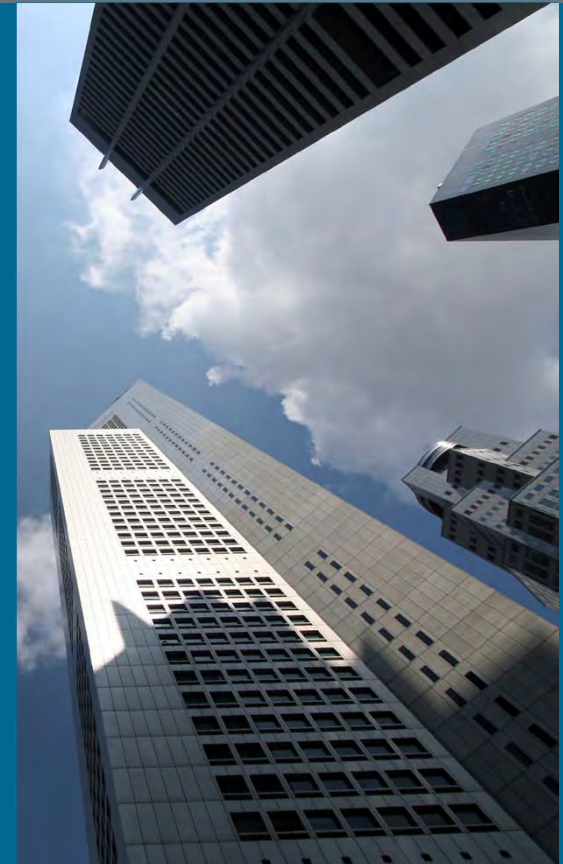




**Buildings in the 21st Century:
Ultra-Efficient and Business-Smart Strategies
for Transforming the Nation's Buildings**

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Building Technologies Program
November 29, 2011

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE 29 NOV 2011		2. REPORT TYPE		3. DATES COVERED 00-00-2011 to 00-00-2011	
4. TITLE AND SUBTITLE Buildings in the 21st Century: Ultra-Efficient and Business-Smart Strategies for Transforming the Nation's Buildings				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Department of Energy, Energy Efficiency and Renewable Energy, 1000 Independence Avenue SW, Washington, DC, 20585				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES Presented at the Partners in Environmental Technology Technical Symposium & Workshop, 29 Nov ? 1 Dec 2011, Washington, DC. Sponsored by SERDP and ESTCP					
14. ABSTRACT The presentation will provide an overview of the cutting-edge efficiency strategies and technologies being employed to design new and renovate existing buildings ? and show how federally sponsored research and development supports this progress.					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 24	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

KEYNOTE ADDRESS

**BUILDING THE 21ST CENTURY: ULTRA-EFFICIENT AND BUSINESS-SMART
STRATEGIES FOR TRANSFORMING THE NATION'S BUILDINGS**

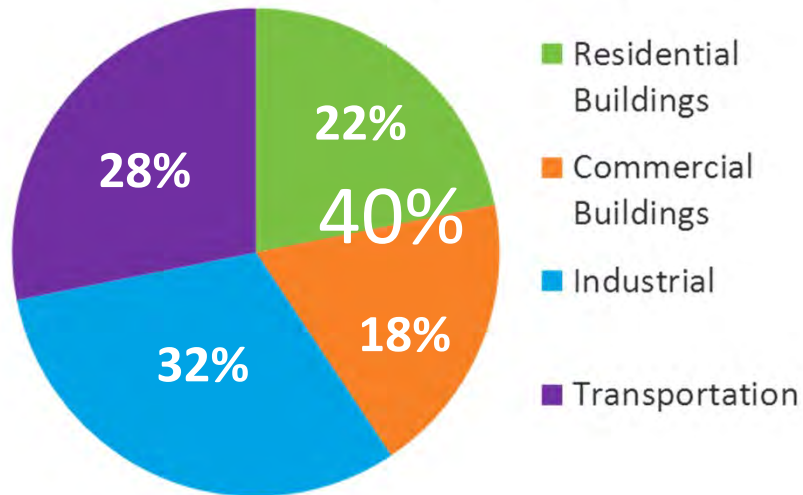
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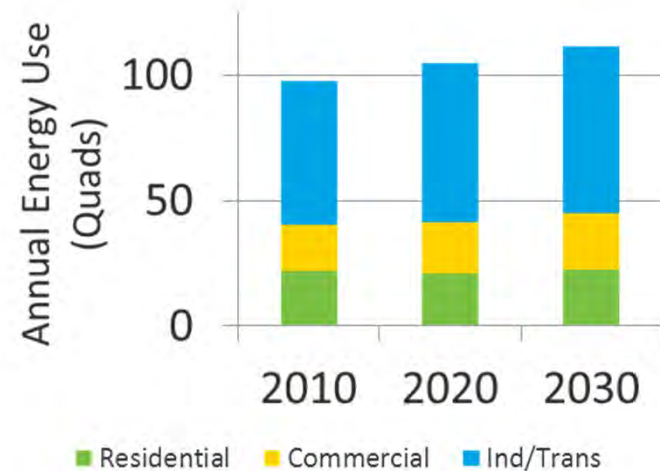
The presentation will provide an overview of the cutting-edge efficiency strategies and technologies being employed to design new and renovate existing buildings – and show how federally sponsored research and development supports this progress.

The U.S. Energy Big Picture...

U.S. Primary Energy Consumption



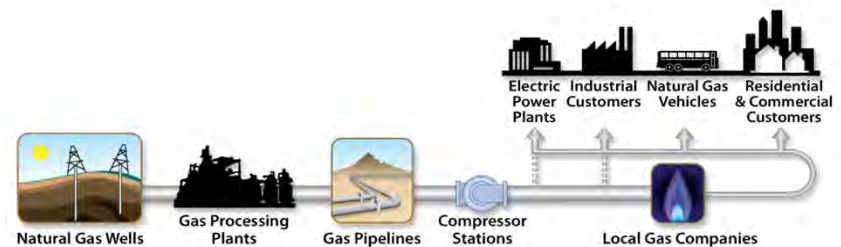
Total U.S. Energy Consumption



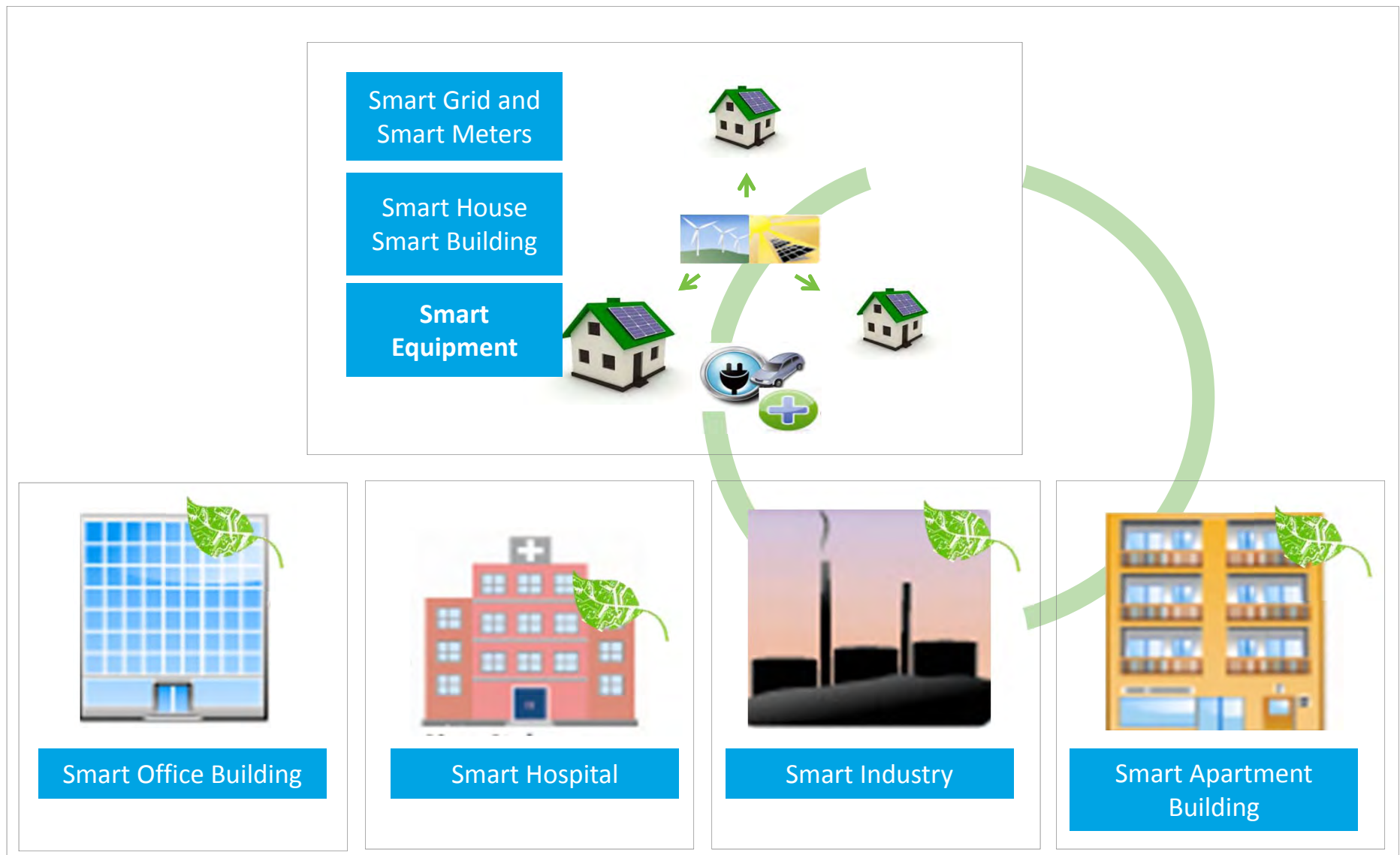
73% of U.S. Electricity Consumption



55% of U.S. Natural Gas Consumption



Future Opportunities for an Energy Efficient Nation



The Building Technologies Program (BTP) uses an Integrated Approach to Deliver Savings

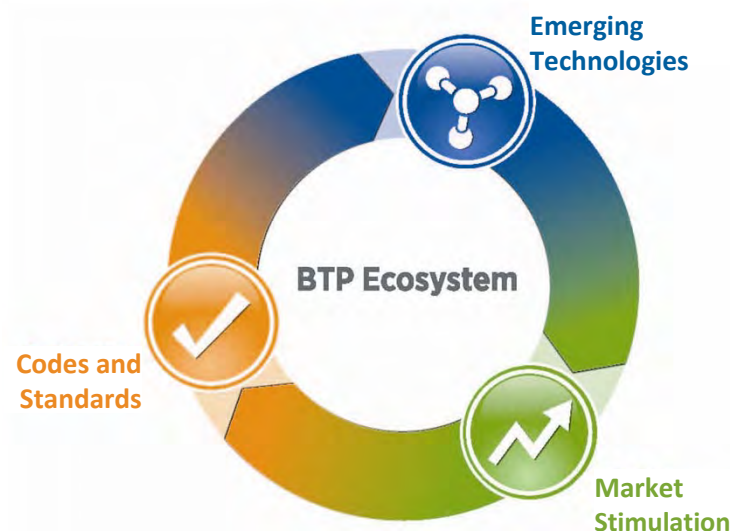
Research & Development

- Develop technology roadmaps
- Prioritize opportunities for DOE
- Solicit and select innovative technology solutions
- Collaborate with researchers and market performers
- Solve technical barriers and test innovations to prove effectiveness
- Measure and validate energy savings



Market Stimulation

- Identify barriers to “speed and scale” adoption
- Develops solutions to policy, adoption, and financial barriers
 - Collaborate with industry partners to improve market adoption
 - Increase usage of products and services
 - Communicate the importance and value of energy efficiency
 - Provide technical assistance
 - Support development of workforce training and certification



Codes and Standards

- Establish minimum energy use in a transparent public process- raise the efficiency bar
- Protect consumer interests
- Reduce market confusion
- Enhance industry competitiveness and profitability
- Expand portfolio of energy efficient appliances and equipment

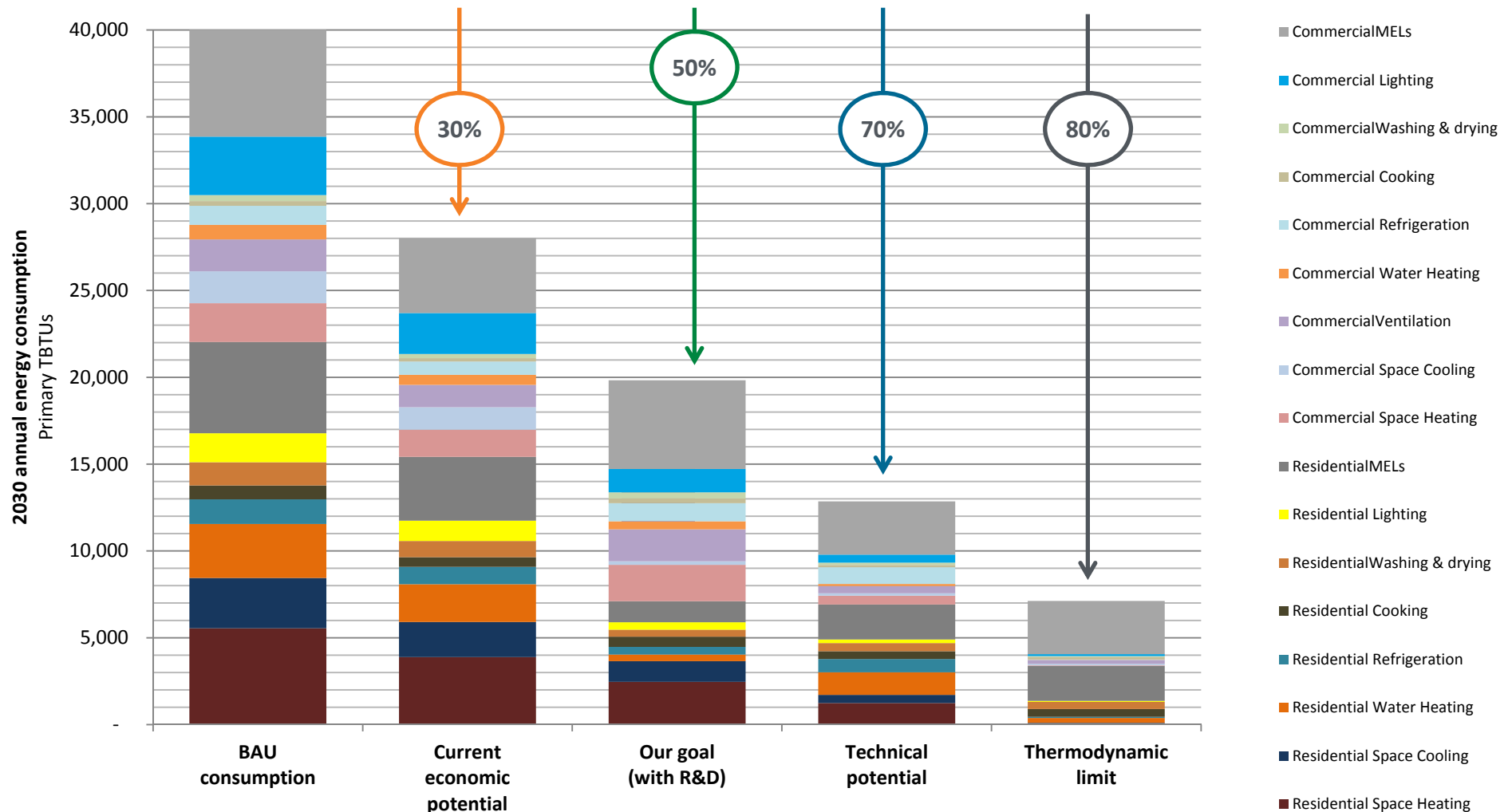


BTP is Pursuing an Overarching Goal

U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy

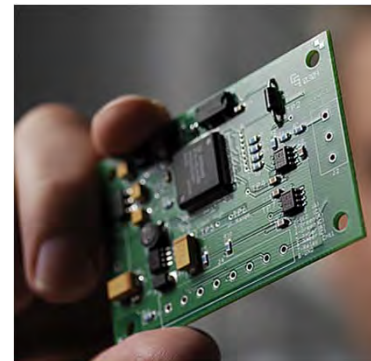
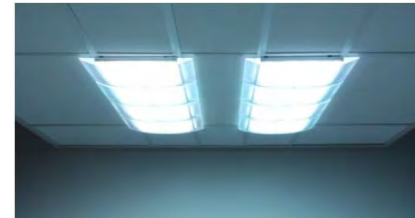
Reduce Building-Related Energy Use 50% by 2030- Preliminary



Source: BTP Prioritization tool, NAS, McKinsey.

What might the Market look like 5 years from Now?

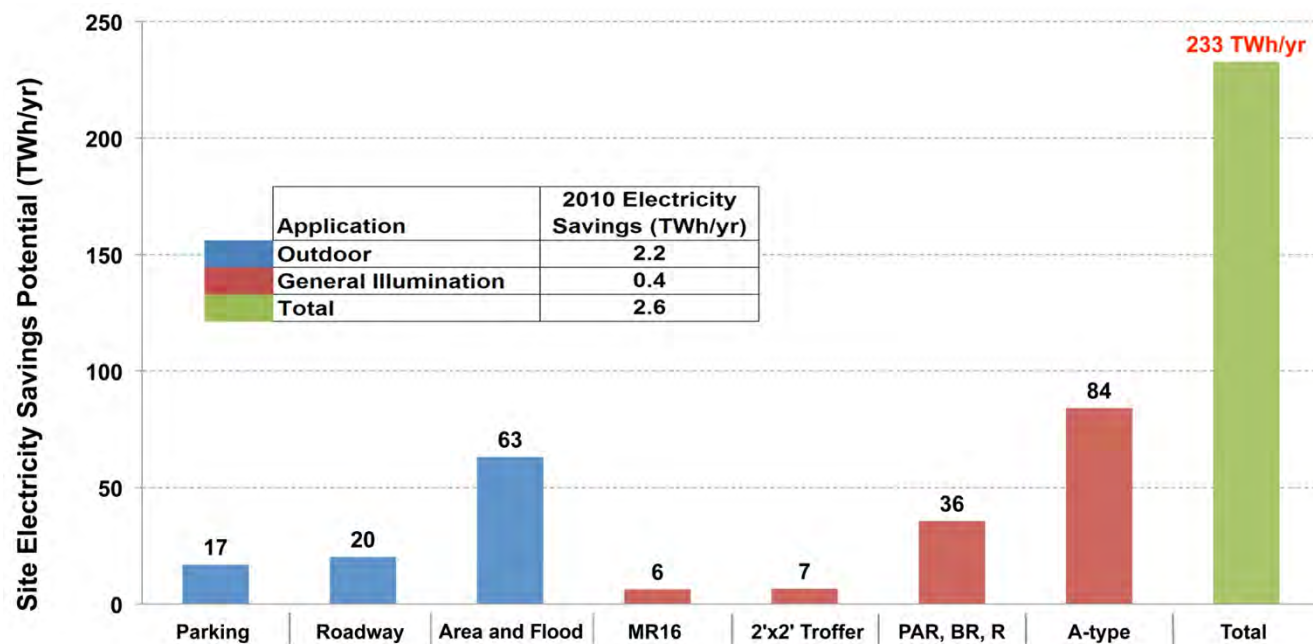
- **Cooler:** Significant advancements in cooling and refrigeration technology enable the market to choose from a larger variety of energy-efficient products at competitive prices
- **Brighter:** DOE recognizes that solid-state lighting has the potential to save significant energy
- **Smarter:** Advances in sensor & control technology are improving our ability to detect faults, diagnose problems, and facilitate repairs before costly failures occur; products are getting 'smarter' AND more efficient



Emerging Technologies: LED Savings Potential is Significant

- Electricity savings potential of niche LED-based lighting = **233 TWh/yr**
- Equivalent to the electricity needed to power **19 million households**

LED Energy Saving Estimates for Niche Applications



Energy Savings Estimates of Light Emitting Diodes in Niche Lighting Applications, Navigant Consulting, Inc., January 2011: www.ssl.energy.gov/tech_reports.html

Emerging Technologies: LED Applications Will Be Game Changers

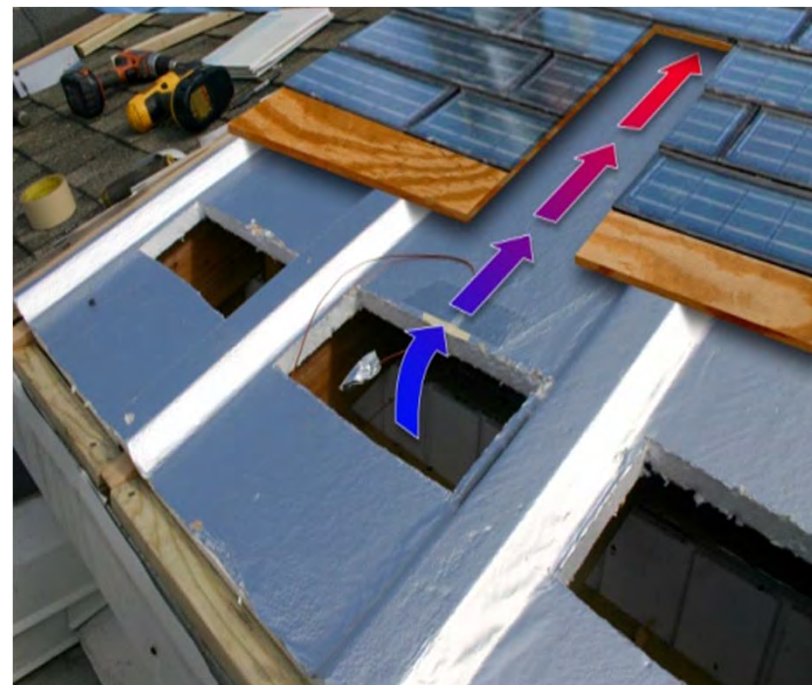
- **Solid-state lighting (SSL) technology has the potential to cut U.S. lighting energy use by ¼ and contribute to U.S. climate change solutions**
- DOE, its national laboratories, and Commercial Building Energy Alliance (CBEA) members are working to support the market deployment of LED parking lot lighting



- A Walmart in Leavenworth, Kansas, has the first retail parking lot to meet the CBEA LED parking lot site specification
- Walmart expects LEDs to reduce energy needs in its parking lots by more than 50%, delivering average energy savings of <125,000 kWh/year per site
- Walmart has planned for over 225 new sites that will include this LED parking lot lighting specification

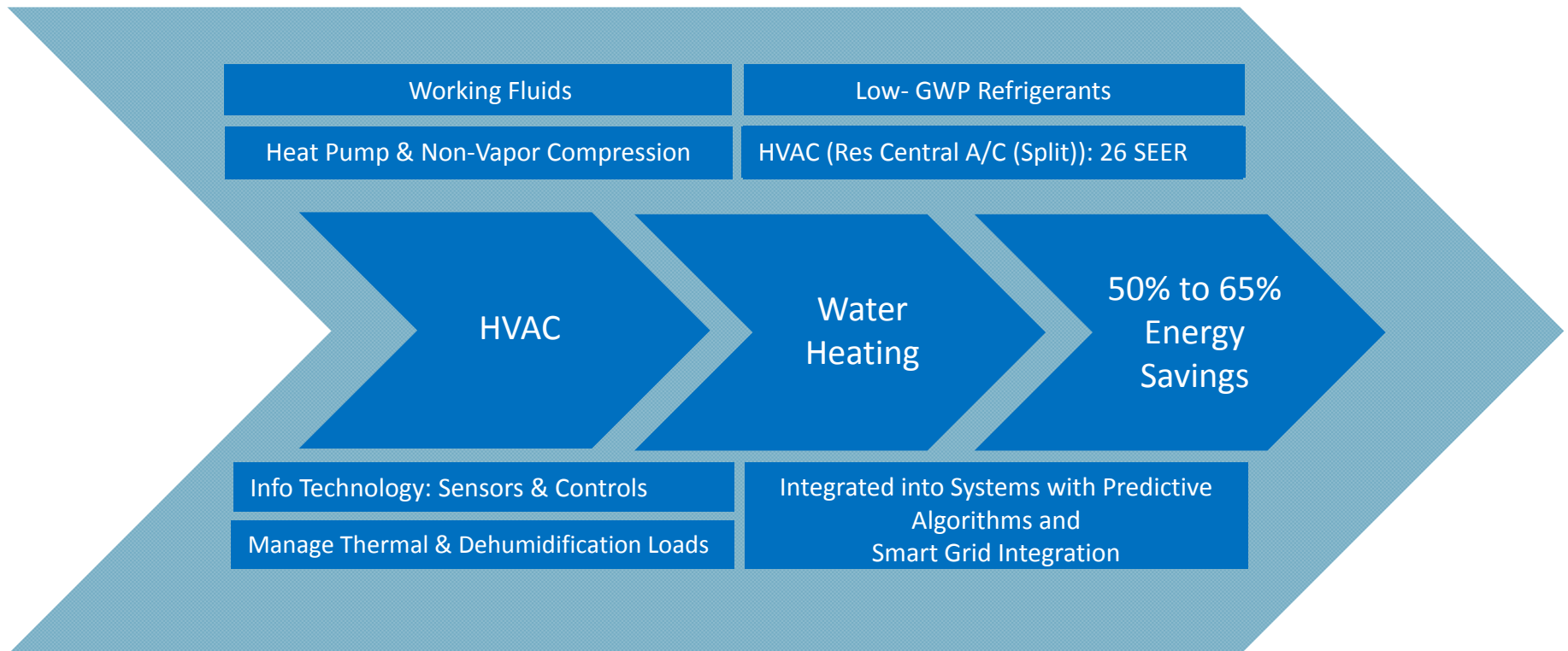
Emerging Technologies: Building Envelope has an Expansive Portfolio

- Roofs:
 - Increase aged performance of roof coatings by 25%
 - Develop cost effective “cool-colored” asphalt shingles with no increase in 20 year life cycle cost by 2015
 - Next gen attic systems with 50% savings
- Windows:
 - Develop a cost-effective R-10 window
 - 0.1 U-Value windows at \$3/sq ft price premium by 2020
- Insulation:
 - Dynamic insulation with over 20% peak load reduction
 - Dynamic annual performance of attics and walls with no increase in life cycle cost by 2015
- Building Integrated PV with higher PV output and min. 25% thermal load reduction



Sample advanced roof design applied to BIPV to be evaluated (50% reduction of roof thermal load)

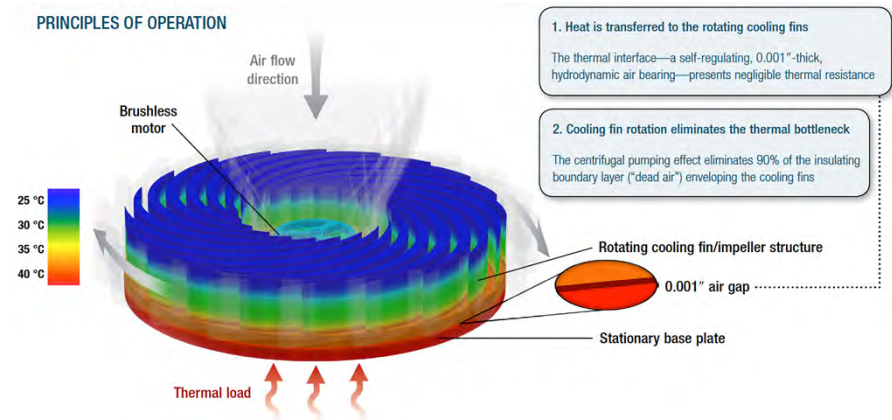
Emerging Technologies: HVAC, Water Heating, and Working Fluids Make the Push for Big Energy Savings



Emerging Technologies: Heat Exchangers will Significantly Impact many End Uses

- Crosscutting technology: Heat exchangers are used not only in refrigeration, heating, and air conditioning but also nearly every application that generates waste heat
- Potentially impacting 21 quadrillion BTUs (53%) of building energy consumption
- First application - Data Center cooling loads (chip cooling)

New heat exchange technology has a 30x improvement versus current technologies



Technical white paper: <http://prod.sandia.gov/techlib/access-control.cgi/2010/100258.pdf>

Emerging Technologies: BTP Pursues Integrated Heat Pump Technology for Residential & Small Commercial Applications



Energy Efficiency &
Renewable Energy

- **Improved Air-Source Heat Pumps (ASHP) for Cold Climates**
 - Potential 50% – 70% savings at low ambient temps vs. current min efficiency ASHP
- **Multifunction Electric Heat Pumps** (Space conditioning, water heating, dehumidification, and ventilation)
 - Potential 40% – 65% energy savings for HVAC/WH vs. suite of individual systems
 - 13 SEER ASHP, 0.9 Energy Factor (EF) Water Heater, 1.4 EF stand alone dehumidifier, whole house ventilation per ASHRAE 62.2
 - Two-speed and variable speed compressor versions;
 - Variable speed fans and pumps
- **Residential Multi-Function Fuel-Fired Heat Pump**
 - Potential 70% peak demand savings; 40% source energy savings vs. min efficiency electric heat pump
 - Space conditioning, dehumidification, water heating, up to 3 kW of electrical energy

Example Application: Heat Pump Coupled Washer/Dryer - heat pump cycle to facilitate intracycle heat recovery and minimize energy use- 2011-2013 project time frame

Emerging Technologies: A Next Generation Window Air-Conditioner (WAC) can Deliver 30% Energy Savings

- **Aim: WAC unit in 1.5 – 3.5 kW cooling capacity range with a energy efficiency ratio (EER) of 13**
- 30% energy savings vs. current minimum efficiency standard
- Market & Energy Saving Potential
 - US has ~57 million units in use
 - Current DOE minimum EER is 9.8
 - Replacement of existing units with advanced WACs could save ~2.5 quads of energy over next 20 years
 - Future Cooperative Research and Development Agreement (CRADA) project

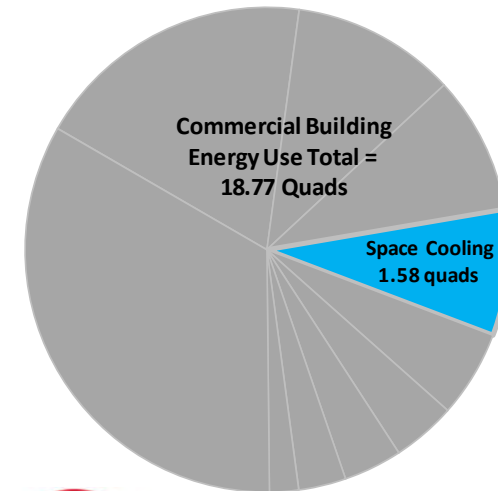


BTP supports a Diverse Program of Deployment to Achieve Speed and Scale

- Technology Specifications – Market Driven
- Minimum Performance Standards
- Training and Certification Programs
- Technology Identification and Screening
- Successful Retrofit Business Models – Better Buildings
- Building Performance Database – Standardized Data Taxonomy
- Advanced Retrofit Guides
- Advanced Design Guides
- Modeling and Tools
- Superior Energy Performance

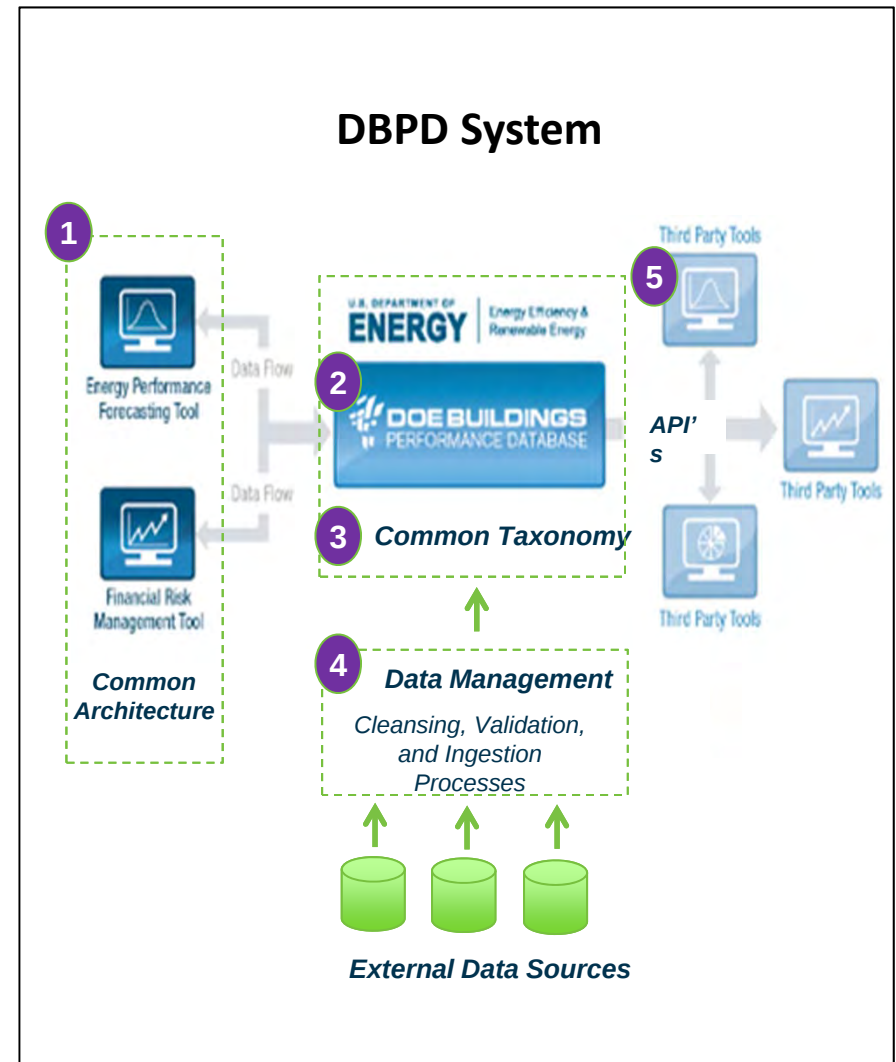
Working with Industry to Drive Innovation: The RTU Challenge

- Package units such as RTUs use ~ 50% of the cooling energy in commercial buildings
- ~40,000 ten ton RTUs sold/year
- Challenge U.S. manufacturers to build and deliver innovative, competitively priced, energy-saving rooftop HVAC units (RTUs) that meet CBEA high-performance specification requirements such as
 - ARI rated efficiency from baseline 11.0 EER/11.2 IEER to 18 IEER
 - Decrease air flow by specifying variable over constant air volume
 - Increase fan efficiency from 45% to min. 60% with variable volume or multi-stage operation capability



Deployment: The DOE Building Performance Database (DBPD)

- 1 **Applications:** Web-enabled tools that leverage data to forecast energy savings and related cash flows.
 - As more use-cases are identified, additional tools will be created and released to the market
- 2 **Data Warehouse:** platform to house Energy data within standard taxonomy
- 3 **Common Taxonomy:** a standardized “data model” to organize energy use and building characteristic data
- 4 **Data Management:** processes and tools to support the on-boarding and validation of data from multiple sources
- 5 **3rd Party Tool Support:** API's that allow 3rd Party developers to create applications that use DBPD data



RSF Design/Build Process Drives Efficiency through Integrated Approach

- **Performance based**, not solution/prescriptive Request for Proposal (RFP)
- No drawings/plans in the RFP
- Short list of qualified Design-Build Teams complete with RFP
- Design decisions from energy modeling
- Optimal use of “free” energy sources
- Select **best value for a fixed price**
 - Data center waste heat recovery
 - Evaporative cooling in dry climate
 - Day lighting
- Single contract to Design-Build firm
- Financial incentive for superior performance
- Substantiate design and construction elements to validate performance



Cutting energy consumption in half at zero added cost is possible.

Greater Philadelphia Innovation Cluster for Energy Efficient Buildings Integrates Systems

- **House and Foster Collaboration** between research, training, and commercialization activities focused on clean and energy efficient processes, policies, and technologies
- **Function as a Living Laboratory** to research and demonstrate processes and products identified and/or developed by the HUB as scalable, near market-ready retrofit approaches
- **Serve as a regional resource** that makes energy efficiency attractive to building owners, researchers, and policy-makers
- **Demonstrate intersection of energy efficiency and energy effectiveness** (efficient spaces that are comfortable, healthy, functional, and appealing)



Facility Energy Decision System (FEDS) brings Big Value to Energy Industry

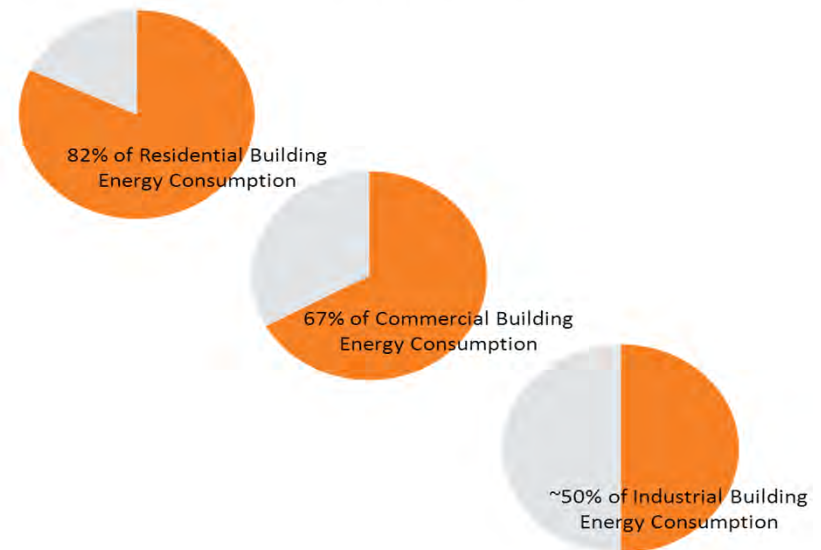
- FEDS estimates energy consumption for all energy systems & fuels types
- FEDS determines the minimum life-cycle-cost of retrofits to systems within a single facility and for an entire installation or campus, considering interactive effects
- FEDS can be used by government or private sector for single or multi-building campuses to quickly and easily assess:
 - Energy efficiency opportunities
 - Energy/\$ savings
 - Emission reductions



Appliance Standards and Test Procedures is DOE's Most Effective Energy Saving Program

- Energy saved since first 1987 standards = construction of ~31 power plants avoided or the amount of electricity consumed annually by Spain
- 1988 – 2006 standards est. cumulative energy savings = 39 quads by 2020 and 63 quads by 2030
- Cumulative consumer benefit*:
 - \$64 billion at the end of 2005
 - \$150 billion as of 2010
 - \$241 billion by 2030
 - \$269 billion by 2045
- Annual carbon savings will reach 38 million tons by 2020
- Cumulative carbon savings by 2045 is estimated at 1,200 million tons

- <\$650 in net savings for every federal dollar spent
 - Consumers and businesses are saving \$15 billion a year as of 2010 and this is expected to nearly double by 2025
- Over 50 products covered:



*Net present value

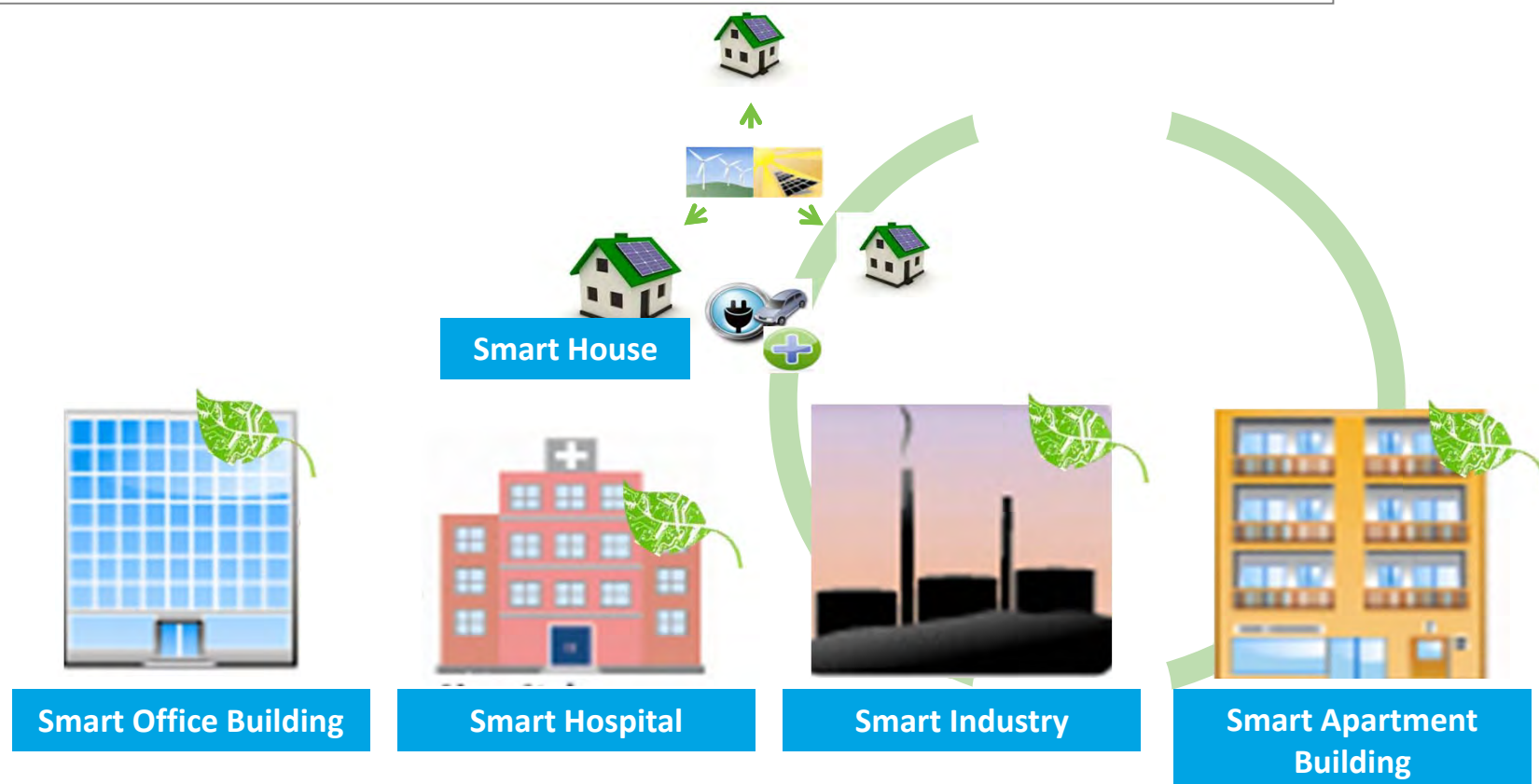
And From There? Future Opportunities...

Distributed Generation Systems: Dynamic Control

Smart equipment: Auto demand response, self-correcting

Energy storage with local generation: PV, wind, batteries, thermal storage

DC vs. AC: Minimize transformer losses



- DOE is actively working to balance...
 - US investments in high potential advanced technologies, integrating the recyclability of the components in the initial design
 - Developing tools and strategies to drive market adoption of energy efficient approaches and innovations
 - Removing excessively inefficient technologies and practices from the market through cost effective codes and equipment standards

....While focusing on accelerating a future where energy is easily, transparently, and cost effectively managed without negatively impacting our quality of life

Thank You