

Energy Efficiency: Promise and Realities

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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

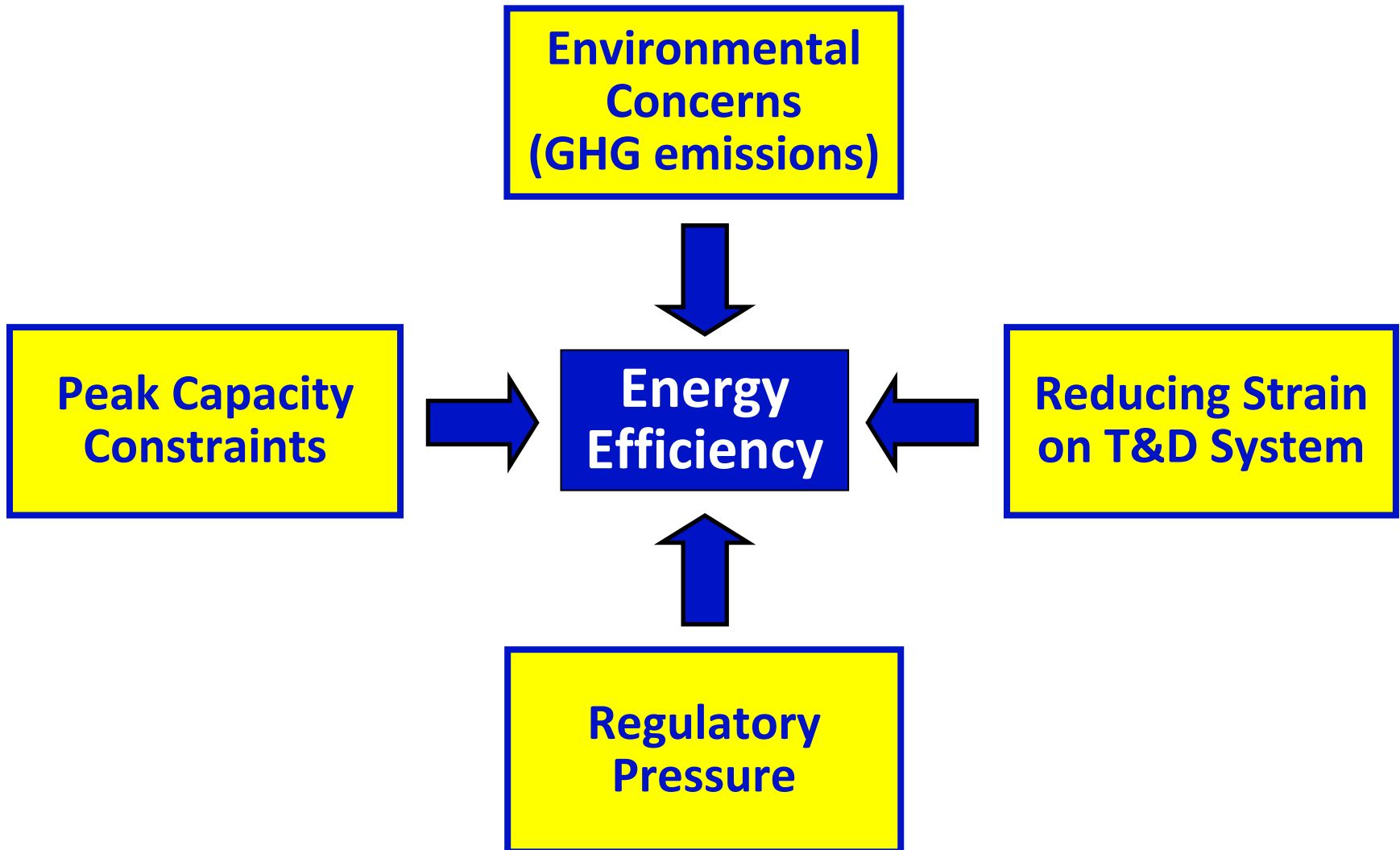
Advance technology to enable automated, ubiquitous DR

Provide analytical frameworks on EE/DR

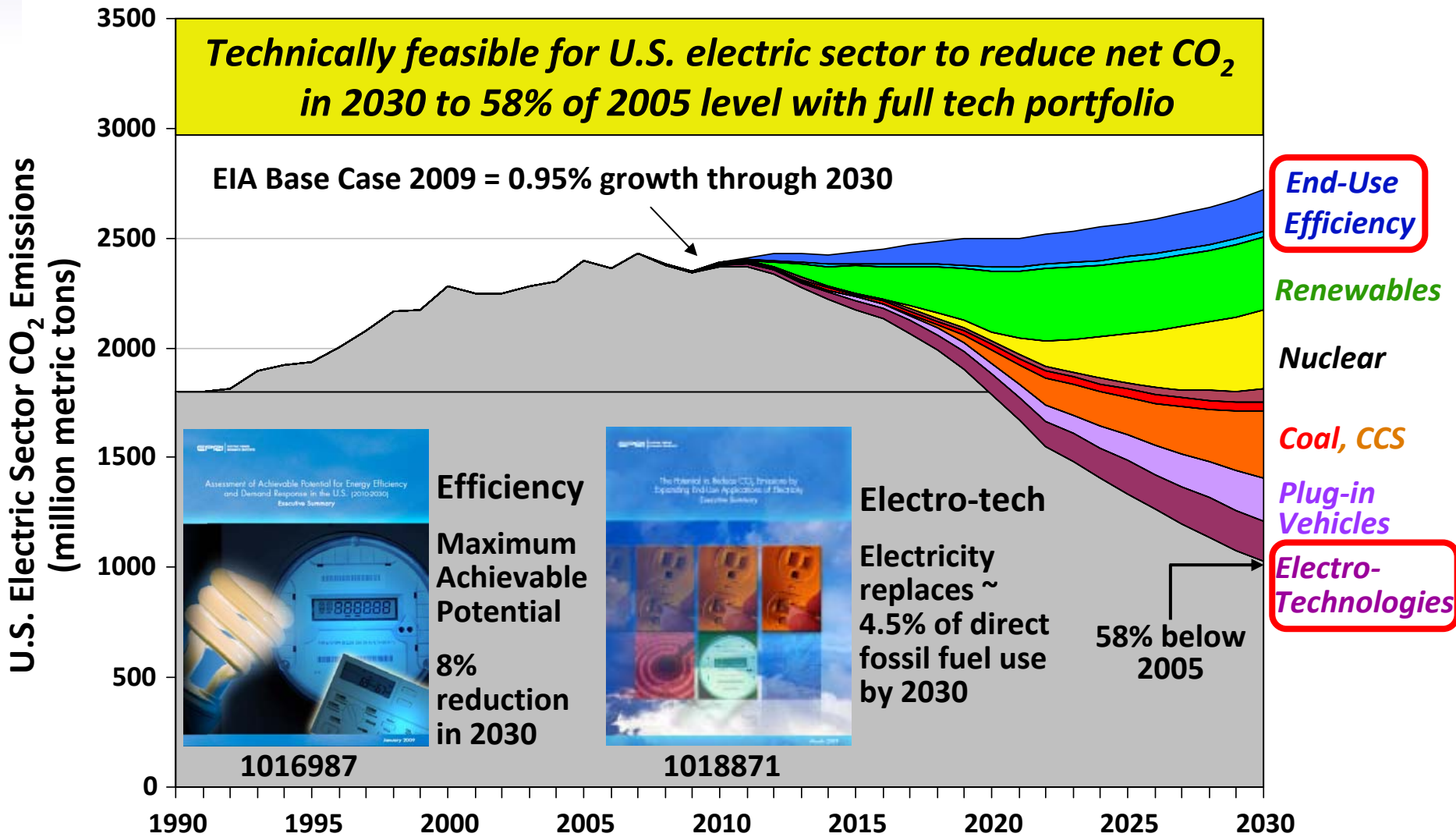
- Potential magnitude
- Environmental impact (CO₂)
- Valuation/economic impact
- Measurement & verification
- Feedback and behavior effects



Several forces are driving interest in Energy Efficiency



2009 EPRI Prism – End-Use Energy Efficiency and Electrotechnologies Figure Prominently



U.S. Energy Efficiency Potential Study (2010-2030)

Technical Report

EPRI | ELECTRIC POWER
RESEARCH INSTITUTE

Assessment of Achievable Potential from Energy
Efficiency and Demand Response Programs in the U.S.

(2010-2030)



Executive Summary

EPRI | ELECTRIC POWER
RESEARCH INSTITUTE

Assessment of Achievable Potential for Energy Efficiency
and Demand Response in the U.S. (2010-2030)
Executive Summary

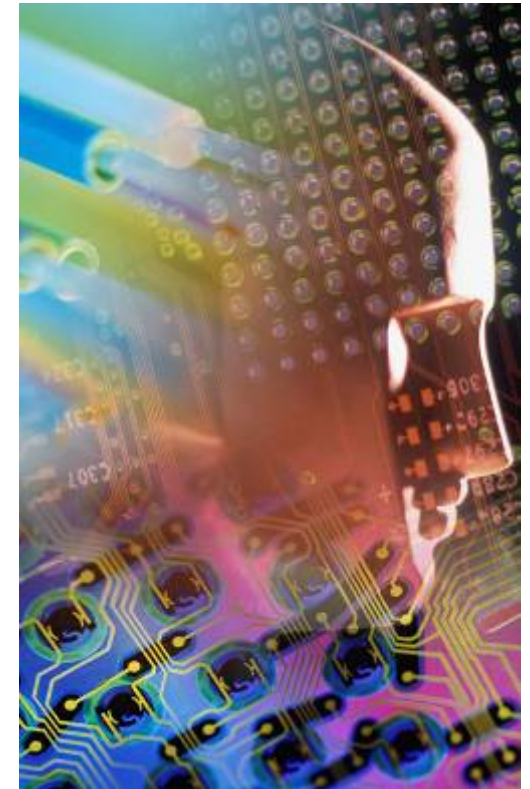


Publicly
available at
EPRI.com

Energy Efficiency Potential Study

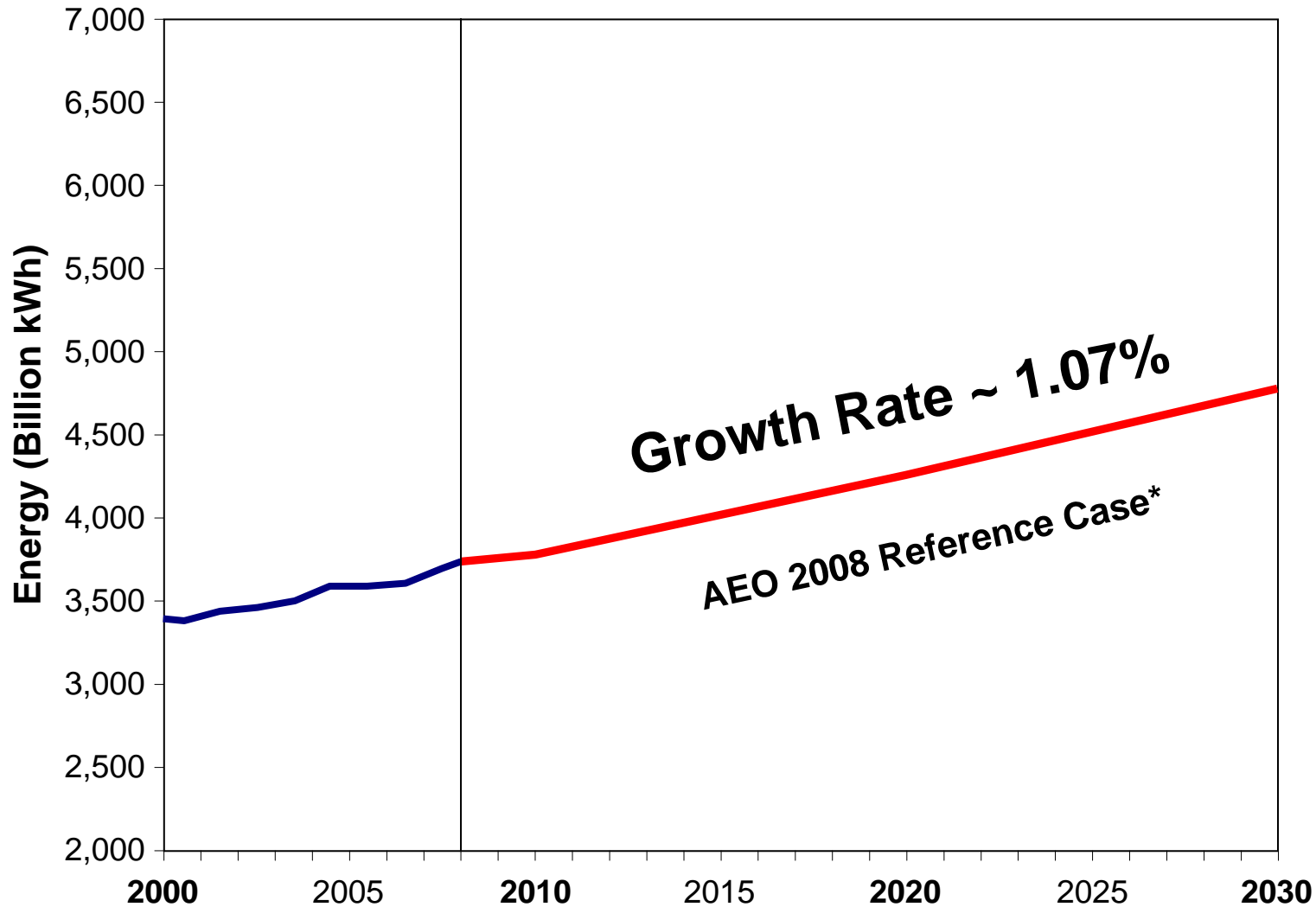
Potential U.S. Energy Efficiency Savings – Now to 2030

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



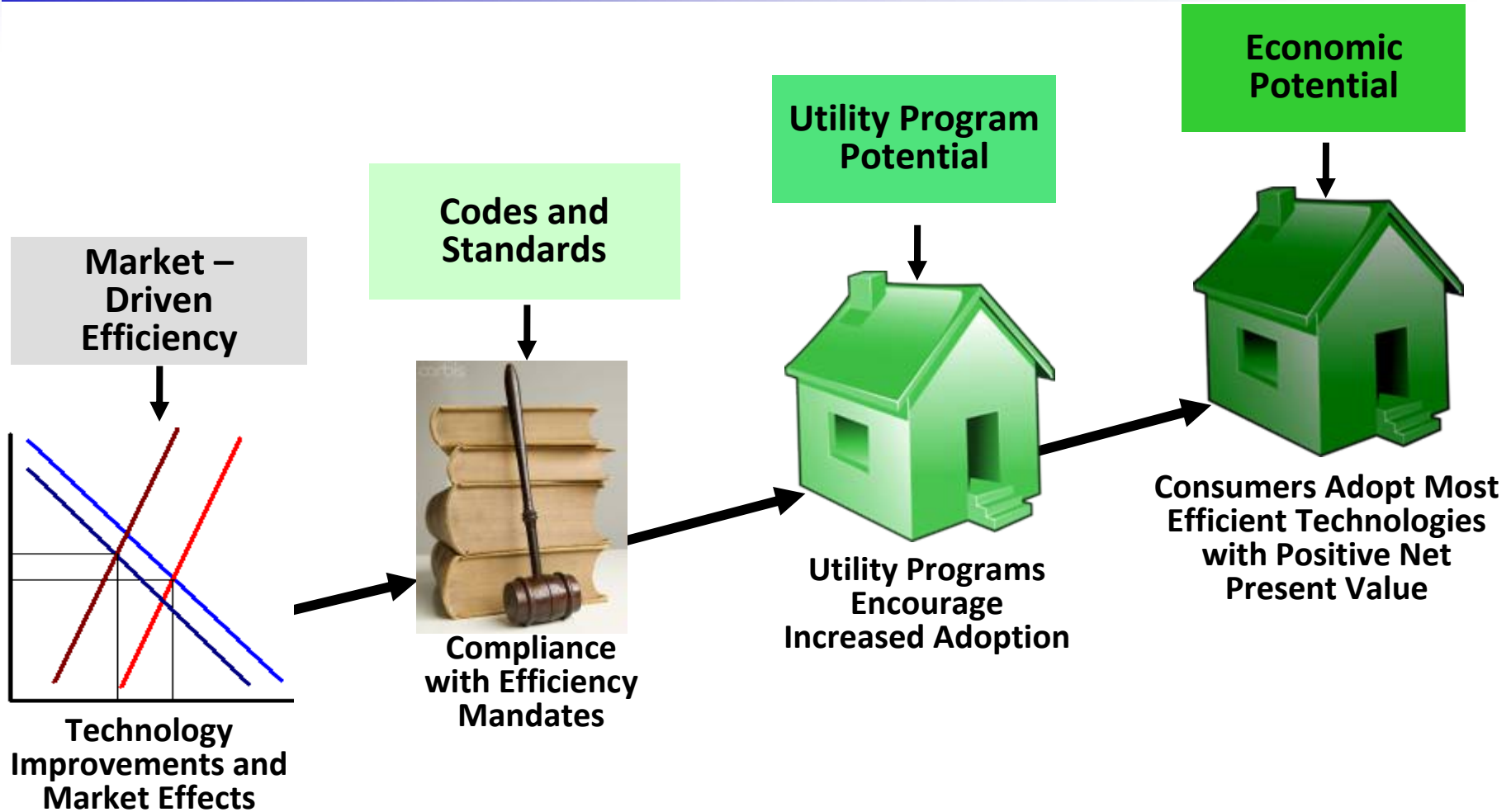
Latest Research Results from EPRI's Living Laboratory

Baseline Electricity Consumption Forecast

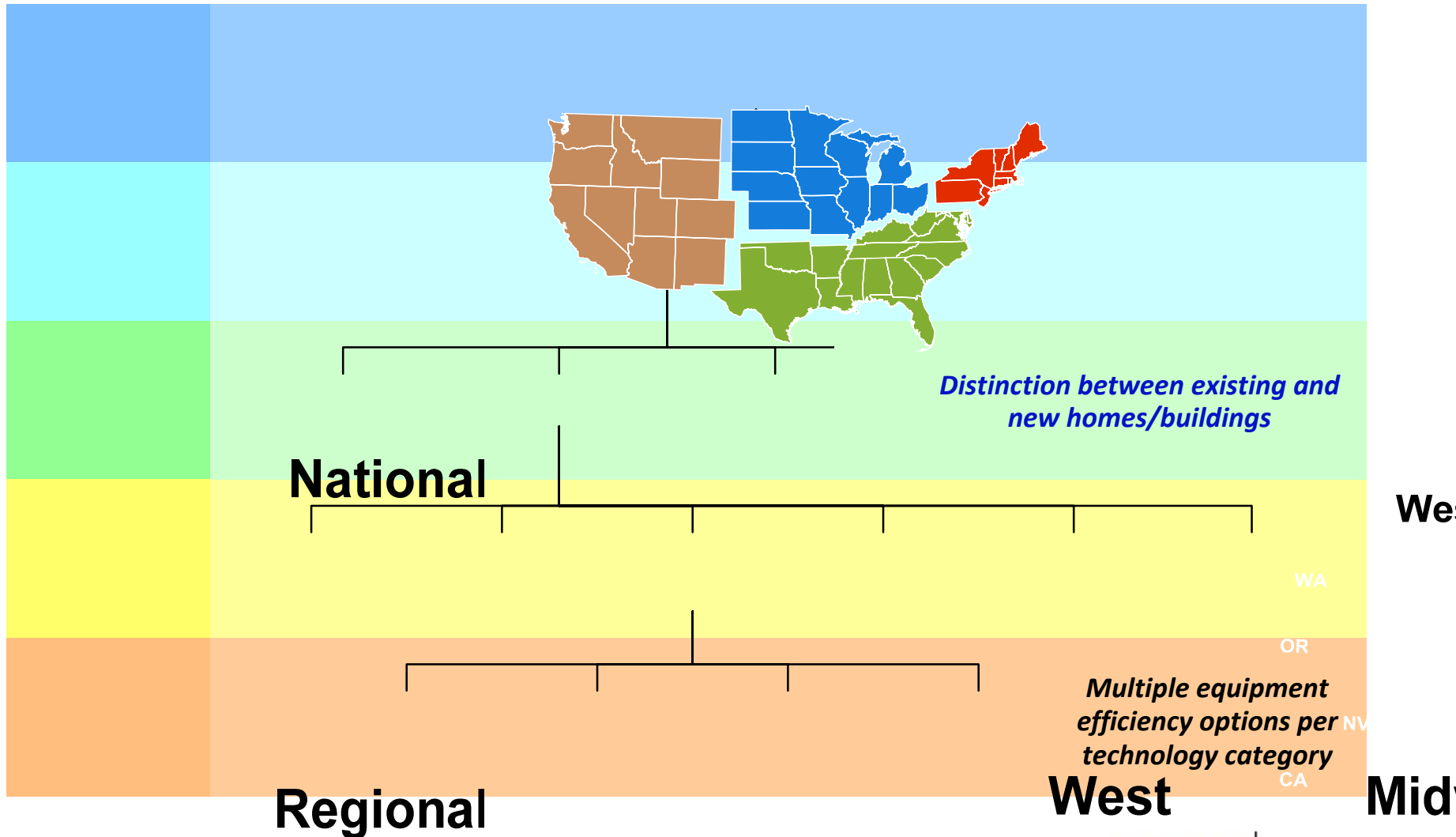


* EIA Annual Energy Outlook 2008, Final Edition (Residential, Commercial, and Industrial sectors)

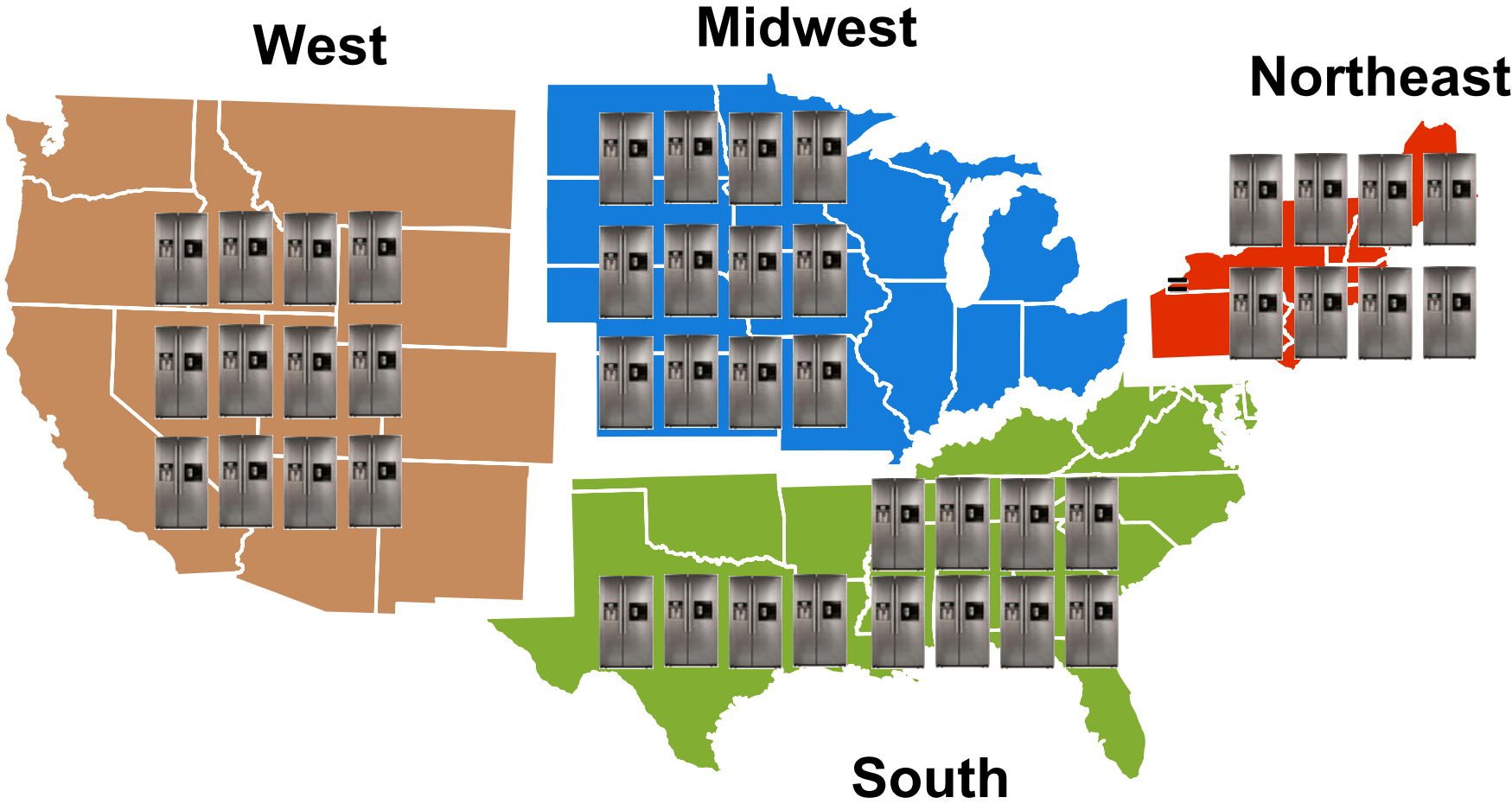
Becoming More Energy Efficient



Segmentation of Analysis



Stock Turnover – Residential Refrigerators



Stock Turnover – Residential Refrigerators



Technology Choices



- Standard Efficiency
- ENERGY STAR Tier 1
- ENERGY STAR Tier 2
- Inverter-Driven

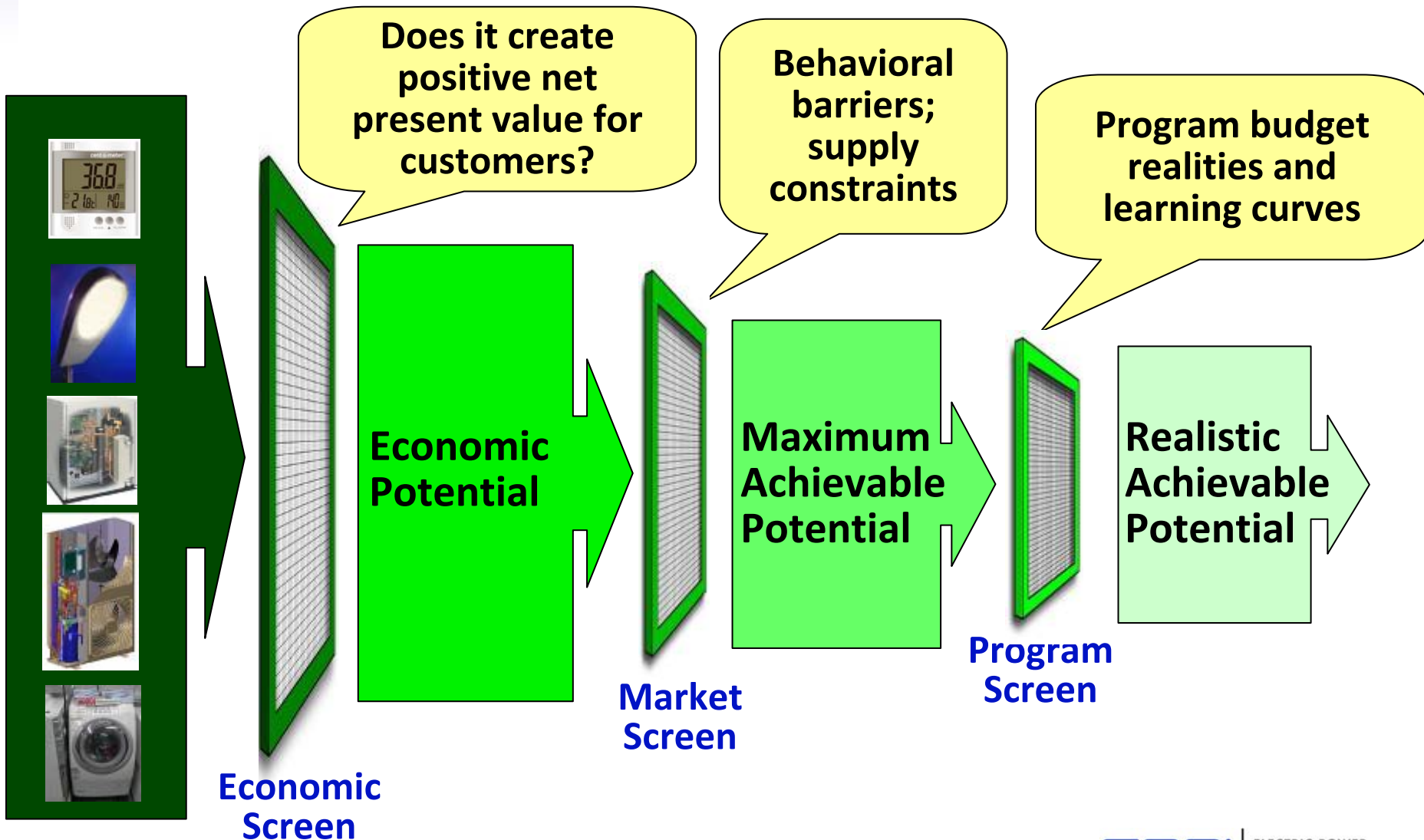


Economic Screening
Benefit/Cost Analysis



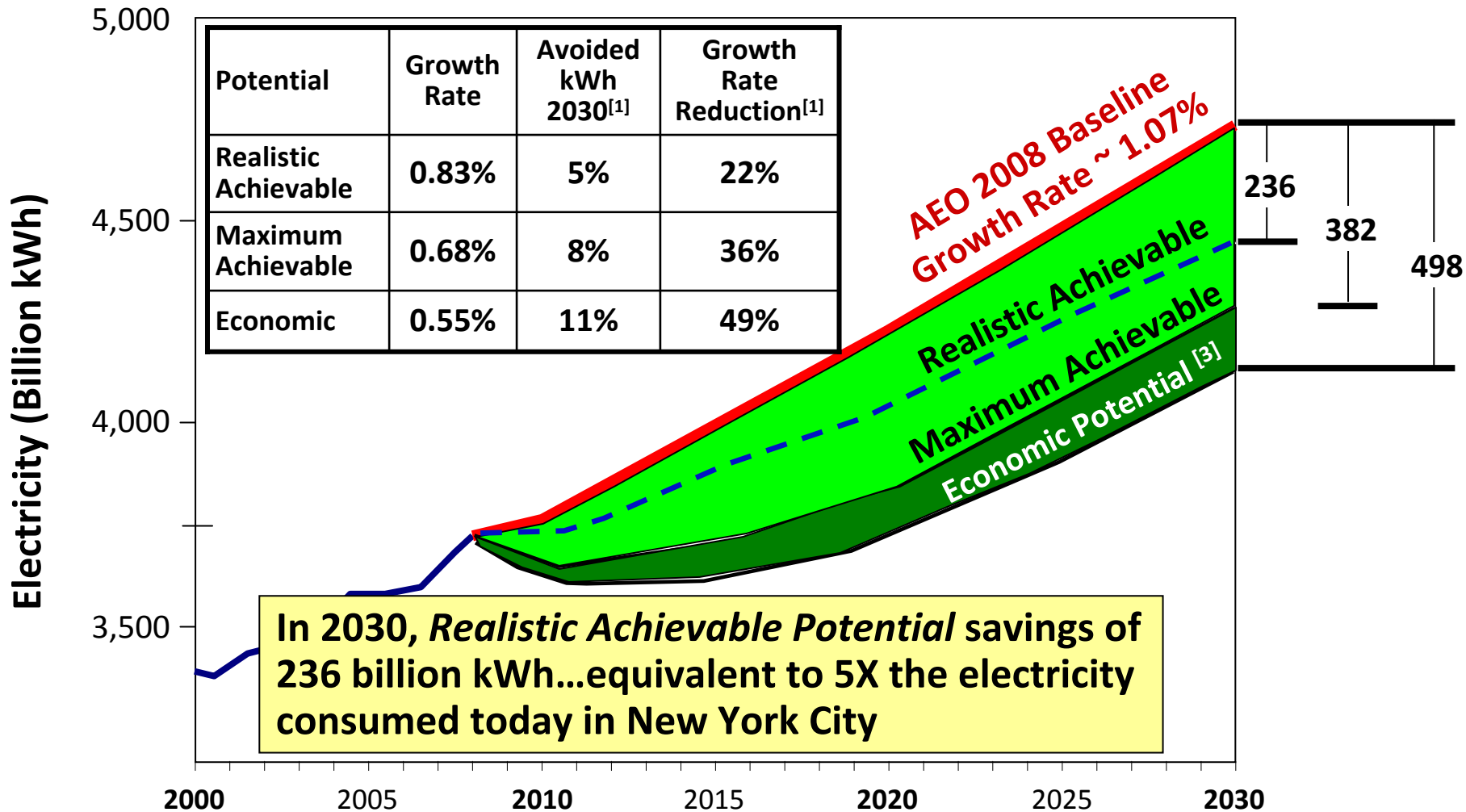
Adoption
Rates

Energy Efficiency Potential Analysis



U.S. Electricity Consumption

Impact of Utility Programs



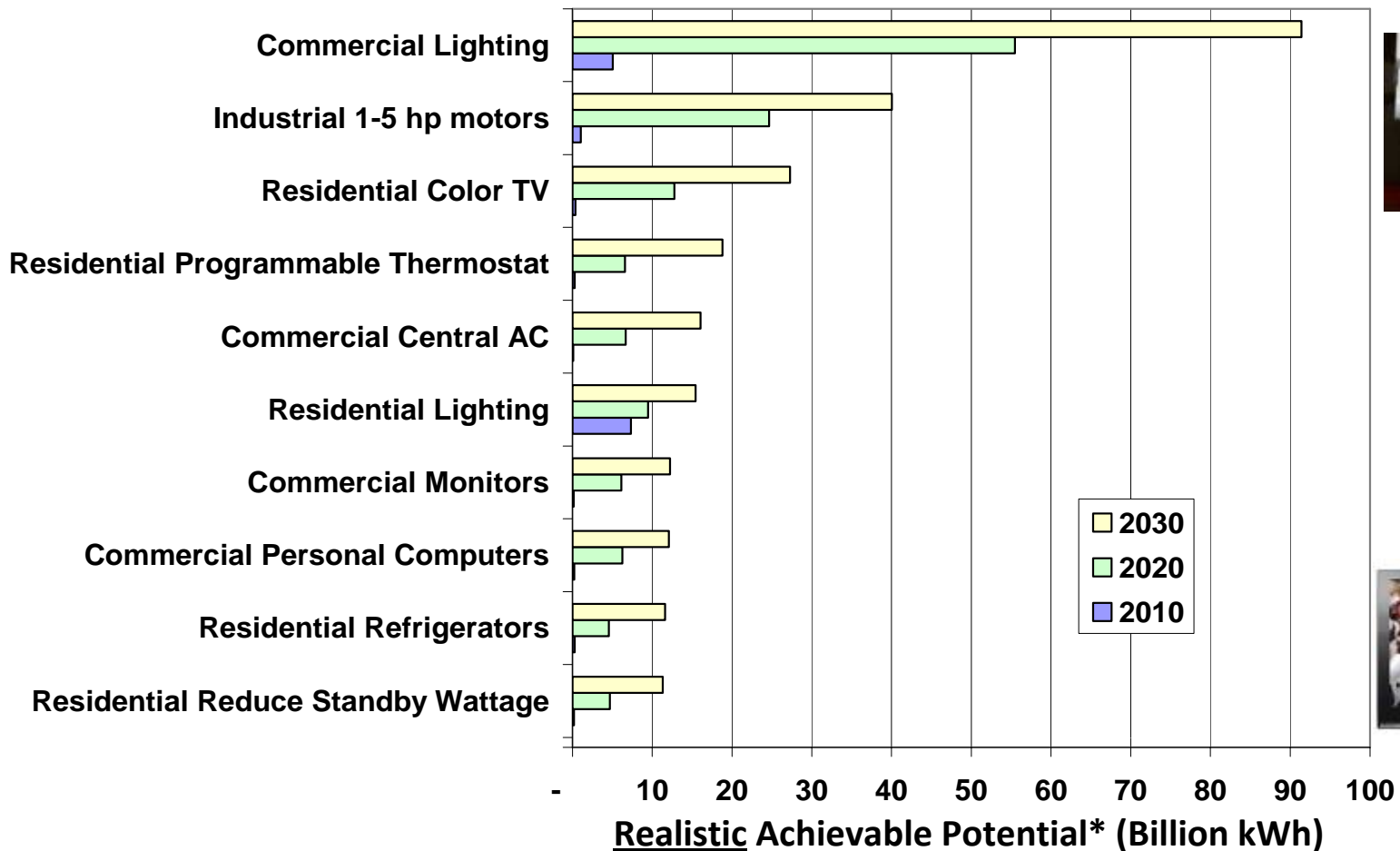
[1] Relative to AEO 2008 Reference Case

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

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

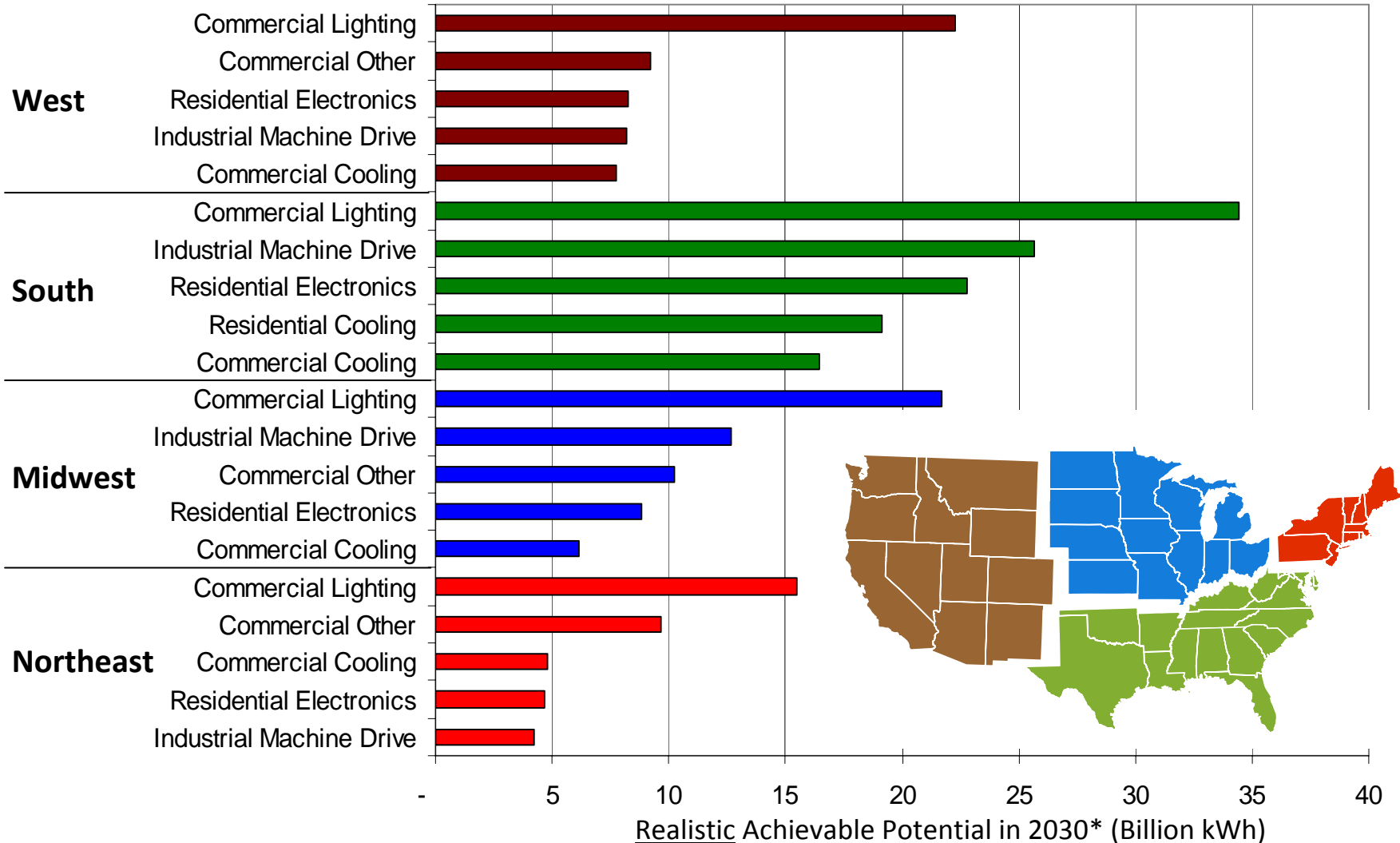
Opportunities for Energy Efficiency Savings

Top 10 Energy Efficiency Achievable Potential Opportunities



* Savings reflect total EE program savings potential, inclusive of savings implicit in AEO 2008

Opportunities for Energy Efficiency Savings



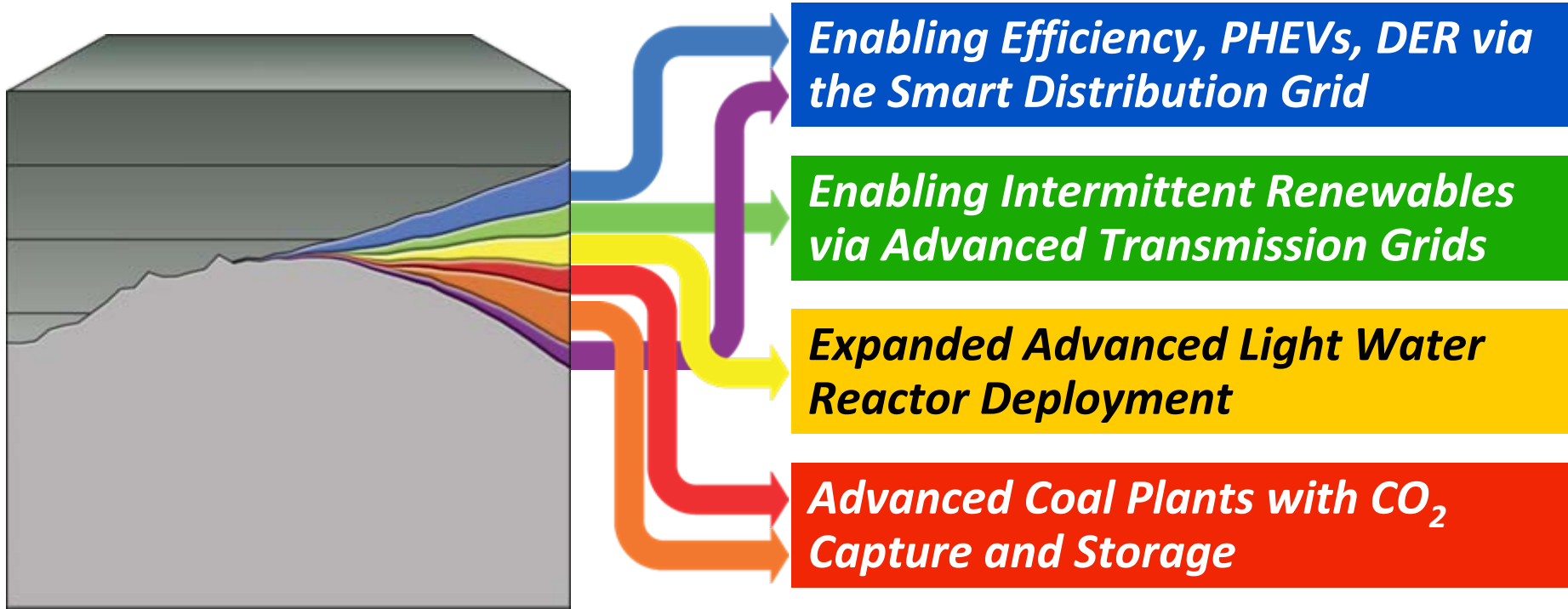
* Savings reflect total EE program savings potential, inclusive of savings implicit in AEO 2008

EPRI Customized Energy Efficiency Potential Studies

- EPRI has conducted several EE potential studies for utilities based on the methodology of the national study*
- Continuous enhancements to energy efficiency model
 - Refreshing underlying measure performance and cost data
 - Allowing for technology innovations to become more cost-effective over time
 - Greater flexibility to model scenarios based on alternate regulatory paths (i.e. codes & standards, CO₂ policy) and retail price forecasts

* Results and documentation not yet publicly available

Prism into Action: Transition to Low-Emissions Technologies



EPRI RD&D provides critical data to accelerate emerging technologies into utility EE & DR programs

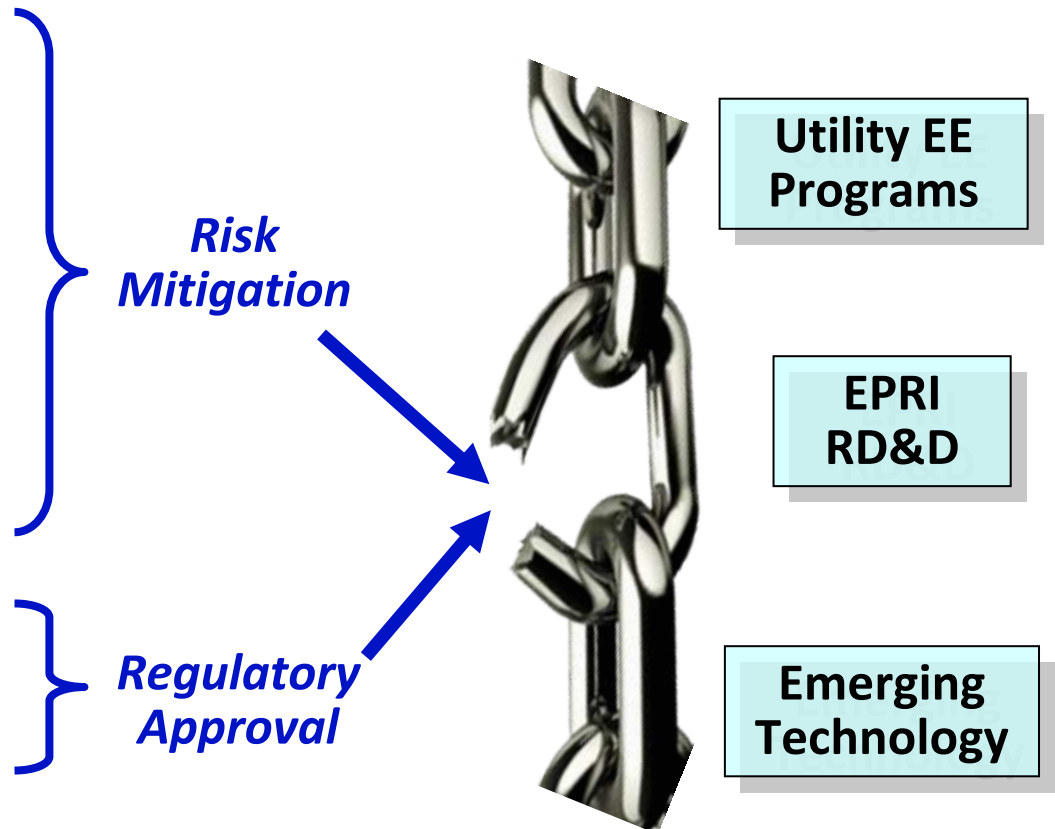
Clear performance metrics

Performance validation (testing, field demos, pilots)

- Energy savings
- Durability, reliability, compatibility
- Cost, ROI
- Customer satisfaction

Deemed savings

- Region/segment-specific
- Persistence/lifetime

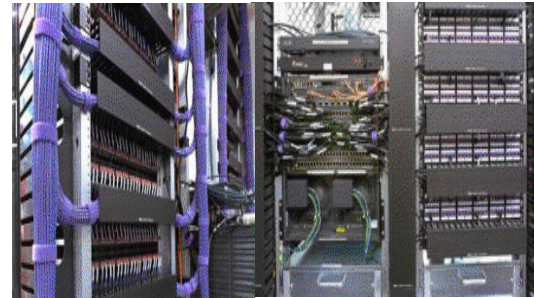


EPRI working with other organizations to accelerate acceptance of emerging energy-efficient technology into programs

EPRI field demonstrations of six categories of “hyper-efficient” technologies to fundamentally change energy usage in U.S. buildings and homes



**Variable-Refrigerant-Flow
Air Conditioning**



Efficient Data-Centers



**LED Street and
Area Lighting**



**Heat-Pump
Water Heaters**



**Ductless, Residential Heat-
Pumps and Air-Conditioners**



**Hyper-Efficient
Residential Appliances**

Demo is answering fundamental questions to accelerate adoption of efficient technologies into programs

Test

How do these **technologies** perform?

What level of **energy savings**?

What about **diversity factors**?

- manufacturer, climate, electric rates, building design and construction, etc.

Evaluate

Are they compatible with **building designs and various codes and standards**?

Demonstrate

Are there differences in quality and other effects **compared to traditional technologies**?

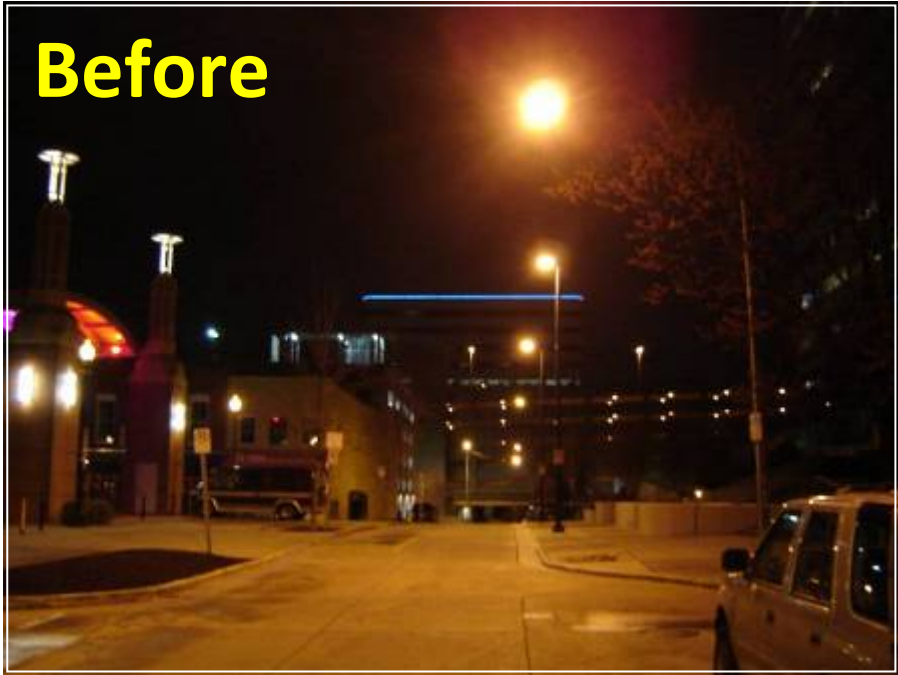
Accelerate
Adoption

What are the **technical and market obstacles** and how do they impede adoption?

LED Street Lighting

TVA Hosted Location, Knoxville, TN

Before



310 W (each),
High Pressure Sodium (HPS)

After

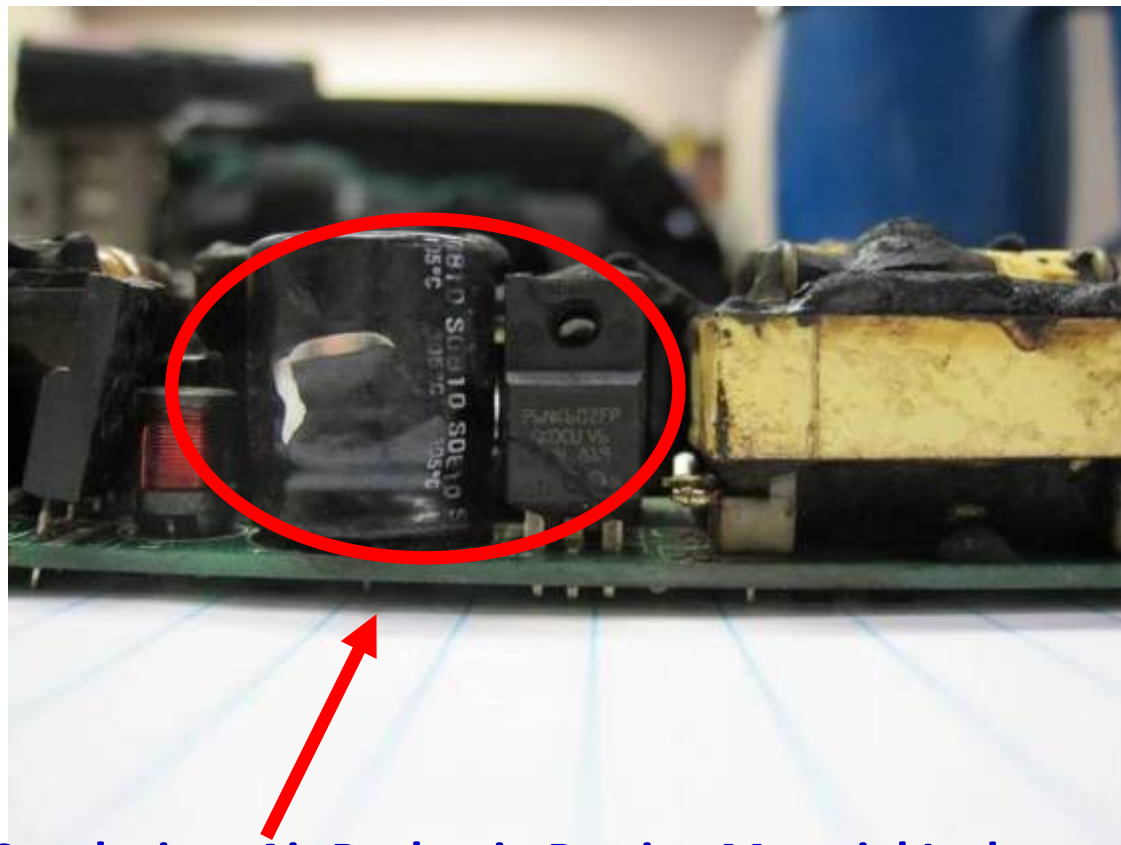
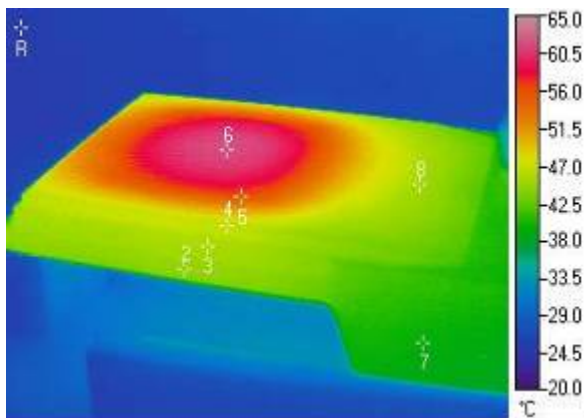
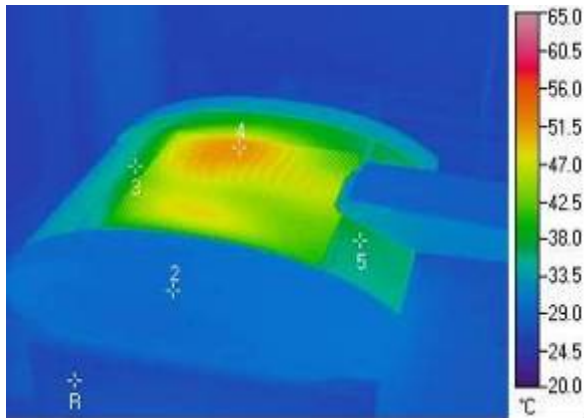


94 Watt (each),
Light Emitting Diode (LED)

TVA Supplemental project: Wall Ave., Knoxville, TN

Disclaimer: Colors are approximate

LED Lighting Thermal Testing: Root Cause Determination of Transistor Damage



Conclusion: Air Pocket in Potting Material Led to Overheating and Ultimately Failure of LED Ballast

Installations: VRF* Air Conditioners

Southern Company – Mobile, Alabama

Before



After

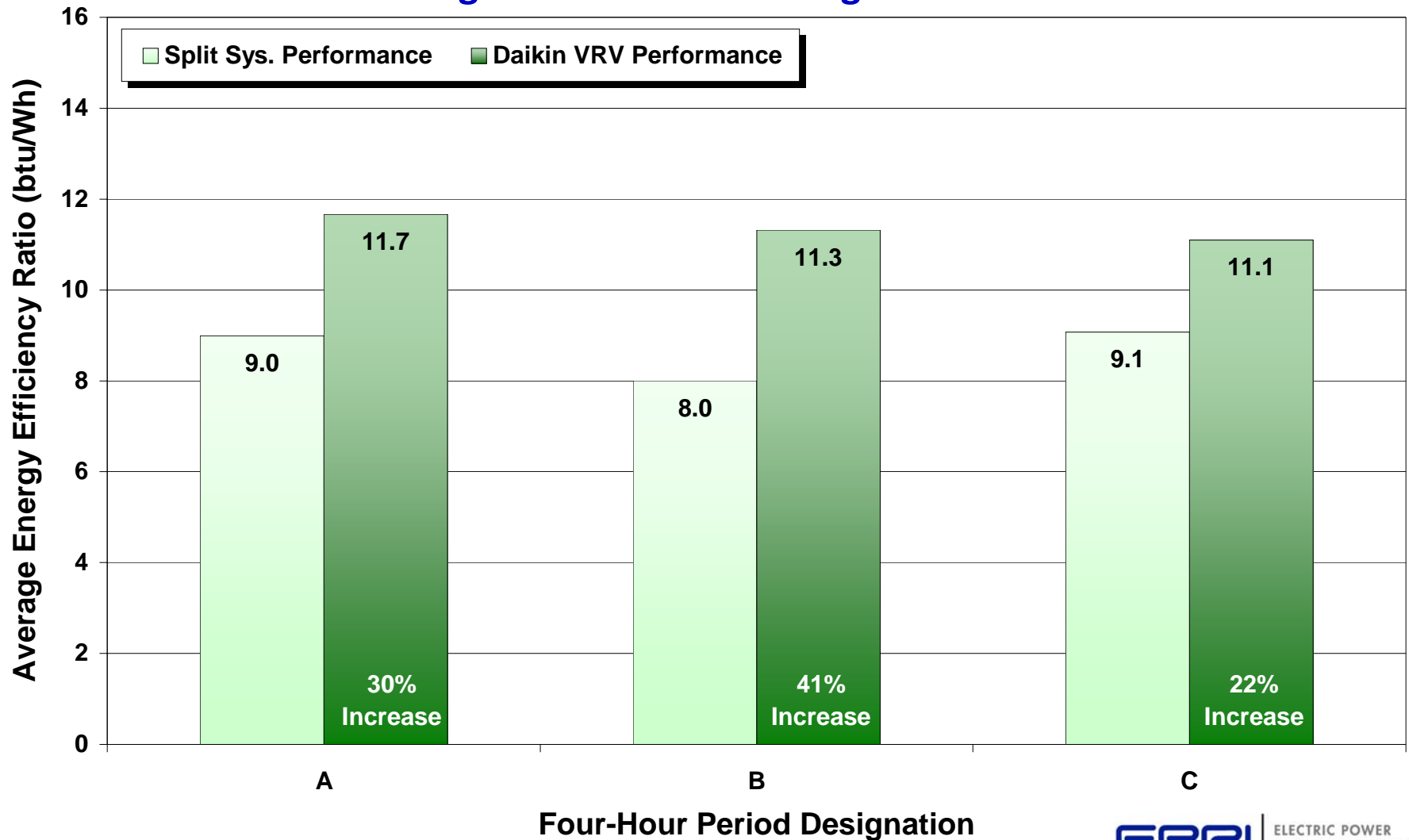


Potential to save up to 40%.
Monitoring will verify the savings.

*VRF – Variable Refrigerant Flow

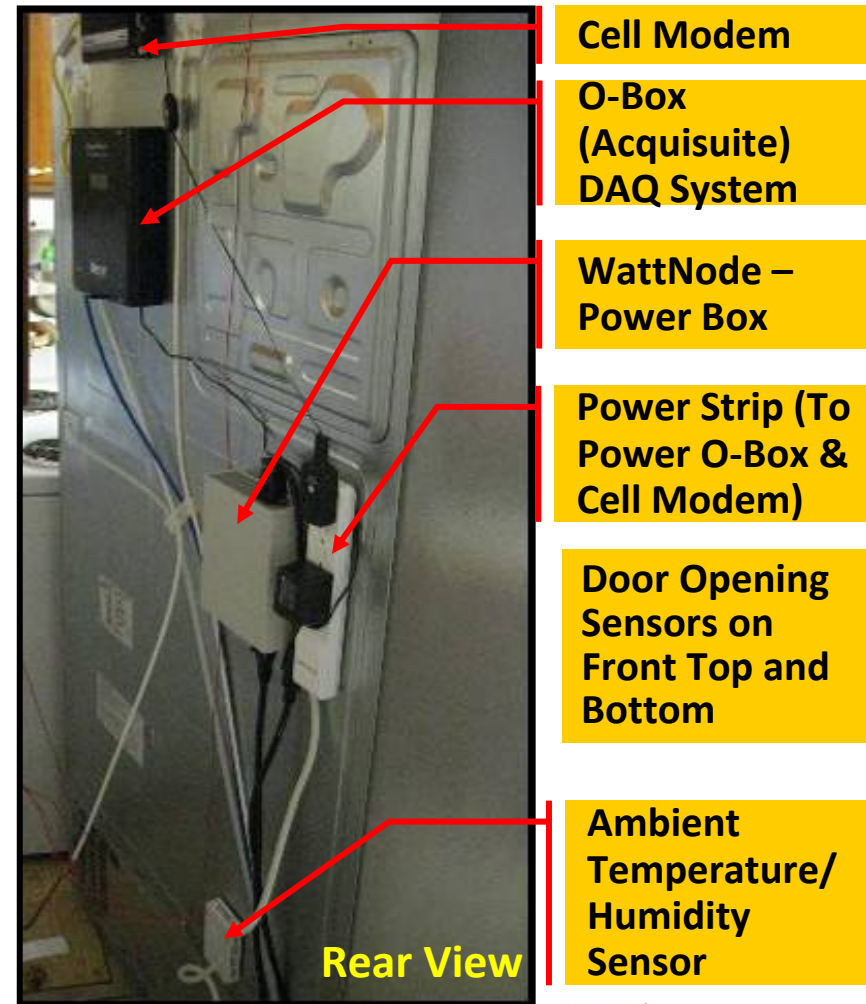
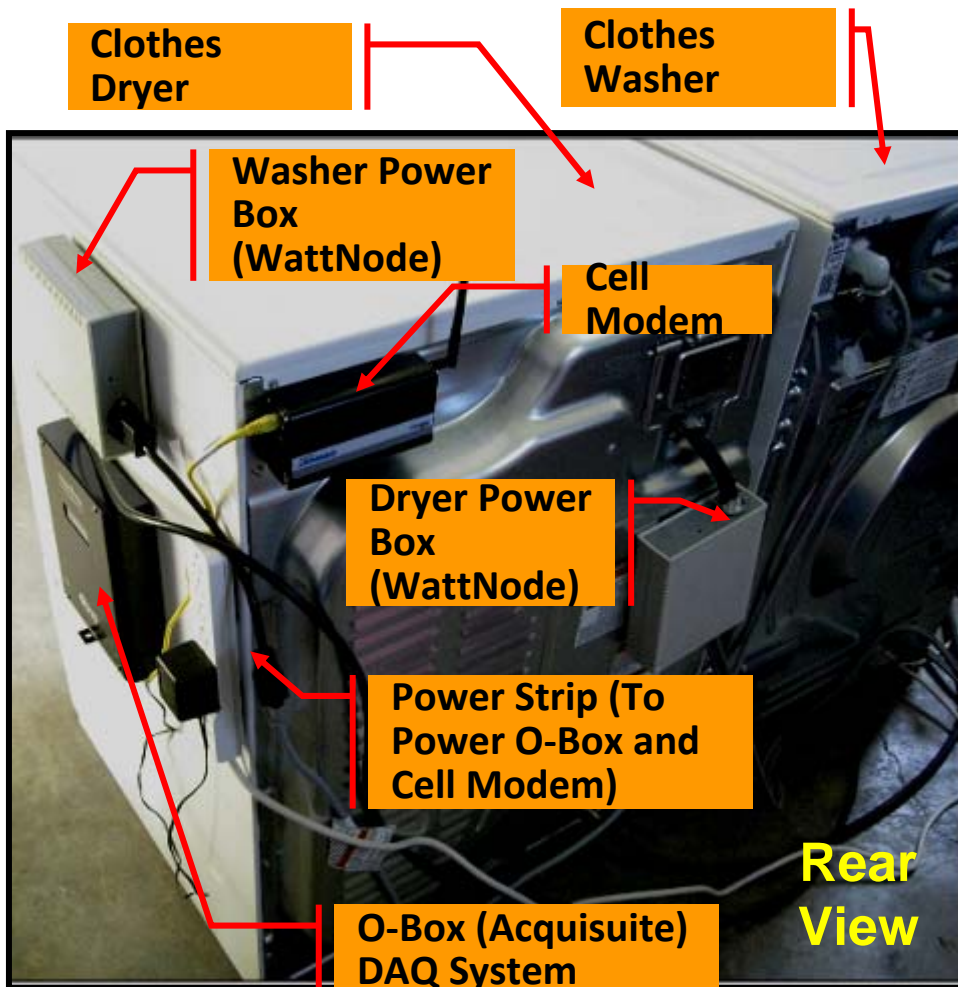
2009 Lab Test Results: VRF 20 – 40% more Efficient than Conventional Split System AC

Variable Refrigerant Flow AC Testing Results: Daikin VRV

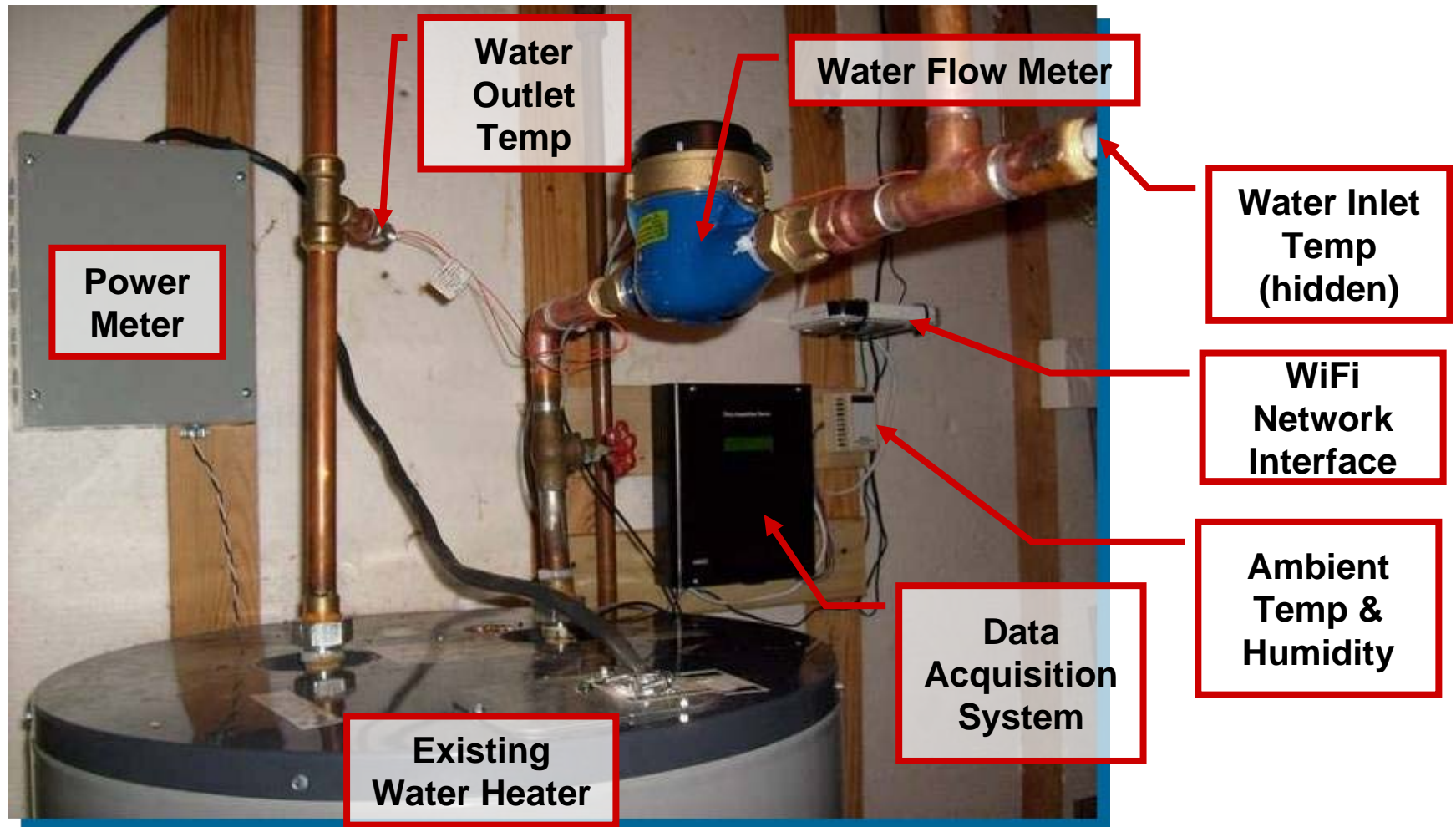


Demonstrating innovative high-efficiency refrigerators, washers, and dryers

Robust Instrumentation

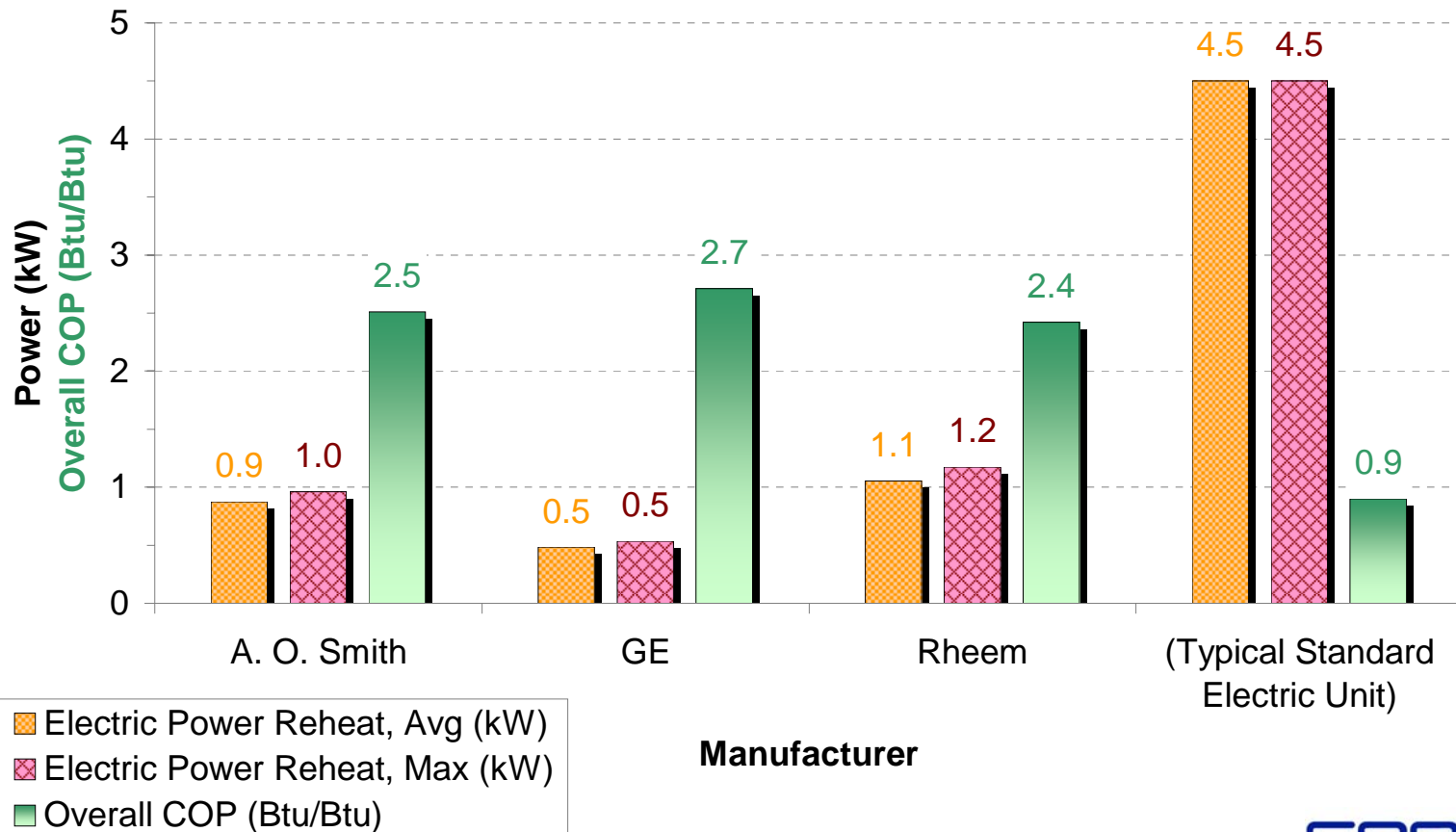


Heat Pump Water Heater (HPWH) Test Instrumentation



2009 HPWH Test: 3x Efficiency Improvement; Power Draw Reduced ~ 75-85%

Six hourly draws, 10.7 gal each at 3 gpm, then standby for 18 hours
 Default operating mode (Hybrid or Energy Saver) at 120°F setting
 Targeted conditions: ambient 68°F, 50% RH, and 58°F inlet water



Ductless Residential Heat Pumps and Air Conditioners (DHPs)

Split system heat pumps

No duct systems

**More efficient variable speed
DC inverter driven fans and
compressors**

**Match heating or cooling load
at any instance**

Improved comfort for the user

Lower noise levels

Easy to retrofit

**Commonly installed in Asia and
Europe**



Installation in Chattanooga, TN (TVA)

Data Center Energy Efficiency

Power Consumption: 100 W System Load

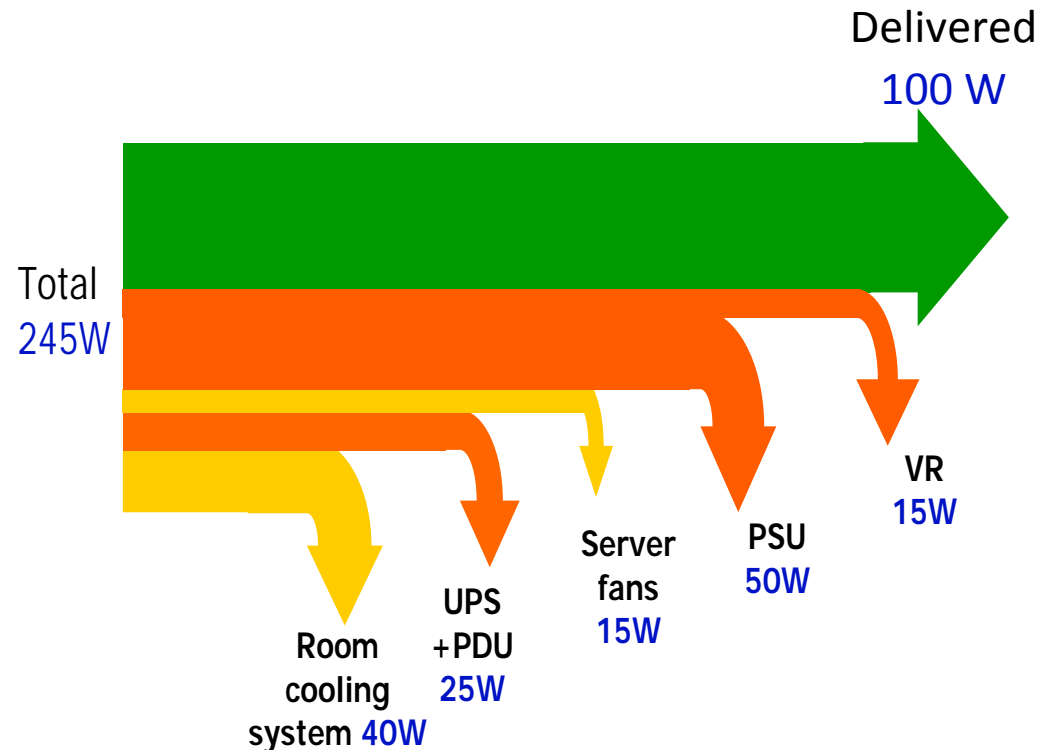
Evaluate strategies for reducing losses in ac/dc and dc/dc power conversions

Examine new software strategies for reducing server requirements

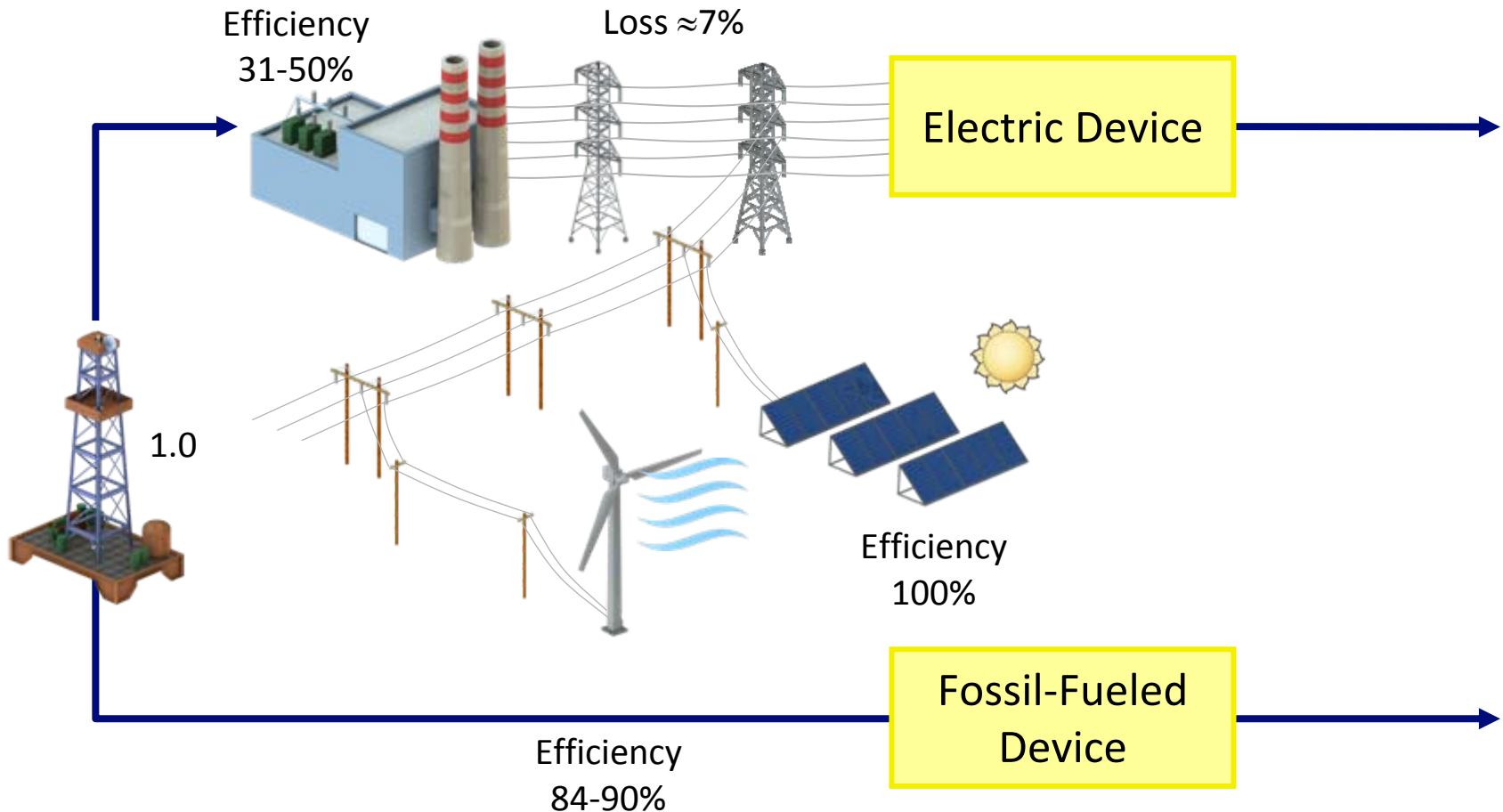
Test and evaluate alternative cooling technologies & systems

- potential for 40-80% cooling unit fan energy savings
- potential for 10-20% total data center energy savings

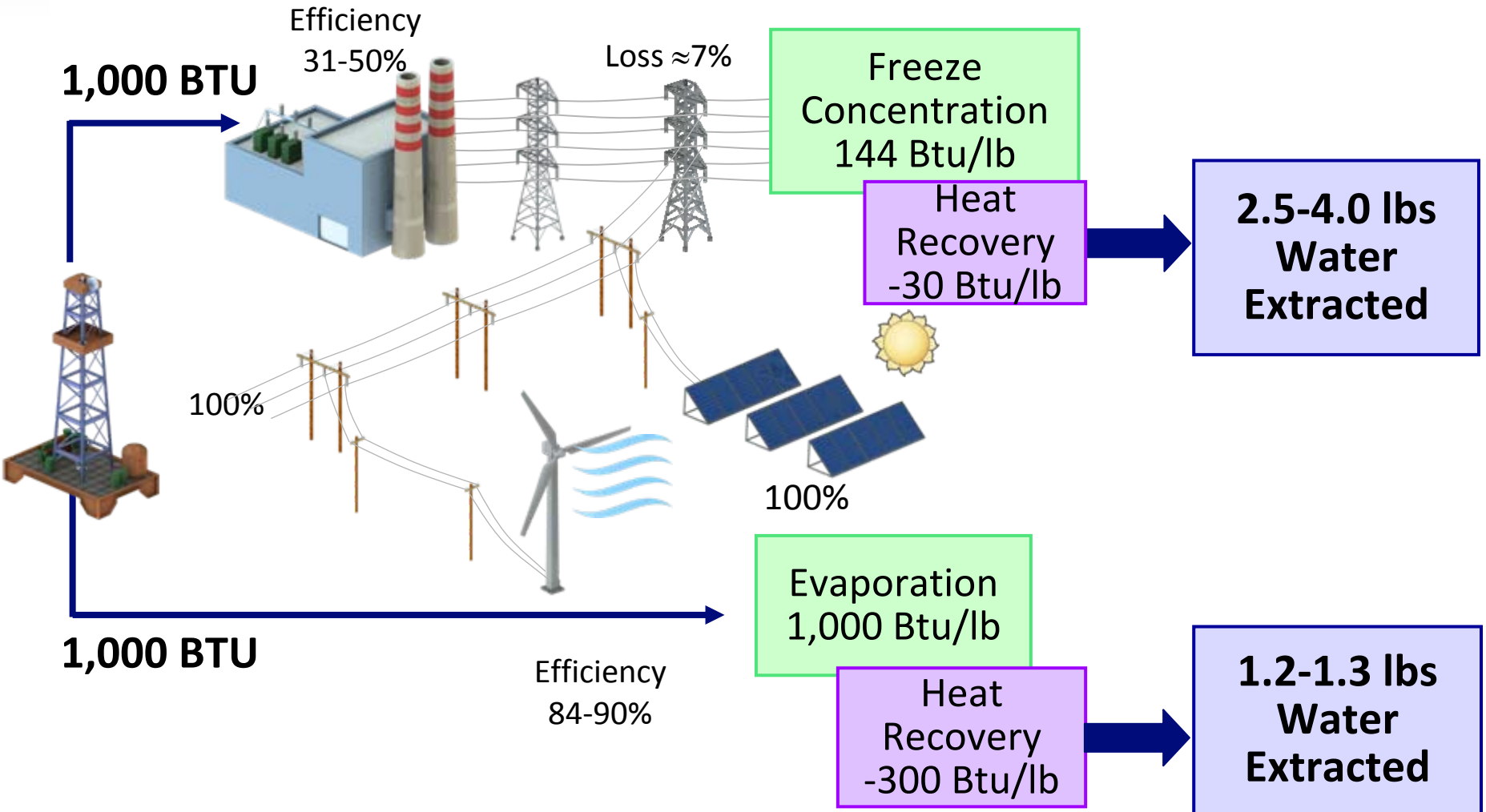
Consider use of DC-bus as alternative powering strategy for the computing systems



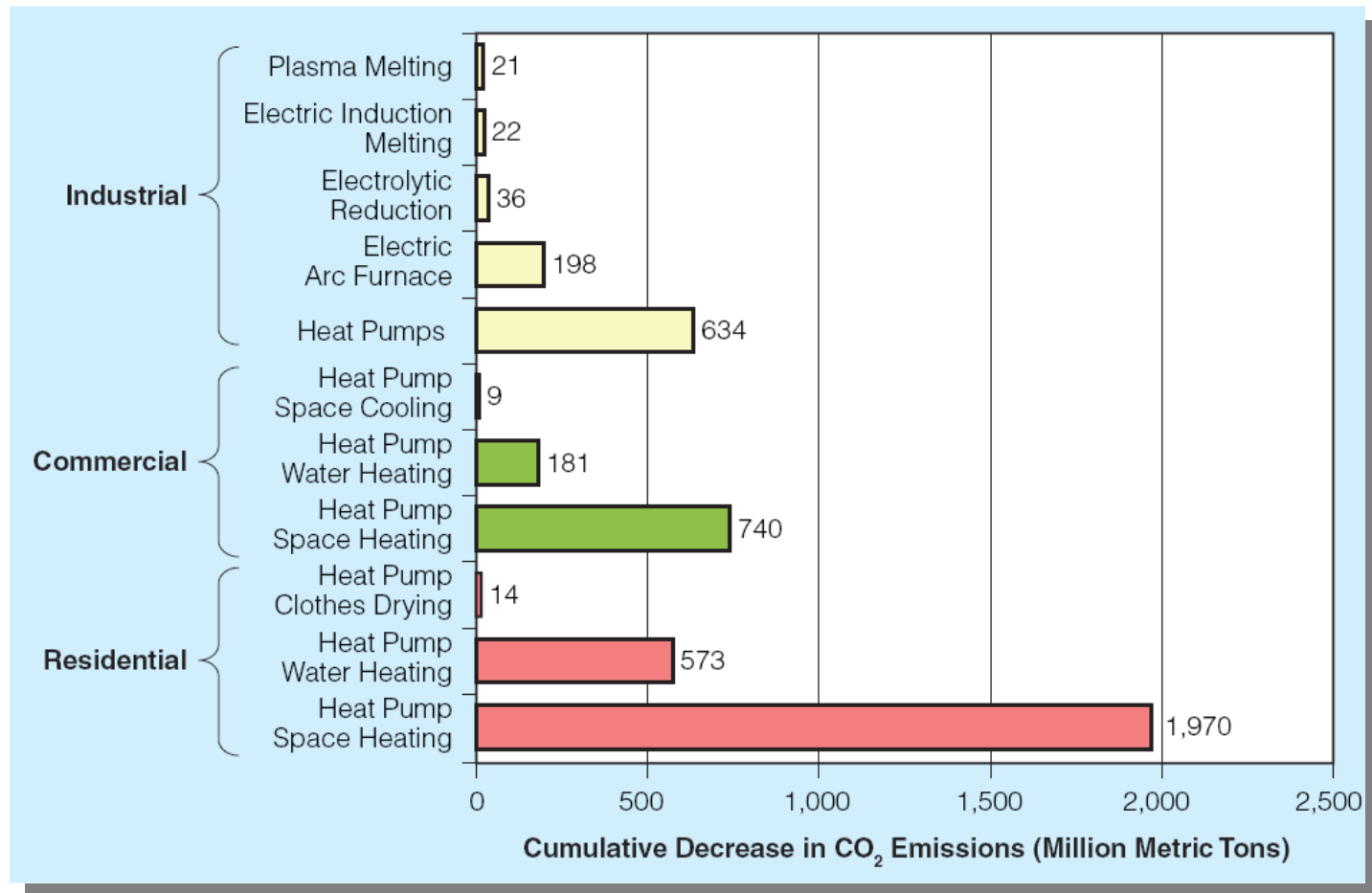
Electro-technologies: Total System Efficiency of Many Electric End Uses Have Far Less Overall CO₂ Impact



Total System Efficiency – Freeze Concentration Example



Potential CO₂ Reductions



**Cumulative Decrease in Energy-Related CO₂ Emissions Between 2009 and 2030
by Sector and Efficient Electric End-Use Technology**

End-to-End Energy Efficiency R&D

The Full Portfolio...



Generation

Heat rate improvement

Efficient auxiliary loads

Transmission & Distribution

Green Circuits™

Green Transmission™

End Use

Key Insights and Recommendations

Insights

- Technical potential exists for U.S. electricity sector to significantly reduce CO₂ emissions over next several decades
- No silver bullet – full portfolio of technologies needed
- Substantial R&D and demonstration required
- Energy efficiency is the most abundant near-term, cost-effective resource option to reduce CO₂

Recommendations

- Install and demonstrate emerging smart and efficient end-use technologies in the field today
- Explore applications in which electrification enables decarbonization
- Pursue upstream energy efficiency opportunities (i.e. reducing Generation and T&D losses), which can yield cost-effective energy savings and CO₂ reduction

Together...Shaping the Future of Electricity