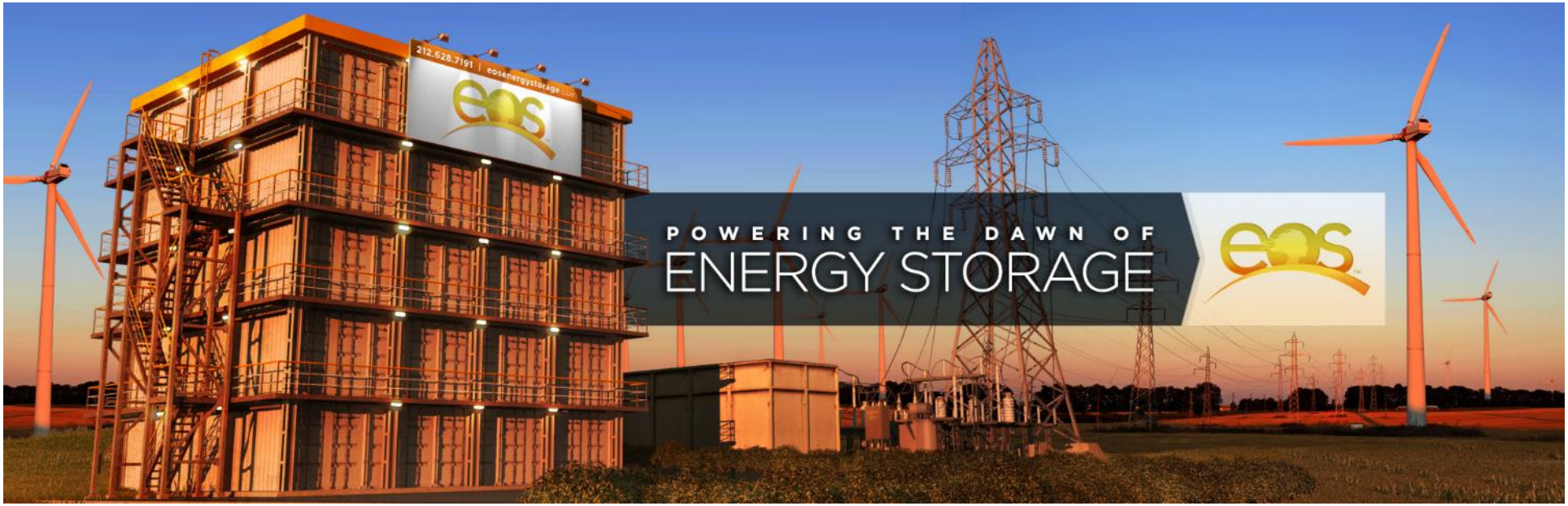


Eos Energy Storage

LSU CES Energy Summit

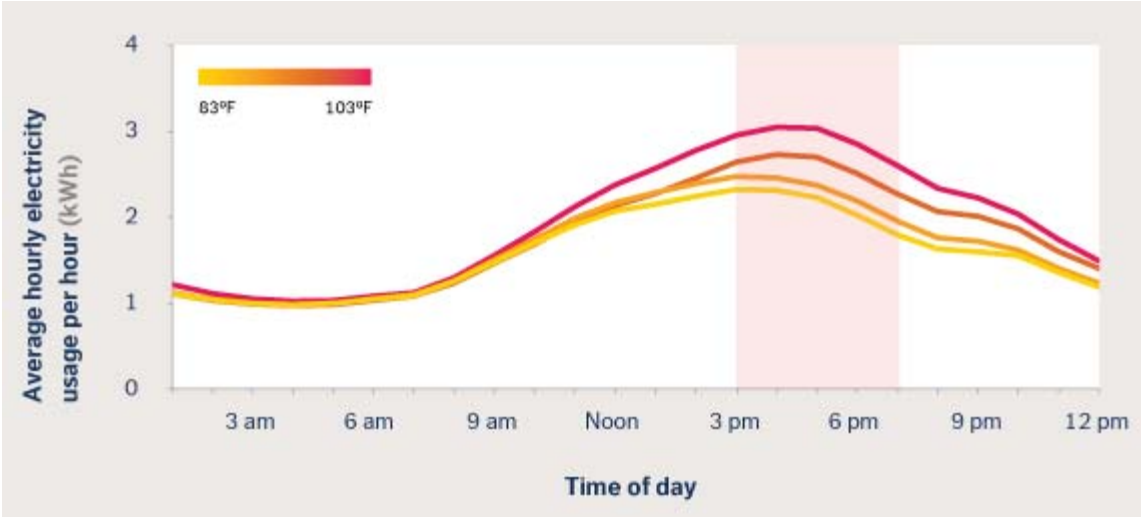
October 21, 2015

Who is Eos?

- Founded in 2008 to develop cost effective energy storage solutions.
- Solutions that are not only less expensive than other battery technologies but less expensive than the most economical alternative used today to provide the same services – gas turbine for peak power generation and transmission and distribution assets for delivery capacity.
- Energy storage is a solution to real business problems and Eos is developing a battery technology that responds directly to the requirements of the business case at hand.

Why Energy Storage?

- Without cost-effective storage, electricity supply must instantaneously match demand.
- The result is a costly and underutilized electricity grid.
- Energy storage can buffer demand spikes and meet growing needs with the infrastructure that is already in place, mitigating the need for costly upgrades while decreasing environmental impact.

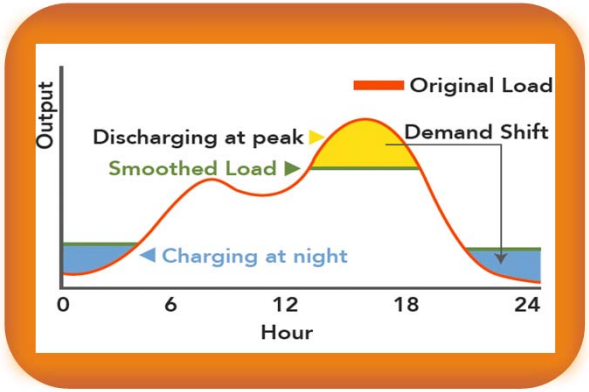


- The problem in the grid is managing uncertainty - increased amount of renewables, increased capital risks of fast-moving technology, and increased security requirements.

Storage is a key element of certainty!

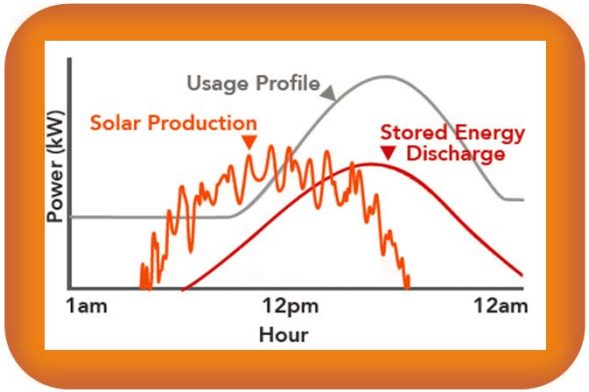
Multiple use-cases for energy storage

Peak-Shaving and Demand Management



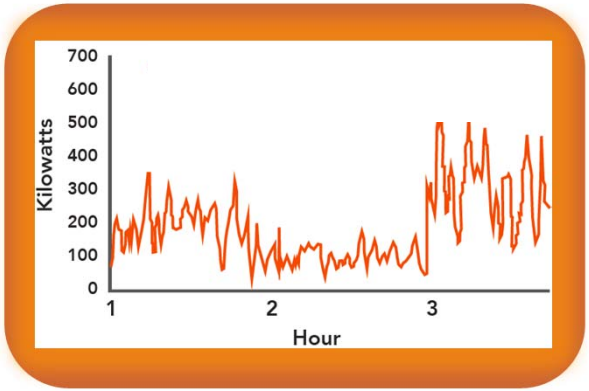
- Store excess base-load generation and renewable energy produced offpeak
- Discharge during peak hours

Renewable Integration, Solar/Wind Time-Shifting



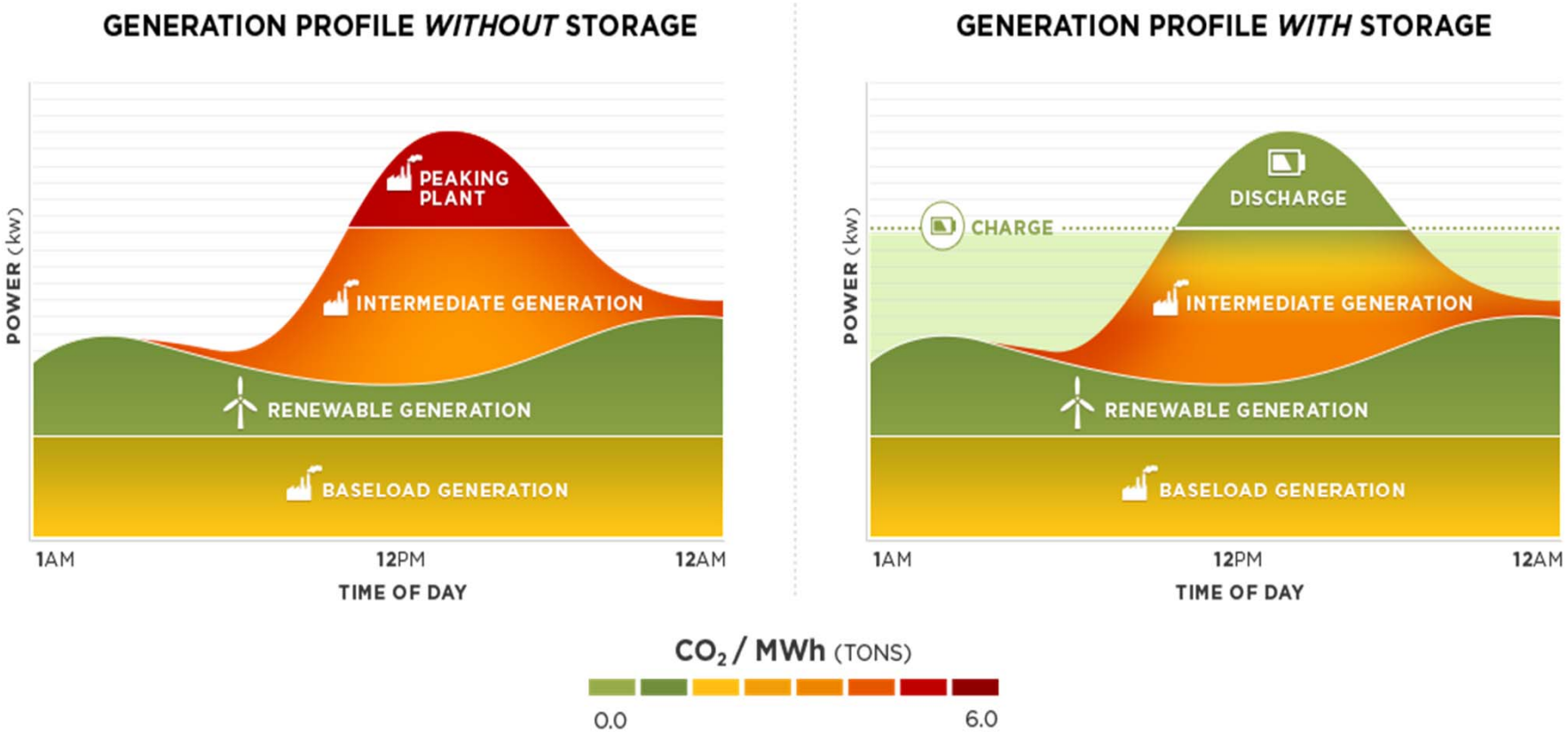
- Counteract intermittency of renewable generation
- Smooth production cycles

Frequency Regulation

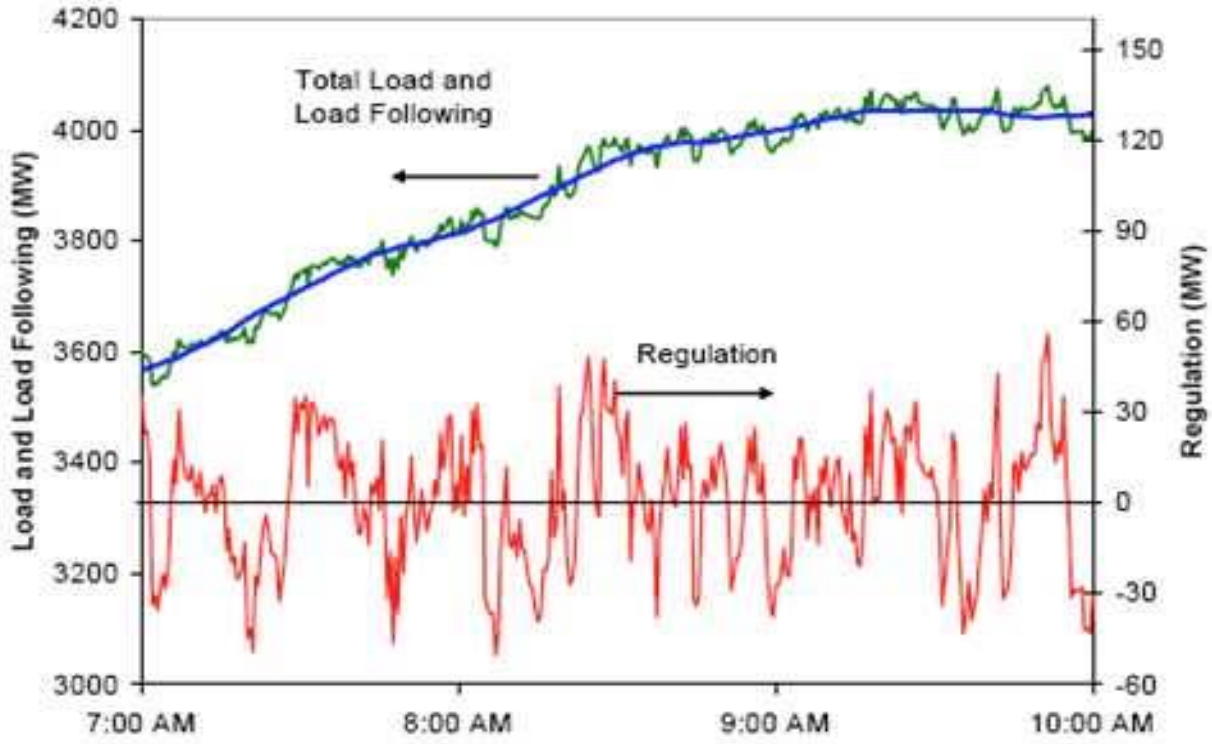


- Eligible for entry to ancillary markets

Peak-Shaving and Demand Management



Frequency Regulation



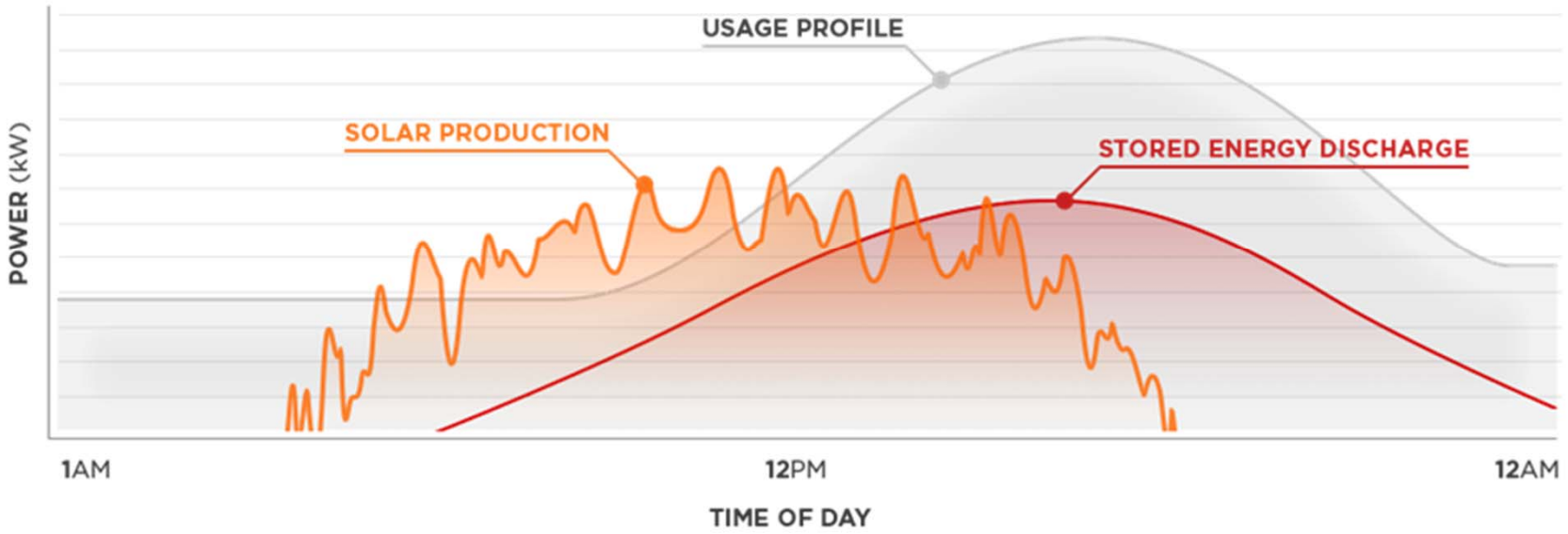
Source: ORNL

Energy storage is useful even in conventional utility settings

Why the Need for Frequency Regulation

- A gap between power generation and demand on the grid causes the grid frequency to move away from its nominal value.
- When demand momentarily exceeds generation, the missing energy is supplied by the kinetic energy of the generators' rotors: the synchronous machines slow down, and so does the grid frequency.
- If generation is greater than the load, the grid frequency increases.
- Rotating machines are manufactured in order to work best within a given frequency range. If the frequency goes out of bounds, machines disconnect themselves to avoid damages, and blackouts can occur.

Renewable Integration, Solar/Wind Time-Shifting



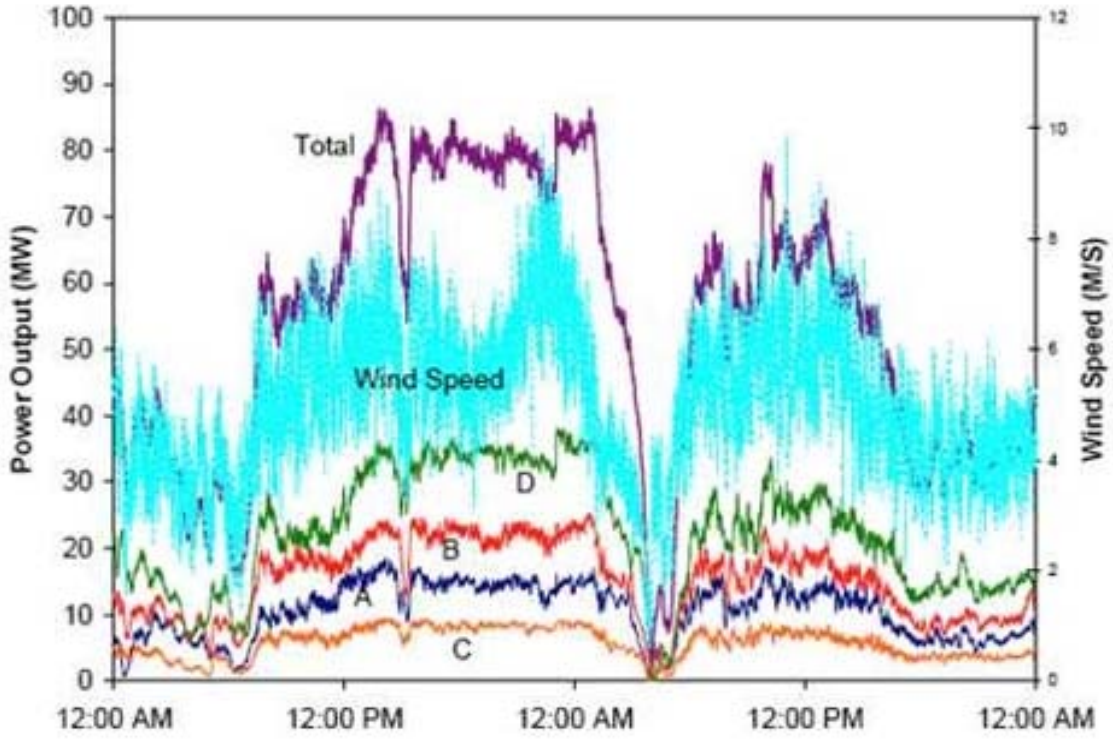
Renewables such as wind and solar are intermittent, potentially introducing instability into the grid and limiting their viability as a firm, dispatchable power source.

Peak production does not always coincide with peak consumption.

Storage allows utilities and consumers to smooth production and time shift renewable energy.

Solar electricity produced at noon can be stored and deployed as a stable power source at peak demand in the afternoon.

Renewable Integration, Wind Time-Shifting



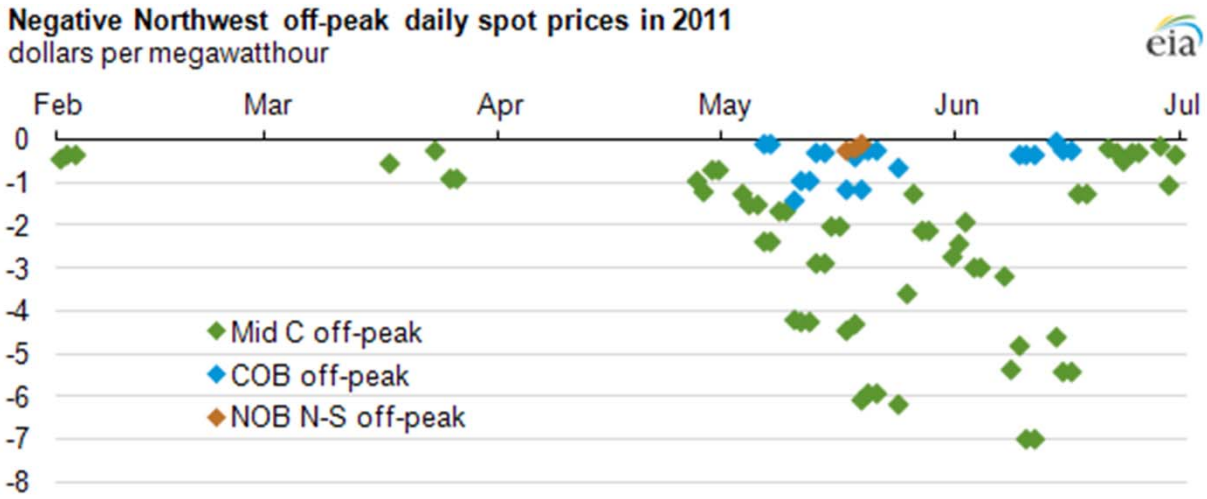
Two days output and wind speed from a four-section Midwestern wind plant (*source: ORNL*)

Energy Storage can create a firm dispatchable resource from solar and wind energy

The Night They Drove the Price of Electricity Down

Wind power was so plentiful in Texas that producers sold it at a negative price. What?

By Daniel Gross (Slate)



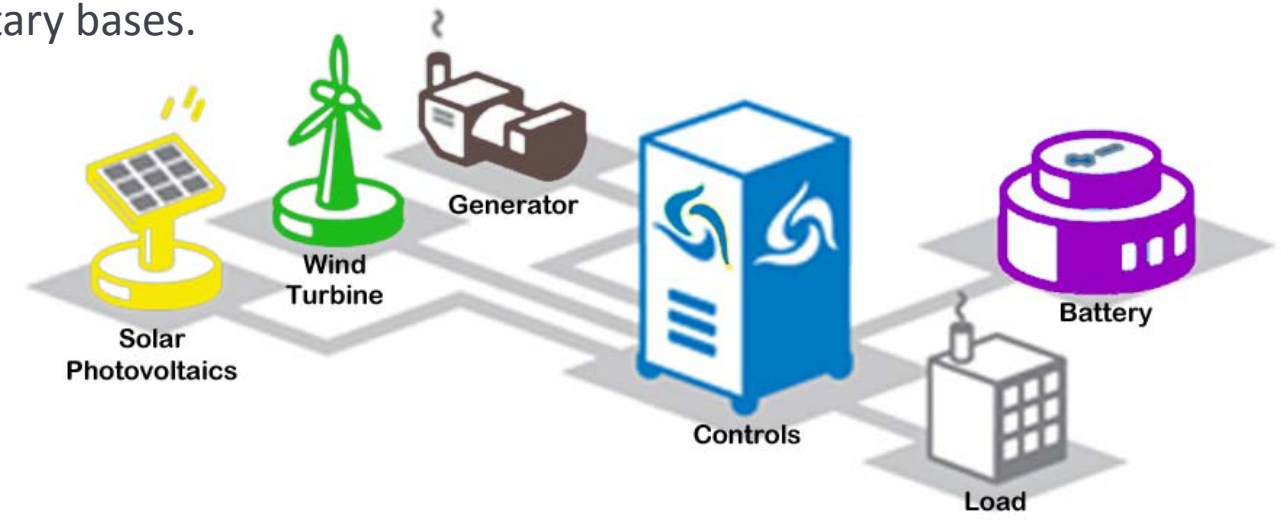
Source: U.S. Energy Information Administration, based on InterContinental Exchange (ICE) prices as reported by Ventyx.
Note: Off-peak is 10 p.m. to 6 a.m. on Monday through Saturday and all hours on Sunday. Mid C is Mid-Columbia, COB is California-Oregon Border, and NOB is Nevada-Oregon Border.

Record wind generation pushes ERCOT prices into negative territory

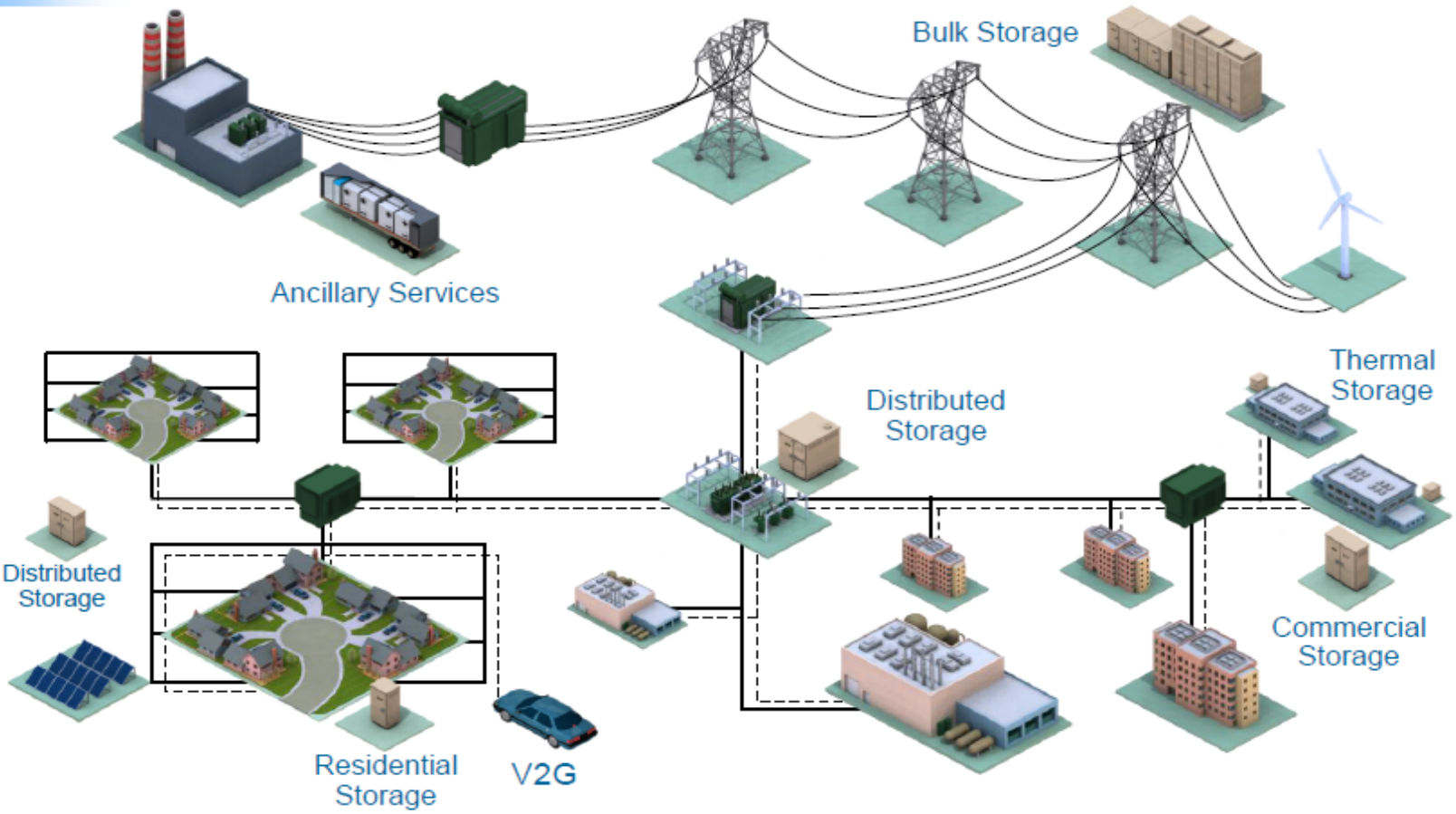
By Robert Walton | September 15, 2015

Microgrid Storage

- Microgrids can operate seamlessly both in parallel to the grid and in “island” mode, providing critical customers and facilities with power even if the utility grid goes down.
- When combined with solar or other forms of distributed generation, energy storage can enable self-sufficient microgrids that can power a facility for weeks.
- Energy storage enabled microgrids create access to electricity in remote locations and communities, where conventional distribution infrastructure is prohibitively expensive or practically unattainable.
- Variable sized - individual homes, rural villages, industrial facilities, or supporting entire military bases.

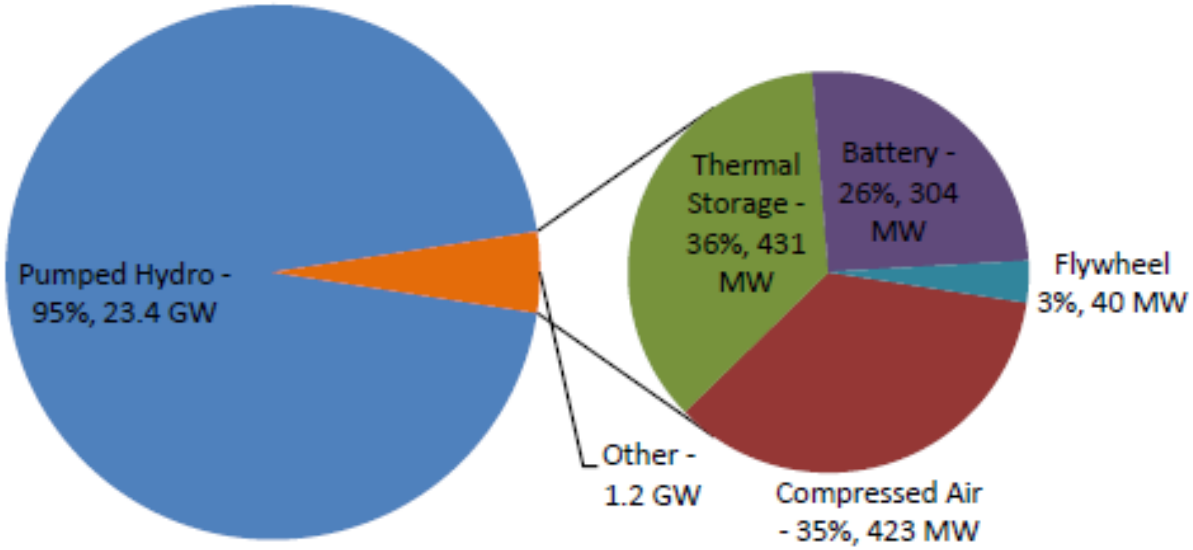


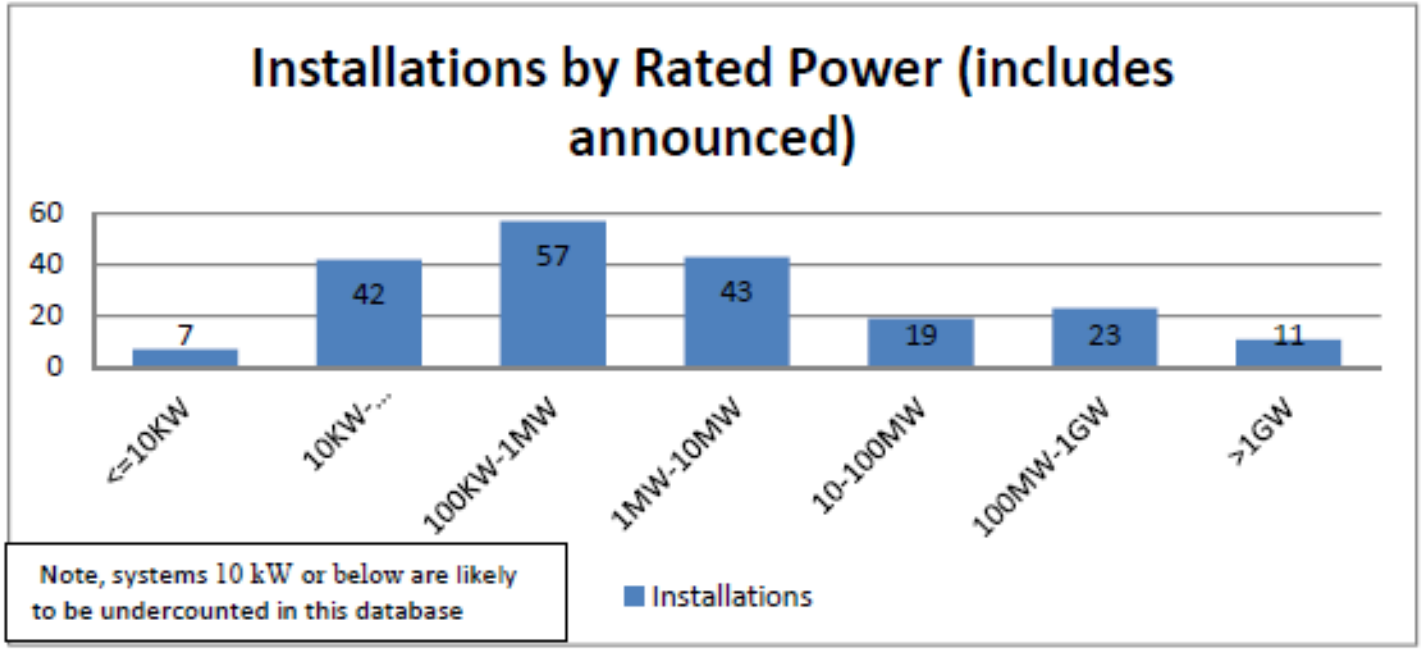
The Roles of Storage on the Grid



Why the push for Energy Storage???

Current State of Grid Storage in the US





Source: DOE

California Assembly Bill 2514

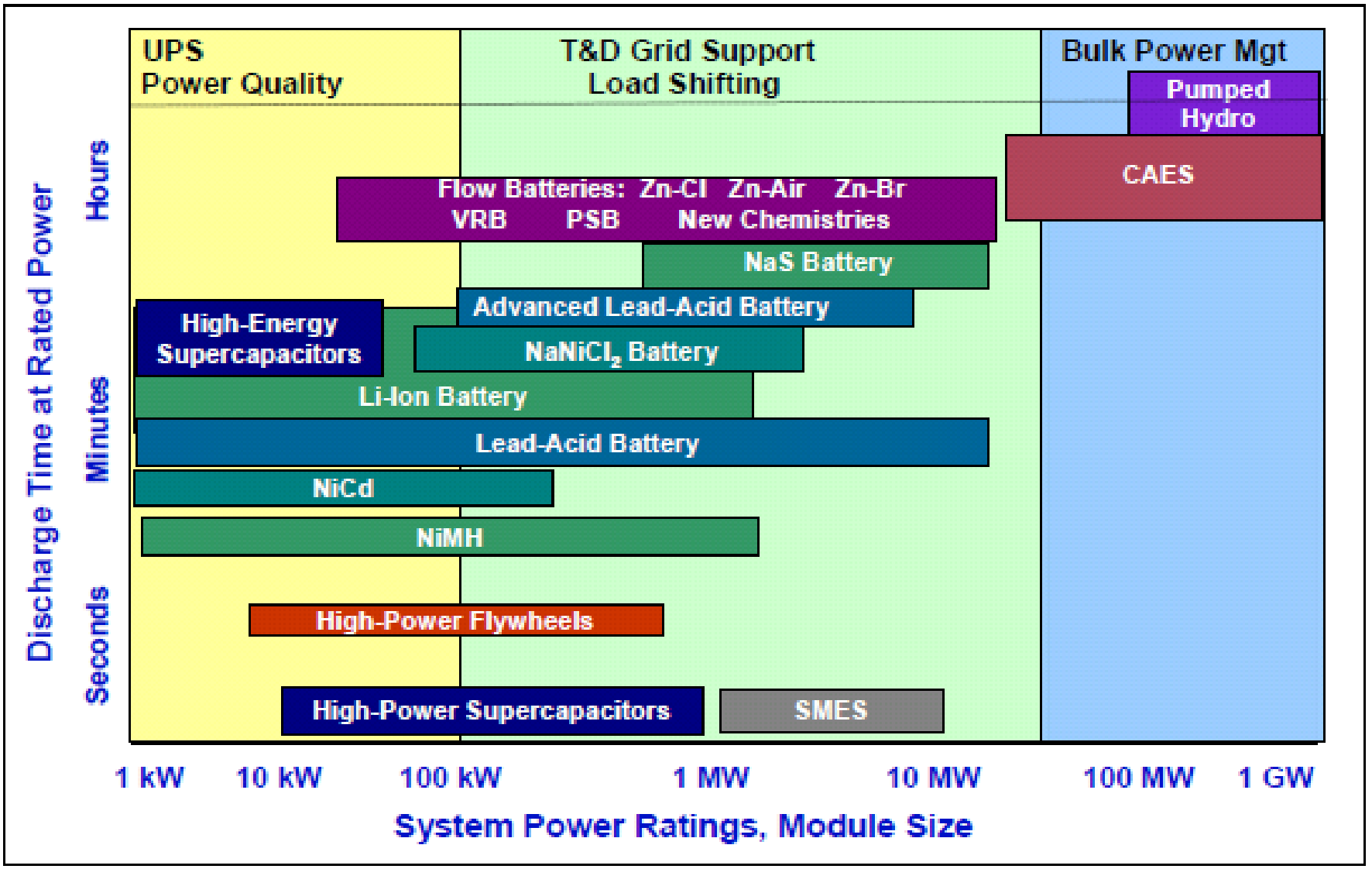
- Enacted in 2010
- 33% of delivered electricity to come from renewable sources by 2020
- Statewide energy storage mandate
- CPUC mandates in 2013 that California's big three utilities add 1.3 gigawatts of energy storage by 2020

CPUC Energy Storage Procurement Targets

Proposed Energy Storage Procurement Targets (in MW)[22]

Storage Grid Domain Point of Interconnection	2014	2016	2018	2020	Total
Southern California Edison					
Transmission	50	65	85	110	310
Distribution	30	40	50	65	185
Customer	10	15	25	35	85
Subtotal SCE	**90**	**120**	**160**	**210**	**580**
Pacific Gas and Electric					
Transmission	50	65	85	110	310
Distribution	30	40	50	65	185
Customer	10	15	25	35	85
Subtotal PG&E	**90**	**120**	**160**	**210**	**580**
San Diego Gas & Electric					
Transmission	10	15	22	33	80
Distribution	7	10	15	23	55
Customer	3	5	8	14	30
Subtotal SDG&E	**20**	**30**	**45**	**70**	**165**
Total - all 3 utilities	**200**	**270**	**365**	**490**	**1,325**

How to solve the issue of Energy Storage


UPS
Power Quality
T&D Grid Support
Load Shifting
Bulk Power Mgt
Pumped Hydro
CAES
Flow Batteries: Zn-Cl Zn-Air Zn-Br
VRB PSB New Chemistries
NaS Battery
Advanced Lead-Acid Battery
High-Energy Supercapacitors
NaNiCl2 Battery
Li-Ion Battery
Lead-Acid Battery
NiCd
NiMH
High-Power Flywheels
High-Power Supercapacitors
SMES
Discharge Time at Rated Power
Hours
Minutes
Seconds
1 kW
10 kW
100 kW
1 MW
10 MW
100 MW
1 GW
System Power Ratings, Module Size

Source: EPRI

5 Critical Requirements for Energy Storage

Market Drivers

- **Underutilization of Grid Infrastructure**
- **Need for Local Peaking Capacity in Urban Areas**
- **Growing Grid Instability From Intermittent Generation**
- **Reliability Concerns with Aging Infrastructure**

Energy Storage Requirements

Low Cost /kWh

Low cost per kWh is required to compete with incumbent grid solutions (e.g. gas turbines, copper wire). Price is the primary barrier to adoption today

Long Life

Amortization of upfront cost over long life (20+ years) is critical for cost effectiveness

Energy Dense

Compact footprint required for dense urban load centers or space-constrained areas. Critical for distributed storage for locational capacity use cases

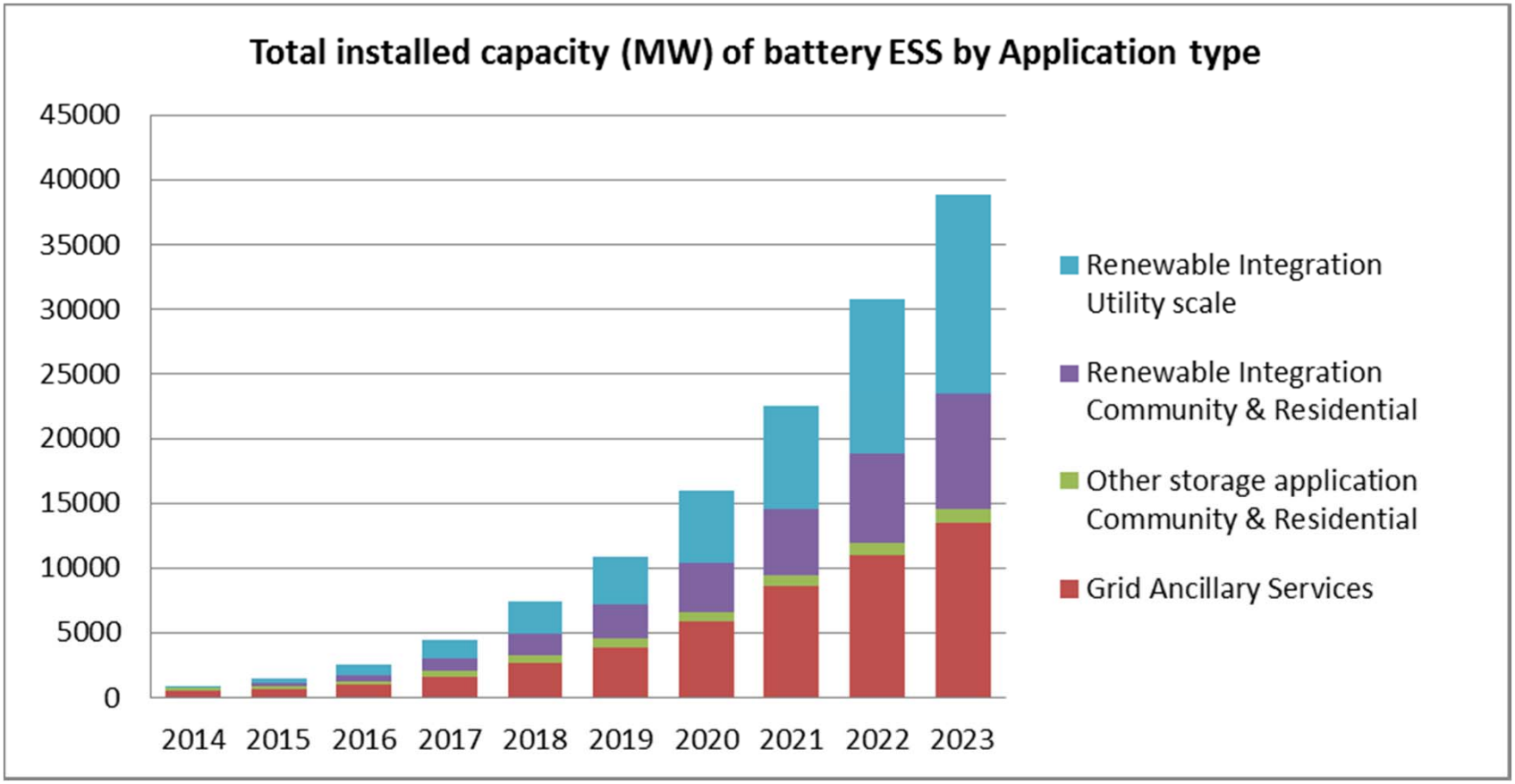
High Efficiency

High efficiency required to maximize revenues when charging and discharging the storage device

100% Safe

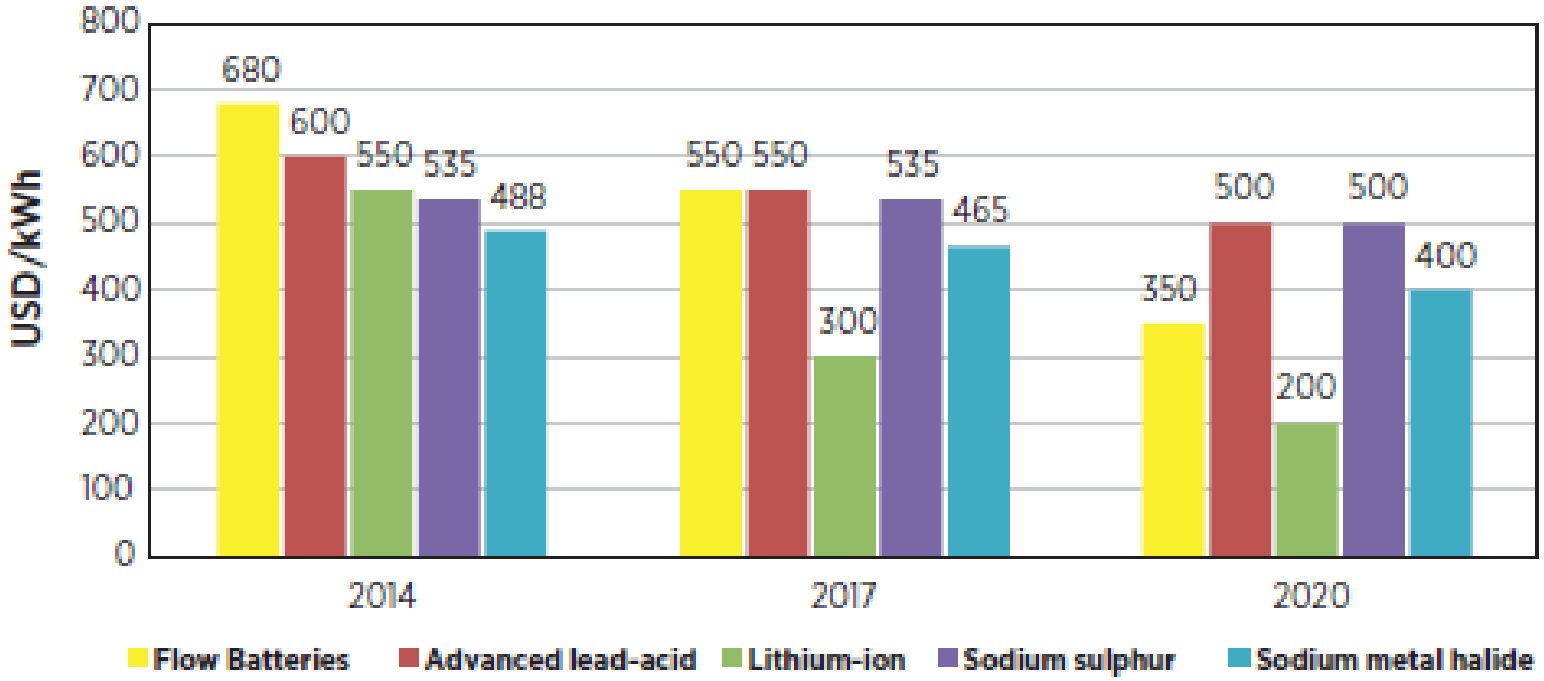
Energy storage with little or no toxicity, fire hazard, and environmental mitigation required for siting behind-the-meter or in urban areas

Storage technologies meeting these requirements will be the most flexible across applications and capture the largest market share



Source: Navigant Research

Lowest Current and Projected Battery Cell Price by type for Utility-Scale Applications

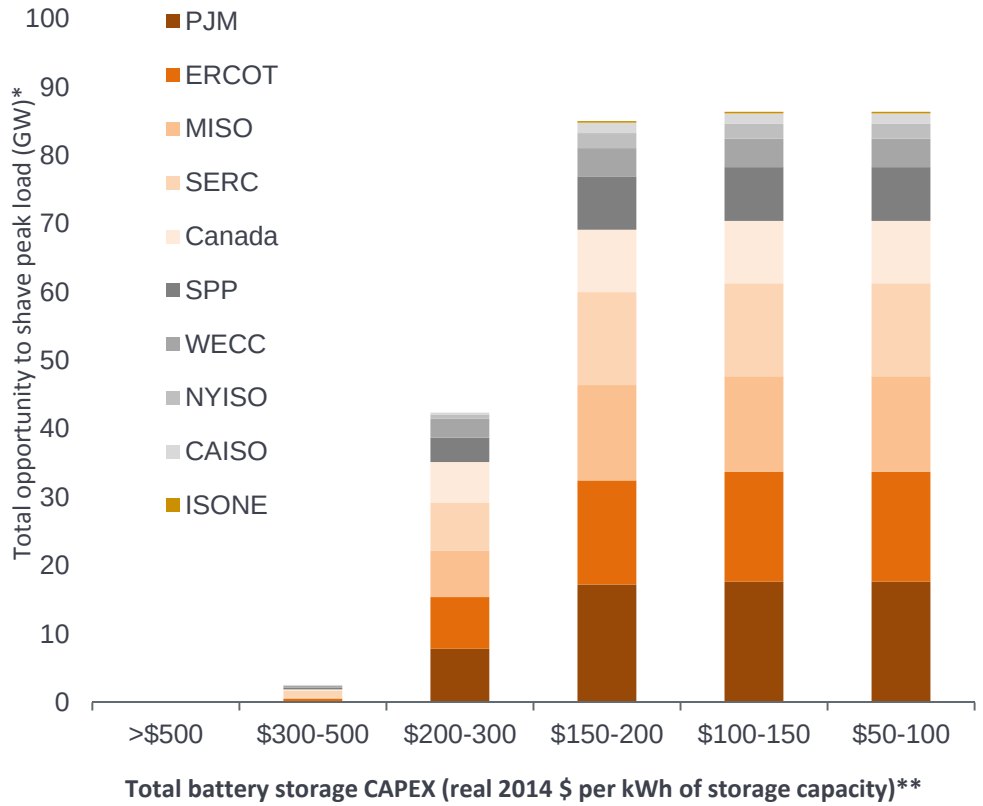


Source: Navigant Research

Price Point Unlocks Key Storage Markets

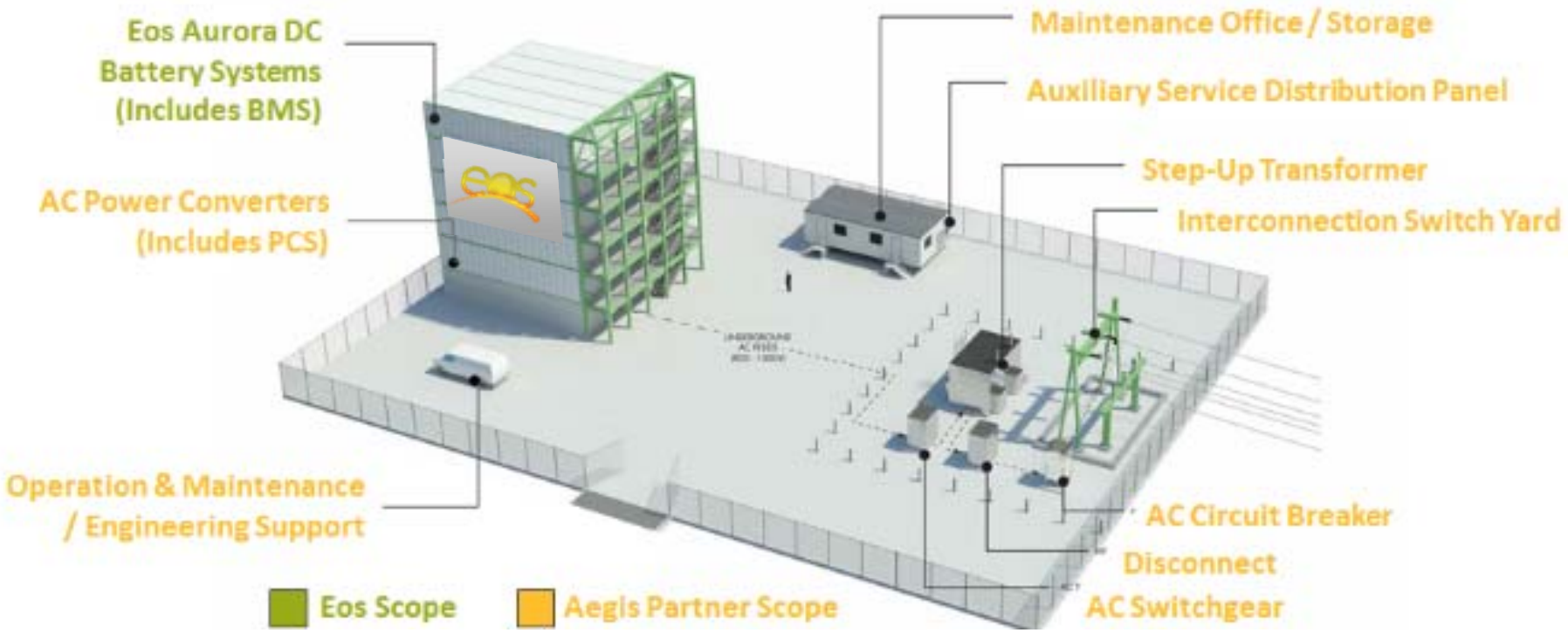
- At <$300/kWh, batteries begin to be competitive with gas combustion turbines to supply peaking capacity
- At <$200/kWh, batteries can supply peaking capacity at **lower cost than new CTs in almost all locations**
- Large opportunity in dense urban areas, where there is limited space for new generation and/or T&D infrastructure, along with strong peak demand
- At Eos' $160/kWh price point, IHS estimates opportunity for capacity resource battery market grows to **86GW by 2030** ***in the US alone…***

Total Opportunity for Batteries to Compete in Capacity Markets (2030)



Notes: *The opportunity for batteries to shave peak load depends on their competitiveness with gas combustion turbines in capacity markets, and the incremental demand for new capacity resources. **Including battery module, balance of plant, and EPC costs. ERCOT does not currently have a mechanism for mandating load serving entities to procure capacity, but this chart assumes that batteries will still compete with CTs to supply peaking capacity needs.
Source: IHS

Typical Multi-Megawatt System Installation



Successful Deployments in the US and Abroad

Systems shipped to ConEd in New York and GDF Suez in Belgium with current focus on scale up to systems 500-1,000 kWh in size. Aegis Partner testing supporting commercial product integration, maintenance, and warranty.

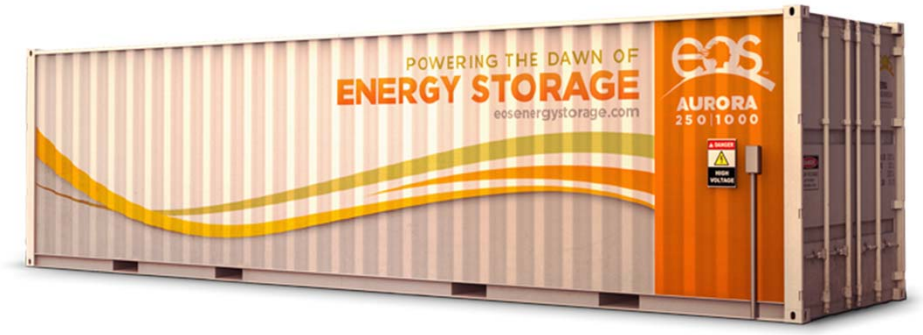
6 months of successful testing with continued operation at DNV GL's facility in upstate NY

DC battery system currently being integrated at GDF Suez's test center in Belgium

AC system performing 4-hr load shaving, testing w/ Aegis partners supports product design & warranty

Eos Introduces Lowest Cost Energy Storage Product: Aurora 1000|4000

The Aurora 1000|4000 is a 1 MW | 4 MWh DC battery system designed specifically to meet the requirements of grid-scale energy storage



Pictured above: 250kW/1000KWh subsystem

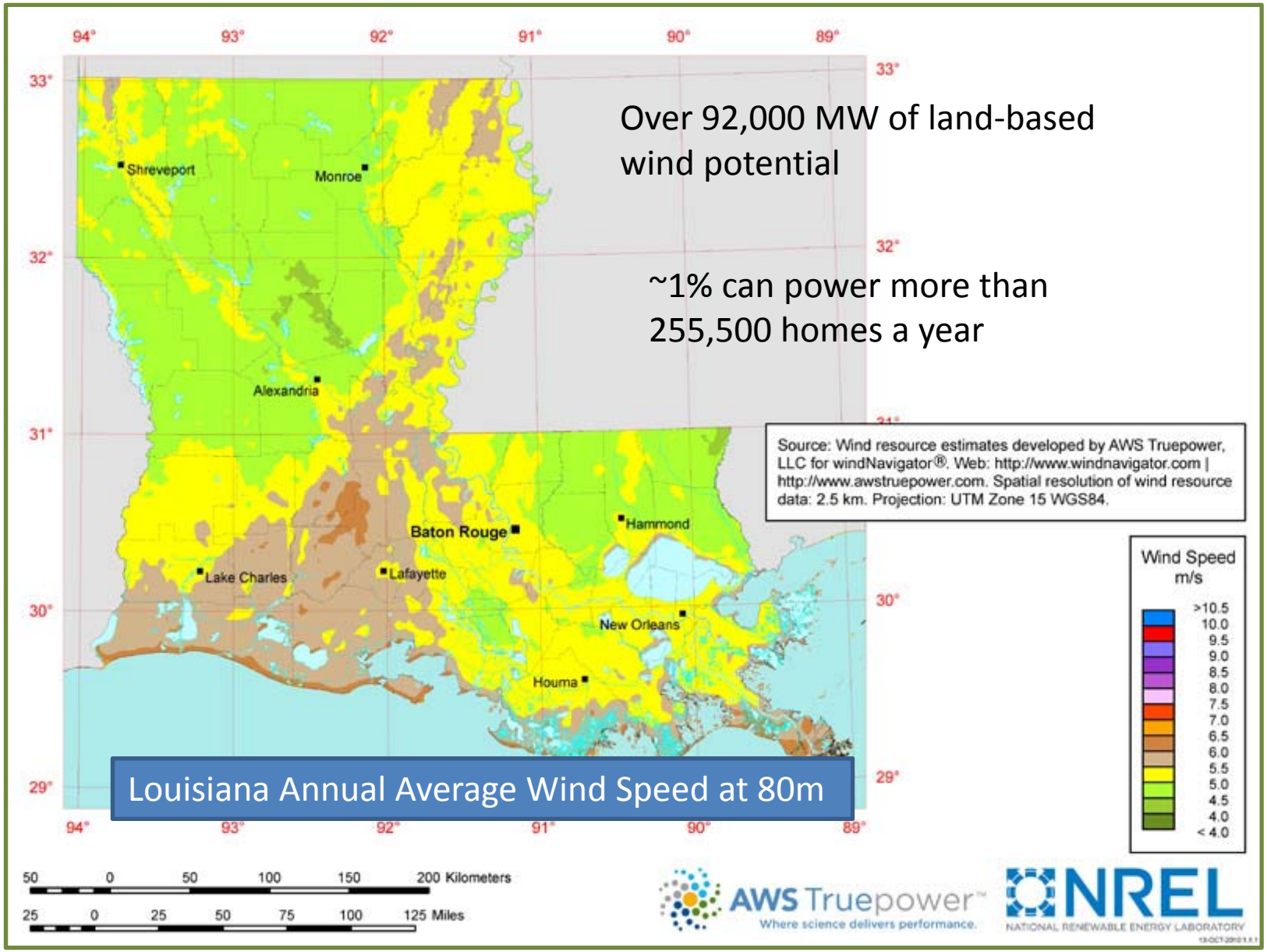
BATTERY MODULES → RACKING/ CONTAINER → BMS → **AURORA 1000|4000**

Critical Attributes	
Low cost	**$160/kWh**
Long Cycle life (Full DoD)	**5,000 cycles**

Other Relevant Attributes	
Energy Density	1MWh / 40 ft container
Efficiency (Full DoD)	75-80%
Safety	Non-hazardous Non-flammable

The Aurora system can reduce cost and maximize profitability for utilities, project developers and industrial end-users

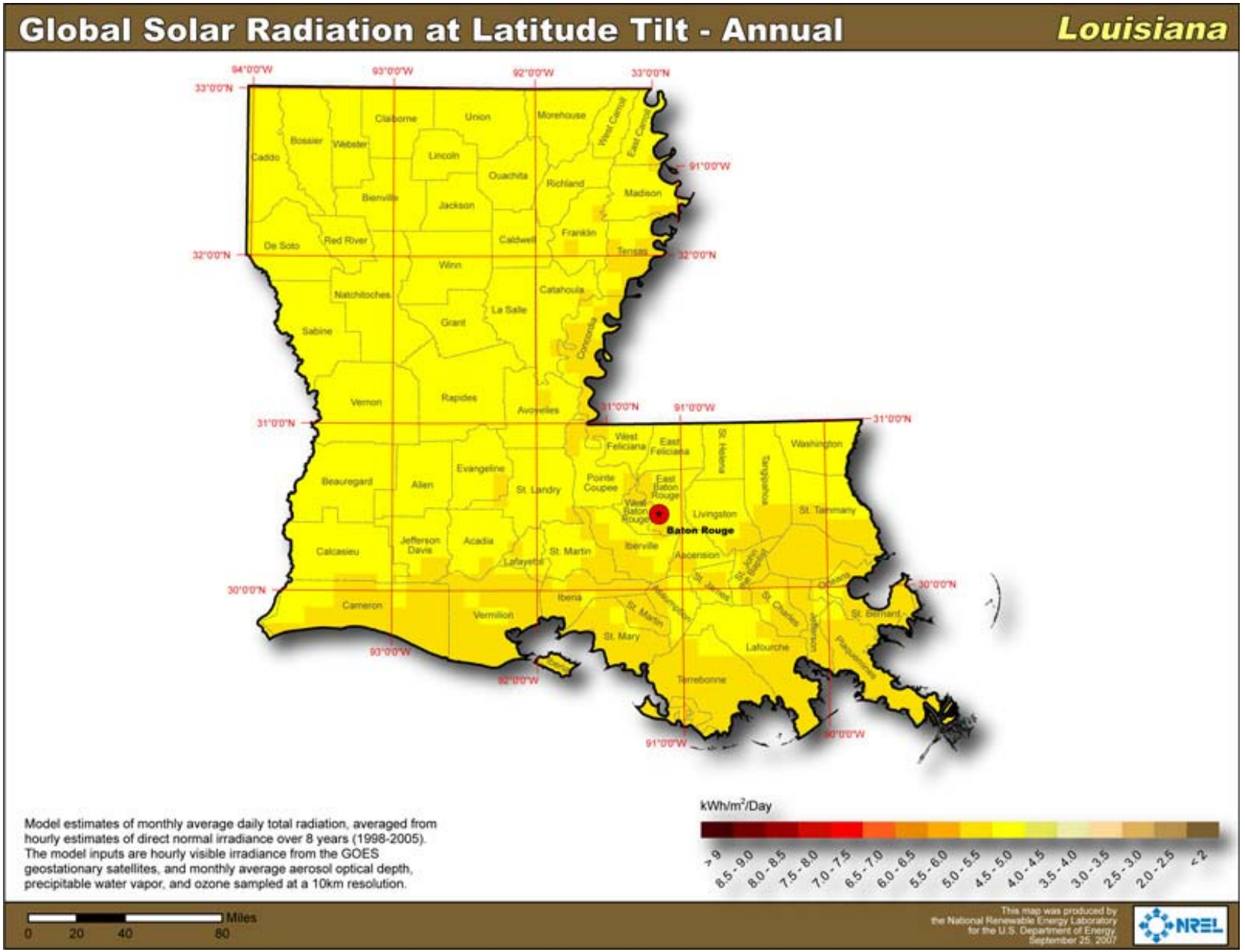
What Does This Mean for Louisiana?



Louisiana Annual Average Wind Speed at 80m

Global Solar Radiation at Latitude Tilt - Annual

Louisiana



Model estimates of monthly average daily total radiation, averaged from hourly estimates of direct normal irradiance over 8 years (1998-2005). The model inputs are hourly visible irradiance from the GOES geostationary satellites, and monthly average aerosol optical depth, precipitable water vapor, and ozone sampled at a 10km resolution.

This map was produced by the National Renewable Energy Laboratory for the U.S. Department of Energy. September 25, 2007

NREL

Entergy NEWSROOM

Powered by the Sun: Entergy New Orleans Launches First Utility-Scale Solar Project
05/12/2015

Addition of batteries will store harnessed energy for later use

The 1 megawatt project, which will be built on existing company property off Chef Menteur Highway, will consist of more than 4,000 solar panels and is estimated to be in service by late 2016.


eos

Storage Appliance Strategy

Partnership Options & Approach

- Eos Product, OEM Distributed
- OEM-Branded Product

Potential Entry Markets

- Market Test in California (CEC/UCSD, SGIP incentives) and New York
- Residential & Commercial: Demand Mgmt, Solar Integration, Reliability
- Industrial: Short-Duration Backup and Energy/Demand Optimization

2kW|8kWh
Residential Product

125kW|500kWh
C&I Product

Storage Appliance Commercialization

Goal	Productize sub-modules to address growing market for smaller-scale storage appliances at low cost
Applications	• Energy management • Back-up power • Solar PV integration • Off-grid diesel replacement
Customers	Residential, Telecom, C&I, Utility
Partners	In discussion with retail and manufacturing partners to lead product development and distribution
Timeframe	12-18 months

Partnership opportunity with original equipment manufacturers (OEMs) to package, distribute and service behind-the-meter storage appliance products with Eos

Eos Wins $1.9M Storage Appliance Demonstration at UCSD

Proposal Overview

- Demonstration of multiple Eos battery systems distributed behind-the-meter on a stand-alone basis and integrated with solar PV

Eos 3|12
Residential System

Eos 30|120
Commercial System

Teaming Arrangements

- Host Site: University of California San Diego
- Integration Partner(s): Bay City Electric, RP Power, Rhombus Energy Solutions, Stem
- Utility Support: SDG&E, SCE, PG&E
- Economics: Brattle Group
- M&V: DNV GL

Project Cost & Timeline

- Target installation date of mid 2016
- 1-yr testing, measurement & verification
- Coordination with SDG&E experimental rate design pilot & new SCE rate structures
- Total project cost: $1.9M

Eos wins $1.9M CEC funded project to demonstrate Eos low-cost storage appliance products at the University of CA San Diego

Eos Uniquely Able to Drive Rapid Market Growth

1. **The Eos Product: Tailored to Industry Needs**
   - Low-cost, long-life, safe, efficient, and compact zinc hybrid cathode (Znyth™) battery
   - At $160/kWh, Eos is a low cost leader and a cost-effective solution in a wide range of applications
2. **Path to Commercialization: Paved by Strategic Partnerships**
   - Eos technology specifically designed to use standard manufacturing equipment and processes, enabling two years of MW-scale production with manufacturing partner for only $5M in CapEx
   - The Eos Genesis Program includes 8 global utilities for product development, pilot demonstrations and broad commercial deployment, creating a rapid path to market
3. **Storage Appliance Strategy**
   - Utilize $1.9M grant to demonstration storage appliance products at UCSD in mid 2016
   - Develop partnerships with original equipment manufacturers (OEMs) to package, market, distribute, and service residential and C&I storage appliance product(s)
   - Introduce game-changing storage appliance product in early 2017