IEA-WBCSD Workshop on Building Energy Efficiency Policies

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Building Energy Efficiency Policies and Programs of the United States

Mark Friedrichs
US Dept of Energy
16 March, 2012
mark.friedrichs@ee.doe.gov

The U.S. Energy Big Picture…

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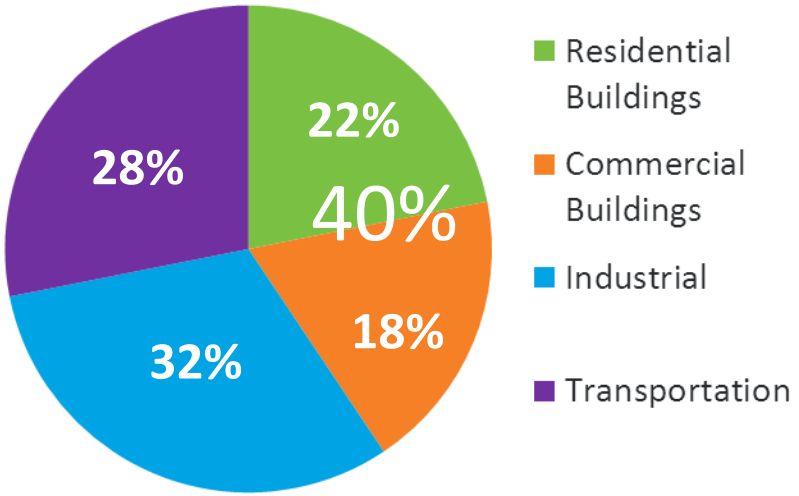
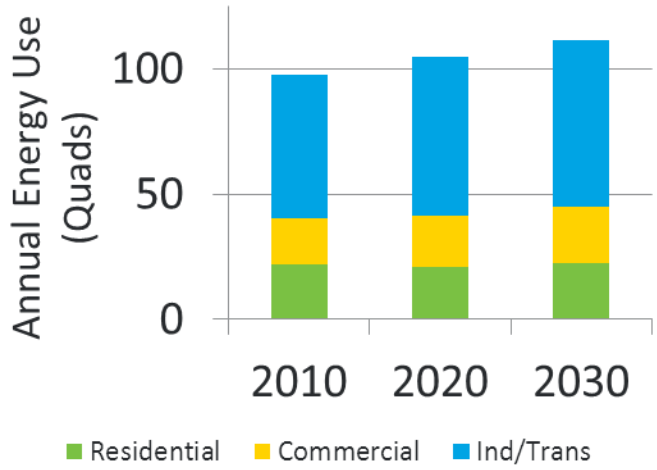
U.S. Primary Energy Consumption

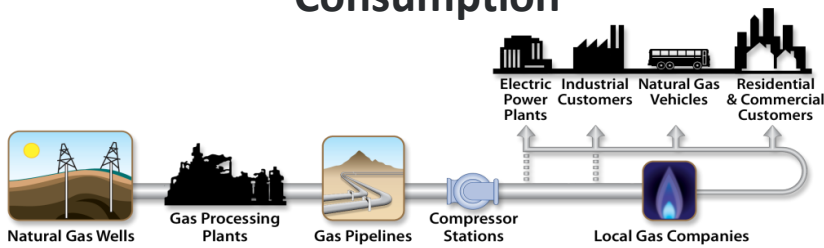


Total U.S. Energy Consumption



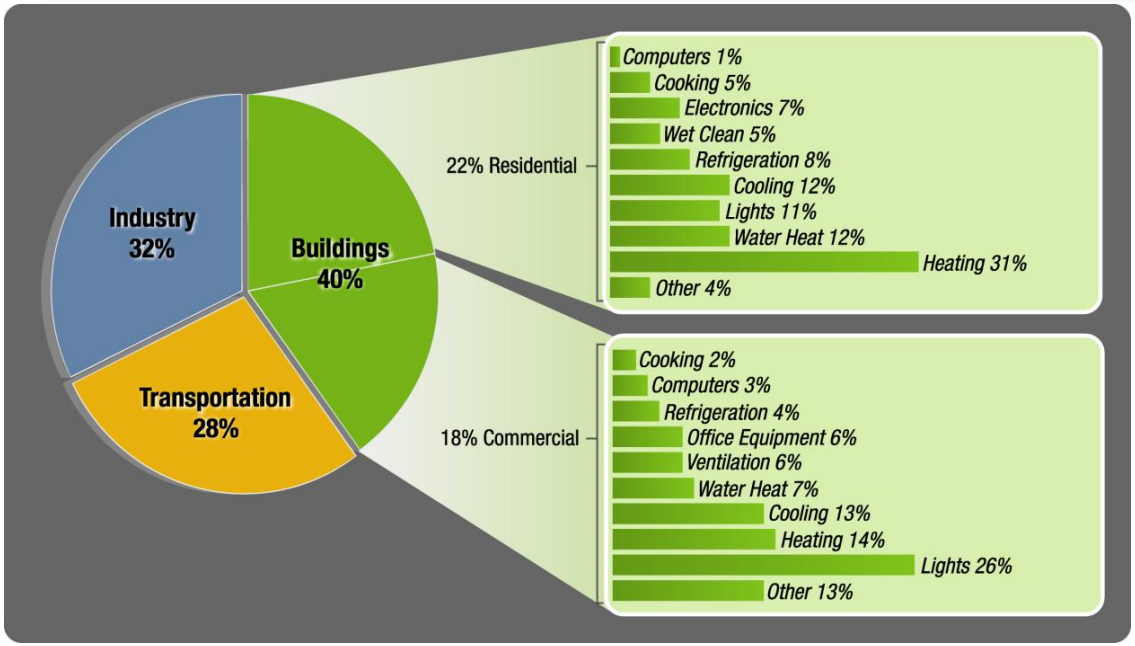
Buildings represent 73% of U.S. Electricity Consumption

and 55% of U.S. Natural Gas Consumption



Residential and Commercial Buildings Consume 40 Quads of Primary Energy Per Year

Buildings use 72% of nation's electricity and 55% of its natural gas.



Source: LBNL Environmental Energy Technologies Division, 2009

By 2030, Business as Usual

- 16% growth in electricity demand
- Additional 200 GW of electricity at cost of $500-1000B, or $25-50B/yr

Heating & cooling is about 50% of energy consumption

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

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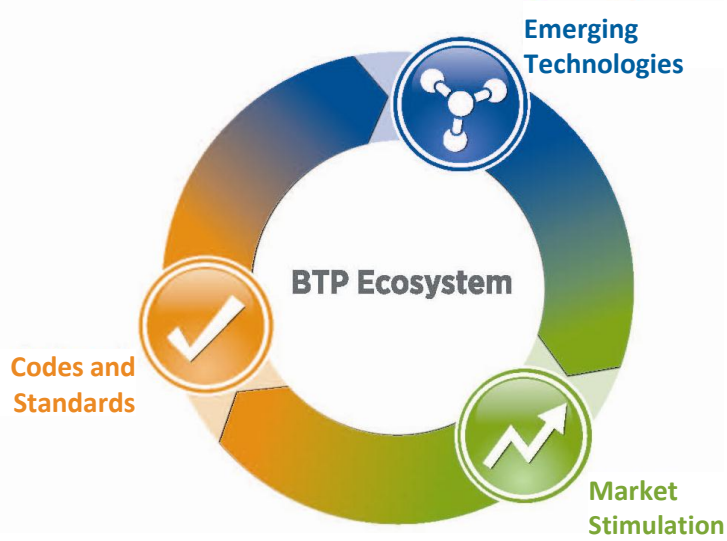
Research & Development

- 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

Overview of United States Building Efficiency Policies and Programs

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- **New Buildings**
  - Mandatory state and local codes, plus labels, design, technology, information
- **New Appliances and Equipment**
  - Mandatory efficiency standards (MEPS), plus labels, technology, incentives, information
- **Existing Residential Buildings (shells and systems)**
  - Audits/information, labels, incentives/grants, financing, technology
- **Existing Commercial Buildings (shells and systems):**
  - Audits/information, labels, incentives/grants, financing, technology

New Goal: Reduce Buildings Energy Use 50% by 2030

DOE Building Technologies Program (BTP) Pursues an Overarching Goal

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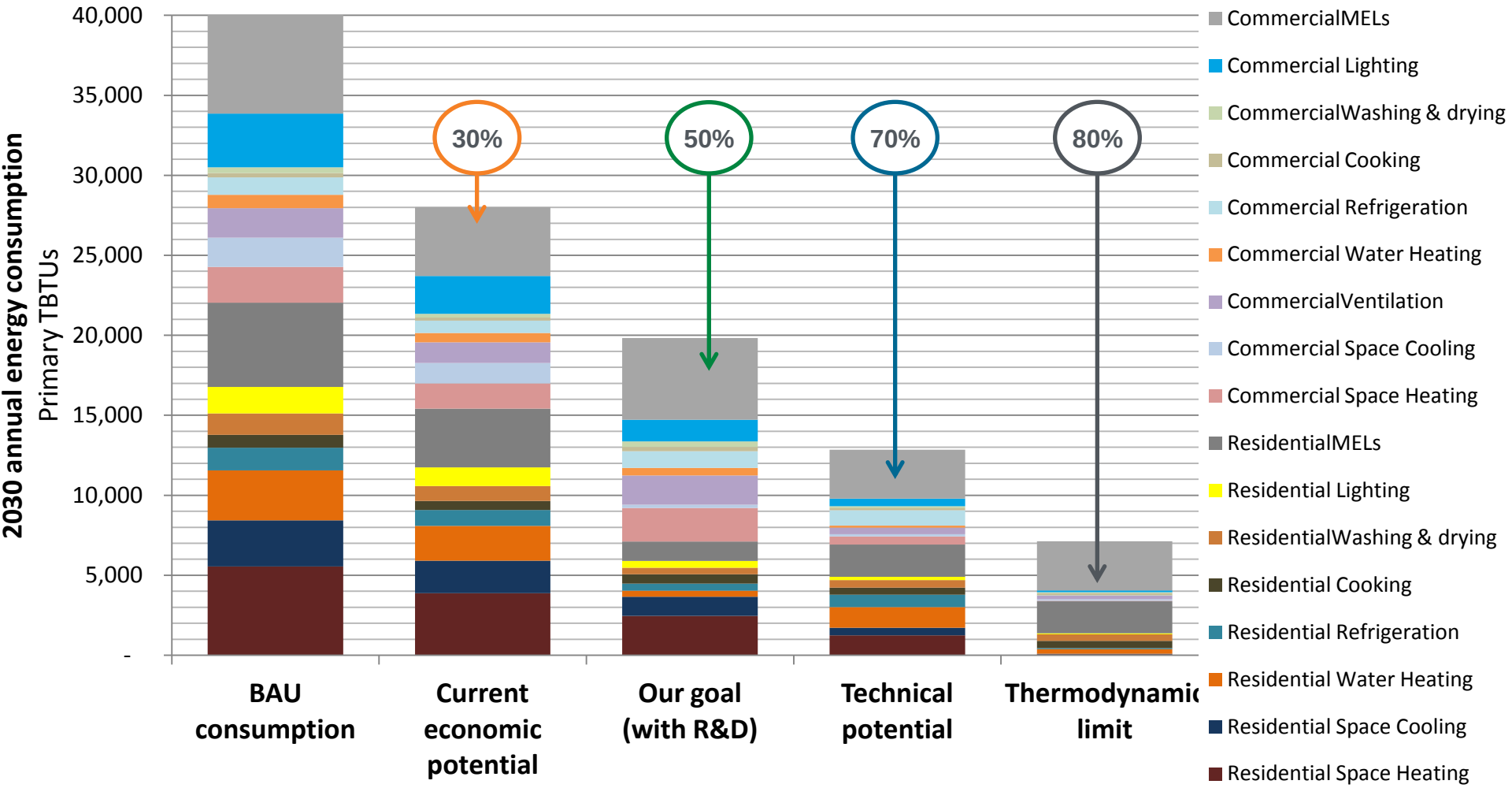
Reduce Building-Related Energy Use 50% by 2030



Source: BTP Prioritization tool, NAS, McKinsey

US Policies and Programs for New Buildings

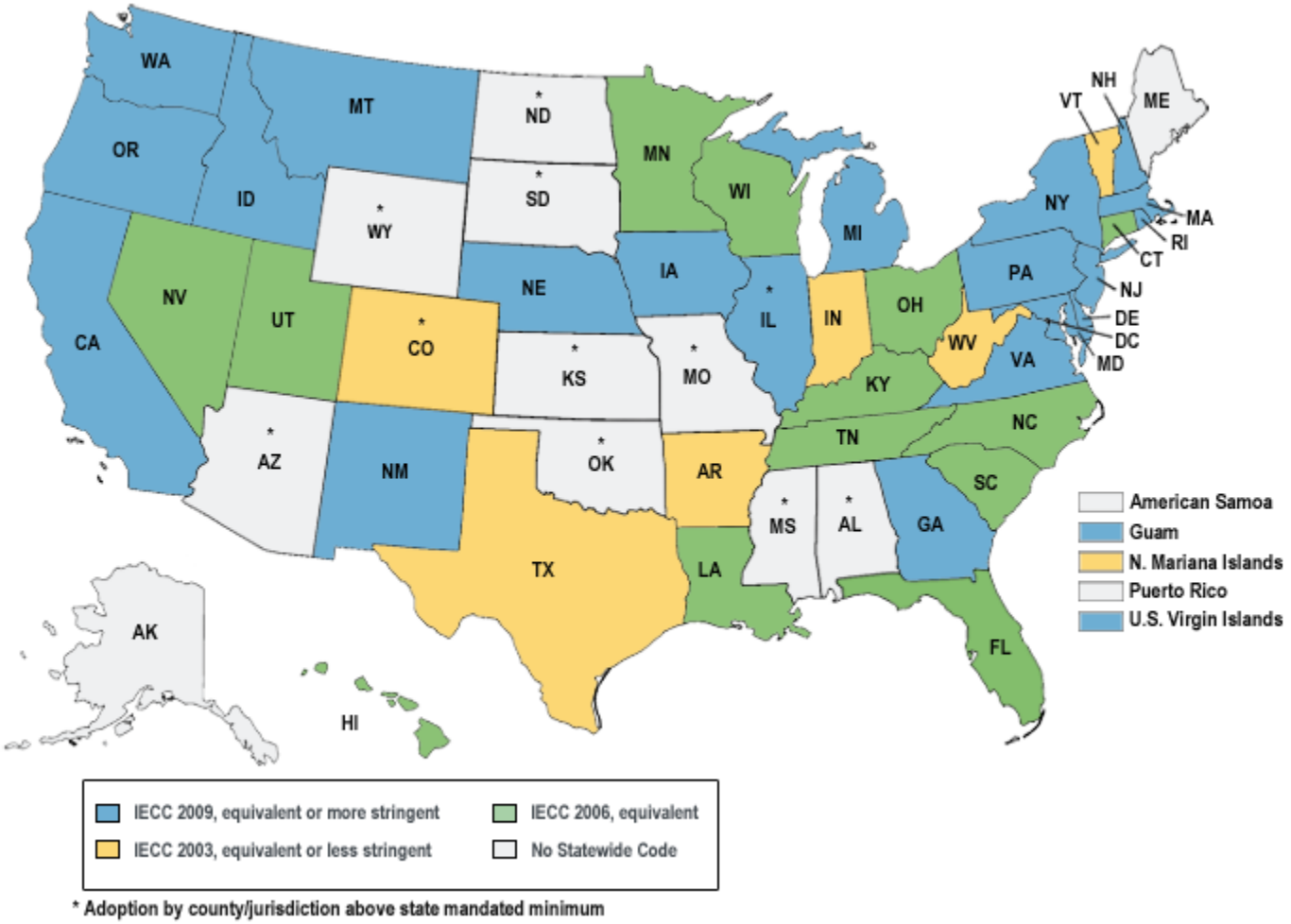
- Increasingly stringent model energy standards
- Accelerated adoption by state and local governments
- Energy Star and other energy performance labels and ratings
- Voluntary programs to support high efficiency builders
- Improved building energy design tools
- Development of high performance building windows, insulating techniques and other technologies (for both new & existing)

Energy Codes work with Stakeholders to Improve Model Codes and Increase Adoption & Compliance

Model Energy Codes

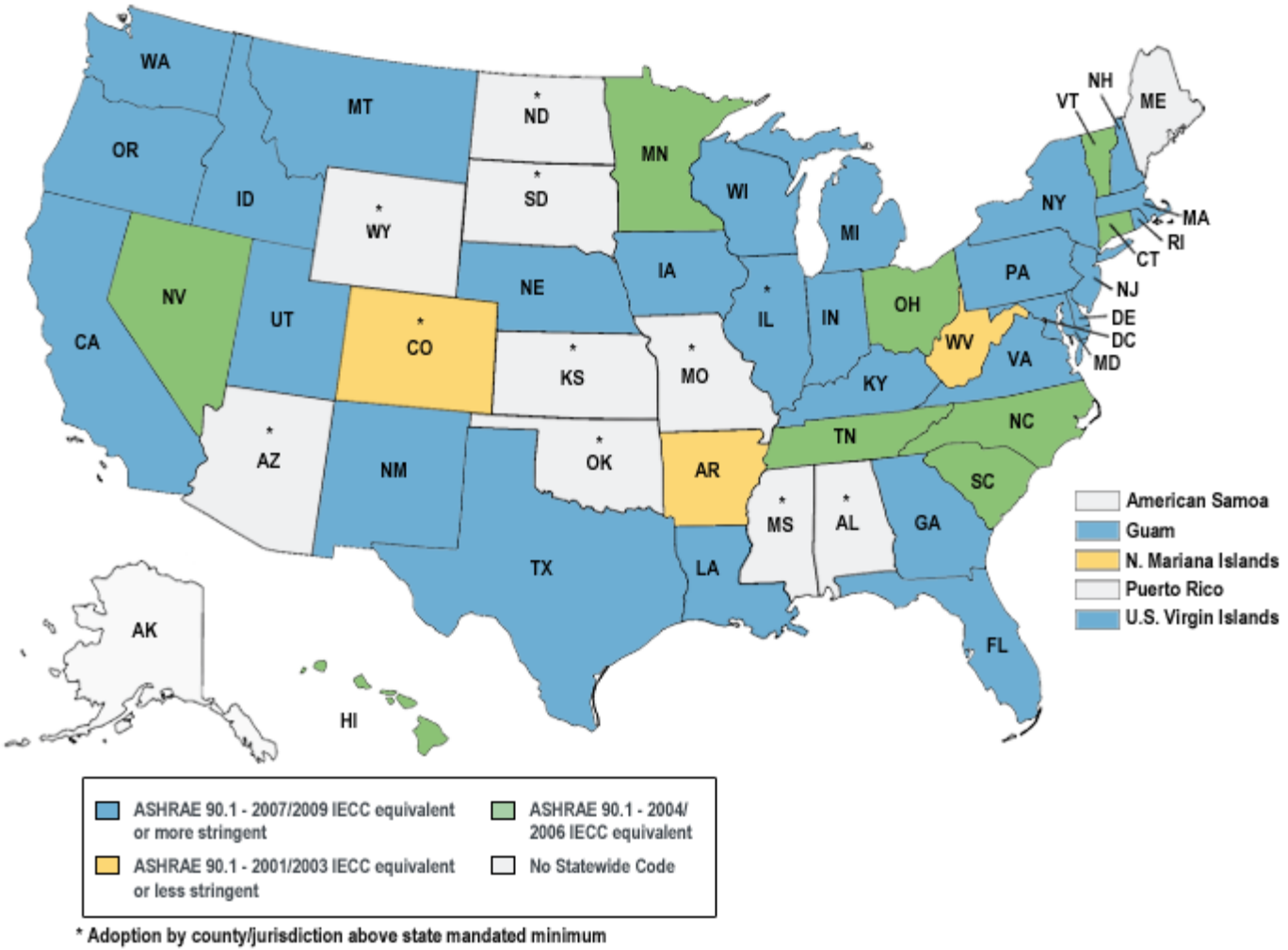
- **Already Accomplished:**
  - 30% Initiative for Increased Energy Savings
- **In Development:**
  - 90% Compliance by 2017
    - Comprehensive adoption and compliance strategy
    - Goal: 10 states to adopt the ARRA target codes or more efficient in FY2011

Status of Residential Code Adoption



As of September 29, 2011

Status of Commercial Code Adoption



As of September 29, 2011

50% AEDG Series

Two AEDG series:

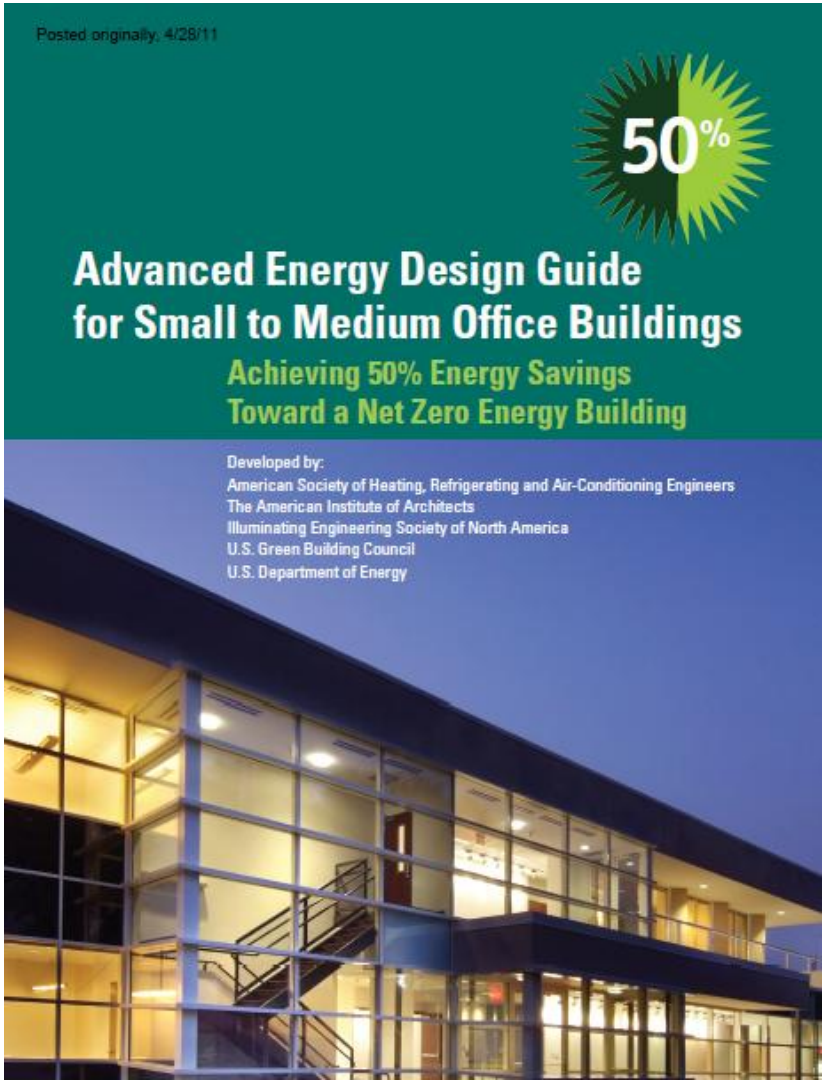
- 30% energy savings
- **50% energy savings**

50% energy savings over *ASHRAE Standard 90.1—2004*

50% AEDG Building Types:

1. Small to Medium Office Buildings
2. K-12 Schools
3. Medium to Big Box Retail
4. Large Hospitals

Free download:
www.ashrae.org/technology/page/938



Building Energy Modeling (BEM) Tools

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Status

- BEM has made impact in codes (ASHRAE 90.1), tax credits (179D) & research
- But significantly less so on energy-efficiency of individual buildings
- Yet by supporting integrated design, BEM is key to achieving DOE efficiency goals

Vision

- BEM tools are used effectively in the design of every new building and deep retrofit, in operation of every building and in ensuring code compliance

Goals

- EnergyPlus on an open co-simulation platform by 2013
- BEM middleware with BIM interoperability by 2013, code compliance by 2014
- EnergyPlus 5X faster on desktops and 25X faster on servers by 2014
- Full-fidelity BIM export from 4 leading CAD vendors by 2014
- BEM training (live and offline) by 2013
- BEM validation tests (direct and comparative) by 2015
- BEM tools for automated model acquisition & calibration by 2015
- 50,000 EnergyPlus users by 2015 (currently ~2,500)

Accomplishments

- Trane adopts EnergyPlus as calculation engine for TRACE800 (not public!)
- EnergyPlus GUI vendor partnership (InfoSys, Trane, HydroQuebec)
- EnergyPlus v7: 2X speedups, general air loop configurations, HVAC update
- OpenStudio v0.5: Google SketchUp plug-in, run management on clusters

Moving Ahead

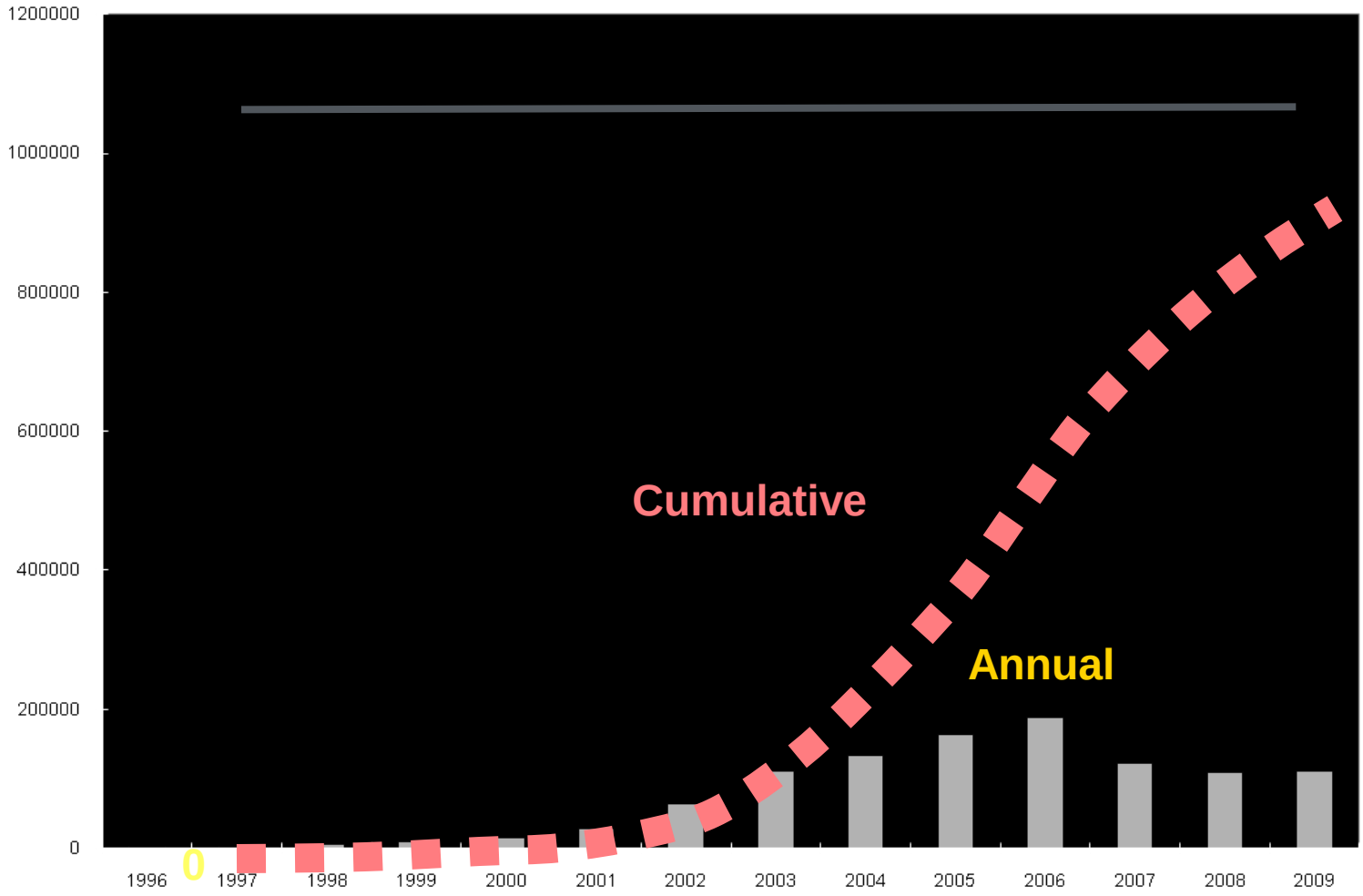
- Increased partnerships with vendors, organizations & federal & state agencies
- Unified tools strategy for BTP, shared platform for all projects (OpenStudio)

ENERGY STAR FOR HOMES

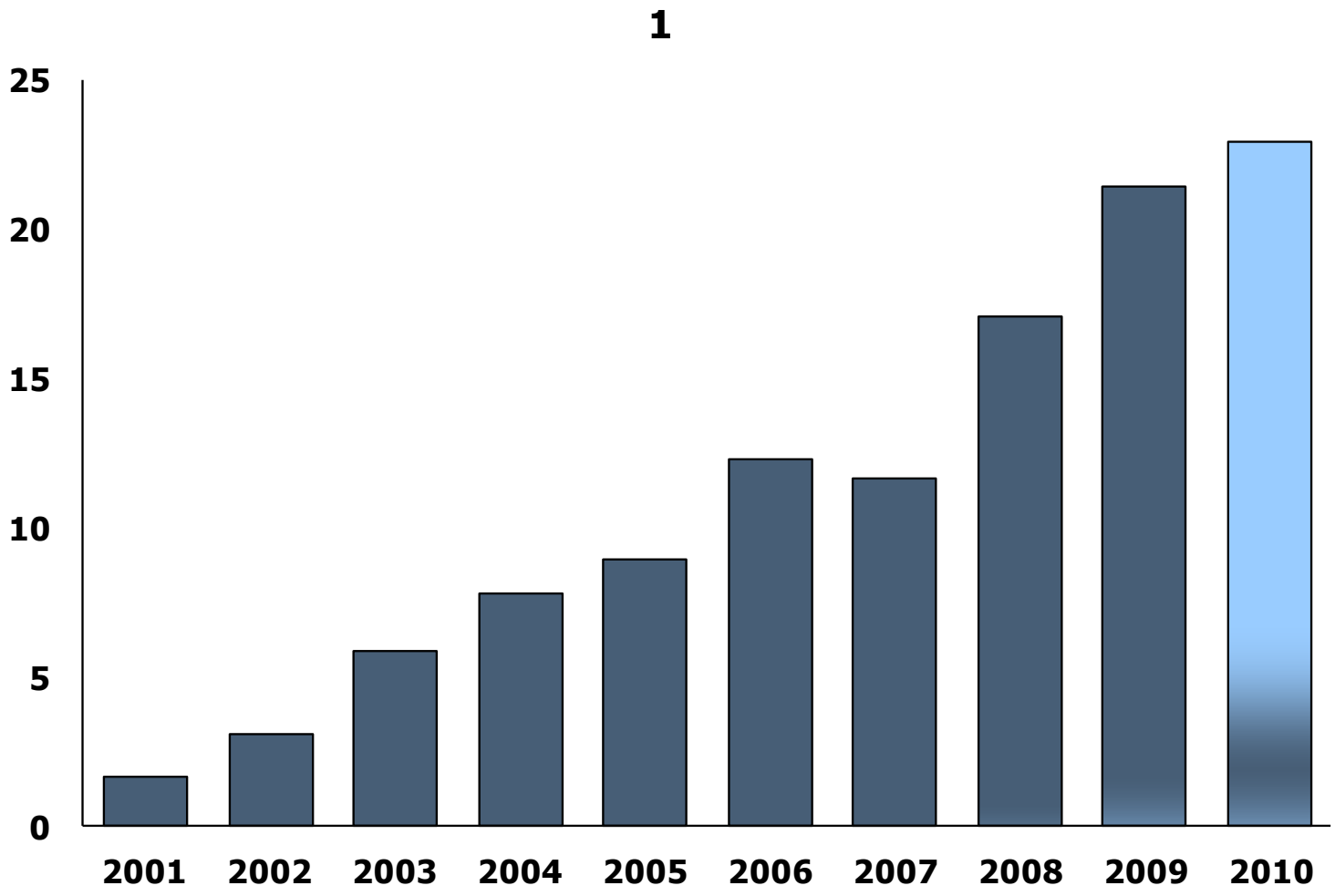
Truly Energy Efficient

Cost-Effective

Performance Meets or Exceeds Expectations



ENERGY STAR FOR HOMES

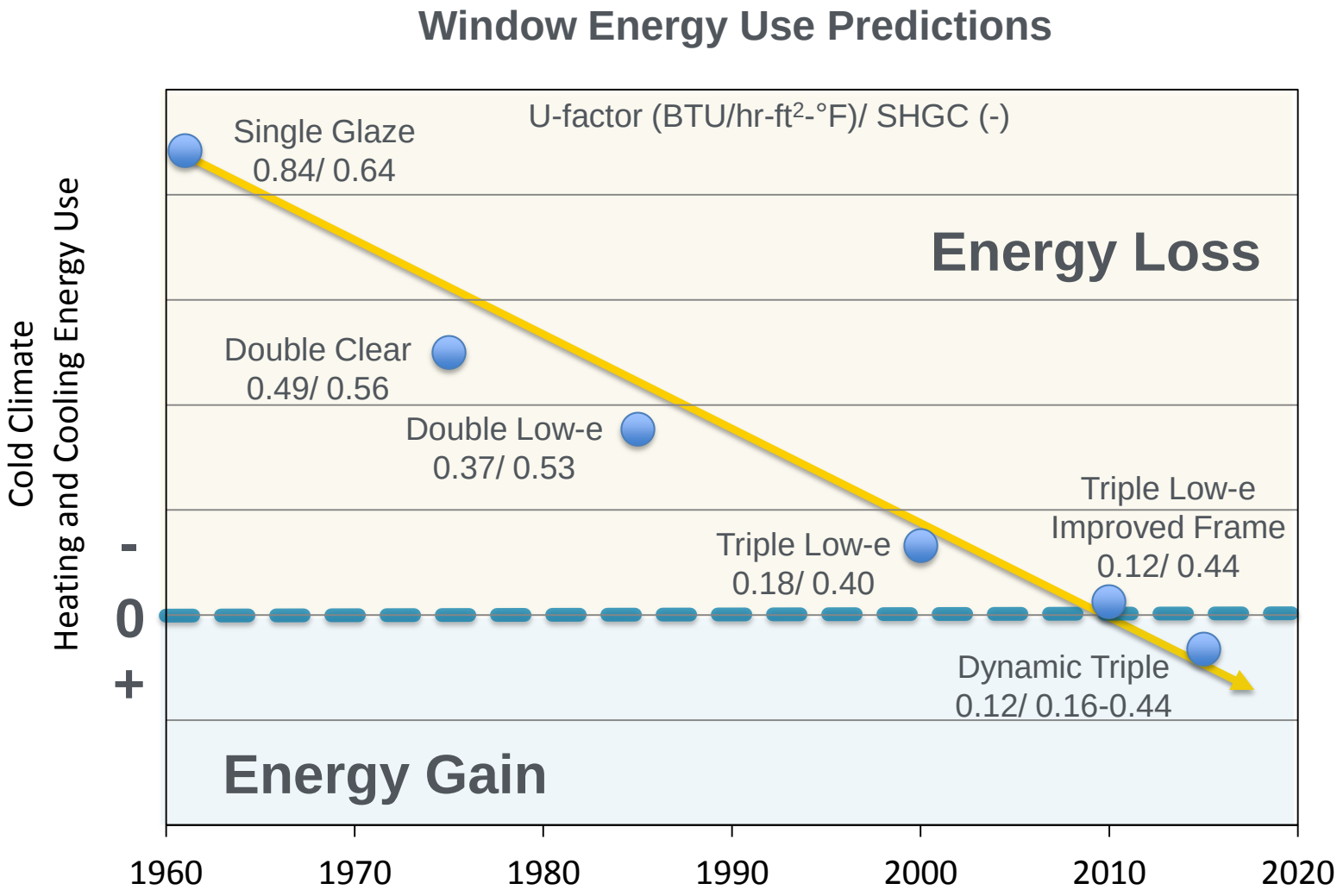


Emerging Technologies: Building Envelope has an Expansive Portfolio

- 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)

Advanced Windows May Eventually "Produce" Energy



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

- **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

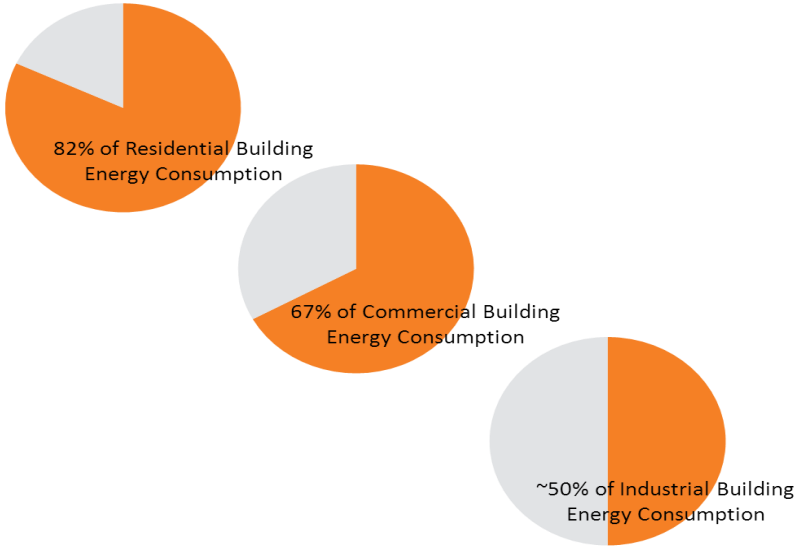
US Policies and Programs for New Appliances and Equipment

- Minimum energy performance standards for roughly 50 products
  - with regular updates (~5 years)
- Energy Star and other labels for roughly 60 products
- Improved test procedures and enforcement
- Federal (and some state) and utility incentives for selected high efficiency products
  - Utilities now spend over $6 billion per year, mainly on product incentives
- Development of high performance new lighting and other technologies

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

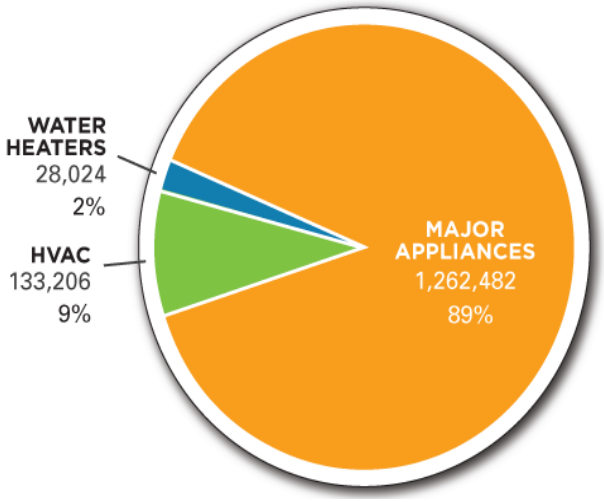
- Energy saved since first 1987 standards = construction of ~31 power plants avoided or the amount of electricity consumed annually by Spain
- 1988 – 2006 standards est. cumulative energy savings = 39 quads by 2020 and 63 quads by 2030
- Cumulative consumer benefit*:
  - $64 billion at the end of 2005
  - $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

The State Energy Efficient Appliance Rebate Program (SEEARP) Impact



- Launched December 2009
- $300 million in funding– 56 state programs
- 1.6 million rebates issued
- 90% of funds drawn-down
- Expected to close February 2012

	MAJOR APPLIANCES	HVAC	WATER HEATERS	ALL PRODUCTS
TOTAL REBATES (THOUSANDS) AND PERCENT OF TOTAL	1,400 (88%)	162 (10%)	29 (2%)	1,592 (100%)
REBATE PAYMENTS TO CUSTOMERS (MILLIONS)	$156	$77	$6	$239
CONSUMER SPENDING (MILLIONS) AND LEVERAGING RATIO	$1,217 (7.8:1)	$573 (7.5:1)	$36 (6:1)	$1,826 (7.6:1)
SALES TAX LEVERAGED (MILLIONS ESTIMATED) AND LEVERAGING RATIO	$67 (0.4:1)	$33 (0.4:1)	$2 (0.3:1)	$102 (0.4:1)
ANNUAL COST SAVINGS (MILLIONS)	$45	$14	$3	$62
ANNUAL ENERGY SAVINGS (BILLIONS OF BTU)	696	699	142	1,536

Interim results through March 31, 2011

SEEARP… The Rebates

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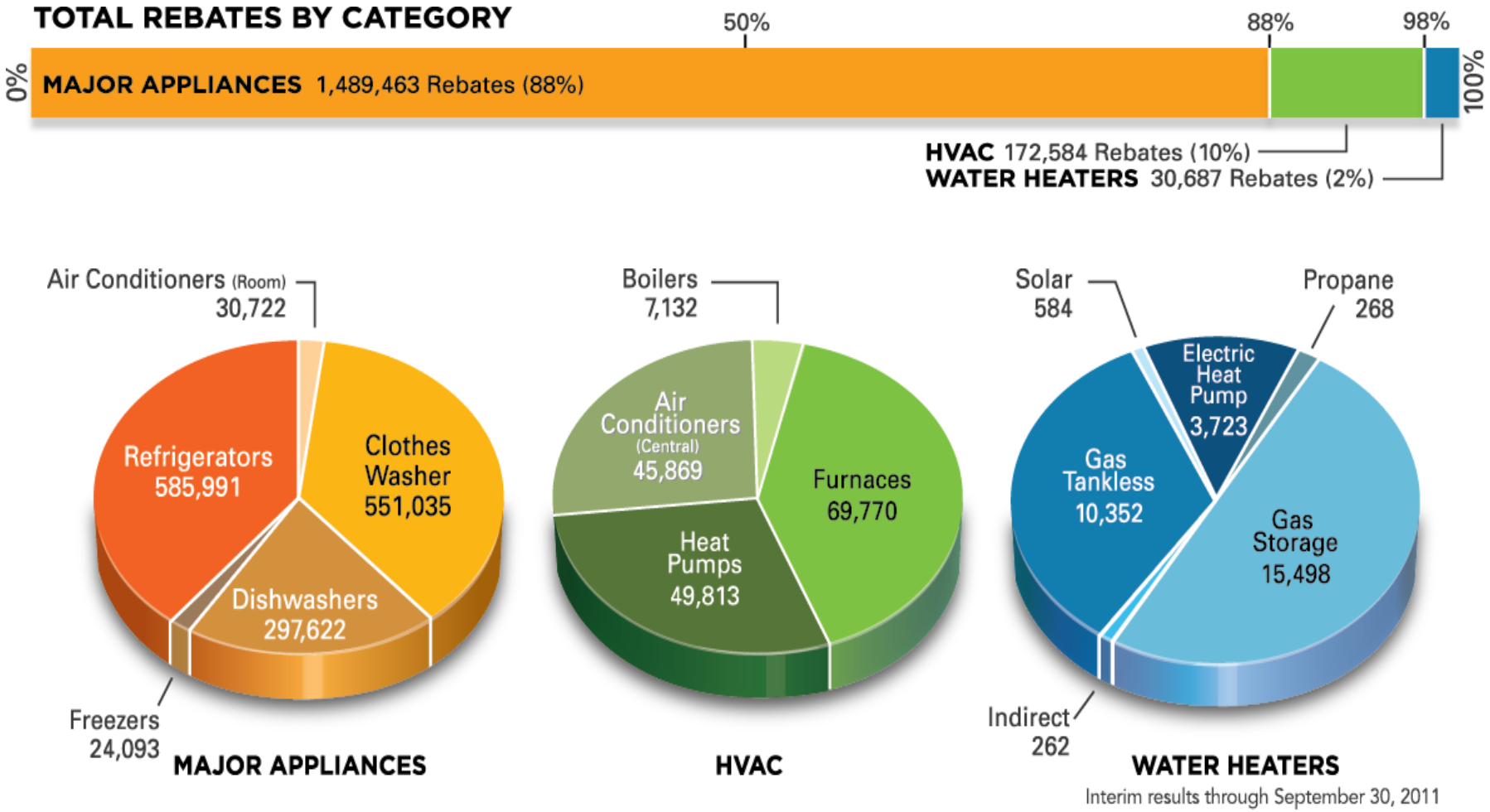
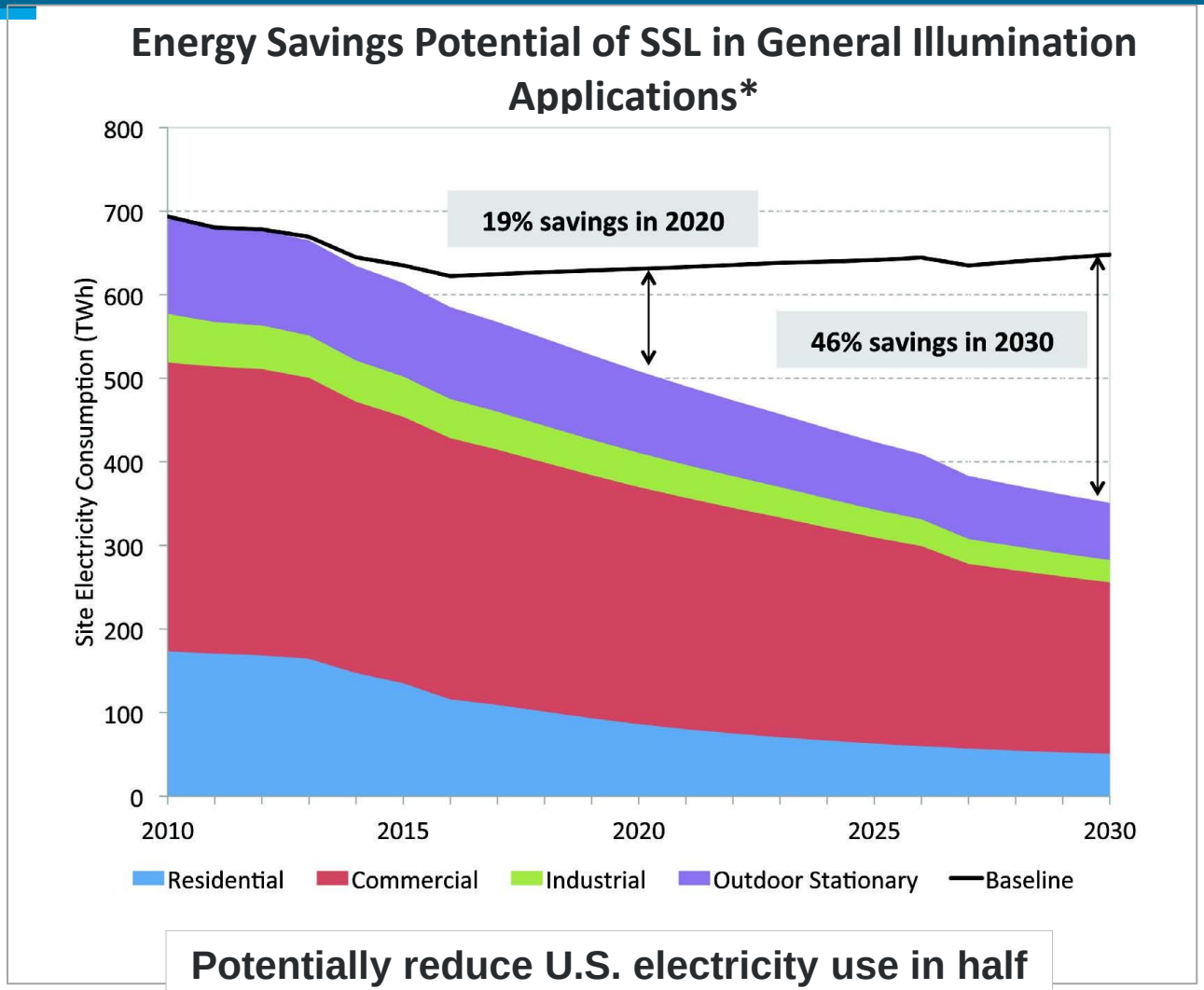


Major Impacts of New Technologies: SSL applications will cut lighting energy use by 46%



Potentially reduce U.S. electricity use in half

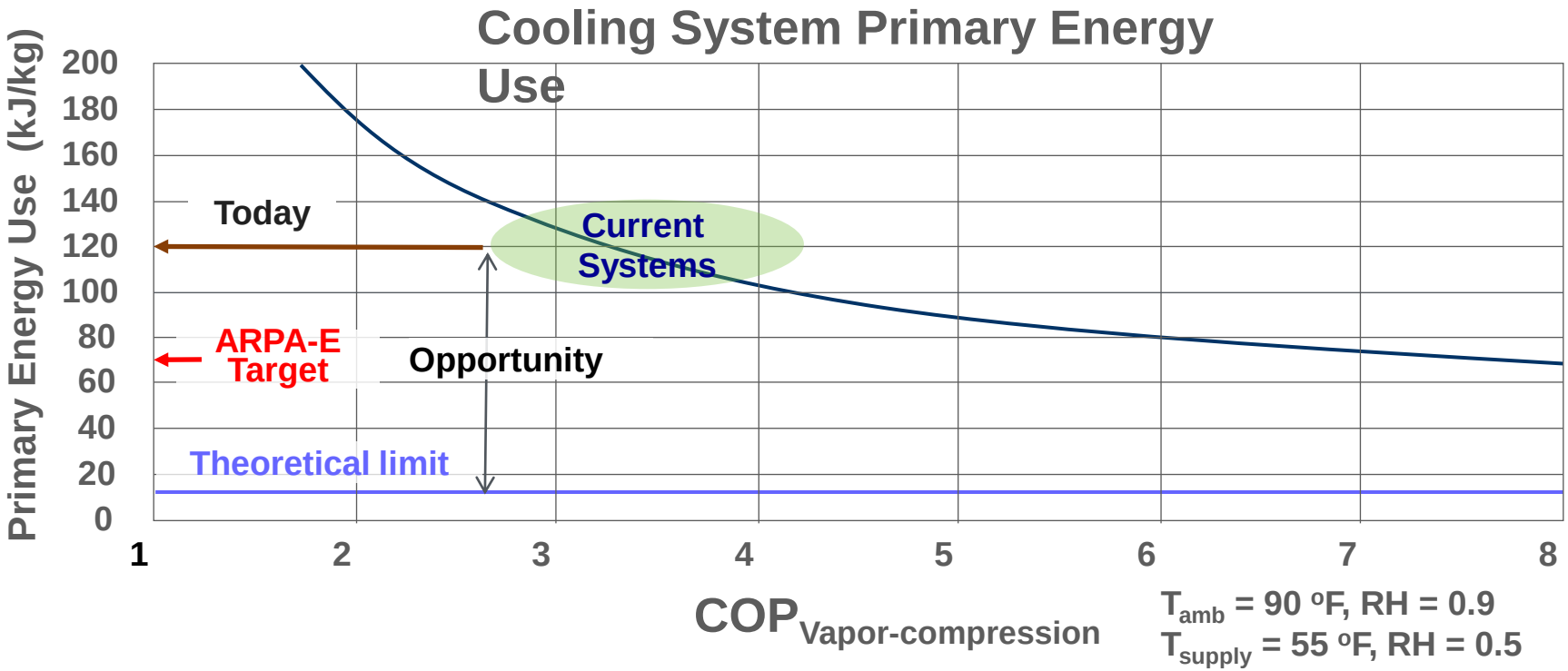
=

electricity needed to power 24 million households

*DOE Report "Energy Savings Potential of Solid-State Lighting in General Illumination Applications" January 2012

Building Energy Efficiency Through Innovative Thermodevices (BEETIT)

Building cooling is responsible for ~5% of US energy consumption and CO_2 emissions



Reduce primary energy consumption by ~ 40 – 50%

US Policies and Programs for Existing Residential Buildings (shells and systems)

- **Developing innovative methods of delivering effective, largely private-sector retrofit services at the state and local level (Better Buildings)**
  - Marketing and information programs
  - Home energy auditing and rating tools
  - Smart meters and improved energy monitoring/management systems
  - Installer training/certification
  - Some financing mechanisms
  - Some government and utility incentives for efficiency improvements
- **Weatherization of homes occupied by low-income**
- **Development of improved technologies and retrofit methods…….**

Residential Strategies Support Increased Market Adoption of Energy Efficiency

Goal: Establish a self-sustaining energy efficiency market that meets the needs of American households

Market Priming Activities

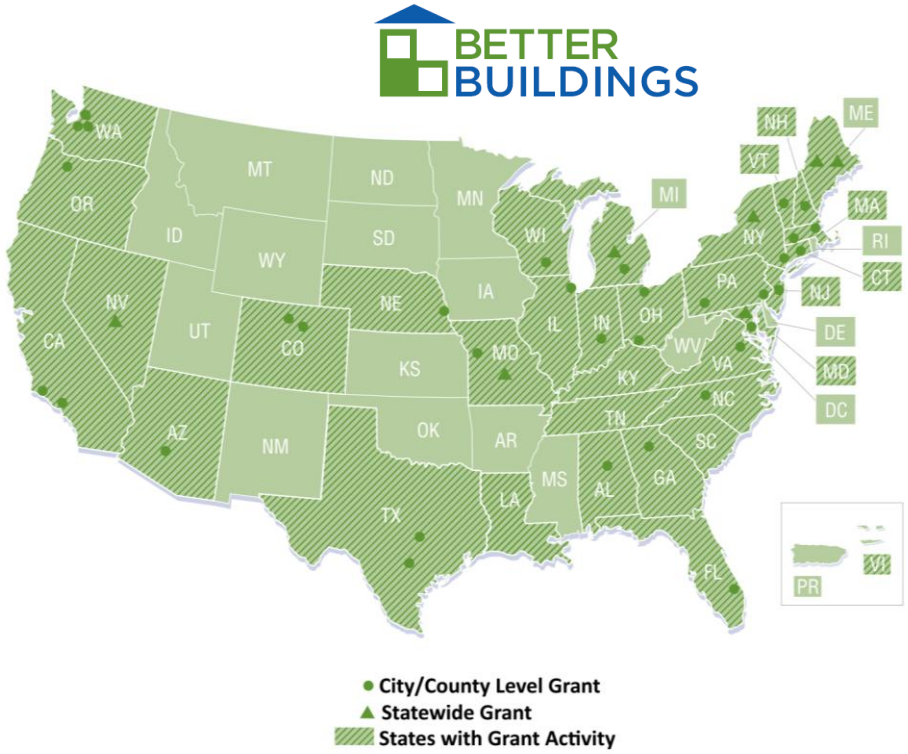
- Promote market-driven business models and establish financing mechanisms for rapid adoption of effective, high quality, low-cost energy improvements;
- Give homeowners the information and tools to make smart energy decisions;
- Foster a trained and trusted workforce to implement energy improvements that address savings, comfort, health and safety; and
- Prepare builders to take advantage of the market differentiation associated with energy efficiency.

Better Buildings Neighborhood Program

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Goals

- Retrofitting 150,000 buildings (residential and commercial)
- Using over $500 million in grants to leverage over $3 billion in additional resources
- Creating or retaining approximately 30,000 jobs
- Reducing the cost of retrofit program delivery by 20% or more
- Achieving 15-30% energy savings from energy efficiency upgrades
- Saving consumers approximately $65 million per year on energy bills
- Developing sustainable energy efficiency retrofit programs.



Accomplishments

- Thousands of building efficiency upgrades have already been completed through the Better Buildings program

Key Questions

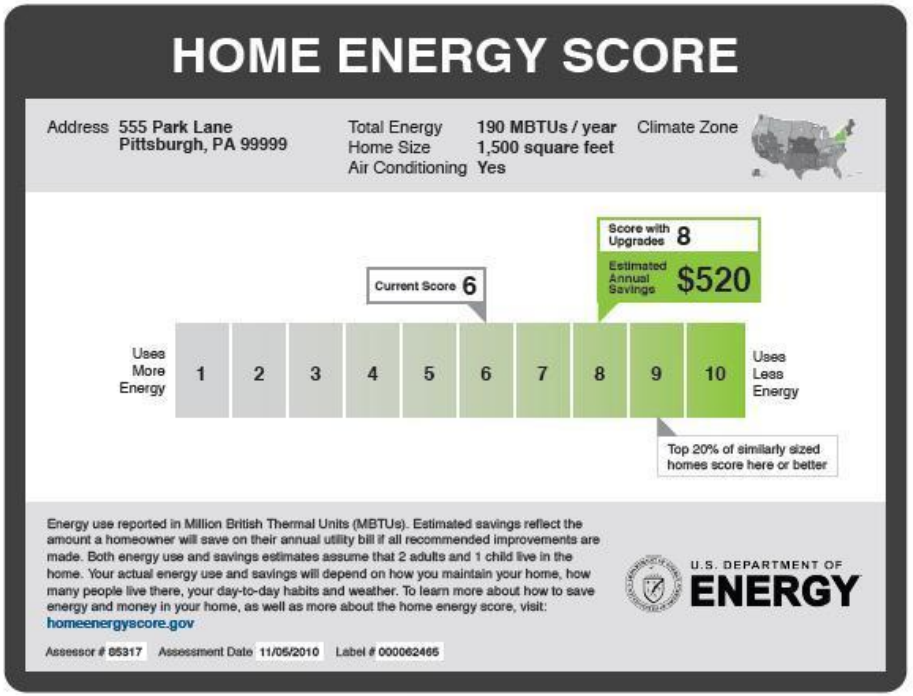
How to more effectively drive demand for home energy upgrades:

- Should we target the "early adopters" or try to saturate a neighborhood?
- How much does it cost per upgrade to run a door-to-door campaign versus a print and TV campaign, versus other strategies?
- What messages motivate which market segments?
- Which messengers are the most effective at attracting program participants?
- Is it more effective and affordable to fund high-level program advertising, or to partially fund contractors' marketing efforts?
- How big do incentives need to be to attract attention? What kind of incentives work best? Can we eliminate rebates?
- Do third party energy advisors significantly increase program participation (especially as compared to their cost)?

Home Energy Score Provides Accessible Information to Homeowners

A Reliable, Easy to Understand Tool

- DOE is testing the program through 10 pilots across the U.S.
- Specific interest in assessing the following:
  - Efficacy of the scoring tool and methodology
  - Homeowner understanding and response
  - Assessor feedback
- Based on findings, DOE will refine the tool and the program



Innovative Marketing

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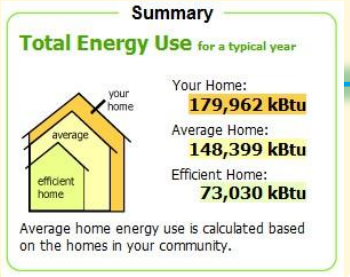
*Connecticut has employed an **online leader board** to track energy upgrade progress, instigating friendly competition among neighbors*

*The Southeast Energy Efficiency Alliance's award-winning elephant in the room ads **use humor** to increase EE awareness*

*Massachusetts equipped a hybrid SUV with a **thermal imaging system** to document evidence of wasted energy in homes*



*Charlottesville is using a **handheld tool** that Americorps volunteers use to engage homeowners at events*

RePower Bainbridge created Electric Avenue, a visual street painting that builds awareness by displaying the collective energy savings of two island neighborhoods

*Rutland has created a **H.E.A.T Squad** of friendly neighborhood experts to educate the community about EE benefits*

Guidelines for Home Energy Professionals

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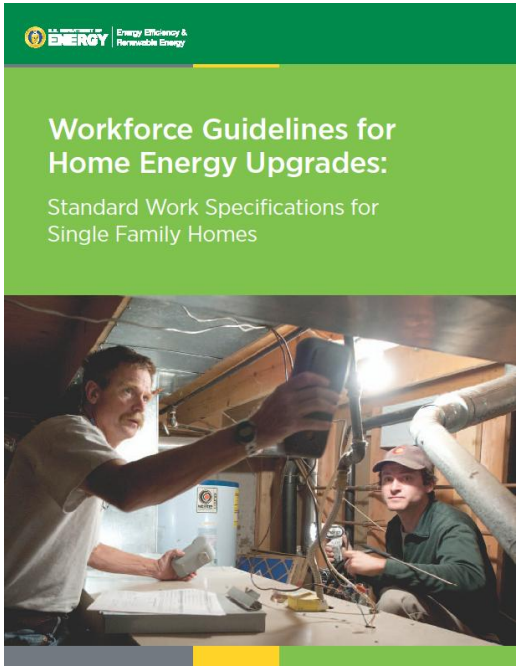
Goal: Collaborate with industry to develop the tools for a high-quality residential energy upgrade industry, supported by good training and a skilled and credentialed workforce.



Guidelines for Quality Work

Guidelines for Effective Training

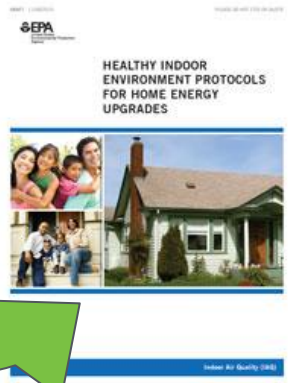
Guidelines for Professional Certifications

Recommendation of the Vice President's Middle Class Task Force

Status: Public comment #2 on Guidelines for Quality Work Q1 2012; Guidelines for Effective Training in place; 4 new professional certifications available Q2 2012

Putting it All Together

Building AMERICA
U.S. Department of Energy



Assess efficiencies and viability of technical EE innovations through Building America and lab research

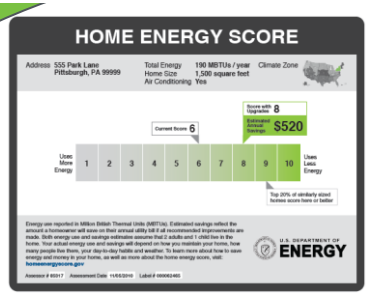
Incorporate Workforce Guidelines and Indoor Air Protocols for Home Energy Upgrades

2010 | **2011** | **2012**

BETTER BUILDINGS
U.S. DEPARTMENT OF ENERGY

Promote Successes for all DOE Retrofit Programs – Expand Beyond Grants

HOME PERFORMANCE WITH ENERGY STAR



Integrate HPwES

Incorporate Home Energy Score

Incorporate SEE Action recommendations

Leverage bulk purchasing strategies

Weatherization Assistance Program (WAP) Performance Under the Recovery Act

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As of December 31, 2011, WAP has weatherized over

680,000 HOMES

including nearly…

165,000 MULTI-FAMILY UNITS

WAP ranks

3rd IN JOB CREATION

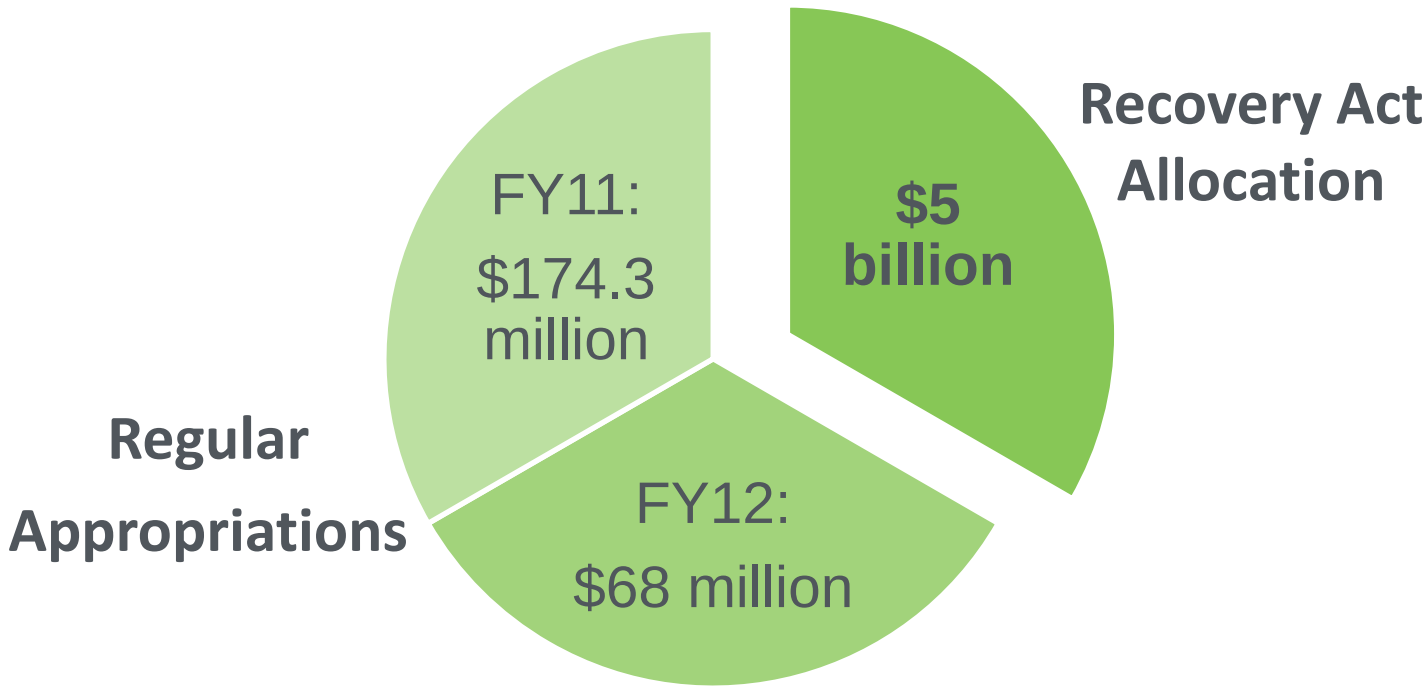
as reported on *Recovery.gov*

In quarter four of 2011, WAP supported ***13,230 jobs.***

Nationwide, the weatherization of ***650,000 homes*** is estimated to save ***$350 million in energy costs*** in just the first year.

Approximately ***32,000 homes*** were weatherized in the final month of 2011 alone. This is the highest month of production using Recovery Act funds.

Weatherization Assistance Program (WAP) Funding Overview



Cumulative Recovery Act Spending:

As of March 5, 2012

$4.3 billion (87%)

DOE's Weatherization Assistance Program (WAP)

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WAP provides funding to 59 states, territories and Indian tribal governments which fund a network of local community action agencies, non-profit organizations and local governments to provide weatherization services to low-income family homes.

- **Received $5B in Recovery Act Funding**

- High Priority Performance Goal (HPPG) from the White House: DOE and HUD will work together to enable the cost-effective energy retrofits of a total of **1.1 million housing units** through the end of FY13. Of this number, DOE programs will contribute to retrofits of an estimated one million housing units.

- Overall Impacts of Weatherization
  - $437* average first year energy savings
  - Returns $1.80 in energy related benefits for every $1 invested
  - Avoids residential and power-plant emissions of carbon dioxide by 2.65 metric ton/year per home
  - Over life of the measures, saves 53 metric tons of CO2 emissions per home.
  - Decreases national energy consumption by the equivalent of 24.1 million barrels of oil annually.
  - Reduced consumption contributes to long-term energy independence
  - Decreases electricity generation and resulting pollution; thus improving local air quality reducing adverse health effects

US Policies and Programs for Existing Commercial Buildings (shells & systems)

- **Development of building energy analysis and rating tools**
  - Public and private labeling programs, eg, Energy Asset Ratings, LEED
- **Deployment of building performance data bases**
- **Support for adoption of ISO 50001** (Superior Energy Performance)
- **Development of improved sensor and control technology**
- **Innovative delivery and challenge programs**
  - State and local, especially under Economic Stimulus programs
  - Trade/company-based challenge programs
  - Coordinated purchases of high performance systems, eg, roof top a/c units
- **Some government incentives; more utility incentives**
- **Continued improvements to Federal government buildings**
  - Energy Performance/Service Contracting (ESCOs)
  - Support for Deep Retrofits

Commercial Initiatives' Accomplishments

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Better Buildings Commercial Challenge	• The Better Buildings Commercial Challenge tasks corporations, universities and communities to become leaders and innovators in Energy Efficiency, saving businesses $40B in the next 10 years. • These Partners have signed up: Best Buy; Green Sports Alliance; Lend Lease; Transwestern; USAA Real Estate; City of Atlanta, Los Angeles and Seattle
Commercial Building Partnerships	• Demonstrated that through building modeling we can achieve 30% savings in retrofits (JCPenney store, VA) and 50% savings in new construction (PNC Bank, FL). • Replication of proven EE measures in Partners' portfolio.
Commercial Building Energy Alliances	• Working with members of the Commercial Building Energy Alliances, DOE developed new performance criteria for 10-ton capacity commercial air conditioners, expected to reduce energy use by 50-60% over current equipment. • Wal-Mart utilizing DOE's LED Site Lighting Specification and pledging to utilize the Specification for LEDs for Refrigerated Display Case Lighting • An interagency collaboration retrofitted one parking structure using the alliance-developed LED Parking Garage Lighting Specification, which has projected total electricity savings of more than 75%.

Energy Asset Rating Program

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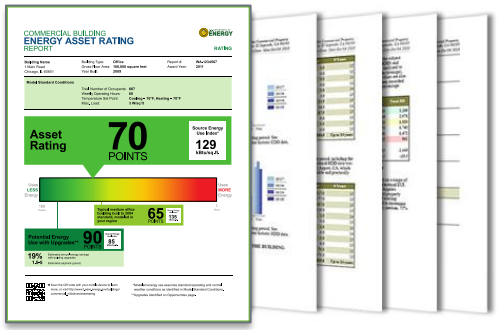
- The commercial building energy asset rating program, which includes a free online energy asset rating tool, will provide:
  - A rating based on the building envelope, mechanical and electrical systems, and other major energy-using equipment.
  - Building system evaluations for building envelope, service hot water, HVAC, and lighting systems
  - A set of recommended cost-effective improvements.
  - An additional "after upgrades" rating that demonstrates the potential energy impact assuming you implement the recommendations.

DOE provides A centralized tool similar to Portfolio Manager to facilitate ease of use, reduce cost, and increase model standardization, allowing for consistent and reliable comparisons.



The SEED Platform makes the taxonomy freely available for any entity to use in storing their data internally

Standard Energy Efficiency Data (SEED) is:

A Database

- Building owners, governments, or other entities can use SEED to store building energy performance data according to a common, extensible taxonomy

A Data Transfer Mechanism

- SEED includes a standard API which a data owner can use to share selected data with third parties.

An Analysis Platform

- SEED provides a standard structure for building energy data to support a variety of analyses.
- As an open-source publicly-documented database, 3rd parties can build applications for SEED to utilize data in new ways.

SEED Platform Benefits:

Open Source Platform

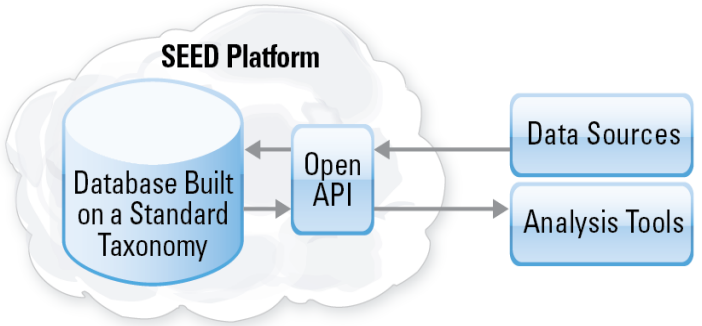
- Low cost for local government to use
- Set up in a matter of minutes
- Security and backup/redundancy in place

Flexible Input Mechanisms

- Portfolio Manager web services
- Spreadsheet upload
- API in future
- Direct entry through web forms in future

Common between jurisdictions

- Comparison of approaches & shared learning
- Sharing of resources & analysis approaches
- 3rd party creation of standardized apps



Sensors & Controls Technology Goals Moving Forward

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Building-Wide, Proactive Energy Management Systems

Achieve energy savings beyond the current 30% targets in commercial buildings through optimization of building equipment based upon weather and utility forecasts.

Characterization of HVAC Equipment Responsiveness and Field Performance Assessment Framework

Catalog the performance of commercial building HVAC components to enable energy efficiency and demand management products.

Self Configuring & Correcting HVAC Controls

Develop, test and deploy algorithms for control systems to automatically correct and optimally compensate for faults in HVAC systems.

Wireless Sensor Mote

Reduce the cost of procuring and installing a network of sensors by creating an inexpensive, self-powered mote with wireless communication utilizing a mesh network.

Automated Diagnostics Market Deployment

Enhance building diagnostic tools/technologies and transfer them to commercial partners for commercialization.

Image Processing Occupancy Sensor

Integrate current image processing techniques to enable occupancy sensors to more accurately control lighting systems and as well as self-calibrate.

Moving Ahead

- Need to develop industry driven roadmap; focus on extensive CRADAs with industry
- Portfolio started with ARRA funds
- FY12 = Consolidate Commercial/Residential activities and discretely fund whole area against a portfolio

Economic Stimulus Funding for State and Local Efficiency Programs

As of March 5, 2012

Program	Recovery Act Appropriation: ($ million)	Cumulative Payments to Date ($ million)	Percent of Total Goal Reached
State Energy Program (SEP)	$3.1 billion	$2.3 billion	**74.5%**
Energy Efficiency & Conservation Block Grant (EECBG) Program	$3.2 billion	$1.9 billion	**68.5%**

Impacts of SEP & EECBG Under ARRA
Putting Efficiency to Work in the Economy

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Selected ARRA achievements through December 2011:

State Energy Program

- Contributed to the increased energy efficiency of nearly ***75,000 buildings*** through the installation of energy upgrades.
- Over **4,427 jobs** created or retained in Oct-Dec 2011 quarter – *includes only* ***direct jobs.***
- Educated over ***200,000 people*** in performing energy audits and upgrades and contributing to the installation of renewable energy systems.

Energy Efficiency & Conservation Block Grant Program

- Performed **energy upgrades of roughly 56,000 buildings**, covering a total area of approximately 427 million square feet (roughly the equivalent of 213,000 single family homes)
- Is one of the **top 10 job-creating** and retaining Recovery Act programs, with over **4,763 jobs created or retained in** in the Oct – Dec 2011 quarter (*includes only direct jobs).*

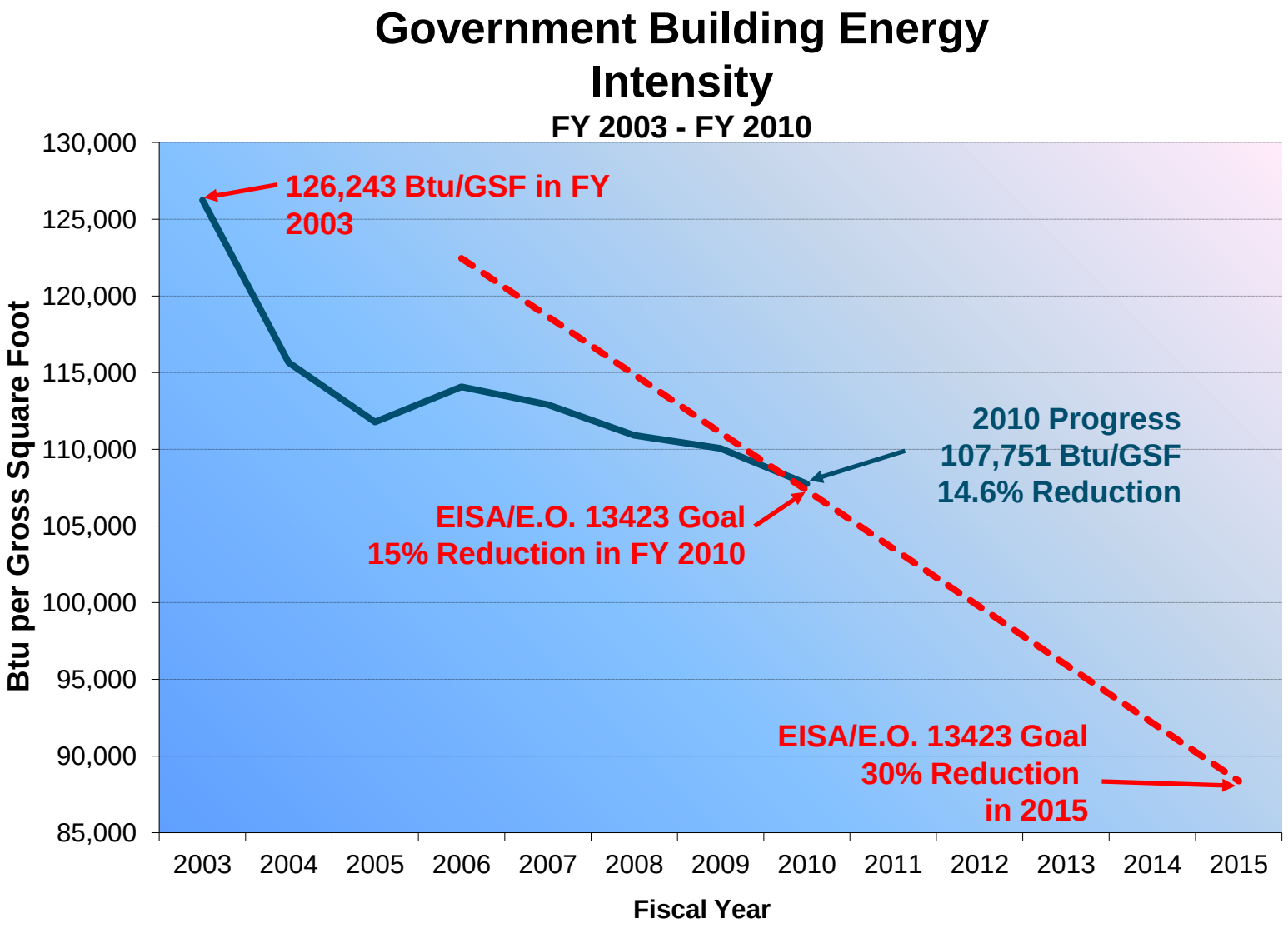
Federal Energy/Water Goals and Status

- **Federal Facilities**
  - Nearly 500,000 buildings
  - 3.1 billion square feet,
  - Accounts for 0.4 percent of the nation's energy usage,
  - Emits about 2 percent of all U.S. building-related ghgs

- **Reduce Energy Intensity**
  - **Goal:** Reduce energy intensity (Btu/square foot) by 15% in FY 2010 compared to FY 2003; 30% reduction required in FY 2015.
  - **Status:** 14.6% reduction (only 10.8% without additional credits)

- **Reduce Greenhouse Gas Emissions**
  - **Goal:** Reduce government-wide GHG emissions by 28% for Scope 1&2 emissions and 13% for Scope 3 emissions by 2020 (from 2008 levels)
  - **Status:** 6.4% reduction for Scope 1&2; Scope 3 pending

Federal Energy/Water Goals and Status



Deep Retrofits

- GSA Competition: ESCOs and Deep Retrofits
  - DOE IDIQ ESCO competition, in partnership with GSA's Office of Federal High-Performance Green Building, to achieve deep reductions in energy use paired with significant renewable energy production
  - Objective is to approach EISA requirements for reductions in use of fossil fuel (65% by 2015, 80% by 2020, 100% by 2030)
- Army Net Zero installation program.
  - The Army selected nine sites to become net zero energy and FEMP is supporting this effort thorough funding and technical assistance.
  - Each of the nine sites will be assigned FEMP and national laboratory support teams to assess energy efficiency and renewable energy opportunities, analyze life-cycle cost effectiveness, and develop an implementation plan to get them on track toward achieving the goal of becoming net zero by 2020.

Through participation in the Clean Energy Ministerial (CEM) Process as well as the International Partnership for Energy Efficiency Cooperation (IPEEC), there are increased opportunities for:

- **Super-efficiency Equipment and Appliance Deployment (SEAD)**
- **Global Superior Energy Performance (GSEP)**
- **Energy Management Network (EMAK)**

…and more.

Thank You

mark.friedrichs@ee.doe.gov