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www.ViridityEnergy.com

Dynamic Load Control and the Smart Grid in NYC
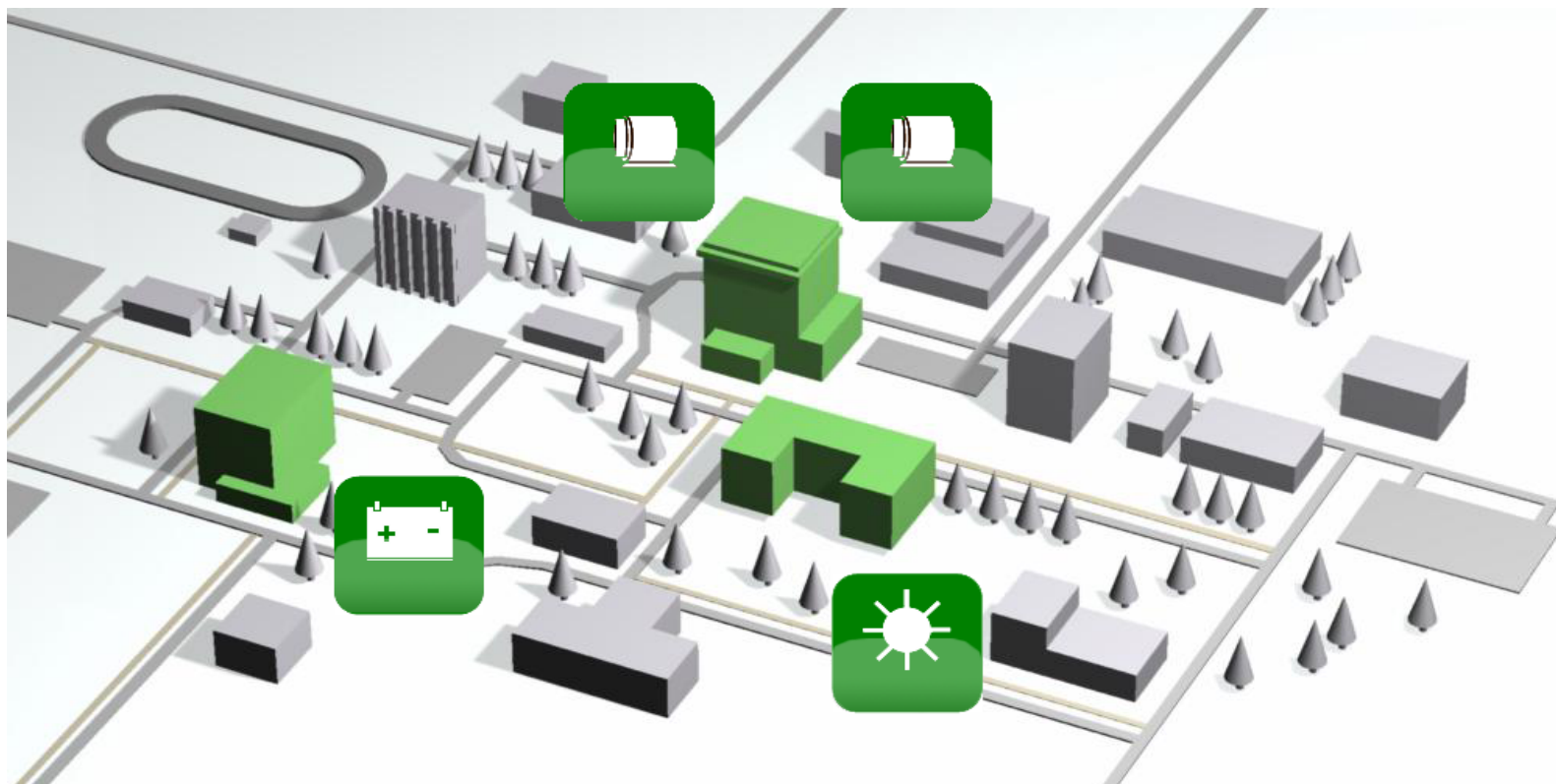
Allen M. Freifeld

Viridity Energy, Inc.

443.878.7155

Converting Load Control into Energy Assets

Earning a Revenue Stream and Cutting Costs by Managing and Curtailing Load.

And Doing Good at the Same Time.

Electric Pro-sumer
Definition

pro-sum-er │prō-soōmər│

—noun
An electric consumer that proactively produces maximum
<u>economic and environmental</u> benefits by using information,
technology, distributed generation, and storage resources to
successfully reduce and reshape energy demand on the grid.

Where We Are Today?

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Just like IT and telecom, our energy network is on the cusp of a paradigm shift – led by advanced technology, networked devices, and <u>informed consumer choice.</u>
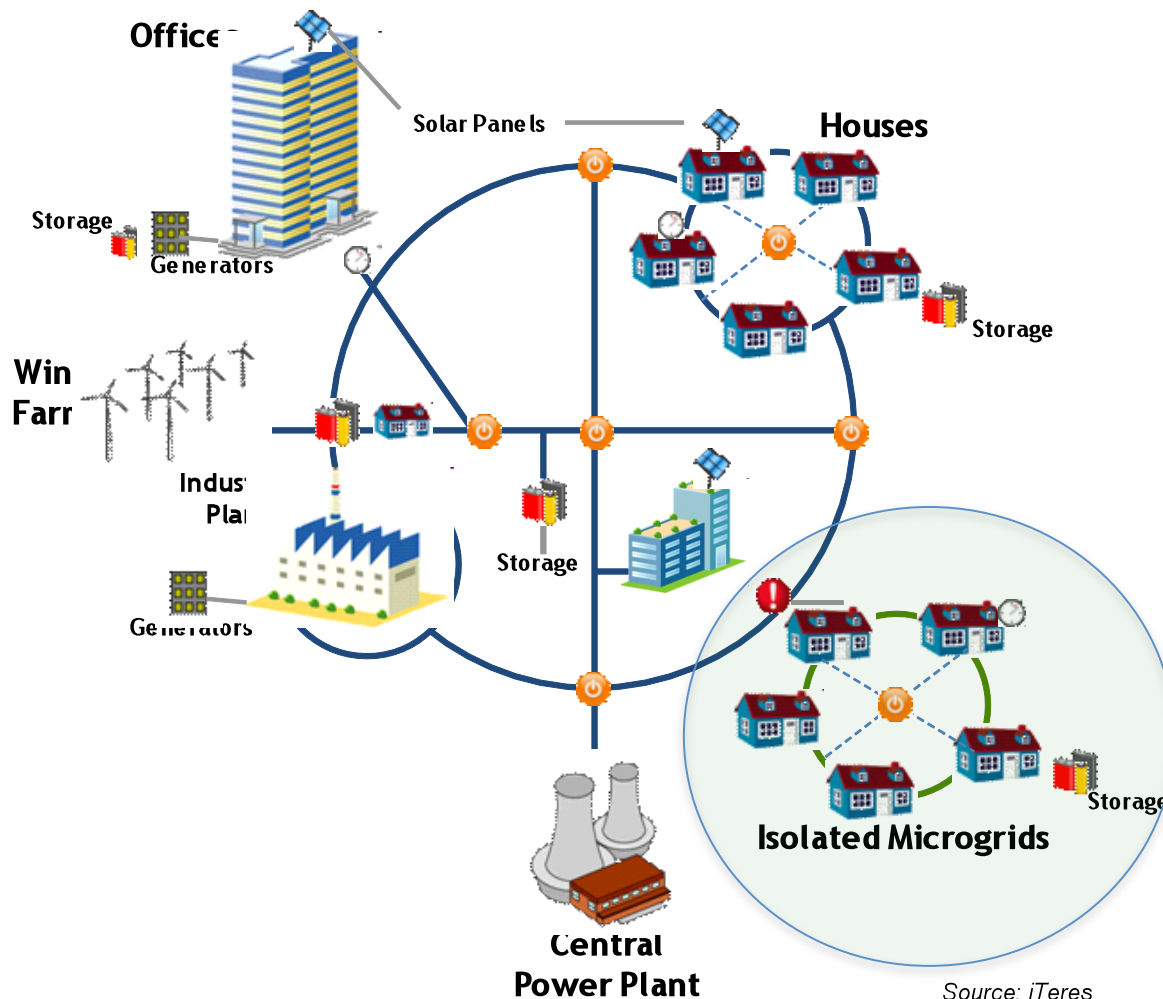

Phone　　　　　　　　　　Computer　　　　　　　　　　Smart Phone

- New technology allows for a dynamic distributed power network, where load can be controlled, dispatched and valued as virtual power generation

- **<u>April 2011 FERC Order: a MW generated is financially equivalent to a MW conserved</u>**

- Consumer-led demand management leads to lower power prices and a more secure grid

Microgrids will transform power distribution, enabling new levels of system reliability and efficiency

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Focus on: Microgrid Intelligence

Office
Solar Panels
Houses
Storage
Generators
Storage
Win Farr
Indus Plar
Storage
Generators
Isolated Microgrids
Central Power Plant

Source: iTeres

Self-healing
- Responds to system disturbances automatically
- Capable of operating as an "island" off of the regional grid

Self-coordination
- Coordinates real-time demands of energy users, distributed resources, microgrid operations and distribution system integrity

Self-scheduling
- Schedules dispatch of distributed energy resources using decisioning tools to optimize overall grid operational performance

U.S. Organized Electricity Markets: new paradigm

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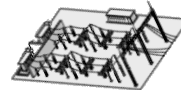| Exchanges (ICE, NYMEX) |
|---|

Financial Markets
Regulatory agencies: SEC, CFTC

Regulatory agency: FERC

RTO Markets Grid Operators

Generation

Transmission

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Distribution Utilities Retail Energy Suppliers

SELL

MW and MWh

Retail Markets
Regulatory agencies: states

Industrial

Residential

Commercial
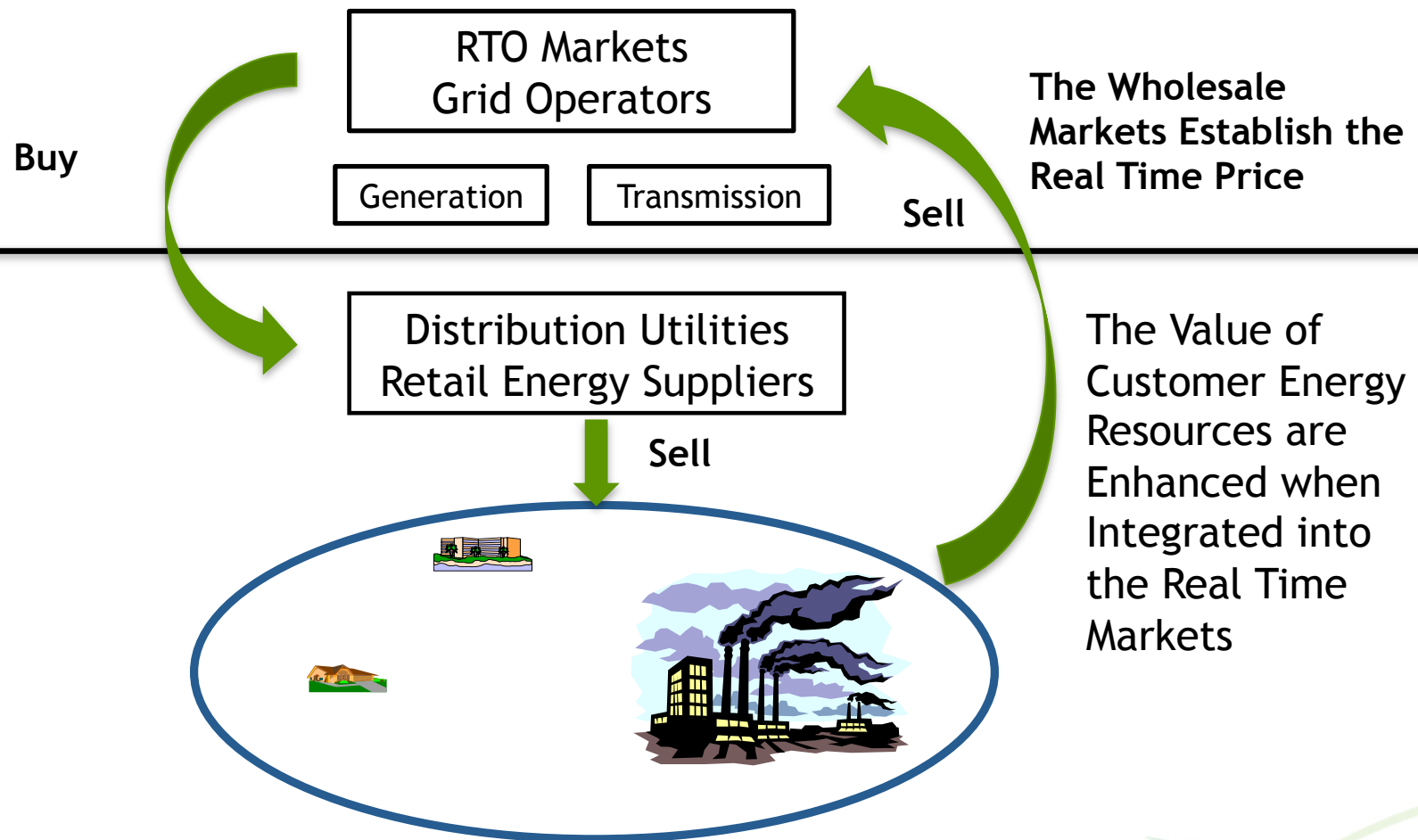
Load

NW and NWh

Viridity Energy's Demand Optimization (vs. Traditional Demand Response) integrates controlled load into real time market operations as a virtual power resource (a closed loop system)

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Buy

RTO Markets Grid Operators

| Generation | Transmission |

The Wholesale Markets Establish the Real Time Price

Sell

Distribution Utilities Retail Energy Suppliers

Sell

The Value of Customer Energy Resources are Enhanced when Integrated into the Real Time Markets

Prosumer Evolution

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**Value to Utility & End Customers**

High — Low

Dynamic Pricing

- Building infrastructure allows it to react in 5 mins to utility signals
- Through trading partners, allows arbitrage of real time pricing markets

Load Shaping

Dynamic Pricing $

12AM   Noon   12PM
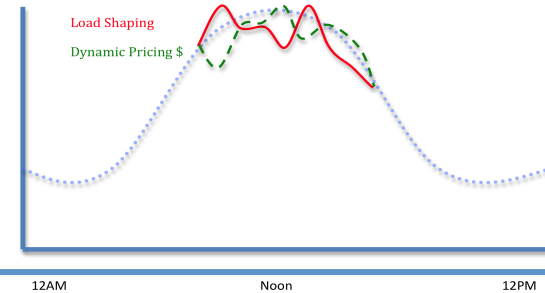
Day Ahead

- Day ahead signal from utility allows building to shift loads to non-peak hours

12AM   Noon   12PM

Capacity Only

Load Shedding
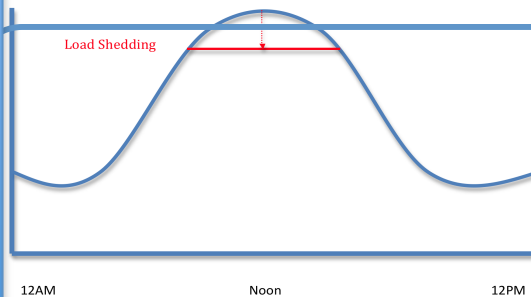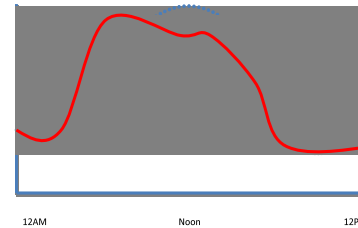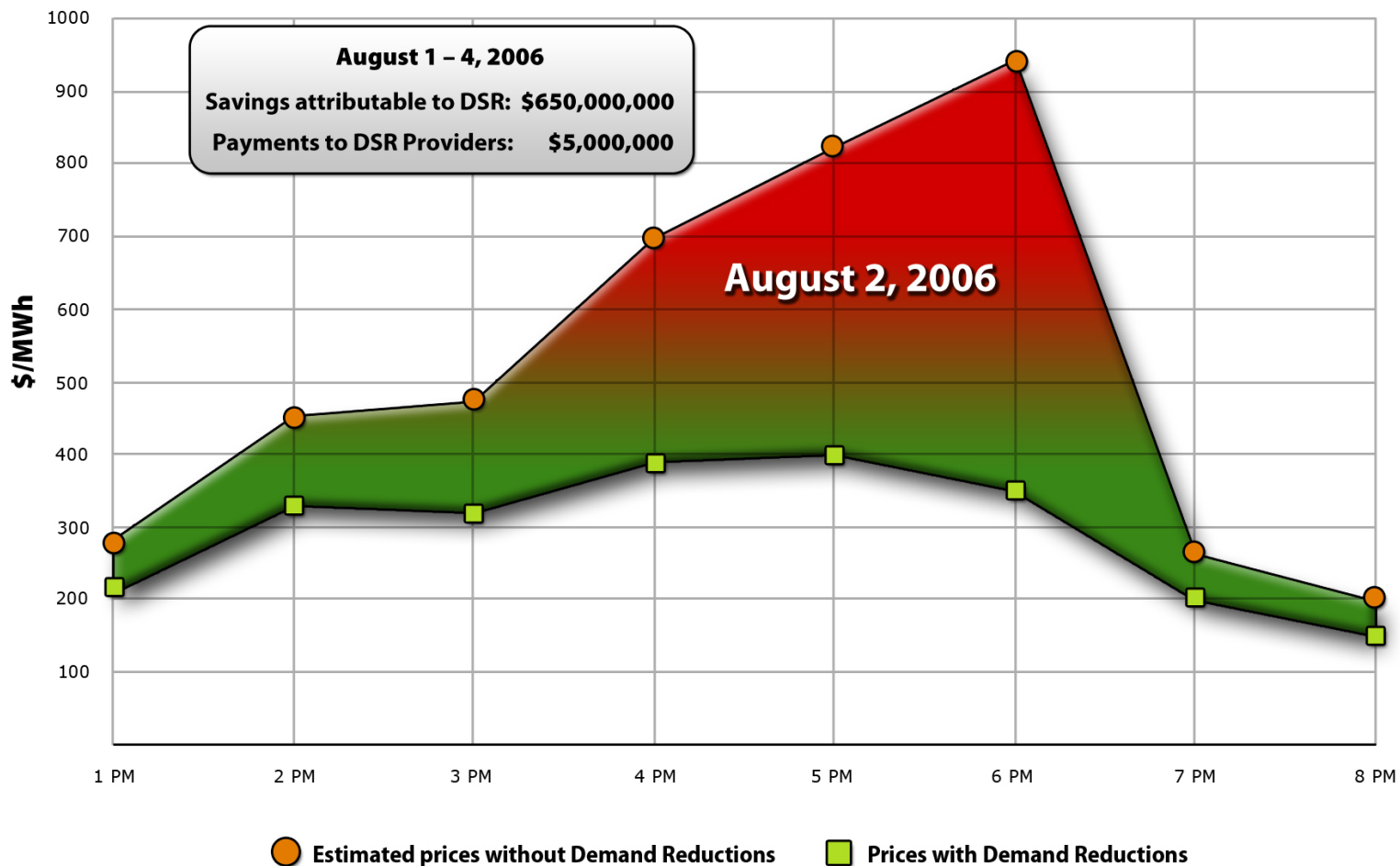

- Predominant form of DR in place today
- Building agrees to shed load at peak times in exchange for payment
- Called only on peak usage days (<10 X p.a.)

12AM   Noon   12PM

Economic Value to the Market

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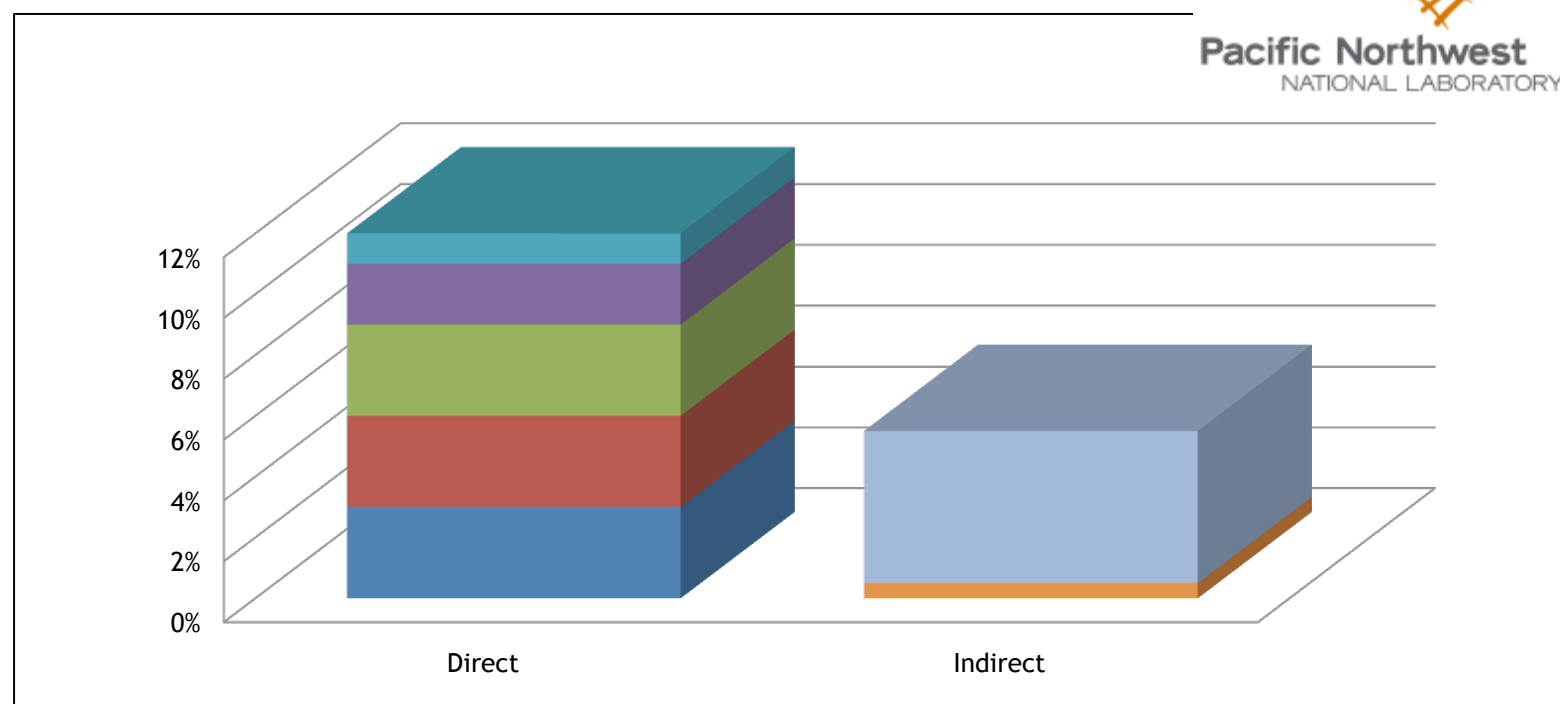## PJM – Impact of Demand Response on Prices

Environmental Value of a Smart Grid

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A fully implemented smart grid can cut CO$_2$ emissions by 12% in 2030.
- equal to the output of 66 coal-fired power plants.

Pacific Northwest National Lab, January 2010:

Pacific Northwest
NATIONAL LABORATORY

→ *PNNL estimates that smart grid will enable an additional 6% indirect reduction of CO$_2$ emissions **by making wind, solar, and efficiency more cost-effective.***
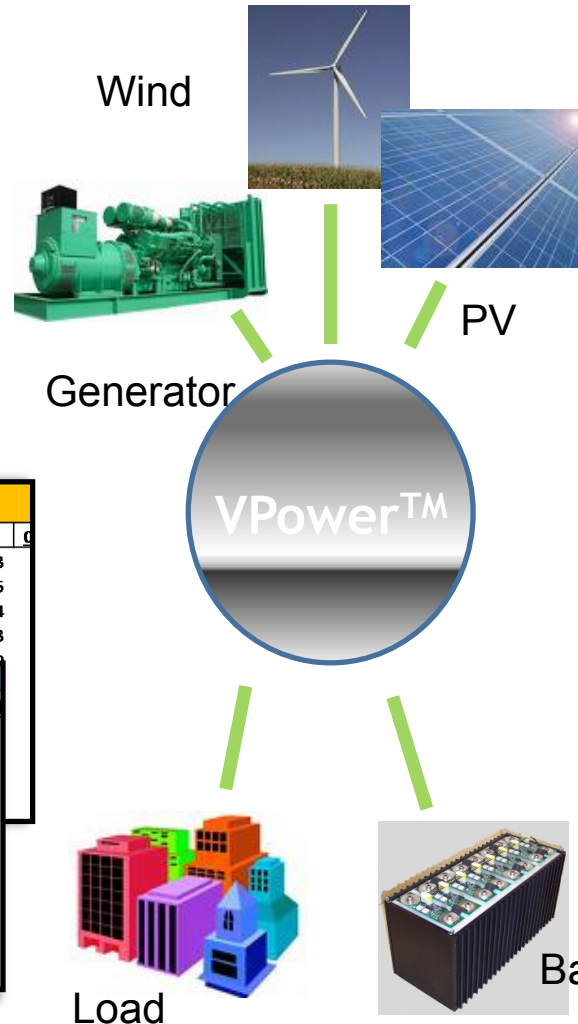
Creating the Pro-Sumer

Inputs:
- Load Forecasts
- Weather Forecasts
- Pricing Forecasts

Outputs:
- Optimized Energy Asset Operating Schedules
- Market Revenues and Retail Savings

Wind

PV

Generator

VPower™

Load

Battery

WHOLESALE POWER PRICES

Date	0100	0200	0300	0400	05
7/1/2007	$ 55.00	$ 50.00	$ 54.00	$ 64.00	$
7/2/2007	$ 56.00	$ 55.00	$ 57.00	$ 66.00	$
7/3/2007	$ 67.00	$ 66.00	$ 65.00	$ 71.00	$
7/4/2007	$ 45.00	$ 45.00	$ 45.00	$ 48.00	$
7/5/2007	$ 54.00	$ 56.00	$ 53.00	$ 61.00	$
7/6/2007	$ 66.00	$ 64.00	$ 66.00	$ 66.00	$
7/7/2					
7/8/2					
7/9/2					
7/10/2					
7/11/2					

WEATHER FORECAST

Date	0100	0200	0300	0400	0
7/1/2007	76	73	73	73	
7/2/2007	77	75	74	75	
7/3/2007	78	78	76	74	
7/4/2007	75	74	74	73	
7/5/2007	73	73	71	70	

LOAD FORECAST

Date	0600	0700	0800	0900	10
7/1/2007	2.10	2.20	2.50	2.50	
7/2/2007	2.10	2.20	2.60	2.50	
7/3/2007	2.00	2.20	2.50	2.60	
7/4/2007	1.90	2.10	2.50	2.60	
7/5/2007	2.00	2.10	2.40	2.50	
7/6/2007	2.00	2.00	2.40	2.50	
7/7/2007	2.10	2.10	2.50	2.60	
7/8/2007	2.10	2.20	2.50	2.50	
7/9/2007	2.10	2.20	2.50	2.60	
7/10/2007	2.00	2.10	2.50	2.50	
7/11/2007	1.90	1.90	2.50	2.50	

Battery

Building T

Demand Response

To participate in this complex landscape, individual users need tools and optimization platforms as sophisticated as those used by the markets.
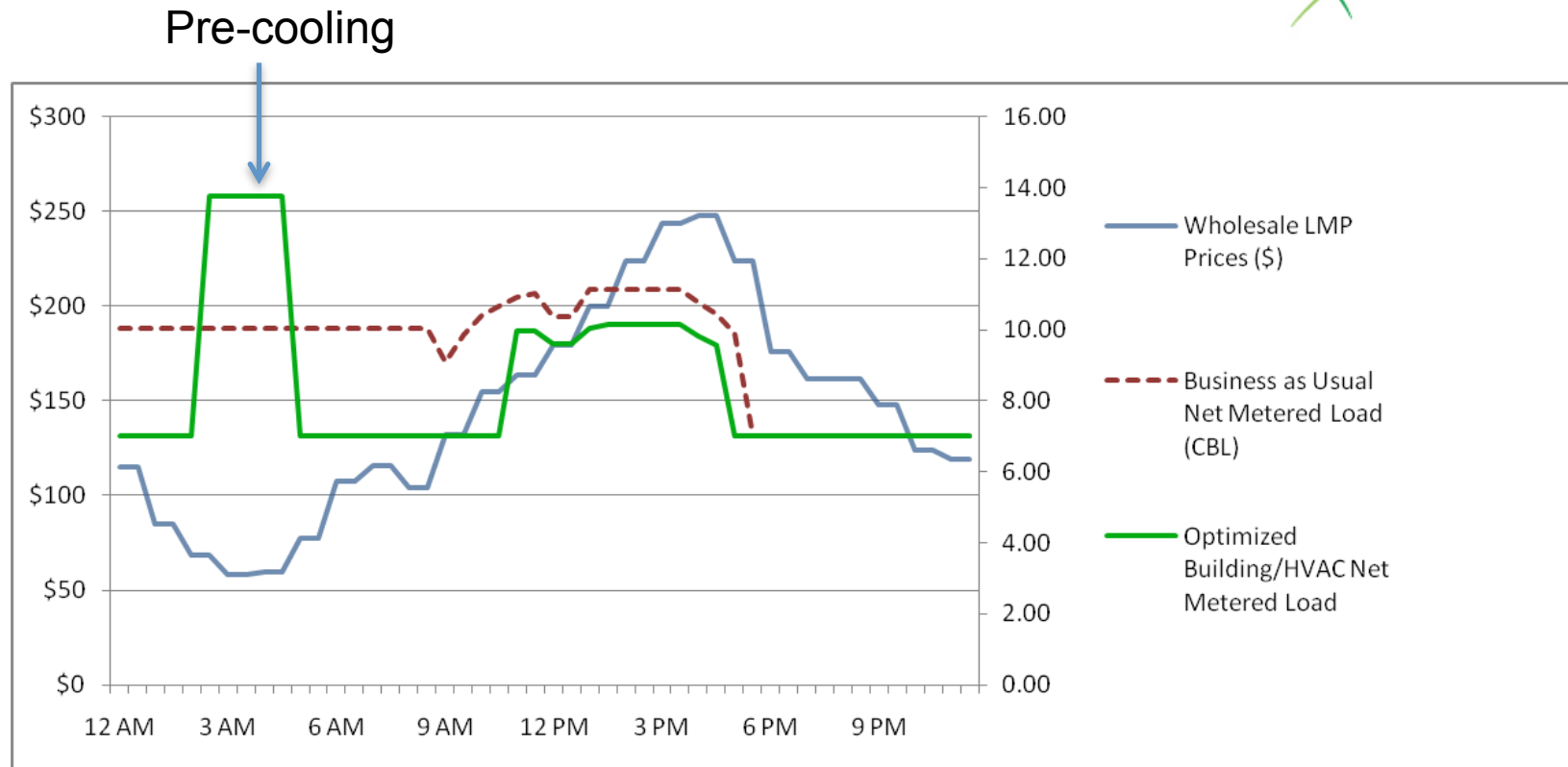
Business as Usual
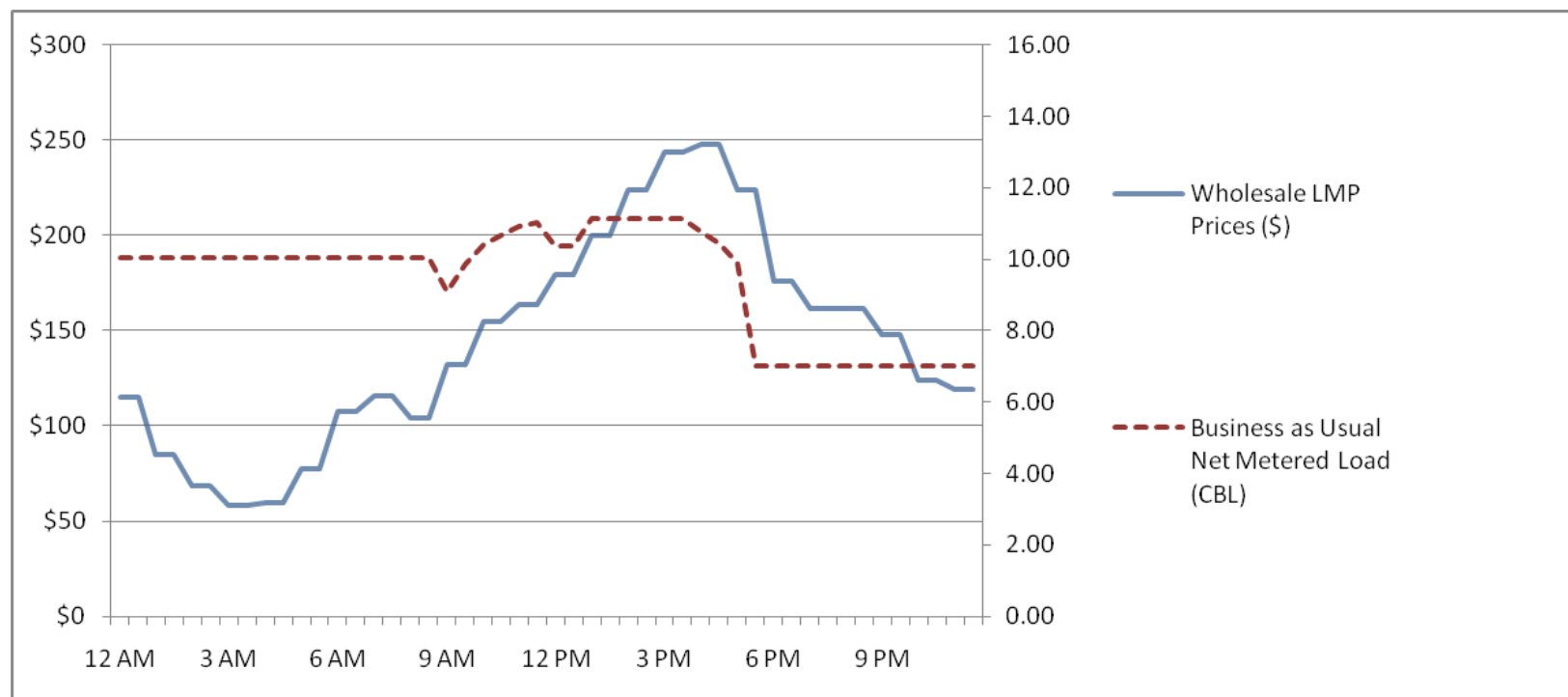
Business as Usual	
Daily Electricity Bill:	$13,574
Supply Savings:	n/a
Virtual Generation Revenue:	n/a
Total Daily Economic Benefit:	n/a

Optimized Building/HVAC Net Metered Load

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Pre-cooling

Optimized Building/HVAC Case	
Daily Electricity Bill:	$12,153
Supply Savings:	$1,422
Virtual Generation Revenue:	$3,108
Total Daily Economic Benefit:	**$4,530**

Optimized w/Solar, Battery, Onsite Generation
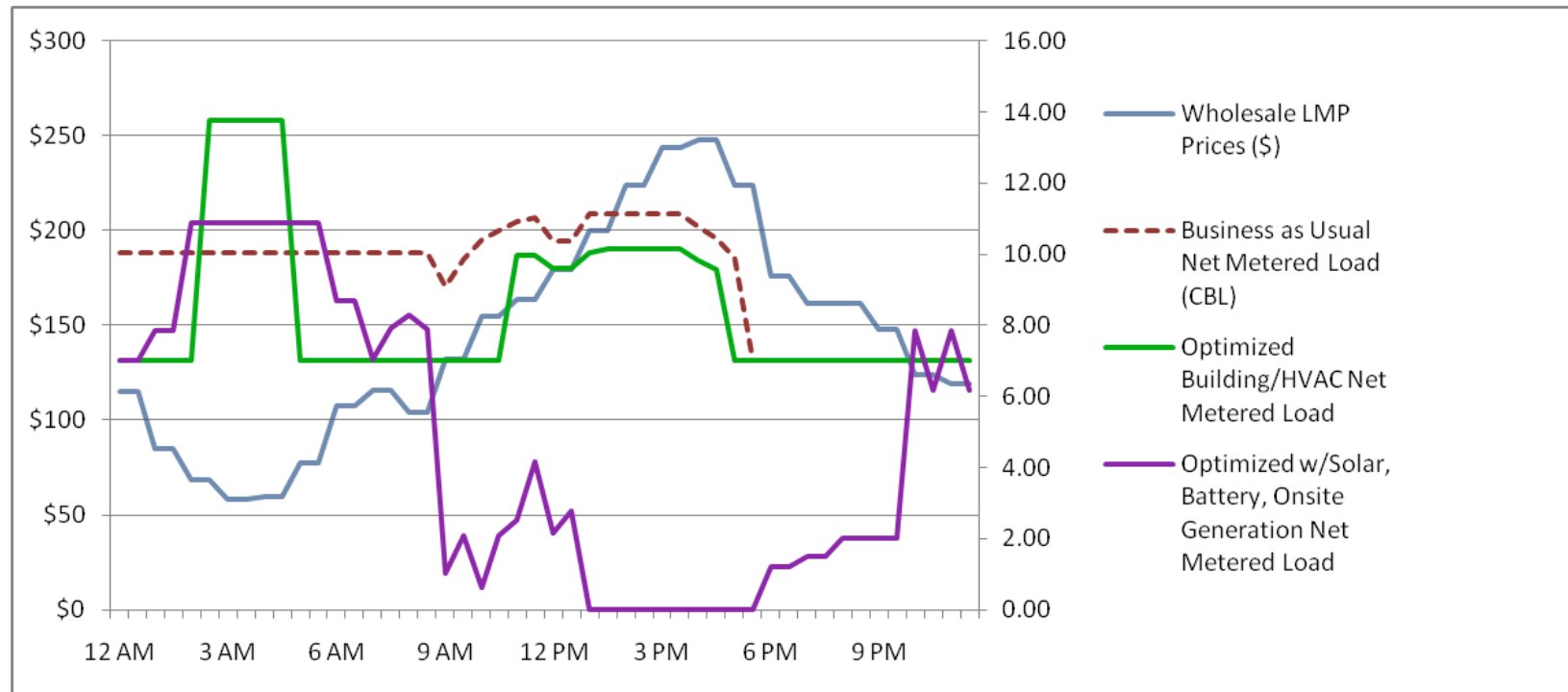
Optimized w/ Solar, Storage, and Onsite Generation Case	
Daily Electricity Bill:	$6,723
Generation Costs:	($13,218)
Supply Savings:	$6,851
Virtual Generation Revenue:	$17,832
Total Daily Economic Benefit:	**$11,465**

The Value of Optimized Load in a Real Time Wholesale Market

One Day in July: How Viridity Optimizes Distributed Resource Economic Value

July 16, 2010
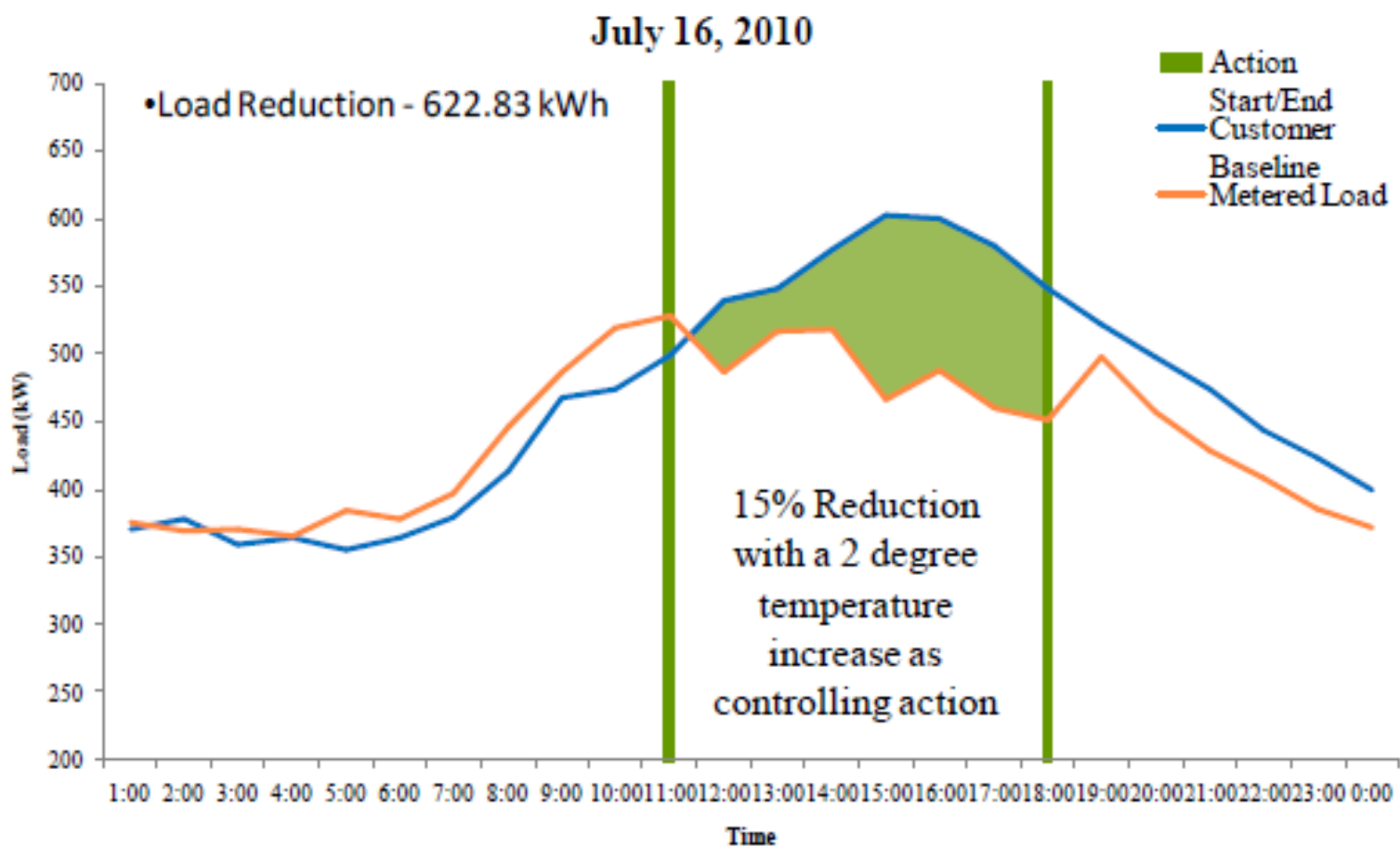
Overview- NYC SGDG

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Viridity is one of 8 Partners in this DOE Funded Project

- Viridity's Specific Scope -
    - Optimize energy load resources on select buildings to reduce energy costs and enhance market opportunities
    - Monitor and control energy resources based on real-time information such as weather and market signals
    - Provide Curtailment services to Con Edison and schedule demand side resources back into the grid
    - Aggregate different customer loads as virtual generators to provide supply and demand side economic benefit
    - Define and Monitor carbon footprint for and dispatch accordingly
    - Participate in Lower Manhattan and Long Island City DOE Smart Grid Demonstration Events

Physical Layout
6 Identified Buildings, 4 TBD

conEdison

Control Center

Middleware

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**Viridity Energy's
Network Operations Center
Conshohocken, PA**

VPower™

**Lower Manhattan
2 Rudin & 1 Verizon**
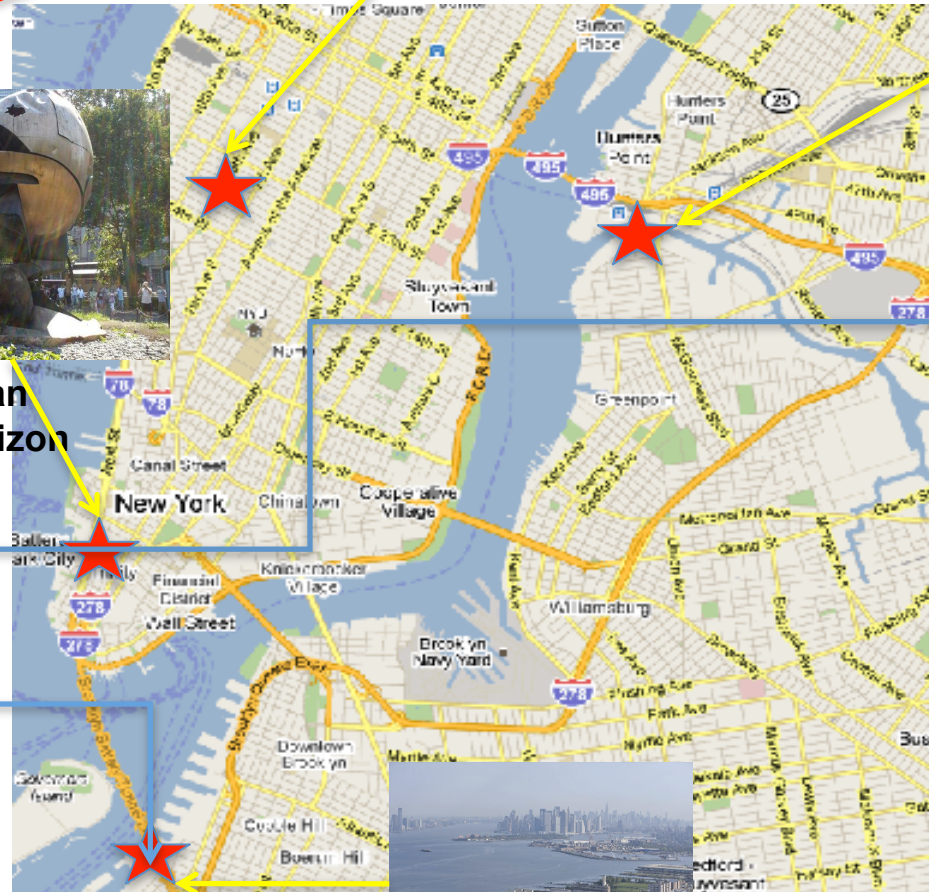
**2 Buildings in
Long Island City**
**CitiGroup
La Guardia
Community College**

ISO

**New York ISO
Control Center**

NYCEDC 3 Bldgs
**Brooklyn Cruise Terminal,
Brooklyn Army Terminal,
Brooklyn Meat Terminal**