



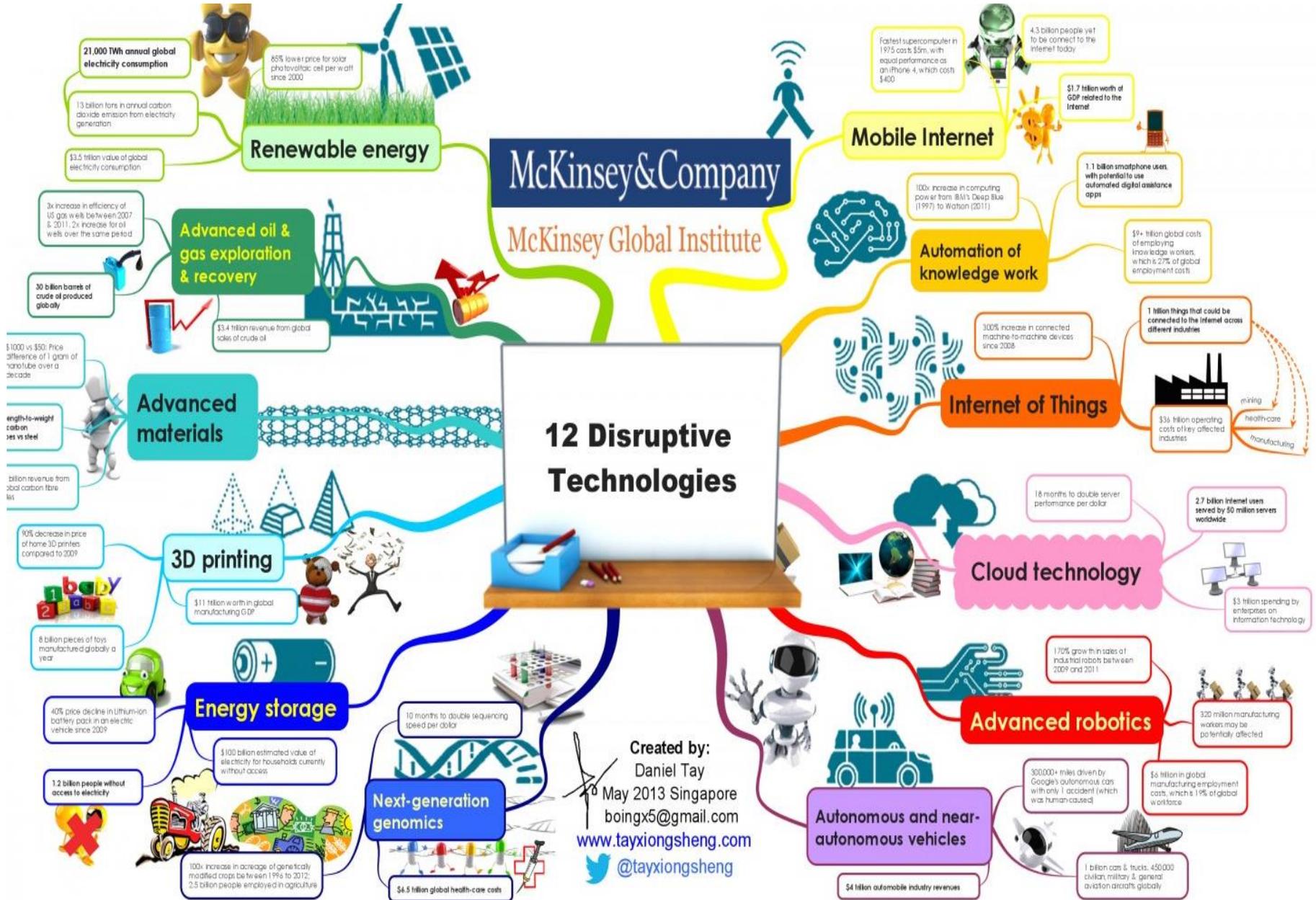
# The Stella Group, Ltd.

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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 three 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 re-appointed to the US Department of Commerce Renewable Energy & Energy Efficiency Advisory Committee, through June 2020.

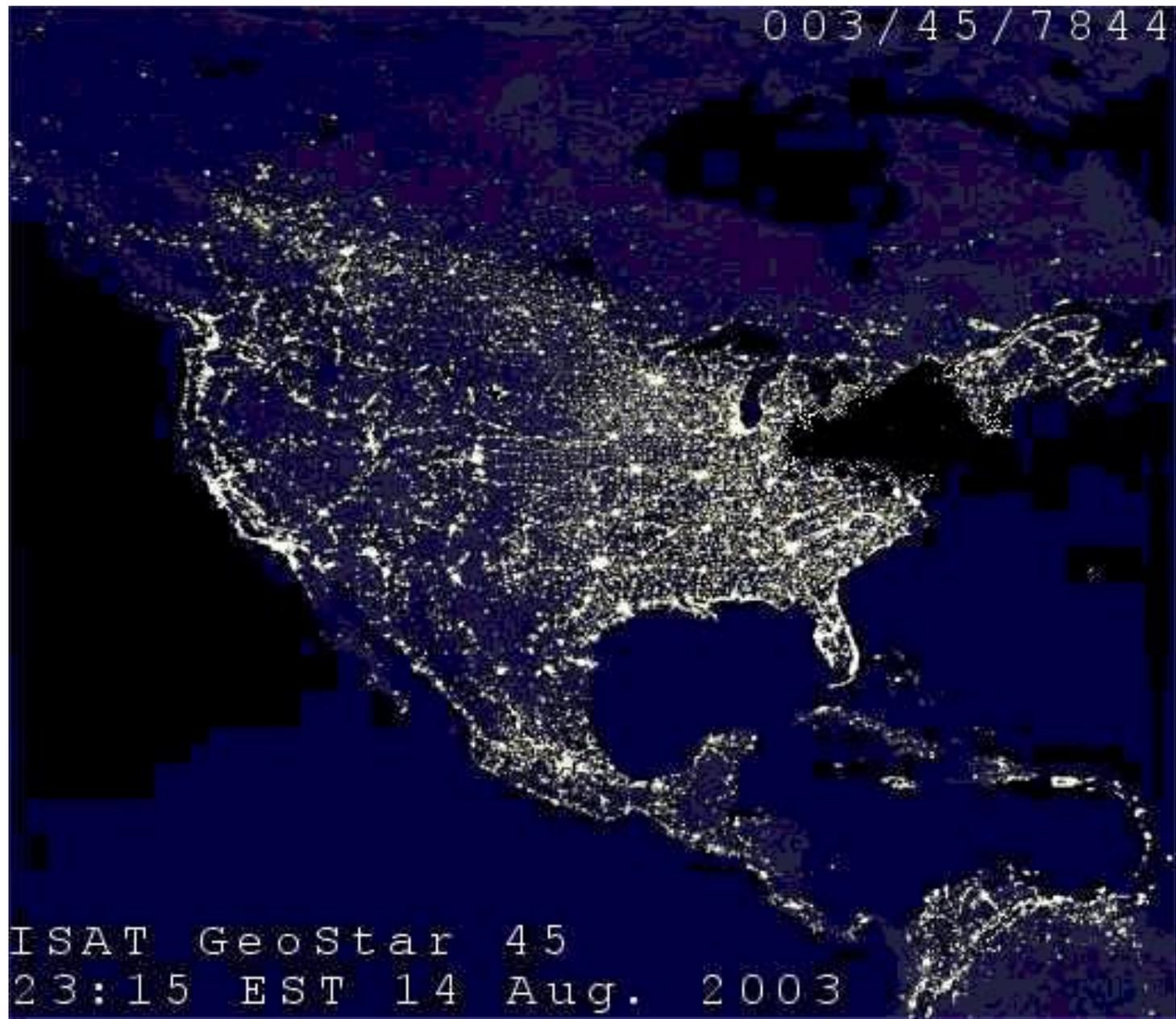
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ISAT GeoStar 45  
23:15 EST 14 Aug. 2003

## Top states for outages caused by weather/falling trees

2013 (966 total outages)	2012 (953 total outages)	2011 (1,229 total outages)	2010 (1,127 total outages)
1. California (65)	1. California (90)	1. California (81)	1. California (111)
2. Michigan (60)	2. New York (58)	2. Michigan (76)	2. New York (79)
3. Texas (47)	3. Texas (52)	3. New York (75)	3. Washington (50)
4. New York (41)	4. New Jersey (48)	4. Illinois (62)	4. Michigan (45)
5. Ohio (41)	5. Pennsylvania (44)	5. Pennsylvania (57)	5. New Jersey (42)
6. Virginia (41)	6. Washington (38)	6. Texas (55)	6. Pennsylvania (41)
7. Pennsylvania (38)	7. Michigan (36)	7. Ohio (52)	6. Texas (41)
8. Illinois (30)	8. Oregon (32)	8. Wisconsin (48)	8. Connecticut (39)
9. New Jersey (30)	8. Virginia (32)	9. Virginia (37)	9. Ohio (38)
10. Missouri (27) Wisconsin (27) North Carolina (27)	10. North Carolina (29) Ohio (29)	10. New Jersey (37)	10. North Carolina (37)

NOTE: OUTAGES – MORE THAN ONE HOUR

## 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.

$SAIFI = (\text{Total number of sustained interruptions in a year}) / (\text{Total number of consumers})$

#### **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.

$SAIDI = \text{Total duration of sustained interruptions in a year} / \text{total number of consumers}$

## **BATTERY STORAGE: FOUR TRENDS –**

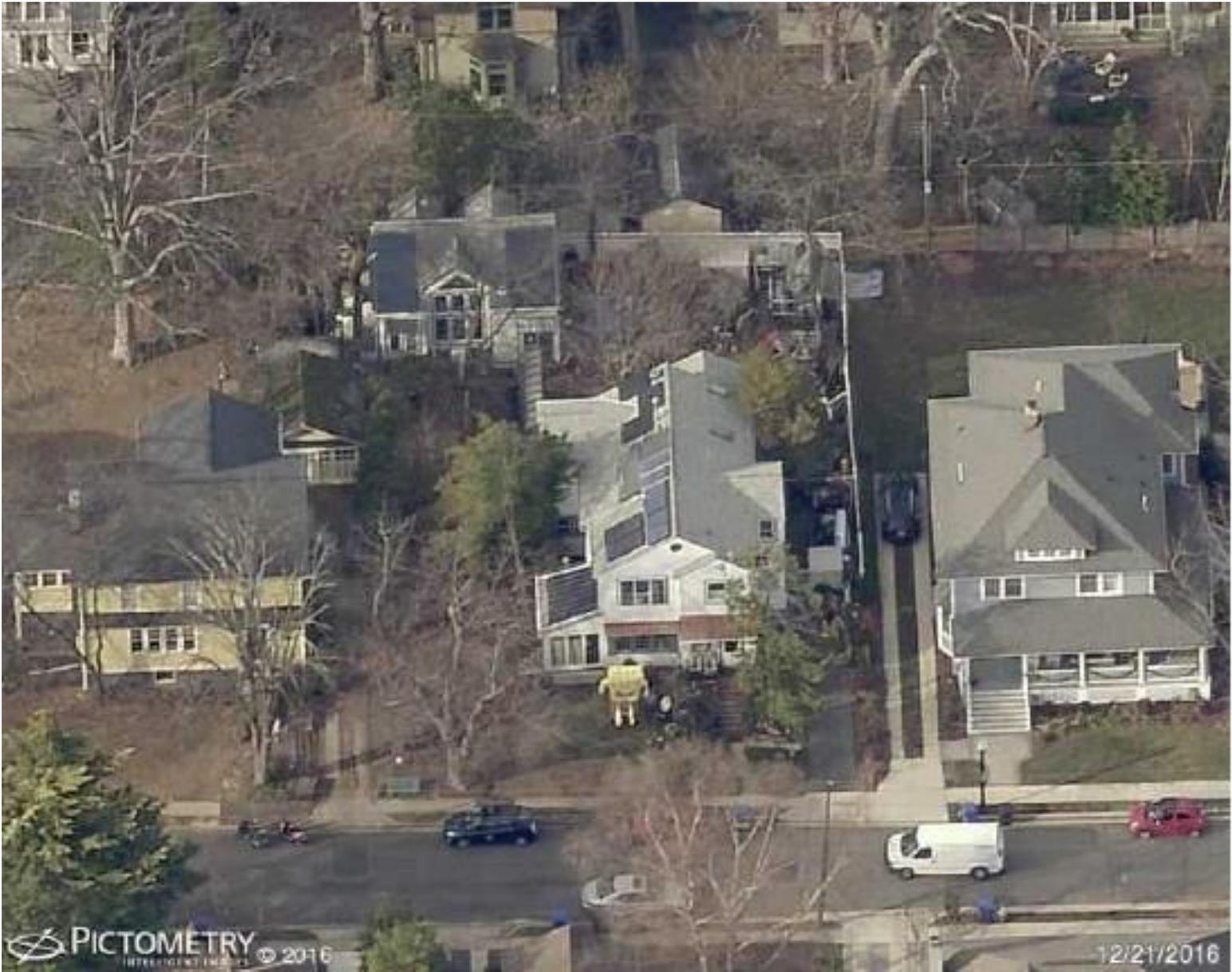
SHORT TERM – power quality & arbitraging sub-rates

MEDIUM TERM – resiliency & reliability – first play  
critical shared infrastructure

But please note, these markets will not be penetrated by larger companies most likely. but more agile, smaller technology companies.

Five kinds of market focus –

- utilities (slow, uneven, and state-based)
- commercial/industrial/institutional (my markets) \*\*
- infrastructure (mostly on-site at towers, pumps, etc) \*\*
- government – military & remote \*\*
- residential (ie LG,Tesla-Solar City, etc.)



EAST SIDE

All my projects for 15 years revolve around these market drivers --

The driver for energy storage has been fourfold:

1. Dedicated to critical circuits for absolute power quality (preventing surges sags, transients) and/or frequency control as the distribution grid ages and becomes more fragile
2. Dedicated to critical functions for absolute electric power reliability to insure communications, internet, manufacturing controls, security, signage, etc.
3. Arbitraging higher electricity sub-rates (expressed as demand charges, peak & seasonal power rates, and in some states spot/ratchet rates)
4. Solely power critical infrastructure with charging inputs by on-site renewable energy for cellular towers, data centers, monitoring systems, signal lights (railways, roadways, harbor ways, etc), and all sorts of security and sensing systems, etc.

# Reforming the Energy Vision

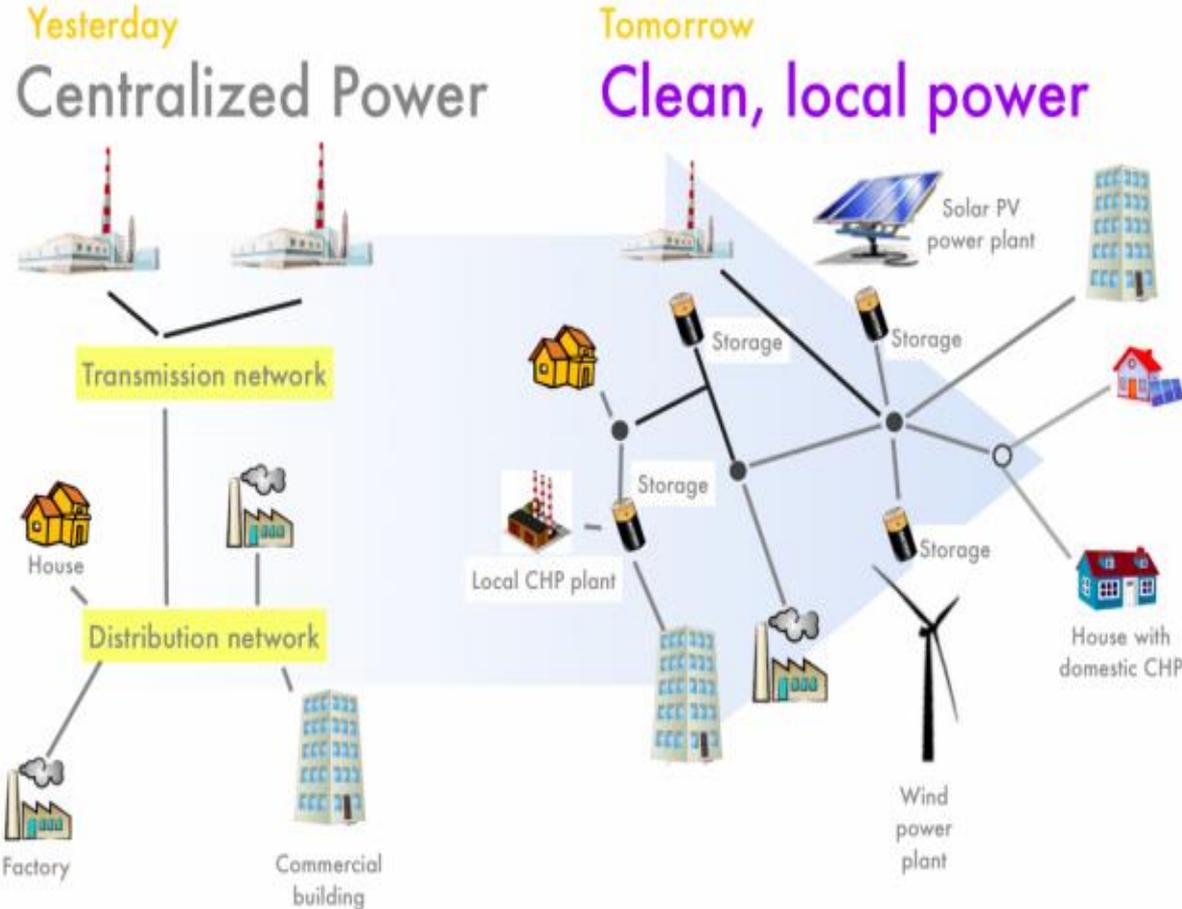
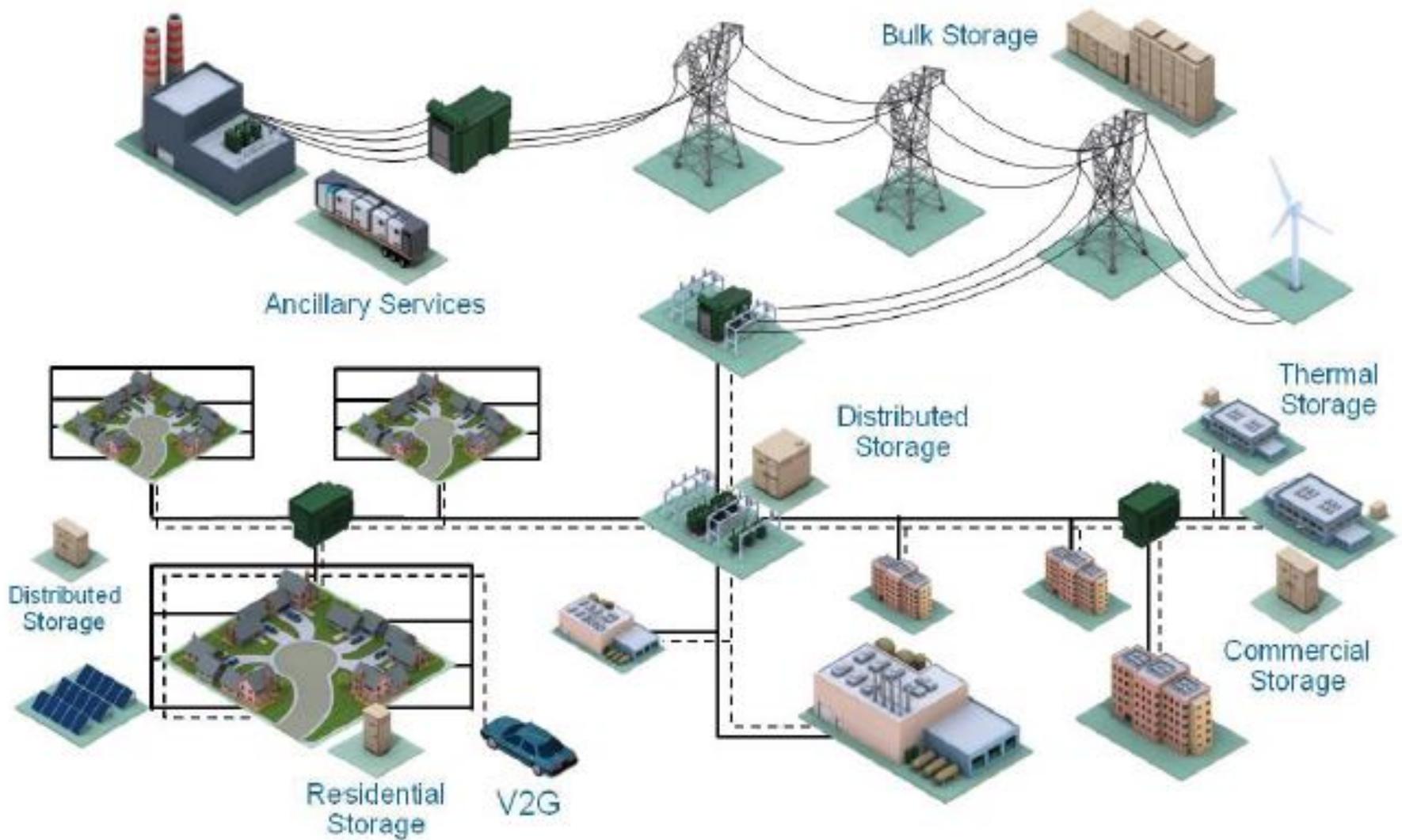


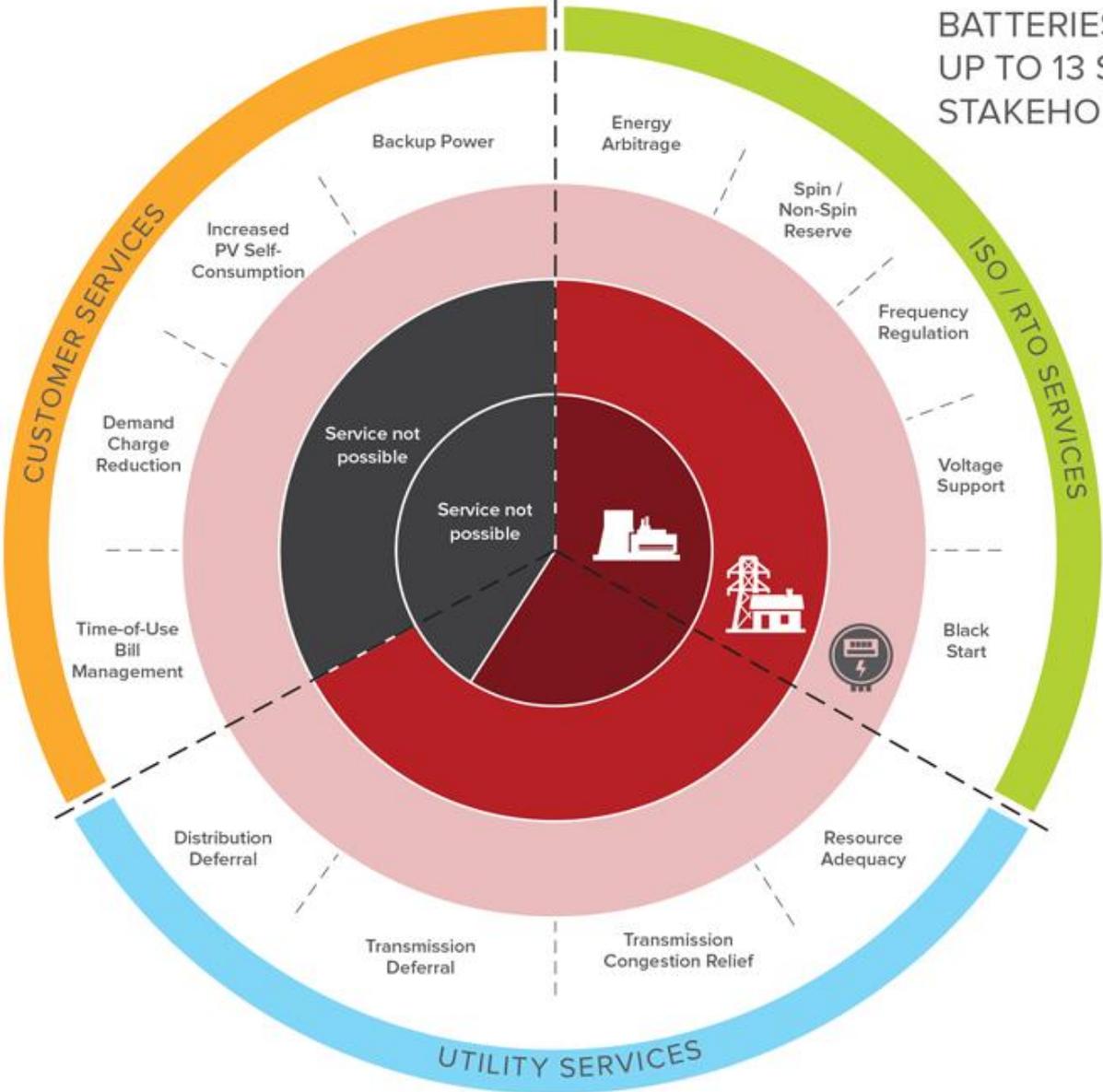
Figure L-1: Overview of Energy Storage Roles on the Electric Grid



Source: EPRI

Battery System Cost Assumptions ... peak reduction, contribution to reliability needs, or deferral of transmission ... storage” if battery prices fall to \$350 per kWh.

# BATTERIES CAN PROVIDE UP TO 13 SERVICES TO THREE STAKEHOLDER GROUPS



CENTRALIZED



TRANSMISSION

DISTRIBUTION

BEHIND THE METER



DISTRIBUTED

## 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

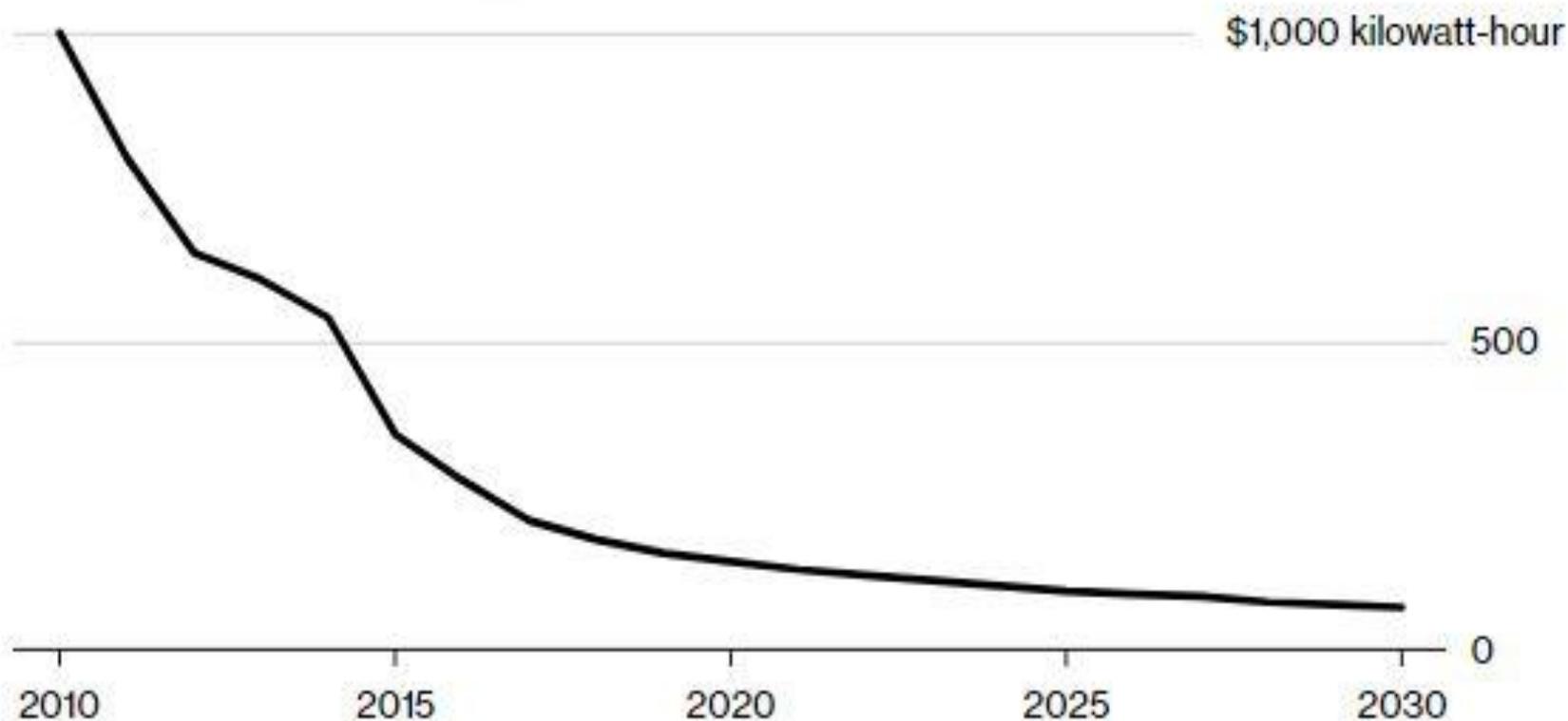
- Power disruptions may cause sensitive equipment to fail.
- As a result, organizations face potential for significant losses – lost data, lost materials, lost productivity, and lost income – as well as risks to public safety.
- A study by Sandia National Laboratories estimates losses from power disruptions 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.



## Cheaper Batteries

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

／ Lithium-ion battery pack price



Source: Bloomberg NEF

Note: Prices starting in 2018 are forecasts

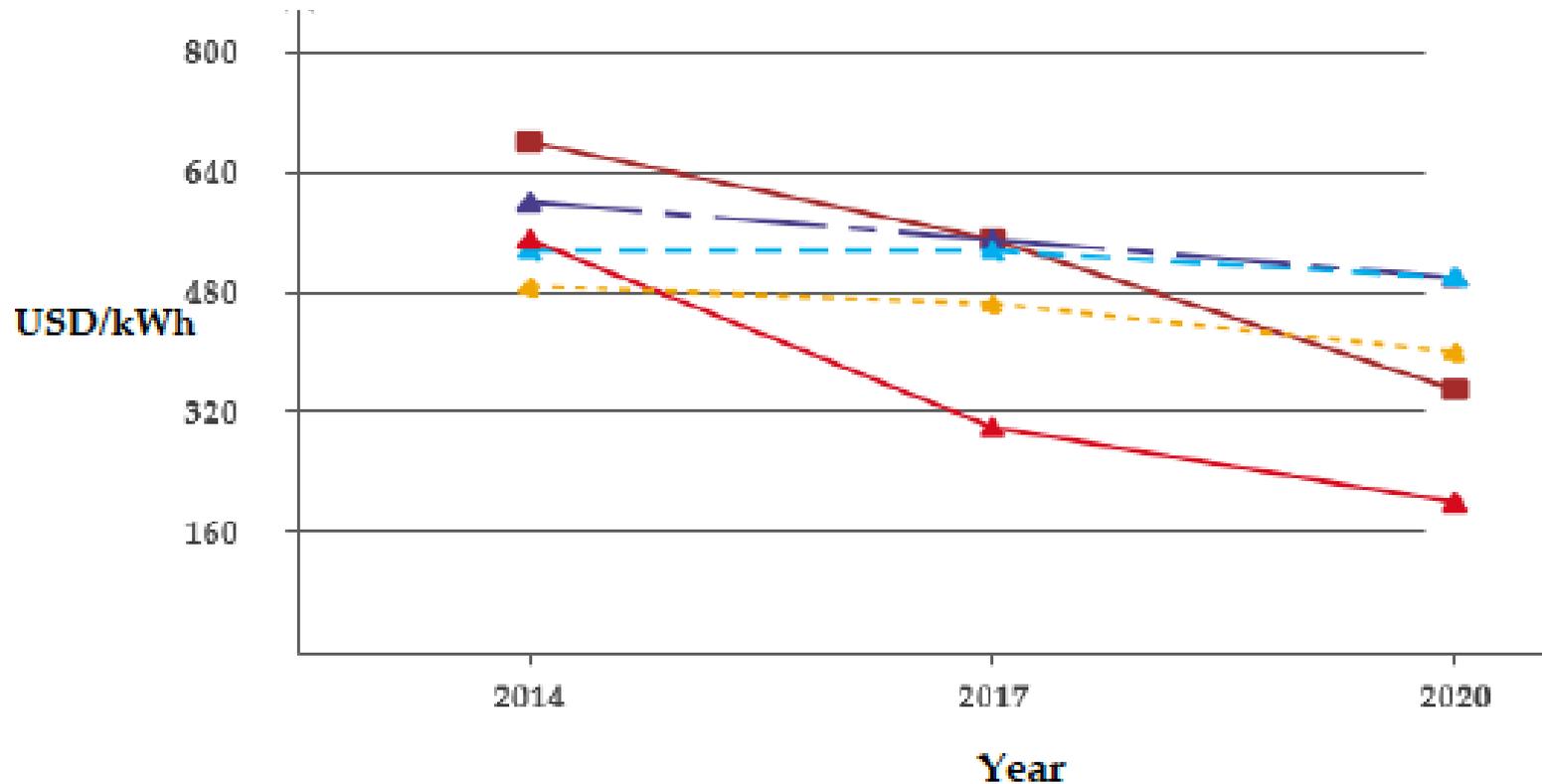
# Battery Prices Are Falling Fast



Bloomberg New Energy Finance

Figure 4: Current and projected battery prices (USD/kWh) by type for utility-scale applications

- Flow batteries
- Advanced Lead Acid
- Sulphur Sodium
- Lithium ion
- Sodium Metal Halide

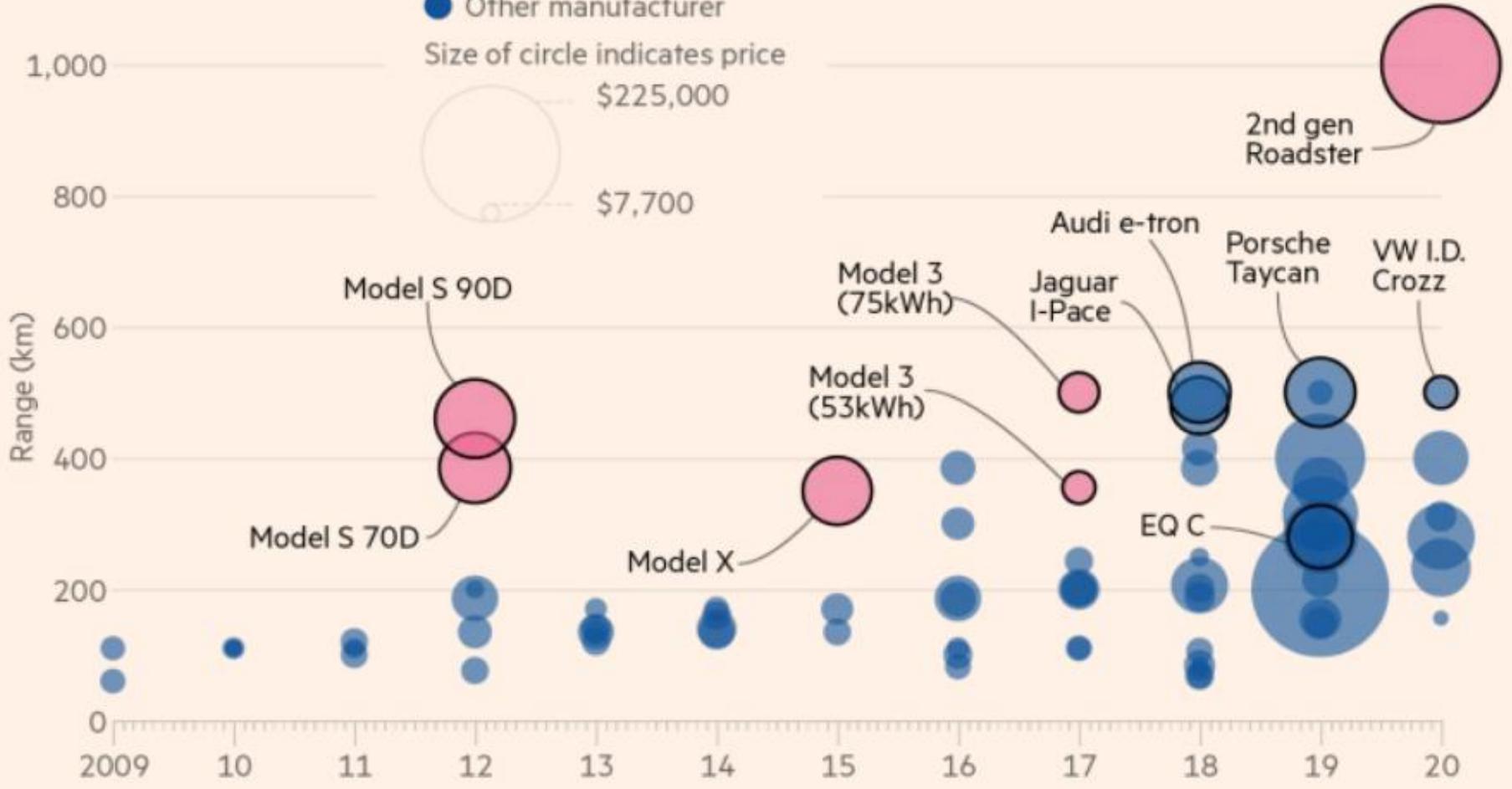


# Electric cars

Battery range over time

- Tesla
- Other manufacturer

Size of circle indicates price  
\$225,000  
\$7,700



Source: UBS; Goldman Sachs  
© FT

## **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.

## California's First-in-Nation Energy Storage Mandate

by Bill Sweet Posted 25 Oct 2015 | 17:30 GMT

<http://spectrum.ieee.org/energywise/energy/renewables/californias-firstinnation-energy-storage-mandate>

California has adopted the United States' first energy storage mandate, requiring the state's three major power companies to have electricity storage capacity that can output 1325 megawatts in place by the end of 2020, and 200 MW by the end of next year. The new rule issued by the California Public Utilities Commission (CPUC) will be key to implementation of the state's ambitious renewable portfolio rules, which calls for 33 percent of delivered electricity to come from renewable sources by 2020 and virtually guarantees that California, along with Germany, will remain in the world vanguard of those aggressively building out wind and solar.

# Key State Regulatory and Legislative Energy Storage Policies and Actions

(As of Q3 2016)

## Oregon

- PGE 2016 [IRP](#)
- Energy Storage Program [UM 1751](#)
- \$300K from ODOE for [Energy Storage Projects](#)
- PGE storage included in RFP [UM 1535](#)
- [HB 2193](#)

## California

- Energy Storage Framework and Procurement [R1503011](#)
- SGIP Program [R1211005](#)
- DRP [R1408013](#)
- Integrated DER [R1410003](#)
- Demand Response [R1309011](#)
- Aliso Canyon [Storage RFO](#)
- [SB 350](#)
- [AB 33](#)
- [AB 2888](#)
- [AB 1637](#)
- [AB 2881](#)

## Washington

- Valuing Energy Storage [UE-151069](#)
- \$14.3 MM from [Clean Energy Fund 1](#) and \$12.6 MM from [Clean Energy Fund 2](#)
- UTC request for storage as resource option in future IRPs [UE100961](#)
- [HR 1115](#)

## Minnesota

- Grid Modernization Investigation [15-556](#)
- [HF 3](#)

## New York

- Reforming the Energy Vision [14-M-001](#)
- DSIPs [16-M-0411](#)
- BCA Handbooks [16-M-0412](#)
- Value of DER [15-E-0751](#)
- NYC Storage [Target 100 MWh by 2020](#)
- CEF [Energy Storage Chapter](#)
- [ConEd Peak Load Reduction Program](#)
- BQDM peak reduction RFP [14-E-0302](#)
- PSEG-LI peak reduction RFP

## NYISO

- DER [Roadmap](#)
- Storage Market Integration and Optimization [Initiative](#)

## Vermont

- [GMP and Tesla BTM Storage Pilot](#)
- [HB 40](#)

## New Hampshire

- Grid Modernization [IR 15-286](#)

## Massachusetts

- \$10 MM [DOER Energy Storage Initiative](#)
- Conference on Energy Storage [15-ESC-1](#)
- [H 4568](#)
- [S 1770](#)
- [S 1762](#)

## Nevada

- Battery Storage Investigation [16-01013](#)
- Governor's Clean Energy [Task Force](#)

## Iowa

- MidAmerican Community Solar and Storage Pilot [NOI-2014-0001](#)

## District of Columbia

- Grid Modernization [FC1130](#)

## Maryland

- [Technical Conference on DER Policies](#)
- Grid Modernization: [PC44](#)

## Connecticut

- Investigation into Energy Storage [15-11-34](#)
- [Draft Energy Storage RFP](#)
- [Demonstration Projects](#)
- DEEP Microgrid [Grant Program](#)
- [SB 272](#)
- [SB 1079](#)
- [SB 1502](#)

## Utah

- [SB 0115](#)

## Colorado

- [Innovative Clean Technology Projects Program](#)
- PNM 2011 IRP storage as supply-side resource [11A-869E](#)

## New Mexico

- [Renewable Energy Storage Working Group](#)
- [Energy Policy & Implementation Plan](#)

## Texas

- ONCOR Compressed Air Energy Storage Interconnection [44872](#)
- \$1MM [New Technology Implementation Grant](#)

## New Jersey

- \$6 MM [Renewable Electric Storage Incentive Program](#)
- Town Center [Microgrid Program](#)
- [S 2016](#)

## North Carolina

- Duke Energy Storage Pilot [E-2 Sub 1089](#)
- Interconnection Standards [E-100 Sub 101](#)

## Arizona

- APS Energy Storage Pilot and Incentive Program [E-01345A-15-0241](#)
- TEP Energy Storage Pilot [E-01933A-15-0239](#)
- APS DSM Storage Carveout [E-01345A-16-0176](#)
- [APS/RUCO Settlement for All-Source RFPs](#)
- Interconnection Standards [RE-00000A-079-0609](#)
- [ACC Technology workshop](#)
- SRP and ASU [Storage Pilot](#)
- [SB 1465](#)

## Hawaii

- Investigation into DER Policies (Self-Supply NEM) [2014-0192](#)
- HECO PSIPs [2014-0183](#)
- HECO 2013 IRP storage as supply-side resource [2012-0036](#)
- [HECO and Stem Storage Pilot](#)
- [HECO and Greenlots V2G Pilot](#)
- Integrated DR Portfolio Plan [2007-0341](#)
- [HB 2236](#)

## ERCOT

- Future Ancillary Services Team (FAST) [NPR6877](#)

## Georgia

- Value of DER for Georgia Power's 2016 IRP [38732](#)
- Georgia Power Tesla Storage Pilot and Demos [40161](#)

## CAISO

- ESDER [Initiative](#)
- Flexible Capacity [Procurement](#)
- Flexible Ramping [Product](#)
- Expanding Metering and Telemetry [Options](#)
- 2015-16 Transmission [Planning](#)

**Companies Unplug From the Electric Grid, Delivering a Jolt to Utilities:  
Wall Street Journal, by Rebecca Smith & Cassandra Sweet, September 17, 2013**

[http://online.wsj.com/article\\_email/SB10001424127887324906304579036721930972500-1MyQjAxMTAzMDEwODExNDgyWj.html?mod=wsj\\_valettop\\_email](http://online.wsj.com/article_email/SB10001424127887324906304579036721930972500-1MyQjAxMTAzMDEwODExNDgyWj.html?mod=wsj_valettop_email)

**From big-box retailers to high-tech manufacturers, more companies across the country are producing their own power. Since 2006, the number of electricity-generation units at commercial and industrial sites has more than quadrupled to roughly 40,000 from about 10,000, according to federal statistics. Experts say the trend is gaining momentum, spurred by falling prices for solar panels and natural gas, as well as a fear that power outages caused by major storms will become more common. On-site generation still accounts for less than 5% of U.S. electricity production. But it is peeling off some of the bulk sales that utilities find especially profitable. And some of the companies getting into the business think it is approaching a tipping point called "grid parity," at which point power would be as cheap to make as to buy from a utility. The growing number of companies that are at least partly energy self-sufficient is sending a shudder through the utility industry, threatening its revenues and growth prospects, according to a report earlier this year by the Edison Electric Institute, a trade association for investor-owned electric companies.**

**U.S. Surpasses 100-MW of Storage Deployments Through Q3 2015,  
Already Best Year Ever:GreenTechMedia.com, by Mike Munsell,  
December 3, 2015**

**<http://www.greentechmedia.com/articles/read/us-surpasses-100-mw-of-storage-deployments-through-q3-2015-already-best-yea>**

**The U.S. just experienced its largest quarter for energy storage deployments since the fourth quarter of 2012. According to GTM Research and the Energy Storage Association's U.S. Energy Storage Monitor, the U.S. deployed 60.3 megawatts of energy storage capacity in the third quarter of the year. This represents 53.1 megawatt-hours. The U.S. has now deployed 108 megawatts (94 megawatt-hours) through the first three quarters of the year. The Energy Storage Monitor tracks deployments going back to 2008, and until now, deployments had never surpassed 100 megawatts in a given year. The report forecasts total deployments of 192 megawatts this year, triple last year's total.**

Hawaii's largest solar array, complete with storage, now online

by Robert Walton | November 3, 2015

REC Solar has brought online Hawaii's largest solar array yet, a 12 MW (AC) facility paired with a 6 MW lithium ion battery system, PV Magazine reports. Developed for Kaua'i Island Utility Cooperative (KIUC), the system is located on 60 acres and will supply 20% of the island's annual power needs. The solar plant will help the island meet its goal of 38% renewables by the end of 2015, on the road to hitting the statewide 100% renewables target by 2045. The solar power will allow KIUC to cut fossil fuel imports and will save \$250,000 each month on operating costs alone, according to the company.

SOURCE:

<http://www.utilitydive.com/news/hawaiis-largest-solar-array-complete-with-storage-now-online/408472/>



Kaua'i to meet 1/4 of power needs with solar thanks to Tesla system

*By Christian Roselund on Mar 10 2017, 2:50pm*

Today Tesla will officially put online its solar-PV-plus-storage project on the island of Kaua'i, at the end of Hawaii's chain of islands. The 13 MW solar and 52 MWh battery storage project will supply electricity under a 20-year contract with the island's public utility. Unique among utility-scale PV systems, Tesla's project will be used to meet peak demand between 5 PM and 10 PM – after the sun goes down. This will be accomplished through the use of the battery system, which is comprised of 272 Tesla Powerpack batteries using lithium-ion technology developed by Panasonic in collaboration with Tesla.

EDF Renewable Energy has created a new subsidiary for distributed solar and storage projects up to 30 MW.

EDF creates U.S.-based storage unit

*By Emiliano Bellini on Mar 16 2017, 2:39pm*

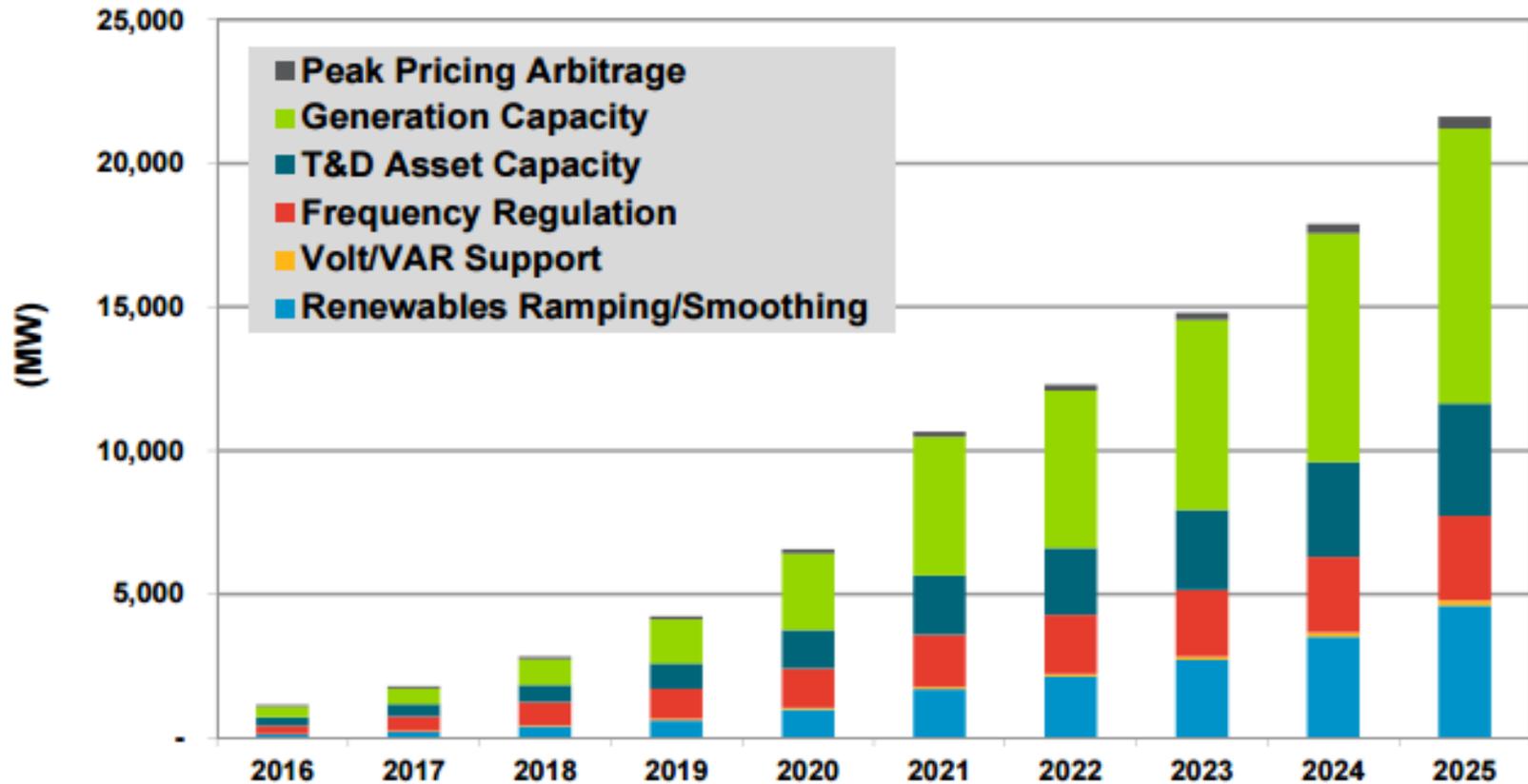


<https://pv-magazine-usa.com/2017/03/16/edf-creates-u-s-based-storage-unit/>



PJM's frequency response market adds 31.5MW of Invenergy's renewables storage in Illinois [May 15, 2015 9:49](#)

**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/>

## **Invenergy bringing over 60 MW of storage online for PJM frequency regulation**

by Herman K. Trabish | May 19, 2015

Invenergy has brought a new 31.5 MW storage facility online in central Illinois, The Grand Ridge storage facility, situated nearby an existing 1.5 MW storage site, increases the capacity available to grid operator PJM Interconnection for frequency regulation. The battery storage facility is also near a 210 MW wind project and a 20 MW solar array, part of Invenergy's 9 GW of U.S. renewables. Battery-stored energy can provide quick-response grid-balancing power on a sub-hourly basis that is valuable to grid operators in sustaining system frequency and prevent outages.

<http://www.utilitydive.com/news/invenergy-bringing-over-60-mw-of-storage-online-for-pjm-frequency-regulatio/399140/>



### **Tesla Finishes Building World's Largest Battery Month and a Half Ahead of Schedule**

Elon Musk has won an audacious bet he made back in March to build a [battery](#) system for South Australia in “100 days from contract signature or it is free.” The 100-megawatt Powerpack system is the world's largest. Tesla CEO was responding to a challenge from Australian IT billionaire Mike Cannon-Brookes to help fix the Australian state's electricity woes. Losing the bet would have cost Musk probably \$50 million or more.” The grid connection deal was finally signed on Sept. 29—kick-starting the 100-day clock—Tesla was already halfway finished with installation. So if you want to be technical, you could say that the project was finished a month and a half before the contract's deadline. The company originally estimated completion by December 2017. The lithium-ion battery storage facility will be charged by Neoen's Hornsdale wind farm near Jamestown, South Australia and deliver electricity during peak hours. According to Business Insider, when fully charged, the battery should hold enough power for 8,000 homes for 24 hours, or more than 30,000 houses for an hour during a blackout.



Florida Power & Light has added a 10 MW / 40 MWh battery to its existing 74.5 MW Babcock Ranch Solar Energy Center, creating what the utility believes to be the largest solar-plus-storage installation in the United States. It is also the second such project FPL has unveiled in an many months. In February the utility announced it had installed a 4 MW / 16 MWh storage system at its Citrus Solar Energy Center, which was completed in 2016. Following an agreement the Florida Public Service Commission approved in 2016, FPL intends to develop 50 MW of battery storage over the next few years. (by **Robert Walton** March 12, 2018)

<https://www.utilitydive.com/news/fpl-adds-40-mwh-battery-to-solar-array-claiming-largest-combined-system/518959/>

## **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.

US Army Installs Largest Battery Storage System

## **US Army Installs Largest Battery Storage System**

August 27, 2018 \_\_\_ by Nicholas Nhede, Smart Energy International

**The US' largest stand-alone battery energy storage system ever to be developed at an army base is being installed at Fort Carson, El Paso County in Colorado.**

The project is part of an energy savings performance contract signed between the US Army, infrastructure development firm AECOM and technology provider Lockheed Martin. The 4.25MW/8.5MWh lithium battery energy storage system is expected to help reduce energy demand during peak intervals and reduce the base's energy costs. Lockheed Martin Energy, said: "The versatility of energy storage is a key enabler for the military's aggressive goals of achieving energy resiliency." The plant will help the base to optimize its solar photovoltaic assets and will be used for microgrid support. Lockheed Martin's energy storage batteries will be integrated with predictive analytics software developed by Growing Energy Labs to enable real-time operation, monitoring and management. The revenue-generating system will operate behind Fort Carson's electric utility meter.

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This article [was originally published at Smart Energy International](#) and was reprinted with permission.

Source: [https://www.renewableenergyworld.com/articles/2018/08/us-army-installs-largest-battery-storage-system.html?cmpid=enl\\_rew\\_energy\\_storage\\_news\\_2018-08-29&pwhid=3cf9a21d4d81e0aea476e2322be758a3f411304d216c3dd1b50901a8f4bba6e4ee73b9096927f9fd43ffb0c49bbb3348543dd7c6eac631fcbc4cad903ccc0a43&eid=291124330&bid=2222176](https://www.renewableenergyworld.com/articles/2018/08/us-army-installs-largest-battery-storage-system.html?cmpid=enl_rew_energy_storage_news_2018-08-29&pwhid=3cf9a21d4d81e0aea476e2322be758a3f411304d216c3dd1b50901a8f4bba6e4ee73b9096927f9fd43ffb0c49bbb3348543dd7c6eac631fcbc4cad903ccc0a43&eid=291124330&bid=2222176)

Tucson Electric Power has signed a power purchase agreement for a solar-plus-storage system at "an all-in cost significantly less than \$0.045/kWh over 20 years," according to a company official. Exact prices are confidential, but a release pegged the PPA for the solar portion of the project at below \$0.03/kWh.

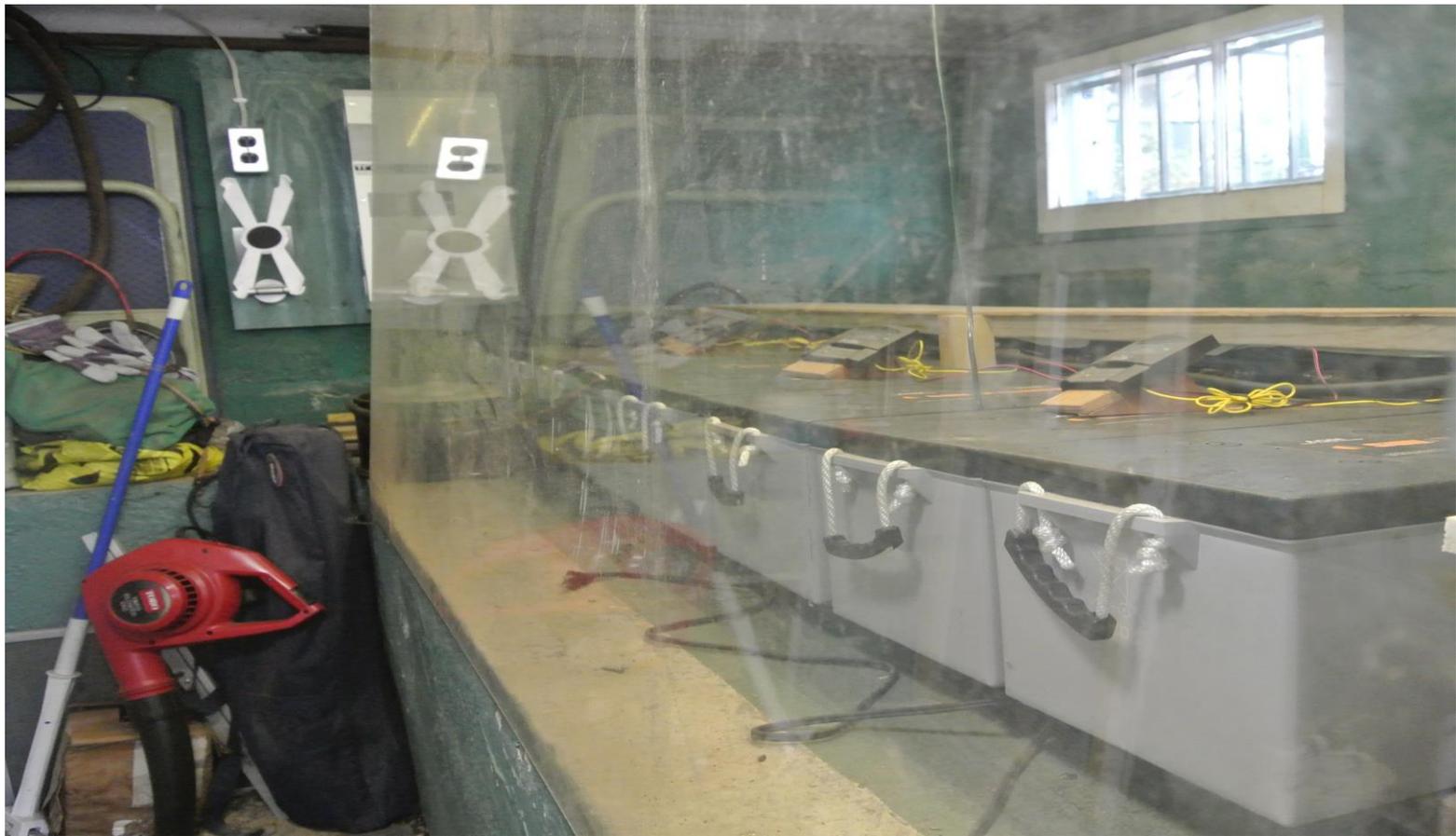
The project calls for a 100 MW solar array and a 30 MW, 120 MWh energy storage system, both developed by an affiliate of NextEra Energy. If the pricing proves accurate, it would represent a major cost reduction for combined storage facilities since the signing of the last significant PPA — a \$0.11/kWh Hawaii contract in January 2018.

The PPA would confirm a forecast in Arizona's proposed "Clean Peak Standard" that solar-plus-storage facilities could compete with gas peakers on price. But TEP does not support the proposal, now on hold with regulators.

SOURCE: <http://www.utilitydive.com/news/updated-tucson-electric-signs-solar-storage-ppa-for-less-than-45kwh/443293/>



PJM's frequency response market adds 31.5MW of Invenergy's renewables storage in Illinois May 15, 2015 9:49



16 Concorde (CA) Absorbed Glass Matrix (AGM) Battery Bank (Sklar Home)  
Model: PVX-2580L      Deep Cycle AGM Battery 12 volt, 258 AH 159 lbs

100% charge -94 degrees F at 50% charge – 13 degrees F Max 125 degrees F

# 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.





Japan – 40 miles from Tokyo (pre-Fukushima)

# Secondary Battery Types and Characteristics

BATTERY TYPE	Cost	Deep Cycle Performance	Maintenance
<b>FLOODED LEAD-ACID</b>			
Lead-Antimony	low	good	high
Lead-Calcium Open Vent	low	poor	medium
Lead-Calcium Sealed Vent	low	poor	low
Lead Antimony/Calcium Hybrid	medium	good	medium
<b>CAPTIVE ELECTROLYTE LEAD-ACID (VRLA)</b>			
Gelled	medium	fair	low
Absorbed Glass Mat	medium	fair	low

Until battery storage systems become: standardized, modular, interoperable, more service-friendly, with web-enabled color-coded diagnostics --- their use will be limited until they follow what solar, wind, and CHP systems have begun to incorporate 15 years ago which now has allowed them to scale into the market.

JCI and other large companies focus on technology optimization, not optimization and ease for the user. Sharing my story on Navy submission by JCI, and utilization of sectoral experts.

More diverse form factors to allow faster integration into buildings, along infrastructure, and greater versatility for use during emergencies is needed. And finally, smarter approaches than bundling hundreds of wires needs to be re-considered and supplanted with easier-to-service approaches (think laptop batteries). Unless this is done, battery banks will not reach their market potential as fast as desired, but JCI being a systems integrator as well as a battery manufacturer, seems ideally positioned to fill this void.

## RECENT ENERGY STORAGE STUDIES

### CALIFORNIA

[http://www.cpuc.ca.gov/NR/rdonlyres/1110403D-85B2-4FDB-B927-5F2EE9507FCA/0/Storage\\_CostEffectivenessReport\\_EPRI.pdf](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](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**

## **COMPLETED - UTILITY MOVES ...POSTED: 01:30 a.m. HST, Jan 07, 2014**

In particular, Hawaiian Electric Co. and the Hawaii Natural Energy Institute are partnering on a project, due to begin by the second quarter of this year, to try out battery technology in West Oahu, one area where photovoltaic solar systems have particularly high market penetration.

It will employ a 1-megawatt lithium-ion battery to be installed between the HECO Campbell Industrial Park substation and a distribution circuit serving homes that have more than 3 megawatts of PV capacity. The mission is to gain a clearer understanding of how to use the storage technology to keep voltages constant on circuits with high PV use.

The energy institute also is working on Molokai with Maui Electric Co., a HECO subsidiary, on another, similar battery-storage test. This momentum should not be surprising, given the explorations being made by the private industry to promote a battery-enabled transition "off the grid" for their customers.

[http://www.staradvertiser.com/editorialpremium/20140107\\_Better\\_batteries\\_will\\_boost\\_PV\\_use.html?id=238990301](http://www.staradvertiser.com/editorialpremium/20140107_Better_batteries_will_boost_PV_use.html?id=238990301)

**Where the energy storage expansion will happen first and why**  
**The commercial-industrial segment of the market is ready to buy in**  
By [Herman K. Trabish](#) | January 7, 2015

People who watch the energy storage market say they now know where and how it will break out commercially.

New numbers show solar plus storage technology, on the strength of 20%-plus annual price drops over the last 4 years, is on the verge of turning into a billion dollar market by 2018, Utility Dive just reported.

"This \$6 billion energy market is a huge opportunity," said [Clean Coalition Economics & Policy Analysis Director Kenneth Sahm White](#). "The value proposition is there. The questions are how smoothly the market will open up, how fast it will happen, and who will get the economic benefits."

[http://www.utilitydive.com/news/where-the-energy-storage-expansion-will-happen-first-and-why/346265/?utm\\_source=Sailthru&utm\\_medium=email&utm\\_term=Utility%20Dive&utm\\_campaign=Issue%3A%202015-01-08%20Utility%20Dive%20Newsletter#.VQ7YT0clTEo.mailto](http://www.utilitydive.com/news/where-the-energy-storage-expansion-will-happen-first-and-why/346265/?utm_source=Sailthru&utm_medium=email&utm_term=Utility%20Dive&utm_campaign=Issue%3A%202015-01-08%20Utility%20Dive%20Newsletter#.VQ7YT0clTEo.mailto)

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Six Axion PbC-30HT-12V Battery Modules  
Module rating: 70 Ah, 500 Wh @ C rate  
Sealed AGM construction  
Axion Battery Management System  
Battery Cabinet—24"x30"x24"  
Estimated Weight: 500 pounds

One Outback VFX3648 Inverter—  
3600 VA, 120 VAC, 60 Hz output  
Weather resistant sealed aluminum chassis  
Modular stackable design

One Midnite Solar Classic MPPT FM60 Charge  
Controller  
Arc fault protection  
Ground fault protection  
Internet ready  
Large graphical display

One Midnite Solar FW-SP-ACA surge arrestor



**REH0403 Building Energy Hub**

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)





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)

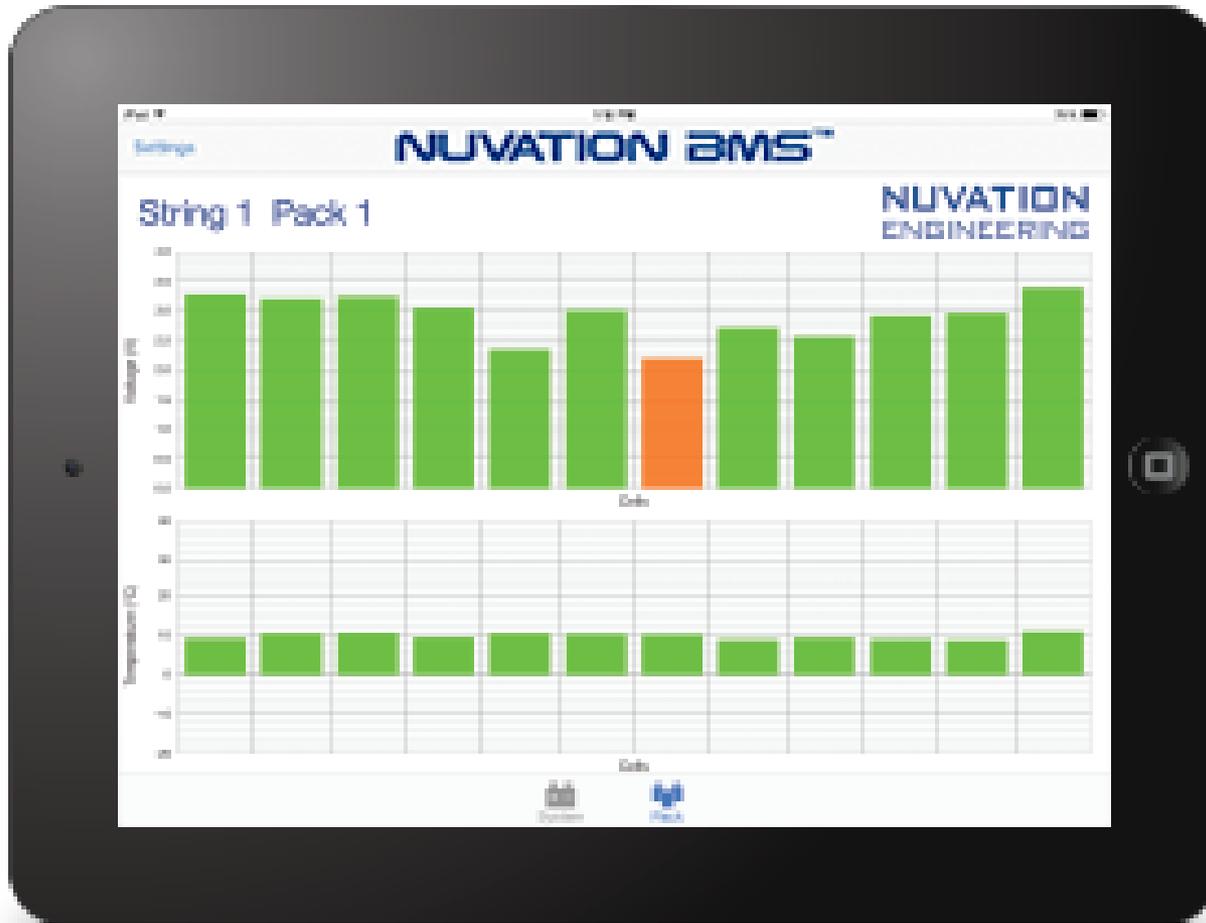
40.7 MW of energy storage was deployed in Q2 2015, a nine-fold increase from Q2 2014, and six-fold increase from Q1 2015. Behind-the-meter market continued its strong showing of previous quarters, and grew over eleven times from same period last year.

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.



# **BATTERY MONITORING**





SOURCE: NUVATION

<http://www.nuvation.com/battery-management-system/bms-for-telecom-datacom-systems>



# Energy Monitor

OUTSIDE  
TEMP 23 °F



Consumption

Current 99.9 MPG

Any questions ???

Need reports, contacts ???

Contact:

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