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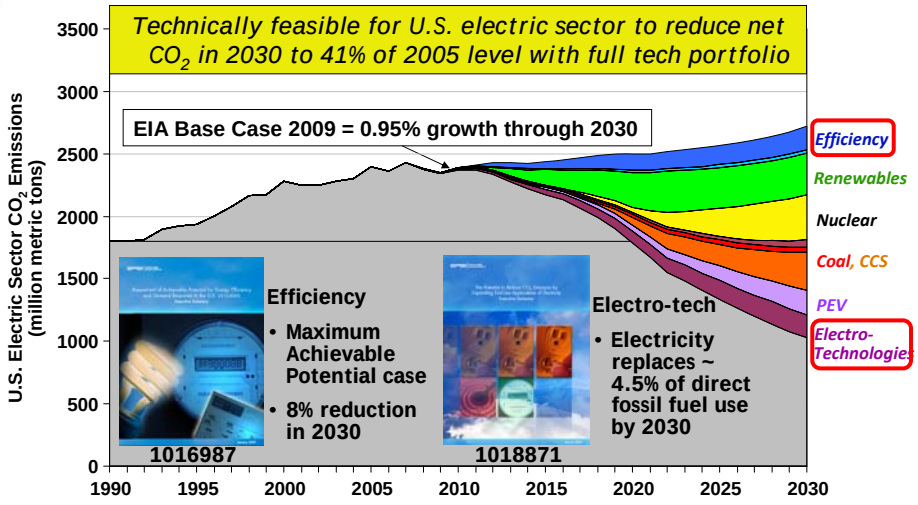
End-Use Energy Efficiency and Demand Response

ASERTTI Meeting at EPRI
Palo Alto, California

October 6, 2009

2009 Prism: Energy Efficiency and Electrotechnologies figure prominently



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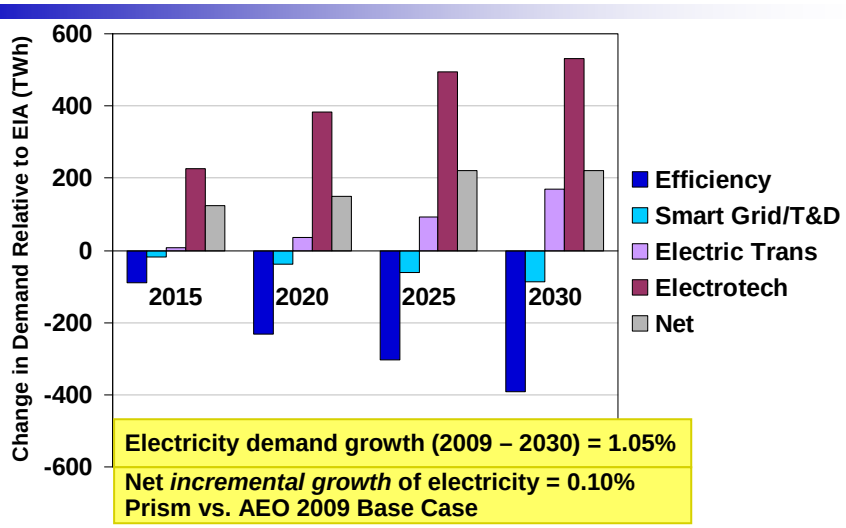
Prism Changes in Electricity Demand



Electricity demand growth (2009 – 2030) = 1.05%

Net *incremental growth* of electricity = 0.10%
Prism vs. AEO 2009 Base Case

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EPRI End-Use Energy Efficiency Program

Advancing EE & DR as Reliable Resources

- **Infuse** technology pipeline for EE/DR programs through testing & demonstration
- **Lead** efficiency development in electronics and "infotainment" technology
- **Advance** technology to enable automated, ubiquitous DR
- **Provide** analytical frameworks on EE/DR
  - Potential magnitude
  - Environmental impact (CO_2)
  - Valuation/economic impact
  - Measurement & verification
  - Feedback and price effects

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Program Structure, 2009-2010

Program 170
End-Use Energy Efficiency & Demand Response

170A Analytical Frameworks	170B Demand Response Systems	170C Energy-Efficient Technologies

P170 2009 Portfolio of Projects

170A Analytical Frameworks

EE → CO2 Modeling
Energy-Use Feedback
DR Valuation Framework
Plug Load Analysis

170B DR Systems

DR-Ready Appliance Designation
Thermal Energy Storage
Integrated Controls for Smart Home
Intelligent Building Control Systems

170C EE Technologies

Industrial Energy Management Tool
Efficient Data Centers
Heat Pumps
Appliances & Commercial Equipment
Advanced Lighting
Electronics Power Supplies
Advanced Motors

Heat Pump Technology

Assessment, Testing, Demonstration

Integrated Heat Pump – Space Conditioning & Water Heating

System and instrumentation installed; testing commencing

Heat Pump Water Heater Testing

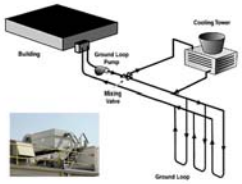
GE, AO Smith, Eco Cute

Variable Refrigerant Flow

Field testing Daikin VRV system

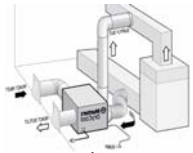
Geothermal Heat Pump

Evaluation of hybrid applications



Advanced Dehumidification

Lab tests using thermal chambers



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Advanced Efficient Lighting

LED Signage

- Efficient, yes, but…
- Potential massive growth
- Power quality questions
- Each module has own power supply, fan, data connection
- Lab testing sample power supplies

14 x 56 ft LED billboard

= 2,162 CFLs (20-Watts)

= 13 homes

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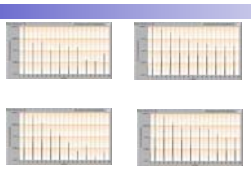
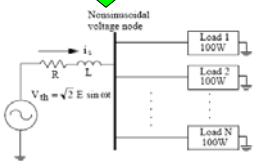
Simulation of High Concentration CFL Impact on Distribution System

Selected variety of CFLs



Test current, phase angle, power factor in lab

Defined CFL Selection & Usage for 3 Living Scenarios



Selected distribution circuits for modeling

Compute simulations using PQ model

Documented Results

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Efficient Data Centers

- Data centers hitting thermal limits
- Can't remove enough heat → can't build to capacity
- Need credible data on innovative heat reduction and efficiency strategies
- Helped draft DOE road map for data center efficiency
- Helping write specification for DC power distribution
- Testing UPS efficiency

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Consumer Electronic Plug Loads: Efficient Power Supplies & Load Research

- Advance power supply efficiencies of HDTVs, gaming consoles, laptops, home theater systems
  - Similar model as "80+" for desktop PCs
  - Game console ~ 1/3 of a refrigerator
  - Designers only beginning to think about efficiency
- Updating standard test procedures
- Quantifying losses in device power supplies
- Distributed measurement plan to characterize plug load usage

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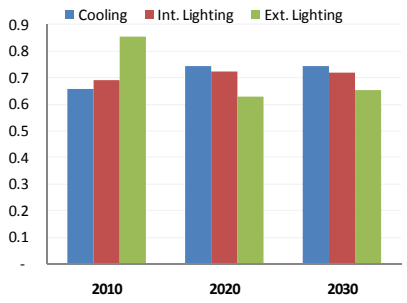
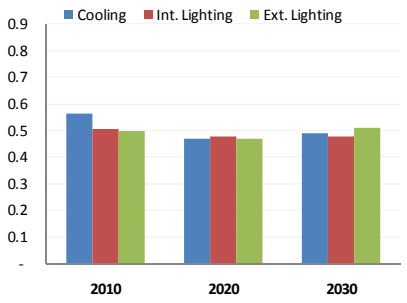
Modeling CO_2 Impacts of Energy Efficiency

CO_2 Intensity for Selected Commercial EE Programs (Tons / MWh)

ECAR



ERCOT



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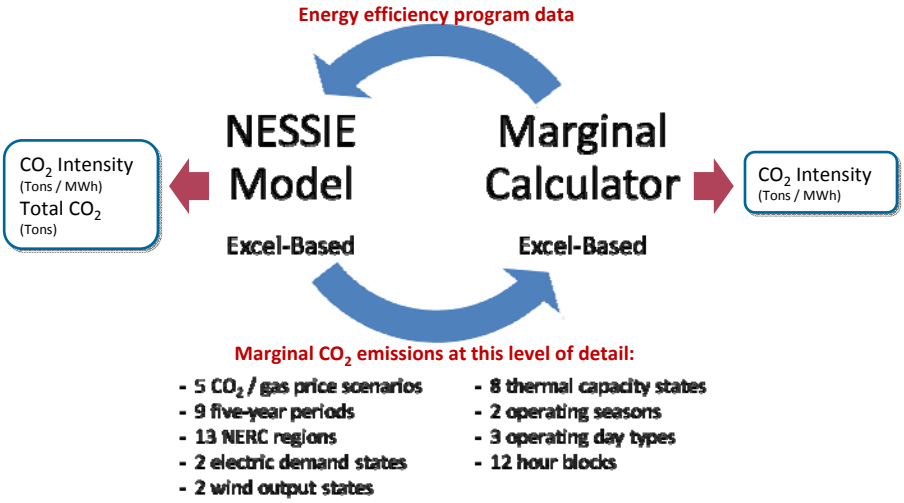
Making complex modeling results easy to apply



Residential Electricity Use Feedback

1 Standard Billing	2 Enhanced Billing	3 Estimated Feedback	4 Daily/Weekly Feedback	5 Real-Time Feedback	6 Real-Time Plus
	Puget Sound		SDG&E	AEP	AEP
	SMUD		TXU	Ameren*	Ameren*
			WPS*	BG&E	CPS Energy
				ComEd	SDG&E
				Energie Baden-Württemberg (Germany)	VEIC*
				Hydro One*	
				LGIS (Australia)*	
				SCL	
				SDG&E	
				SMUD	Interview/update completed
				TXU	
				WPS*	

- Feedback EM&V (back-end protocols)
- Supplemental – Pilot design (front-end protocols)
- SRP M-Power program review
- Monitoring Feedback pilots, programs, initiatives
- New market entrants: Google and Microsoft

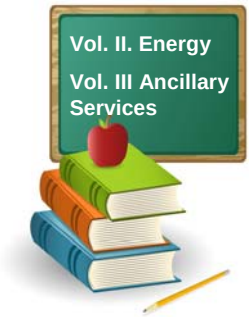
DR Valuation Framework

2009 Field Guide to Valuing Demand:

Volume I. Demand Response as a Capacity Resource

- **DR Categorization scheme**
- **DR as a Capacity Resource – Market Value**
- **Mitigation Factors and their Impact**
- **Boundaries to Market Value**
- **How Much DR is Enough?**
- **Impacts of Subsidizing DR to Foster Participation**

2010 Extensions



DR-Ready Appliance Designation

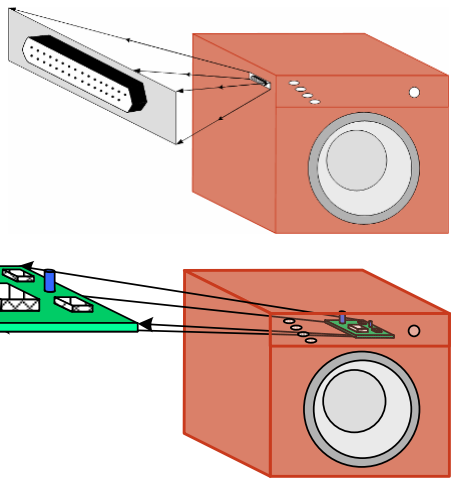
Data Needs

- Use cases
  What would a…
  AC/HP; water heater; pool pump; clothes washer; dishwasher; refrigerator; etc.

  Need to do in order for <u>your company</u> to consider it "DR-Ready"
- Interviews and survey responses

Issues/Challenges

- No standard communications protocol (yet); physical vs. application-layer
- Definitional variations by utility as function of Smart Grid strategy
- Does a consumer-oriented designation like ENERGY-STAR make sense for DR?



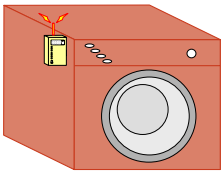
Robust DR-Ready Designation for Diverse Utility and Customer Conditions and Preferences

Home Infrastructure
- Smart Meter
- Gateway/Breaker-Panel

Dispatch Requirements
- Economic DR (price)
- Emergency DR (event)
- Spinning reserve
- Voltage regulation

M&V Requirements (Metrics)
- kW reduction
- kWh reduction
- CO_2
- Time in "active DR" mode

Pricing Structure
- Flat (conventional)
- TOU
- Dynamic (RTP)
- Demand Limiting



Communication Method
- Physical "socket"
- Application layer chip (i.e. Smart Energy Profile)

State Presentment
- In-situ display
- Signal to external display device

Automation
- Pre-program ("set & forget") (who defines defaults?)
- Feedback & behavior-based

Functionality
- Load shifting (timer)
- On/off cycling
- Partial loading

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