Ed Koch

CTO, Akuacom

ed@akuacom.com 415-256-2583

Tariq Samad

Corporate Fellow, Honeywell

Demand Response and Energy Efficiency for the Smart Grid

Honeywell

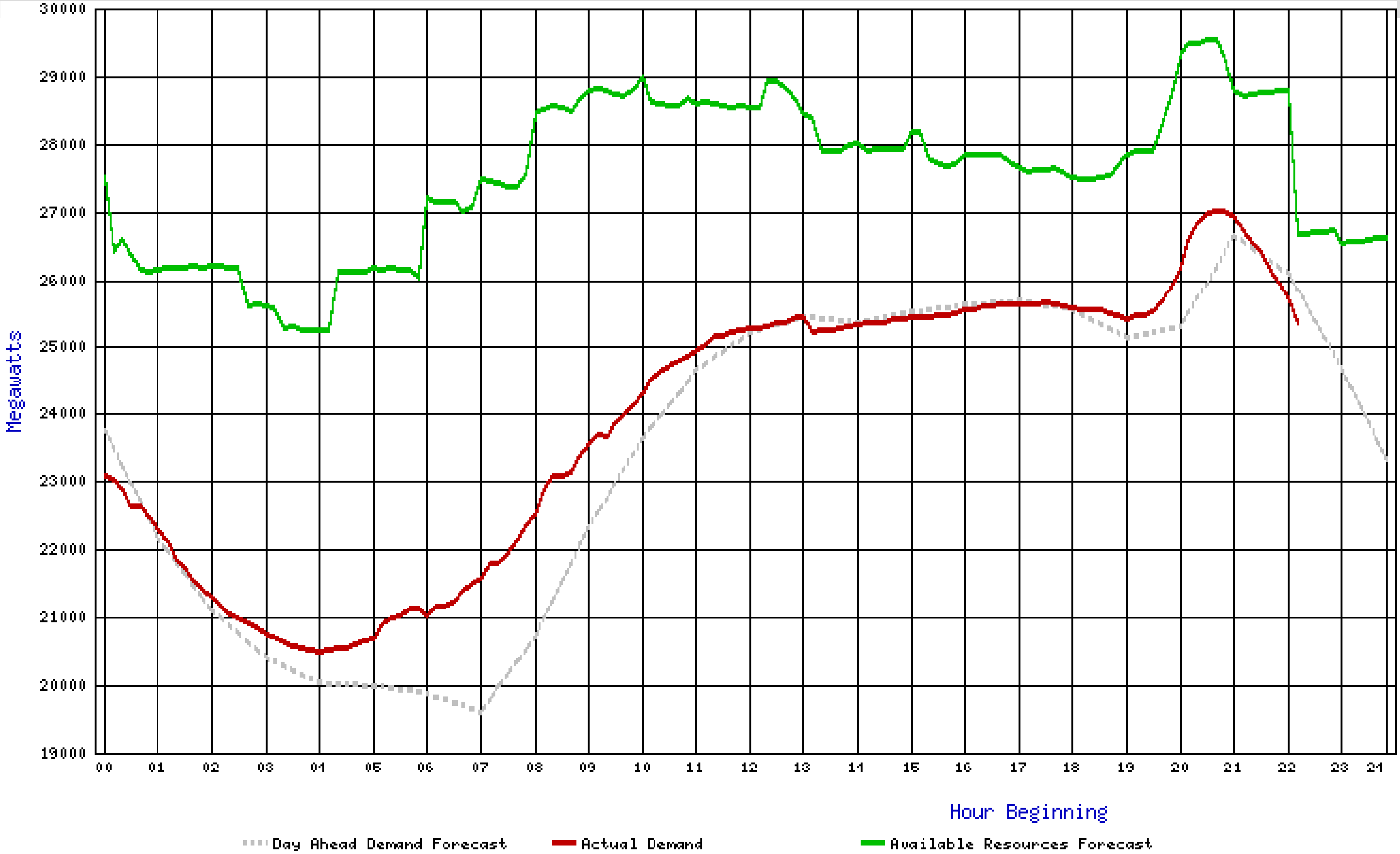
Stanford University, 16 May 2011

Outline

- Introduction to Demand Response (DR)
- Demand Response Architectures and Issues
- Facility Load Control Issues
- Smart Grid Standards for DR
- Backup Material - Honeywell projects in energy efficiency and demand response

Energy and the Grid: A Balancing Act

Actual CA Demand Profile (5/15/2010)



Grid Balancing Issues

(diagram courtesy of DRRC)

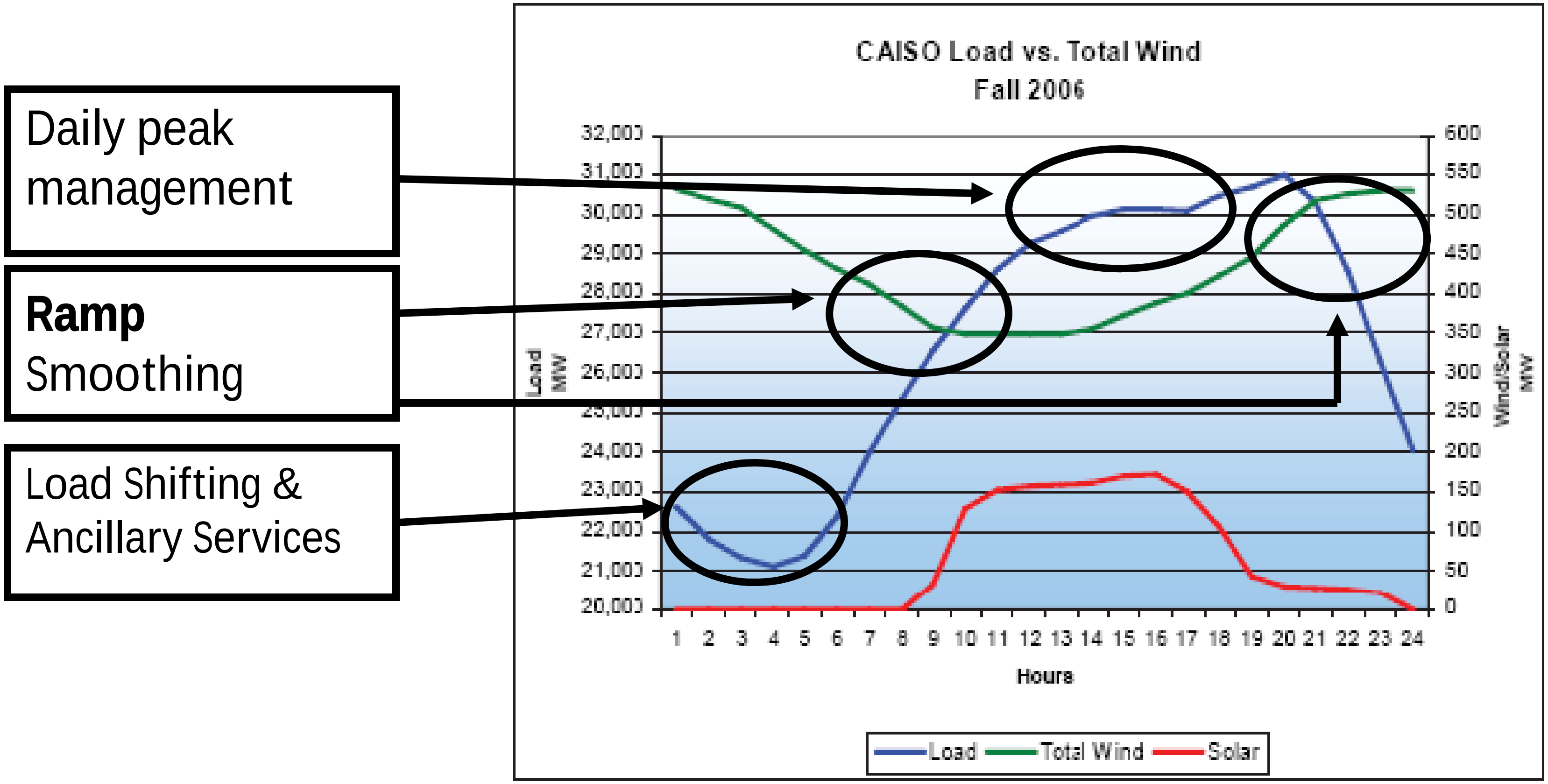
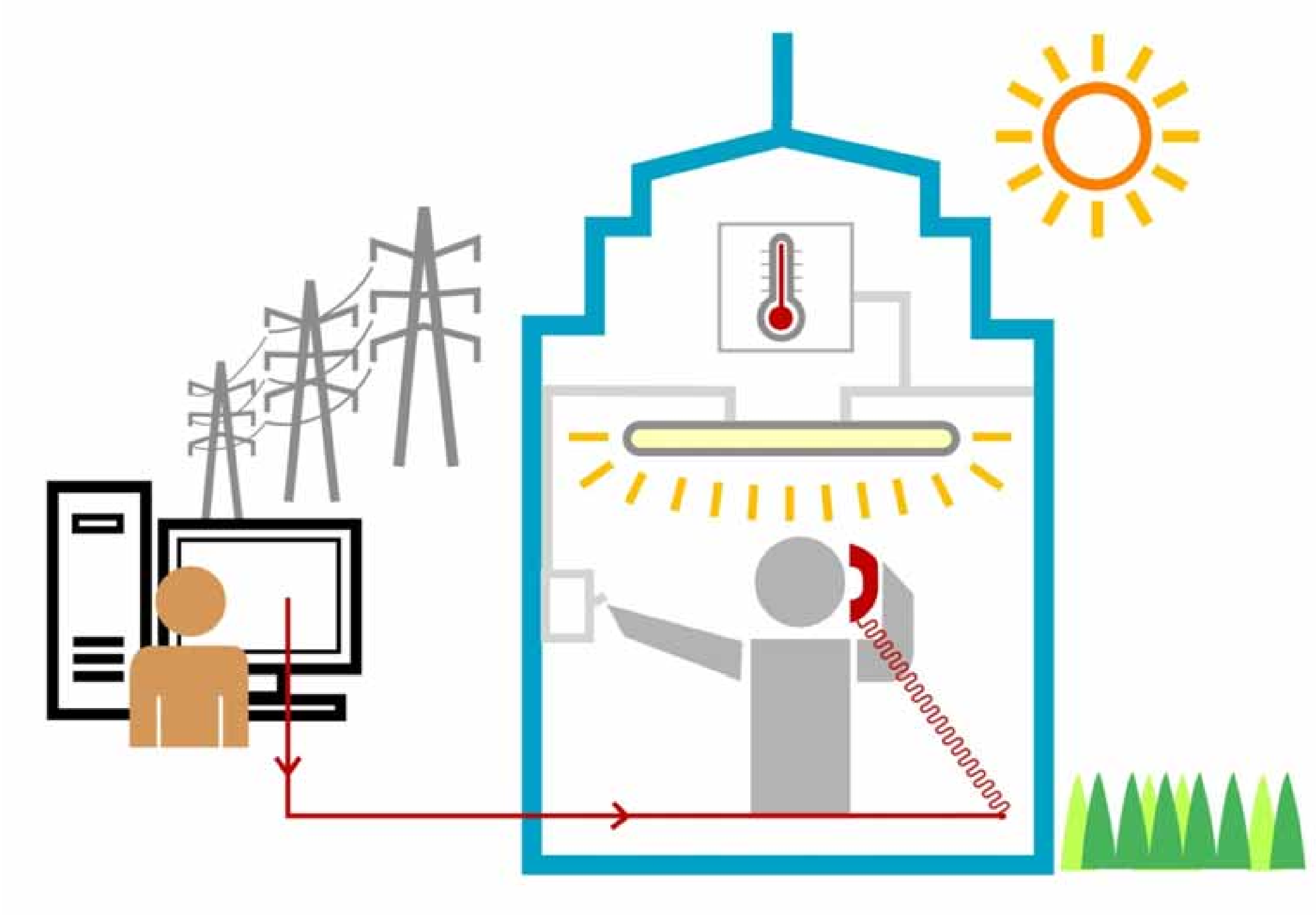


Figure 5-9: Actual System Load, Wind Generation and Solar Generation for Fall 2006

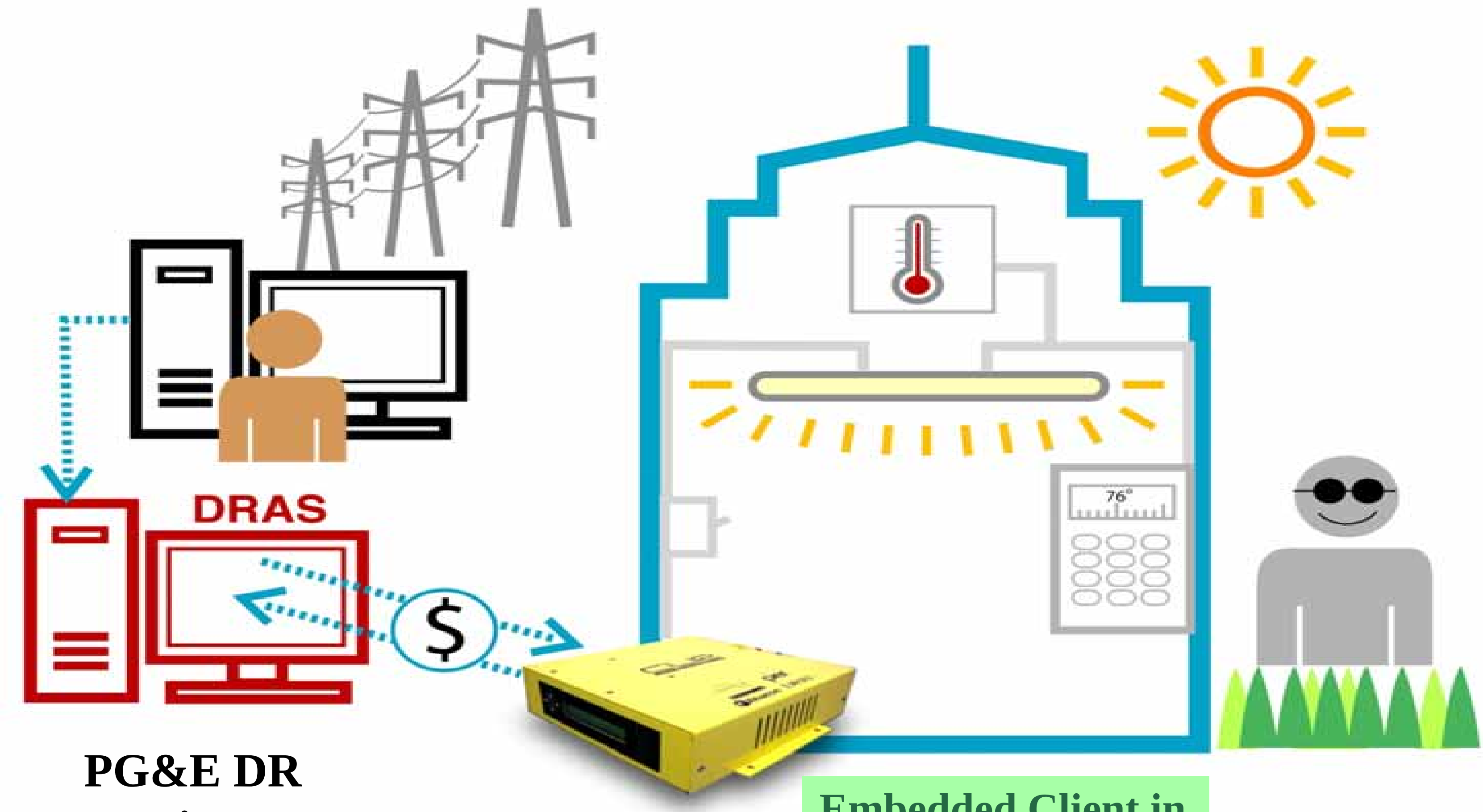
What Is Automated Demand Response (Auto-DR)?

- Imbalances in the grid may cause grid reliability issues or energy price fluctuations, both of which may result in the need to actively balance the supply/demand of the grid.
- Options for dealing with imbalances include:
  - Purchasing power from another state, e.g. Canada, or Mexico (expensive)
  - Start up old generation plants (AQMD issues)
  - Build new power plants (Very Costly)
  - Black outs, Brown outs (High customer impact)
  - Voluntary customer power reductions (Demand Response)
- Auto-DR is a well defined, automated, voluntary reaction to a DR event called by Utilities and Independent System Operators requiring energy consumption/reduction during an anticipated period of imbalance in the grid.

Manual Demand Response



Reliable, Persistent DR - Auto-DR with OpenADR



PG&E DR
Automation Server

Embedded Client in
New Controls

Example of a Typical DR Event

Honeywell-Akuacom LBNL

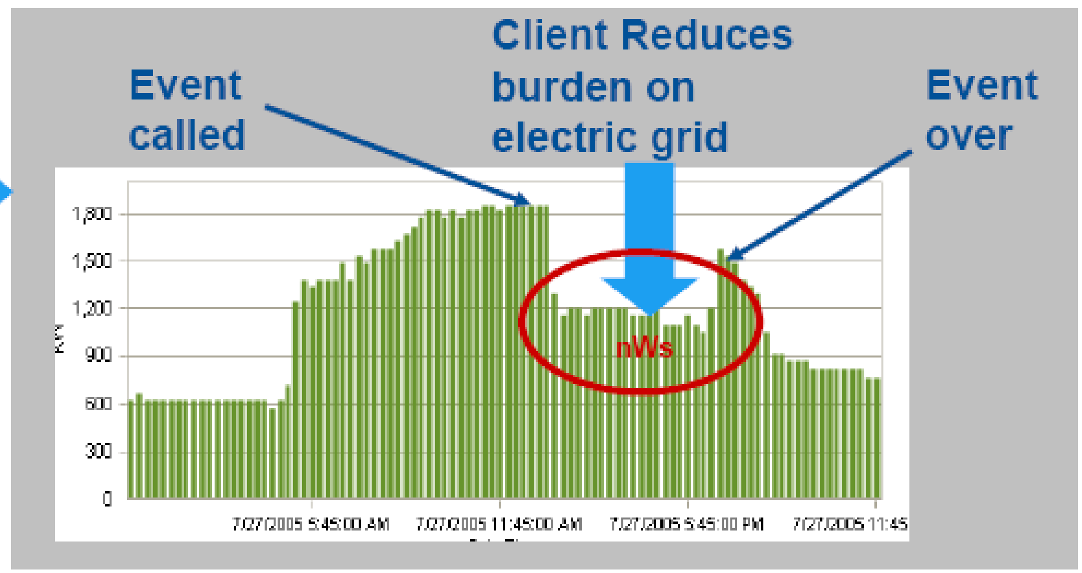
GRID STRESS ⟶ Notification ⟶ Client Actions

Turn off 1 of 4 elevators

Pre-cool building in early morning hours

Turn on emergency generator (can use as monthly generator test)

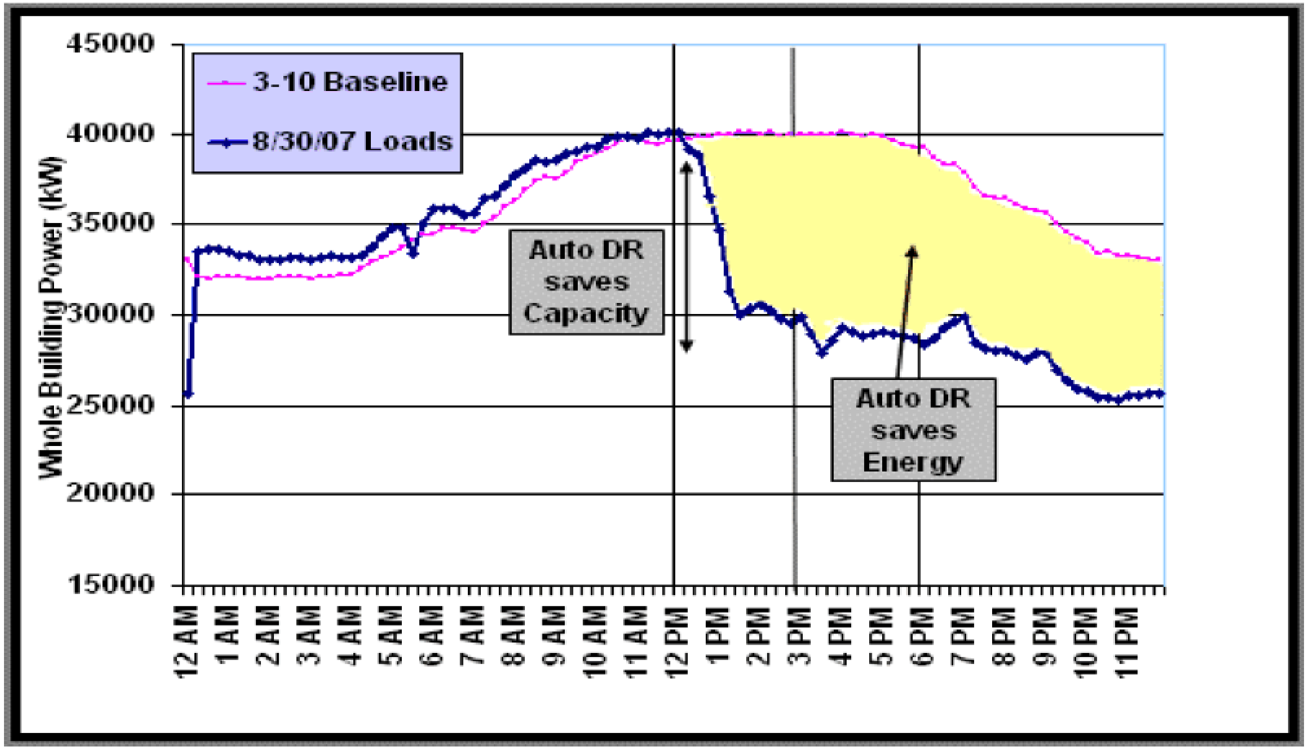
Turn off non-essential lighting



Secretary Chu – Grid Week 2009

Automated Demand Response Saves Capacity and Energy

Electric load profile for PG&E participants on 8/30/2007



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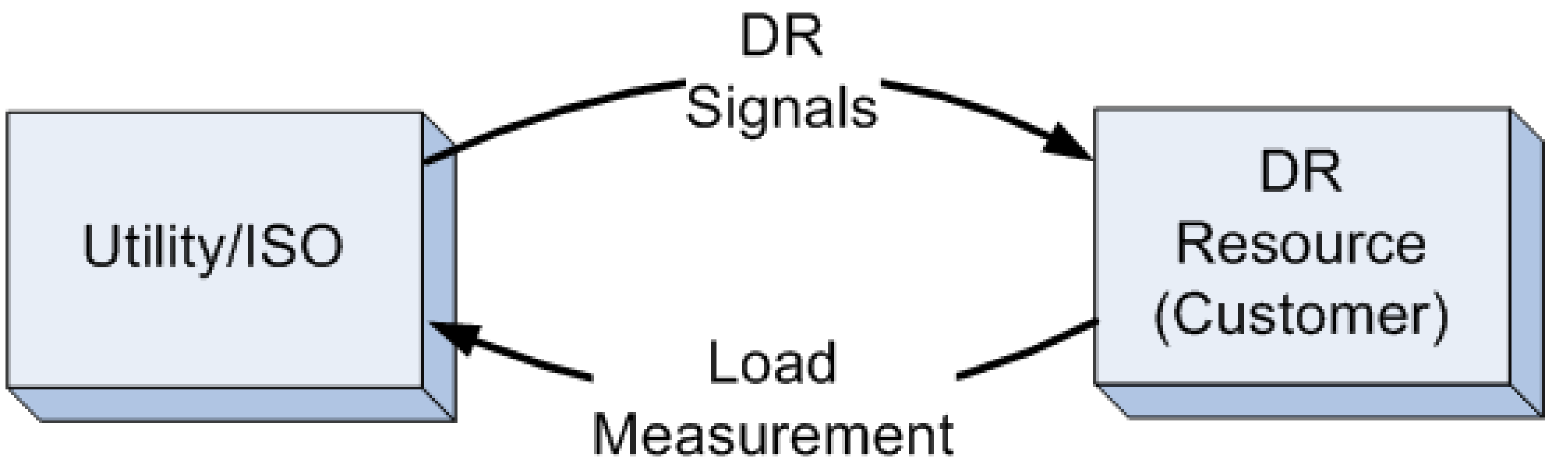
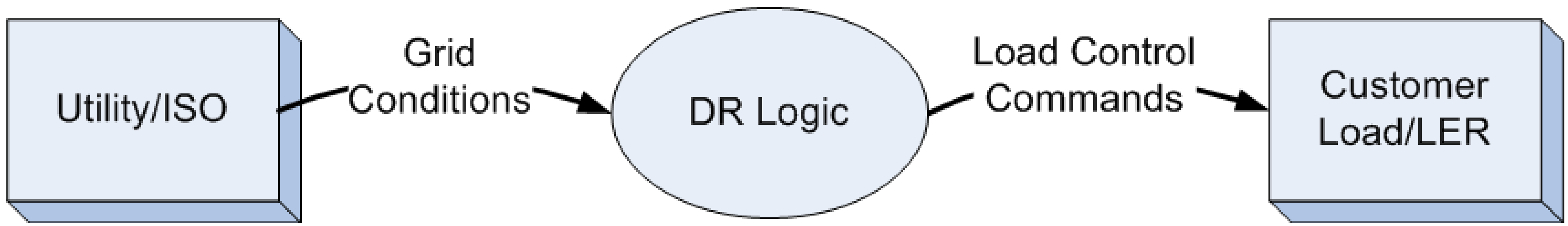
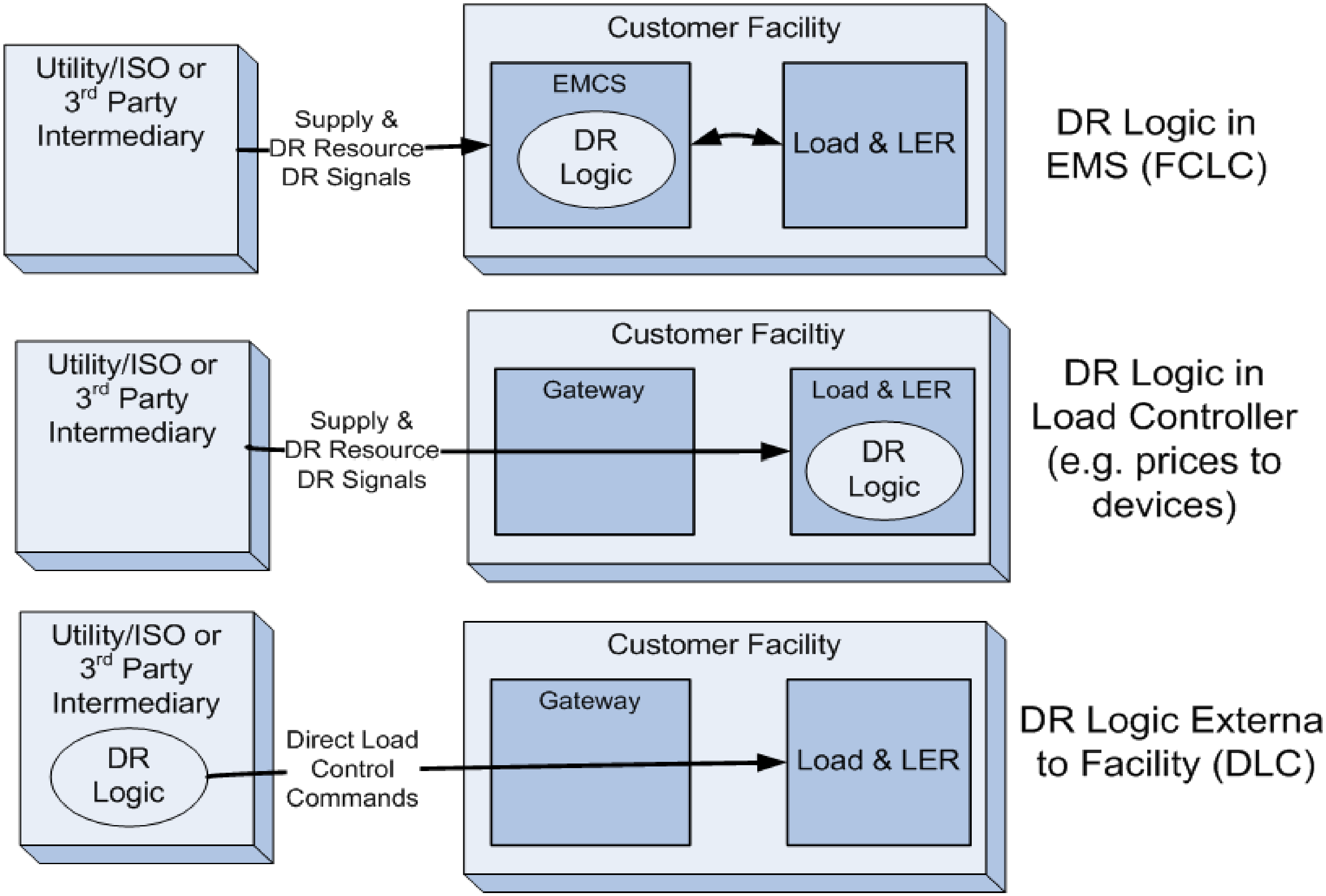
Simple Interaction Model



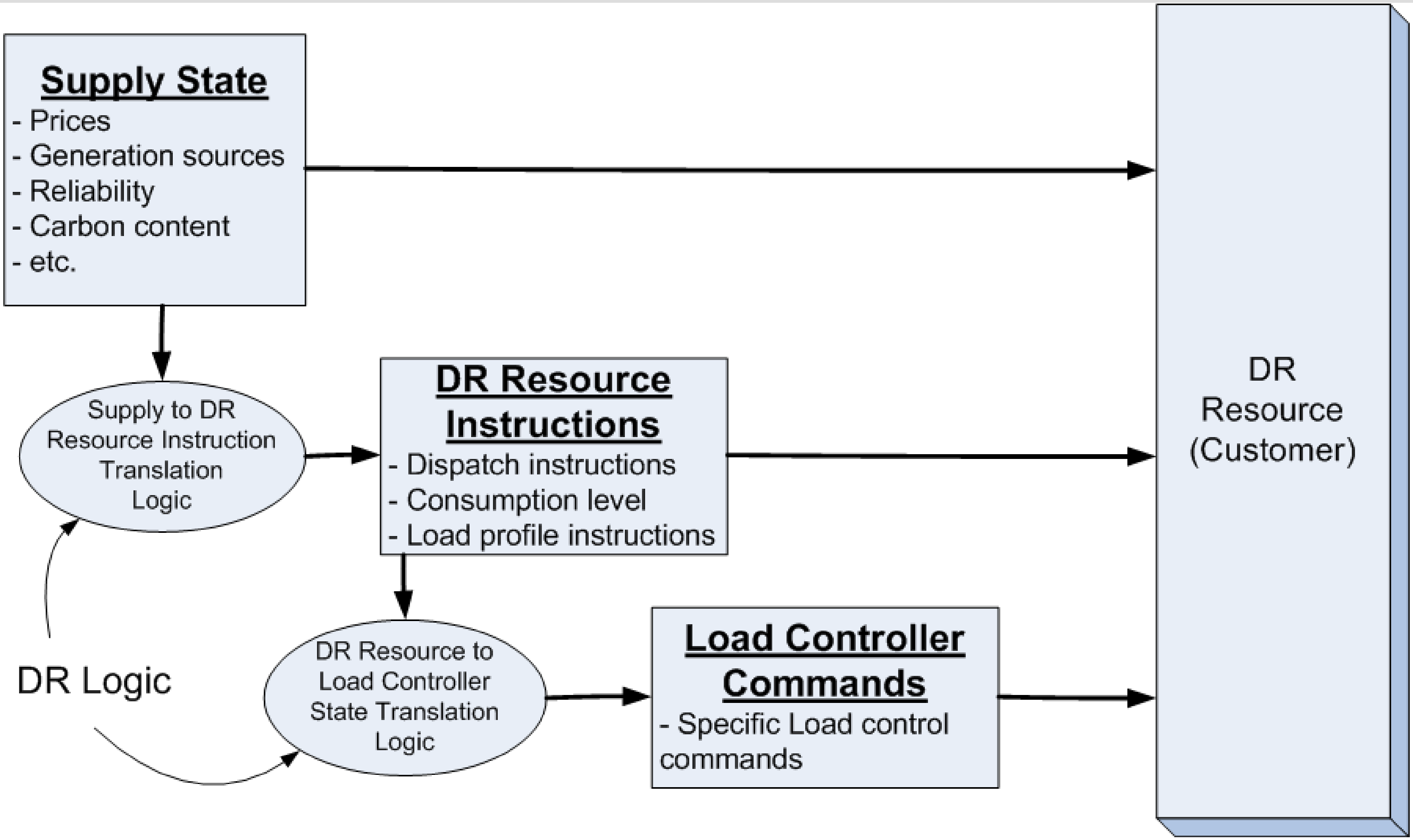
DR Logic Concept



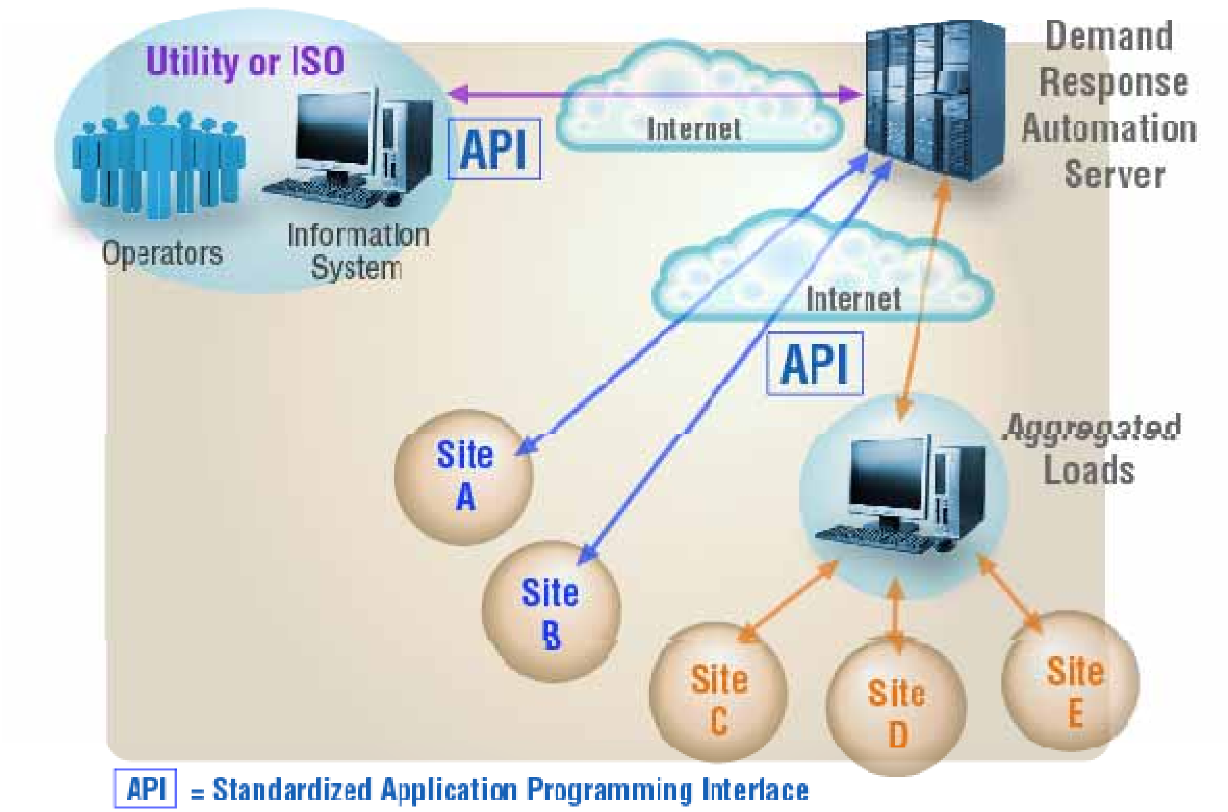
DR Logic Scenarios



DR Signal Hierarchy



DR Architecture - OpenADR



Signaling- continuous, 2-way, secure messaging system for dynamic prices, emergency and reliability signals. One-way applications are under development

Client-server architecture - uses open interfaces to allow interoperability with publish and subscribe systems

Current system - uses internet available at most large facilities or broadcasting points.

Hardware retrofit or embedded software - many clients fully implemented with existing XML software

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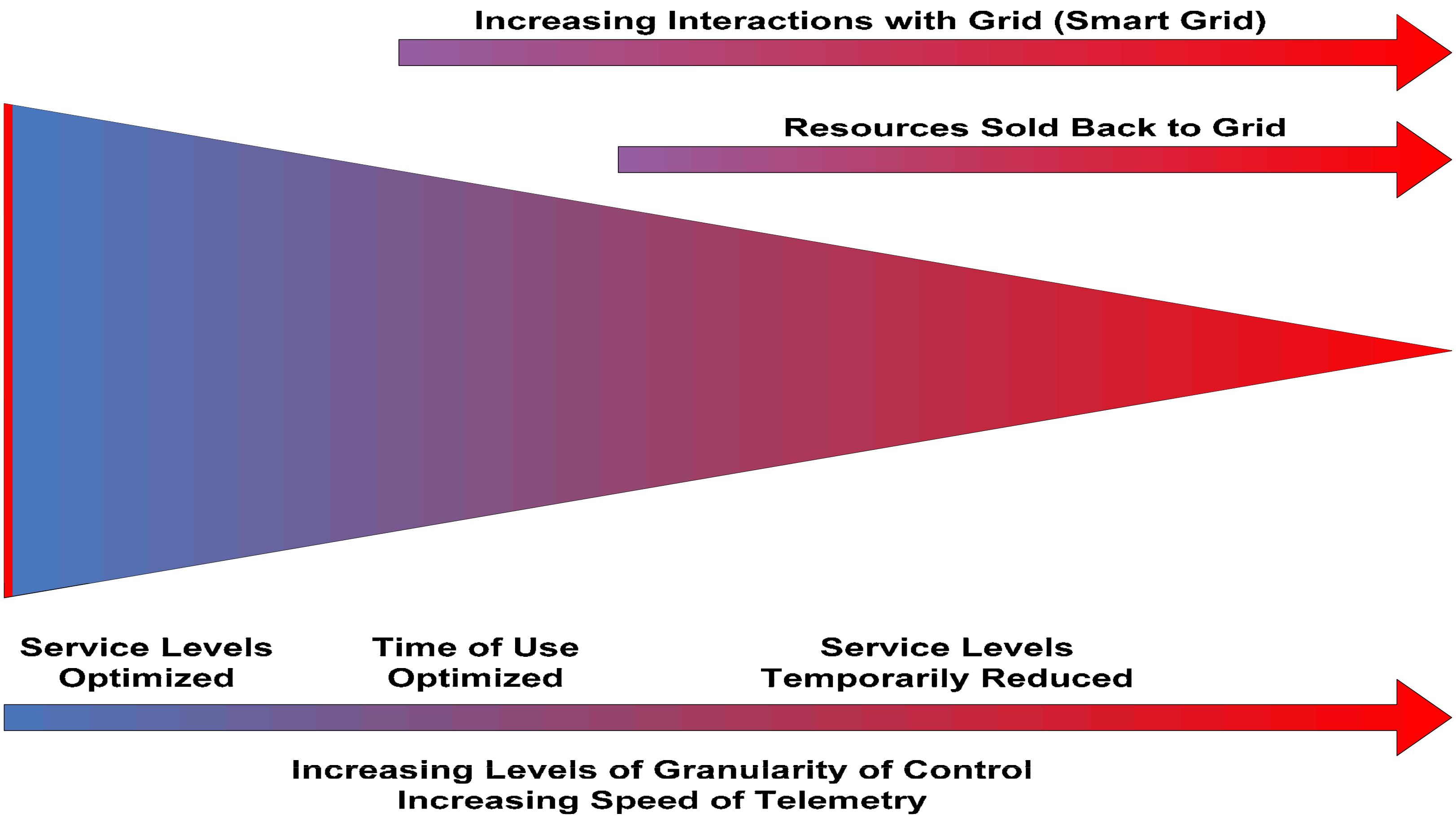
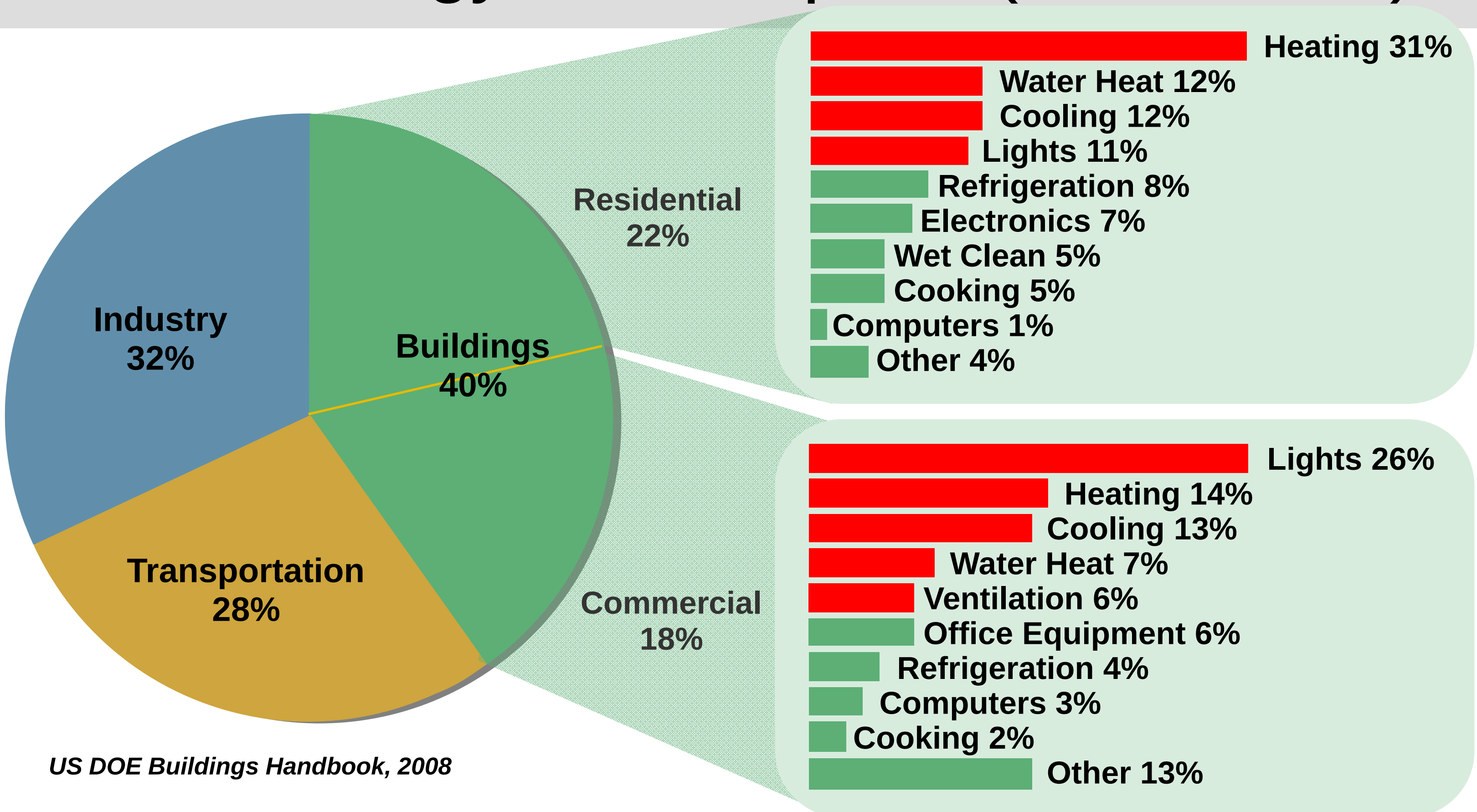
Facility Energy Management and the Smart Grid



U.S. energy consumption (all sources)



US DOE Buildings Handbook, 2008

Building automation controls 66% of energy use in homes and buildings today—the smart grid will enable more

About 70% of the nation's electricity consumption is in homes and buildings

DR Shed Strategies

Global Temperature Reset Migrating to California Energy Code

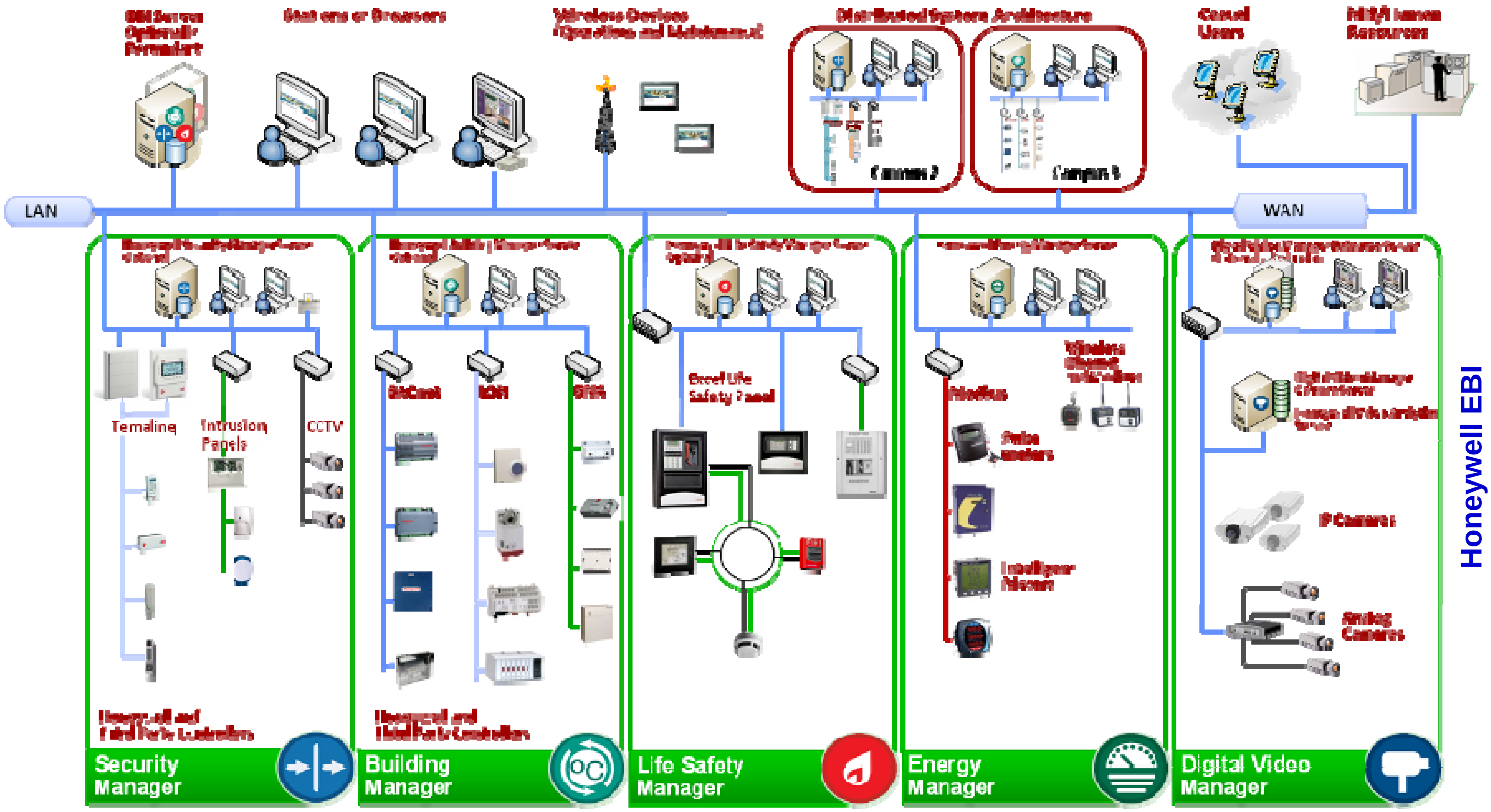
	Building use	HVAC: Global temp. adjustment	HVAC: Duct static pres. Increase	HVAC: SAT Increase	HVAC: Fan VFD limit	HVAC: CHW temp. Increase	HVAC: Fan qty. reduction	HVAC: Pre-cooling	HVAC: Cooling valve limit	HVAC: Boiler lockout	HVAC: Slow recovery	HVAC: Extended shed period	Lighting: Common area light dim	Lighting: Office area light dim	Lighting: Turn off light	Lighting: Dimmable ballast	Lighting: Bi-level switching	Other: Non-critical process shed
ACWD	Office, lab	X	X	X		X			X	X		X						
B of A	Office, data center		X	X	X	X			X									
Chabot	Museum	X						X										
2530 Arnold	Office	X									X							
50 Douglas	Office	X									X							
MDF	Detention facility	X																
Echelon	Hi-tech office	X	X	X			X						X	X	X	X		
Centerville	Junior Highschool	X						X										
Irvington	Highschool	X						X										
Gilead 300	Office			X														
Gilead 342	Office, Lab	X		X														
Gilead 357	Office, Lab	X		X														
IKEA EPaloAlto	Furniture retail	X																
IKEA Emeryville	Furniture retail	X																
IKEA WSacto	Furniture retail																	
Oracle Rocklin	Office	X	X															
Safeway Stockton	Supermarket																X	
Solectron	Office, Manufacture	X													X			
Svenhard's	Bakery																	X
Sybase	Hi-tech office														X			
Target Antioch	Retail	X					X											
Target Bakersfield	Retail	X					X											
Target Hayward	Retail	X					X						X				X	
Walmart Fresno	Retail	X															X	

Commercial buildings—smart grid complexities

- The energy used for “overhead” (HVAC / lighting / etc.) must be balanced with the energy used for “production,” or meaningful work in a facility
  - requires detailed knowledge of overhead and production loads
- Building codes must be followed (indoor air quality, energy efficiency, etc.)
  - specific operating conditions must be maintained
- Control schedules for commercial buildings must be designed with knowledge of weather, indoor conditions, expected occupancy, etc.
  - building should be “comfortable” just in time for first occupants but not any earlier
- Startup of loads (in occupied mode or after power failure) must be managed
  - e.g., electrical spikes cannot be tolerated
- Complete replacement of existing control systems typically not feasible
  - gateways used to interface with newer technologies
- Thermal / ice storage increasingly common for load shifting
  - requires knowledge of current and future cost of energy, weather information, current and future demand, existing storage capacity, etc.

Domain knowledge essential for load management

Building automation system example



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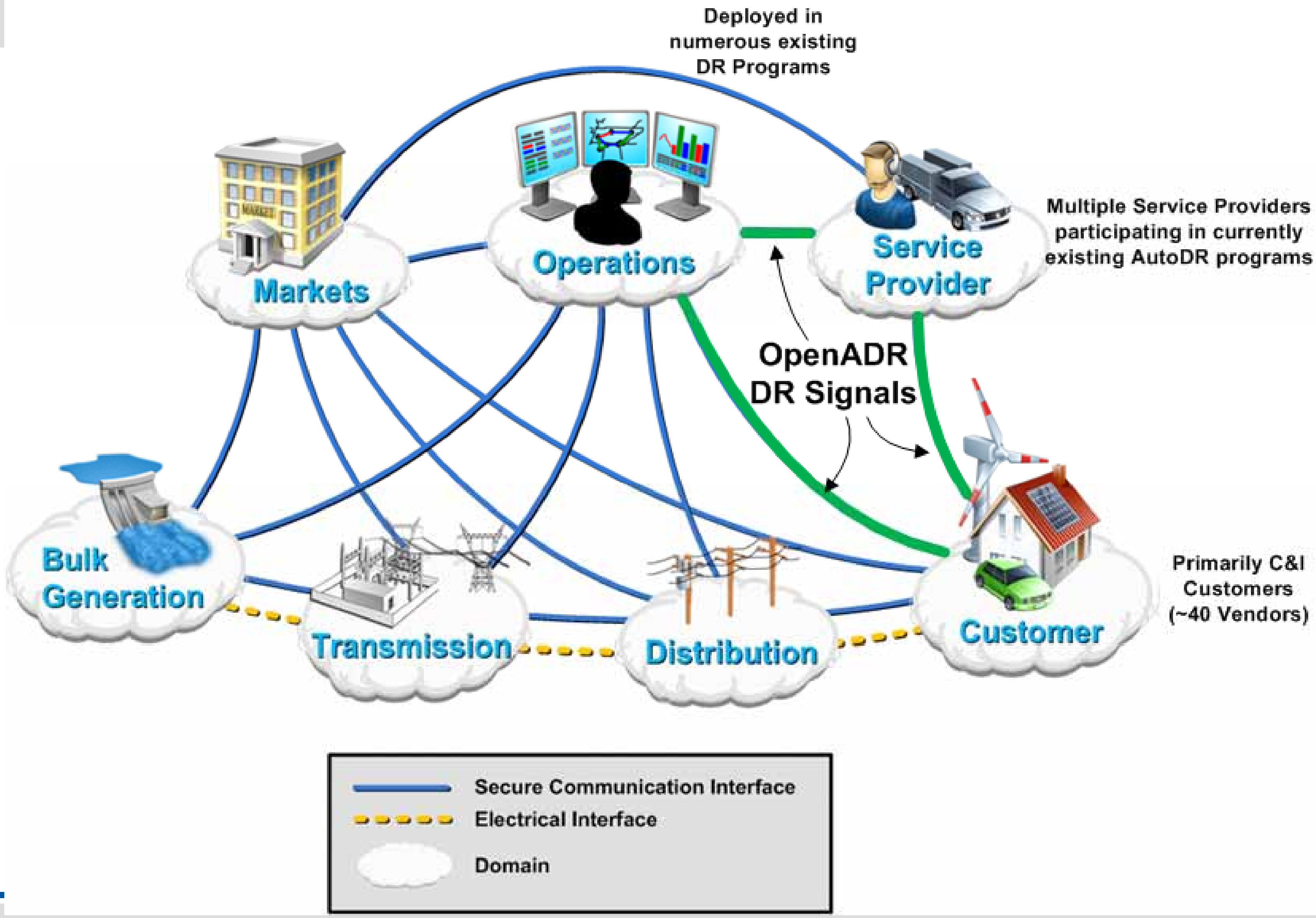
OpenADR and NIST Smart Grid Roadmap Conceptual Model



OpenADR History and Timeline

Research initiated by LBNL/ DRRC
(California Energy Commission PIER)

Pilots and field trials
- 2003: Developments, tests
- 2004: Scaled-up tests, relay
- 2005-06: CPP/ Auto-CPP (PG&E)

OpenADR Commercialization
(PG&E, SCE, and SDG&E)

First official OpenADR v1.0 specification by LBNL/CEC*

1. OpenADR standards
2. Pilots and field trials
- Wholesale markets (CAISO)
- Pacific-NW (Winter DR)
3. International demos.

2002 2003 2004 2005 2006 2007 2008 2009 2010

1. OpenADR donated to OASIS and UCAIug
- UCA OpenADR Taskforce formed
- OASIS EI TC formed
2. NIST Smart Grid, PAP 09
3. Honeywell Smart Grid
- ARRA 80MW Auto-DR w/ SCE

openADR ALLIANCE

***OpenADR v1.0:** http://openadr.lbl.gov/

Smart Grid Interoperability Panel Priority Action Plans Related to DR

http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/WebHome#Priority_Action_Plans_PAPs

- PAP 03 – Common Price Communication Model
  - http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/PAP03PriceProduct
- PAP 04 – Common Scheduling Mechanism
  - http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/PAP04Schedules
- PAP 09 – Standard DR and DER Signals
  - http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/PAP09DRDER
- PAP 10 – Standard Energy Usage Information
  - http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/PAP10EnergyUsagetoEMS
- PAP 17 – Facility Smart Grid Information
  - http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/PAP17FacilitySmartGridInformationStandard

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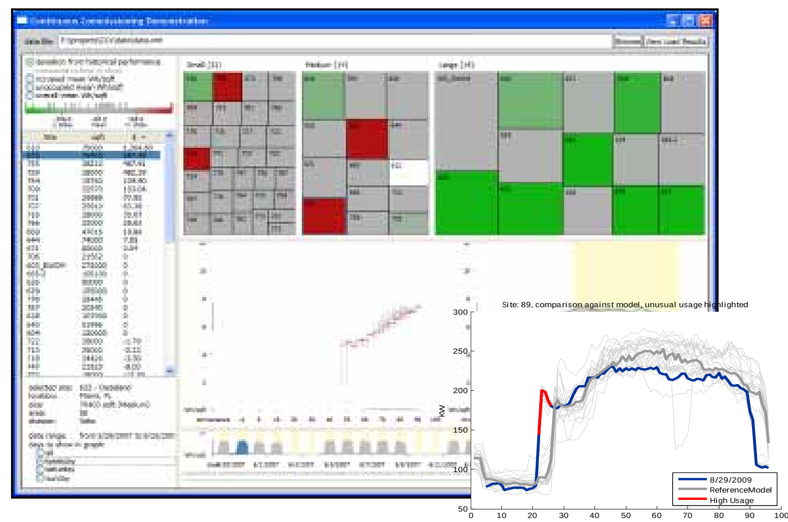
Novar Remote Energy Management Service

- Honeywell Novar keeps energy consumption and costs low for multi-site businesses and reduces peak loads for utilities
  - 6 GW under management in U.S.
- Novar multi-site customers include:
  - Walmart, Office Depot, Home Depot, Lowes
- Internet and standard protocols used
- Typical results
  - 20-40% improvement in energy efficiency and maintenance costs
  - 10-20% reduction in peak use
- Analysis & Feedback
  - comparison between buildings and to baseline
  - root cause analysis
  - maintenance and operational recommendations

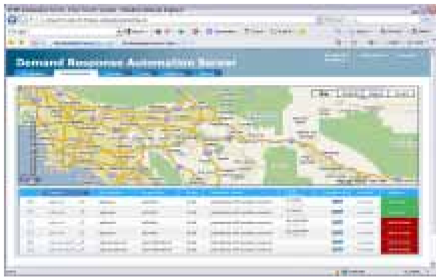


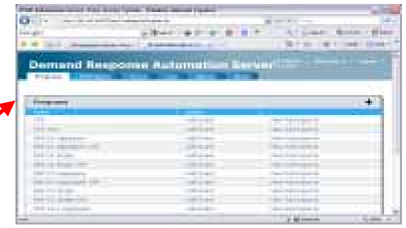
Secure cloud-based energy management with existing communication infrastructure

Automated DR for commercial/industrial customers

Southern California Edison — An Edison International Company

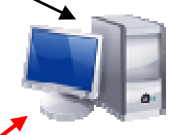
- CPP Tariff Creation
- System Planning
- Event Notification
- Incentive Payment
- Regulatory Reporting





Honeywell

- Project Implementation
- Operating Center
- Reporting



Honeywell (Akuacom)

DR Automation System

- Event Control / acknowledgements
- Information Dashboards
- Reporting

Tridium JACE

- Integration with Existing BAS
- Customer Dashboard

Honeywell

700 SCE Customers (80 MW – AutoDR)

- > 200KW
- Program Participation Agreement
- DR Specific Programming Change to BAS
- Individual Event Participation

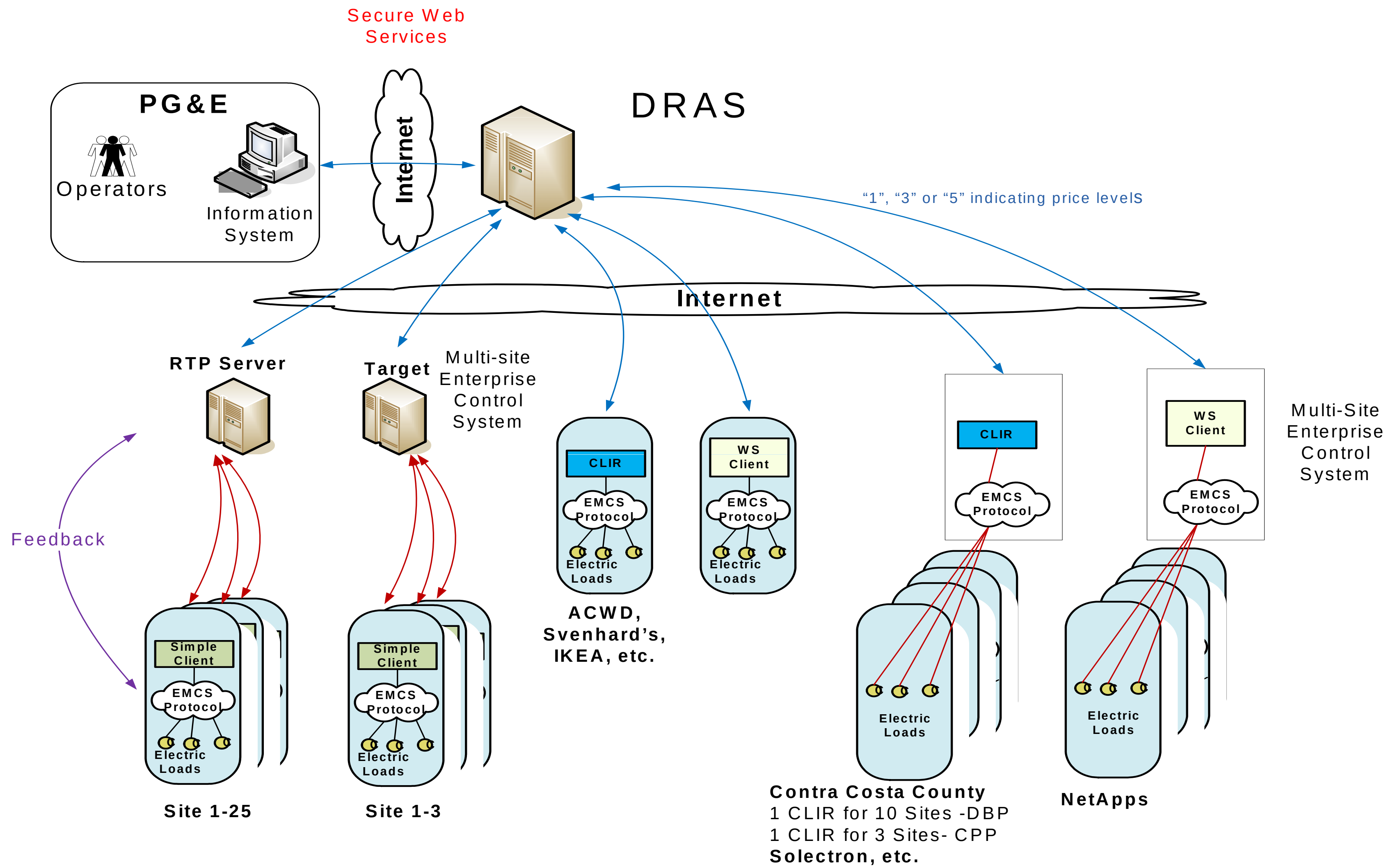
U.S. Department of Energy

- **2009 Recovery Act Selection**
  - Category 2: Customer Systems
  - Recovery Act Funding Awarded: $11,384,363
  - Total Project Size: $22,76,8726
- **2009 Recovery Act Selection**
  - Similar projects with Cities of Tallahassee and Quincy in Florida

Auto DR Programs in CA

- Pacific Gas and Electric
  - Critical Peak Pricing (CPP)
  - Demand Bidding Program (DBP)
  - Peak Choice (PC)
  - Peak Day Pricing (PDP) [proposed]
  - Capacity Bidding Program CBP [proposed]
- Southern California Edison
  - Auto DR
  - Critical Peak Pricing (CPP)
  - Demand Bidding Program (DBP)
  - Real Time Pricing (RTP)
  - Capacity Bidding Program (CBP) [coming soon]
  - Demand Response Contracts (DRC) [coming soon]
  - Default CPP tariff [coming soon]
- San Diego Gas and Electric
  - Capacity Bidding Program (CBP)
  - Critical Peak Pricing Default (CPPD)
- CAISO
  - Participating Loads (PL) (currently piloting)
  - Proxy Demand Response (PDR) [proposed]
- Sacramento Municipal Utility District
  - C&I Automated DR program

PG&E Auto-DR System Architecture



Honeywell

- Automated demand response pilots in China, Southeast Asia, and India
- China State Grid application focusing on managing energy use in commercial buildings
- Goals include “near real-time” demand response for relieving stress on grid

energydigital
global energy portal

HOME NEWS COMPANY REPORTS INDUSTRY FOCUS ASSOCIATIONS EVENTS & TRADESHOWS MARKE

TOP STORIES IN Energy Digital

Mercedes-Benz Hybrid and Hydrogen cars Tops with — 1 of 10

Mango Energy Greenwashing Deskt Wind Turbines — 2 o

MARKET SECTORS: UTILITIES ELECTRIC

Honeywell to Develop First Commercial Smart Grid In China

China has chosen Honeywell to develop and test the country’s first commercial smart grid for USTDA and SGEPRI

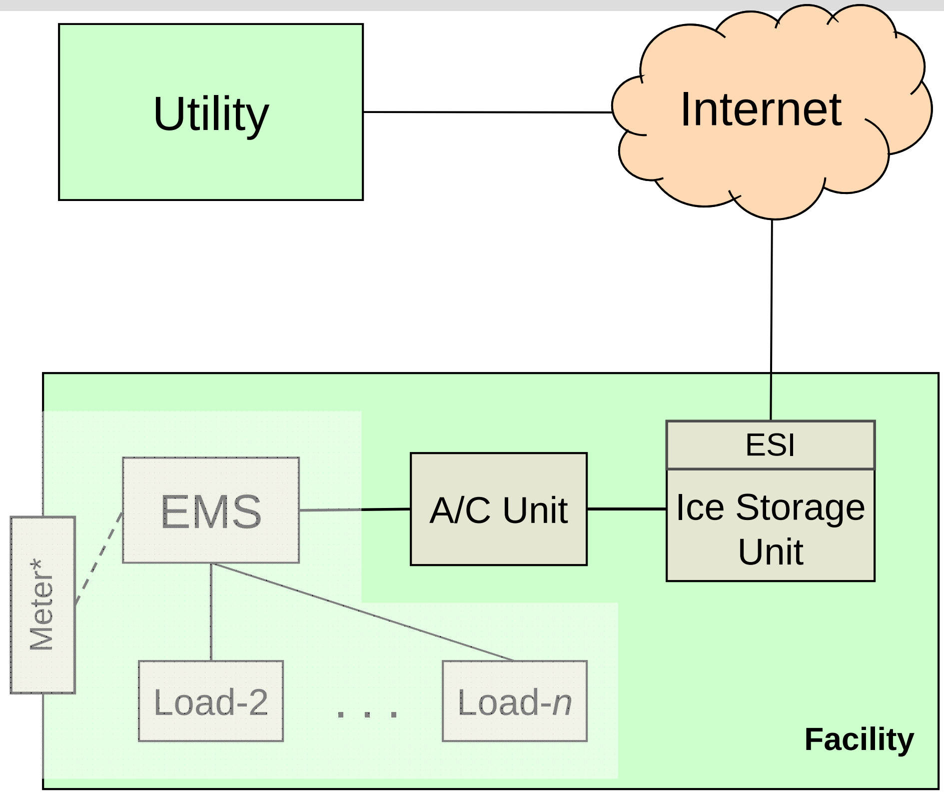
BY: John Shimkus | Mon Feb 28, 2011

TAGS: China, develop, FIRST, Honeywell, SGEPRI, smart grid, USTDA

China smart grid to get upgrade from Honeywell

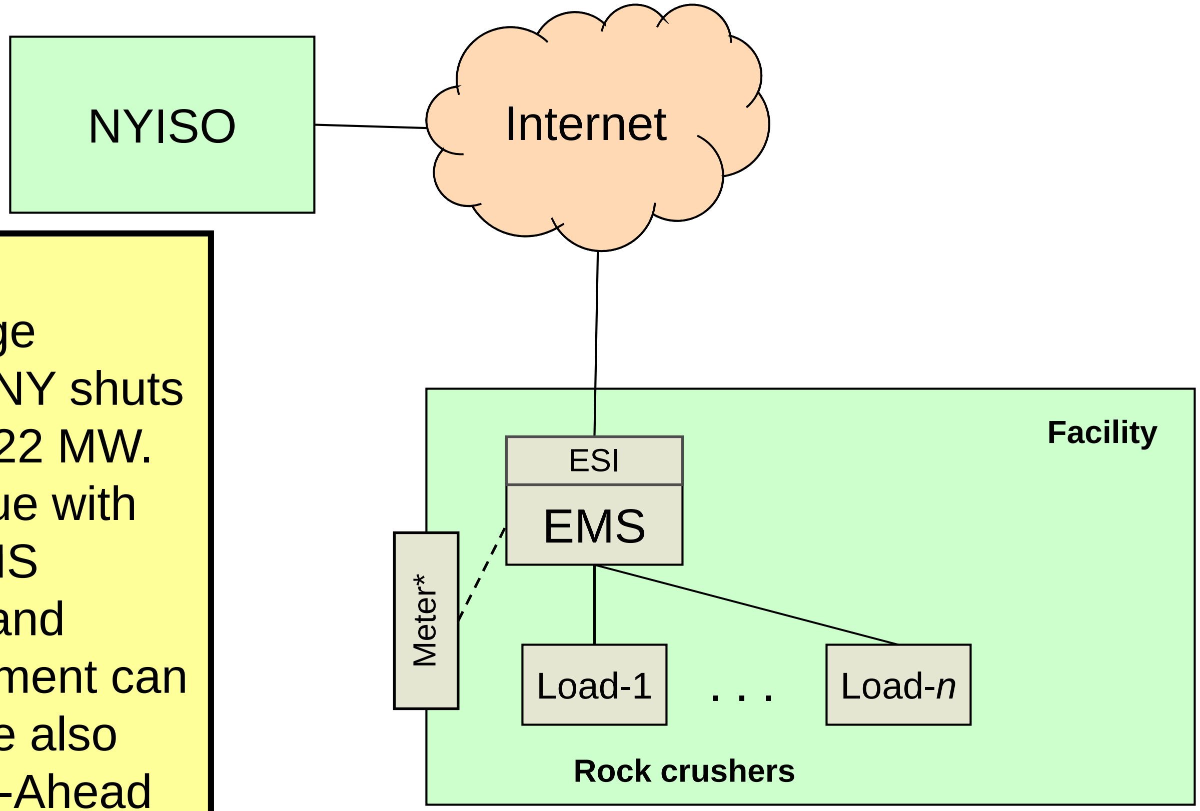
Energy storage to reduce peak demand

C&I smart grid example:
Ice Energy's storage solution (Ice Bear) enables peak load reduction in commercial buildings through the generation of ice during off-peak times and the use of the ice for cooling during peak load. A controller and ESI are part of the Ice Bear product, which determines the energy source (the EMS controls the cooling demand). Condensing unit peak reduction of 94 – 98 per cent is routinely realized in commercial installations.



http://www.ice-energy.com/

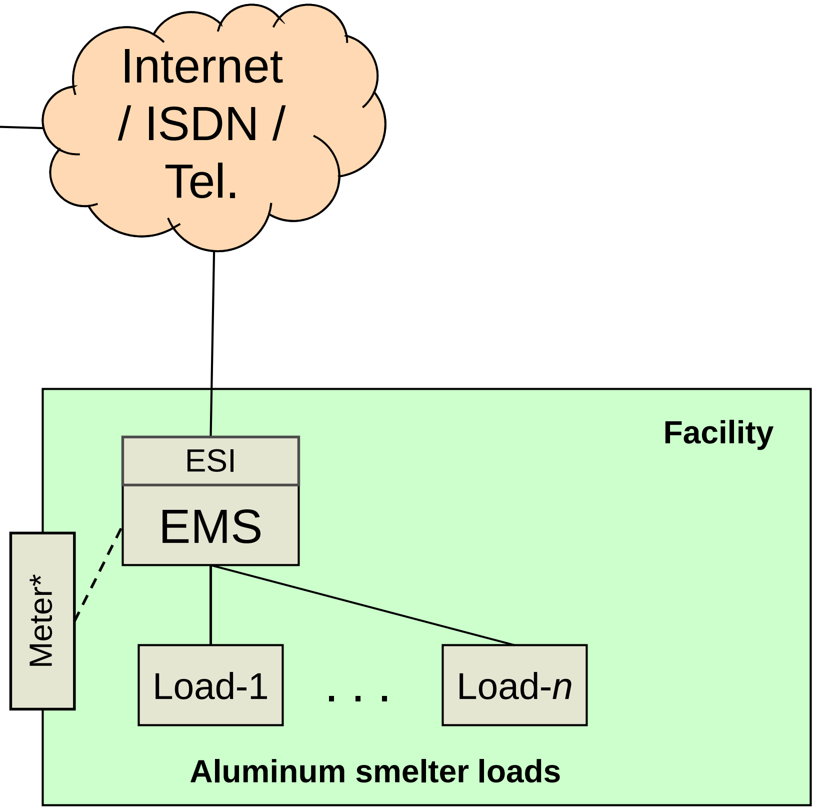
Industrial smart grid application (1)



C&I smart grid example:
On NYISO request, a Lafarge cement processing plant in NY shuts down rock crushers—up to 22 MW. Plant production can continue with stockpiled crushed rock. EMS calculates load curtailment and submissions to NYISO; payment can occur automatically. Lafarge also participates in NYISO's Day-Ahead Demand Response Program—scheduling maintenance during high-priced periods. $2M additional revenue (by early 2005).

Proc. 27th Industrial Energy Technology Conf., 2005.

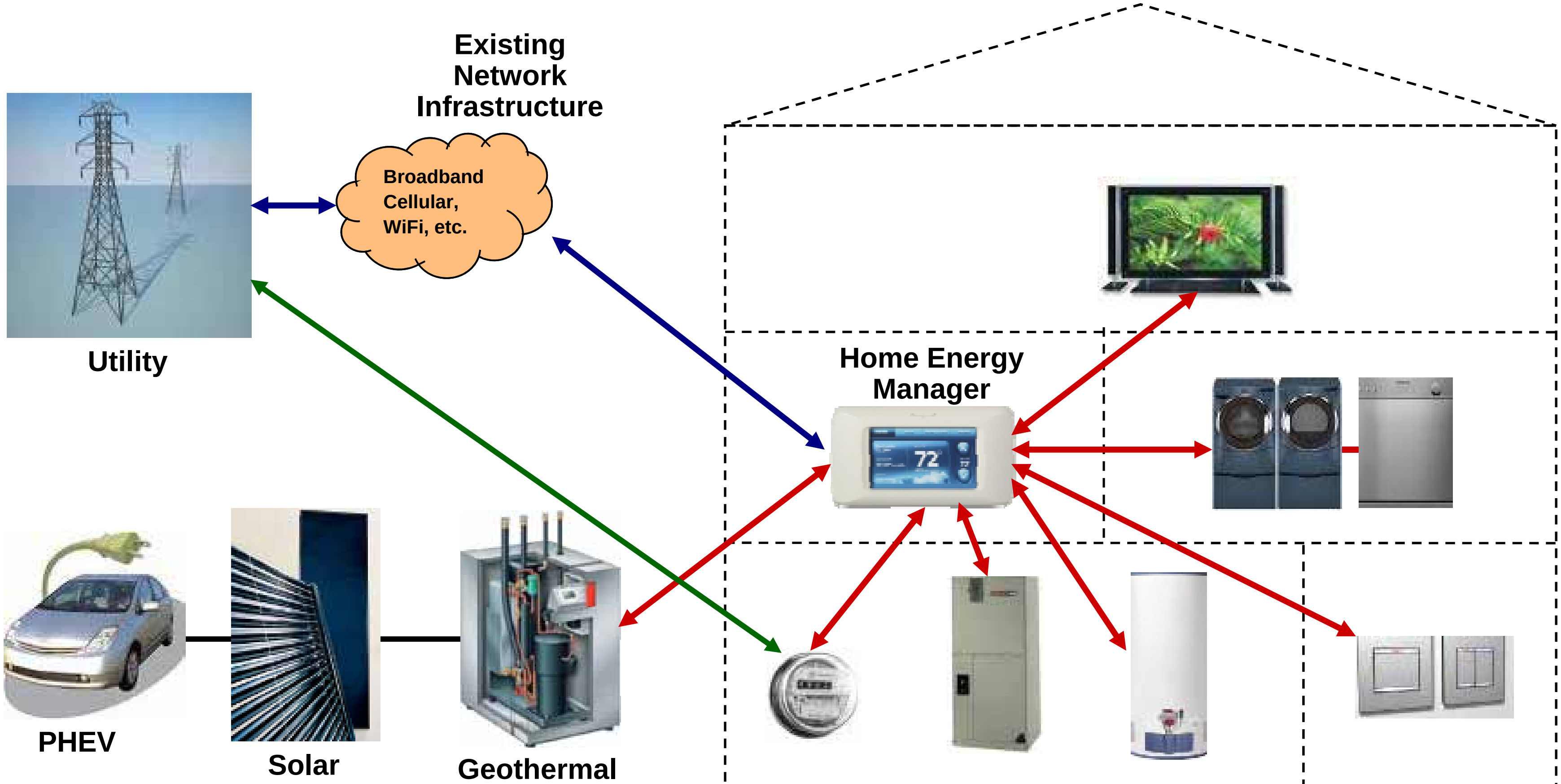
Industrial smart grid application (2)



C&I smart grid example:
Alcoa Power Generation, Inc. participates in the MISO wholesale market by providing regulation of up to 25 MW as an ancillary service through control of smelter loads at Alcoa's Warwick Plant (Ind.). APGI is reimbursed for load modulation as if the energy was generated. Total facility load is 550 MW. More than15 GW of regulation capability is available in U.S. industry. Additional capability exists for other ancillary services.

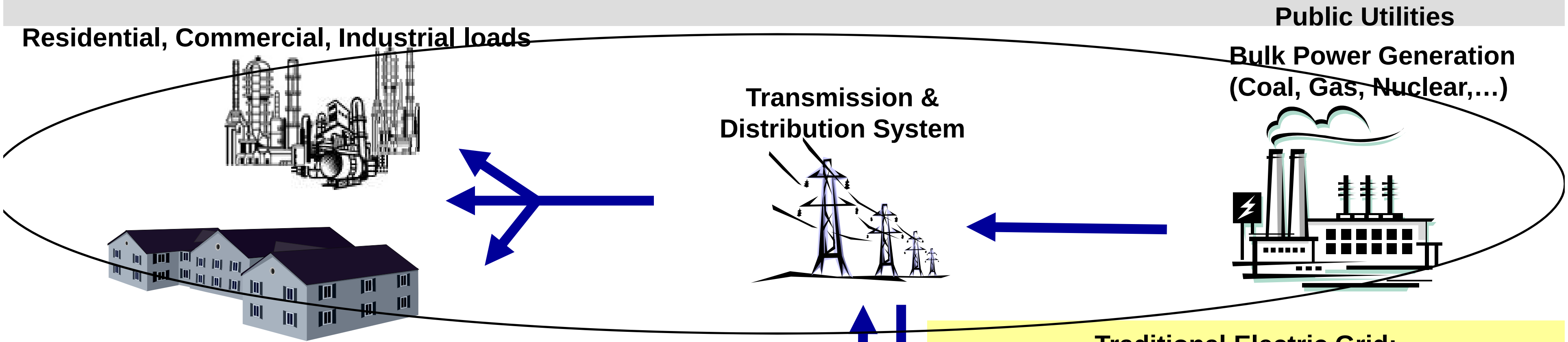
http://info.ornl.gov/sites/publications/files/Pub13833.pdf

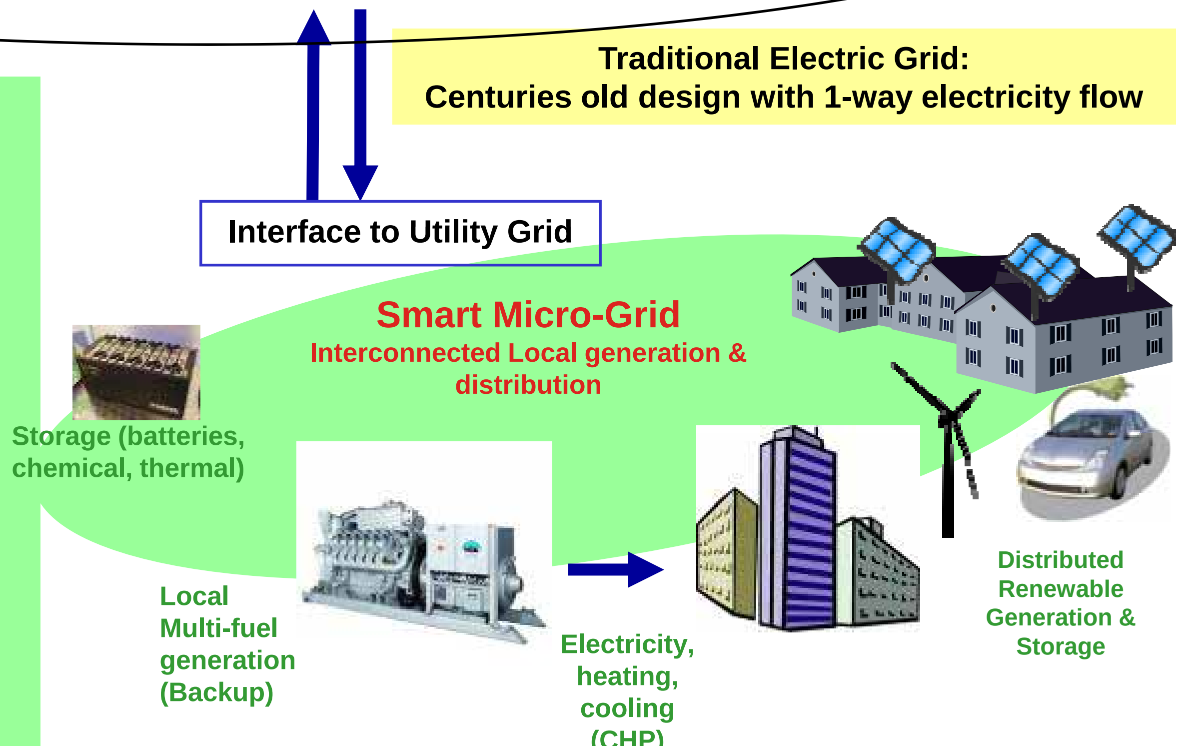
Smart Grid: Residential Perspective



Simple, easy-to-use, secure and efficient solutions using existing infrastructure

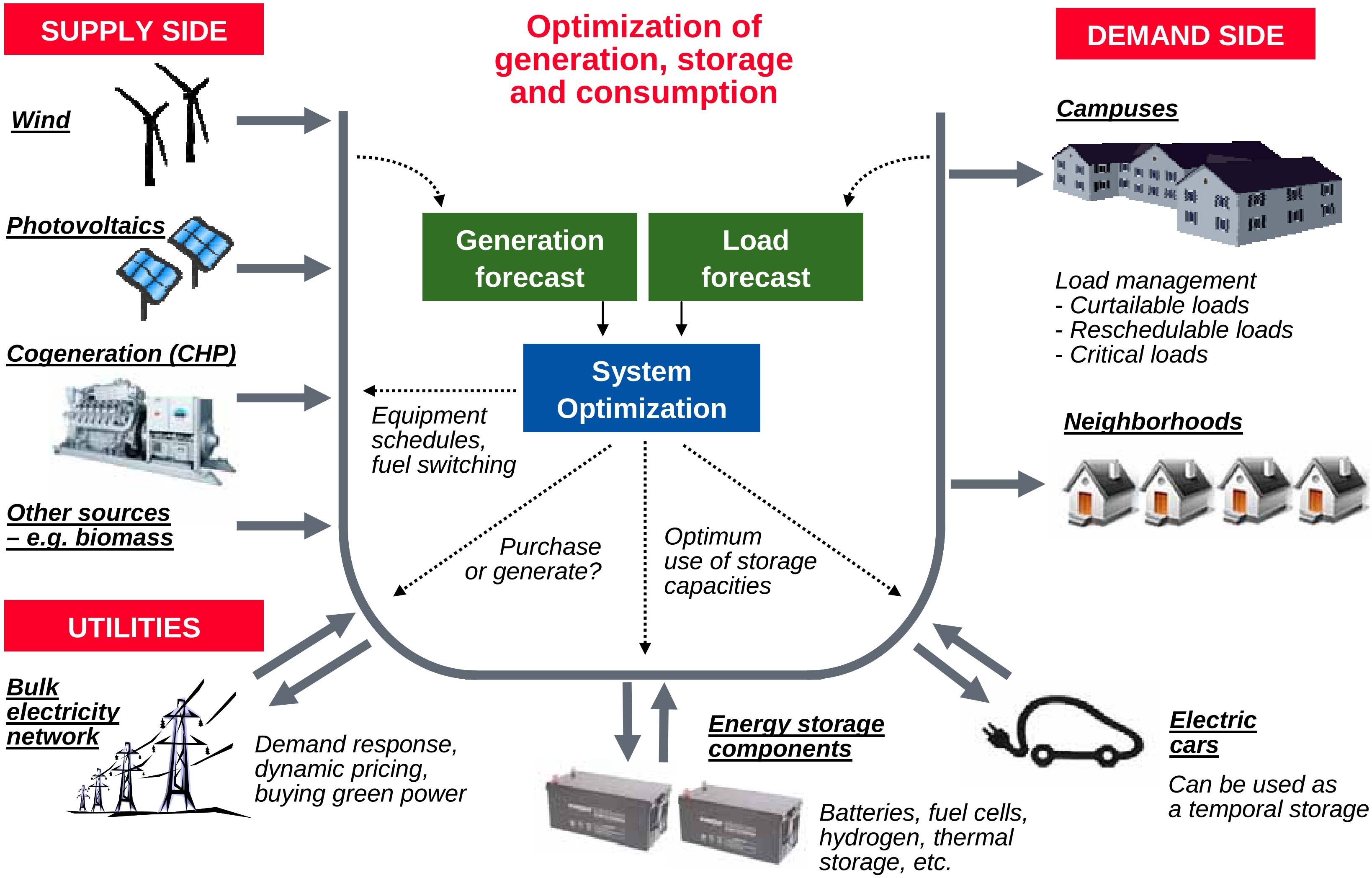
Micro-Grids





- **Micro-Grid Benefits**
  - **Energy security**
    - Renewable generation sources
    - Storage technologies & demand management to integrate intermittent renewables
  - **Increased reliability**
    - Islanding ability to avoid blackout (uninterrupted power)
  - **Improved efficiency**
    - Waste heat recycled for heating/cooling of buildings
    - Reduced T&D losses

Integrated Microgrid Optimization Problem



Common Principles

- The consumer should own and control detailed consumption data
  - utility access to data needed for billing and grid reliability is appropriate
- Existing infrastructure can and should be used for smart grid signals
  - broad-based deployment of new infrastructure is expensive and unnecessary
- Consumers should have incentives and tools to help them manage their demand
  - moving beyond direct load control to demand response

Summary

- Climate change, energy security, grid reliability, economics—issues driving smart grid development
- Beyond yesterday's power system—smart grids extend "beyond the meter"
- End use consumption management includes energy efficiency, direct load control, and, especially, automated demand response
- Successful applications already—existing infrastructure, customer ownership and control
- Research opportunities—microgrids, EV coordination, renewable integration, optimized demand response, and others