Bringing the Electric System into the Information Age

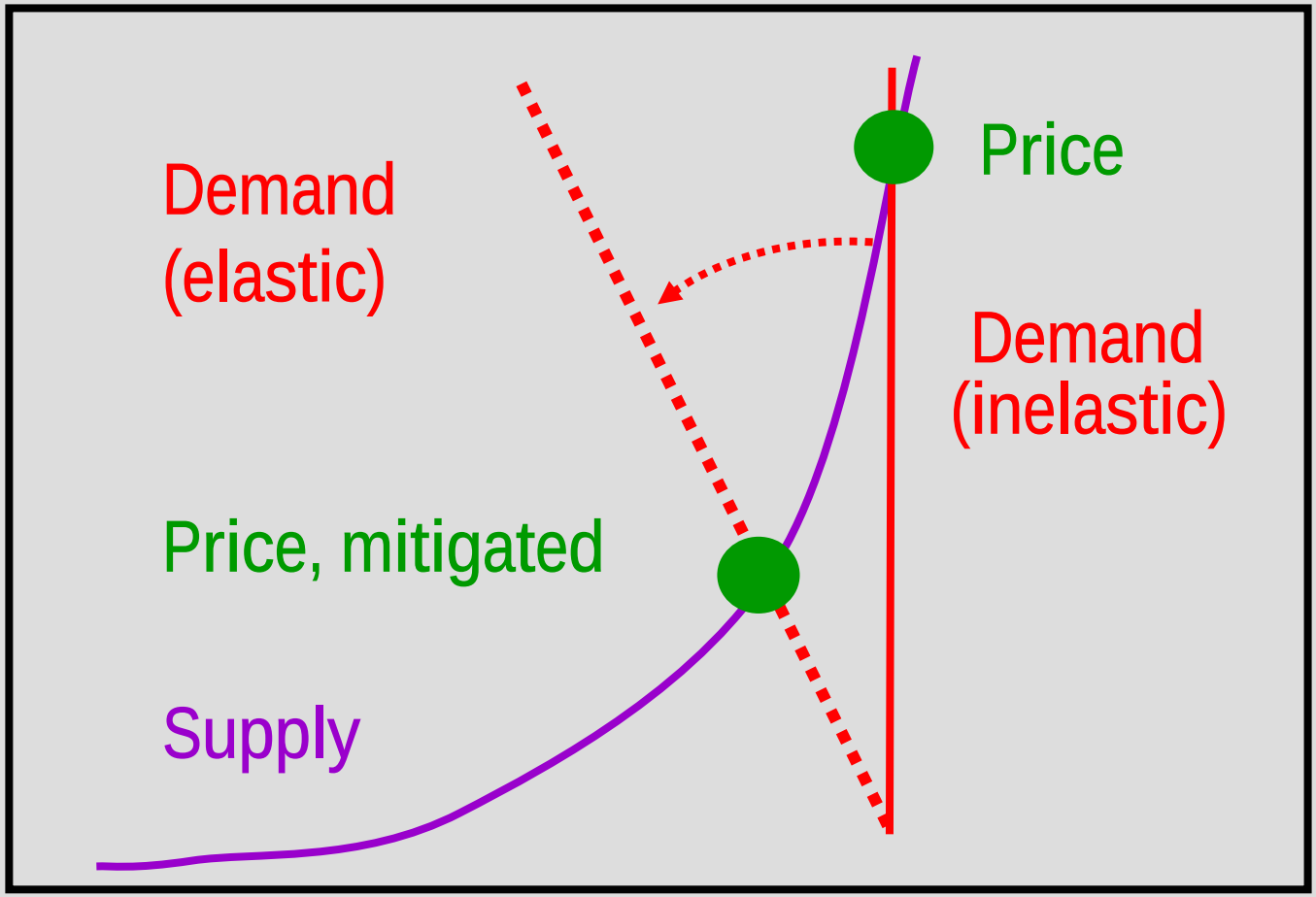
Information technology will profoundly transform the planning and operation of the power grid …

Rob Pratt
Pacific Northwest National Laboratory

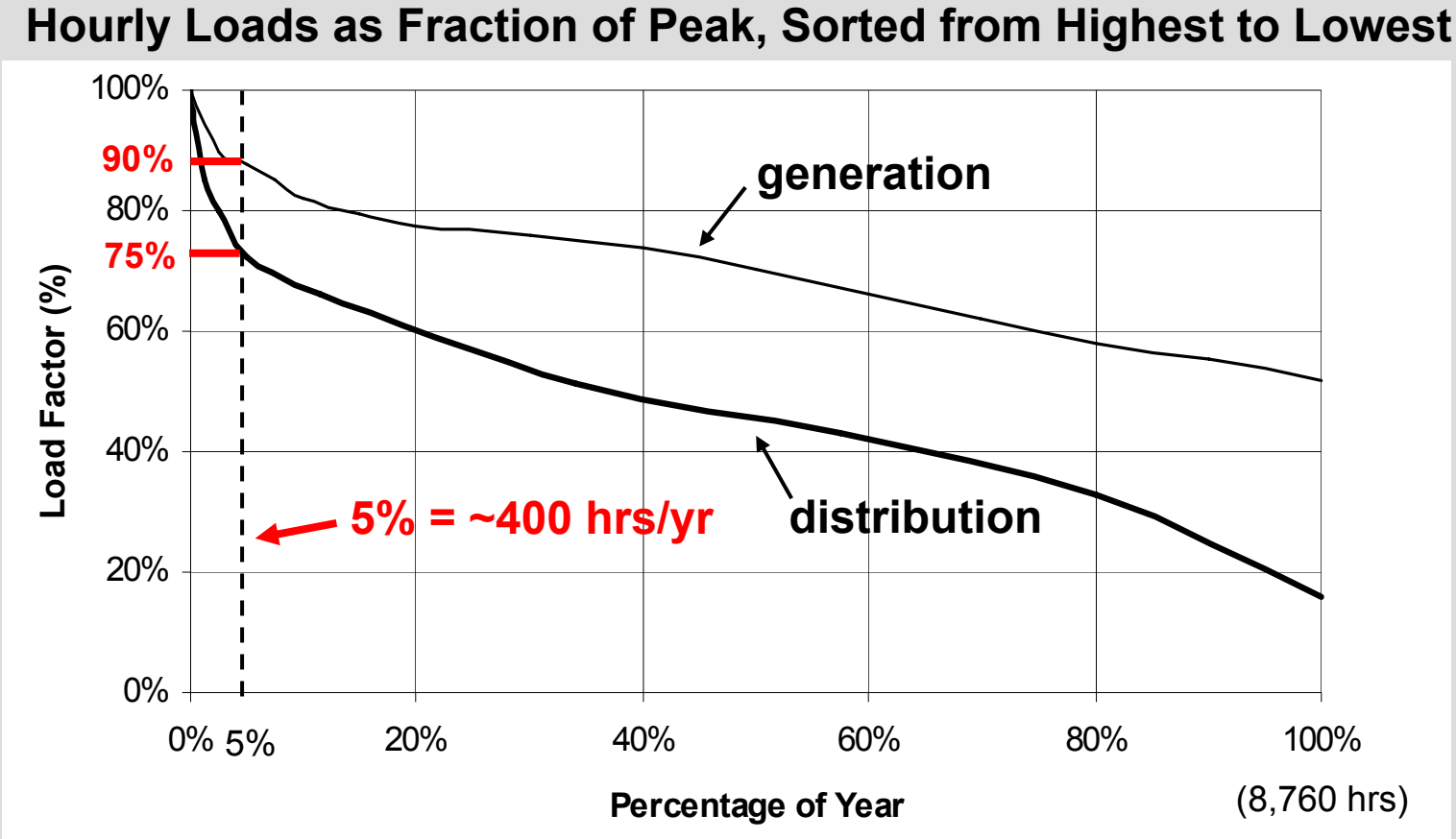
GridWise Expo Europe
October 2006

Transforming the Electric Infrastructure

Value of Demand Elasticity: *Lower Peak Demand & Stabilize Prices*

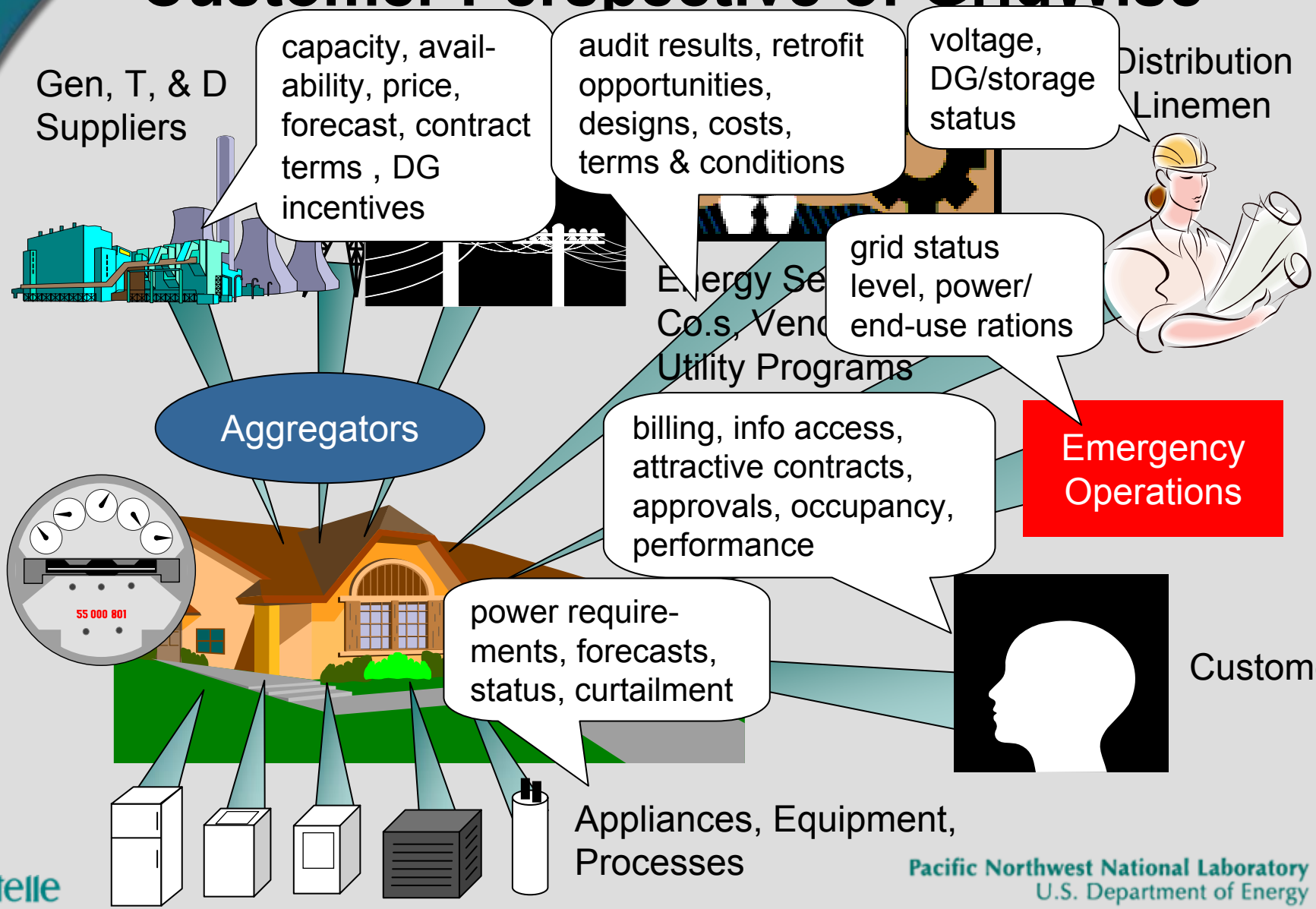


How Does Managing Peak Electrical Demand Save Money?



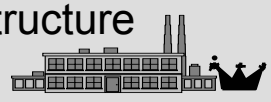
- 25% of distribution & 10% of generation assets (transmission is similar), worth of 100s of billions of dollars, are needed less than 400 hrs/year!

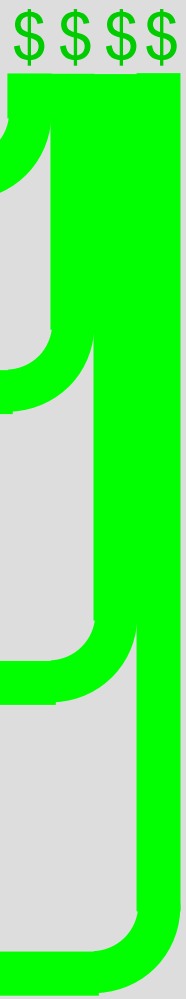
Communicate – With Whom? About What? Customer Perspective of GridWise

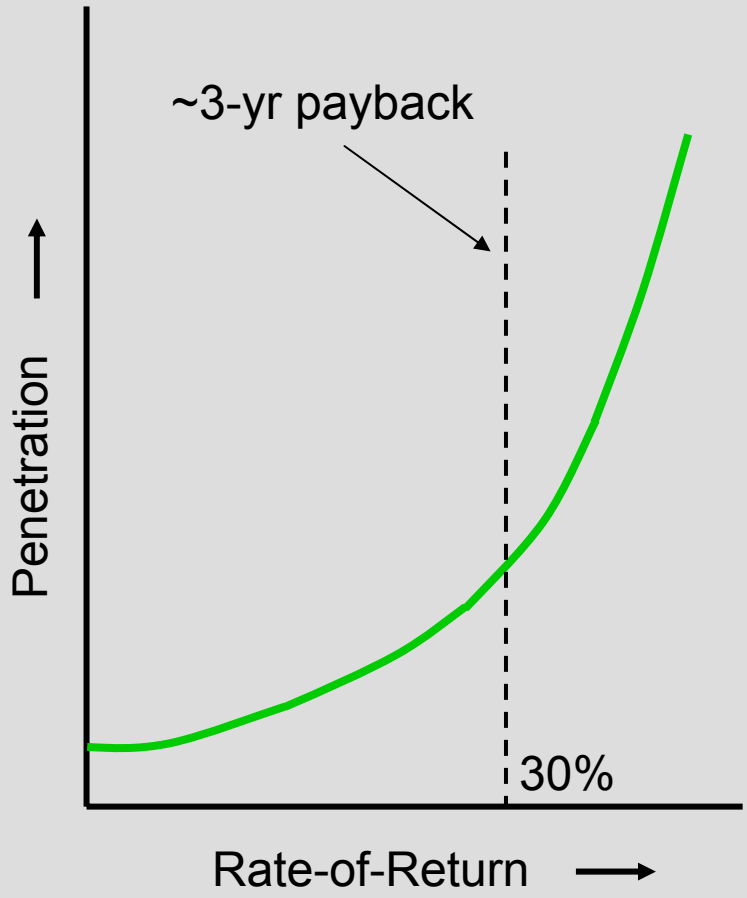


Connecting the Dots of the Value Chain: Revealing Value at All Levels to All Participants

- Central generation
  - Avoided infrastructure
- Transmission
  - Avoided infrastructure
  - Congestion relief
  - VAR support
  - Spinning reserve
  - Non-spinning reserve
- Distribution
  - Avoided infrastructure
  - Voltage support
  - Power quality
- Customer
  - Lower electric costs
  - Waste heat utilization
  - Power quality
  - Backup power

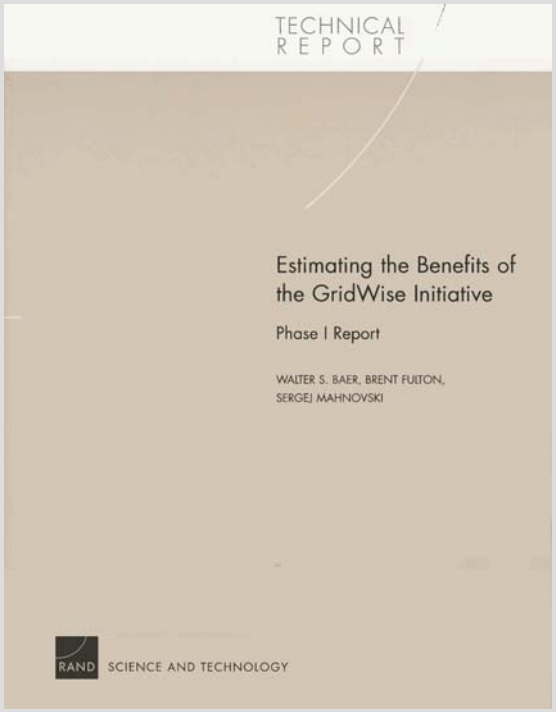


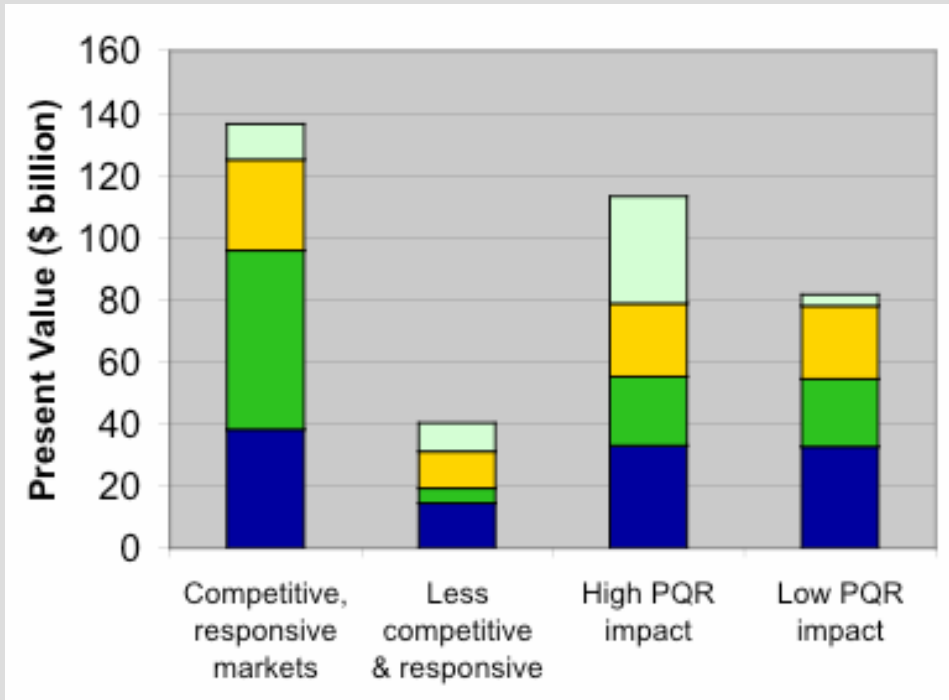




Do the Benefits Outweigh the Costs?

- RAND Corporation study suggests an emphatic yes!
  - Present value of all benefits range from $40B to $140B
  - Deferred capital investments represent $20B to $100B





GridWise Alliance: Mobilizing Industry

the GridWise Alliance is:

The Alliance agenda:

- ***Utilize information technologies to revolutionize energy systems***
- ***Develop and deploy technology solutions that cross enterprise and regulatory boundaries***
- ***Enhance security and reliability through a flexible, adaptive power grid***
- ***Empower consumers to benefit from their participation***

GridWise Northwest Demonstration Projects

Pacific NW GridWise™ Testbed Projects

Unleashing the power of distributed resources

Summary of Projects

Olympic Peninsula Demand Response Demonstration:

- Integrating in-the-field demand response and backup generators in a virtual operating environment
- Experimenting to relieve transmission and distribution congestion during peak periods.

Grid Friendly Appliance Controller Demonstration:

- Equipping 150 homes in Washington and Oregon with Grid Friendly appliance controllers on water heaters and clothes dryers.
- Testing ability to automatically reduce load in response to stress on the grid.

Project Objectives

- Illustrate how the transformed po GridWise will function and explor
- Demonstrate how transmission a investment can be deferred
- Define the role demand response

Who Benefits from GridWise?

Bonneville Power Administration

- Reduce constraints on transmission grid
- Provide ancillary services that increase reliability and minimize outage size and duration.
- Optimize cost-effectiveness by minimizing power purchases and maximizing power sales to regional wholesale market

Local utilities

- Avoid need to expand local capacity by

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anagement

Pacific NW GridWise Project Participants

U.S. Dept. of Energy
Bonneville Power Administration
Pacificorp
Portland General Electric
IBM
Whirlpool/Sears Kenmore
Port Angeles Municipal Utility
Clallam County PUD

PNNL
Invensys
Preston Michie Associates
Dr. Lynne Kiesling

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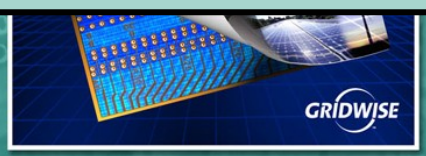
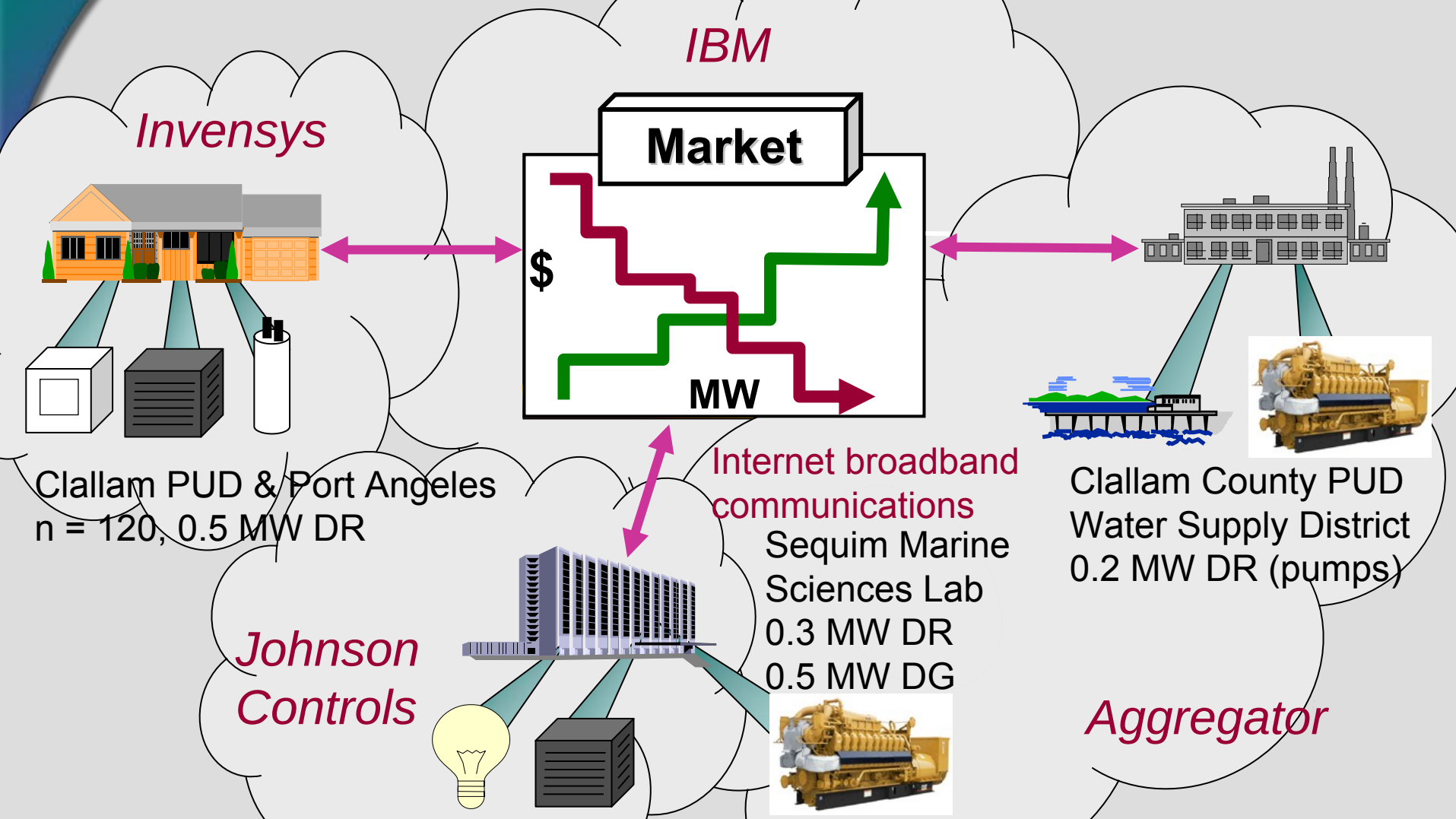


City of Port Angeles Municipal Utility

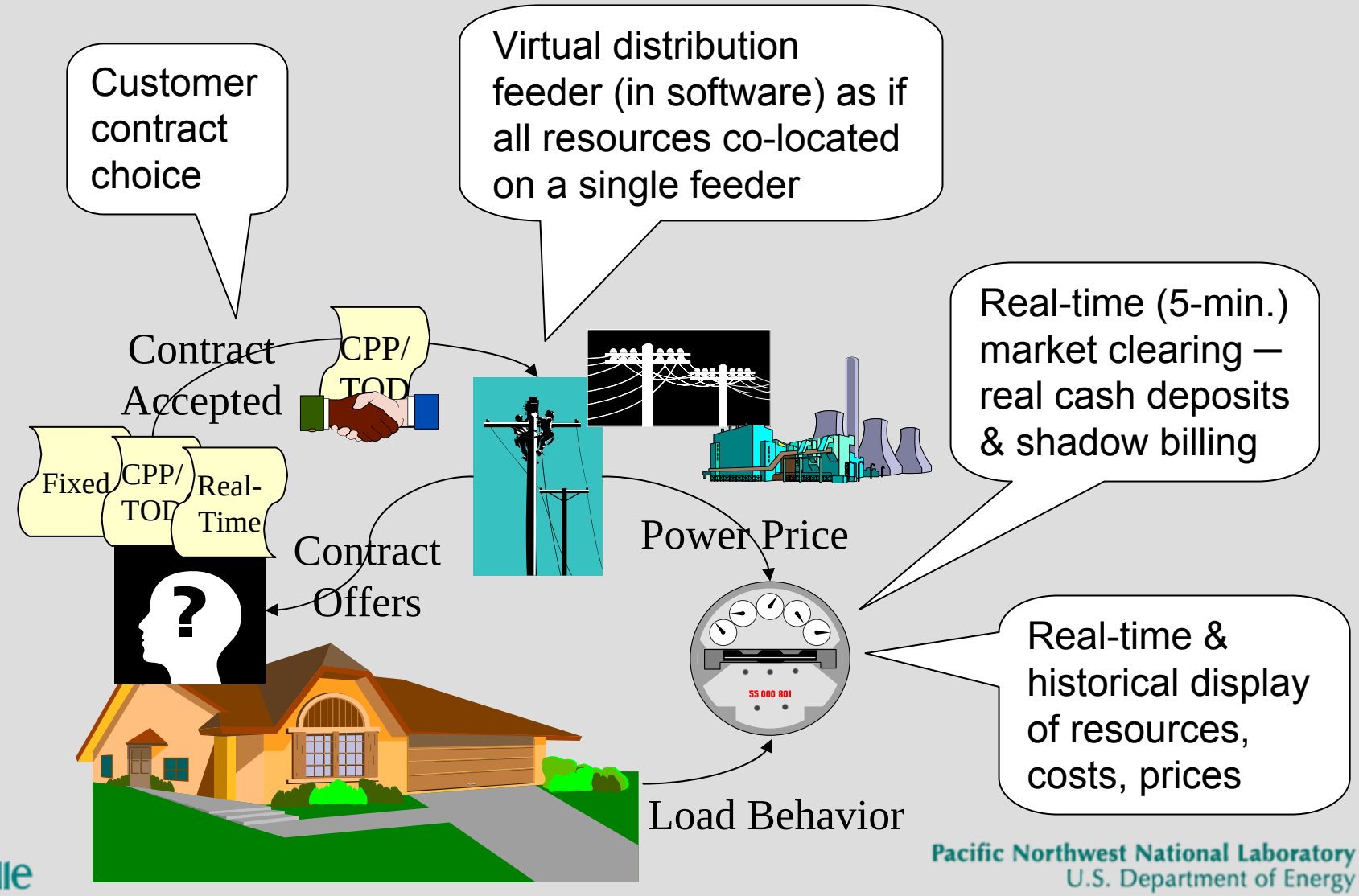
Clallum County Public Utility District #3

Pacific Northwest National Laboratory
Operated by Battelle for the U.S. Department of Energy

Olympic Peninsula GridWise Demonstration



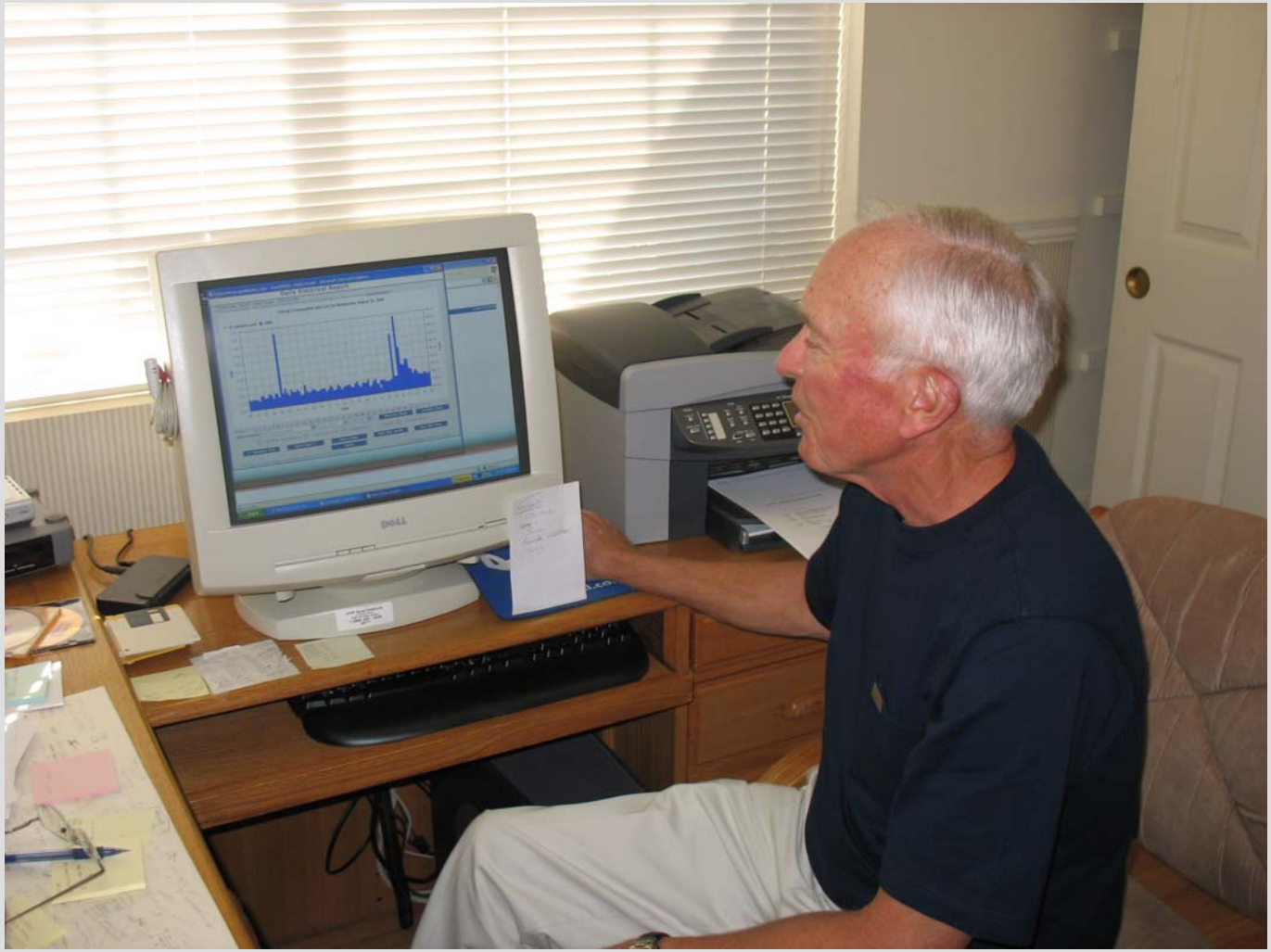
Testing Market-based Customer Incentives



Thermostat Opportunities

Water Heater Controller

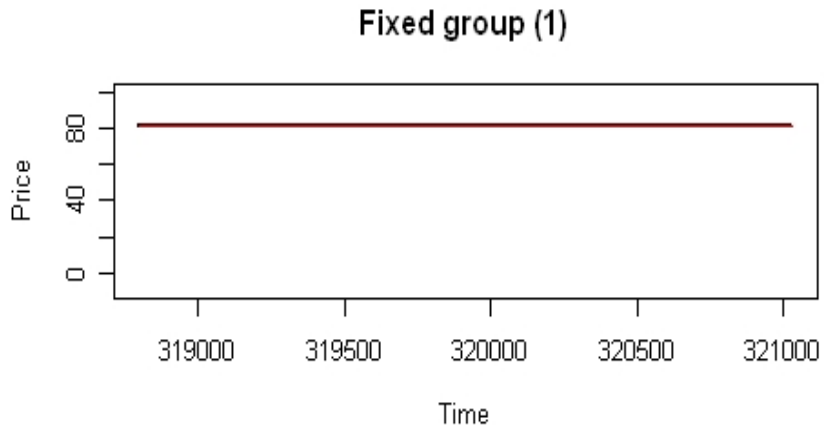
Homeowner Web Interface—the Home's Dashboard

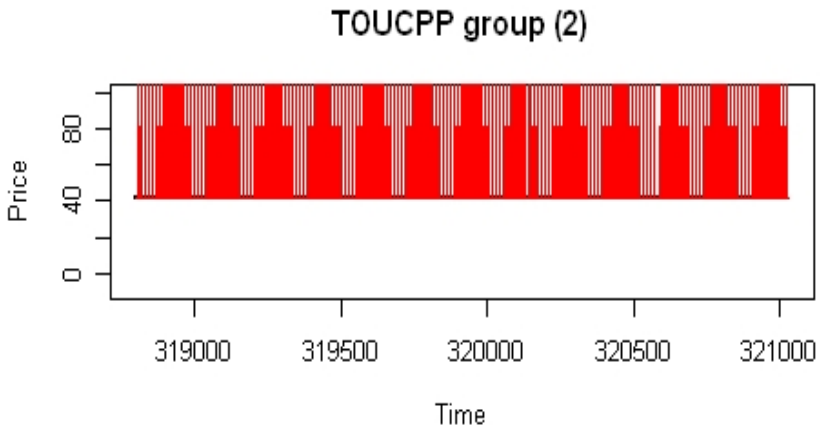


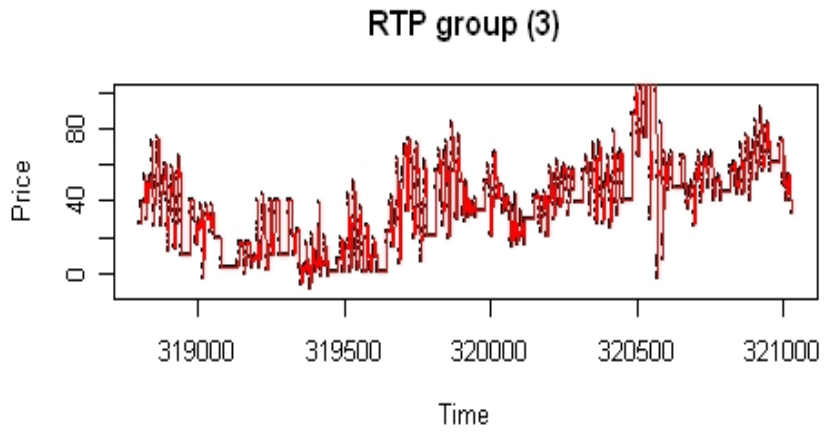
Early Economic Experiment Results

Table 1 - Olypen results for May 15 - June 30, 2006 (4500 observations)

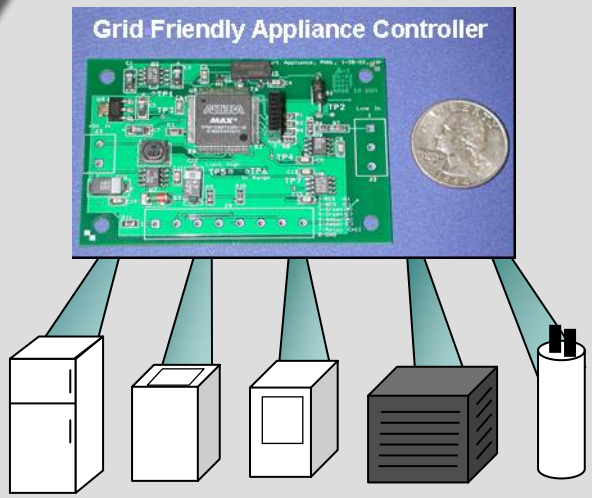
Result	Control	Fixed	TOU	RTP
1 hour AR	0.89	0.83	0.85	0.86
4 hour AR	-0.25	-0.23	-0.22	-0.21
kWh/$	-	-	-0.09~	-0.01!
kWh/F	0.06!	0.13~	0.06!	0.11~
kWh	3.3	3.1	3.4	3.0

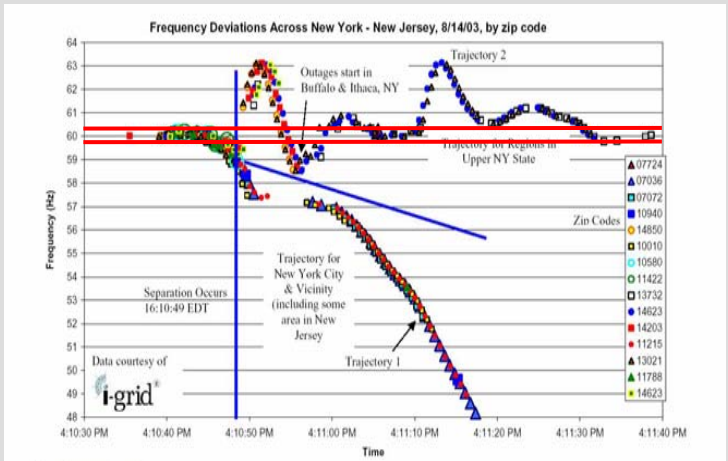




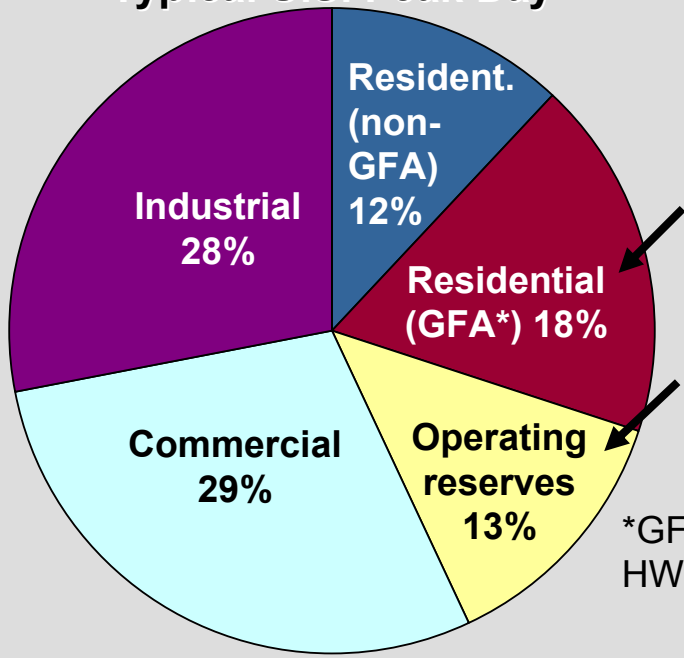


Grid Friendly™ Appliances (GFAs) Help Keep the Lights On!





Loads and Reserves on a Typical U.S. Peak Day



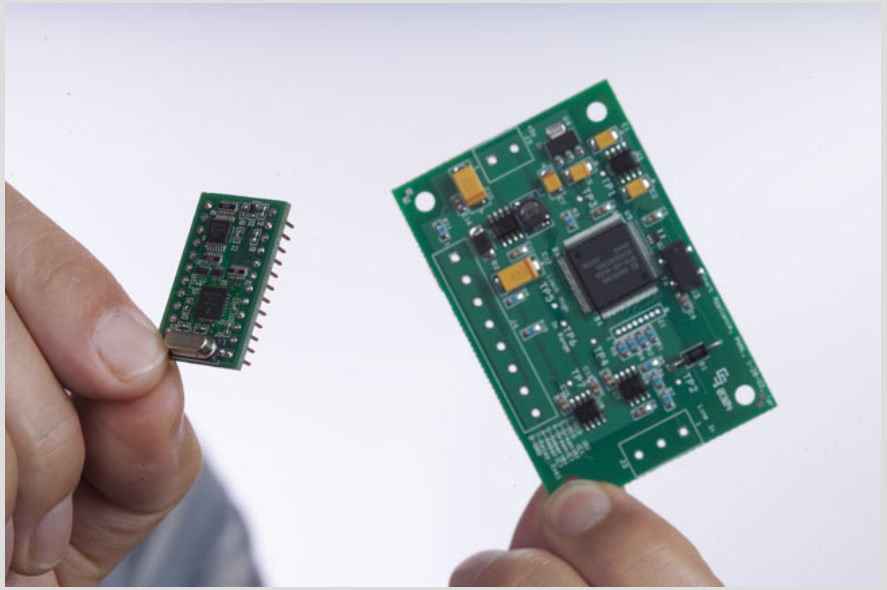
GFA* potential exceeds US operating reserve requirements!

*GFA for: heat, AC, HW, refrig.

Grid Friendly Appliances sense grid frequency excursions & control region's appliances to act as spinning reserve – No communications required!

Grid Friendly™ Appliance Demonstration

- Autonomous GFA under frequency curtailment response to 200 appliances in 150 residences
  - 150 Whirlpool/Sears dryers
  - 50 water heaters
- Assess performance through correlation with frequency events
  - Event log & load data collection (Invensys)
- Assess consumer acceptance – Whirlpool post-survey



- Perform preliminary assessments of costs and benefits

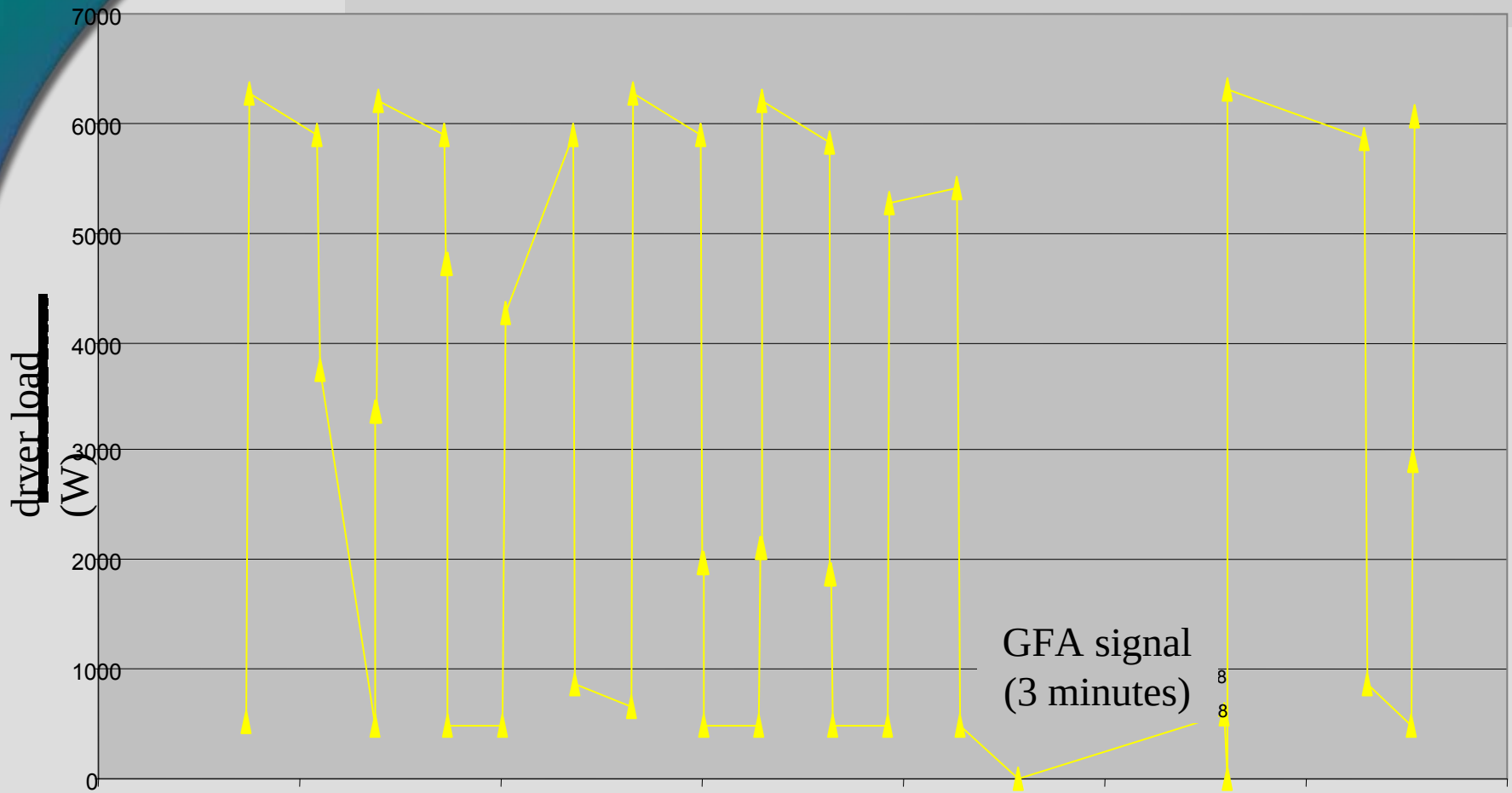
"When the inevitable occurs … people get stuck in elevators and high-value uses of power are shut off along with all the lowest priority uses of energy. It's the meat-ax approach to interrupting power flows."

Dr. Vernon Smith, 2002 Nobel prize Winner, Economics

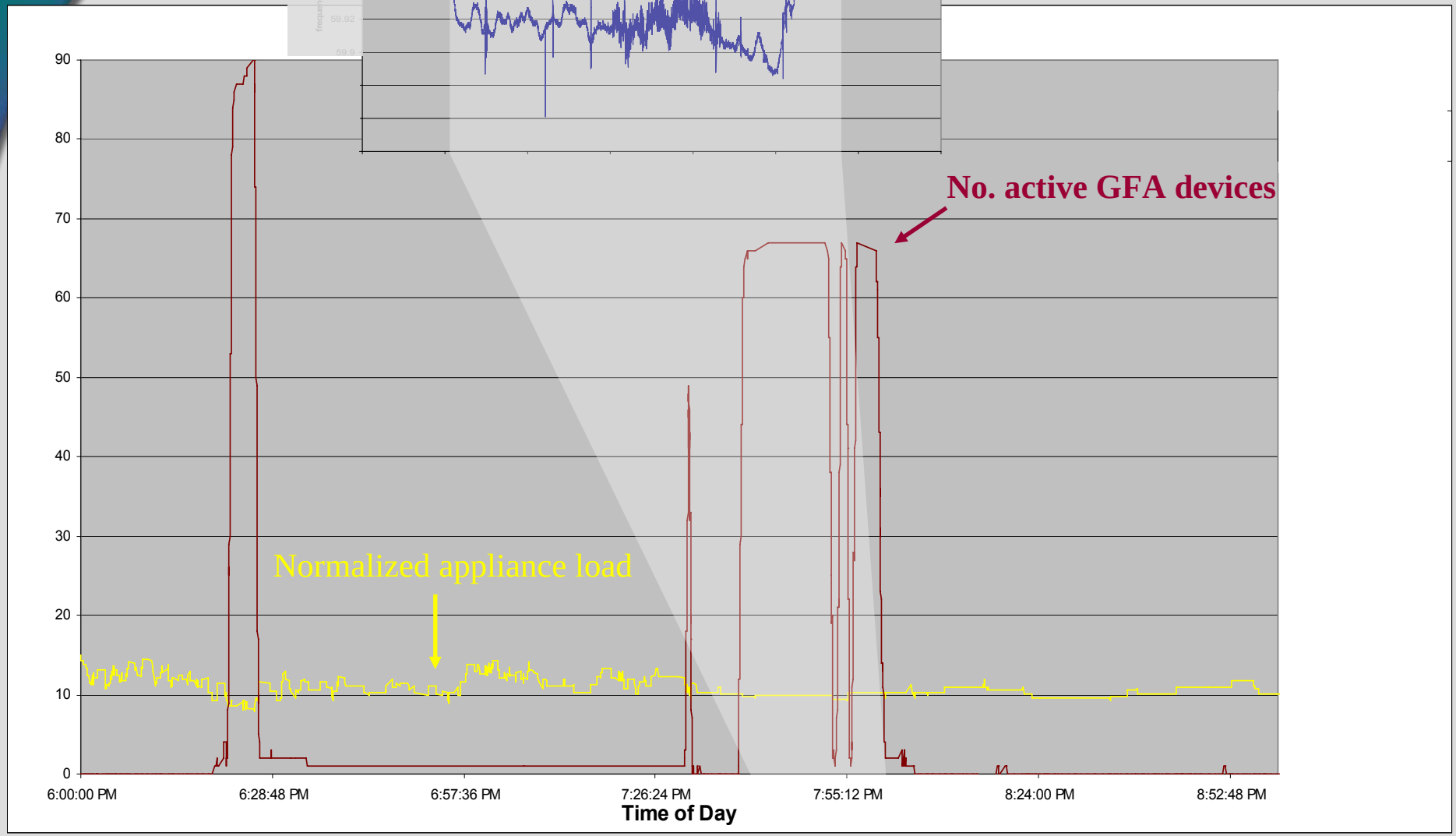
Installed Project Dryer

1501 Dryer 4/13/06 Expanded

Field Dryer Response



May 2 WECC Event



Information: The Virtual Electric Infrastructure

FACT:

In the next 20 years, the U.S. will spend $450B on electric infrastructure, just to meet load growth.

CHOICE:

Perpetuate a 20th Century solution

OR

Invest in a 21st Century system saving ratepayers $80B while increasing reliability and flexibility.

GRIDWISE™:

Revealing Values + Communications + Advanced Controls ≡ Electric infrastructure

The choice is easy because…

$ bits << $ iron

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http://www.electricdistribution.ctc.com

http://www.gridwise.org

http://gridwise.pnl.gov