











### End-Use Energy Efficiency and Demand Response Research Program

Nicaraguan Energy Institute (INE) NARUC

September 18, 2009

### EPRI End-Use Energy Efficiency Program Advancing EE & DR as Reliable Resources

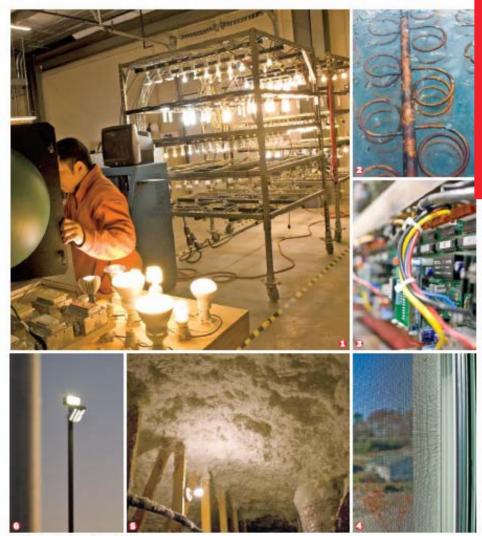
- Infuse technology pipeline for EE/DR programs through testing & demonstration
- Lead efficiency development in electronics and "infotainment" technology
- Advance technology to enable automated, ubiquitous DR
- Provide analytical frameworks on EE/DR
  - Potential magnitude
  - Environmental impact (CO<sub>2</sub>)
  - Valuation/economic impact
  - Measurement & verification
  - Feedback and price effects



### EPRI's EE & DR Living Laboratory Recently Featured in TIME

Wasting Our Watts We don't need new drilling or new power plants.We need to get efficient BY MICHAEL BRUNWALD

Evaluating and testing energy efficiency technology



Photographs for TIME by Jeff Jacobeen-Redux



the green-tech economy. Clearly, it needs an agent. But it's a simple concept waving less energy. Or more peeciely, consuming hers energy to get the same amount of heat for your shower, light for your office and power for your dastructive and time-intensive to rehear damand through efficiency than to increase supply through new drilling worse power plants. A nationwide push to now "negowath" instead of building more megawatic could help rewerse our unsustainable increases in energyhagging and carbon-spewing while creating a sive of jobs and saving a load of cash.

Now this may seeing the primy Carter's payear-old plea for us to turn down the heat and put on sweaters or like an eco-lecture nagging us to turn off lights, drive less and otherwise change our behavior in save answer. It would

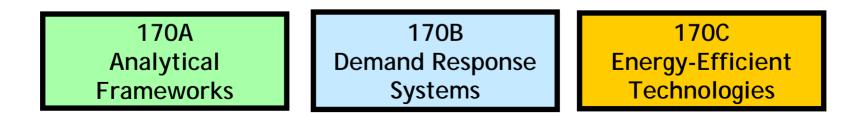
#### 'A lot of simple answers are just sitting around waiting for us to execute.'

-TOM REDDOCH, ELECTRIC POWER RESEARCH INSTITUTE



### Program Structure, 2009-2010

#### Program 170 End-Use Energy Efficiency & Demand Response





# P170 2009 Portfolio of Projects

#### **170A Analytical Frameworks**

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

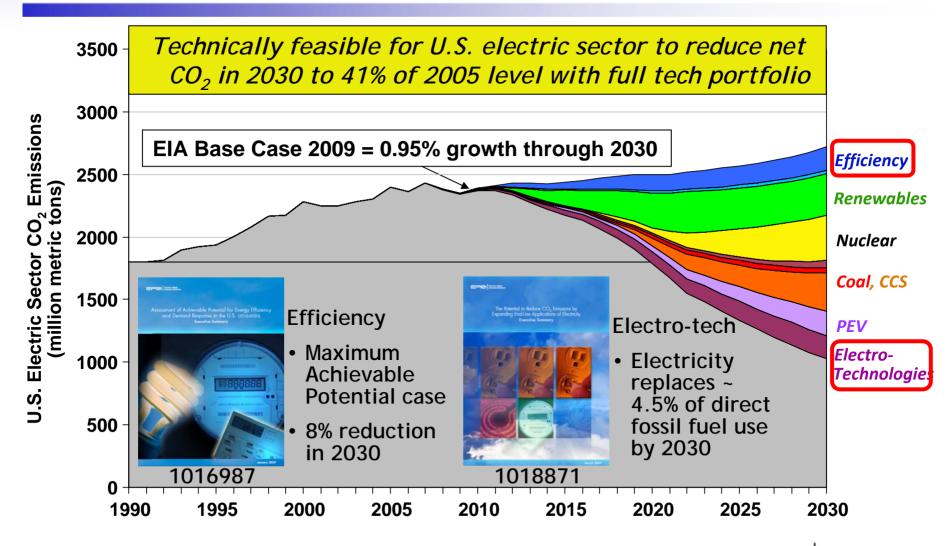
#### 170B DR Systems

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

### 2009 Prism: Energy Efficiency and Electrotechnologies figure prominently

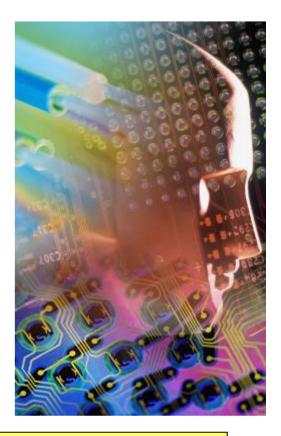




# **Energy Efficiency Potential Study**

# Potential U.S. Energy Efficiency Savings - Now to 2030

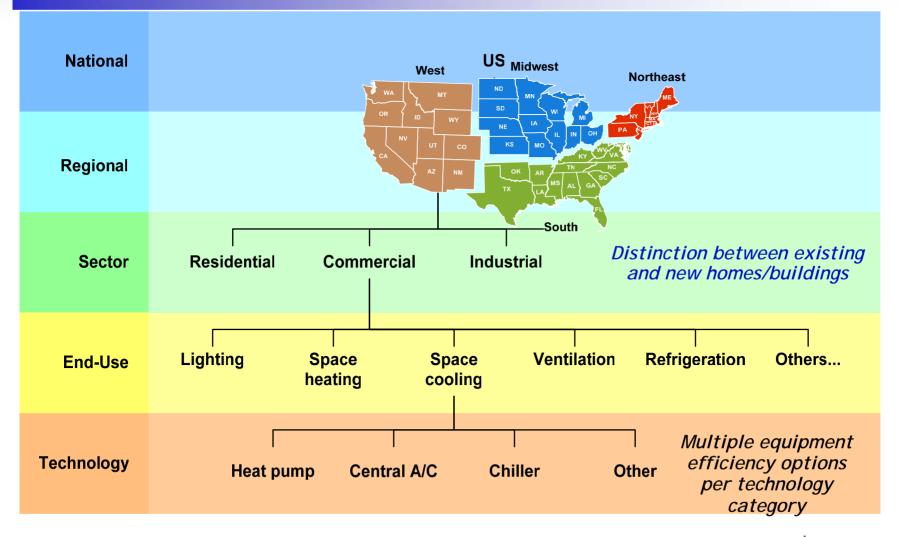
- Detailed micro-economic model
- Calibrated with input from industry experts
- Database of energy efficiency technologies



Latest Research Results from EPRI's Living Laboratory

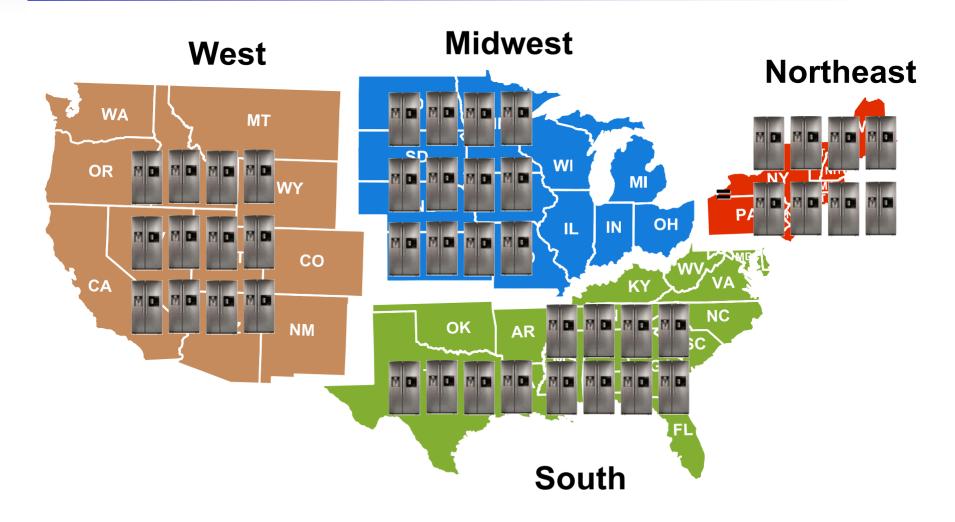


# **Segmentation of Analysis**



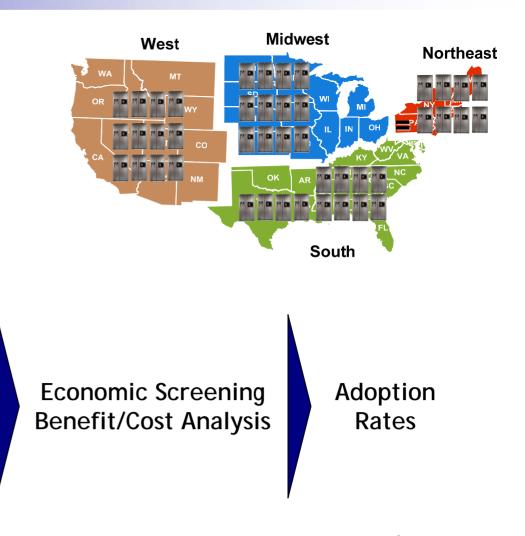


# Stock Turnover - Residential Refrigerators

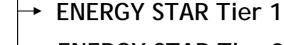




# Stock Turnover - Residential Refrigerators







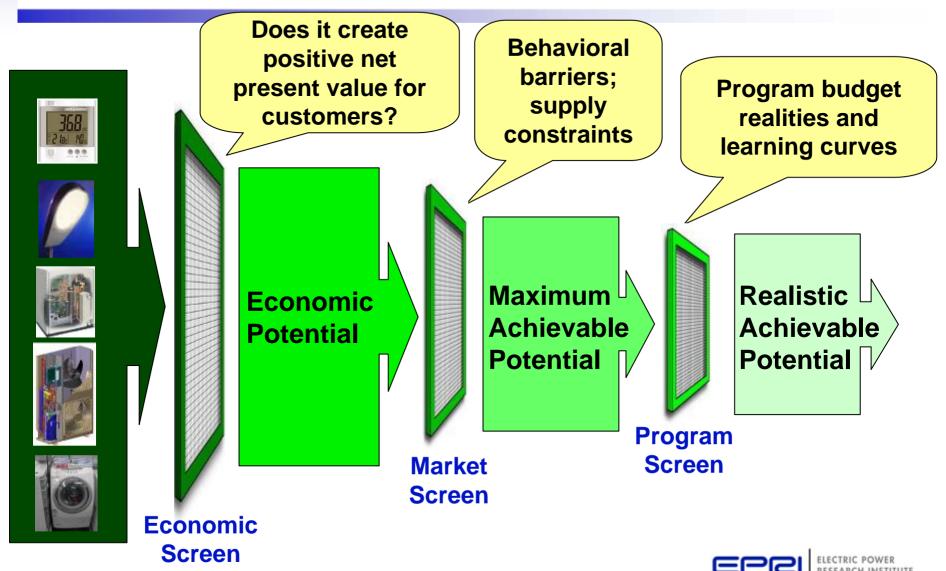
ENERGY STAR Tier 2

**Technology Choices** 

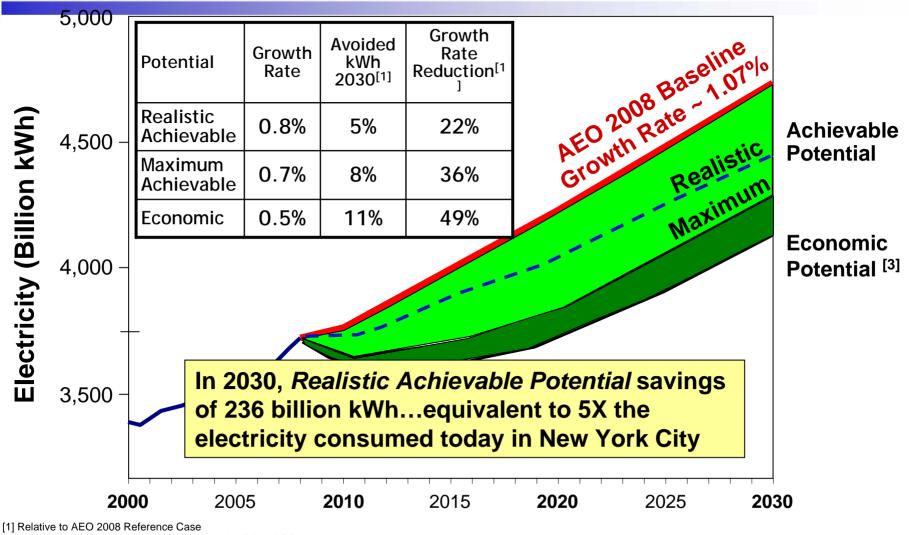
**Standard Efficiency** 

Inverter-Driven

# **Energy Efficiency Potential Analysis**



### U.S. Electricity Consumption Impact of Utility Programs

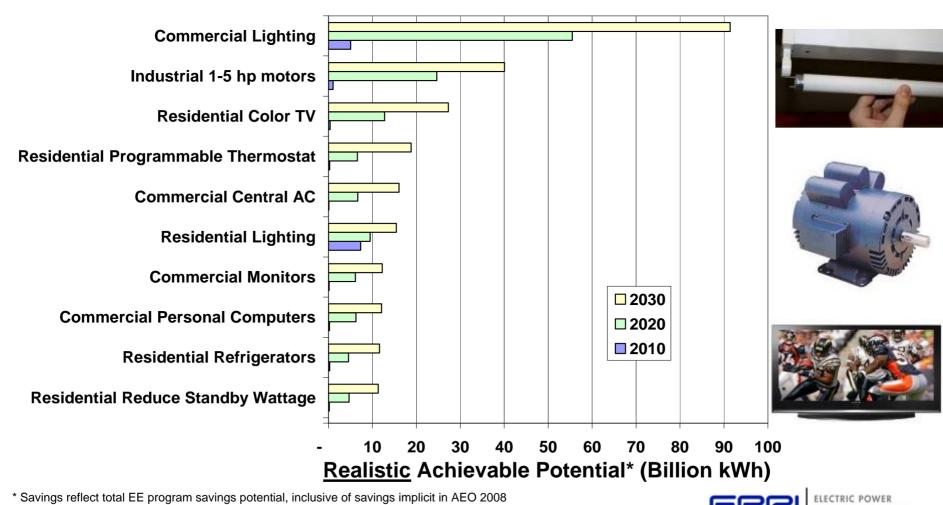


[2] Includes embedded impact of EE programs implicit in AEO 2008

[3] Consumers adopt all available technologies with positive net present value

# **Opportunities for Energy Efficiency** Savings

#### **Top 10 Energy Efficiency Achievable Potential Opportunities**



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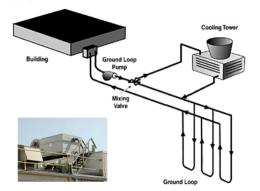
### Heat Pump Technology Assessment, Testing, Demonstration

#### Integrated Heat Pump - Space Conditioning & Water Heating System and instrumentation installed; testing commencing





#### Geothermal Heat Pump Evaluation of hybrid applications



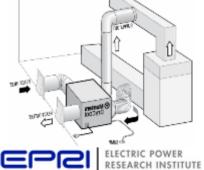
Heat Pump Water Heater Testing GE, AO Smith, Eco Cute



#### Variable Refrigerant Flow Field testing Daikin VRV system



Advanced Dehumidification Lab tests using thermal chambers



# **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



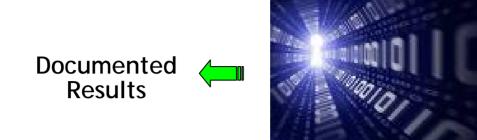
Selected variety of CFLs

Test current, phase angle, power factor in lab

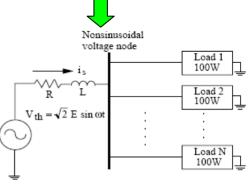




Defined CFL Selection & Usage for 3 Living Scenarios



Compute simulations using PQ model



Selected distribution circuits for modeling



## **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





### 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



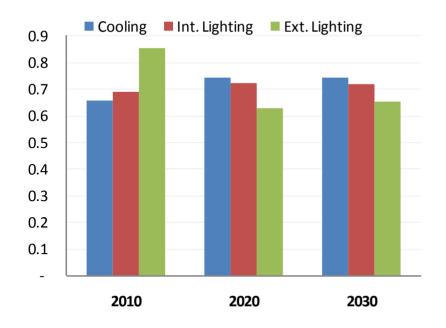




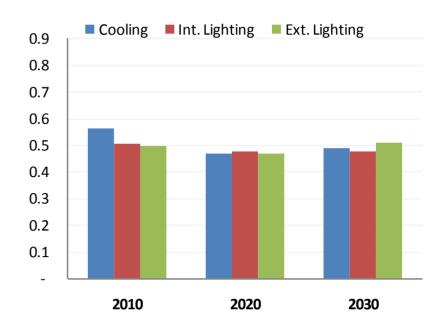
# Modeling CO<sub>2</sub> Impacts of Energy Efficiency

#### CO<sub>2</sub> Intensity for Selected Commercial EE Programs (Tons / MWh)

#### ECAR



#### ERCOT





# **Residential Electricity Use Feedback**

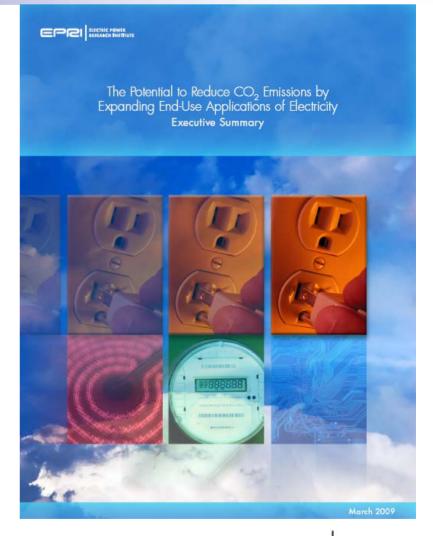
	1 Standard Billing	2 Enhanced Billing	3 Estimated Feedback	4 Daily/Weekly Feedback	5 Real-Time Feedback	6 Real-Time Plus	
	Puget Sound SMUD			SDG&E TXU	AEP Ameren*	AEP Ameren*	
				WPS*	BG&E	CPS Energy	
Feedback EM&V					ComEd	SDG&E	
<ul> <li>(back-end protocols)</li> <li>Supplemental - Pilot design (front-end protocols)</li> </ul>					Energie Baden- VEIC*		
					Württemberg (Germany) Hydro One*		
<ul> <li>SRP M-Power program review</li> </ul>					LGIS (Australia)* SCL		
<ul> <li>Monitoring Feedback pilots,</li> </ul>							
	programs, initiatives				SDG&E		
	<ul> <li>New market entrants: Google and Microsoft</li> </ul>				SMUD	Interview/update completed	
					TXU WPS*		
-					ELECTRIC POWER		

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## **New EPRI Findings**

 EPRI has recently released a study on "The Potential to Reduce CO<sub>2</sub> Emissions by Expanding End-Use Applications of Electricity"

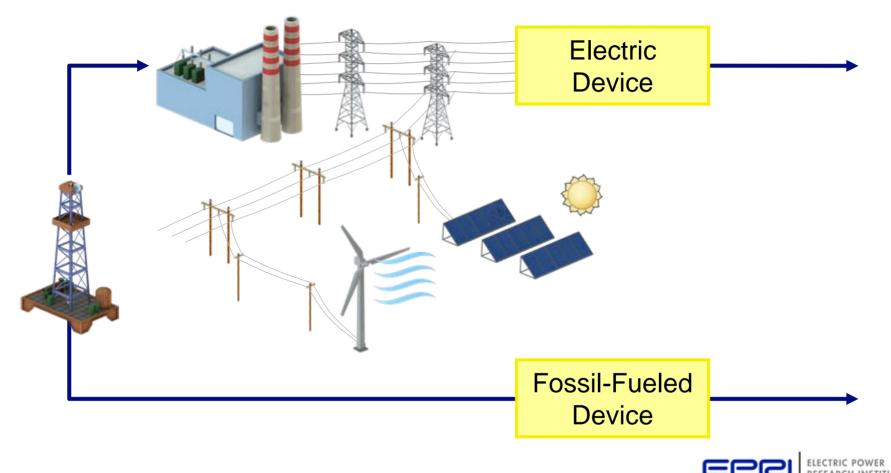
• EPRI Report TR-1018871, March 2009



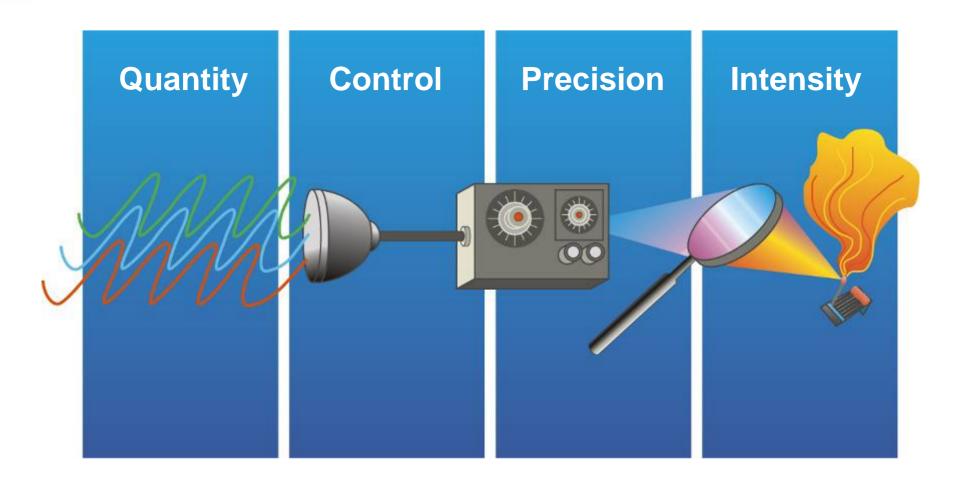


### Total System Efficiency of Many Electric End Uses Have Far Less Overall CO<sub>2</sub> Impact

#### **Requires less energy to produce equal or greater results!**

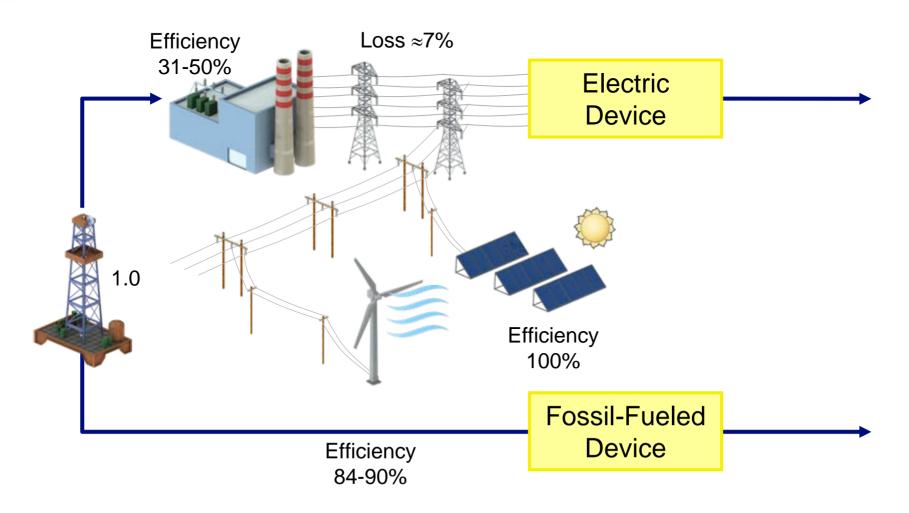


### Electricity's Advantage: A Refined Energy Form



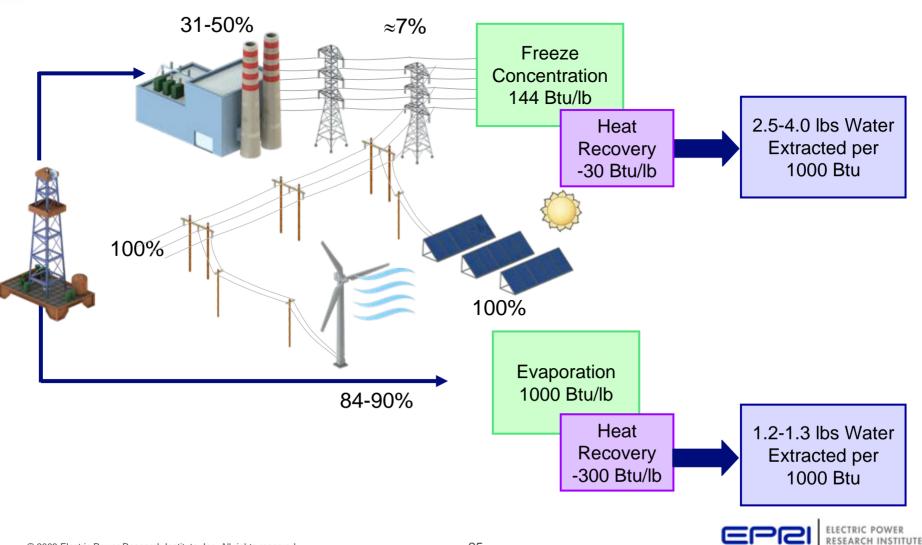


# Example: Total System Efficiency of Electric vs. Gas

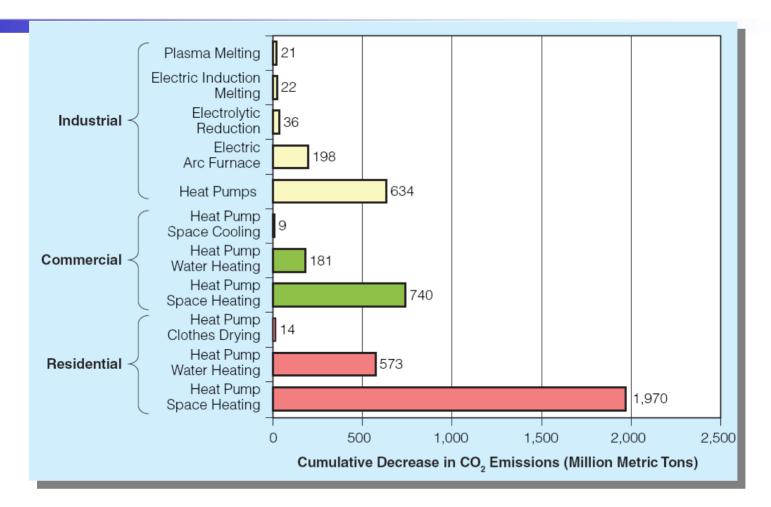




### **Total System Efficiency - Freeze Concentration Example**



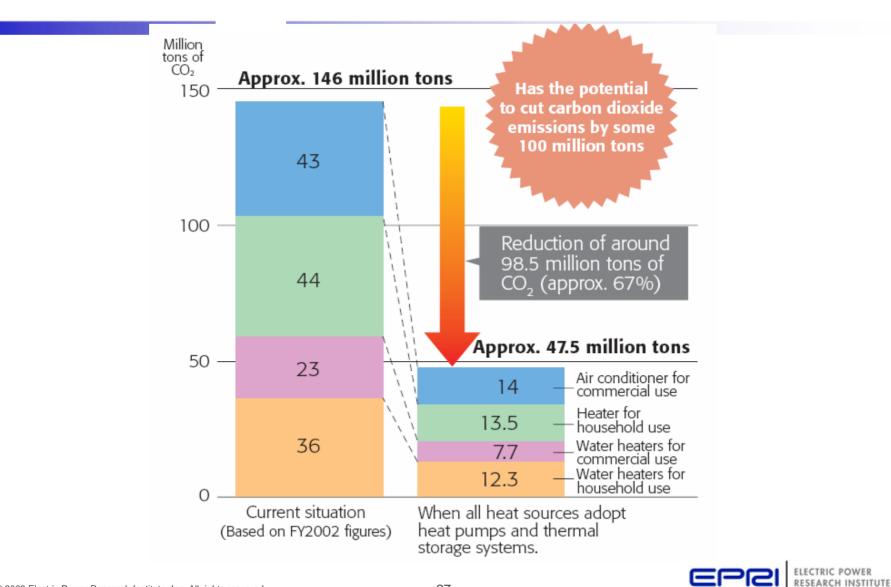
# **Potential CO<sub>2</sub> Reductions**



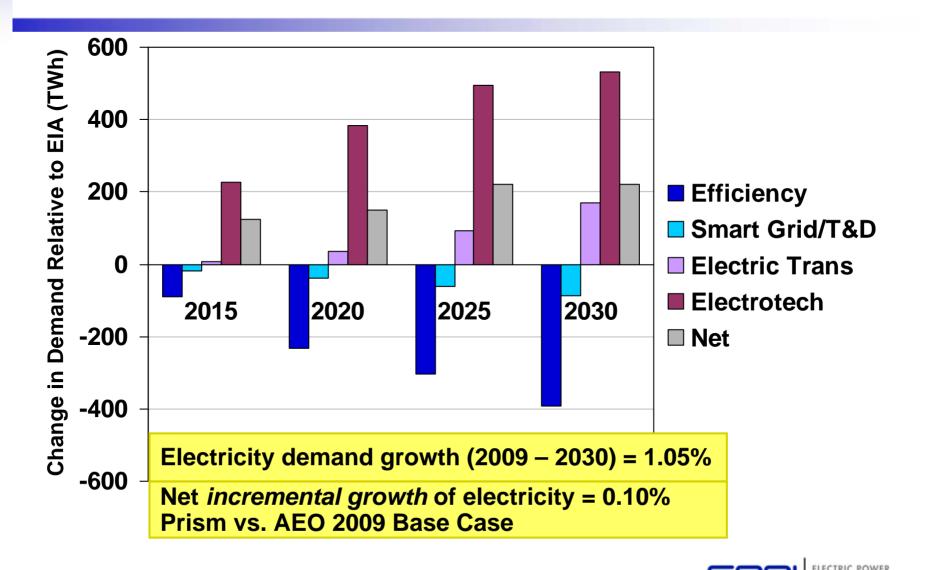
#### Cumulative Decrease in Energy-Related C0<sub>2</sub> Emissions Between 2009 and 2030 by Sector and Efficient Electric End-Use Technology



### **Other Studies - Japan**



## **Prism Changes in Electricity Demand**



### Together...Shaping the Future of Electricity



Image from NASA Visible Earth