



Energy Storage Technology Advancement  
Partnership (ESTAP) Webinar:

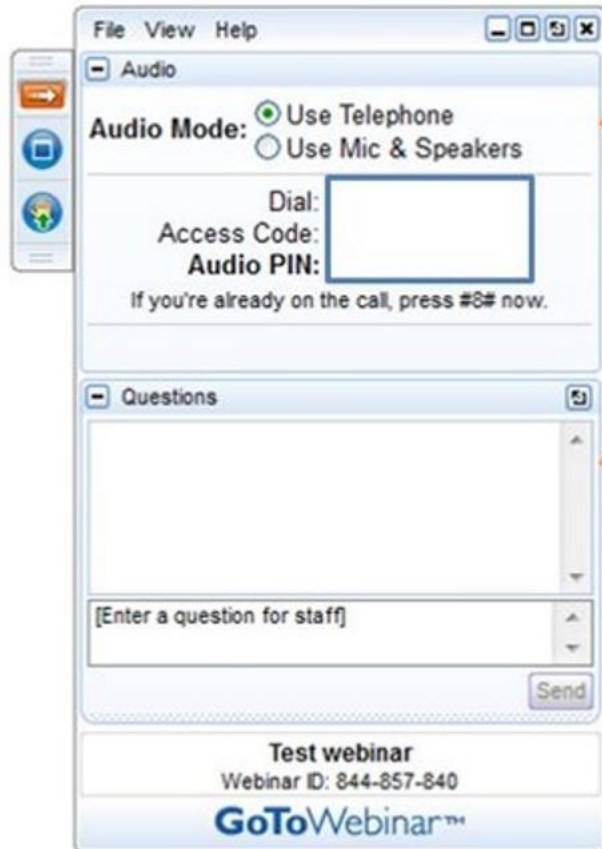
# Electricity Markets and Energy Storage

**Thursday, August 27, 2015**

**Hosted by Todd Olinsky-Paul  
ESTAP Project Director, CESA**



# Housekeeping



All participants are in “Listen-Only” mode. Select “Use Mic & Speakers” to avoid toll charges and use your computer’s VOIP capabilities. Or select “Use Telephone” and enter your PIN onto your phone key pad.

Submit your questions at any time by typing in the Question Box and hitting Send.

**This webinar is being recorded.**

You will find a recording of this webinar, as well as all previous CESA webcasts, archived on the CESA website at

[www.cesa.org/webinars](http://www.cesa.org/webinars)

# State & Federal Energy Storage Technology Advancement Partnership (ESTAP)

Todd Olinsky-Paul

Project Director

Clean Energy States Alliance (CESA)



# Thank You:

**Dr. Imre Gyuk**

U.S. Department of Energy,  
Office of Electricity Delivery and  
Energy Reliability

**Dan Borneo**

Sandia National Laboratories



# ESTAP is a project of CESA

**Clean Energy States Alliance (CESA)** is a non-profit organization providing a forum for states to work together to implement effective clean energy policies & programs:

**State & Federal Energy Storage Technology Advancement Partnership (ESTAP)** is conducted under contract with Sandia National Laboratories, with funding from US DOE.

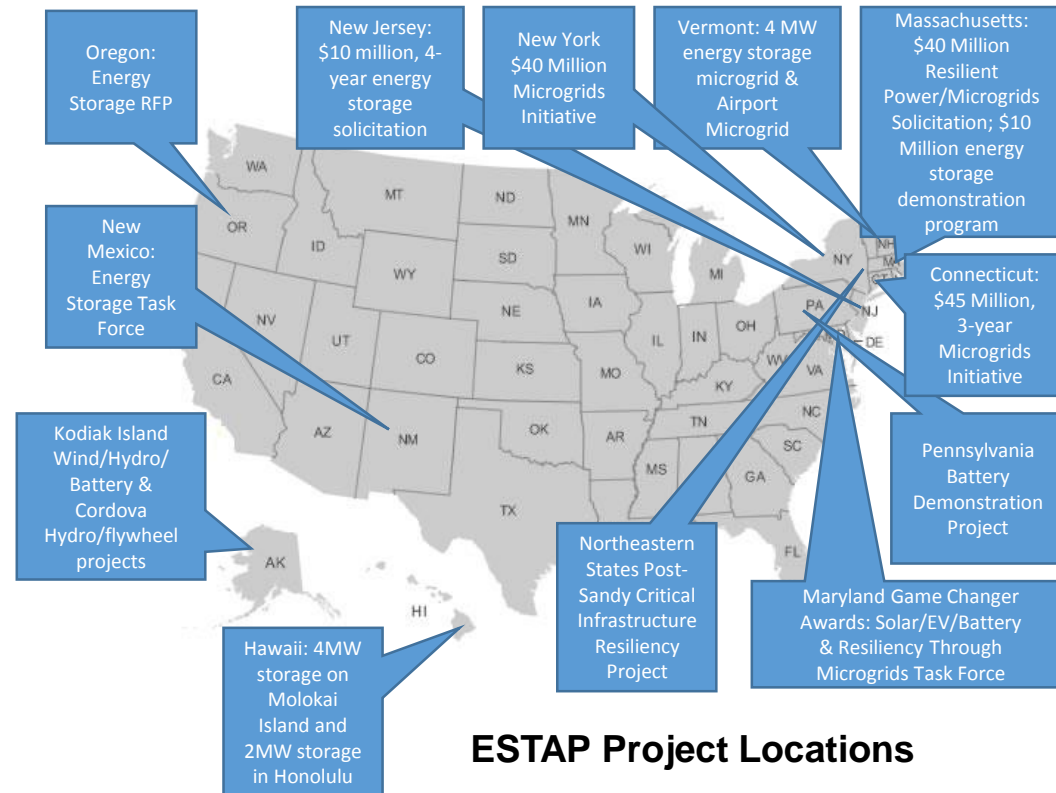
## ESTAP Key Activities:

### 1. Disseminate information to stakeholders

- ESTAP listserv >2,000 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



**ESTAP Project Locations**



# Energy Storage Technology Advancement Partnership

More CESA Projects

## Overview

ESTAP Resource Library

ESTAP Webinars

ESTAP News

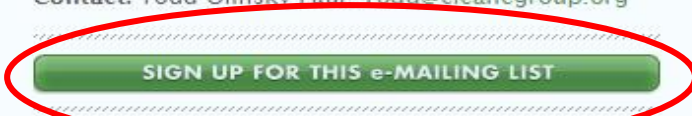
ESTAP Listserv Signup



## ESTAP

Project Director: Todd Olinsky-Paul

Contact: Todd Olinsky-Paul [Todd@cleanegroup.org](mailto:Todd@cleanegroup.org)



The Energy Storage Technology Advancement Partnership (ESTAP) is a federal-state funding and information sharing project, managed by CESA, that aims to accelerate the deployment of electrical energy storage technologies in the U.S.

The project's objective is to accelerate the pace of deployment of energy storage technologies in the United States through the creation of technical assistance and co-funding partnerships between states and the U.S. Department of Energy.

ESTAP conducts two key activities:

1) Disseminate information to stakeholders through:

- The ESTAP listserv (>500 members)
- Webinars, conferences, information updates, surveys

2) Facilitate public/private partnerships at the state level to support energy storage demonstration



### NEW RESOURCES

June 22, 2015  
**Clean Energy Champions - The Importance of State Programs and Policies**  
By Warren Leon, Executive Director, CESA

June 12, 2015  
**Solar+Storage News 6.12.15**  
By Clean Energy Group

April 7, 2015  
**ESTAP Webinar Slides: Upgrading Distribution Resilience - A DOE-OE**

### UPCOMING EVENTS

August 27, 2015  
**Webinar: Electricity Markets and the Economics of Energy Storage,**

More Events

### LATEST NEWS

May 21, 2015  
**ODOE to Offer Research and Development Funds for Energy Storage**

# Today's Guest Speakers

- **Seth Mullendore**, Project Director, Clean Energy Group
- **Jay Marhoefer**, CEO and Founder, Intelligent Generation
- **John Andersen**, Executive Manager, Intelligent Generation



# ESTAP Contact Information

CESA Project Director:

Todd Olinsky-Paul

([Todd@cleanegroup.org](mailto:Todd@cleanegroup.org))

Sandia Project Director:

Dan Borneo

([drborneo@sandia.gov](mailto:drborneo@sandia.gov))

Webinar Archive: [www.cesa.org/webinars](http://www.cesa.org/webinars)

ESTAP Website: <http://bit.ly/CESA-ESTAP>

ESTAP Listserv: <http://bit.ly/EnergyStorageList>





# RESILIENTPOWER

A project of Clean Energy Group



## Energy Storage and Electricity Markets

August 27, 2015

**Seth Mullendore**  
Project Director  
Clean Energy Group

# RESILIENTPOWER

A project of Clean Energy Group



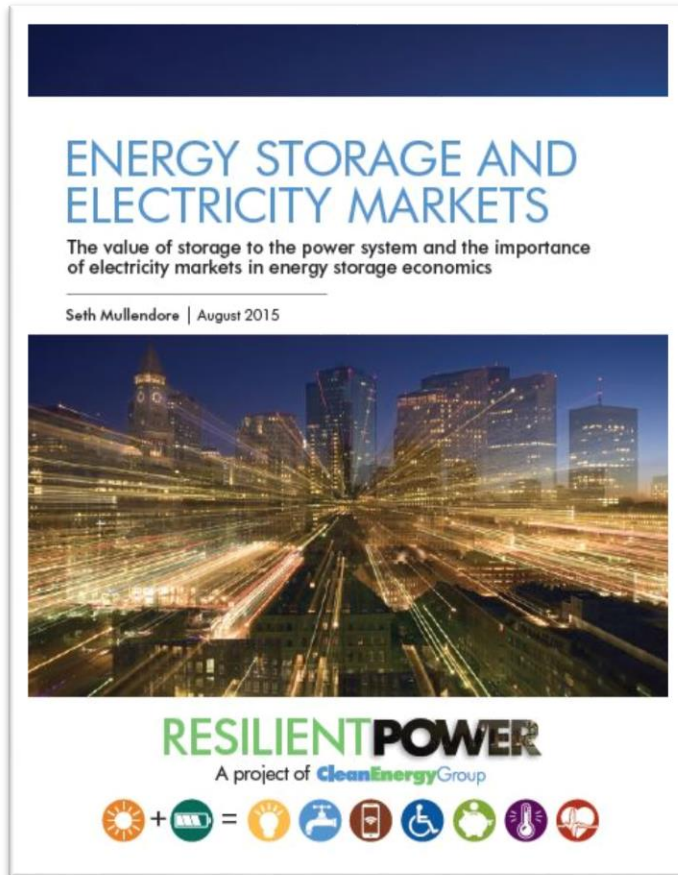
# RESILIENT POWER

A project of Clean Energy Group

- Increase public/private investment in clean, resilient power systems
- Protect low-income and vulnerable communities
- Focus on affordable housing and critical public facilities
- Engage city officials to develop resilient power policies and programs
- Advocate for state and federal supportive policies and programs
- Technical assistance for pre-development costs to help agencies/project developers get deals done
- See [www.resilient-power.org](http://www.resilient-power.org) for reports, newsletters, webinar recordings



# Energy Storage and Electricity Markets



*“There is currently no location in the U.S. where an energy storage system can realize its full economic potential for the multitude of services it is capable of providing.”*

<http://bit.ly/Energy-Storage-And-Electricity-Markets>

# Energy Storage Monetization



## Emerging markets:

- Ancillary services
- Demand Response

## Customer savings:

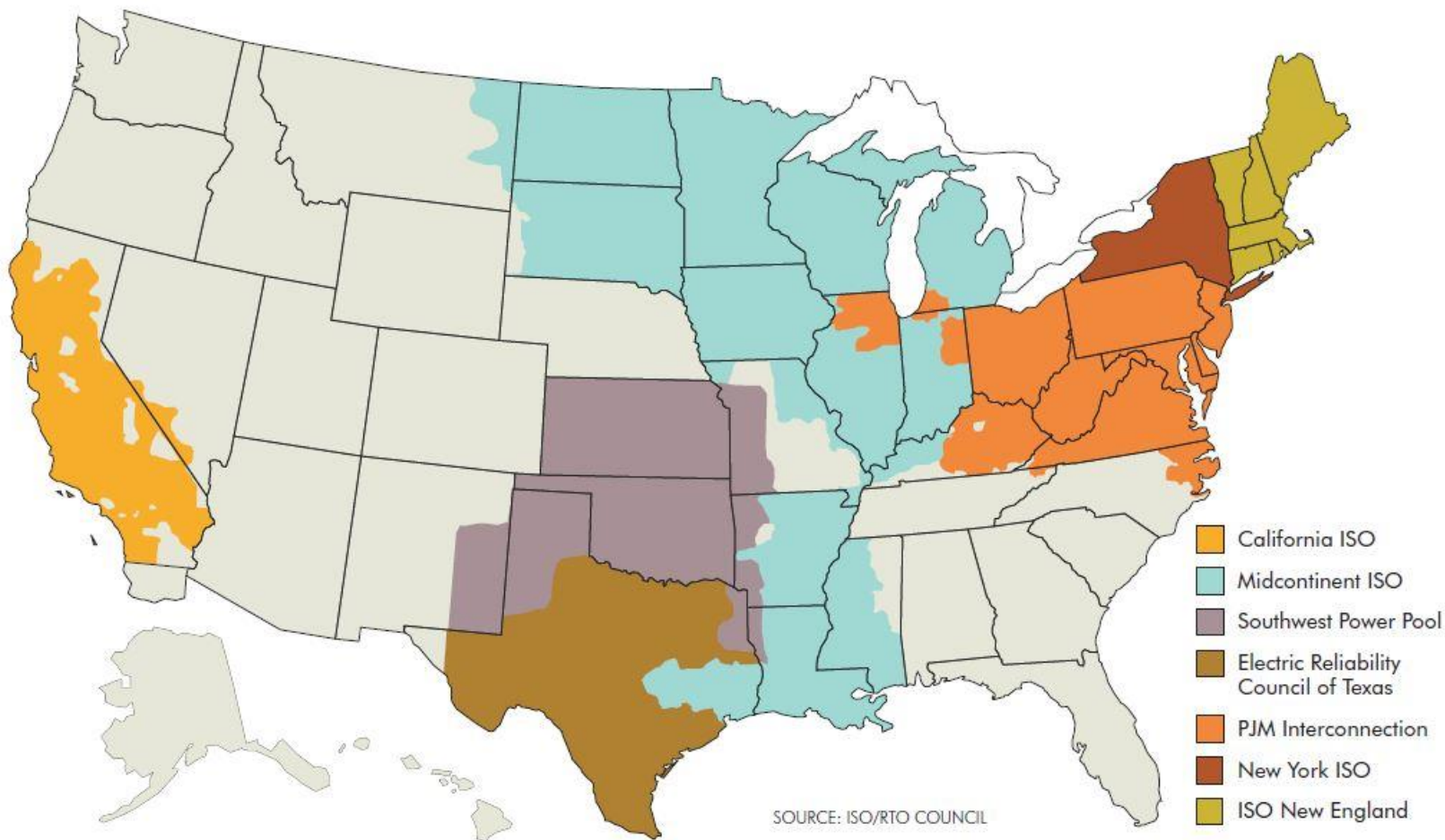
- Demand management
- Time-of-use energy shifting

# Why do energy markets exist?

- Electricity is a commodity
- Demand limited by generation supply
- Must be delivered in a narrow frequency range (60 Hertz)
- Lack of capacity to store energy

# Energy Market Structure

North American independent system operators (ISOs) and regional transmission organizations (RTOs)



# Ancillary Services

<b>Ancillary Services</b>	
Frequency regulation	Balancing of electricity supply and demand to keep frequency within operational bounds. Includes services for responding to both increases and decreases in system frequency.
Spinning reserve	Generation capacity that is connected to the power system but not generating electricity until needed, with the ability to respond immediately, within 10 minutes.
Non-spinning reserve	Generation capacity that is not connected to the system but can be brought online after a brief delay.
Voltage control	Similar to frequency regulation but using reactive power to maintain proper transmission system voltage.
Black start	Ability to restore power to part of the grid after failure occurs.



# PJM Frequency Regulation

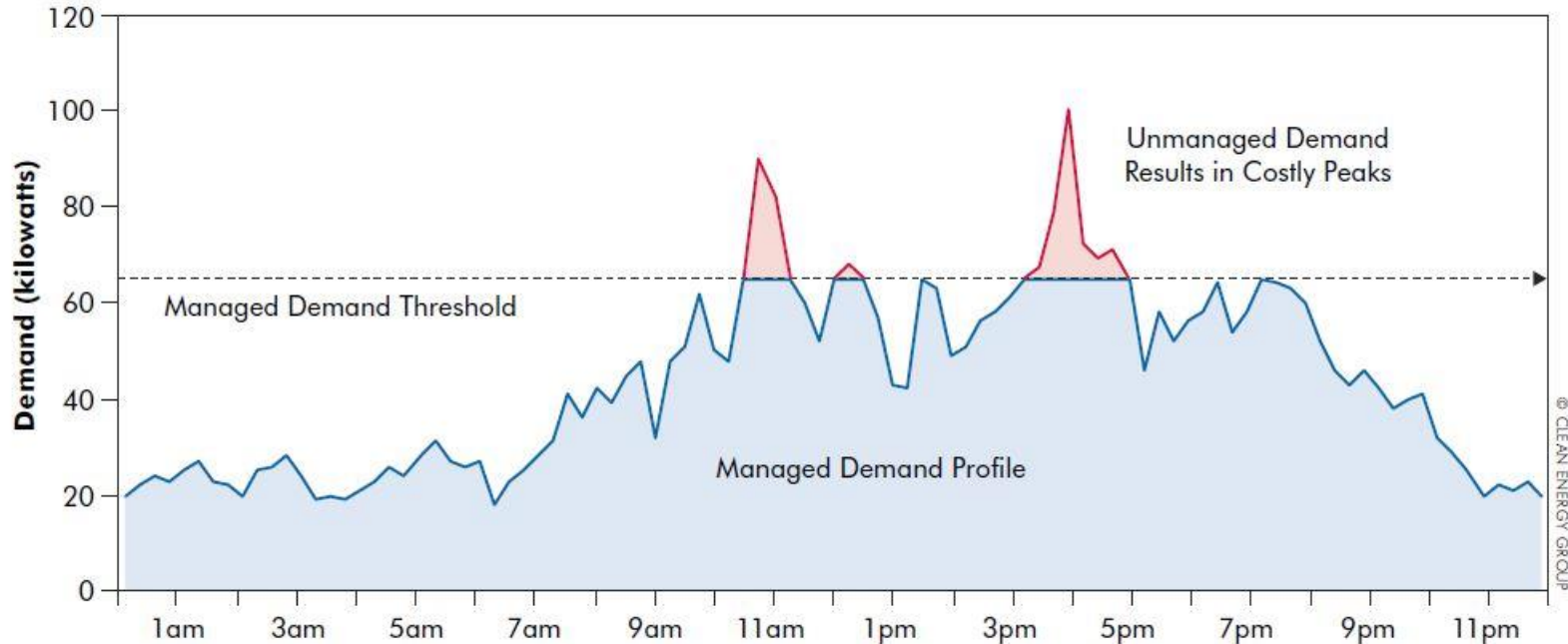
- Two-part compensation
- Effective megawatt compensation
- Five-minute interval lost opportunity cost
- Mileage compensation
- 100 kilowatt participation threshold
- Resource aggregation

# Demand Response



- Demand side resource
- Lower system peak demand
- Delay or avoid new generation capacity
- NYC, CA, HI
- FERC Order 745

# Customer Savings



Peak reduced from 100 kW to 65kW = **35 kW reduction**

@ \$10/kW = **\$4,200 annual savings**

@ \$20/kW = **\$8,400 annual savings**

# Additional Opportunities

## The Value of Storage

Energy storage technologies have the capacity to benefit each segment of the power system.



Increase renewable integration



Reduce dependence on fossil-fuel peaker plants



Reduce operating expenses



Balance electricity supply and demand



Improve power quality and reliability



Avoid costly system upgrades



Keep critical equipment online during power disruptions



Reduce utility bills and generate revenue



Reliable backup power during severe weather and other blackouts



Reduce utility bills and generate revenue

# Contact Information

**Seth Mullendore**

Project Director

Clean Energy Group

Email: [Seth@cleanegroup.org](mailto:Seth@cleanegroup.org)

Phone: (802) 223-2554 x213

[www.cleanegroup.org](http://www.cleanegroup.org)

[www.cesa.org](http://www.cesa.org)

[www.resilient-power.org](http://www.resilient-power.org)

Follow us on Twitter [@Resilient Power](https://twitter.com/ResilientPower) and [@CleanEnergyGrp](https://twitter.com/CleanEnergyGrp)

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Intelligent Generation

# Developing the Operating System for the Networked Clean Energy Grid

Clean Energy Group

August 27, 2015

Jay Marhoefer, Intelligent Generation LLC

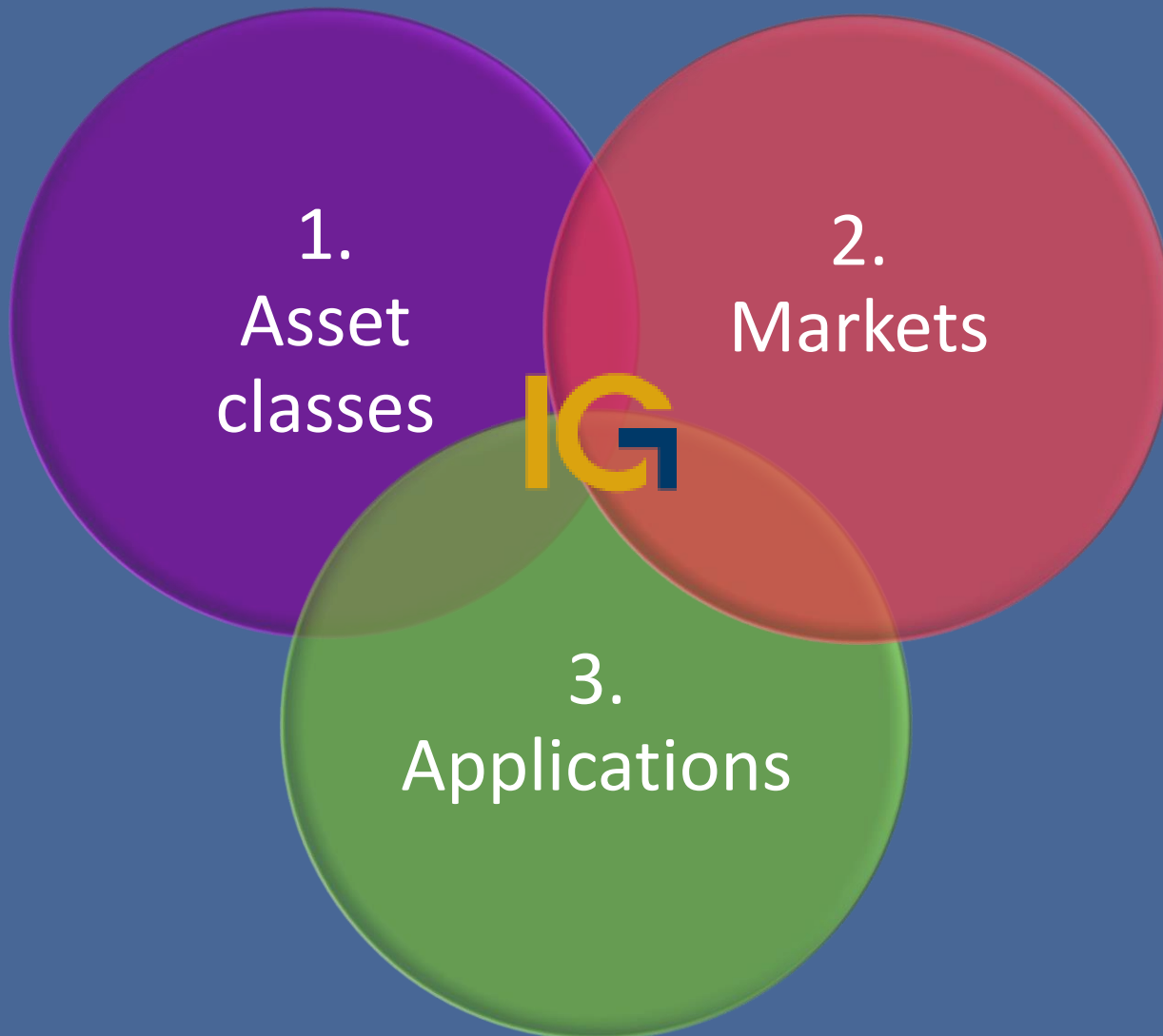


# About Intelligent Generation

- We believe we can create a world of **sustainable abundance**, powered by **clean energy**
- IG empowers everyone to produce clean energy by maximizing their **market power** in an **intelligent** network
- Intelligent Generation provides the operating system for the **networked clean energy grid**

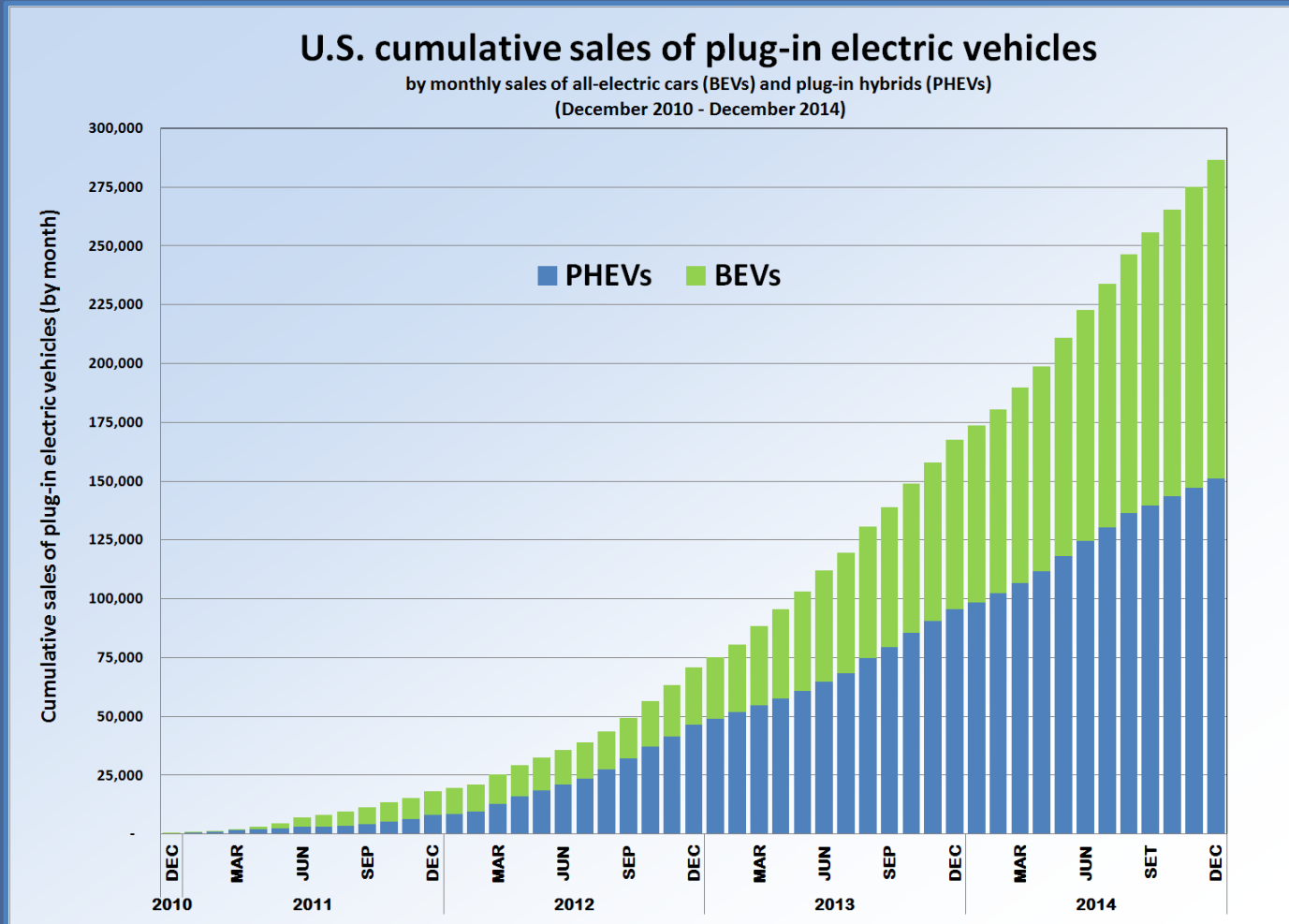


# Operating Model Dimensions





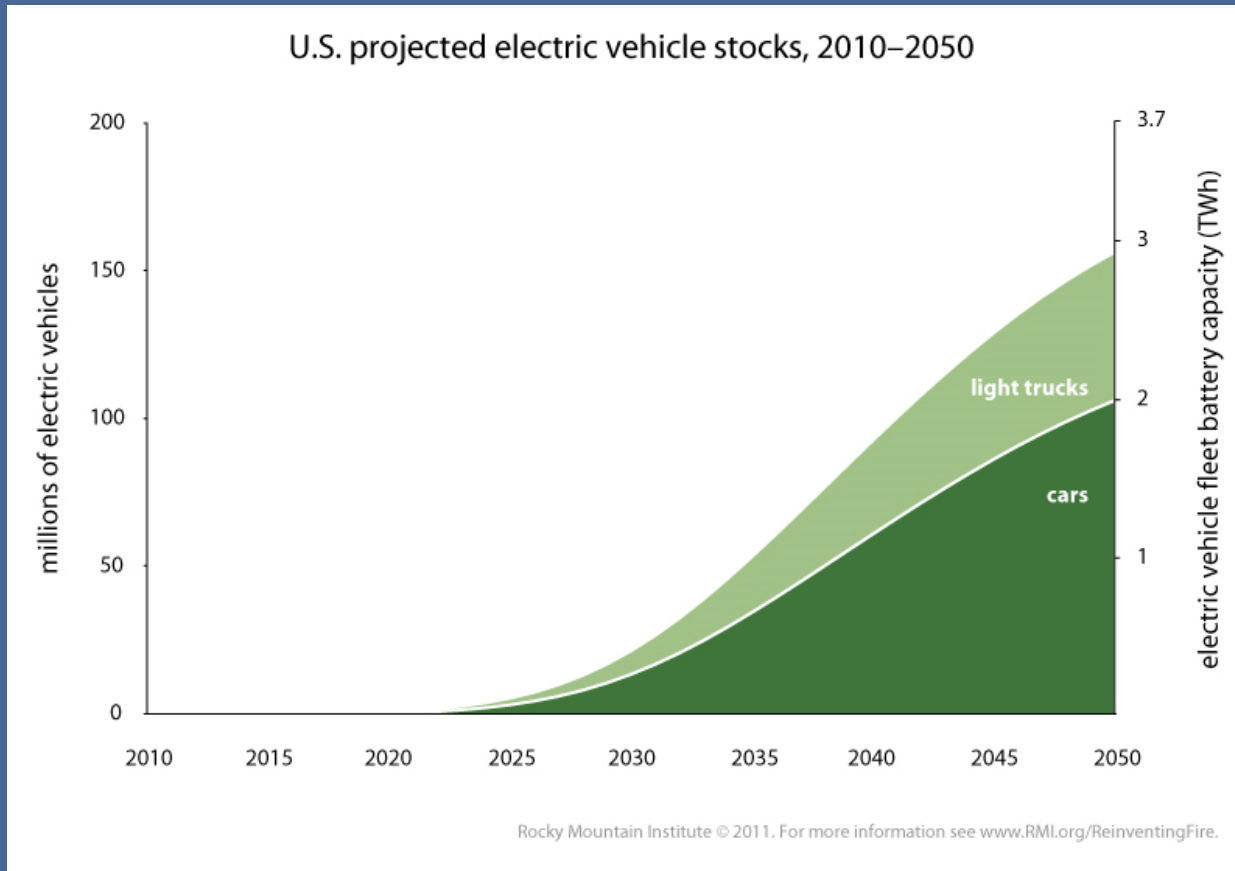
# Asset Class



Jeff Cobb (2014-09-09). "Americans Buy Their 250,000th Plug-In Car". *HybridCars.com*.

# Asset Class

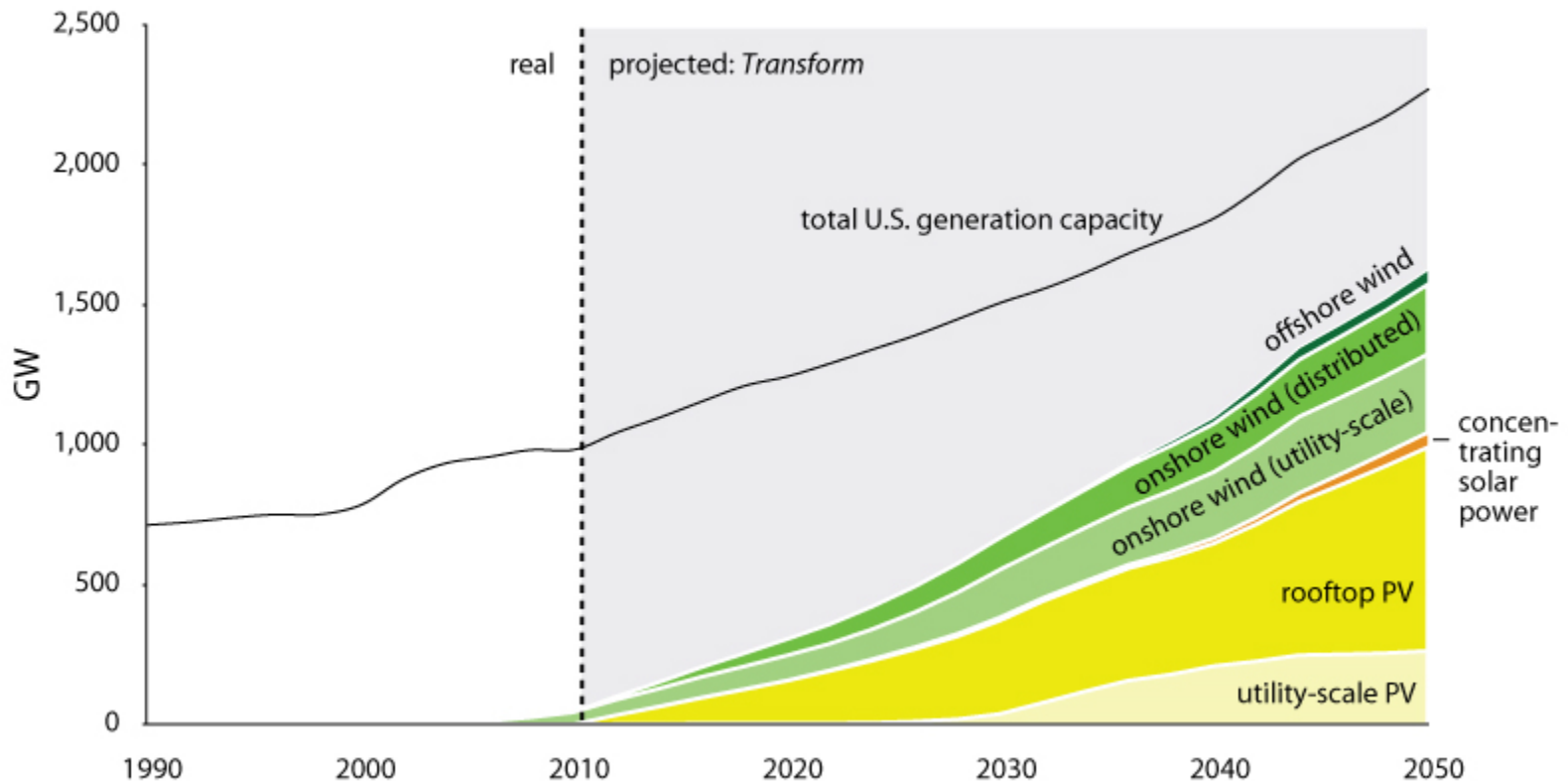
Annual peak demand last year was **800 GW** (.8 TW)



Source: Rocky Mountain Institute

# Asset Class

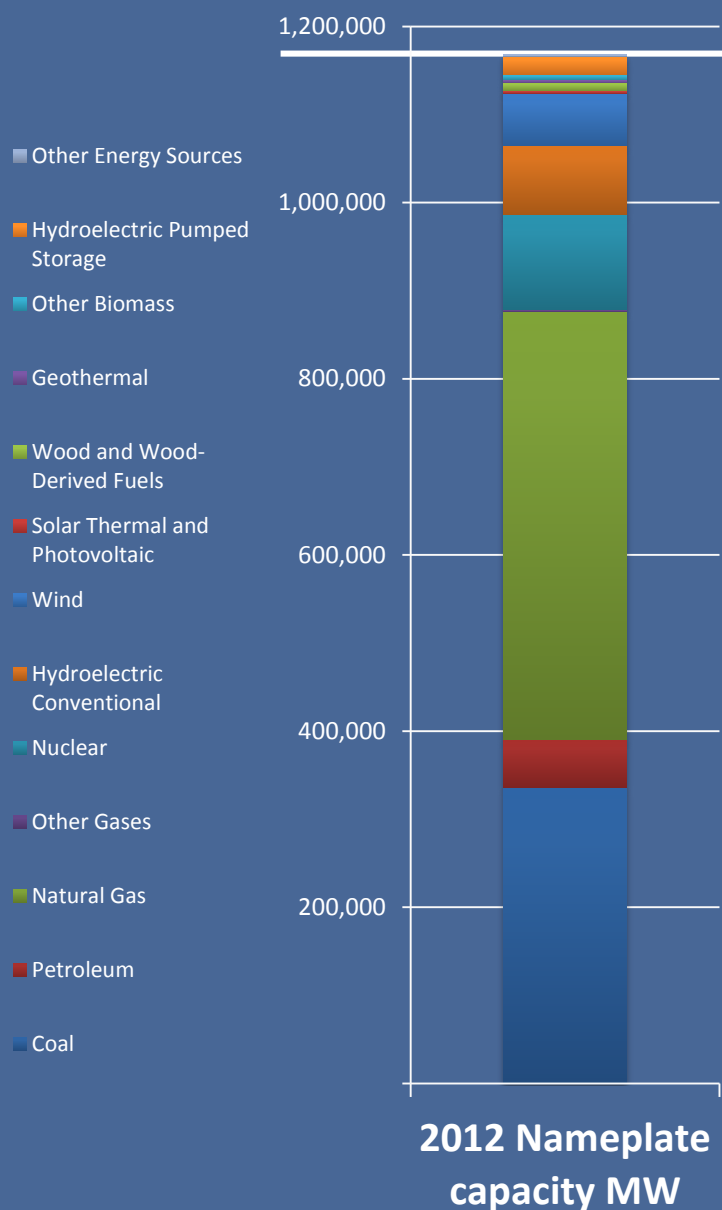
U.S. installed wind and solar power capacities and projections, 1990–2050



Rocky Mountain Institute © 2011. For more information see [www.RMI.org/ReinventingFire](http://www.RMI.org/ReinventingFire).

Source: Rocky Mountain Institute

# Energy storage needed to address inefficiencies

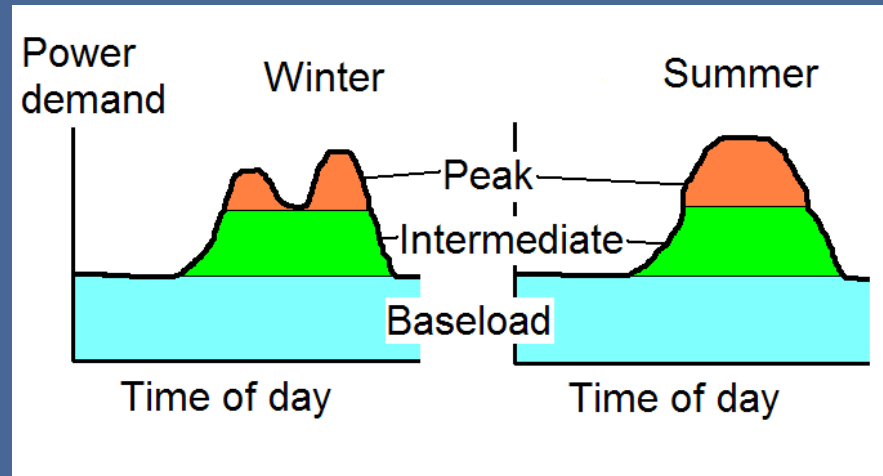


1,167 GW

÷ 2.5

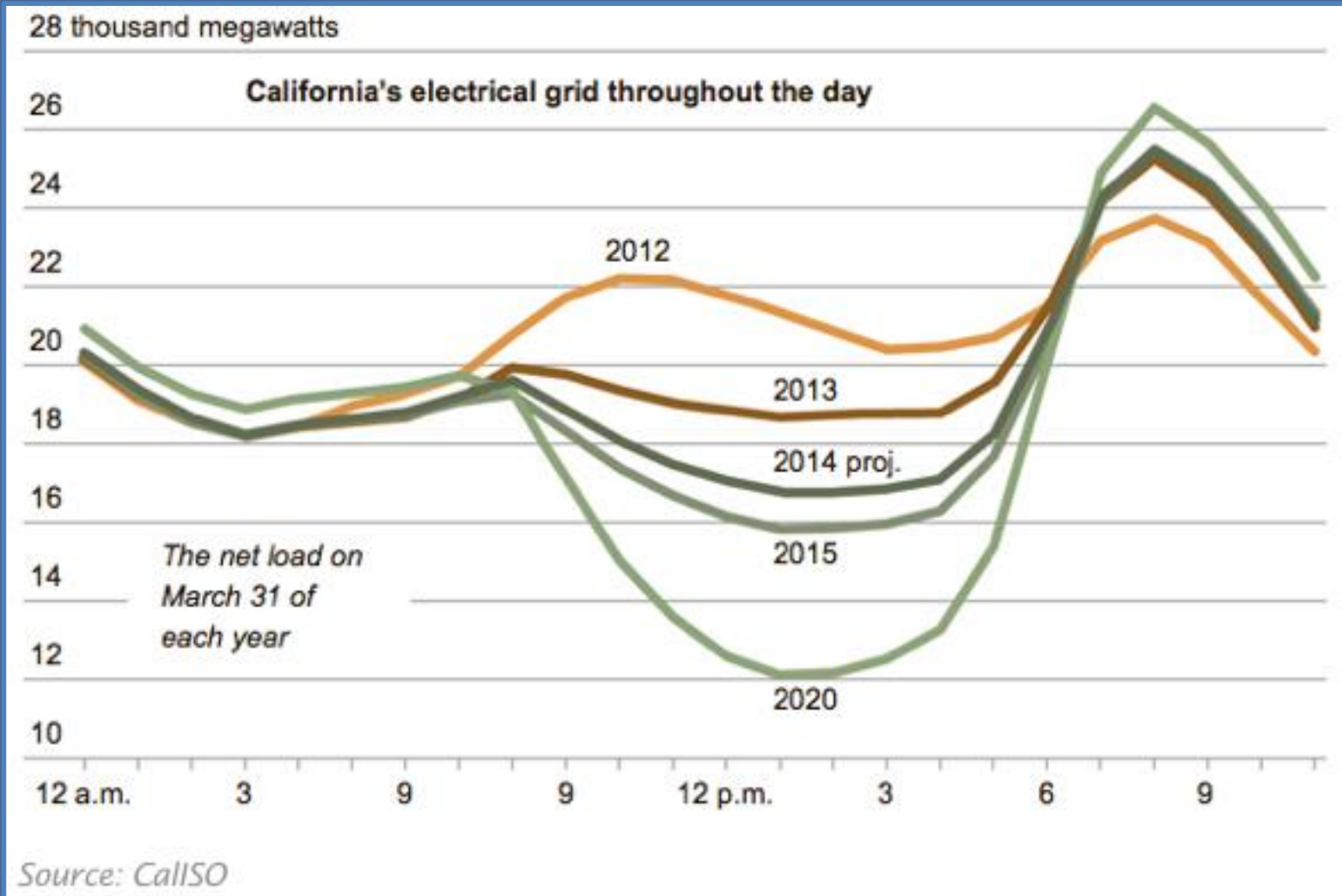
467 GW demand

If electricity were an efficient supply chain, it would have 150% excess capacity!



US Annual electrical consumption 4,095 B.kWh = flat average demand of 467 GW

# The Duck Curve



# Markets



Source: FERC

# A Complex Overlay

- Federal (FERC) vs. state (PUC)
- De-regulated (wires and meters, merchant power, IPP) vs. vertically integrated
- IOU vs. muni vs.co-op
- Utility-sided vs. behind the meter

# Application

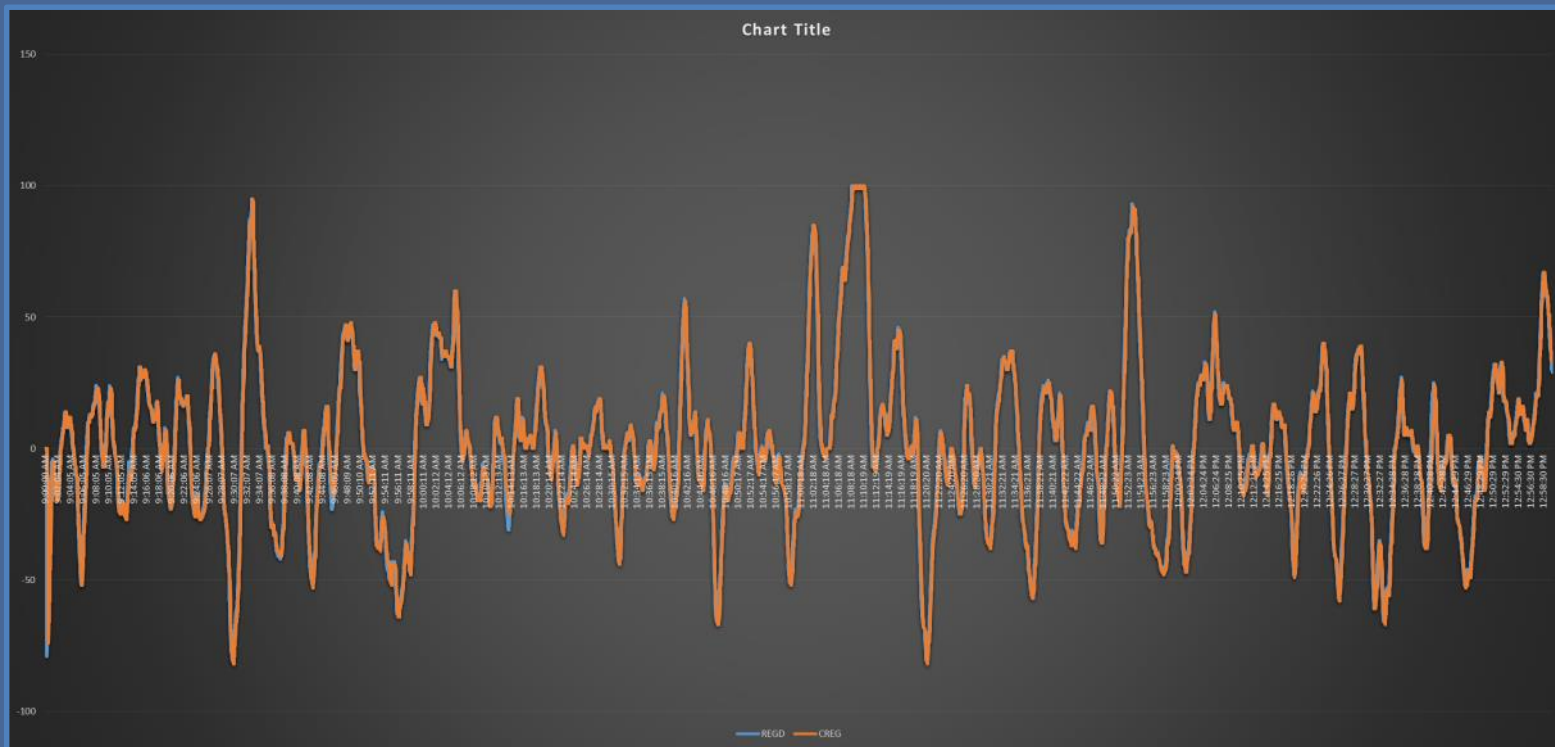
## Relevant grid services to consider

Grid Domain	Type of Avoided Cost	Grid Services Possible with Storage
Generation	Fixed	Resource Adequacy (Capacity)
		Resource Adequacy (Flexibility)
	Variable	Energy (Time-shifting / Arbitrage)
		Frequency Regulation*
		Spinning Reserve*
		Non-spinning Reserve*
Transmission	Fixed	Upgrade Deferral / Avoidance (Capacity)
	Variable	Energy Loss Reduction
		Voltage Support
Distribution	Fixed	Upgrade Deferral / Avoidance (Capacity)
	Variable	Energy Loss Reduction
		Voltage Control / Power Quality

Source: EPRI



# Example: Frequency Regulation



- Blue is PJM regulation signal, gold is IG tracking it.
- **96% performance score** (40% is PJM minimum)
- Average hourly clearing price: \$40/MW-hour

# IG's Genesis of the Operating System

## Problem:

Energy Storage without intelligent application is non-economic



## IG's solution:

Intelligently leverage energy storage to **optimize economics.**



Frequency regulation, capacity reduction and ITC




Frequency regulation during vehicle off hours (\$8,000/yr./vehicle)



Network solution extends battery life

# Intelligent Solar with Storage Benefits

## IG Intelligent Solar delivers benefits stack:

<u>Item</u>	<u>Benefit</u>	<u>Conventional Solar</u>	
<u>Energy</u>	<u>Save on Electricity Bill</u>	✓	✓
<u>Capacity Power</u>	<u>Save on Electricity Bill</u>		✓
<u>Demand Power</u>	<u>Save on Electricity Bill</u>		✓
<u>Fast Response Frequency Regulation</u>	<u>Earn Power Market Revenues</u>		✓
<u>Battery</u>	<u>Protect with Back-up Power</u>		✓

## Bottom Line Results

Earn back 15-20% of annual energy costs, depending on battery size.

Save 10-20% off the power-related charges on electricity bills.

Protect critical operations with battery backup at no extra cost.

# IG Platform for Multiple Storage Applications



Grid Balancing

IG Solar

IG Reserve

IG Fleet

IG Grid



# Summary

- Solar + storage, EVs are emerging markets today
- Impact on the grid within 10 years will be seismic
- Market will drive management, control and monetization of the distributed clean energy grid
- IG poised to be platform leader for networking these distributed assets along dimensions of:
  1. Asset class
  2. Market
  3. Application

# Thank You!

## Jay Marhoefer

Co-founder & CEO, Intelligent Generation  
jay@intelgen.com

## John A. Andersen, Jr.

Executive Manager, Intelligent Generation  
jandersen@greenleafadvisors.net

[www.intelgen.com](http://www.intelgen.com)