CONSORTIUM for BUILDING ENERGY INNOVATION

Integrated Design of Commercial Buildings for Primary Energy Efficiency: Contributions of CHP

Martha Krebs and James D. Freihaut
at the

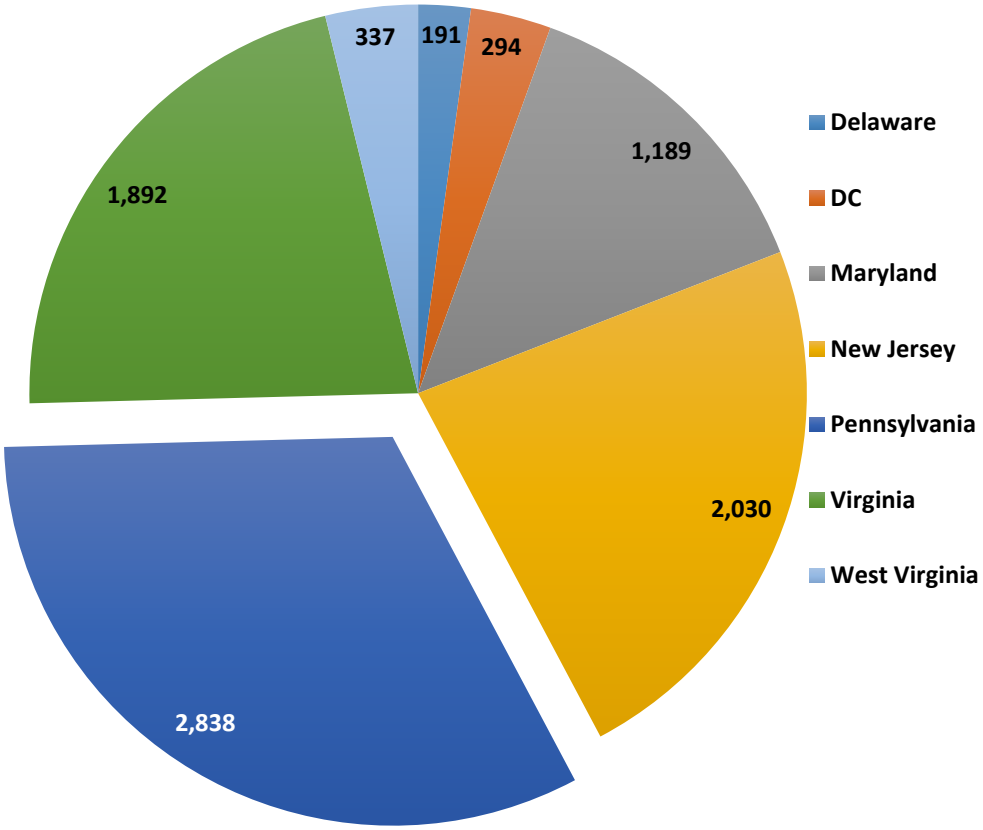
En Banc Hearing

May 5, 2014

Drexel University, Philadelphia, PA

CONSORTIUM for BUILDING ENERGY INNOVATION

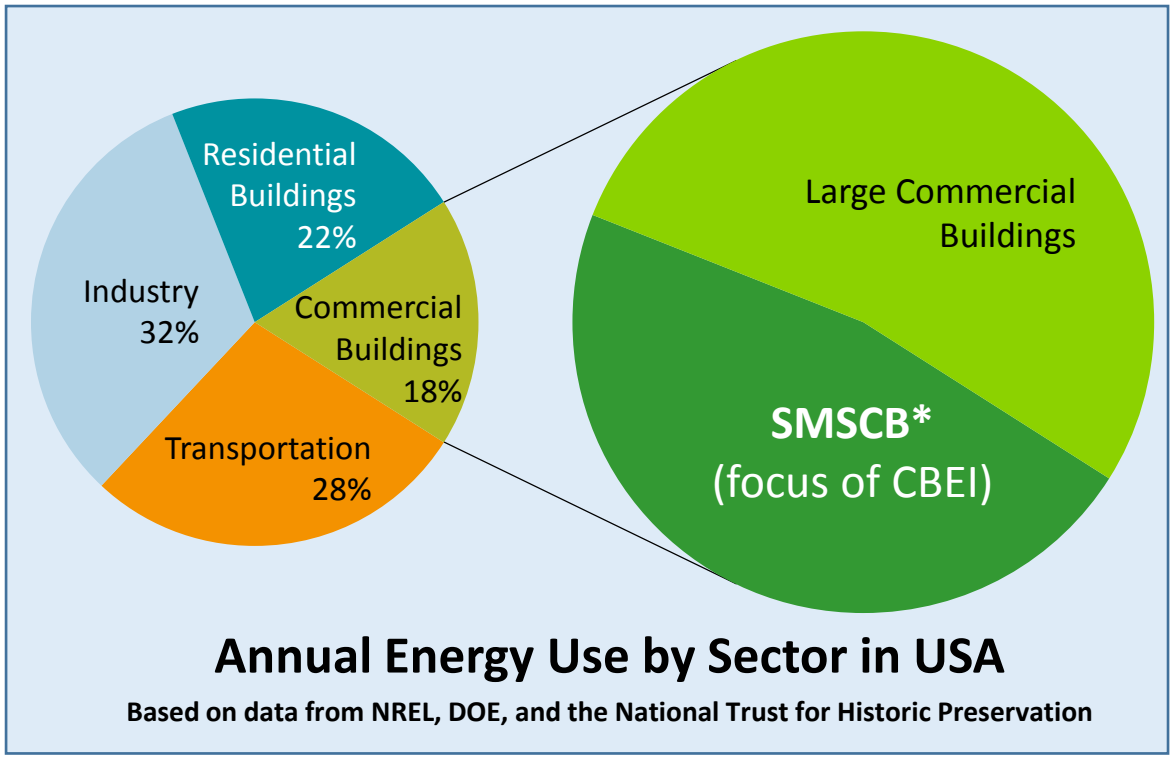
CHP Technical Potential for the Commercial Sector



CONSORTIUM for BUILDING ENERGY INNOVATION

Why SMSCB* Energy Efficiency is Challenging and Important

- Reducing building energy use is a national priority (EPAct 2005)
- Despite ~50% improvement in equipment efficiency (since 1970s), building energy use has only declined by 15%
- **Challenge: SMSCB* are diffuse (>95% of comm. bldgs.), ~half (>47%) of commercial building energy consumption, and has received little attention**



Annual Energy Use by Sector in USA

Based on data from NREL, DOE, and the National Trust for Historic Preservation

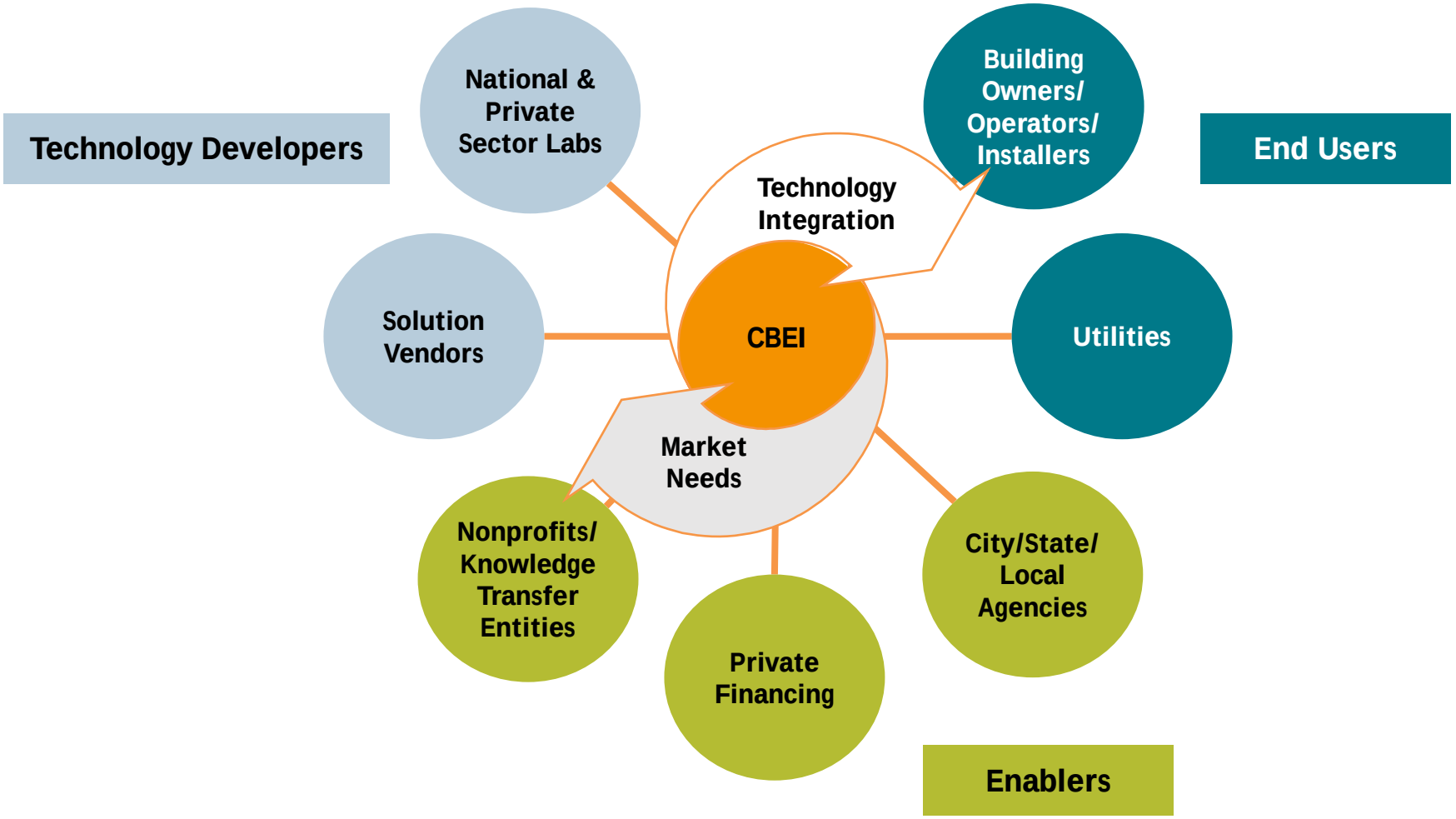
*Small and Medium Sized Commercial Buildings (less than 250k square feet)

CONSORTIUM for BUILDING ENERGY INNOVATION

The CBEI Approach

- Develop cost-effective packages of technology solutions that have demonstrated energy savings
- Adapt solutions to the technical level of SMSCB owners and service providers who are engaged in planning and execution of demonstration efforts
- Engage with key stakeholders (retrofit industry, building owners, tenants, cities, regulators)
- Build on DOE innovations

Technology Systems and Market Efforts Are Interconnected and Iterative



CONSORTIUM for BUILDING ENERGY INNOVATION

The Challenge of Retrofitting Small and Medium Buildings

- Building Owners are inexperienced about energy efficiency.
- Energy Efficiency Best Practices are not easily available or tailored for this sector.
- Service Providers for this sector are not experienced for deep energy retrofits.
- Financing is difficult.
- Tenant interests don't match Owner/Operator interests.

Impact of Energy Efficient Buildings

- **A 50 percent reduction in buildings' energy usage would be equivalent to taking every passenger vehicle and small truck in the United States off the road.**
- **A 70 percent reduction in buildings' energy usage is equivalent to eliminating the entire energy consumption of the U.S. transportation sector.**

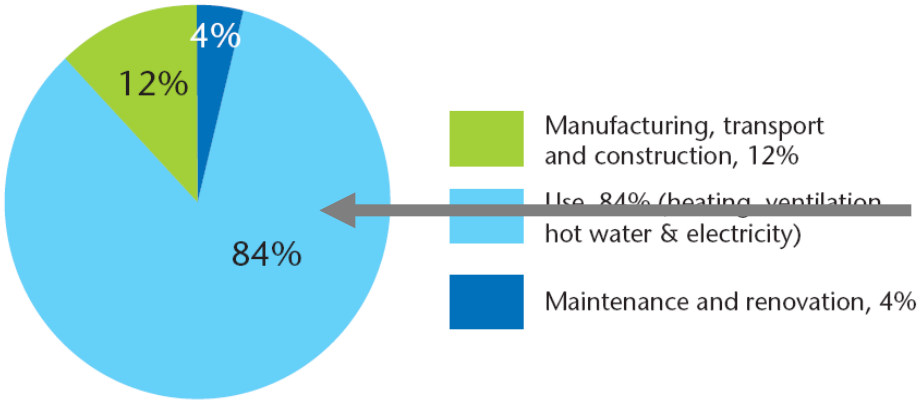


Figure 3.7: Life cycle energy use

DESIGN, CONTROL AND OPTIMIZATION OF WHOLE BUILDING SYSTEMS IS THE ONLY WAY TO GET THERE …

? WHY ?

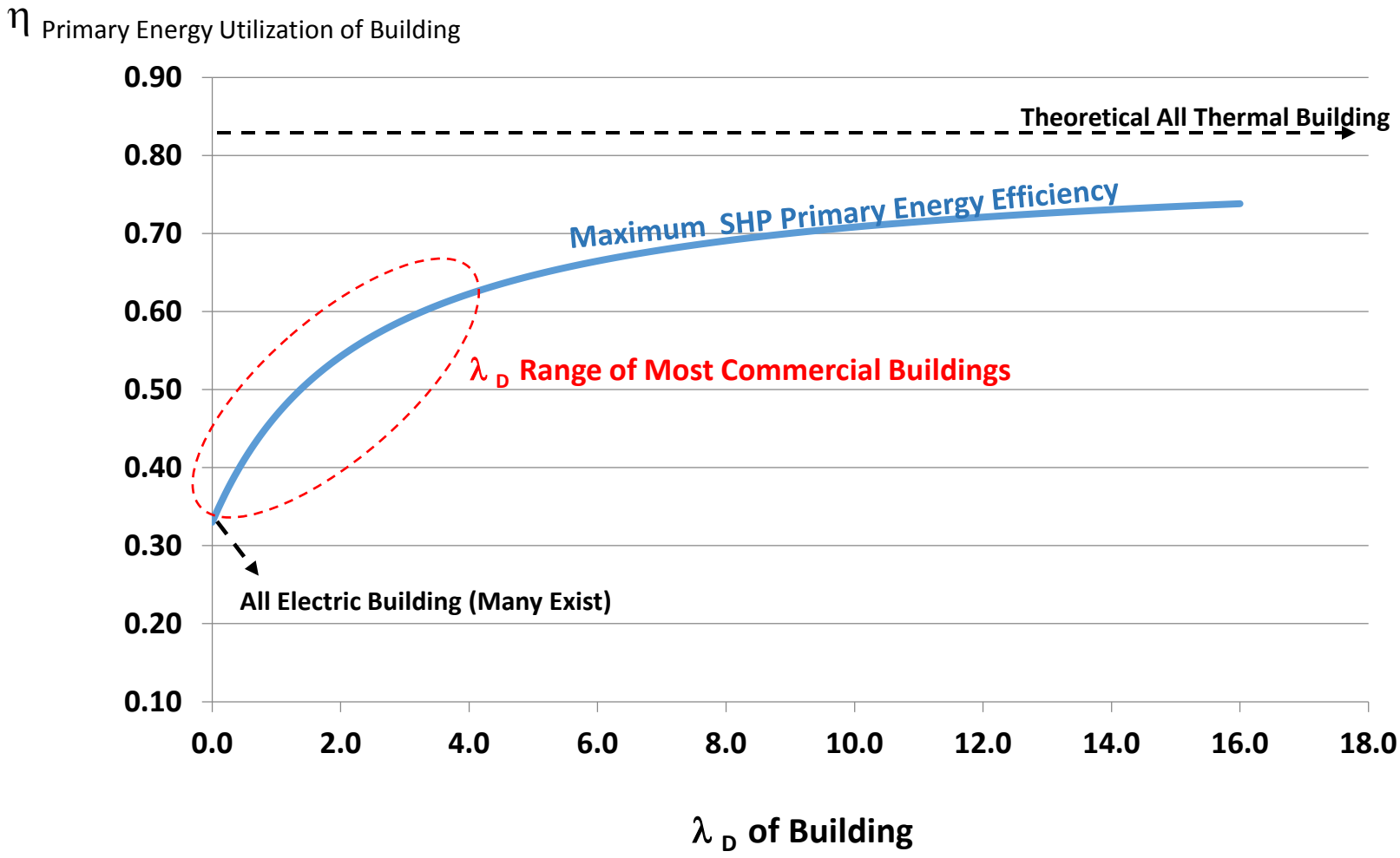
84% of energy consumed in buildings is during the use of the building

CONSORTIUM for BUILDING ENERGY INNOVATION

Every Building Type Has a Specific Thermal/Electric Demand Ratio, λ_D, Signature

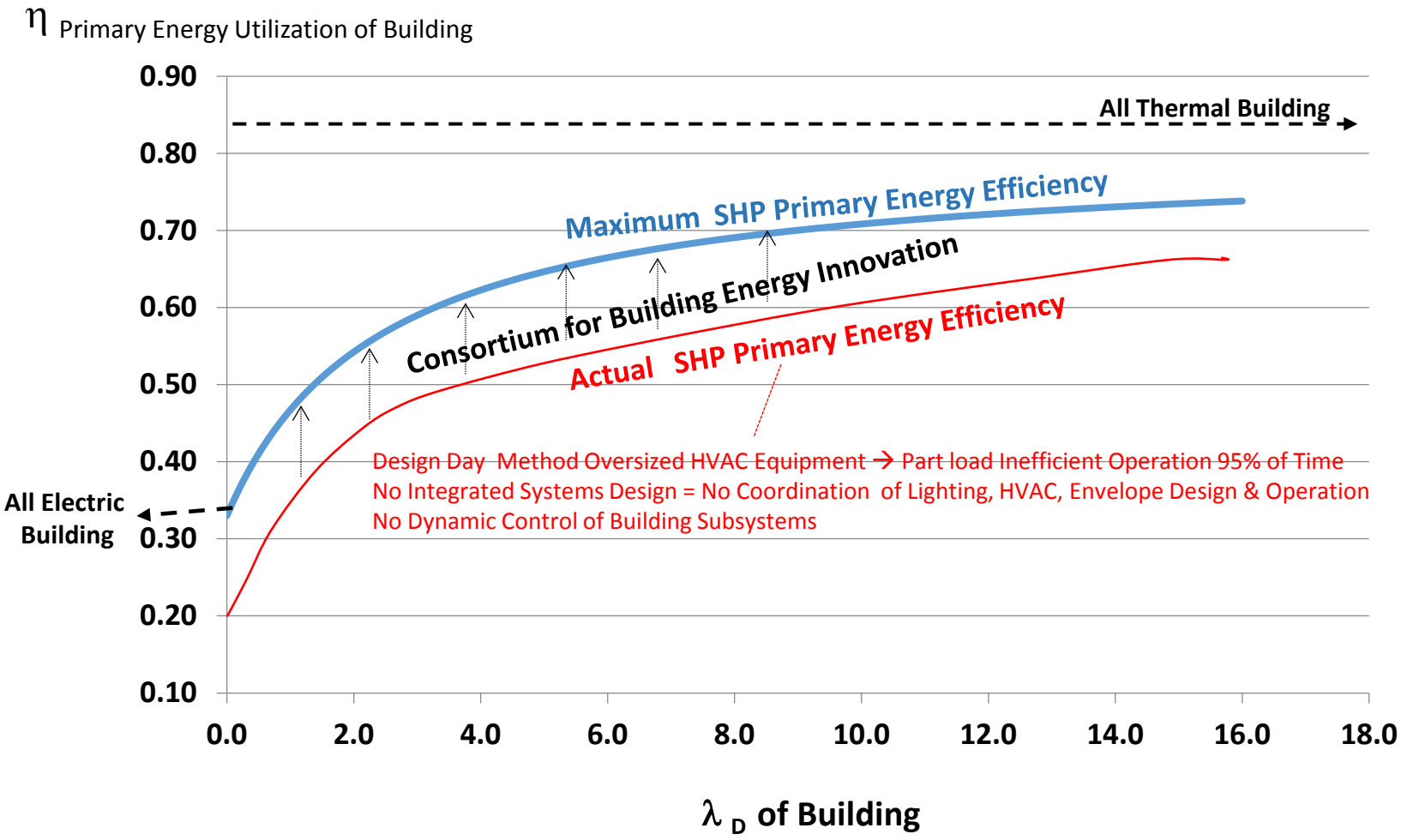
Principal Building Activity	Electricty EUI (kBTU/ft²-yr)	Fossil EUI (kBTU/ft²-fr)	λ thermal/elect
Education	24.7	54.6	2.211
Food Sales	163.9	49.6	0.303
Food Service	96	149.5	1.557
Health Care	76.6	163.8	2.138
Lodging	39.1	88.2	2.256
Mercantile and Service	35.5	40.9	1.152
Office	57.9	39.3	0.679
Public Assembly	35.9	77.8	2.167
Public Order and Safety	30.8	66.4	2.156
Religious Worship	8.8	28.6	3.250
Warehouse and Storage	17.1	21.2	1.240
Other	60.2	112	1.860
Vacant	5.2	16.3	3.135

Separate Heat and Power Commercial Buildings Efficiency Limited by Electric Generation, Transmission, Distribution Efficiency



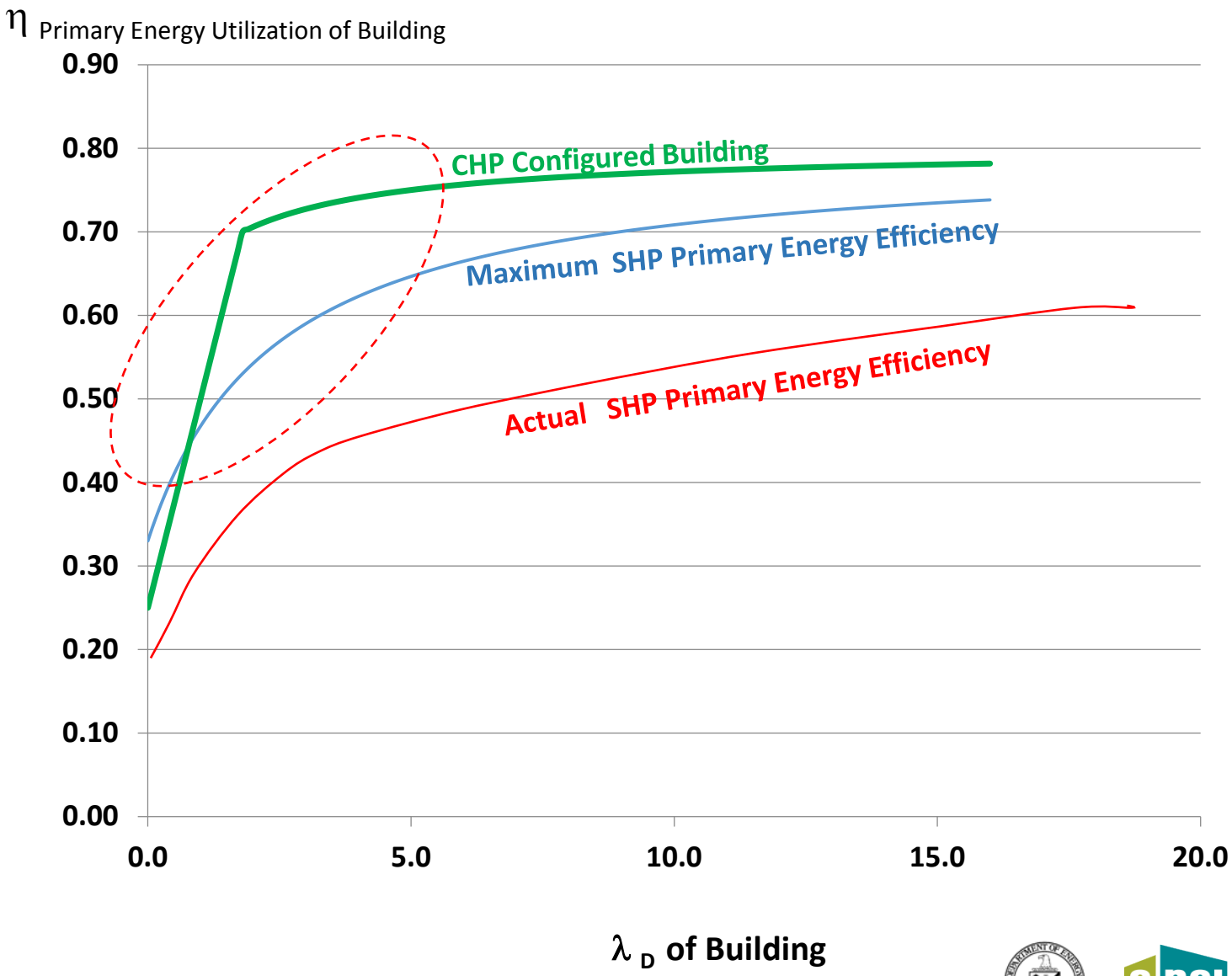
CONSORTIUM for BUILDING ENERGY INNOVATION

Separate Heat and Power Commercial Buildings Efficiency Limited by Electric Generation, Transmission, Distribution Efficiency

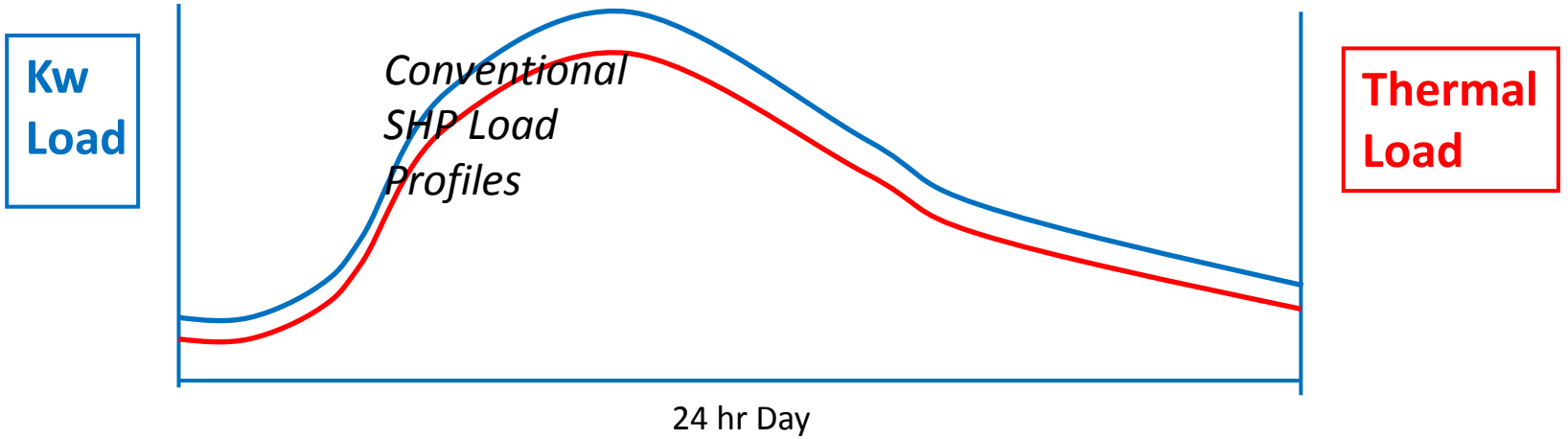


CONSORTIUM for BUILDING ENERGY INNOVATION

Combined Heat and Power Commercial Buildings Efficiency Overcomes Electric Generation, Transmission, Distribution Inefficiency

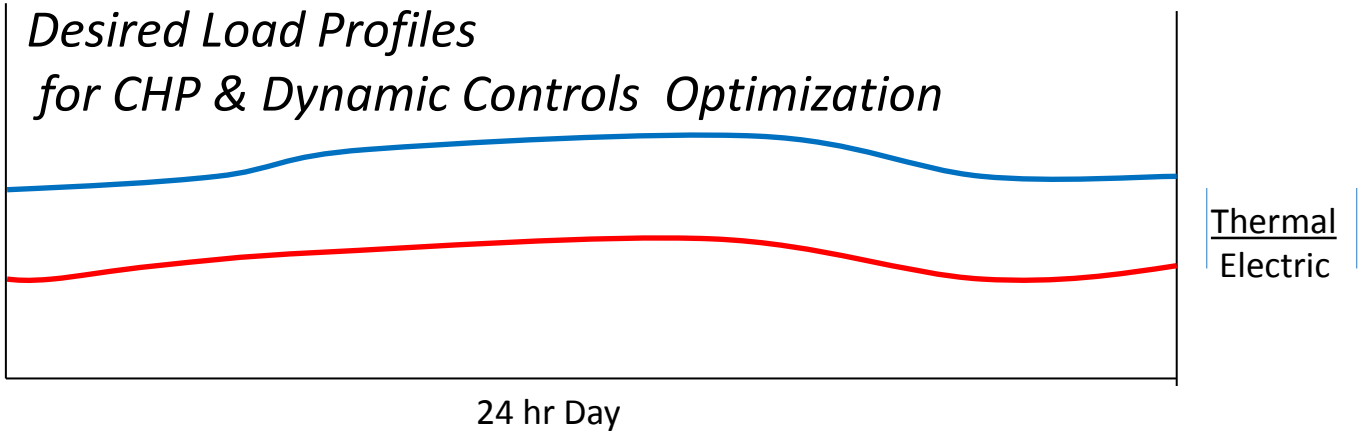


CONSORTIUM for BUILDING ENERGY INNOVATION



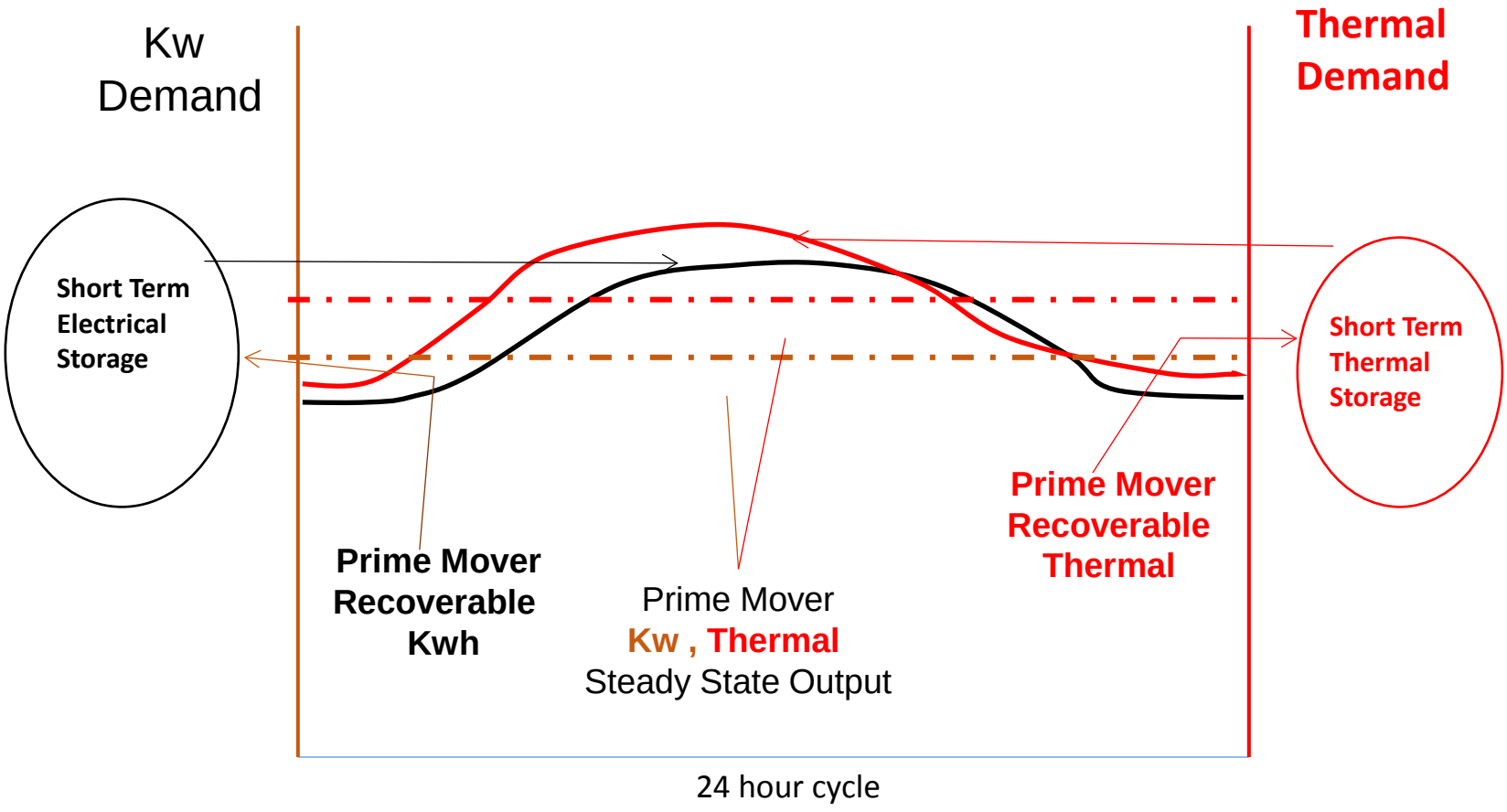
CBEI Integrated Design Paradigm Shift

Increase Building Thermal Capacitance
Controlled and Known Infiltration (Latent Load)
Integrated Daylight and Lighting Controls
Short Term Electric and Thermal Storage
Reliable, Cost Effective Dynamic Controls



CONSORTIUM for BUILDING ENERGY INNOVATION

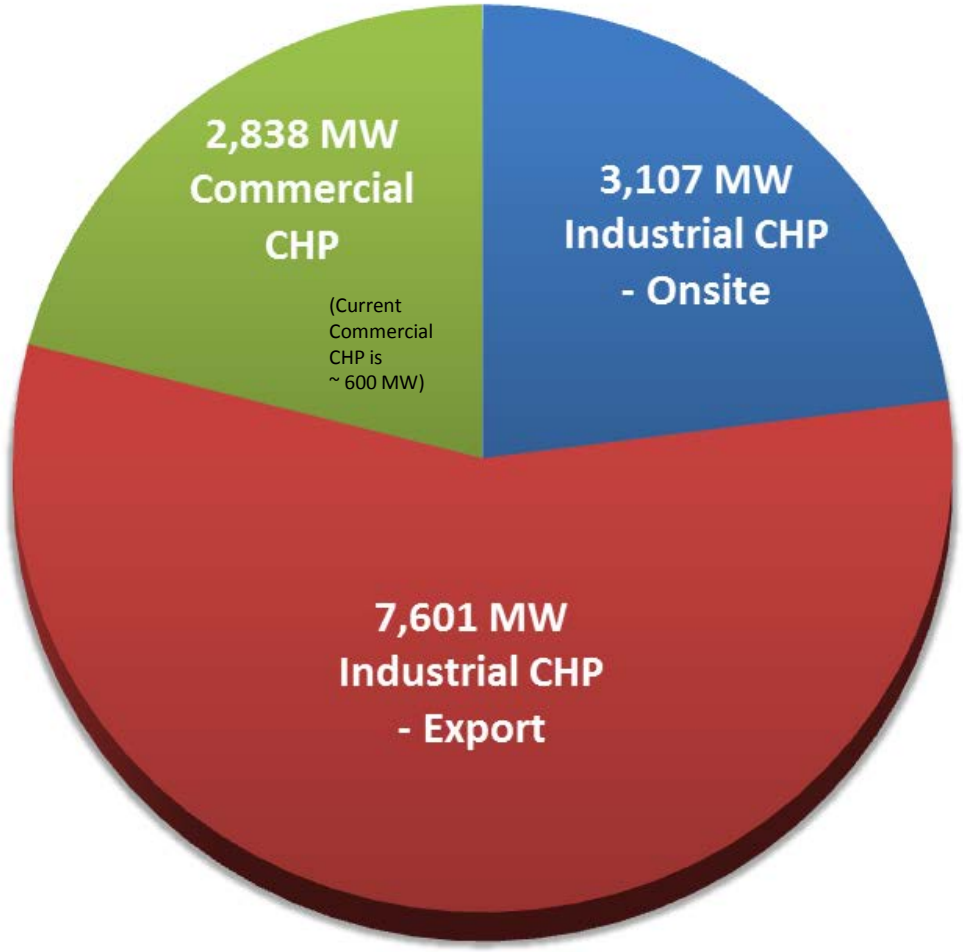
Innovation Needed in Short Term Storage Systems for General Applicability of CHP Design Paradigm



CONSORTIUM for BUILDING ENERGY INNOVATION

Background

PA Future CHP Technical Potential



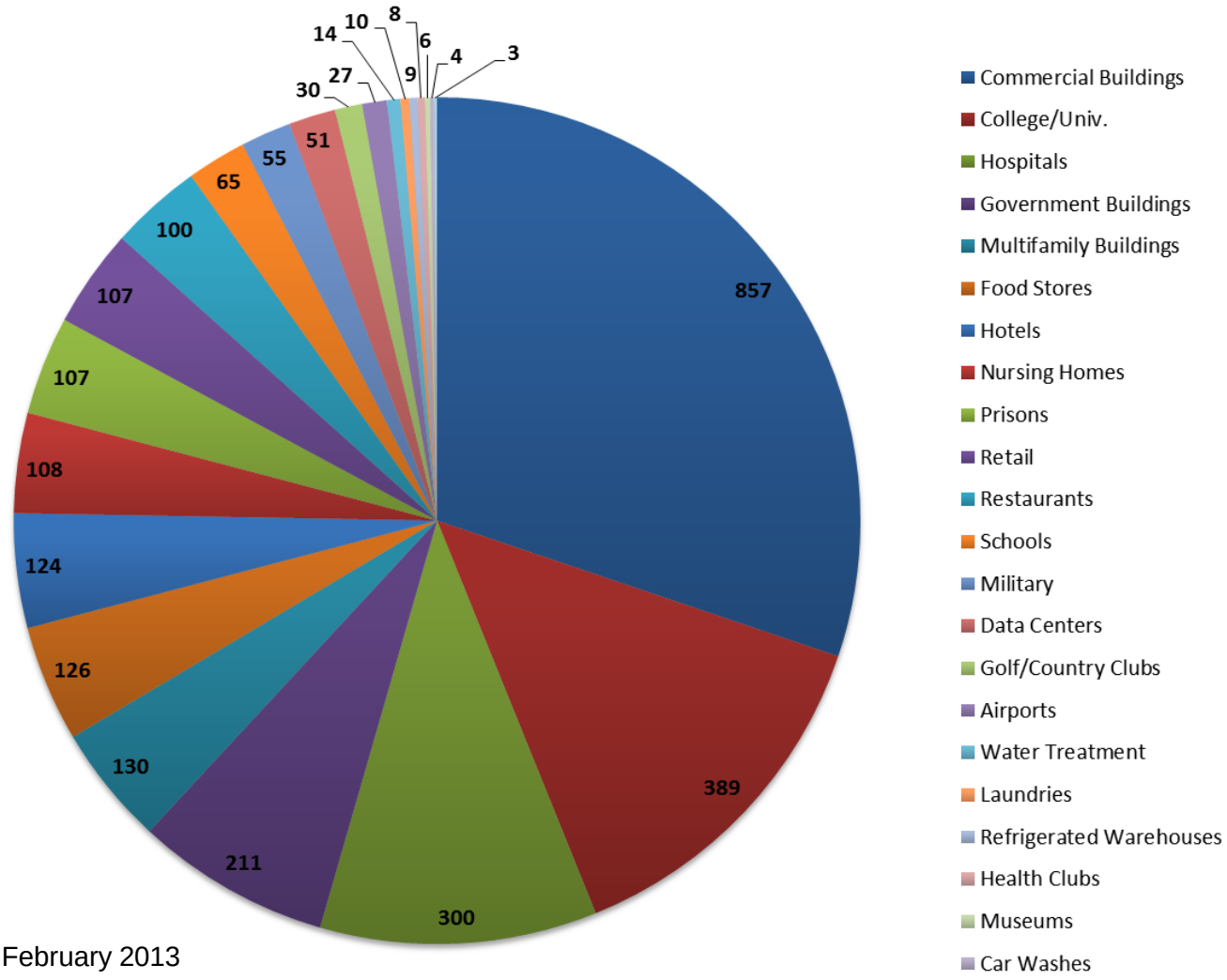
Source: ICF International February 2013

CONSORTIUM for BUILDING ENERGY INNOVATION

PA Commercial Tech Potential

Number of MW by SIC Code

Total: 2,838 MW



Source: ICF International February 2013

CONSORTIUM for BUILDING ENERGY INNOVATION