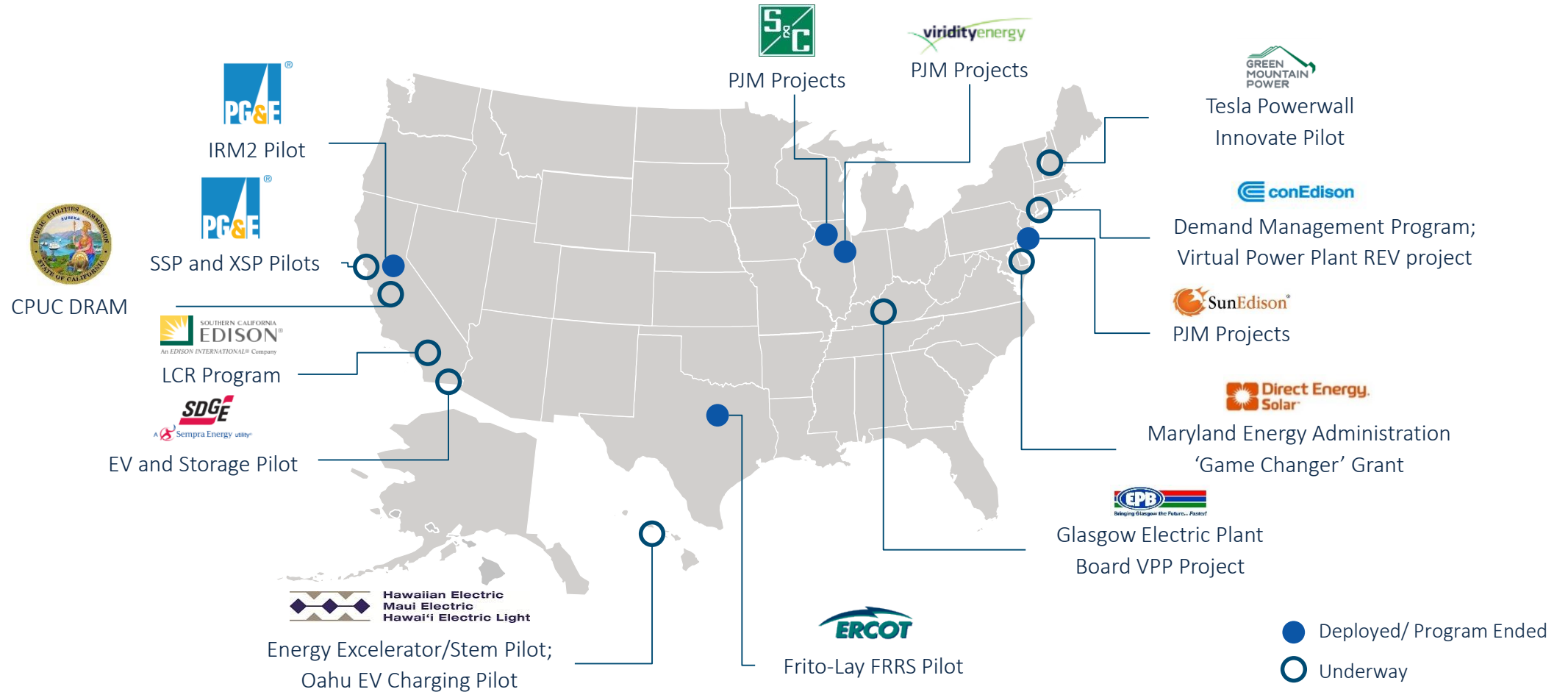
Federal

U.S. DOE announced funding under Grid Modernization Initiative.



Source: GTM Research/ESA U.S. Energy Storage Monitor

5) Significant Early Activity in Behind-The-Meter Storage for Grid Services



Source: GTM Research/ESA U.S. Energy Storage Monitor

5) Green Mountain Power to Use Behind-the-Meter Storage to Reduce Peak Capacity and Transmission Costs

	Option 1	Option 2	Option 3
Total Number of Systems (Est.)	75	225	200
Ownership	End-customer	End-customer	GMP
Control	End-customer	Partial GMP Control	GMP Control
Utility Services	None	Capacity costs: Forward Capacity Market (FCM) – 75% participation Transmission costs: Regional Network Service (RNS) – 50% participation	Capacity costs: Forward Capacity Market (FCM) – 100% participation Transmission costs: Regional Network Service (RNS) – 75% participation
End-customer Benefits	Back-up, Solar self-consumption, and TOU shifting	Back-up, Solar self-consumption, and TOU shifting [Not mutually exclusive with utility services at all times]	Back-up, Solar self-consumption, and TOU shifting [Not mutually exclusive with utility services at all times]
End-customer Payments	\$6,500 plus installation costs paid by customer to GMP.	\$6,500 plus installation costs paid by customer to GMP. Receives monthly bill credit of \$31.76/month for 10 years	No upfront cost paid by customer. Monthly rate rider (lease) paid by customer to GMP: \$37.50/month for 10 years

Source: Green Mountain Power, GTM Research

5) Con Edison VPP Pilot to Test Revenue Streams from Multiple Benefits

Key Features

- 1.8 MW/4 MWh virtual power plant
- Partners: SunPower and Sunverge
- 20-year contract, demonstration phase for 2+ years
- Projected cost: \$12M over project lifetime
- Con Edison estimates 8% returns by 2021, profitable within 10 years

Project Goals

- Determine network benefits for grid from aggregate solar-plus-storage systems
- Determine customer resiliency benefits and assess customers' willingness to pay for resiliency services
- Monetization value of grid services in competitive markets
- Inform rate design for and development of distribution-level markets through testing of different rate design mechanisms via VPP subgroups

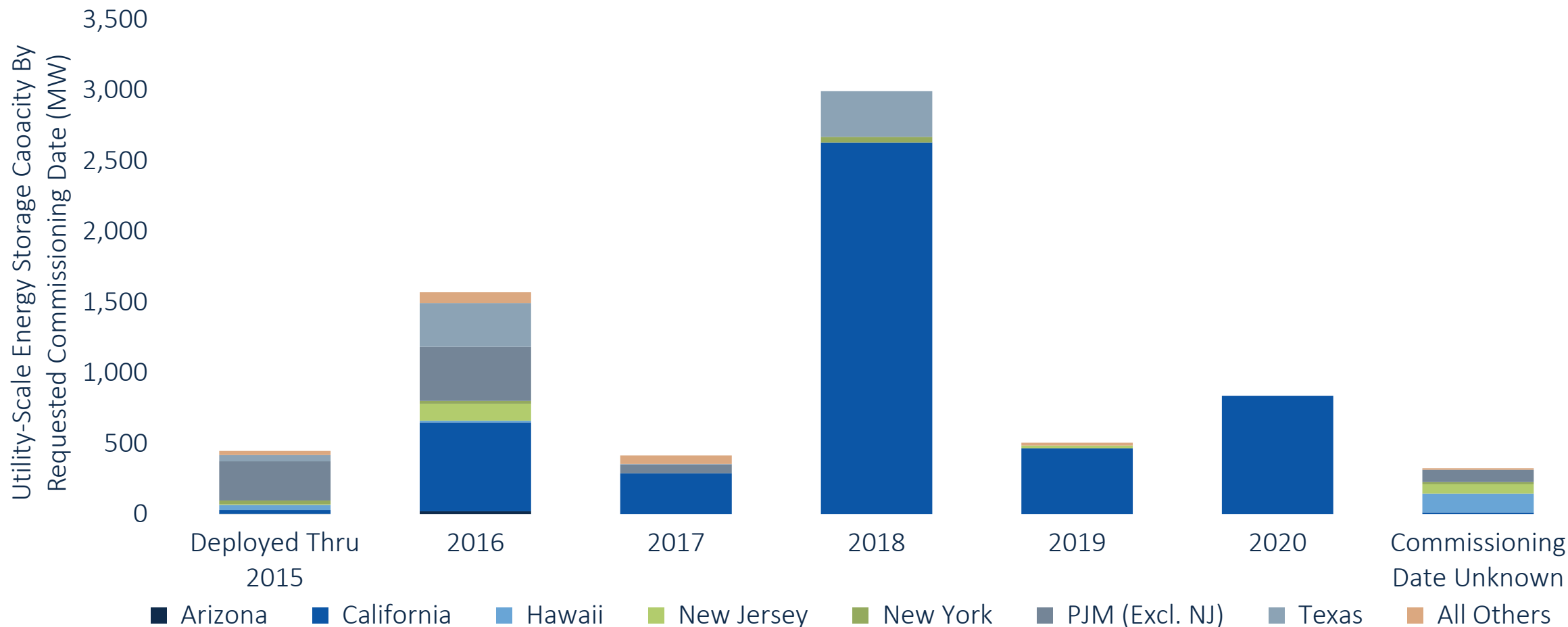
Source: GTM Research/ESA U.S. Energy Storage Monitor

Assumptions

- **Value Streams:** Monthly resiliency payments (to SunPower or Con Ed), VPP's grid services (DR, firm capacity), revenue as distribution service platform (DSP) provider, referral fees
- **Cost Structure:** Initial investment in storage systems, system O&M
- **Resiliency Fees:** Con Ed will test various price levels and payment structures to inform rate design and develop product offering; Con Ed currently values capacity at \$20/kW-month using a forward cost curve
- **Revenue** from VPP services and resiliency payments may lead to profitability before 2021
- **Three-Phase Assessment:** Customer leads vs. customer signups, system integration (ability to consistently receive and respond to dispatch signals, response accuracy, response speed, communication latency, system uptime), and dispatch performance
- **Project Length:** Demo for 2+ years, but leases for 20; VPP seen as long-term business model

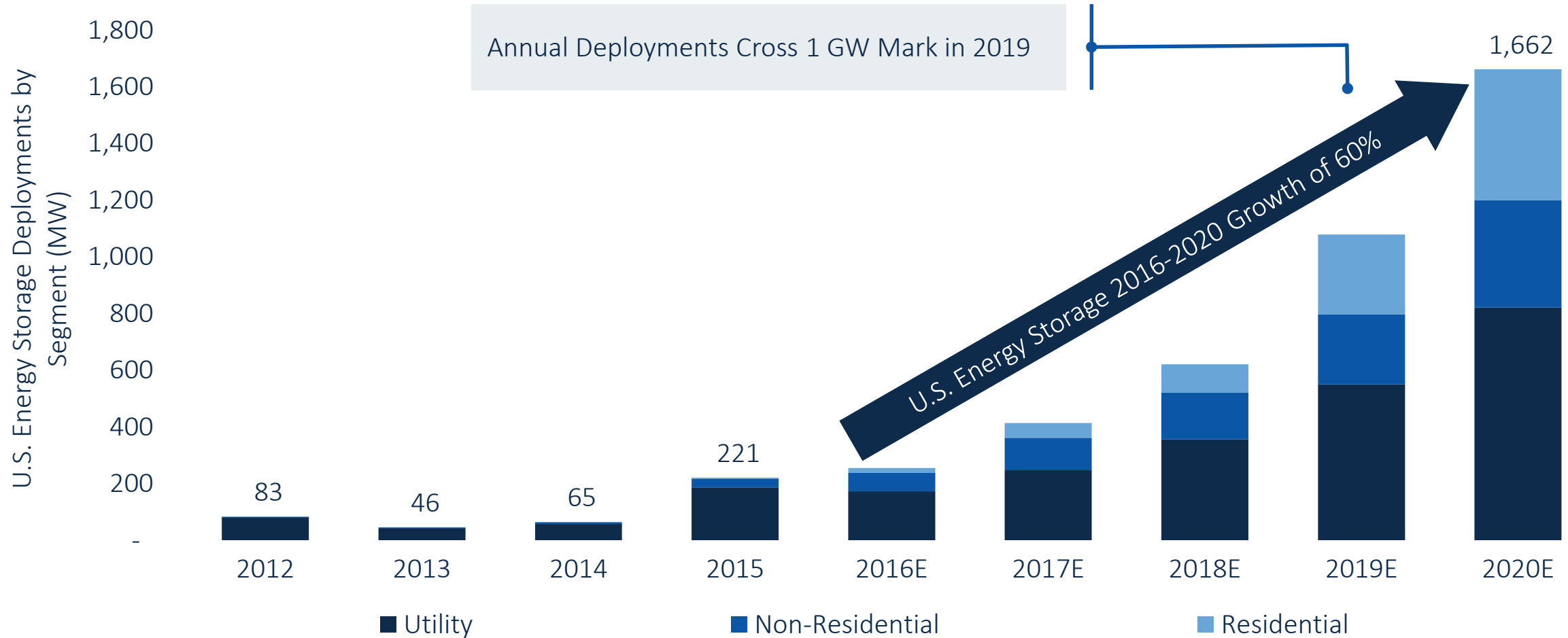
3. Outlook

U.S. Utility-Scale Energy Storage Pipeline Dominated by California [Duh!] But There's More to Interconnection Queue



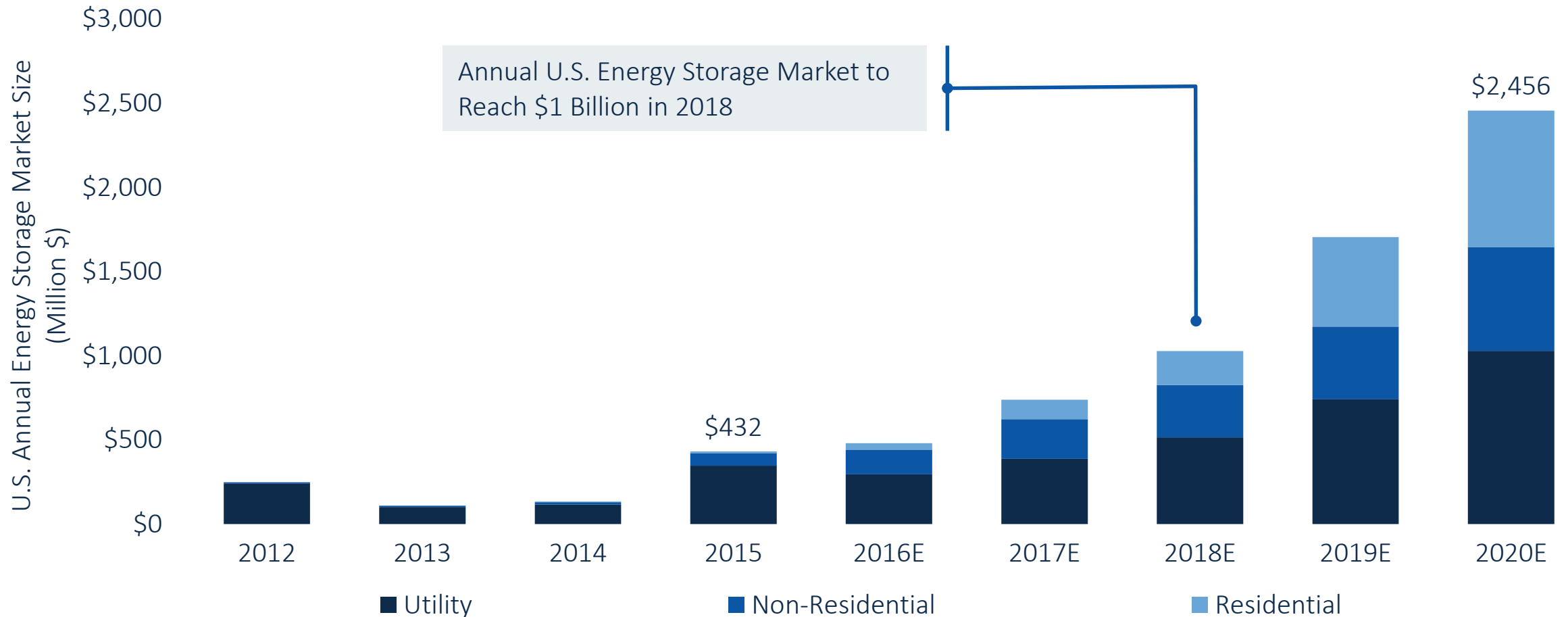
Source: GTM Research/ESA U.S. Energy Storage Monitor 2015 Year in Review

U.S. Annual Energy Storage Deployments Will Cross 1 GW in 2019, Reach 1.7 GW by 2020



Source: GTM Research/ESA U.S. Energy Storage Monitor 2015 Year in Review

U.S. Energy Storage Market to Reach \$2.5 Billion by 2020, Sixfold Growth From 2015



Source: GTM Research/ESA U.S. Energy Storage Monitor 2015 Year in Review

Thank you!

Interested in other GTM Research products and services? Please visit www.gtmresearch.com or contact sales@greentechmedia.com

U.S. Energy Storage: 2015 Year in Review. March 9, 2016

gtmresearch