Grid Scale Energy Storage, Adding Value to Solar Power

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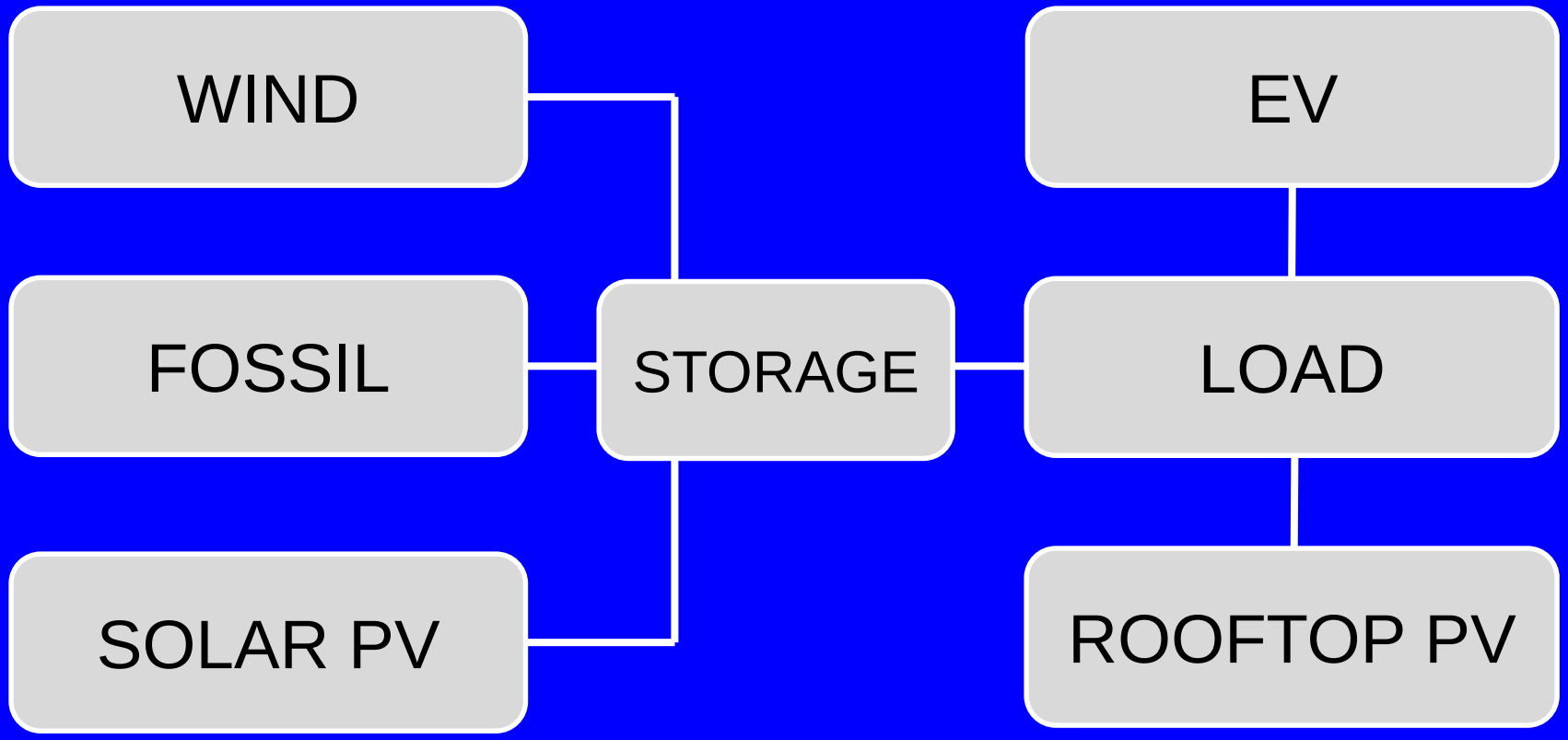
Energy Storage provides Energy

when it is needed

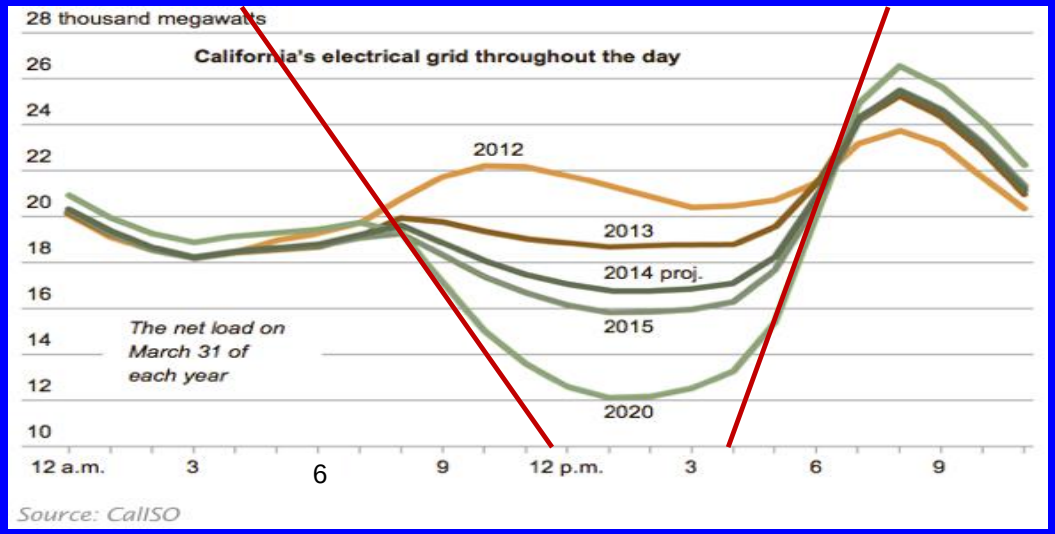
just as Transmission provides Energy

where it is needed

The grid has become stochastic!

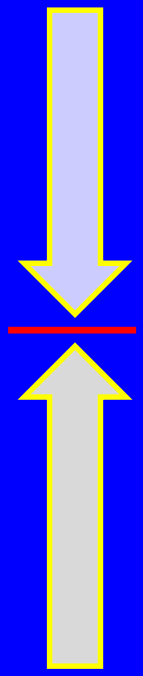


Energy Storage Systems for Peakshaving, Loadshifting, Ramping



October 2013: California PUC sets target of 1.3GW of Storage by 2020

Storage Economics:



The **Cost** of a Storage System depends on the Storage Device, the Power Electronics, and the Balance of Plant

The **Value** of a Storage System depends on Multiple Benefit Streams, both monetized and unmonetized

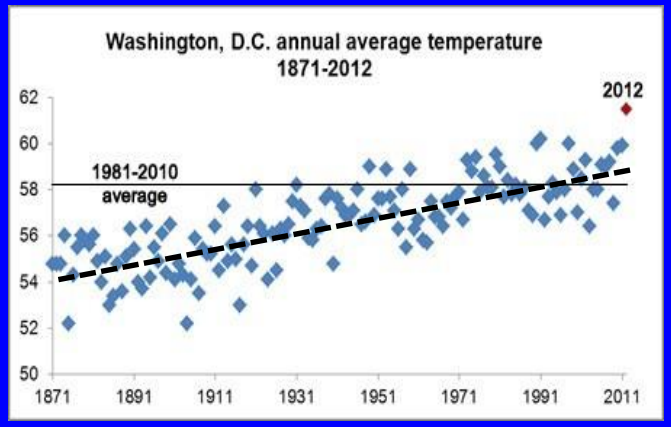
LCOE depends on Application!

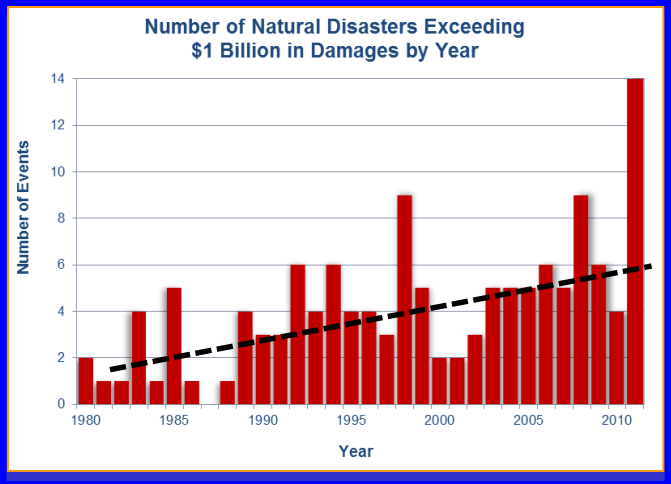
- Power Electronics 20-25%
- Energy Storage Device 25-50%
- Facility 20-25%

- Arbitrage
- Frequ. Reg.
- Dem. Charges month, year
- Resiliency

Energy Storage for Resilience

Every $1 on protection measurements
Can prevent $4 in repairs after a storm!





Trends indicate the situation will get worse not better!!

Vermont Public Service Dept. – DOE - Green Mountain Power

Joint Solicitation issued by VPS/OE
Rutland, VT

4MW / 3.4MWh of storage
Integrated with 2MW PV
Integrator: Dynapower

Groundbreaking: Aug. 12, 2014
Commissioning: Sep. 15, 2015

System can be islanded to provide emergency power for a resilient microgrid serving a highschool / emergency center.

Storage: Ancillary grid services, demand charge reduction
PV: Green power for the grid. Situated on Brown Field area

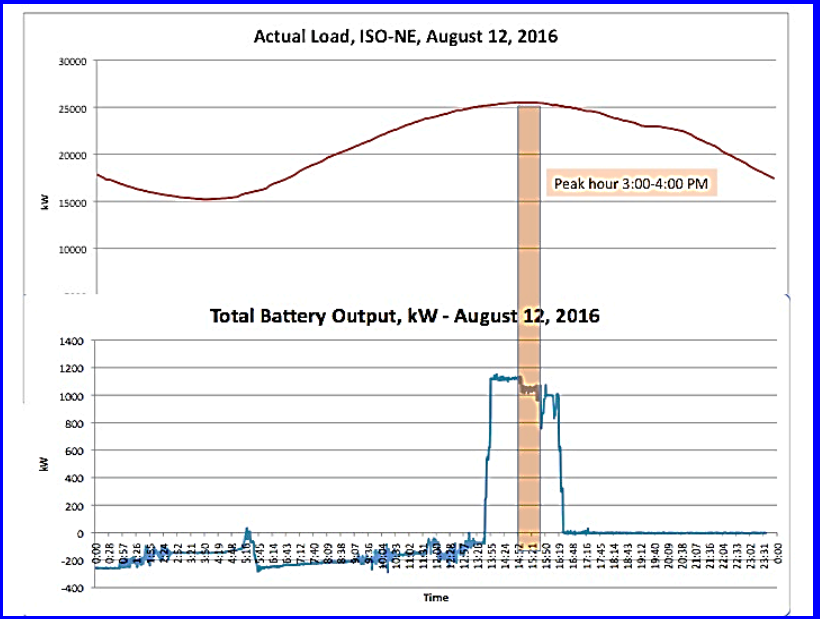
Referenced as model in VT Energy Strategic Plan! New projects planned. Testimony to VT Senate. Bill on Storage Initiative passed.

How to make the Microgrid Pay for itself:

Regional Network Service (RNS): Payments for using transmission lines depend on monthly peak load.

Forward capacity market (FCM): Payments for regional capacity reserves to cover load excursions depend on the yearly peak day/hour identified by ISO-NE,

In addition, there are financial benefits from frequency regulation and arbitrage.



Capturing the yearly peak, $200,000 from PV and storage!

Sterling, MA: Microgrid/Storage Project

Sterling, MA, October 2016

Sterling, MA, December 2016

Sterling Municipal Light Department.

$1.5M Grant from MA Community Clean Energy Resiliency Initiative (Dept. of Energy Resources). DOE/Sandia. Clean Energy Group.

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

Storage Economics in Action!

Description (1MW/1hr)	$
Arbitrage (buy low,sell high)	13,321
Reduced Monthly Peak	98,707
Reduced Yearly Peak	115,572
Frequency Regulation	60,476
Total	288,076

Capital cost: $1.7M/MW

simple payback: 6.7 years

R. Byrne, Sandia

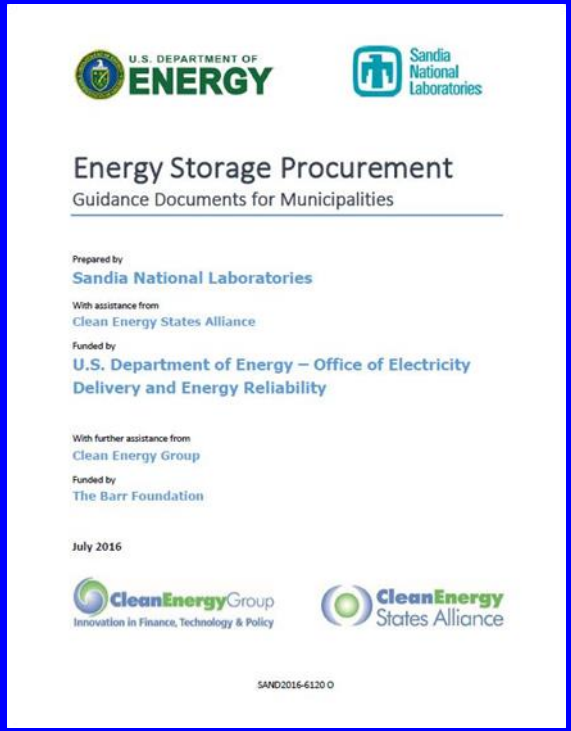
- ✓ **2016** December
- ✓ **2017** February
- ✓ **2017** March
- ✓ **2017** April
- ✓ 2017 May ($19,000!)

S. Hamilton, Sterling

Energy Storage Procurement, Guidance Document for Municipalities

Dan Borneo (Sandia)

Specific examples of the elements that should be included in a solicitation for the procurement and installation of a battery energy storage project designed to provide backup power during outages and facilitate timely cost recovery.



www.sandia.gov/ess

SAND 2016-8544

2017 GTM Grid Edge Award !

Other DOE-OE Storage Projects:

Eugene, OR, Water & Energy Board

Resiliency Microgrid
500kW Storage + 125kW PV + Diesel gen sets
at 2 aggregated sites

Cordova, AK, Study with ACEP

Hydropower Smoothing

Kona, HI, with NELHA and HELCO

Enabling more solar PV
100kW/500kWh of V/V Batteries

Orca Island with OPALCO

WA Clean Energy Fund
500kW/4 hour V/V system for resilience

?

The Bigger Picture

Grid Energy Storage Safety Initiative

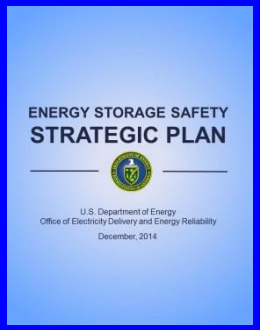
DOE identified *Validated Safety* as a critical need for the success of grid energy storage.

The ability to validate the safety of energy storage systems will:

- Decrease human and financial risk,
- Minimize installation costs,
- Accelerate acceptance of new technologies.

To address this need DOE is engaging key energy storage stakeholders:

- DOE OE Energy Storage Safety Workshop, February 2014
- PNNL Publication: Inventory of Codes and Standards
- *Strategic Energy Storage Safety Plan* – December 2014
- Established 3 ES Safety Working Groups – March 201
- DOE OE Energy Storage Safety Workshop, February 2016



Energy Storage – Equitable Regulatory Environment

Reducing institutional and regulatory hurdles for energy storage to provide an environment where the opportunities for deployment and the services provided by energy storage are recognized, implemented and appropriately valued requires coordination across federal, state and municipal entities

- Hosted regional Pacific Northwest utility regulatory commission workshop on energy storage with commissioners and staff from WA, OR, ID, and MT.
- Hosted Southwest regional utility regulatory commission workshop (May 4th, 2016) with NM, UT, AZ, CO, NV PUC's. With support from NARUC,
- Provided information to WA, OR, CA, and MA commissions on valuation of energy storage assets.
- Supporting plenary dockets on energy storage initiated by the Washington UTC and the Oregon PUC.
- Supported CA-ISO in review of storage market rules.
- DOE OE-VT efforts lauded as model for federal-state engagements in VT Strategic Energy Plan.

Energy Storage Technology Advancement Partnership ESTAP

Regular Webinars
In collaboration with CESA

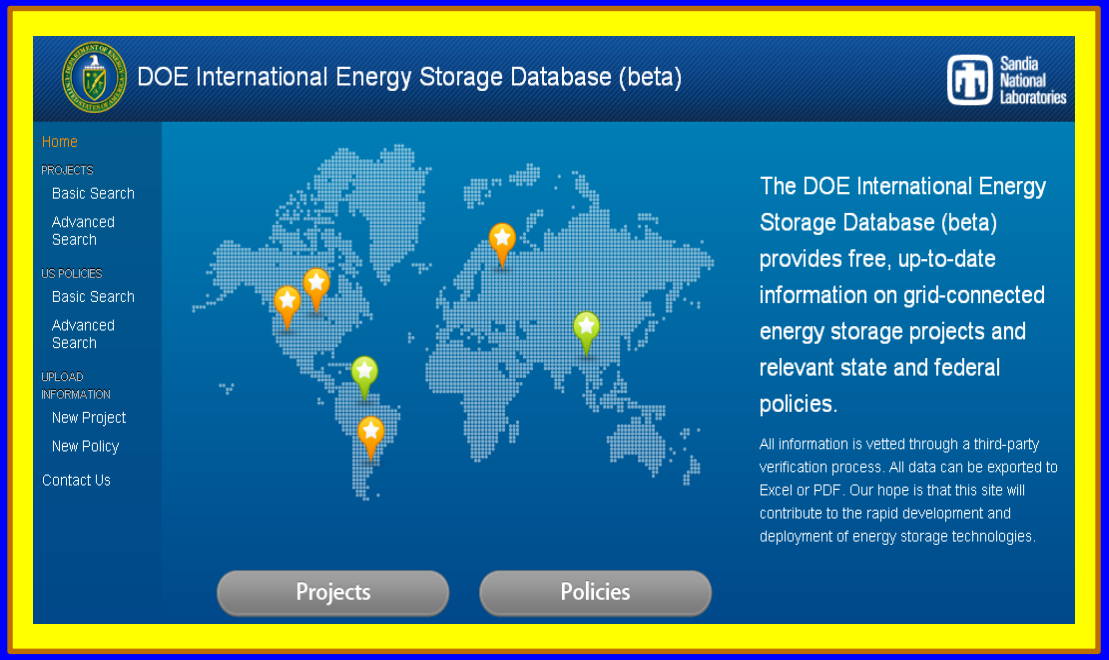
http://cesa.org/projects/energy-storage-technology-advancement-partnership/energy-storage-events/

DOE International Energy Storage Data Base

energystorageexchange.org supported by Strategen

Over 1550 energy storage projects from 60+ countries.

50 energy storage technologies are represented

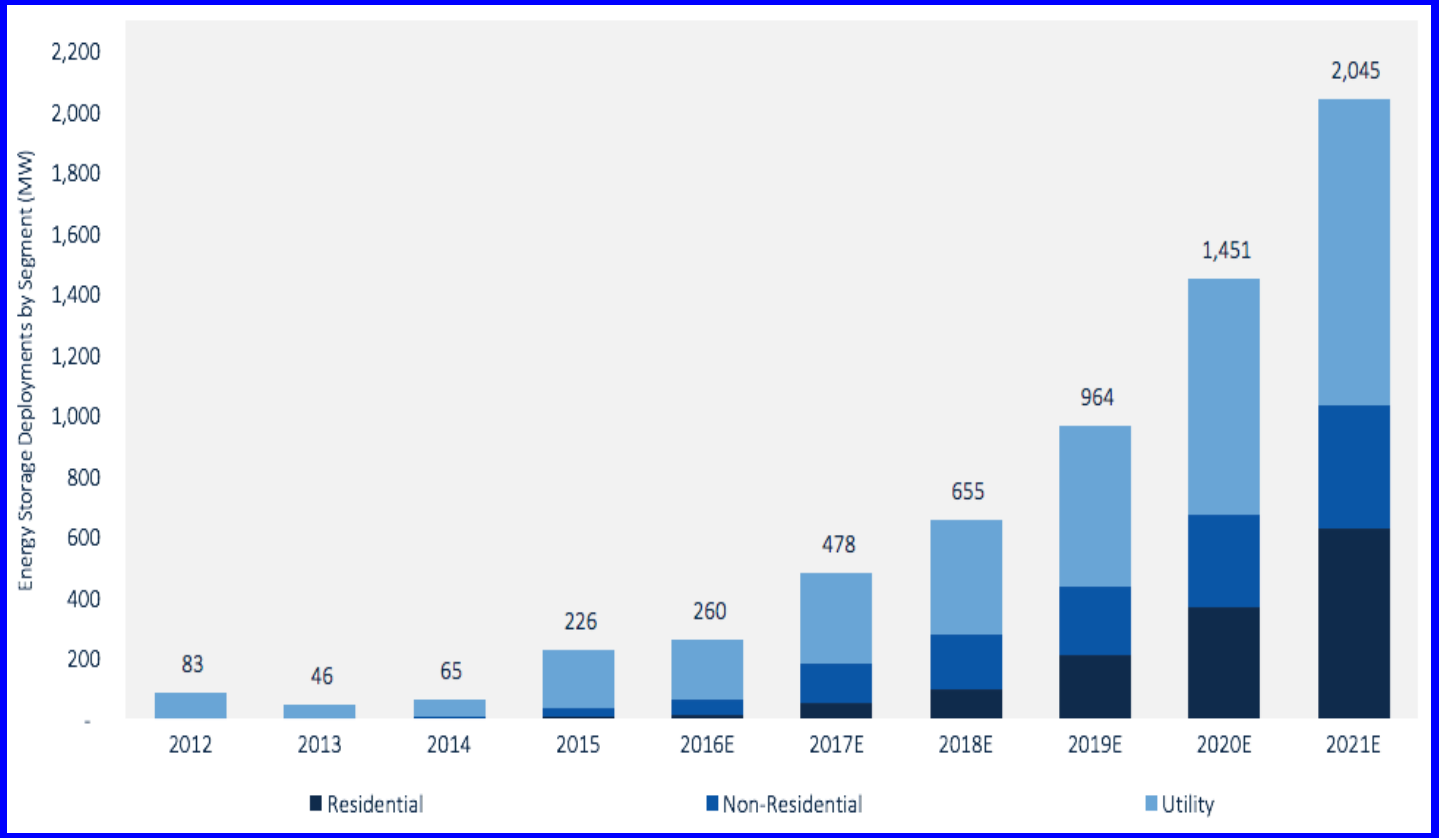


Partnerships with Australian Energy Storage Alliance

Policy Database in Development

Partnership with EIA on Storage Reporting

Annual U.S. Energy Storage Deployments, 2012-2021



GTM Research / ESA U.S. Energy Storage Monitor

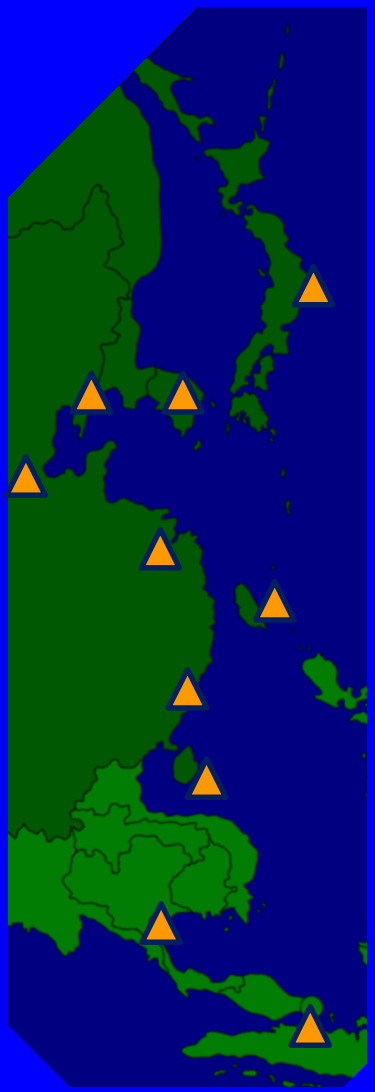
International Collaborations:

Korea: MOU with KETEP/POSCO on Low Temperature NaS Batteries

Singapore: CRADA with EMA to establish ES Test Bed

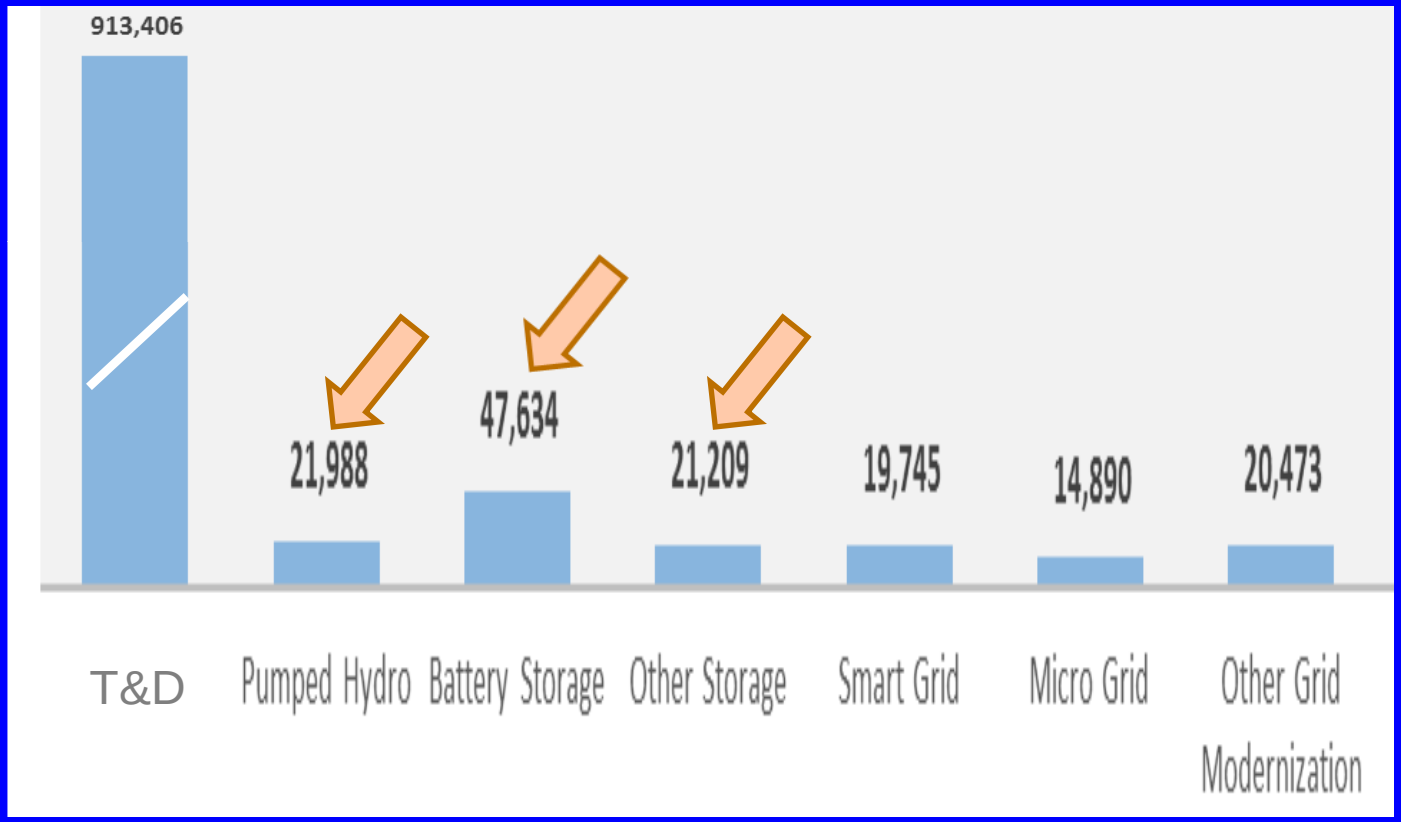
Japan: MOU with NITE on ES Safety Codes and Standards

Australia: Global ES Data Base



▲ Invited Presentations

U.S. Energy and Employment Report, January 2017



Employment by Transmission, Distribution, and Storage Technologies Q1 2016

With new Technologies Cost will go down, Safety and Reliability will increase

With every successful Project the Value Propositions will continue to increase!

More jobs will be created!!