Evolving Energy Codes from Prescription to Real Performance: The Need for Whole Building Target-Based Codes

IRCC Meeting
October 20, 2010

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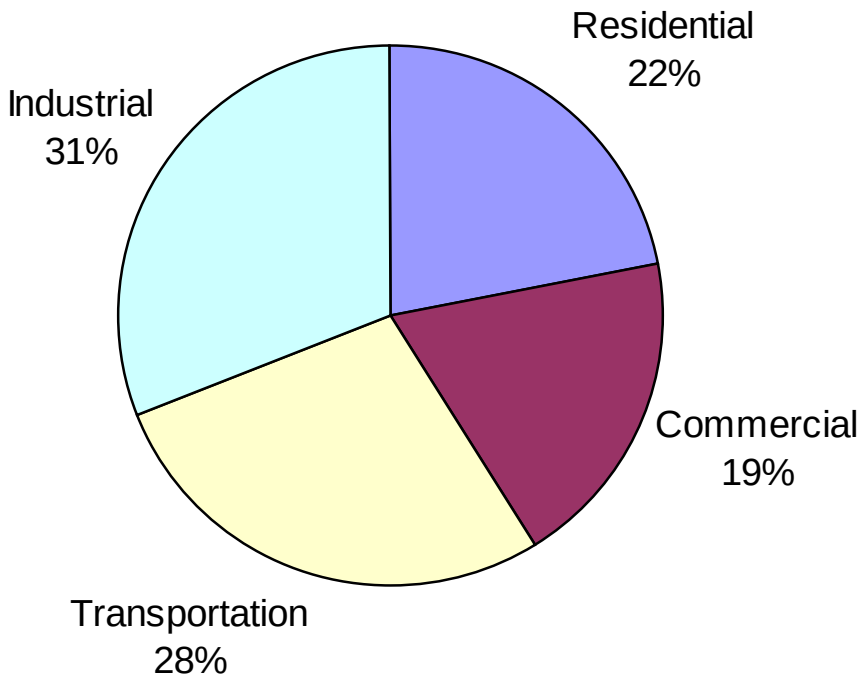
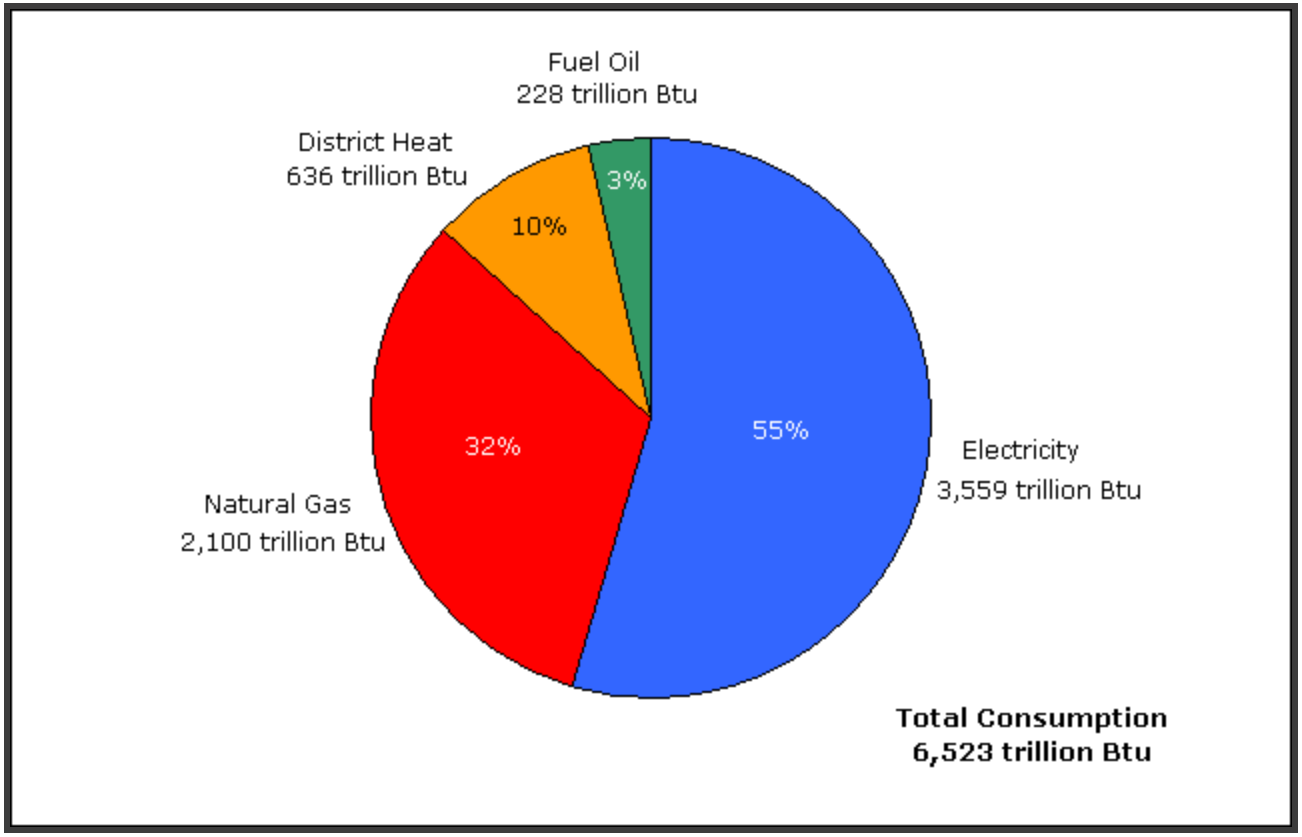
ENERGY STAR

U.S. Energy Consumption



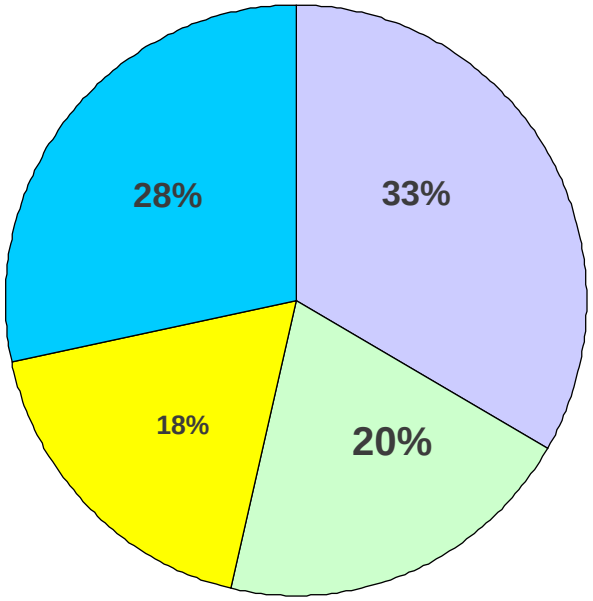
Source: Energy Information Administration, Annual Energy Review (2008)

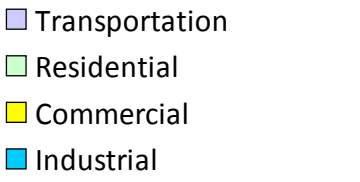
Direct and Indirect Energy Use in Commercial Buildings Equally Important

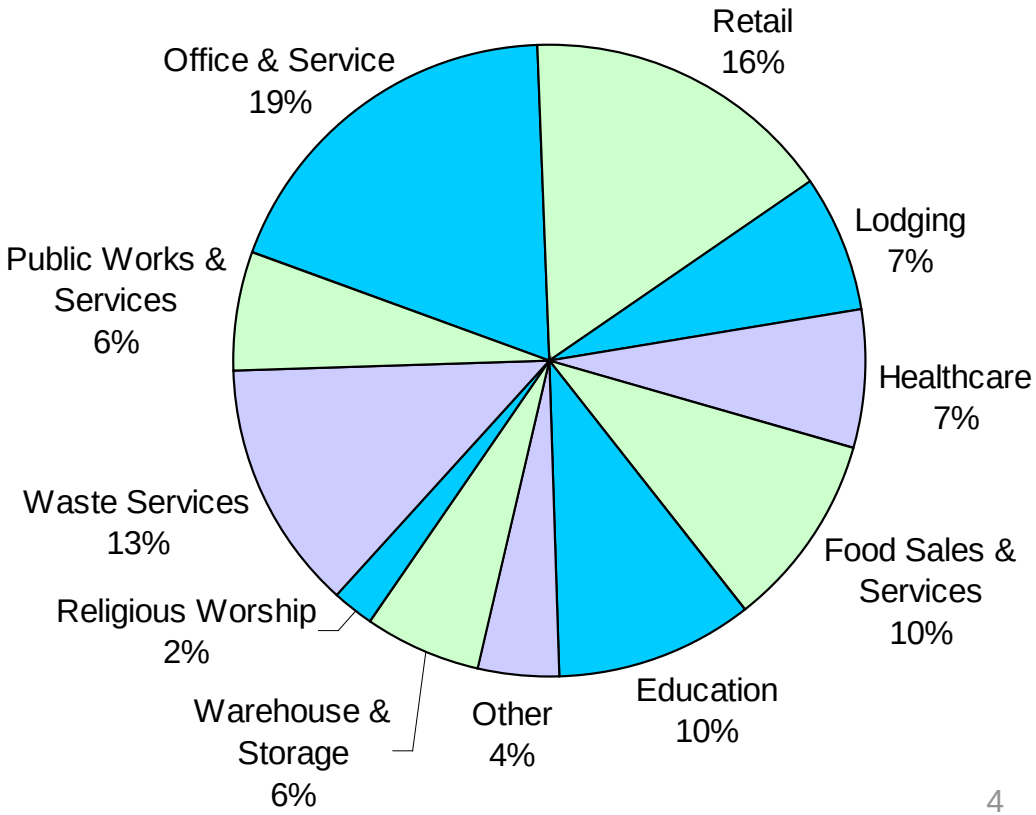


Source: Energy Information Administration, 2003 Commercial Buildings Energy Consumption Survey

U.S. Carbon Dioxide Emissions







Environmental Benefits of Energy Efficiency

- Commercial buildings and industrial facilities generate nearly 50% of U.S. carbon dioxide emissions.

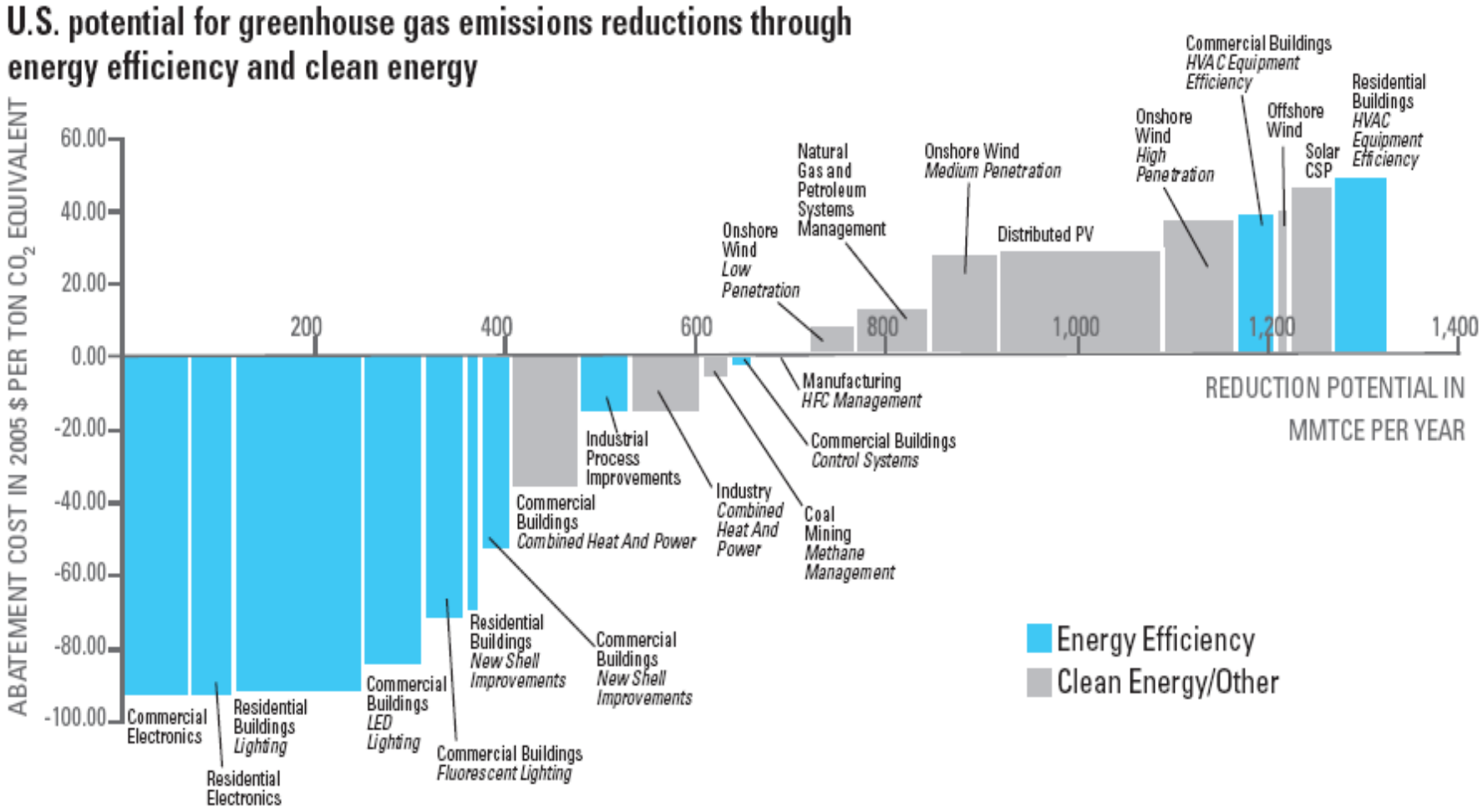
- GHG emissions from commercial buildings are projected to grow faster than any other sector over the next 25 years – about 1.8 percent per year.

- 30% of energy consumed in commercial buildings is used unnecessarily or inefficiently.

- If the energy efficiency of commercial and industrial buildings improved by just 10 percent, Americans would save about $20 billion and reduce greenhouse gas emissions equal to the emissions from about 30 million vehicles.

- **IMMEDIATE, LOW-COST** emission reduction opportunities.

Low Cost EE Available



Source: McKinsey (2007)

Why Building Energy Codes?

- An important state policy for capturing the large, low-cost energy-efficiency resource in the U.S.
  - Set minimum requirements
  - Can help overcome market barriers to greater efficiency
  - Estimated to yield buildings 8 to 35 percent more efficient than they would otherwise be
  - Important complement to other state EE policies
- "Lost opportunity"—cannot harvest later
- Potential exists for significant gas/electric and cost savings over time
- American Recovery and Reinvestment Act of 2009
  - Latest IECC residential code and ASHRAE 90.1-2007 nonresidential code
  - 90% compliance within 8 years

Typical Energy Codes Process

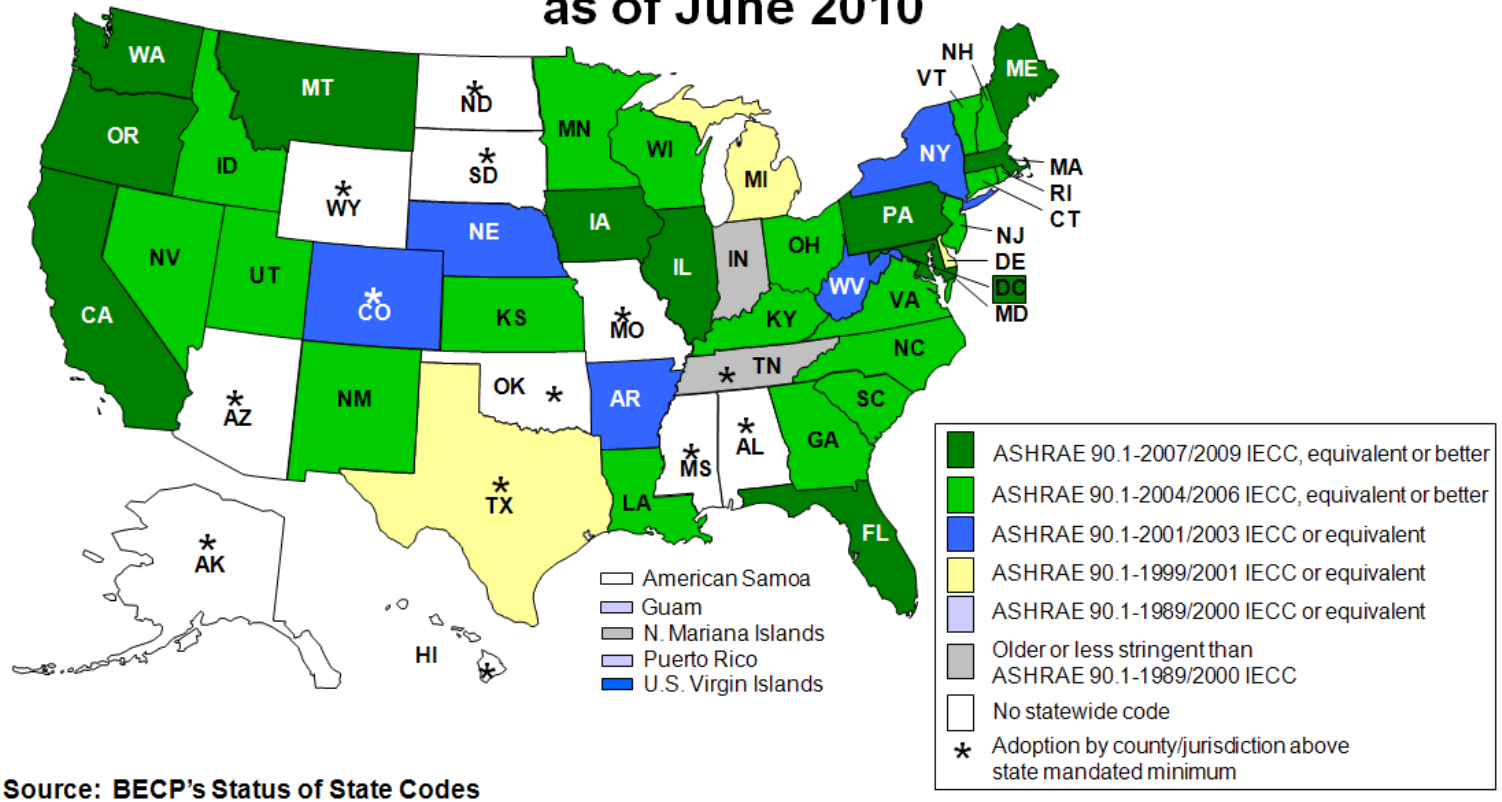
- Development: National Level
  - ASHRAE for nonresidential
  - International Code Council (ICC) for residential
  - Open to outside participation

- Adoption: State and Local Levels
  - States and municipalities that adopt energy codes usually rely on national model codes
    - Some notable exceptions (e.g., California, Florida)
  - Occurs via a legislative or an administrative process
  - Requires stakeholder participation and sound technical/cost data

- Implementation: Local Level
  - Enforcement officials usually give lower priority than life/safety codes
  - Requires active compliance and enforcement efforts
  - Builder and inspector training is key

Status of Commercial Energy Codes

as of June 2010



Source: BECP's Status of State Codes
http://www.energycodes.gov/implement/state_codes/index.stm

as of 6/2010

Energy Use Intensity 1992 - 2003

U.S. Commercial Buildings Energy Intensity Using Weather-Adjusted Primary Energy by Census Region and Principal Building Activity			
(Thousand Btu per Square Foot)			
Principal Building Activity and Census Region	**Survey Years**		
	1992	**1995**	**2003**
U.S. Total *	164	178	190
Education	136	136	158
Food Sales	490	583	534
Food Service	425	488	520
Health Care	406	420	344
Lodging	301	230	192
Mercantile and Service	147	155	203
Office	221	224	210
Public Assembly	148	200	177
Public Order and Safety	184	173	219
Religious Worship	48	61	76
Warehouse and Storage	83	80	94
Other **	305	319	316
Vacant	50	36	33

Source: U.S. Energy Information Administration

Why Is There a Performance Gap?

- Commonly Cited
  - Code Levels not Stringent Enough (focus of new codes)
  - Lack of Code Adoption and Enforcement
  - Growth in Non-Regulated Loads
  - Value Engineering
  - Improper Installation
  - Occupant Behavior
- **It's Time to Assess if We Are Setting the Right Targets**

Existing Approaches to Address Gap

- Tightening of Prescriptive Standards
  - Constant race to keep up with technology
  - Can increase cost and limit flexibility in design
  - Diminishing returns
- "Better than Code"
  - Used in LEED for New Construction
  - Involves modeling regulated energy of design as compared to reference code-level building
  - More credits for greater percent above code

Issues with “Better than Code”

- Only addresses regulated loads
- Modeling imperfect and can be subjective
- Code-level reference case may be an energy hog
- Does not provide whole building energy metric than can be tracked through building lifecycle

Conclusions of *Energy Performance of LEED® for New Construction Buildings*

New Buildings Institute for USGBC, March 2008

- **The LEED Program achieves significant energy savings; the higher the LEED rating, the greater the savings**
- The energy outcome for individual projects is highly variable
- Some project types are not well addressed by LEED
- Energy modeling predicts program impacts well, but the accuracy is highly variable for individual projects
- There is a need to develop a better feedback loop from actual building performance to design intent and modeling

Preview of Conclusions

Performance vs. Code

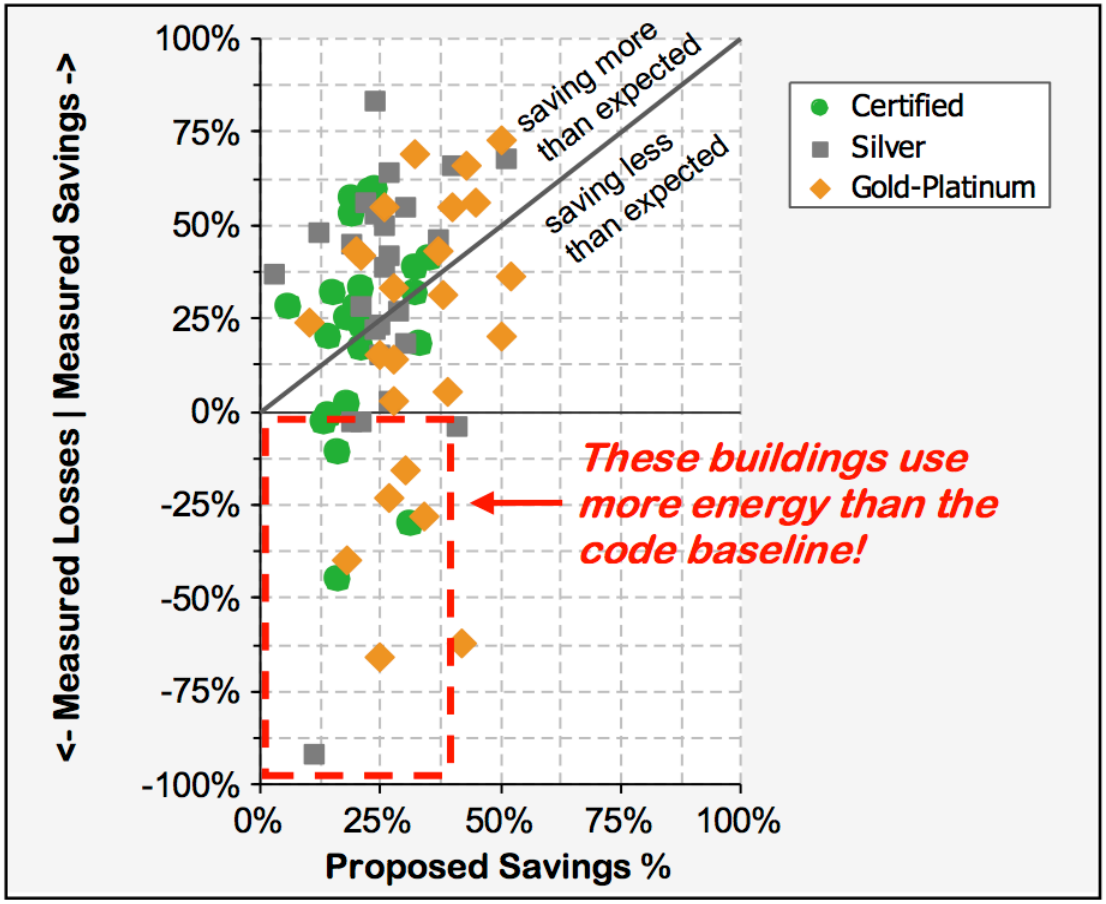


Figure ES-5: Measured versus Proposed Savings Percentages

A Re-examination of the NBI LEED Building Energy Consumption Study

- 2009 Paper by Professor Scofield, Oberlin College
- Use same data as NBI study to conclude:
  - LEED Certified buildings use more site and source energy than comparable non-LEED buildings
  - LEED Gold/Platinum buildings use 13% less source energy than comparable non-LEED buildings

Finding a Solution

Is there a better way to close the gap between design and performance?

Let's start with the real performance of existing buildings and work our way backwards…

Portfolio Manager – Tracking Performance in Existing Buildings

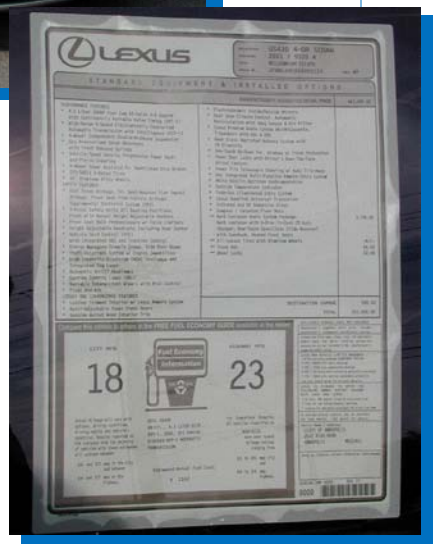
- Free, online, secure tool for existing buildings:
  - Assess the energy use of existing buildings
  - Compare energy use against peers
  - Many building types receive an energy performance rating (1-100 score).
  - Track changes in energy use over time in single buildings, groups of buildings, or entire portfolios.
  - Track cost savings and emission reductions.
  - Track water usage.
- http://www.energystar.gov/benchmark

Standardized Metric

Until recently, a standardized, comparable metric of whole building energy performance did not exist

EPA introduced the *Energy Performance Rating System* In 1999 to meet this need

Is Your Building Performing Well?



Fuel Efficiency

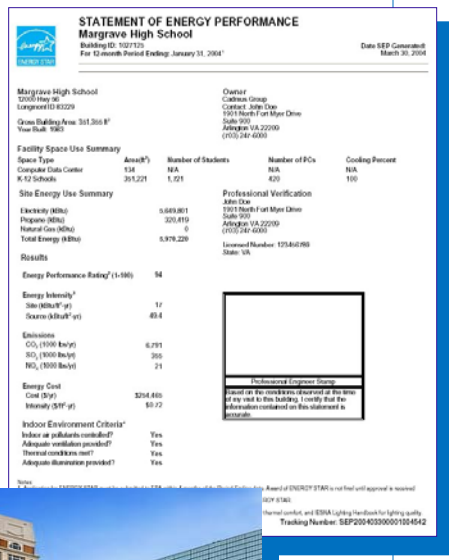
MPG

Is 18 MPG high or low for an automobile?

Is 80 kBtu/SF/YR high or low for a building?

Energy Performance

EPA Benchmarking


STATEMENT OF ENERGY PERFORMANCE
Margrave High School

EPA's Energy Performance Rating System

- Normalizes building energy consumption
  - Accounts for weather, operating hours, occupant density, & plug load by standardized methods
- Benchmarks for comparison
  - Ratings compare to similar buildings nationwide
  - Rating system is available for over 60% of U.S. commercial building space.
  - Transparent and replicable technical documentation
- EPA provides recognition opportunities
  - ENERGY STAR label
  - Designed to Earn ENERGY STAR
  - ENERGY STAR Leaders

EPA Rating: Source and Site Energy

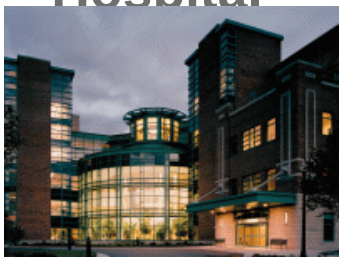
- Because ENERGY STAR rates the whole building, the ratings must account for any mix of fuels
- Site Energy
  - Energy consumption expressed on utility bills
  - Includes combination of primary and secondary energy, which are not directly comparable
    - Some heat and electricity comes from fuels burned on-site (e.g. natural gas); some comes from fuels burned off-site (e.g. district steam)
- Source Energy
  - Traces on-site consumption back to energy content of primary fuels
  - Accounts for the losses in conversion from primary to secondary energy (which can occur either on-site or at a utility)
  - Accounts for losses in distribution to buildings

EPA Rating: Technical Foundation

- The rating ***does***
  - Evaluate as-billed energy use relative to building operations
  - Normalize for operational characteristics
    - Size, Number of employees, Weekly operating hours, Climate
  - Depend on a statistically representative sample of the US commercial building population
- The rating ***does not***
  - Attempt to sum the energy use of each piece of equipment
  - Normalize for technology choices or market conditions
    - Type of lighting, energy price
  - Explain how or why a building operates as it does

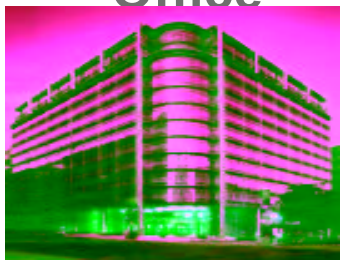
EPA Rating Building Types

Hospital



Retail

Office



Hotel

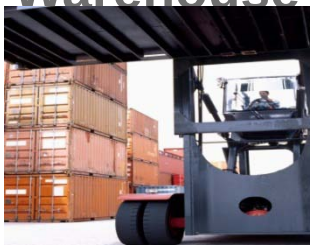
Medical Office

Wastewater Treatment Plant

Courthouse

Bank/Financial

Warehouse



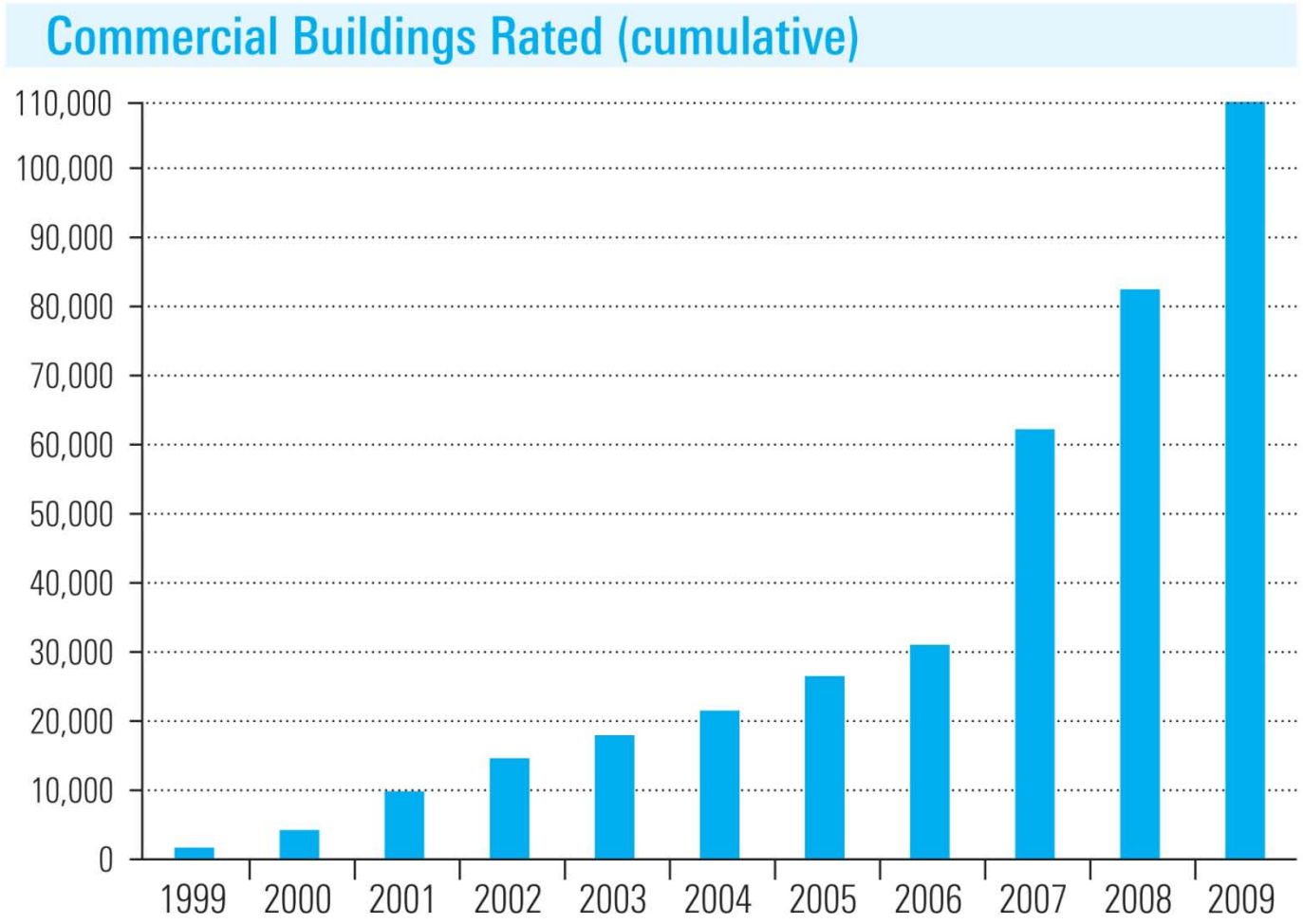
Dormitory

Supermarket

K12 School

EPA Also Houses of Worship (Sept. 2009), Data Centers (April 2010)

Tremendous Growth in Use of Rating



Almost 140,000 buildings as of October, 2010

Buildings not Eligible for Rating

- Any building can use PM to measure and track energy use (including multi-family)
- Close to 40,000 buildings tracked in PM that are not eligible for 1-100 score
- Provides EUI, weather normalized energy use over time, emissions, many other metrics
- Compares EUI to regional CBECS averages for non-eligible buildings

State and Local Mandates Incorporating Portfolio Manager

Jurisdiction	Public Buildings	Private Buildings	Disclosure	Utility Data Requirement
California	√	√ (non-resid)	Transactional	√
State of Washington	√	√	Transactional	√
D.C.	√	√ (non-resid)	Annual	
Michigan	√			
Ohio	√			
Hawaii	√			
New York City	√	√	Annual	
Austin, TX	√	√	Transactional	
Denver, CO	√ (new const)			
West Chester, PA	√ (new const)	√ (new const)		

Standardized Measurement Enables Energy Efficiency Strategy

- Estimate Energy Use at Design
- Verify Energy Use in operation
- Monitoring progress as organizations manage energy better

DESIGNED TO EARN THE ENERGY STAR

ENERGY STAR 2003

Standardized metrics enable strategies, consistency

EPA

How Can We Improve Building Codes?

- Set whole building energy use intensity target for design
  - Must be normalized for key factors (e.g., weather, anticipated schedules)
  - Not an easy task, but worth the effort
  - EPA system is one option; there are many others (e.g., modeling-derived)
  - Could phase in, starting with building types for which there exist adequate data
- Require demonstration that target met in operation
- Require Commissioning
- Improve targets as gather feedback

Compliance and Enforcement

- Compliance with whole building target at design
  - Modeling
  - Proven design (e.g., fast food restaurant)
  - Other?
- Compliance with operational requirement
  - Energy bills
  - Normalization for key factors
- Enforcement
  - Existing energy codes apply only at design and construction
  - New state and local benchmarking mandates providing experience with enforcement for existing buildings

For More Information:

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