

Clean Energy Group

Resilient Power Project Webinar

Energy Storage: New Markets and Business Models

December 18, 2013



Housekeeping

- All participants will be in listen-only mode throughout the broadcast.
- It is recommended that you connect to the audio portion of the webinar using VOIP and your computer's speakers or USB-type headset. You can also connect by telephone. If by phone, please expand the Audio section of the webinar console to select "Telephone" to find the PIN number shown and enter it onto your telephone keypad.
- You can enter questions for today's event by typing them into the "Question Box" on the webinar console. We will pose your questions, as time allows, following the presentation.
- This webinar is being recorded and will be made available after the event on the CEG website at

<http://www.cleangroup.org/ceg-resources/>

About CEG and the RPP

Clean Energy Group (CEG) is a leading nonprofit advocacy organization working in the U.S. and internationally on innovative clean energy technology, finance, and policy programs.

The **Resilient Power Project (RPP)** was started as a response to the devastation caused by Super Storm Sandy. The project provides a forum for states and municipalities to work together to implement effective clean resilient power policies & programs.

Today's Webinar

Today's webinar focuses on new business models and markets for energy storage now emerging as a result of recent FERC orders.

Guest Speakers:

- Judith Judson McQueeney, Director of Emerging Technologies, Customized Energy Solutions
- Thomas Leyden, CEO, Solar Grid Storage
- Cole Walker, Partner, Energy Surety Partners



Contact Information

CEG Resilient Power Project:

Lew Milford (LMilford@cleanegroup.org)

Todd Olinsky-Paul (Todd@cleanegroup.org)

Resilient Power Project Web page:

<http://www.cleanegroup.org/ceg-projects/resilient-power-and-climate/>

CEG/CESA webinars: www.cleanenergystates.org/webinars



Customized Energy Solutions

Storage Applications

Judith Judson McQueeney
Director of Emerging Technologies – U.S.

Customized Energy Solutions

- Customized Energy Solutions (Customized) started as an electric energy consulting company in 1998 to provide wholesale market services to load interests
- Company has over 70 staff members located in Philadelphia (headquarters), Massachusetts, Indiana, Texas, New York, California, and India
- Diverse staff
 - Varied educational backgrounds including business administration, finance, electrical engineering, and law
 - Varied backgrounds focused on regulatory compliance, retail services, transmission, generation, demand response, operations, and planning

Customized Energy Solutions

- Customized serves over 300 different clients in a range of categories
 - Municipal and Cooperative Entities
 - Competitive Load Serving Entities
 - Industrial Customers
 - Generation Developers
 - Investment Banks
 - Technology Developers

- Customized is objective and independent--not affiliated with any trading, marketing, distribution or transmission companies

Services: Emerging Technologies



- Markets & Regulatory
 - ISO/RTO Markets
- Modeling and Consulting
 - Price forecasts
 - Economic analysis and valuation
 - Optimization of product configuration
- Financial Advisory
 - Help secure funding
- Project Development
 - Site selection, interconnection
- Market Operations

Customized assists clients from concept to market implementation



Storage Applications

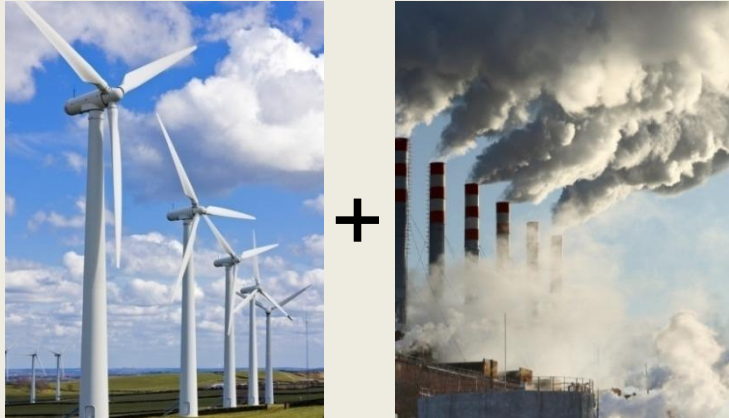
- **End-Users: Bill Management, Power Quality and Back-up Service**
 - Reduce Demand Charges
 - Optimize Retail Rates
 - Power Quality/Uninterruptible Power Supply
 - Integrate onsite renewable generation

- **Grid Services: Sell to wholesale electricity markets**
 - Ancillary Services – Regulation, Ramping
 - Capacity/Demand Response
 - Energy Arbitrage

- **Utility Benefits: Transmission & Distribution Applications**
 - Upgrade deferral – reduce circuit/line overload
 - Grid resiliency – Outage mitigation, back-up
 - Voltage support/power quality
 - Integrate intermittent renewable resources
 - Congestion relief

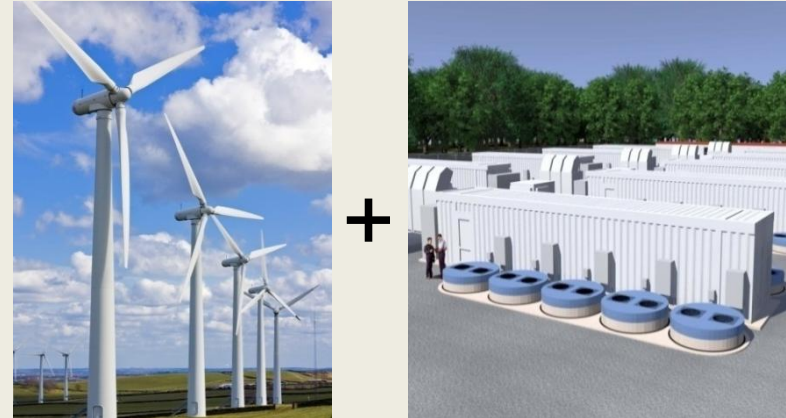
Frequency Regulation

Conventional Grid



- Manage renewable variation by fossil generators varying output
 - Decreases efficiency
 - Increases fuel consumption
 - Requires more maintenance
 - Increases emissions

Smarter Solution: Storage



- Store energy when supply exceeds load; inject energy when load exceeds supply
 - High round trip efficiency
 - Low operating cost
 - Near instantaneous response
 - Zero direct emissions
 - Frees up generation capacity

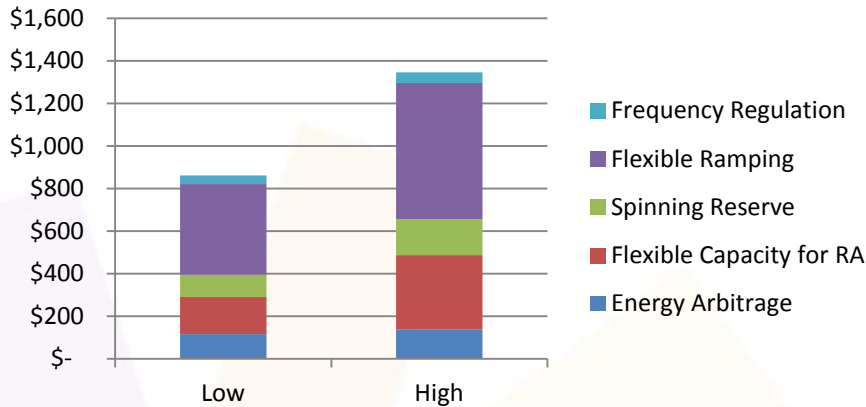
20% of the CO2 emission reduction and up 100% of the NOX emission reduction expected from wind and solar power may be lost because of ramping fossil plants

Market Application Examples:

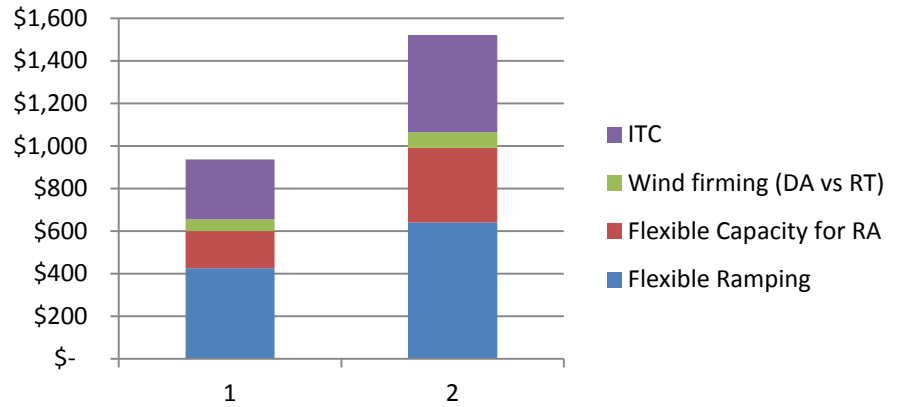
Target System Cost per kW in 2018 (10% IRR, 5 Year Forecast)



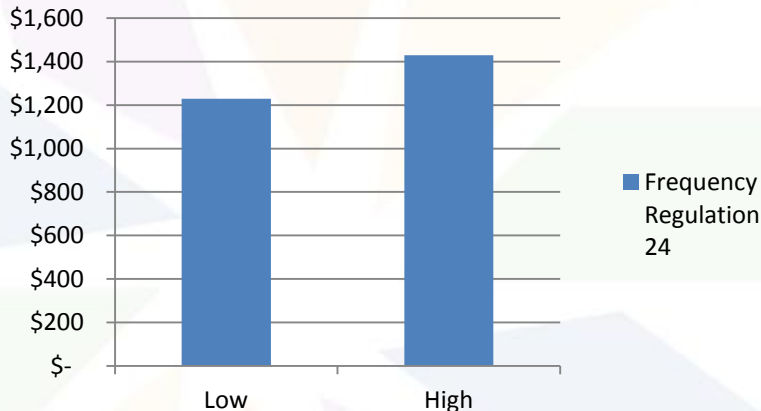
CAISO Market (4 Hr)



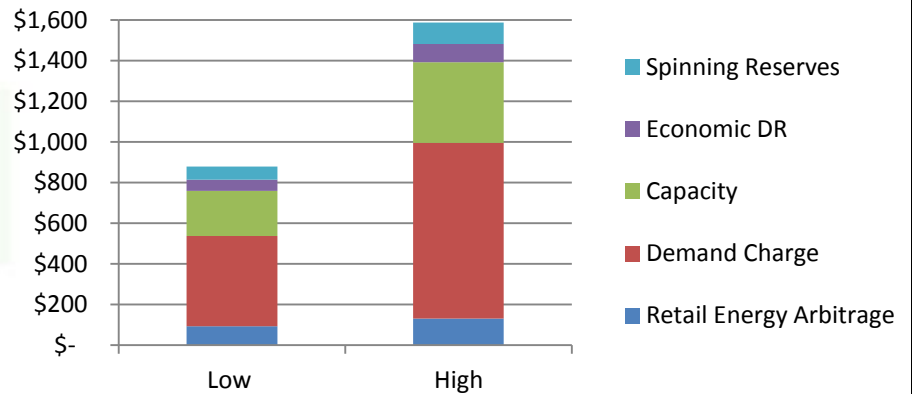
CAISO Renewable Integration (4 Hr)



PJM Regulation (15 min)



PJM Customer-side (6 Hr)



Capturing multiple value streams is critical to most projects

Critical Factors for Developing Storage Projects

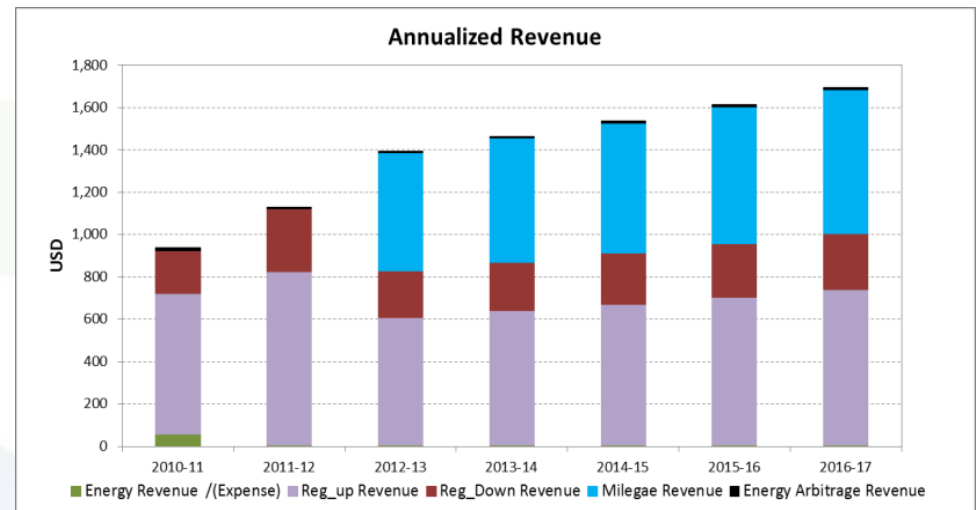
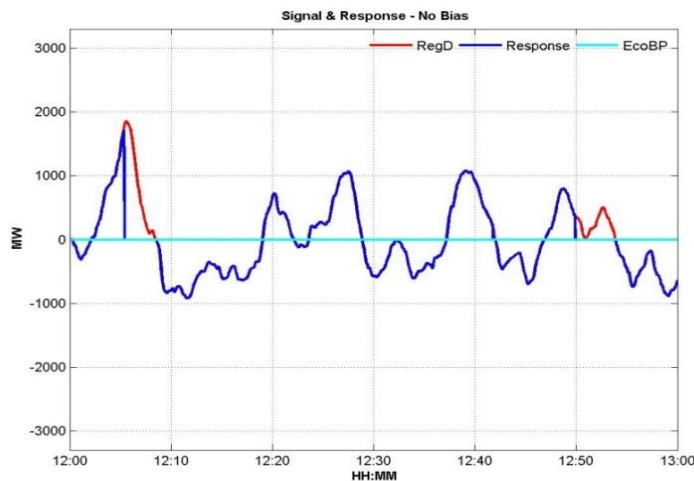
- Understanding of the market rules & performance requirements
 - Significant variation on rules for storage across the country
 - Duration requirements, dispatch methodologies vary
- Technology selection and optimization of product configuration
- Analysis of potential changes in the supply, demand and transmission systems that can influence revenues and costs
- Operational optimization (e.g. response rate, state-of-charge management) and bidding strategies to maximize profit
- Co-optimizing multiple value streams
 - Except for frequency regulation need multiple value streams
- Site selection and interconnection requirement

Case Study I: Regulation Performance Analysis

Storage technology developer needed to understand its U.S. frequency regulation market potential. Modeled performance in various ISOs to understand risks and financial returns.

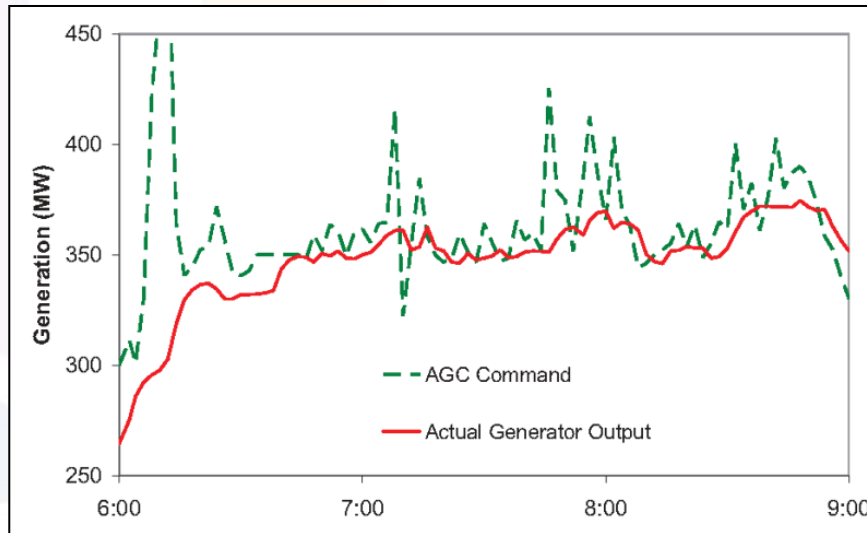
Customized collected signal data of various ISOs. Analyzed market rules to calculate the performance. Simulated the resource response. Calculated metrics affecting performance and cycle life. Built financial model with metrics to calculate ROI.

Sample Outputs

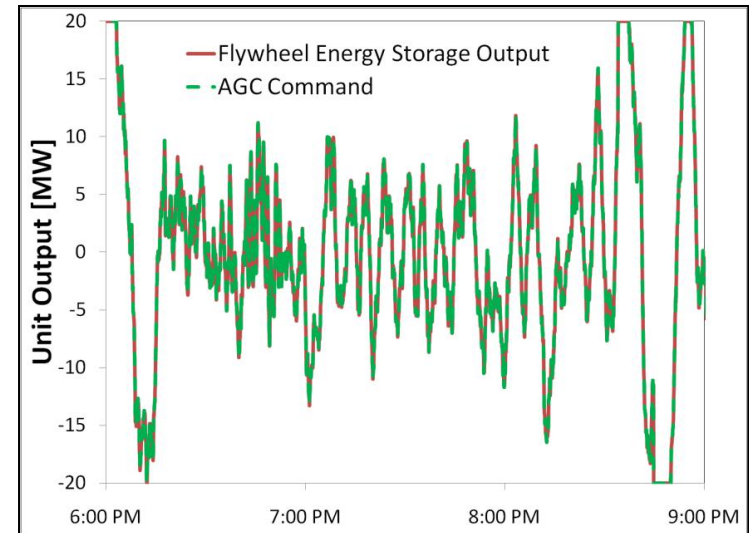


FERC Order 755: Pay-for-Performance

- Created new compensation rules for frequency regulation
- Compensates value of speed and accuracy



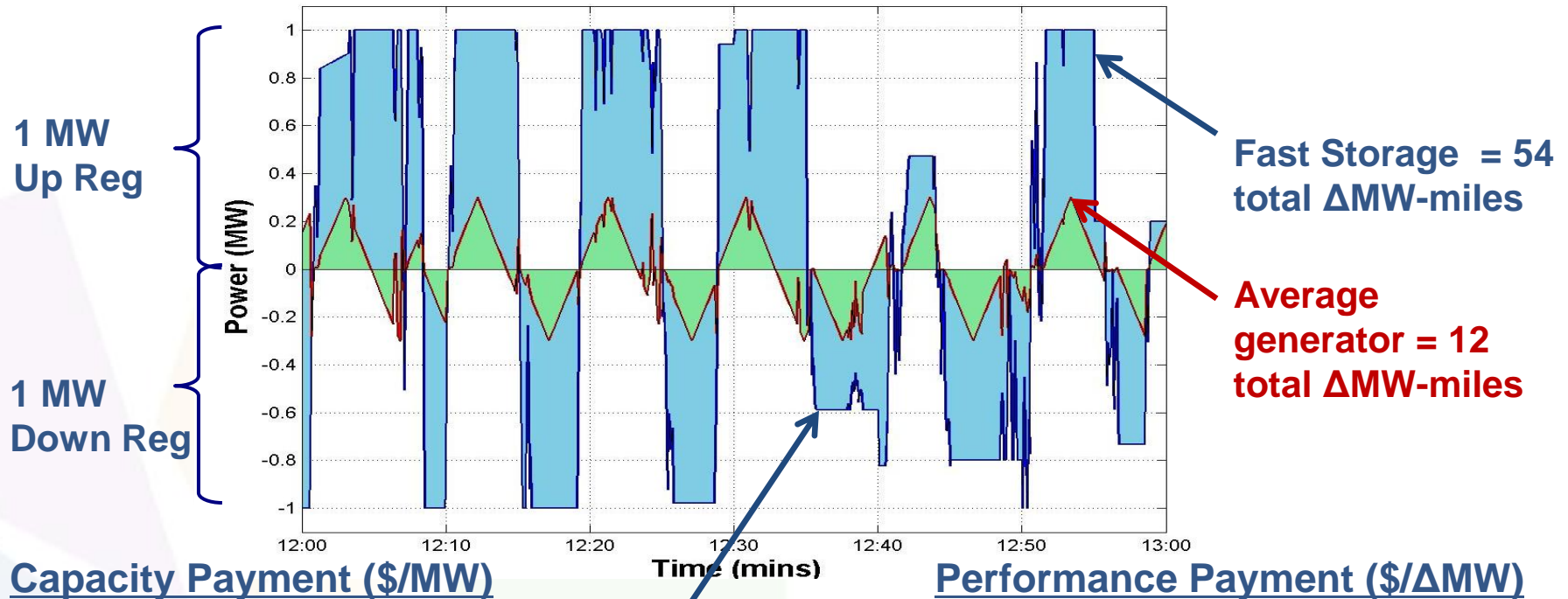
Slow-ramping Generator¹



Fast-ramping Storage²

Superior speed and accuracy provide more value to the grid

FERC Order 755: Created Two-Part Payment



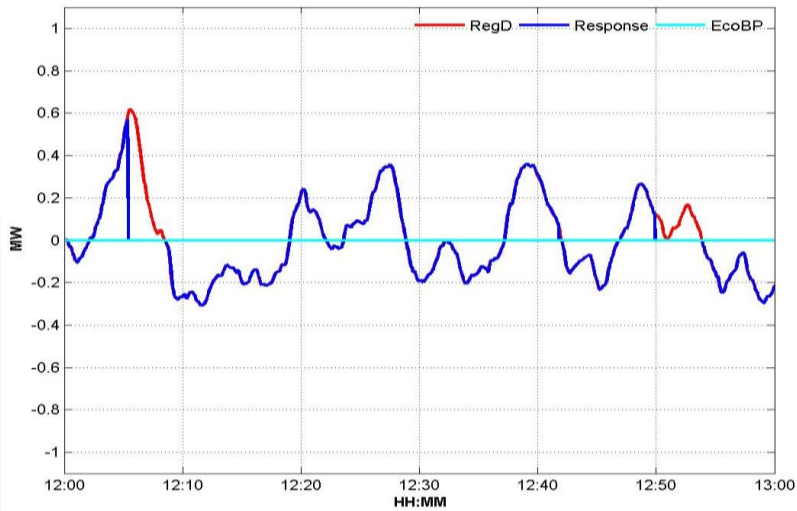
- Amount set-aside (MW)
- Includes Opportunity Cost
- *May be adjusted based on state-of-charge*

- Sum of up and down movement “mileage” (Δ MW)
- Adjusted by accuracy

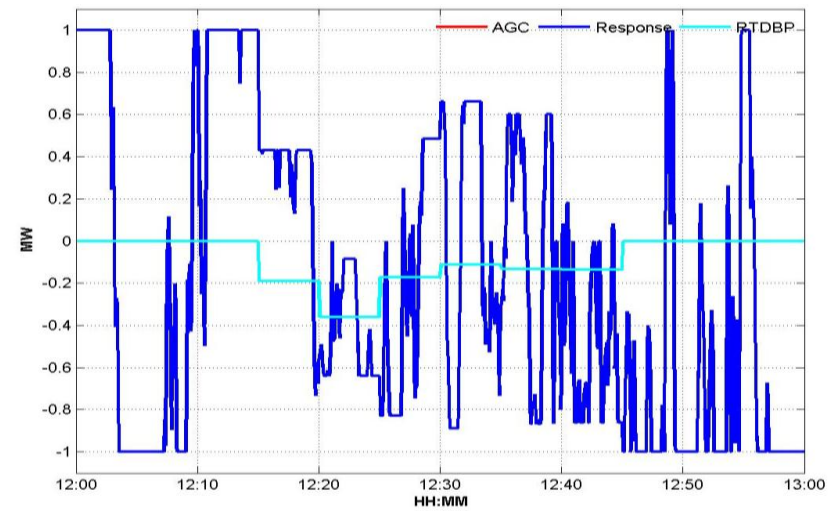
**Key financial factors will vary by technology type,
ISO/RTO dispatch signal and market rules**

Signal Comparison: PJM, CAISO, NYISO

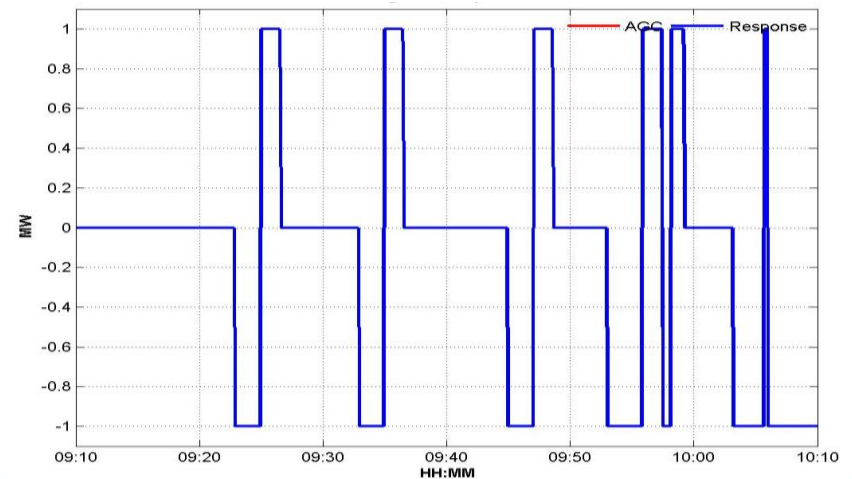
PJM



NYISO



CAISO



Same Resource in PJM, CAISO, NYISO – Significant differences in signal, mileage and cycles

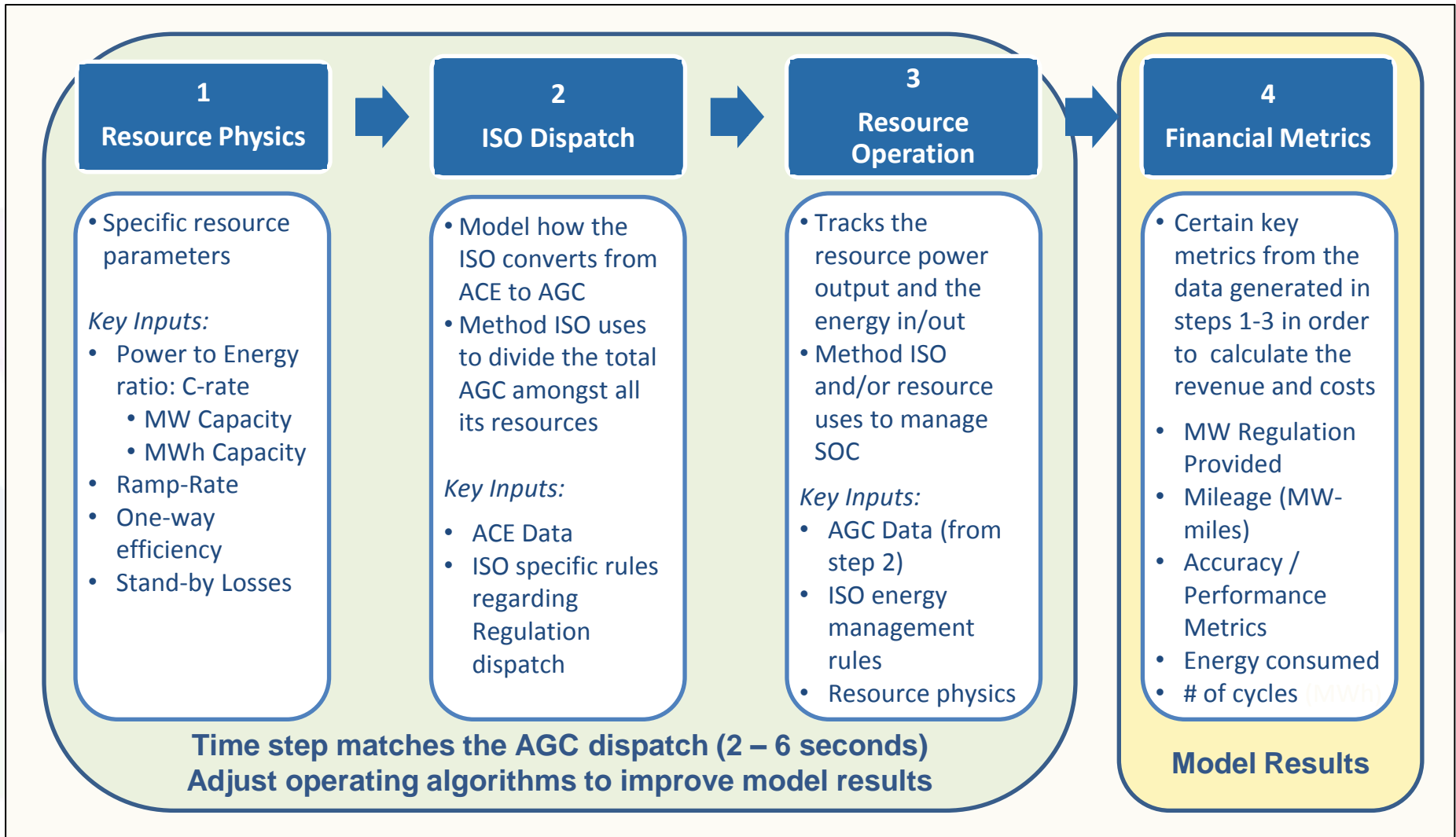
The Challenge for Storage Investors/Developers

- Estimating and Quantifying Revenue and Cost with PFP
 - Amount of mileage
 - Accuracy score
 - Effective capacity
 - Duty cycle – # of DOD cycles, State-of-Charge
 - Energy losses
- *Varies significantly by ISO – depends on ISO's method for dispatching regulation and energy management*
- Determining optimal sizing and product warranty

CES signal modeling determines and optimizes these key metrics

Customized Energy Solutions

ISO/RTO Signal Modeling



Case Study II: Multiple Revenue Streams

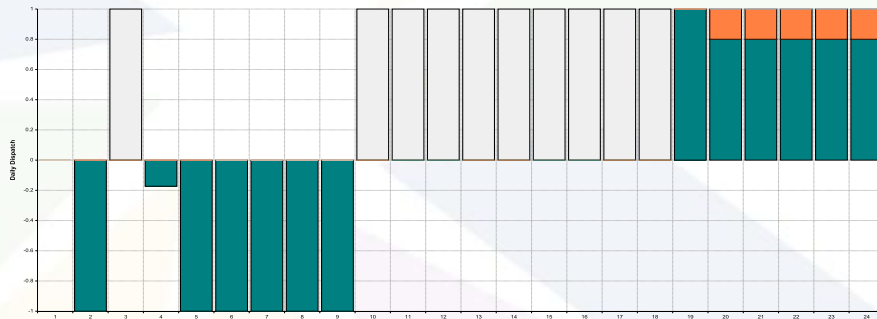
Storage technology developer requested model for optimizing utilization of energy storage technology for multiple purposes.

Objective: Maximize profitability of the plant by hourly co-optimizing the asset's operation for providing various services.

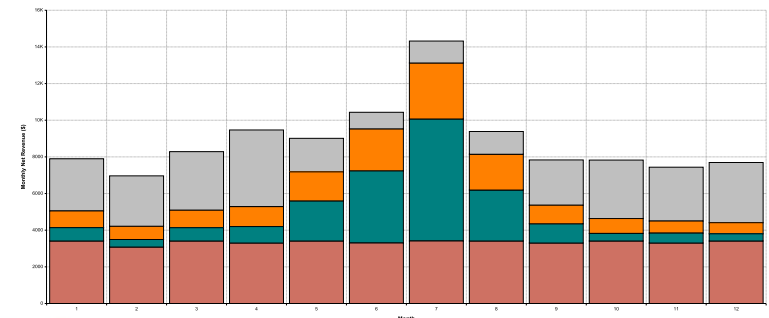
The value streams considered included:

- Frequency Regulation
- Energy Arbitrage/Peak Demand Reduction
- Installed Capacity Revenues
- Synchronous / Non Synchronous Reserves

Sample Analysis - Hourly Optimization



Revenue – by month

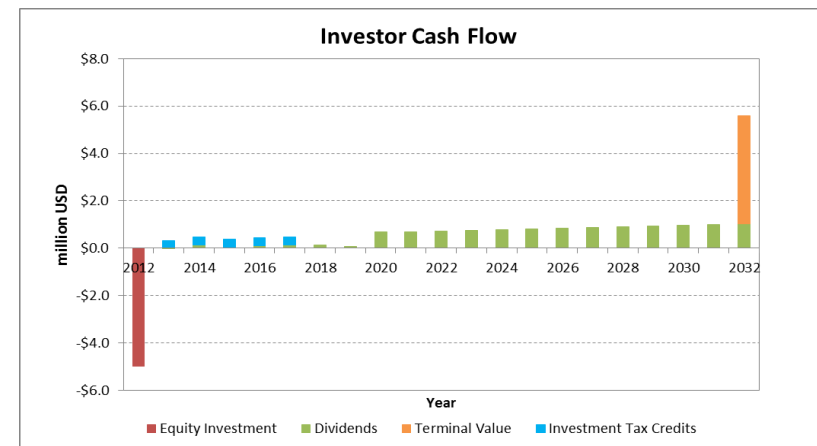
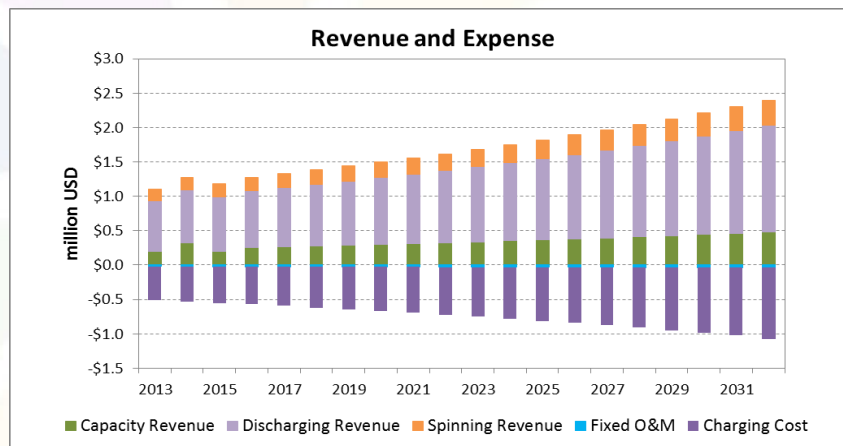


Case Study III: Financial Modeling

Storage technology developer needed detailed financial analysis to determine the bankability of the project in various zones as well as to understand which is the better market for them.

Customized built detailed project finance model. The client can choose any zone in any ISO and the model will forecast revenue based on historical prices in the zone selected. The model also provides all financial statements and typical financial metrics like IRR, NPV, DSCR, Loan Life Ratio.

Sample Analysis



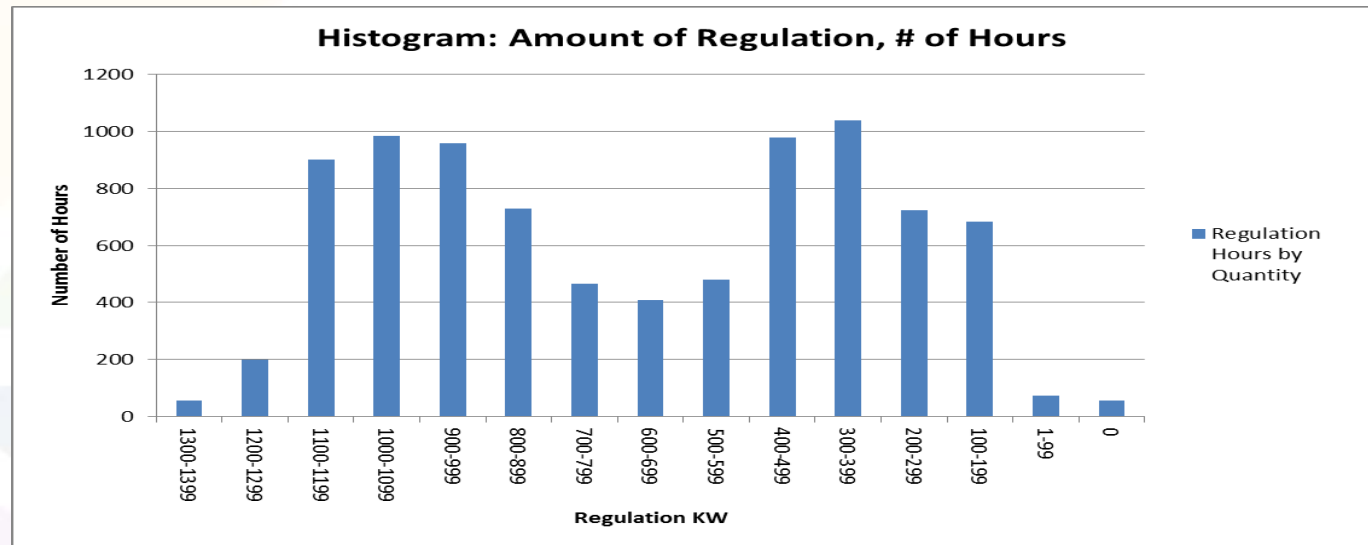
Case Study IV: Behind-the-Meter Storage and Renewable Project

End-Use customer wanted a Wind + Energy Storage project to meet green initiative goals, achieve peak shaving benefits and evaluate sales to grid

Customized modeled the size of the battery required to use wind and battery to achieve peak shaving goals. It was further analyzed to be able to provide Regulation and Spinning Services as and when not required for Peak Shaving.

Sample Outputs

Row Labels	Min of Peak Shaved (1000)
2011	28%
1	38%
2	52%
3	42%
4	42%
5	46%
6	29%
7	42%
8	41%
9	28%
10	45%
11	43%
12	52%



Benefits of Customized Energy Solutions Services

- Provide accurate forecasts of revenues and costs
- Identify target markets and applications
- Determine optimum storage size and configuration
- Operations and Scheduling services for sales to grid
- Determine operating and bidding strategies to maximize profit



Customized Energy Solutions Ltd.

1528 Walnut Street, 22nd Floor
Philadelphia, PA 19102 USA

Phone: +1-215-875-9440
Fax: +1-215-875-9490
info@ces-ltd.com

Judith Judson McQueeney

Director,
Emerging Technologies – U.S.

jjudson@ces-ltd.com
Phone: 978-237-5846
Mobile: 978-314-3776

Customized Energy Solutions India Pvt. Ltd.

A 501, GO Square
Aundh - Hinjewadi Link Rd, Wakad
Pune, Maharashtra 411057 India

Phone: 91-20-32407682
info@ces-ltd.com



SOLAR GRID
storage

Distributed RE Storage Assets For a More Resilient and Smarter Grid

Clean Energy States Alliance Webinar

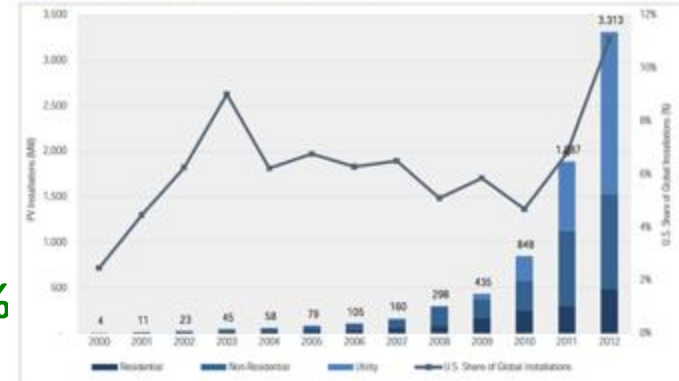
December 18, 2013

Exciting Times in Solar

Exciting Times in the Solar Industry....

Compound Avg. Growth Rates: 5-year = 76%,
10-year = 67%
2013 Estimate = >30%

Figure 2.1 U.S. PV Installations and Global Market Share, 2000-2012



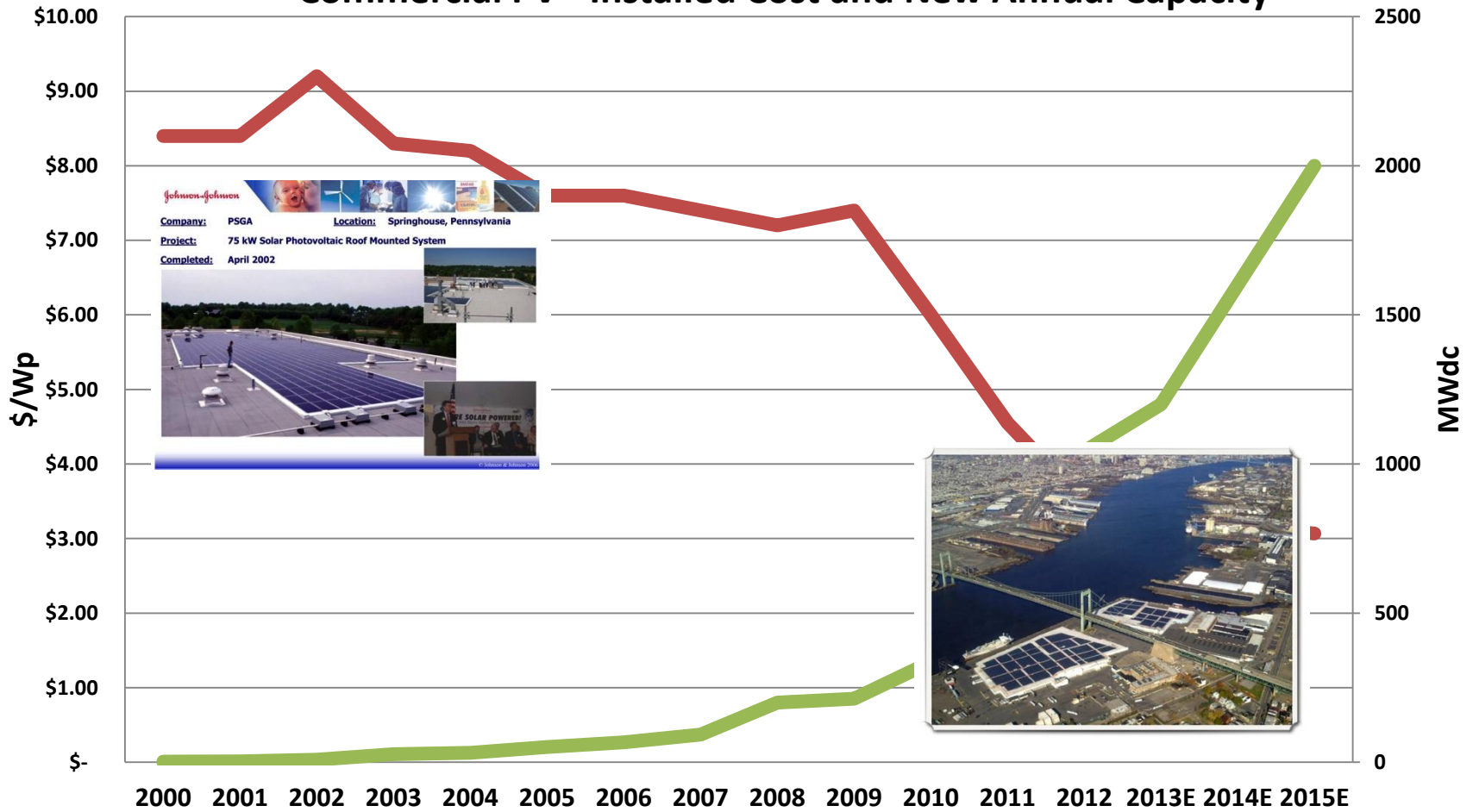
So, to continue the tremendous momentum:

1. Continue to ***drive down costs*** of **technology and installation**
2. Better financing and lower cost of capital
3. ***Find ways to add value to standard solar industry offerings***
4. Push policy makers to support long-term & comprehensive

energy plans

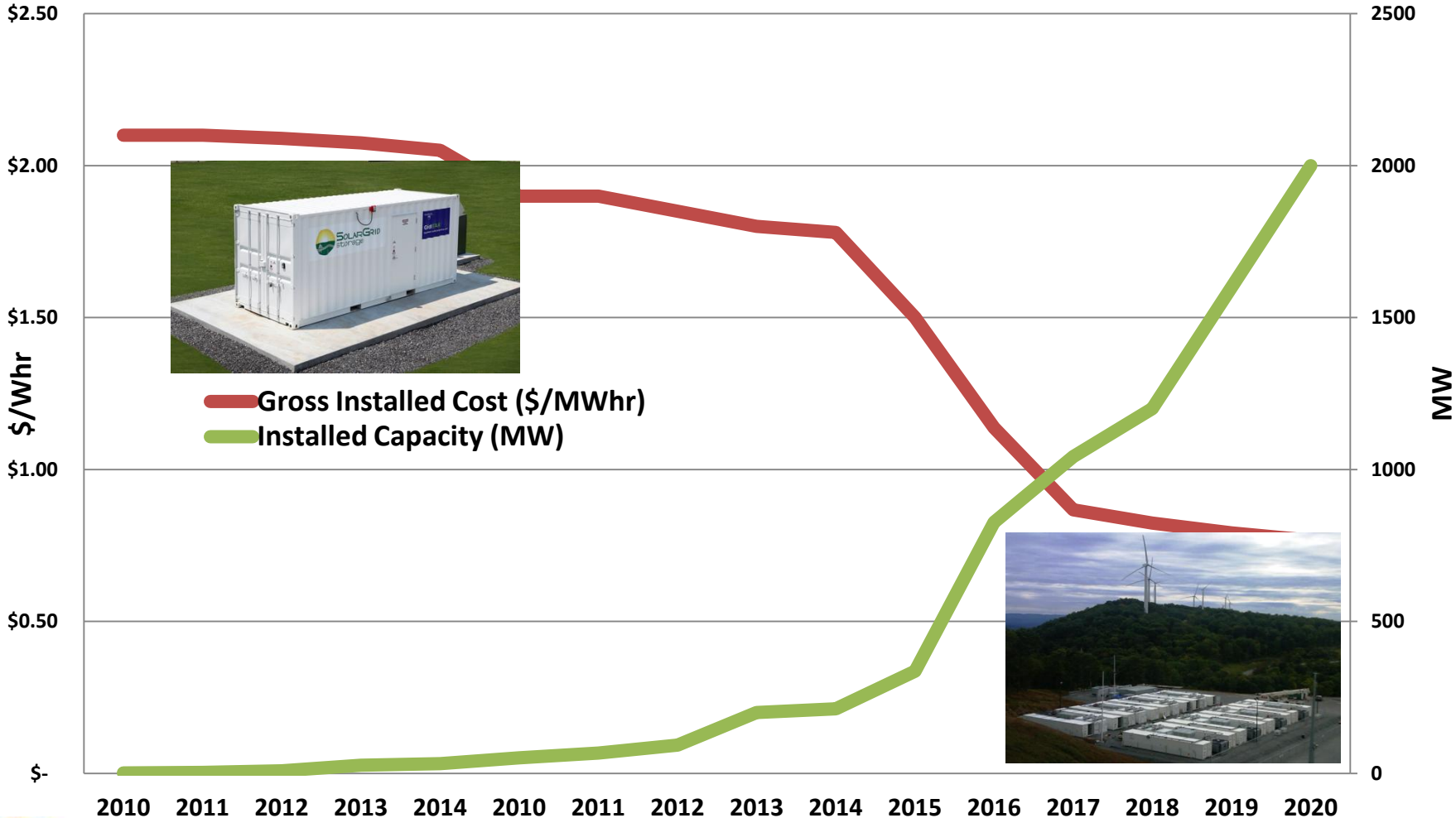
Falling Costs Accelerate Deployment

Commercial PV - Installed Cost and New Annual Capacity



Falling Costs and *Value* Accelerate Deployment

Solar Storage - Installed Cost and Annual Capacity



Growing Challenges = Opportunity

- ✓ Increased penetration of intermittent solar power and other renewables causes utility grid operators to search for additional power balancing technologies
- ✓ Solar energy consumers are increasingly demanding emergency backup for power outages
- ✓ Fierce competition in the solar industry drives solar companies to find ways to differentiate themselves with lower costs and more benefits



Financed Storage = Cost Reduction, Emergency Power, Grid Stability

Delivering Affordable Storage

Solar Grid Storage is at the forefront of delivering affordable energy storage for commercial solar installations, government entities, and electric utilities

We build, finance, and operate energy storage systems (PowerFactor™)

- A complete PowerFactor™ system including inverter and battery is installed alongside solar energy systems
- Solar Grid Storage finances the PowerFactor™ systems separately from the PV system
- Solar Grid Storage maintains and operates the PowerFactor™ systems for 10 years
- Revenues from grid ancillary services provide the revenues for financing allowing Solar Grid Storage to offer “inverter services” to the PV customer at lower cost than buying an inverter



Making solar better

Confidential and Proprietary. Do not redistribute without permission of Solar Grid Storage LLC

Solar Grid Storage Solution

PowerFactor™ Systems Benefit Multiple Parties

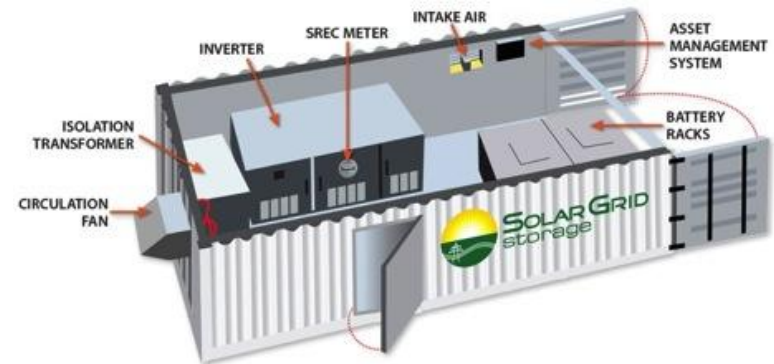
Solar Developer - offers the inverter with multiple uses dramatically *increasing the value* of the system and *differentiating* them from competitors

Host/Customer - reduces PV system cost and includes **backup power** (UPS quality) that enables solar to work *even during power outages*

Utility – provides local distribution system benefits including voltage and VAR control; Solar Grid Storage systems are fully SCADA enabled

Grid - grid operators can use storage for an array of ancillary services – Solar Grid Storage systems are AGC enabled

PV Industry - *accelerates solar deployment*



Completed Projects

Penn State GridSTAR Center
Philadelphia Navy Yard – 150kW



Konterra Headquarters
Laurel, MD – 500kW



WP Properties
Hackettstown, NJ – 250kW



WP Properties
Denville, NJ – 200kW



Making solar better

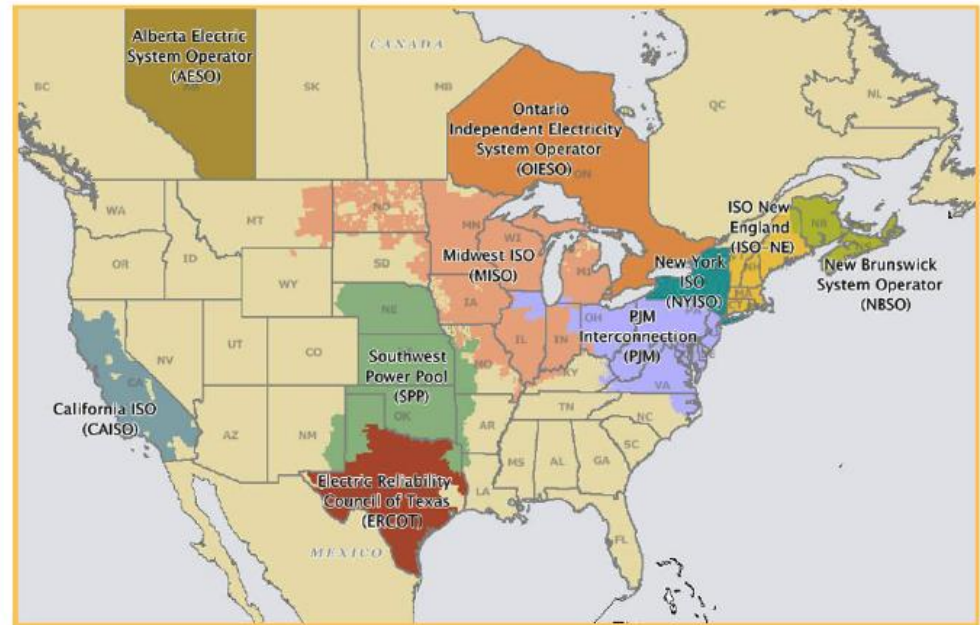
Confidential and Proprietary. Do not redistribute without permission of Solar Grid Storage LLC

The Market

Project finance innovations have created today's \$12 Billion US PV power installation industry. The US PV Industry has developed at breakneck speed growing 76% in 2012 with >30% forecast in 2013. PJM regulation market > 1,000 MWs, US ~4,000 MWs and growing.

North American Regional Transmission Organizations

- FERC has mandated utilities and system operators to implement standardized rules that pay for fast-responding technologies, supporting the Solar Grid Storage business model and a rapid expansion in the on-site battery storage market.
- Current grid-tied solar solutions do not provide energy back-up.



Intense Interest and Media Attention

“If you want to see the future of renewable energy in the U.S., you should check out the large container sitting next to a nondescript office building off the I-95 corridor in Maryland.” *Business Insider*, November 2, 2013

Solar Grid Storage featured in 30+ earned media articles:



Making solar better

Confidential and Proprietary. Do not redistribute without permission of Solar Grid Storage LLC

Proposition For Utilities – “SolarReady”

Utilities could directly participate in solar with inverter/battery systems on either side of the customer meter:

1. Rate base behind-the-meter "Solar Ready" systems for commercial, municipal, state, and federal customers, *or*
2. Rate base grid-side of the meter for system stability, resilience and power quality

SolarReady™ systems provide ***multiple utility values***:

- Provides real time Smart Grid data
- Provides ramp rate control for PV and/or distributed generation systems
- Optimizes circuit voltage by raising/lowering unique customer voltage
- Adds a distribution investment with every solar installation
- Provides utility revenues from Solar DG customers for Inverter services

Ratepayer Cost Recovery via Multiple Benefits

Creating Resiliency Assets *with* Identifiable Cost Recovery

Opportunities for *direct* cost recovery

- *Inverter services to PV owner**
- *Emergency backup services to building occupant**
- Ancillary services
- Volt/VAR support
- 30% ITC + depreciation

Other ratepayer benefits

- T&D deferral
- Voltage support
- Power quality
- Black Start
- Frequency response
- Grid reliability



**from end customer*

Why Regulators Like It

- Helps regulators meet renewable energy mandates at lower cost than direct solar incentives
- Provides backup power option for customers which limits outage calls to regulators from irate customers
- Innovative – politically popular – is a creative action to address grid resiliency and increased outages from storms
- Allows utilities to better utilize distributed solar for grid support functions
- Does not upset the competitive market for solar installations



Why Solar Customers Like SolarReady™

- Makes their home/business/gov't building SolarReady™ from a known respected entity
- Adds backup power to their solar system dramatically increasing its value to them
- Does not upset their ability to select a solar installer of their choosing including financing such as PPA, solar leases, or cash payment
- Inverter maintenance, warranty, and uptime supported by respected entity



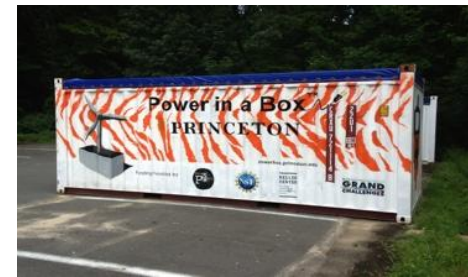
Why Solar Developers Like It

- Eliminates the problems with interconnection process – utility internalizes the IC function, simplifies permitting
- Reduces the cost of solar installation – their PPA to the solar customer looks much better if the solar developer is not paying for the inverter/battery and interconnection cost
- Simplifies the installation process – developers need only work with the panels and DC wiring to the pre-packaged PowerFactor container
- Increases the value of solar to a customer which increases sales of systems



Conclusions

1. Market-based programs required by FERC Orders 755 & 784 valuing fast-reacting storage will lead to private sector storage offerings, particularly combined with renewable energy
2. State-wide programs that further incentivize RE storage will help “jump-start” industry investment and innovation even further, and like solar, will lead to cost-effective installations
3. Markets where current programs don’t provide the financial basis for storage should investigate how grid connected storage can add value for the grid operator and make a much smarter, more efficient grid
4. A combination of private sector and utility programs can quickly add significant resiliency assets into the distribution grid



Thank You

Thomas Leyden
CEO
Solar Grid Storage LLC
609-532-3642 mobile
tleyden@solargridstorage.com

www.solargridstorage.com



Making solar better

Confidential and Proprietary. Do not redistribute without permission of Solar Grid Storage LLC



CESA: New Markets and Business Models



Cole Walker

ESP Partner

cole@energy-surety.com

Why Do We Need Storage?

Load Side



Grid Side



What Makes Storage Viable?

- Model Features:
 - Who Owns the Risk?
 - Bankability
 - Cost Effectiveness
 - Past Performance
 - How Do You Select the Technology?
 - Match the Application
 - How Do you Value the Application?
 - Safe and Reliable
 - Environmental “Product Life Cycle”
 - Experience



Final Thoughts

Every Project Is Different
Choose Your Technology Wisely
Pick the Right Partner

Cole Walker
ESP Partner
cole@energy-surety.com