Clean Energy States Alliance

Smart Grid, Grid Integration, Storage and Renewable Energy

Tom Stepien, Primus Power

Malcolm Metcalfe, ENBALA Power Networks

Hosted by
Todd Olinsky-Paul
CESA Project Director
May 16, 2013

CleanEnergy States Alliance

Housekeeping

- All participants will be in listen-only mode throughout the broadcast.
- You can connect to the audio portion of the webinar using your computer's speakers or a headset. You can also connect by telephone. If by phone, please expand the Audio section of the webinar console to select "Telephone" to see and enter the PIN number shown on there 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 presentations.
- This webinar is being recorded and will be made available after the call on the CESA website at

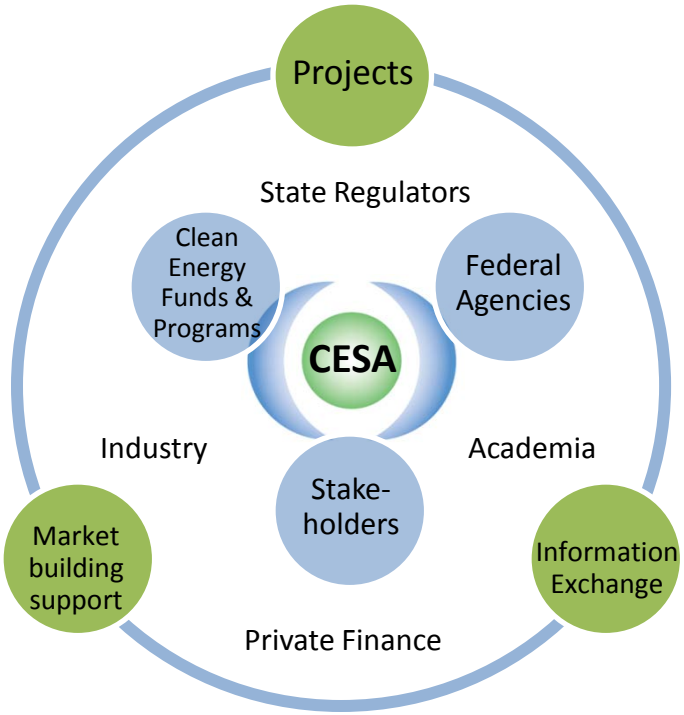
www.cleanenergystates.org/events/

About CESA

Clean Energy States Alliance (CESA) is a national nonprofit organization dedicated to advancing state and local efforts to implement smart clean energy policies, programs, technology innovation, and financing tools to drive increased investment and market making for clean energy technologies.

What We Do

- Multi-state coalition of clean energy programs cooperating and learning from each other, leveraging federal resources
- Members have supported nearly 130,000 renewable energy projects from 1998-2011 with state-based dollars
- Nonpartisan, experimental, collaborative network
  - Information exchange & analysis
  - Partnership development
  - CESA projects: solar, wind, RPS, fuel cells, energy storage, program evaluation, national database



Contact Info

Todd Olinsky-Paul
Project Director
Clean Energy States Alliance
Email: Todd@cleanegroup.org
Phone: 802-223-2554

www.cleanenergystates.org

Malcolm Metcalfe
Founder and CTO
ENBALA Power Networks

Tel: **(604) 788-4004**
Email: **mmetcalfe@enbala.com**

URL: **www.enbala.com**

PRIMUS POWER

Primus Power
3967 Trust Way
Hayward, CA 94545
USA
Phone: +1.510.342.7602

Tom.Stepien@primuspower.com

Energy Storage

Tom Stepien
Primus Power

Clean Energy States Alliance Webinar: Smart Grid, Grid Integration, Storage and Renewable Energy

May 16, 2013

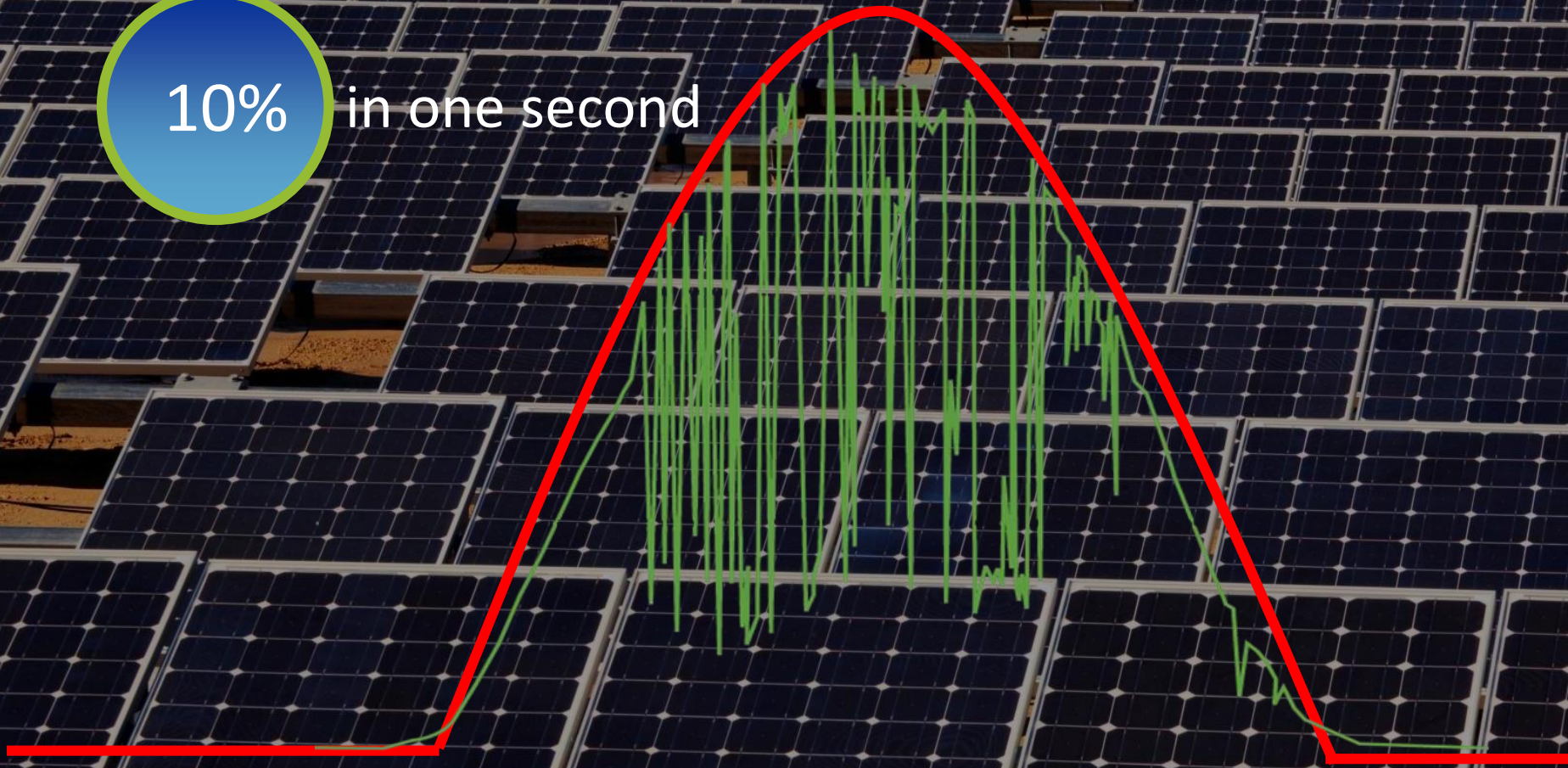
Topics today

- Energy storage introduction
- Real world examples of storage applications
- Energy storage technologies

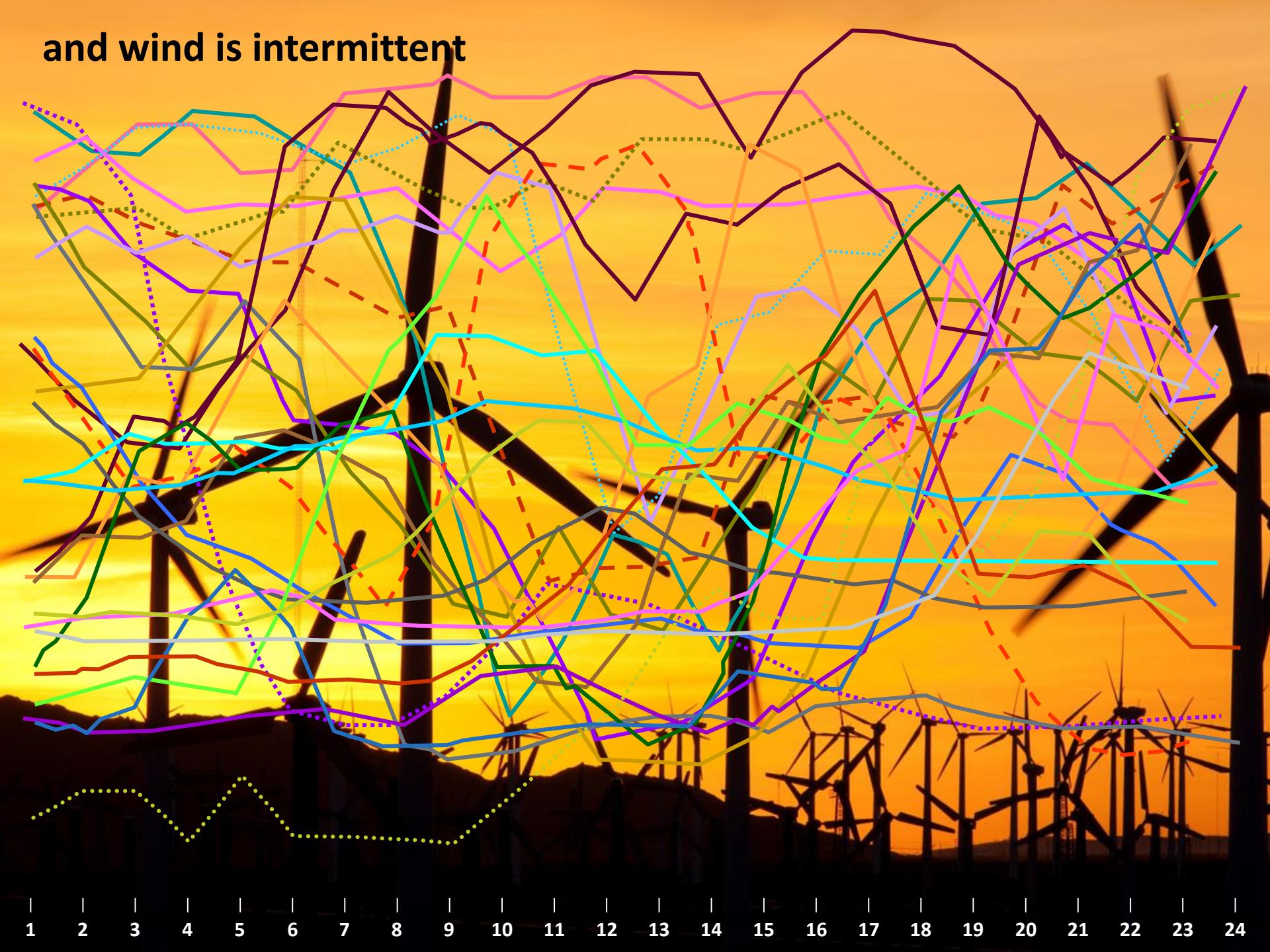
Electricity supply must always in balance with demand

Renewables are great but … solar is affected by clouds

10% in one second

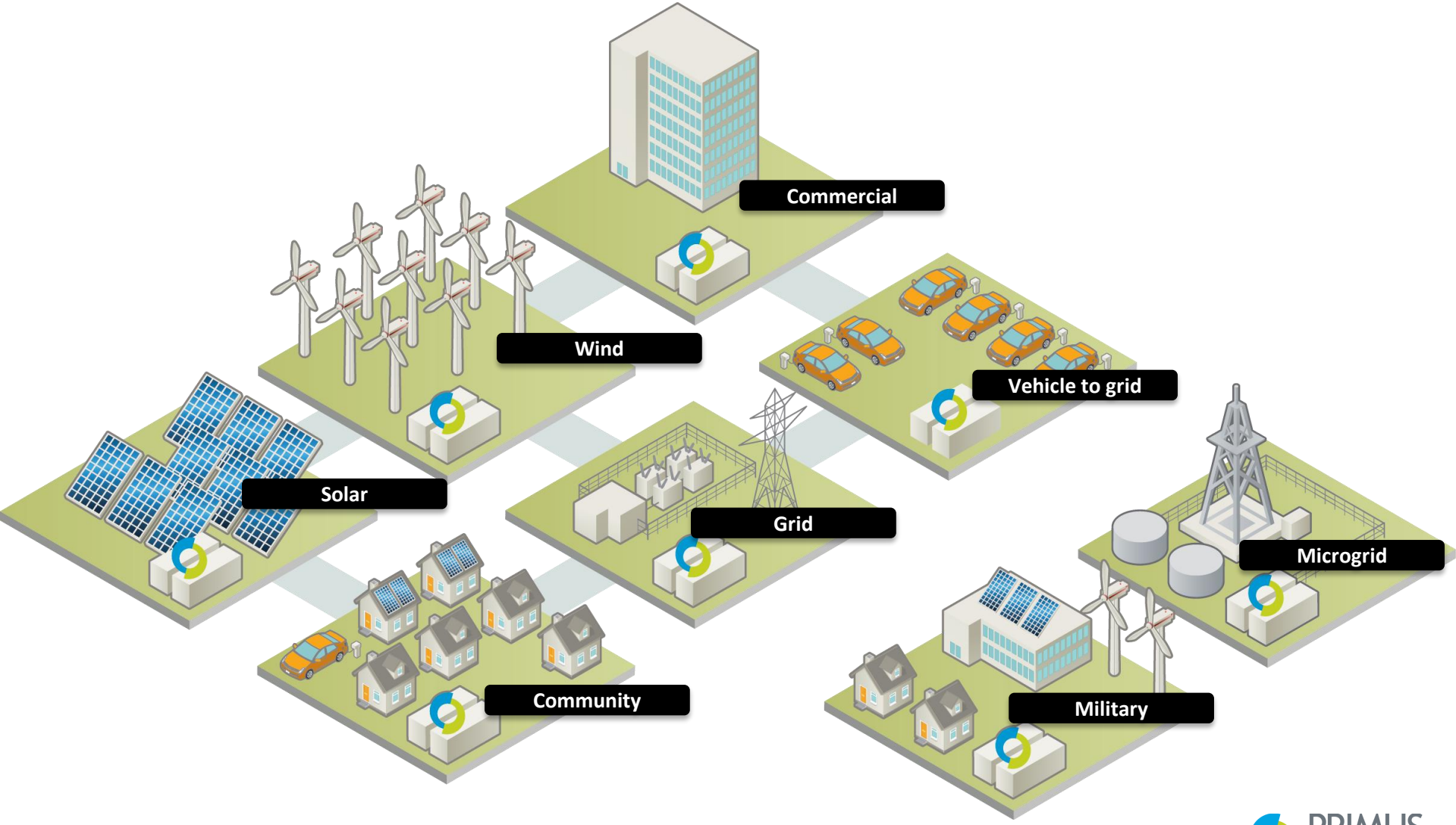


and wind is intermittent



We need assets that allow us to decouple demand from supply

Energy storage decouples instantaneous electricity supply from demand and improves the economics, environmental footprint and reliability of the entire power system



PRIMUS POWER

Topics today

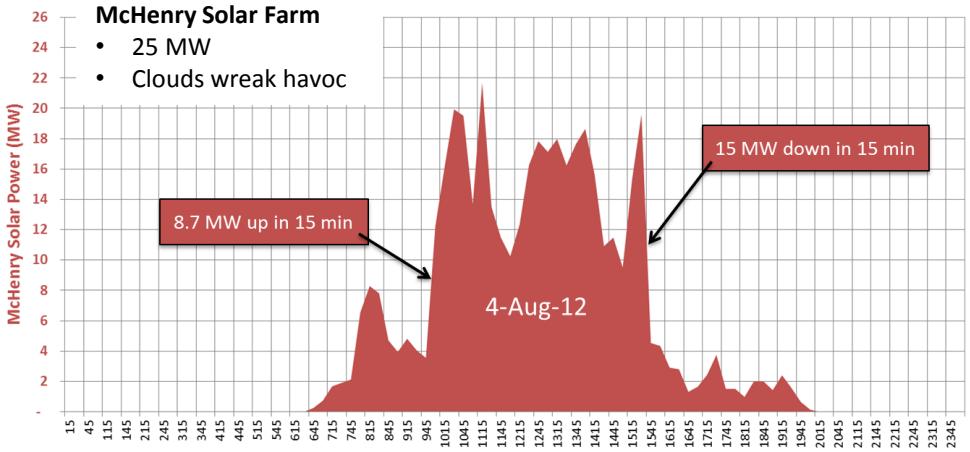
- Energy storage introduction
- Real world examples of storage applications
- Energy storage technologies

PRIMUS POWER

Modesto needs generation flexibility to integrate renewable energy and improve operating costs

Modesto Irrigation District key pain points

- Intermittent solar
- Premium paid for firmed wind
- Pending $50M coal plant upgrade
- 4 years for semi-flexible thermal generation



Woodland 3 Thermal Generation

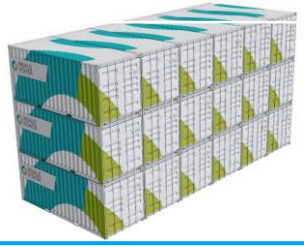
- 4 years start to finish
- 2 acres, new building & road

San Juan Coal

- $50M to meet EPA upgrades
- Upgrade or invest in storage?

PRIMUS POWER

Energy storage systems are a cheaper, cleaner and faster to install alternative to traditional thermal generation

	Natural Gas Reciprocating Engines	Primus Power EnergyPods™
		
Firming range (MW)	4 to 50	-25 to 25
Capital cost	$78 M via Bond	$50 M thru OpEx
Permanent fulltime staff	4	0-1
Time to full power (sec)	300	5
Water use (liters)	66,000	0
Natural gas (mmBTU)	2,900,000	0
Pollutants (metric tons)	20 NOx, 72 CO, 72 VOC	0
CO_2 emissions (metric tons)	66,000	0
Sound (dB)	95 (jackhammer)	30 (whisper)
Permit and install time (months)	36 to 54	2 to 4
Area (acre)	1	¼

10 Annual data, based on 35 MW average use. EnergyPods are charged with renewable solar and wind energy.

PRIMUS POWER

230 kW PV array at Marine Corps Air Station in Miramar, California

Marine Corps Air Station Miramar

- Flight training and operations
- Peak load in summer afternoon: 14 MW
- 7 MW average, 5 MW minimum

PRIMUS POWER

THE SAN DIEGO U-T UNION-TRIBUNE

FRIDAY SEPTEMBER 9, 2011 92¢

- **Massive outage:** 1.4 million SDG&E customers powerless
- **The cause:** Failure in Arizona triggered cascade of events
- **No school:** All county public schools are closed today
- **Water worries:** City issues boil-water order in some areas
- **What's next:** Power to be restored in waves into Saturday

Darkness envelops downtown San Diego as the region endures Thursday's massive power outage, which began at 3:38 p.m. SEAN M. HAFFEY - U-T

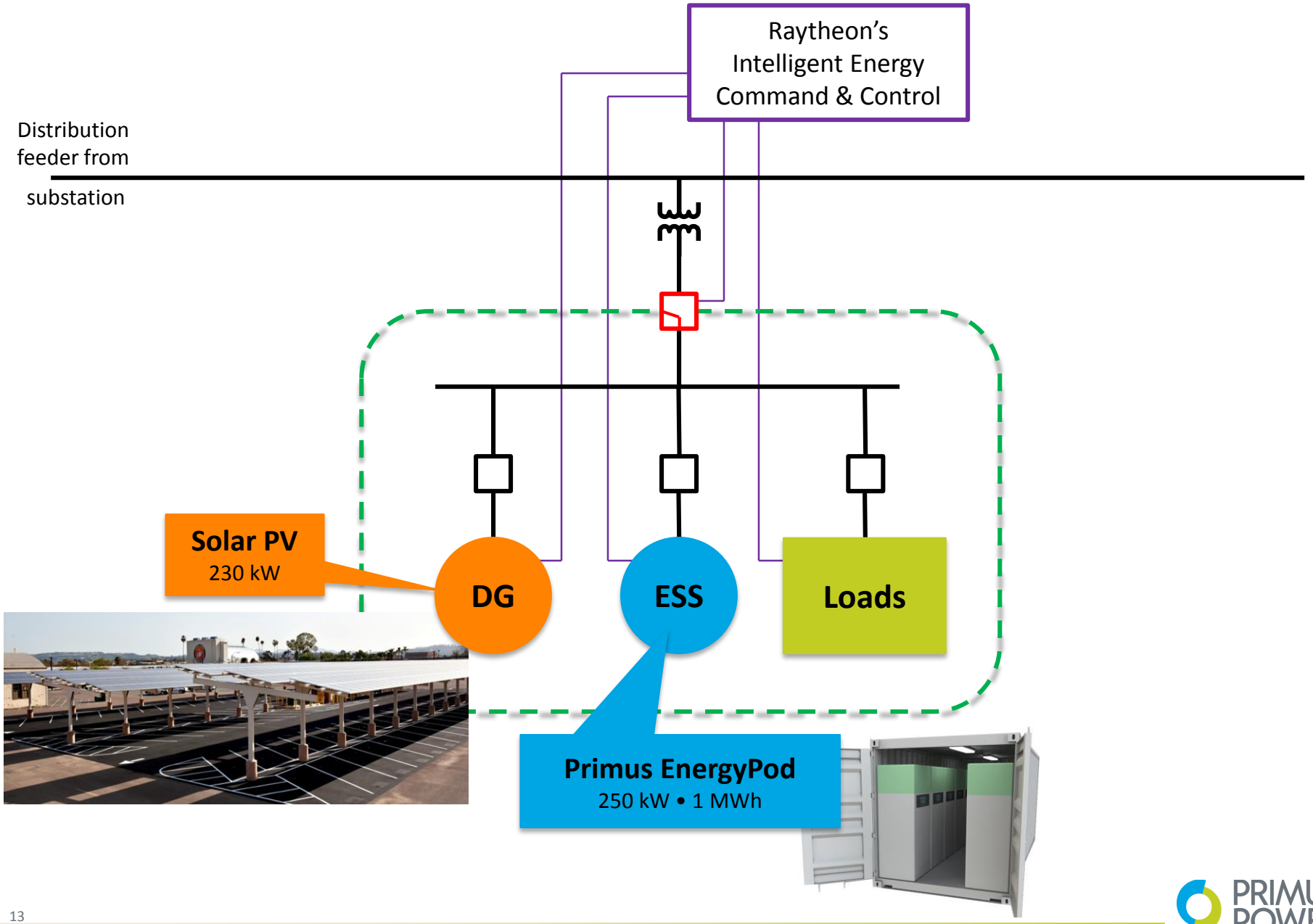
BLACKOUT

OUTAGE CALLED 'UNPRECEDENTED'

2 MAIN LINKS TO REGION ARE CUT

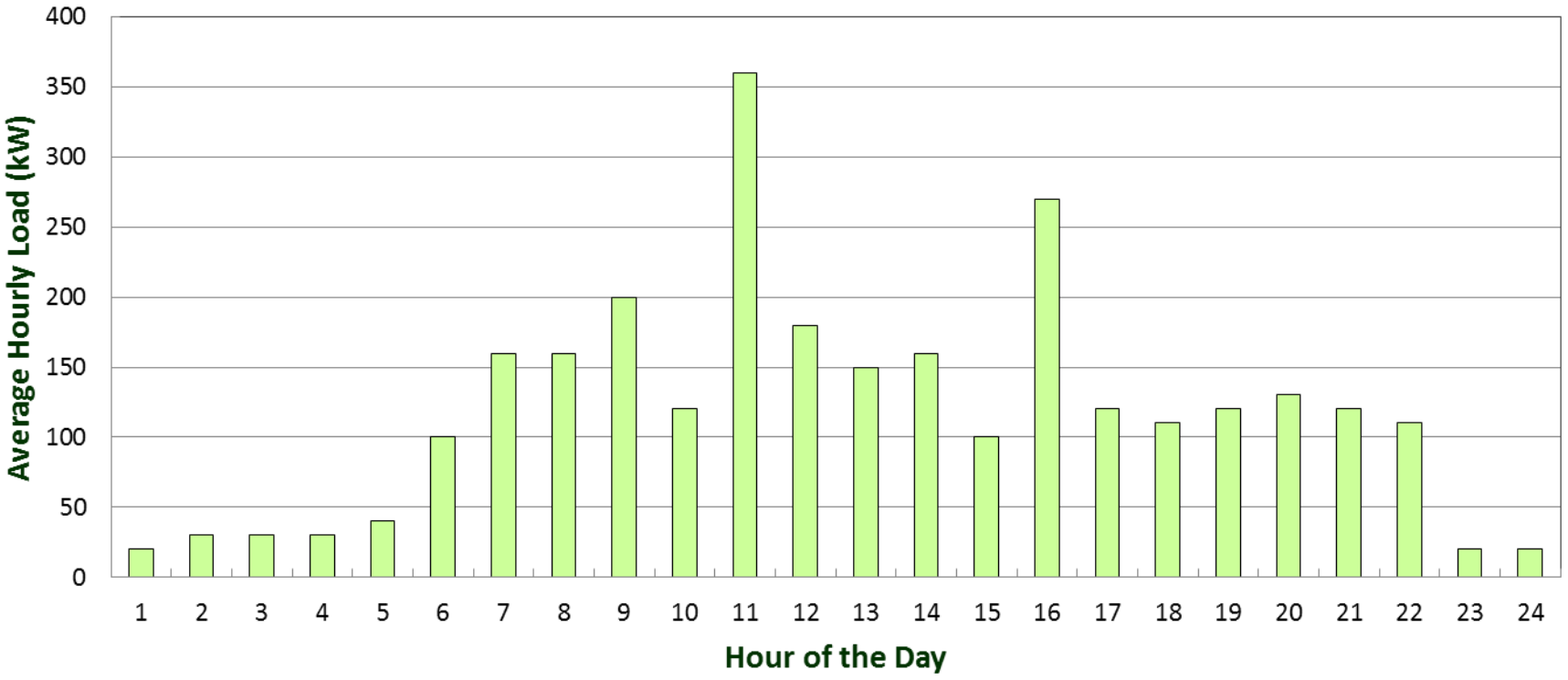
PRIMUS POWER

Miramar's microgrid components



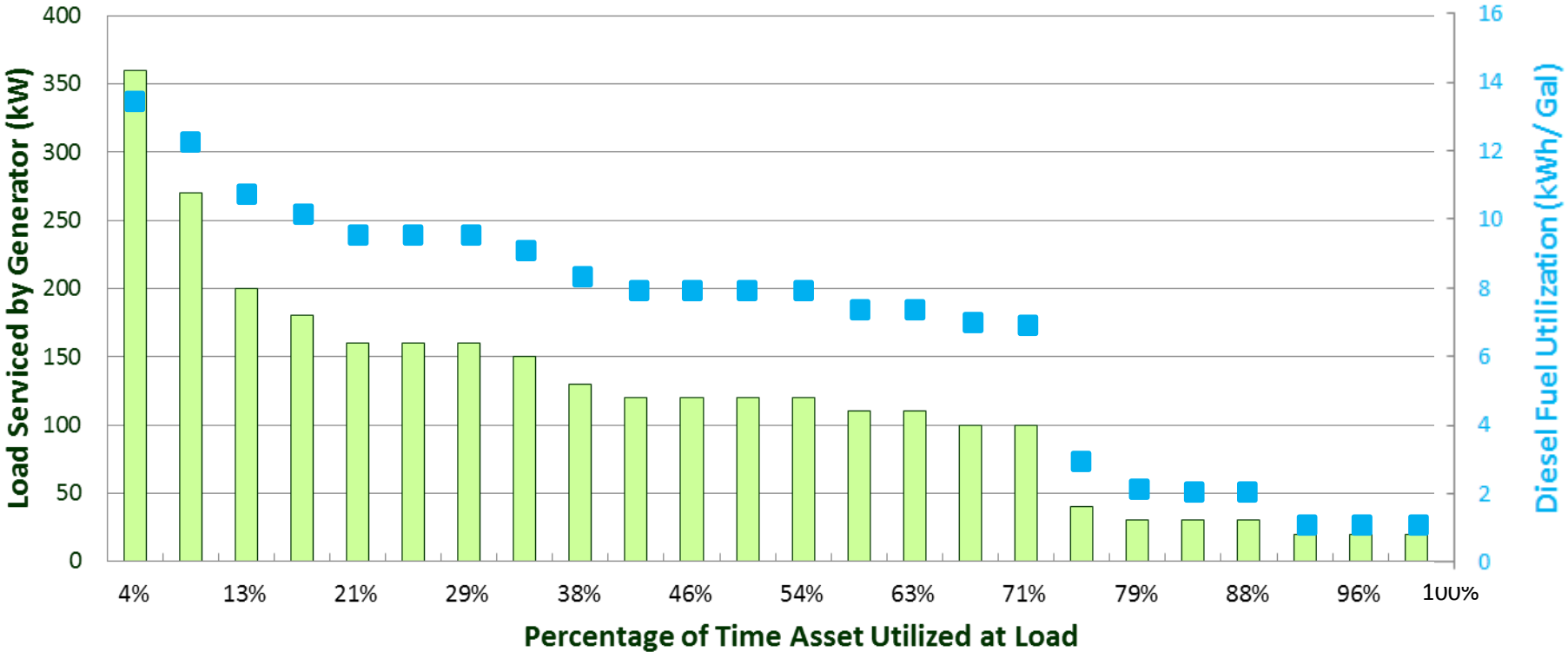
PRIMUS POWER

Off-grid and islands typically use diesel generators for electricity



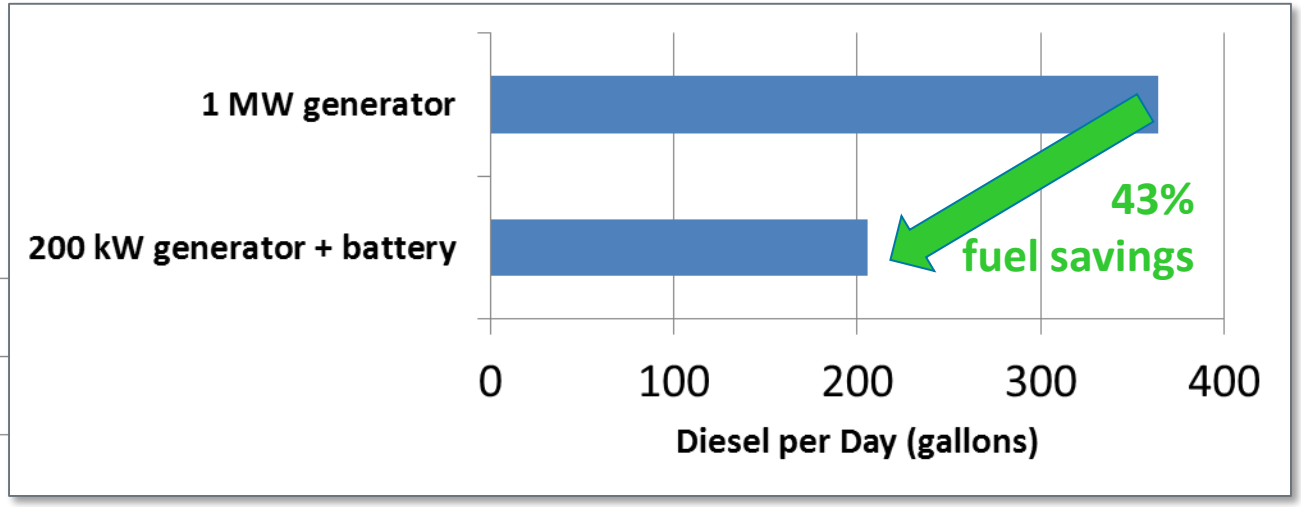
PRIMUS POWER

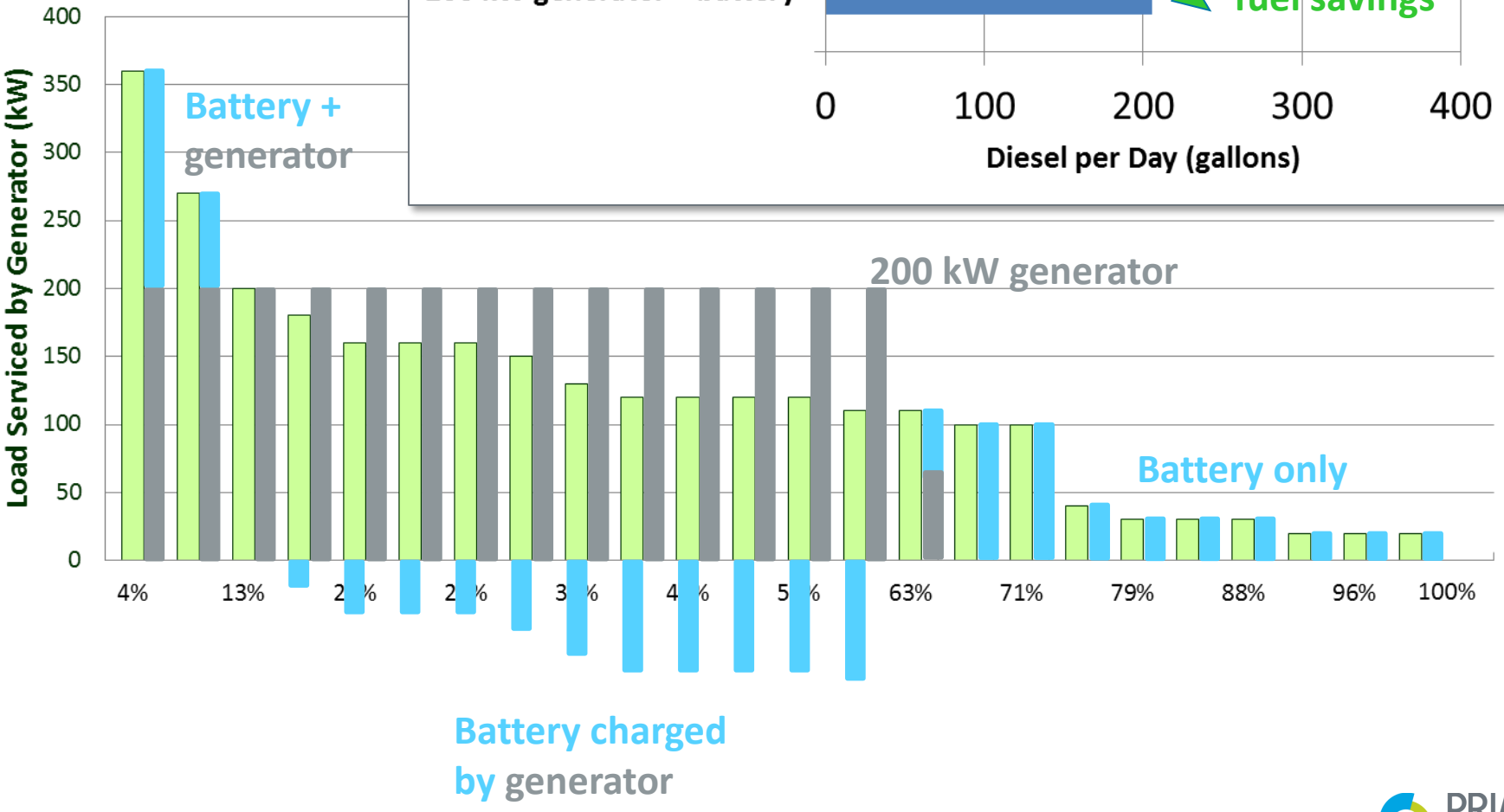
Generators are usually not operated at peak efficiency



PRIMUS POWER

An energy storage system with a smaller generator can save >40% fuel





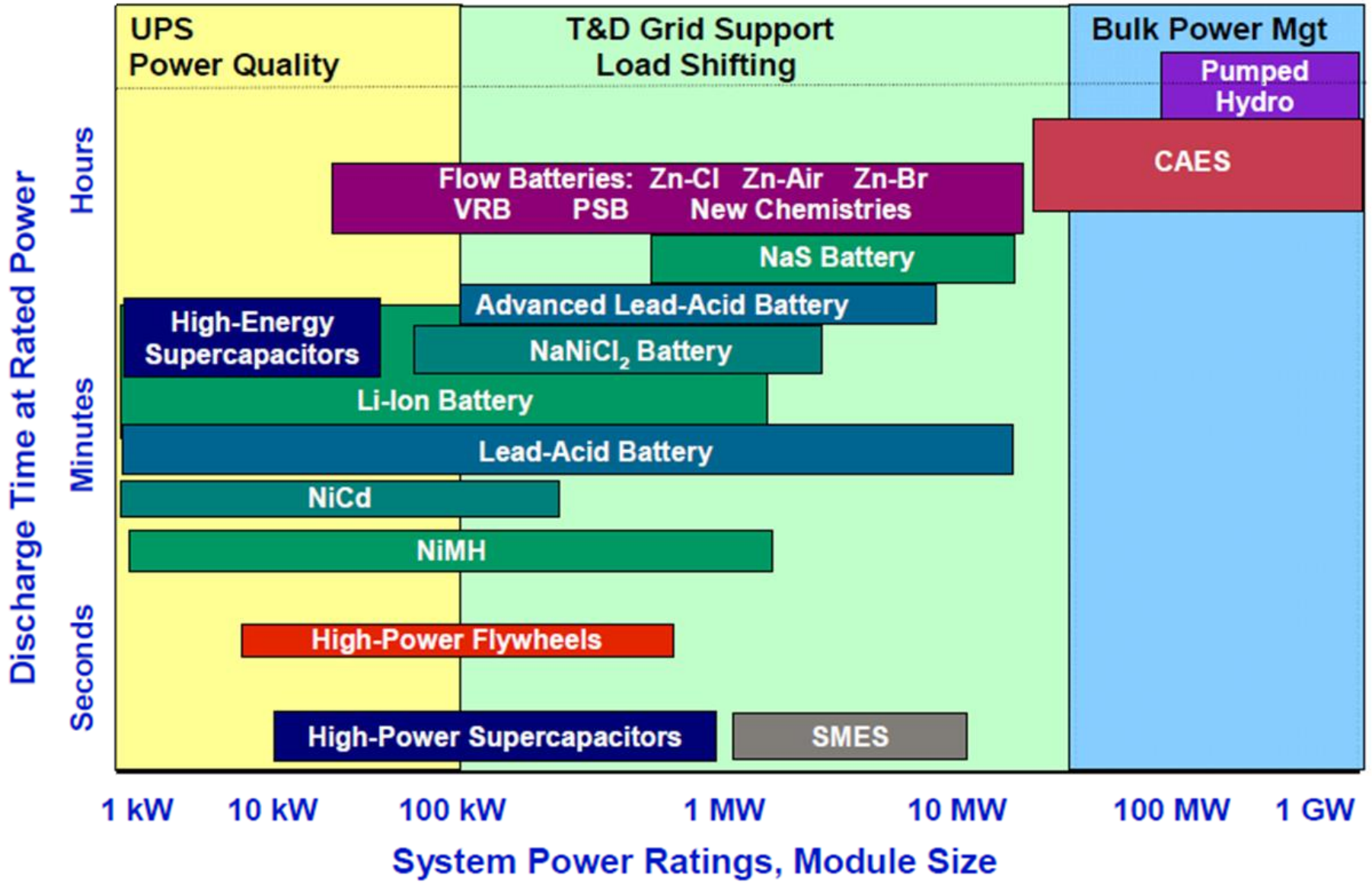
PRIMUS POWER

Topics today

- Energy storage introduction
- Real world examples of storage applications
- Energy storage technologies

PRIMUS POWER

Several technologies can be used to store electrical energy



PRIMUS POWER

Energy storage selection criteria

1. Safety!
2. Performance factors
3. Cost
4. Reliability
5. System characteristics

Energy storage selection criteria

1. Safety!
2. Performance factors
3. Cost
4. Reliability
5. System characteristics

Exploding Sodium Sulfur Batteries From NGK Energy Storage

Exploding—and not in the good way. An emerging market faces growing pains as renewables address the globe's largest challenge.

ERIC WESOFF: NOVEMBER 1, 2011

Xtreme Power works to rebuild warehouse after fire in Hawaii

Posted by Kim Hilsenbeck on Aug 22nd, 2012 and filed under Business, Kyle.

Xtreme Power, headquartered in Kyle, is working with Hawaii's First Wind to repair a 10,000 square-foot battery warehouse after a fire destroyed the facility at a wind farm on the north shore of Oahu earlier this month, according to Greg Vistica, Xtreme Power spokesperson. (Courtesy Photo)

arabian Business.com

EDITION: INT'L | YOU ARE NOT LOGGED IN: SERVICES | LANGUAGE: بالعربية

Home | GCC | World | Industries | Markets | Opinion | Interviews | Photos | Vide

Banking & Finance | Construction | Education | Energy | Healthcare | Media | Real Estate | Retail | Techno

Lithium batteries blamed for fatal UPS plane crash

ARTICLE | PHOTOS

By Claire Ferris-Lay Monday, 4 April 2011 9:52 AM

FACEBOOK | TWITTER | SHARE | EMAIL | PRINT

Lithium batteries onboard a UPS plane that crashed in Dubai last year should have been declared hazardous cargo, a report by the UAE's civil aviation authority said.

CRASH SITE: Emergency services attend the site of the UPS cargo plane which crashed in an unpopulated area of Dubai. (ITP Images)

The Boeing 747 was carrying flammable batteries that were "distributed throughout the cargo decks" while "lithium ion battery packs" should have been singled out and handled as hazardous cargo, newswire UKPA said, citing the report.

PRIMUS POWER

Energy storage selection criteria

1. Safety!
2. Performance factors
3. Cost
4. Reliability
5. System characteristics

Performance: Power
- Power input and output rate
- Precision of power output matching request
- Steadiness of power output over duration
- Partial power range

Duration: total energy storage capability
- Roundtrip efficiency
- Ability to pause charge or discharge
- Reversing state of charge (SOC)
- Accurate SOC estimation
- Self-discharge rate
- Need for strip or refresh cycles

Power ramp rate
- Time from “sleep” to “ready”
- Time from charge to discharge reversal

Energy storage selection criteria

1. Safety!
2. Performance factors
3. Cost
4. Reliability
5. System characteristics

Reliability
- Mechanical design
- Chemistry maturity
- System architecture
- …

Initial Capital Cost
- Batteries
- Support systems: power electronics, thermal mgt
- Site preparation
- Installation
- Commissioning

Operating & Maintenance Cost
- Fuel: electricity to charge battery
- Maintenance: preventative
- Maintenance: corrective
- Replacement of subsystems
- …

PRIMUS POWER

Energy storage selection criteria

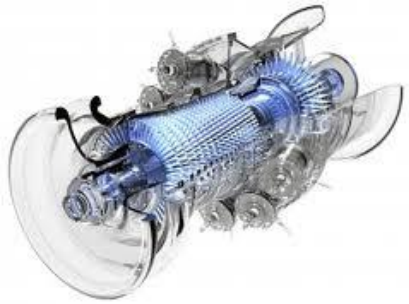
1. Safety!
2. Performance factors
3. Cost
4. Reliability
5. System characteristics

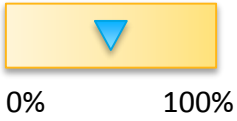
- Modularity
- Transportability
- Ease of installation
- Mobility - after initial installation
- Footprint
- Emissions / noise
- …

PRIMUS POWER

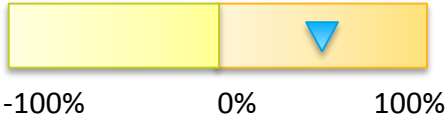
Storage is more than just time shifting energy

Thermal Generation





Storage

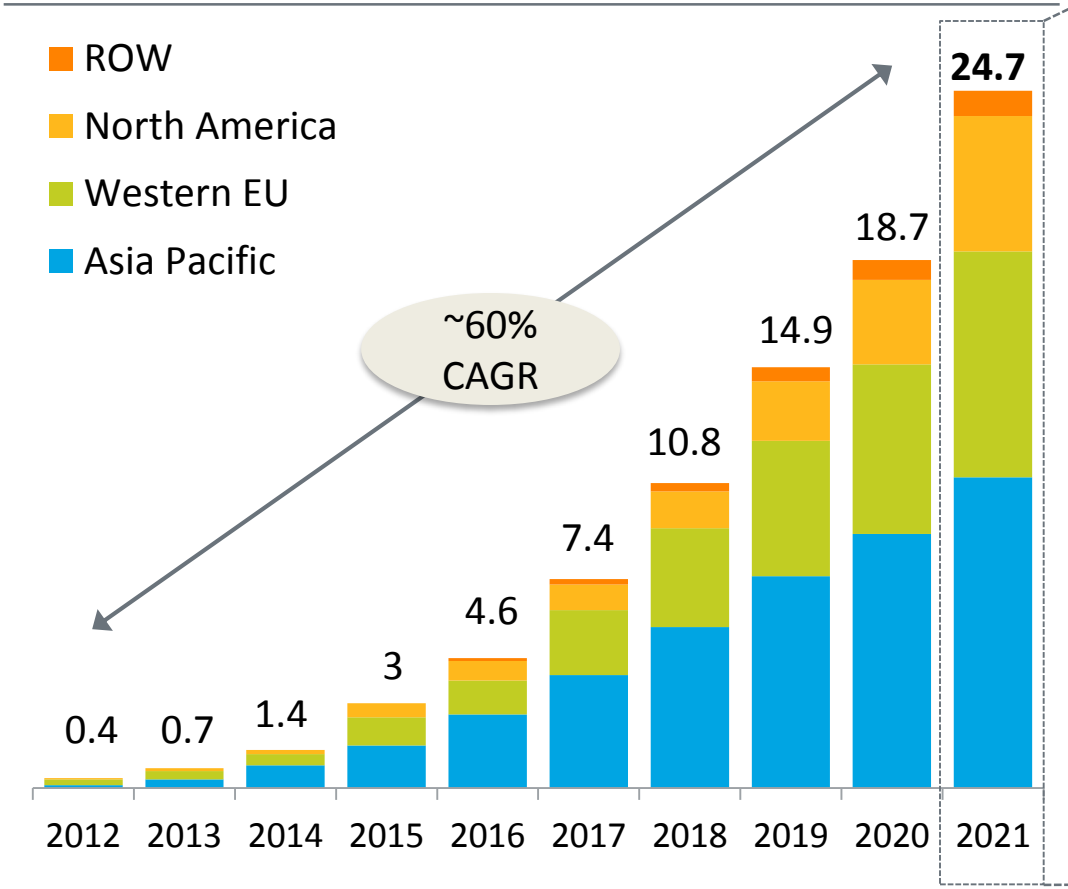


- Highly differentiated generation
- Storage has valuable characteristics when constraints preclude conventional solutions

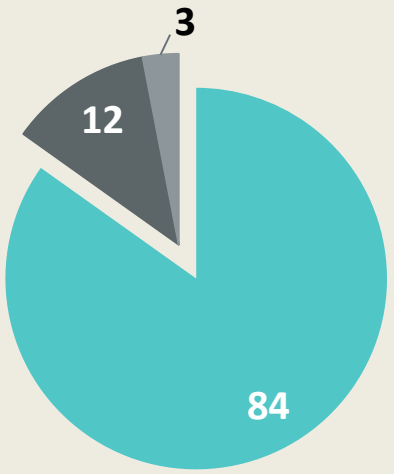
PRIMUS POWER

Stationary energy storage is a large and fast growing market

Estimated size of grid scale energy storage by region
$B, 2012-2021



Storage applications
%, 2021 100% = $24.7 B



- Bulk storage (2-4 hr)
- Short duration (<1 hr)
- Community/Residential (4-6 hr)

 Source: Pike Research/Navigant Consulting, Primus internal research

PRIMUS POWER

Energy

THE JOURNAL REPORT

5 TECHNOLOGIES THAT COULD CHANGE EVERYTHING

PAGE R4

RENEWABLE-ENERGY STORAGE

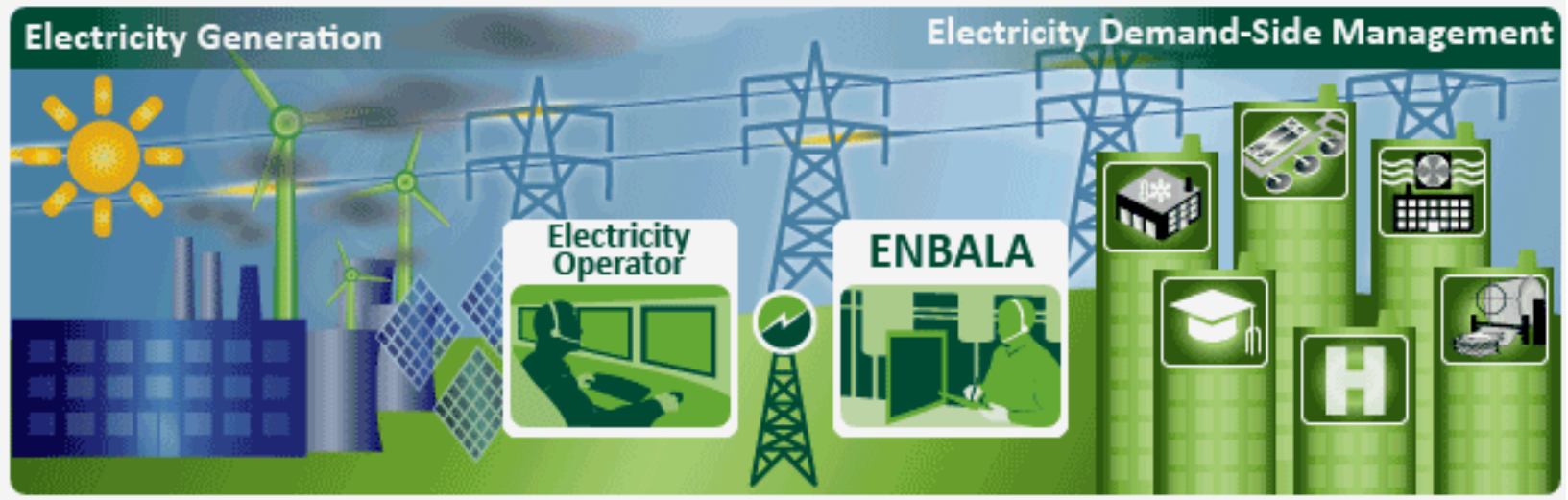
Thank you

tom.stepien@primuspower.com

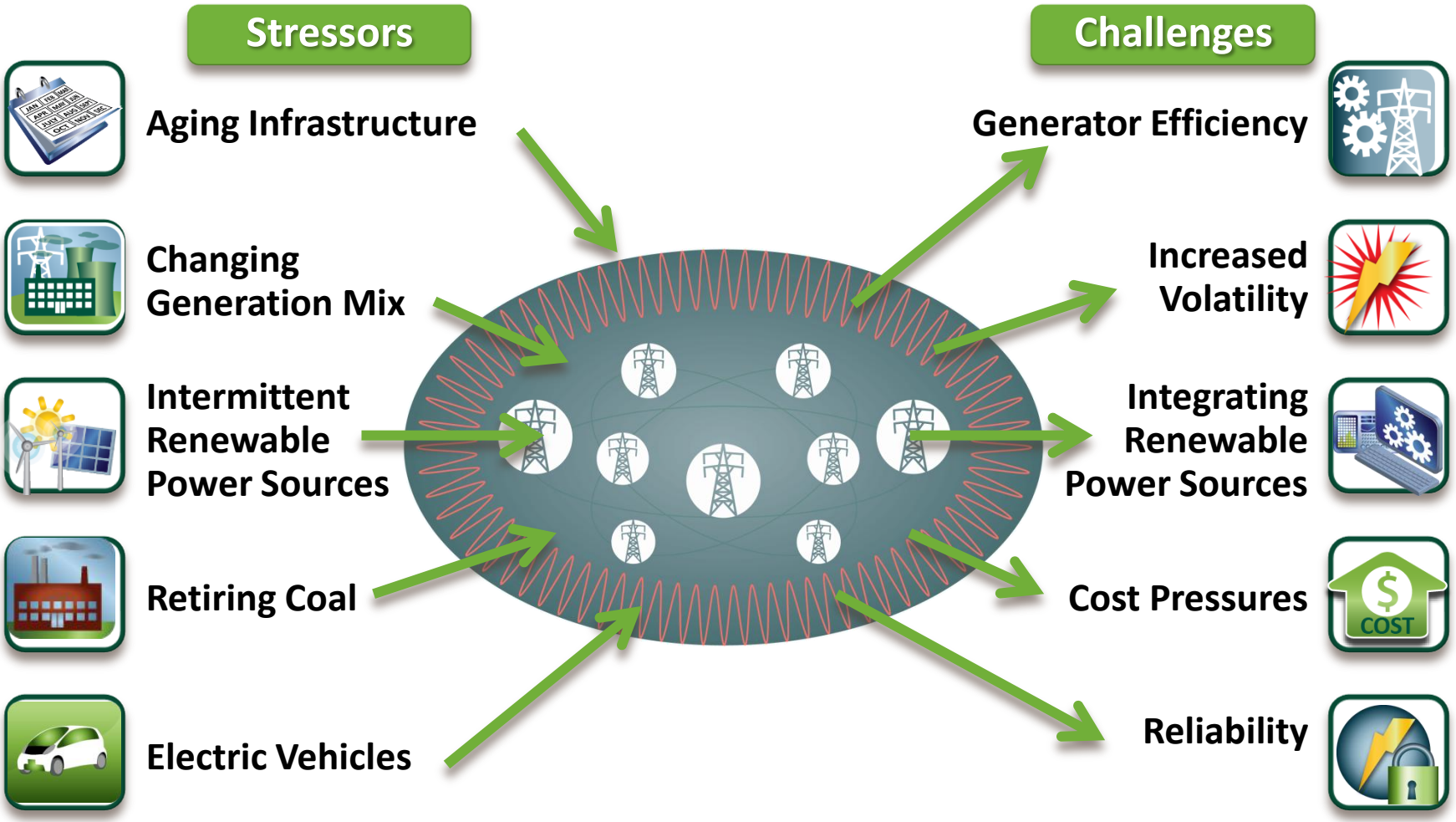
enbala POWER NETWORKS®

Intelligently Balancing Supply with Demand through Continuously Connected Customers

Spring 2013



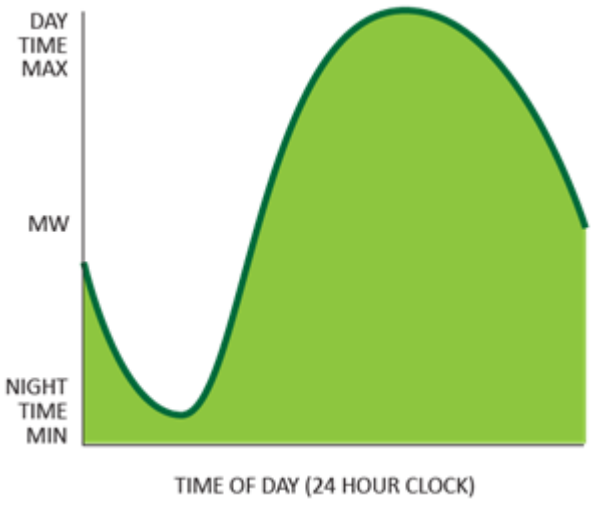
Electricity Industry is in Transformation



enbala POWER NETWORKS

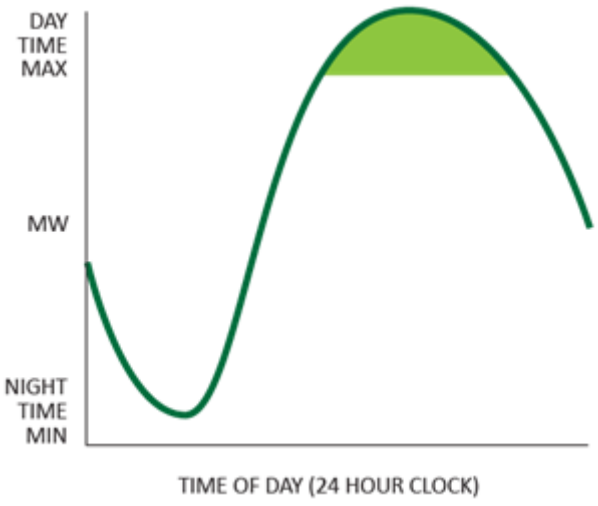
The Power System Needs Real-time Flexibility

Continuous delivery of electricity



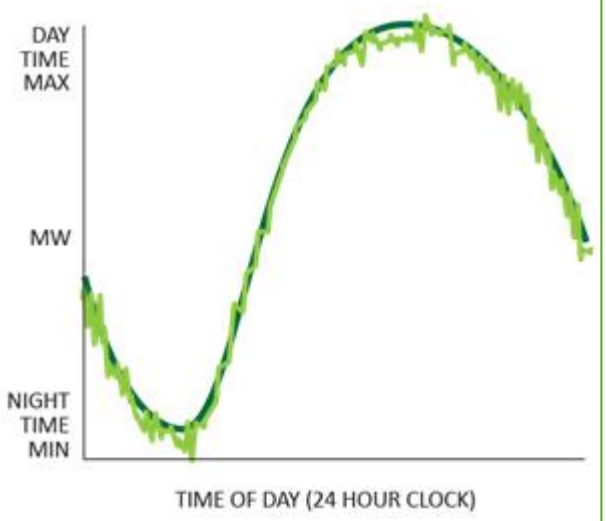
ENERGY

Ability to meet peak requirement



CAPACITY

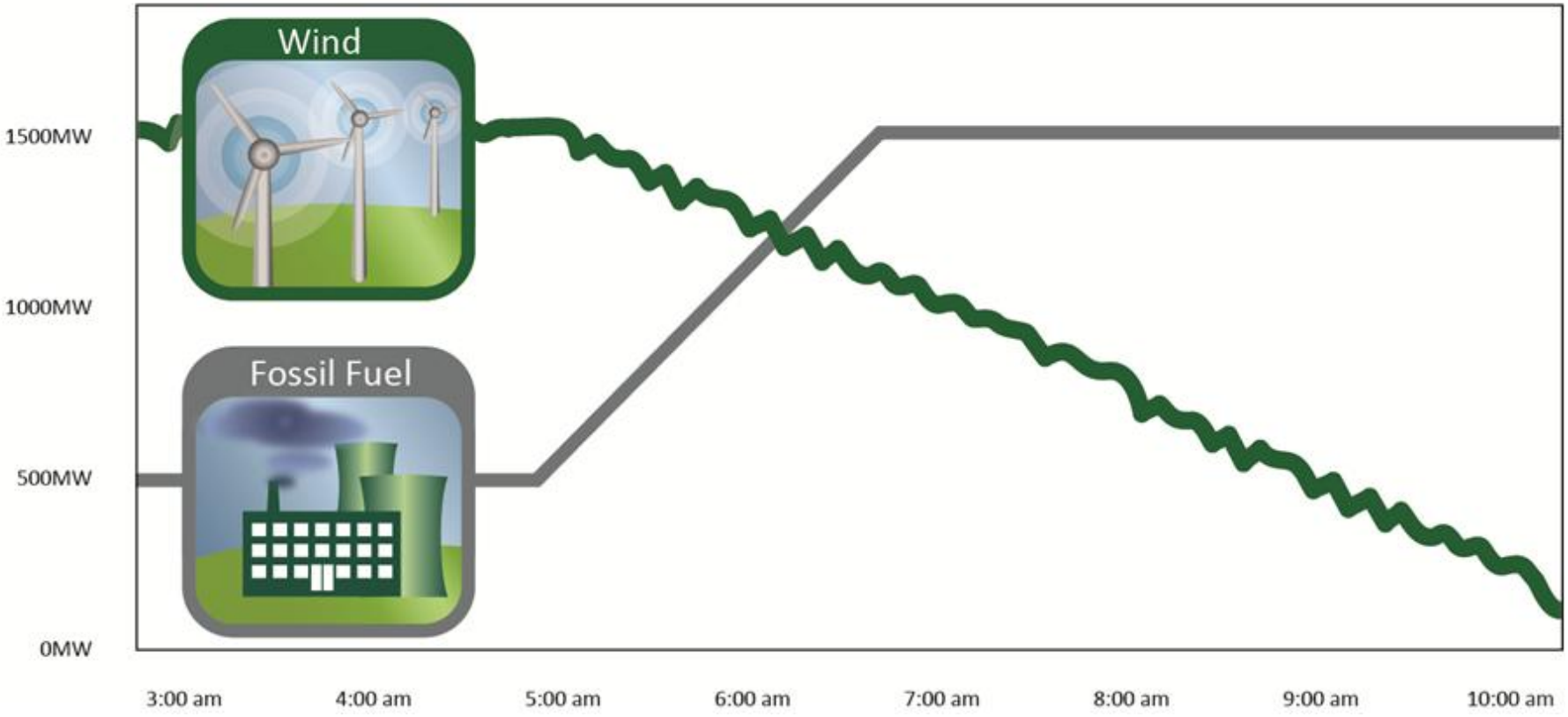
Ability to continually match supply & demand (& manage intermittent generation)



FLEXIBILITY

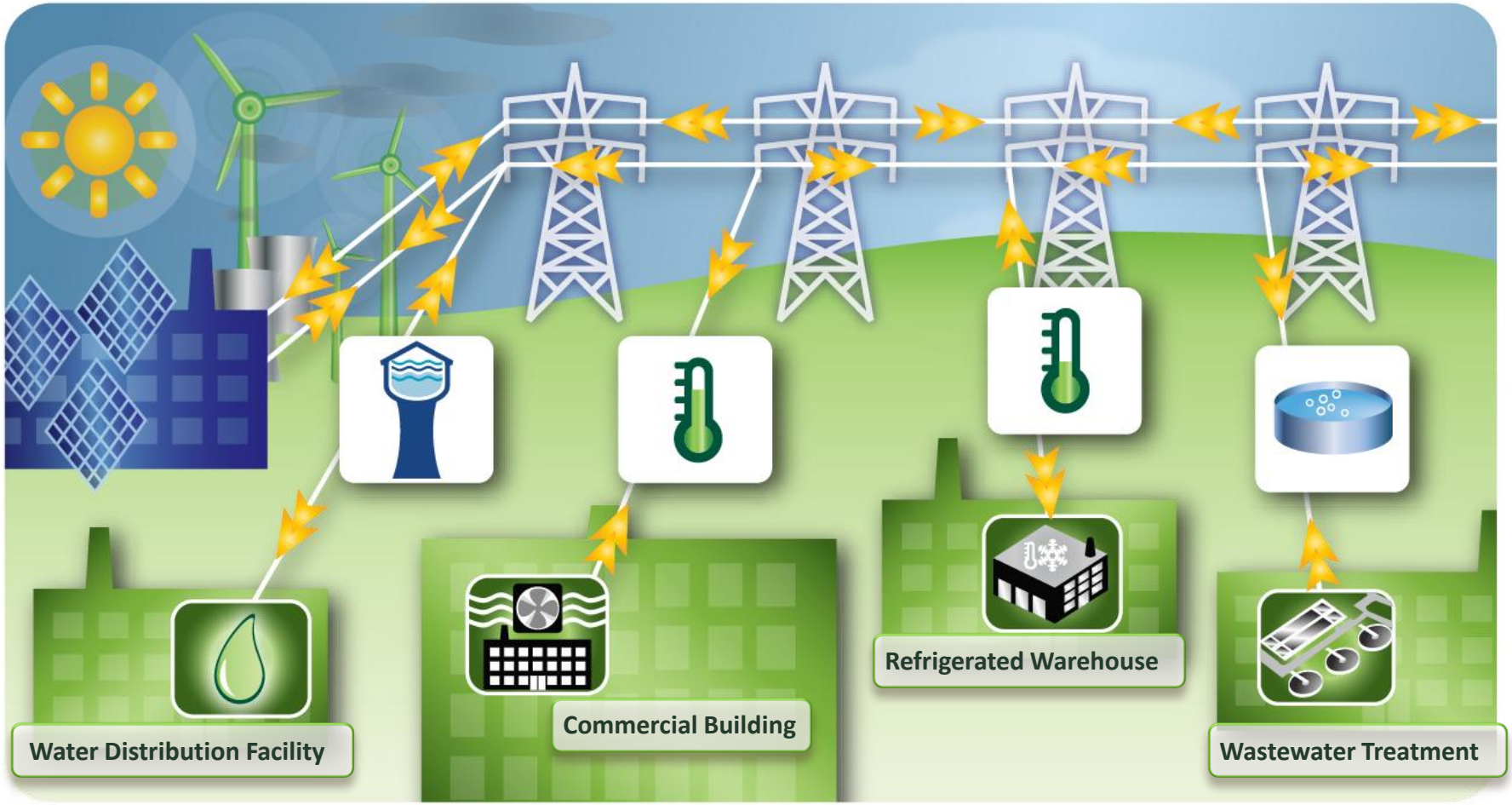
enbala POWER NETWORKS

Traditional Approach to Wind Integration



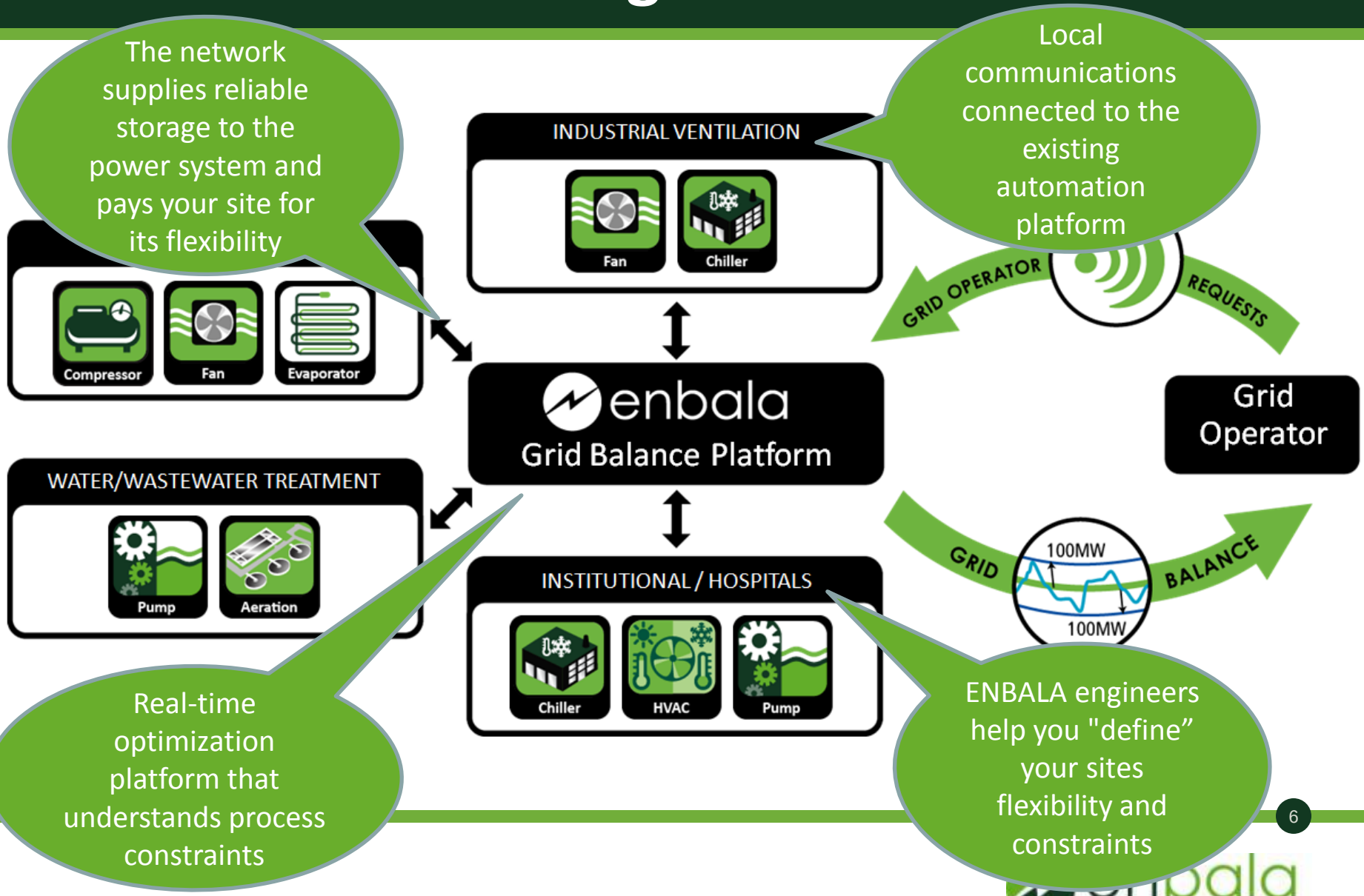
enbala POWER NETWORKS

Inherent Process Storage in Existing Assets



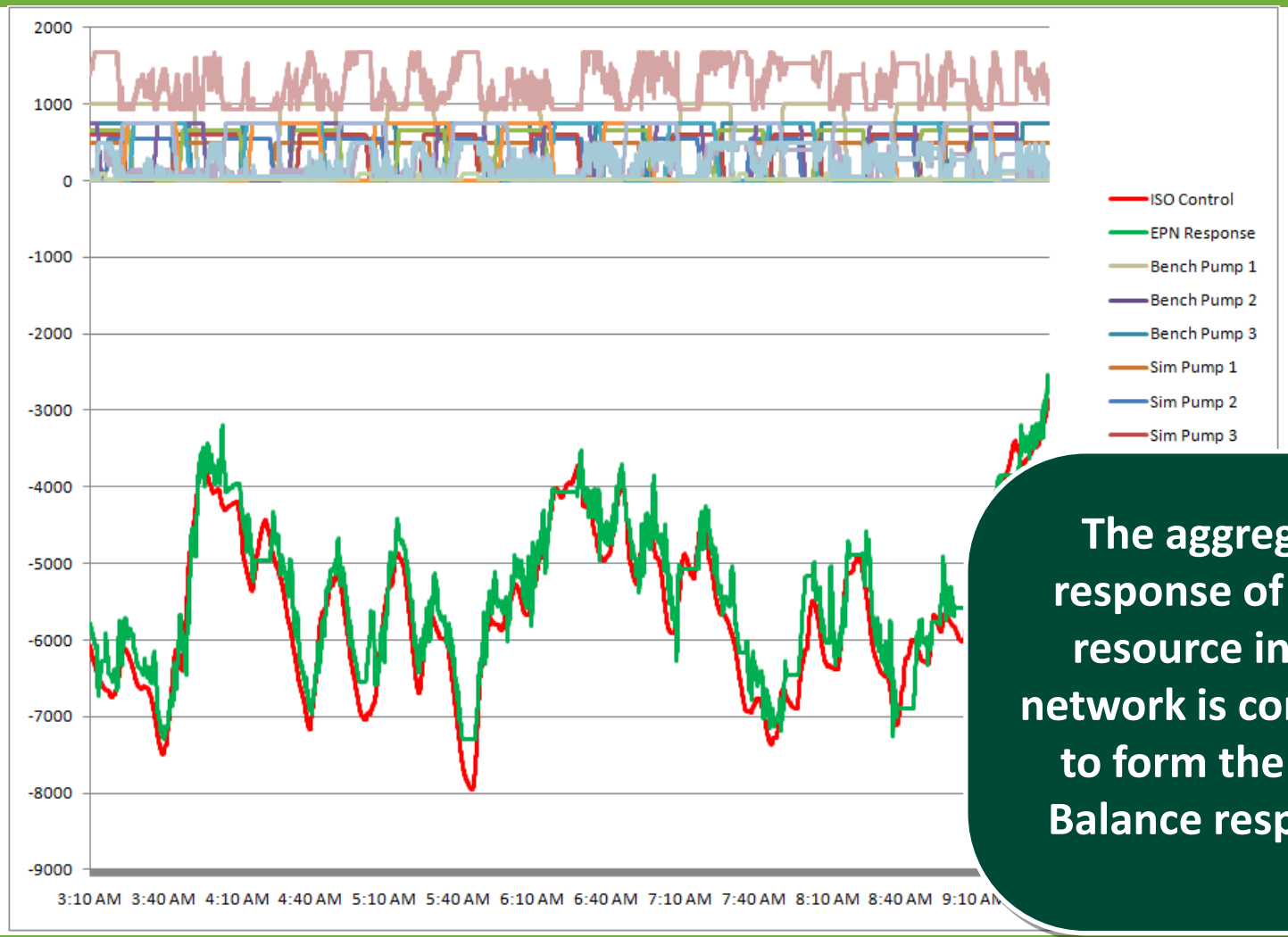
1. Storage already exists in the power system
2. Storage in industrial systems and processes provides flexibility in consumption
3. We only have to connect and manage this storage

Customers Connecting to the Grid



enbala POWER NETWORKS

Network Load Response

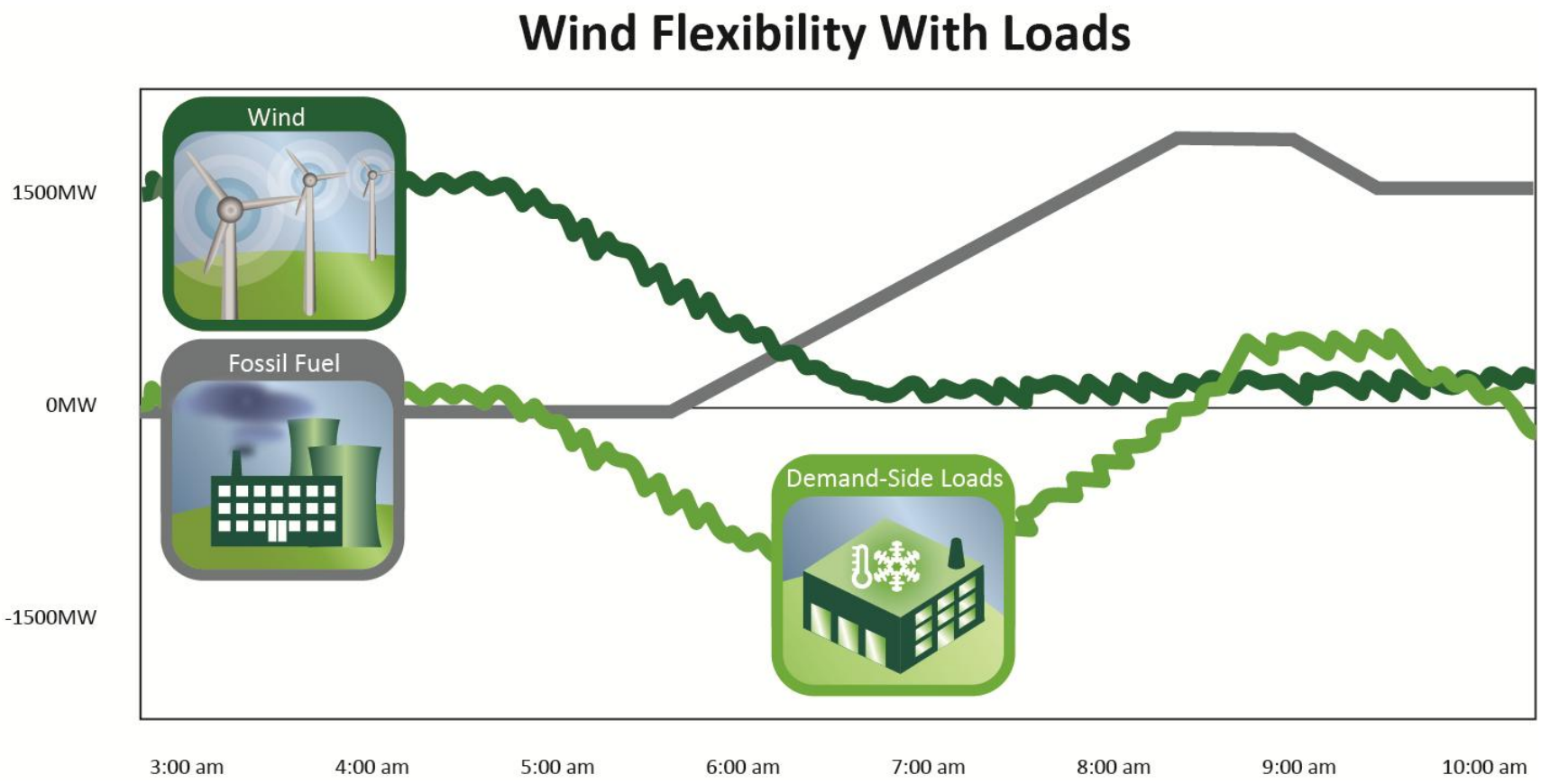


The aggregate response of each resource in the network is compiled to form the Grid Balance response

BACK

enbala POWER NETWORKS

Much Better Approach to Integrating Wind



enbala POWER NETWORKS

Application for the Power System

Grid Balance® Platform

Grid-Scale Applications

Supply/Demand Optimization

Improve the overall efficiency of the generation fleet and reduce O&M costs.

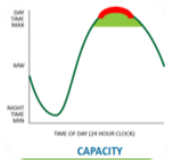
Wind Integration

Provide the reliable integration of distributed generation, supporting a green grid.

Frequency Regulation

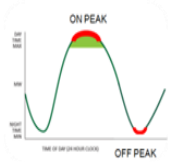
Engaging demand-side loads to provide frequency regulation.

Distribution-Scale Applications



Dynamically Optimized DR

Permission based demand response that allows load to participate on its terms.



Load Shifting

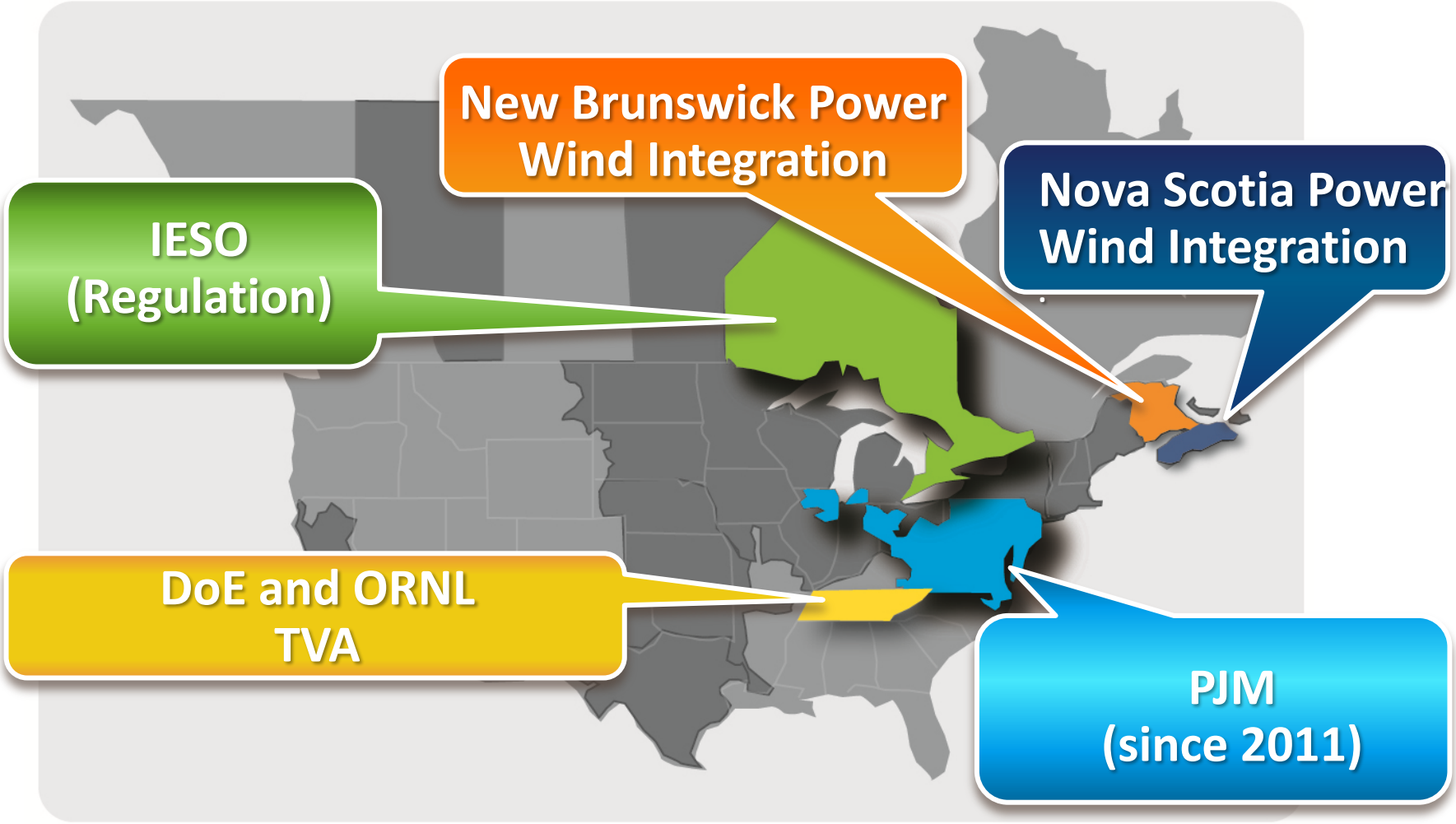
Using inherent process storage to intelligently shift energy consumption that allows load to specify level of impact.

Customer Engagement

Enhanced, bi-directional communication and information exchange that provides deeper understanding and relationship between the customer and their utility.

enbala POWER NETWORKS

Proven Technology in the Market Now



enbala POWER NETWORKS

Why is this Important?

Flexibility is important to the power system to deliver:

- An efficient way to balance supply and demand
- Integrate renewable generation
- Improve efficiency of existing generation assets

Customer Engagement

- Enhance customer satisfaction through operational efficiency and insight to provide more detailed information to the Utility for program design and deliver operational efficiency in real-time

Reduce greenhouse gas emissions

- Demonstrate corporate responsibility

enbala POWER NETWORKS

Thank You

Malcolm Metcalfe
Founder and CTO
ENBALA Power Networks

Tel: **(604) 788-4004**
Email: **mmetcalfe@enbala.com**

URL: **www.enbala.com**