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Energy Efficiency Codes and Standards

USAID Global Workshop on Clean Energy Development

Victoria Kiechel
Architect and Senior Associate, the Cadmus Group, Inc.

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Energy Efficiency Codes and Standards

- Brief history
- What they cover
- How they are developed
- How they are conveyed and enforced
- Benefits
- Voluntary standards and rating systems

Building Codes and Energy Codes

- Building codes: ancient
  - Human safety
  - Earliest c. 1150 BC
- Energy efficiency codes: modern
  - First appliance efficiency standards: 1978
  - First model energy code for buildings: 1983

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Pre-1970 Context

- Erosion of climate-responsive design
- Cheap energy
- Ubiquitous air conditioning
- Universal architectural “languages,” such as modernism, classicism
- Industrial production and supply of globally available materials
- Migration to cities

Timeline

- 1973: Global energy crisis; oil prices quadruple by 1974
  - Policy reaction example: Denmark's measures for energy security
- 1975: U.S. Energy Policy and Conservation Act (EPCA)
  - First U.S. energy-efficiency and conservation program for major household appliances
- 1975: U.S. Congress passes first Corporate Average Fuel Economy (CAFÉ) standards for vehicles
- 1978: the National Energy Conservation and Policy Act (NECPA)
  - Authorizes U.S. Department of Energy (DOE) mandatory energy-efficiency standards for 13 household appliances
- 1983: Model Energy Code for Buildings (US DOE)
- Late 1980s: series of severe climate events and flooding in Europe
  - British scientists talk about global warming
- 1988: Brundtland Commission Report defines sustainability
- 1991: First holistic green building standard, BREEAM, released in UK
- 1992: US Energy Policy Act (EPAct); ENERGY STAR for appliances (computers) established
- 1993: US Green Building Council (USGBC) formation
- 1997: Kyoto Protocol
- 1998: International Code Council established; Model Energy Code becomes International Energy Conservation Code
- 1999: ENERGY STAR for Buildings label
- 2000: First USGBC green building rating system for new construction: Leadership in Energy and Environmental Design (LEED)
- 2005: EPACT update
- 2006: Roll-out of LEED rating system for Existing Buildings
- 2007: US Energy Independence and Security Act – government leads by example
- 2009: US Executive Order 13514 – President Obama mandates federal agency GHG accounting in US

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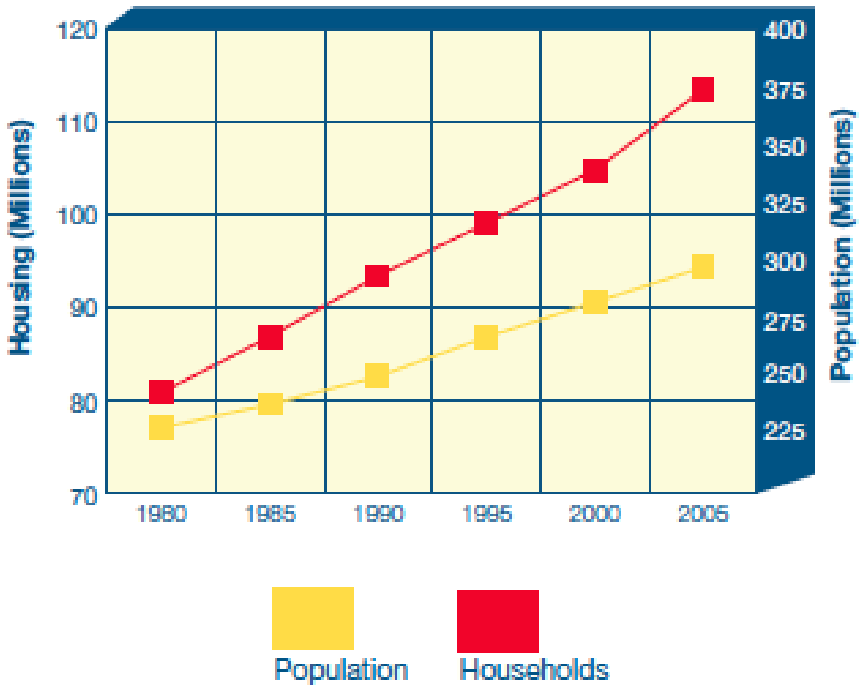
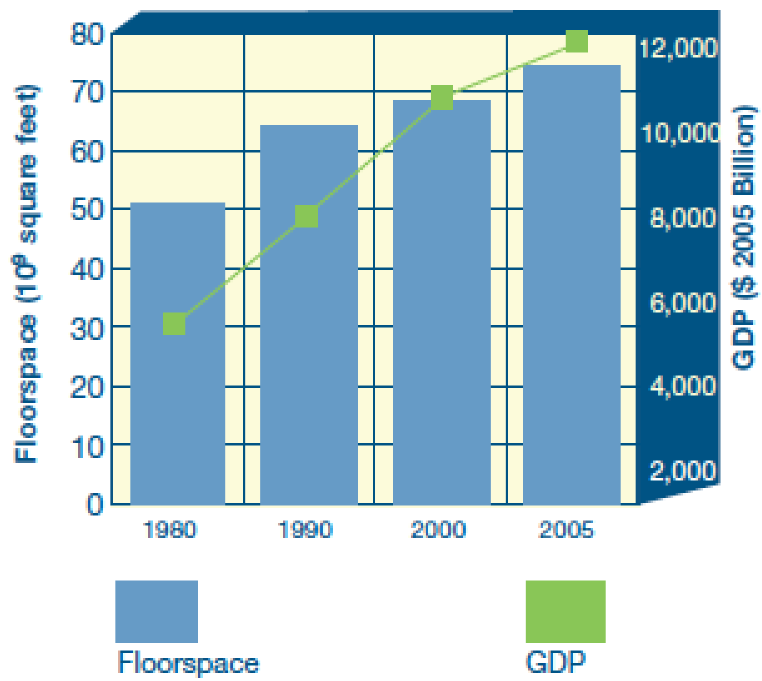
U. S. Trends and Urgency

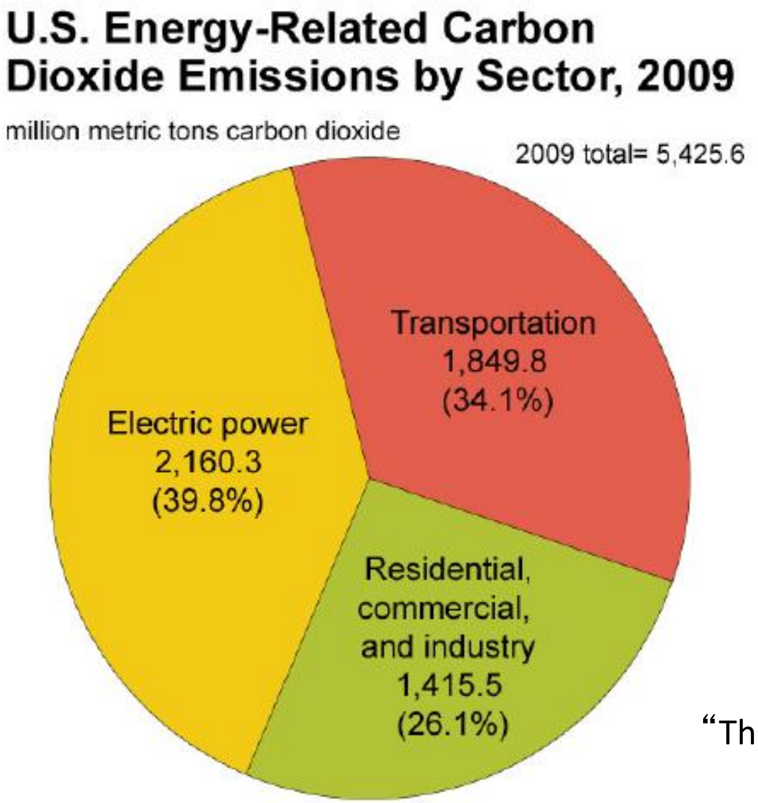
Growth of Dwelling Units per person
Growth in commercial floorspace





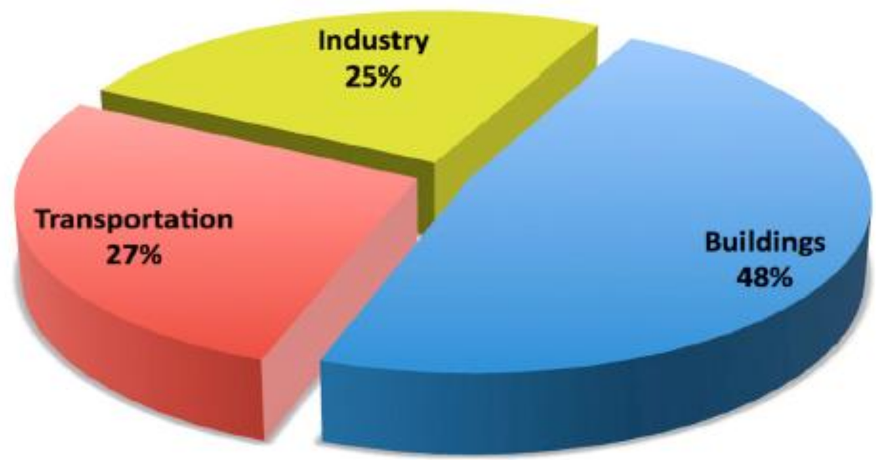
http://apps1.eere.energy.gov/buildings/publications/pdfs/corporate/bt_stateindustry.pdf

CO_2 Emissions and Energy Use



Source: U.S. Energy Information Administration, *Emissions of Greenhouse Gases in the United States, 2009* (March 2011).

U.S. Buildings Energy Use



Architecture2030.org

"The commercial sector — which includes such sources as schools, office buildings, and shopping malls — emits a total of 1.0 billion metric tons CO_2e of energy-related carbon dioxide, with almost 78% of it coming from the power plants providing the electricity used in the buildings. Its emissions have grown the fastest since 1990, at an average annual rate of 1.2%."

Climate Change

Model Code for Building Energy Use

- The International Energy Conservation Code (IECC)
- Residential and commercial buildings
- Energy conservation through
  - Building envelope design
  - Efficient mechanical and lighting systems
  - Renewables
  - New products
  - Processes and controls supporting efficient operation

IECC Requirements

- Wall, roof, and floor insulation
- Window efficiency
- Air tightness in envelope and ductwork
- Controls
- Equipment right-sizing
- Equipment efficiency
- Measurement and verification of performance and savings
- Systems commissioning
  - The process of ensuring that building systems are performing according to the design intent
  - Systematic effort to monitor and optimize functional performance of building systems

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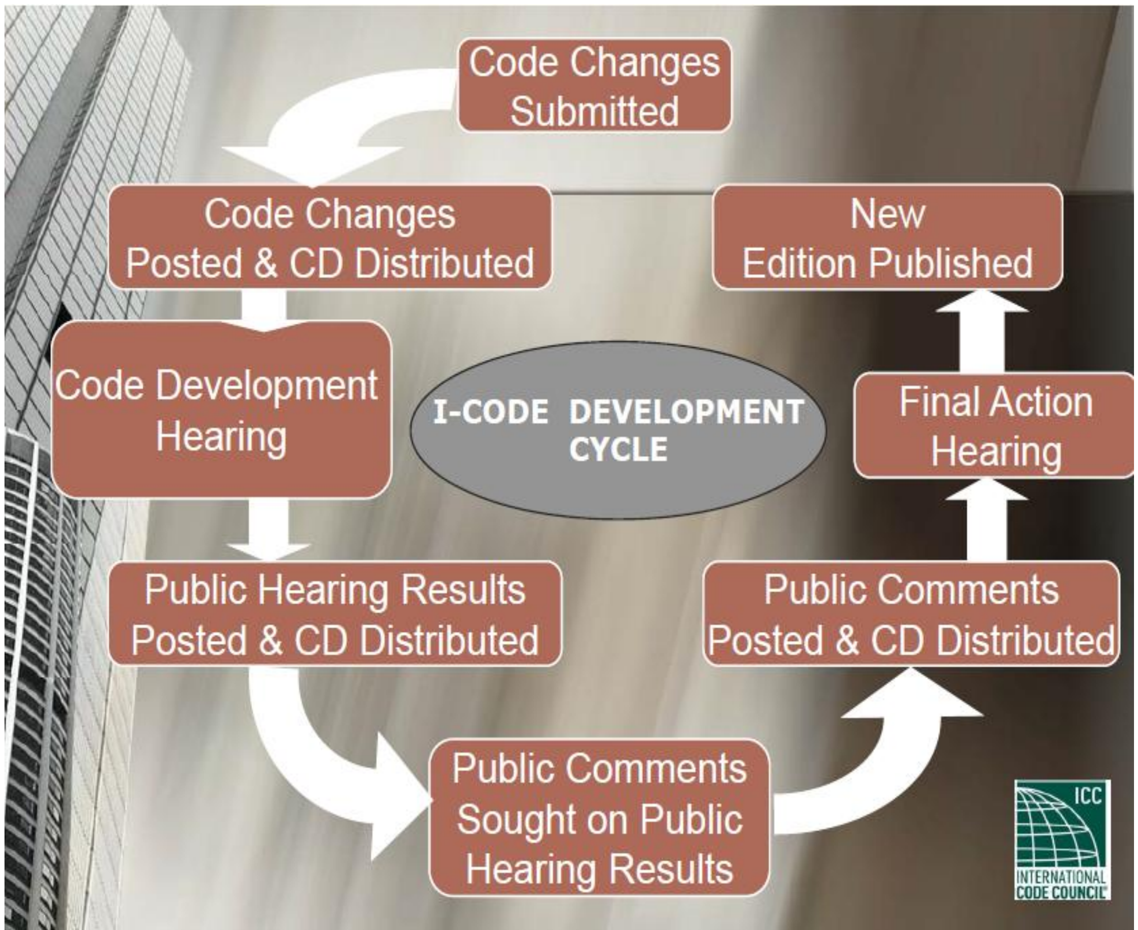
IECC Development Process

- Developed and updated by the International Code Council by large committees of experts in consensus process
- Updated every 3 years (2006, 2009, 2012)
- Relies on local adoption

ICC INTERNATIONAL CODE COUNCIL®

People Helping People Build a Safer World™

Development Process



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Developing Codes and Standards

1. Know your built environment (surveys, research)
2. Establish a business-as-usual or baseline scenario
3. Establish a minimum performance threshold over the baseline scenario
4. Optional: establish “reach” codes and incentives (see California)
5. Raise the bar as market adoption and performance increases

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Role of Third Party Standards

American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE)

- Standard 55 – Thermal Environmental Conditions for Human Occupancy
- Standard 62.1 – Ventilation for Acceptable Indoor Air
- Standard 62.2 – Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
- Standard 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings
- Standard 189.1 – Standard for the Design of High Performance, Green Buildings Except Low-Rise Residential Buildings

Role of New Products and Innovation

Figure 1 View of the concrete cubicles.

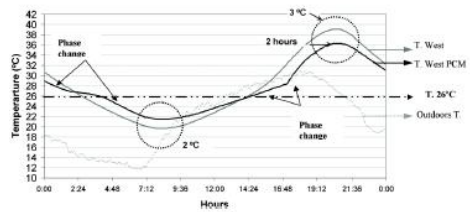


Figure 2 Outside temperature and temperature of the west wall with and without PCM with closed windows tests in July 2005.

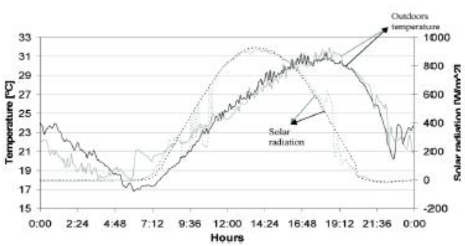


Figure 3 Two different days (05/07/2006 and 28/07/2006) with similar solar radiation and similar outdoor temperatures.

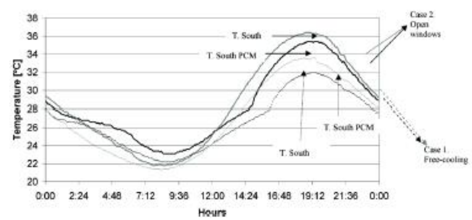
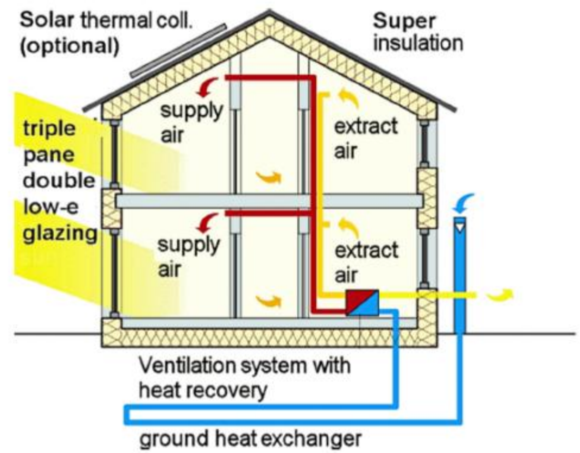


Figure 4 Comparison of the south wall temperature (with and without PCM) on two different days, 05/07/2006 and 28/07/2006 (Cases 1 and 2, respectively).



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Performance–Based Versus Prescriptive Approaches

Energy codes offer alternative compliance paths

- Prescriptive paths: easy-to-use tables contain required minimum or maximum values
- Performance paths based on an overall energy saving goal
  - Greater flexibility in how that goal is achieved
  - Choice of focus on systems performance or renewable energy or high-performing envelope

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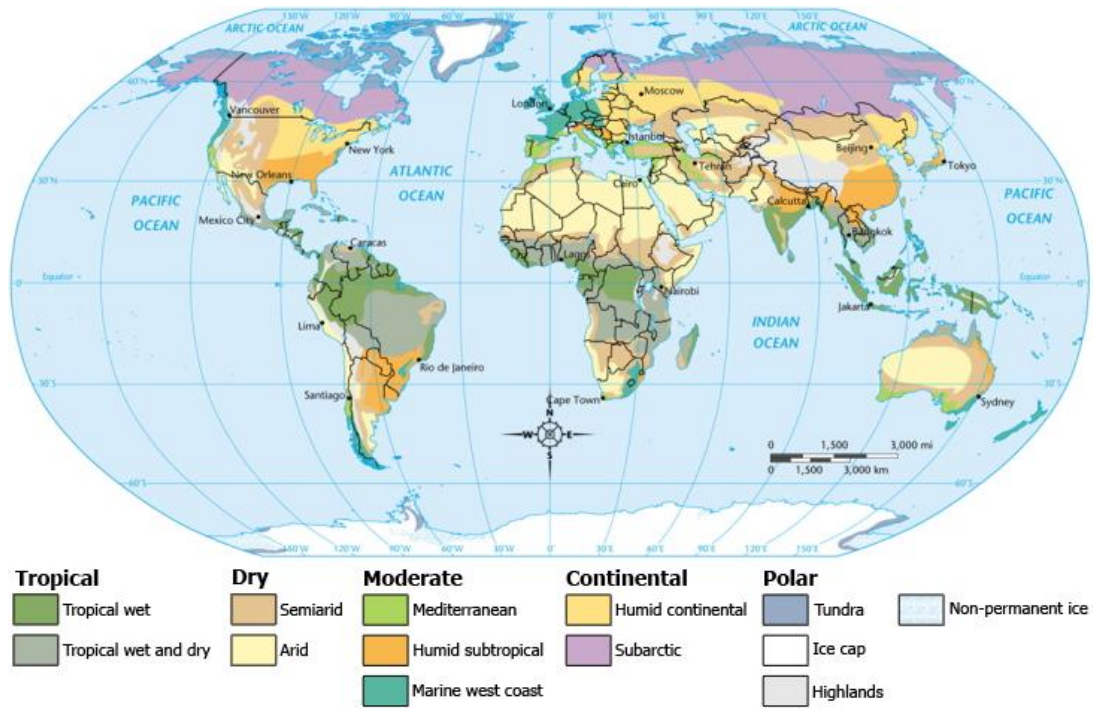
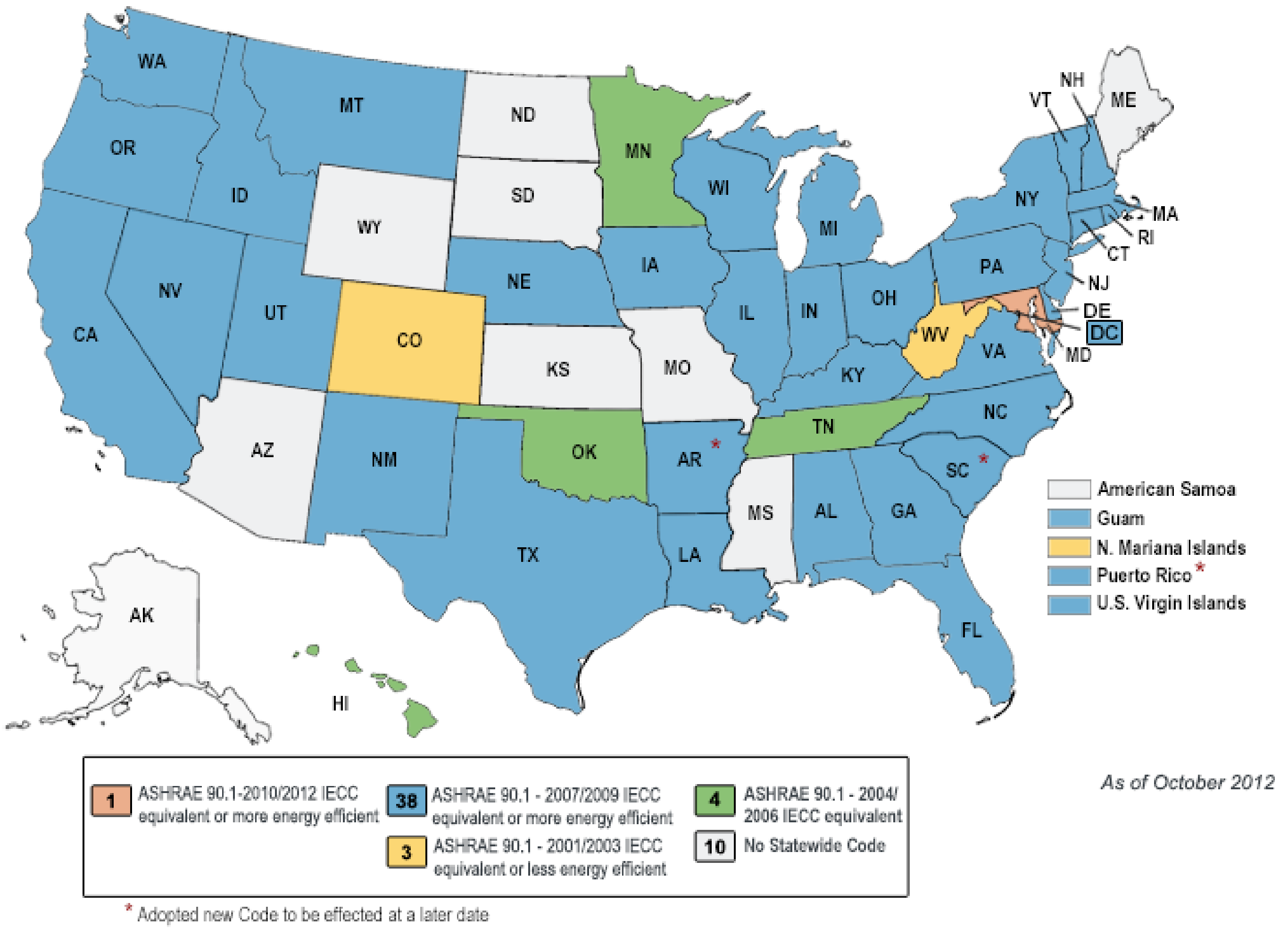
Requirements Vary by Climate Zone

Zone Number	Zone Name
1A and 1B	Very Hot –Humid (1A) Dry (1B)
2A and 2B	Hot-Humid (2A) Dry (2B)
3A and 3B	Warm – Humid (3A) Dry (3B)
3C	Warm – Marine (3C)
4A and 4B	Mixed-Humid (4A) Dry (4B)
4C	Mixed – Marine (4C)
5A, 5B, and 5C	Cool-Humid (5A) Dry (5B) Marine (5C)
6A and 6B	Cold – Humid (6A) Dry (6B)
7	Very Cold
8	Subarctic



Zone 1 countries include Tanzania, Indonesia, Jamaica

US States IECC Adoption



Market Education, Enforcement

- Usually, government sector permits and inspection process
  - Sometimes outsourced

- New construction
- Contractor education programs
- Existing buildings compliance, if any, relies on data collection and performance reporting

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Benefits

- Saves money; according to the US Department of Energy
  - Consumers/ businesses have saved $15 billion per year from appliance efficiency alone
  - Savings expected to double by 2025
  - Frees up money to be spent elsewhere, spurring economic growth
- Enhances economic competitiveness
  - Example: performance of disparate US states
  - Innovators tend to see growth
  - Lease rates 7% higher in energy efficient buildings (CoStar Group)
- In buildings, energy efficiency improves human comfort
- Carbon emissions savings and environmental protection from avoided electricity production
  - 33% of GHG emissions come from electricity

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Beyond the Minimum: Green Codes and “Reach” Standards

- CALGreen Code (California): most stringent US mandate
- Leadership in Energy and Environmental Design (LEED): voluntary and mandatory
- ASHRAE Standard 189.1
- The International Green Construction Code (IGCC)

Scope & Coverage

- Administration
- Site Development & Land Use
- Material Resource Conservation & Efficiency
- Energy Conservation, Efficiency & Atmospheric Quality
- Water Resource Conservation & Efficiency
- Indoor Environmental Quality and Comfort
- Comissioning, Operation & Maintenance
- Existing Buildings

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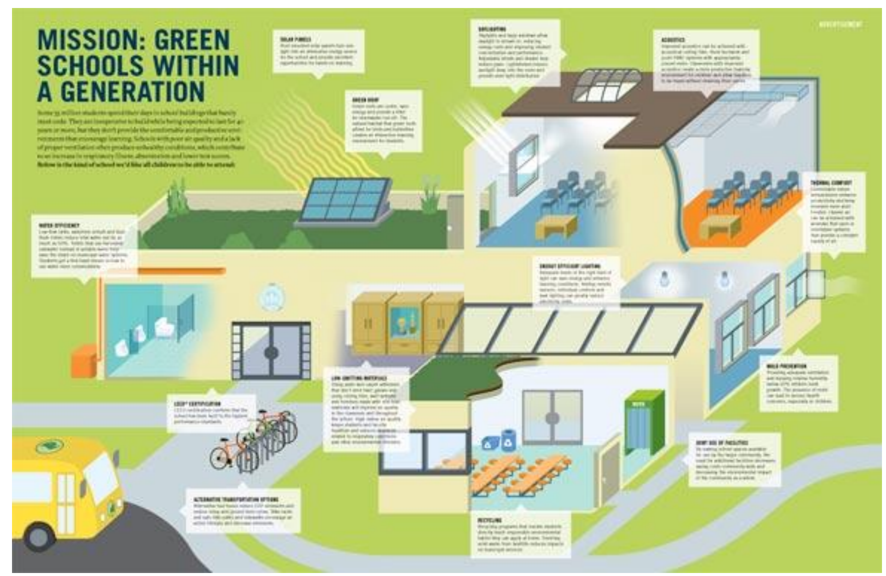
Who’s Adopting, and Why?

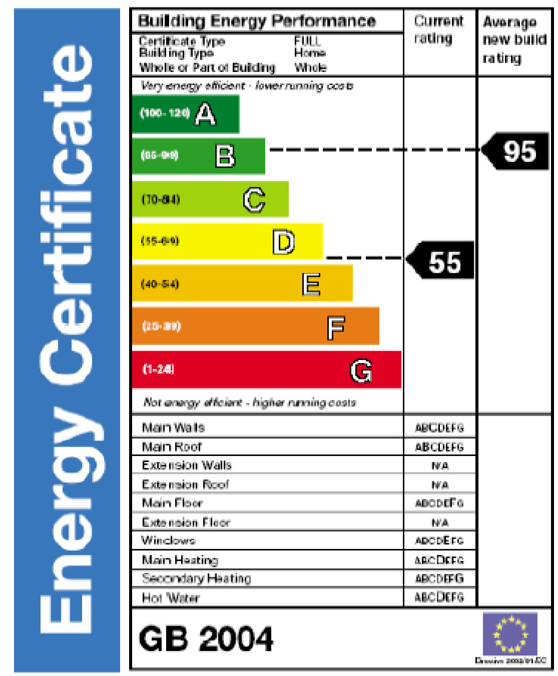
- Commercial institutions, because of cost savings and corporate goals
  - LEED and ENERGY STAR market uptake in office buildings and commercial real estate
  - Owner-driven
- Governments, for greater energy security and to lead by example
- “Priority” institutions such as K-12 schools, for better indoor environmental quality
  - Daylighting
  - Comfort



Outcome-Based Energy Codes

- The future of energy codes
- Criteria: actual rather than predicted performance
- Based on actual energy use
- Needs include
  - Energy metering infrastructure
  - Data collection and transparency
    - Energy use benchmarking and reporting
    - Common measurement tool
  - Enforcement

Building Energy Use Labeling



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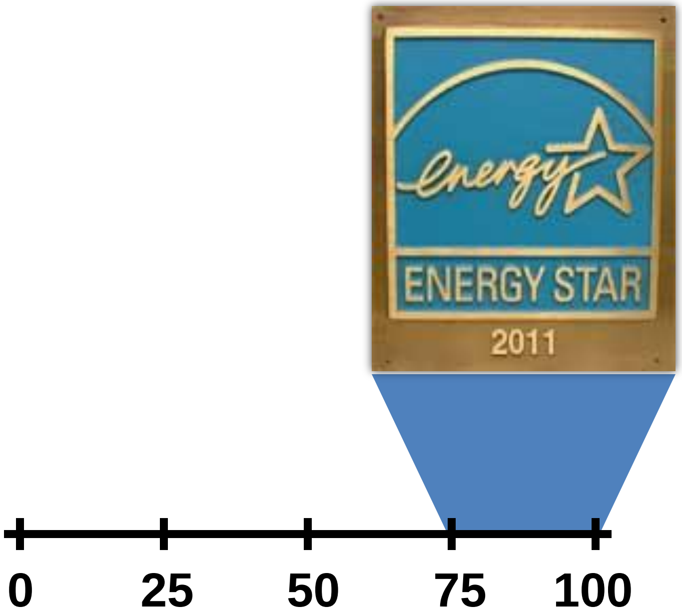
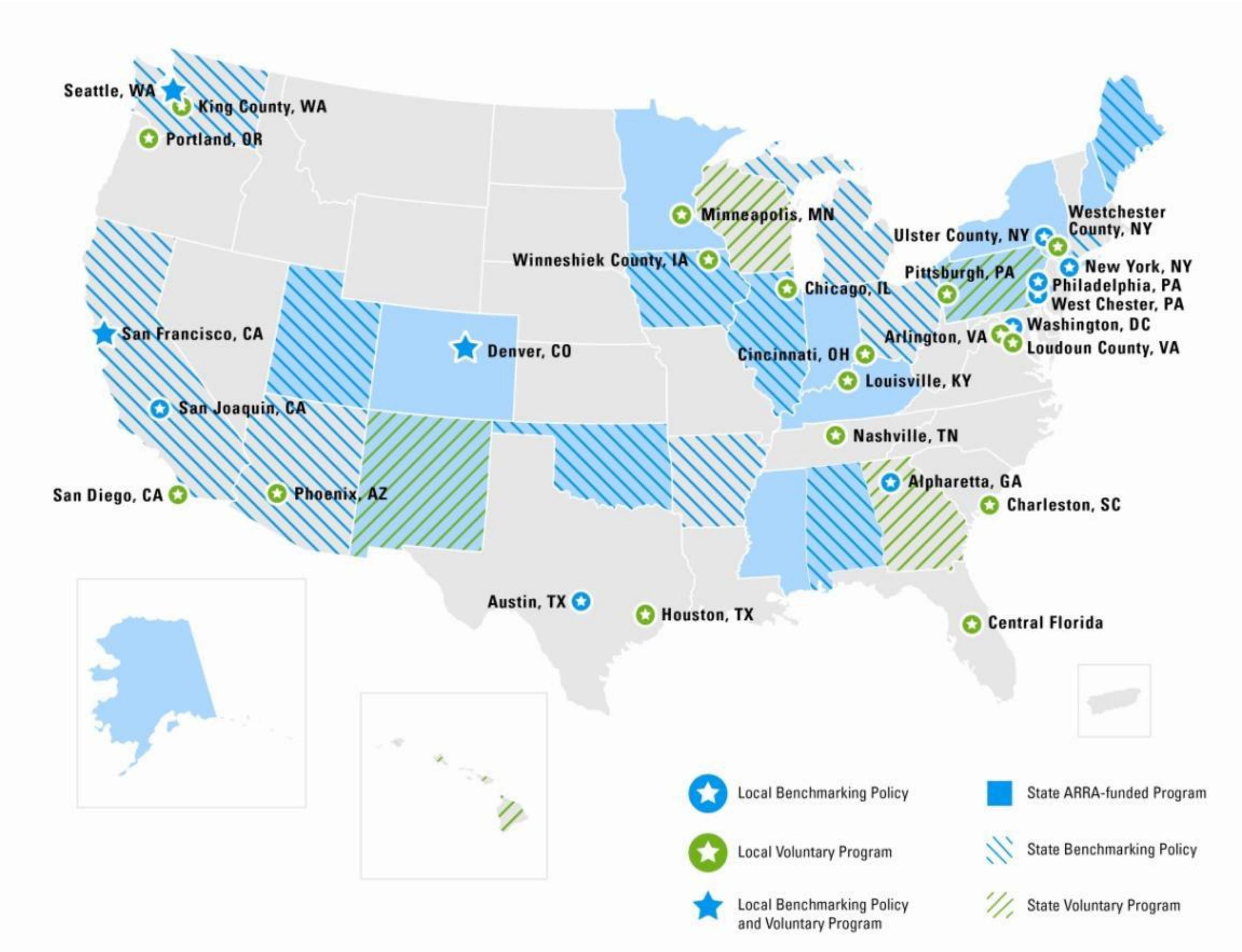
ENERGY STAR Voluntary Certification



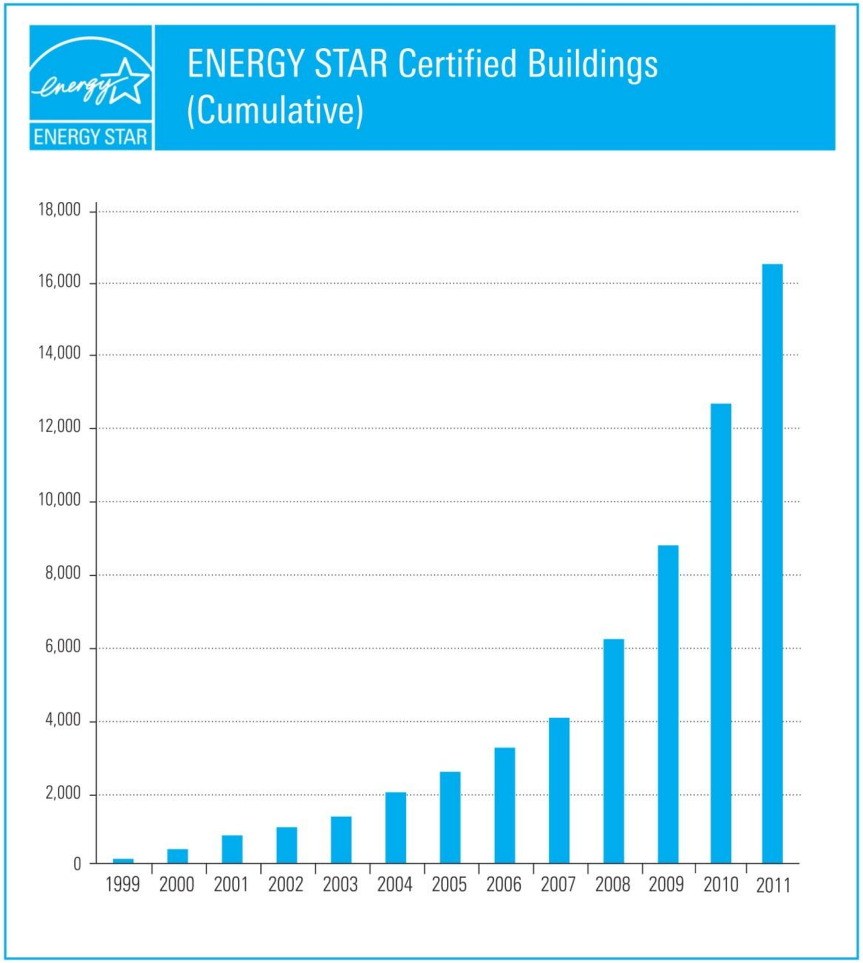
- US buildings in the top 25 percent nationwide are eligible to earn the ENERGY STAR, provided they meet or exceed industry standards for comfort levels
- Famous “brand”
- Cost-effective certification
- Model being adopted or explored by Canada, Mexico, and other countries

ENERGY STAR

ENERGY STAR for Buildings Certification: U.S. Adoption



ENERGY STAR-Buildings Market Uptake



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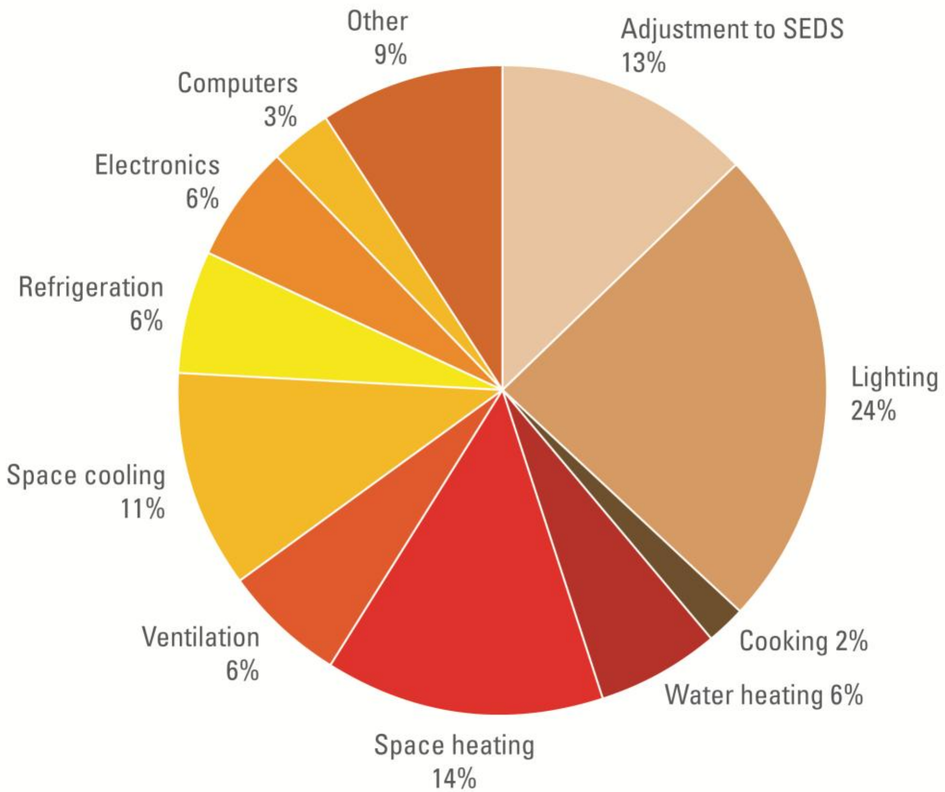
Role of Appliance Standards in Energy Efficiency

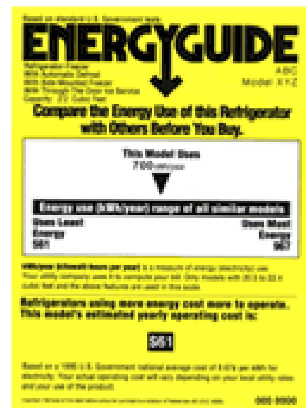


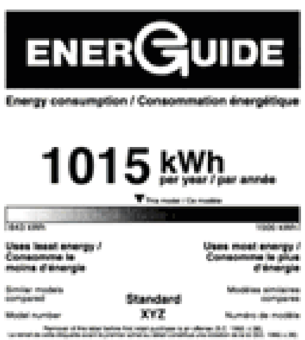
Typical US commercial building energy use: plug loads increasing as a percentage of whole

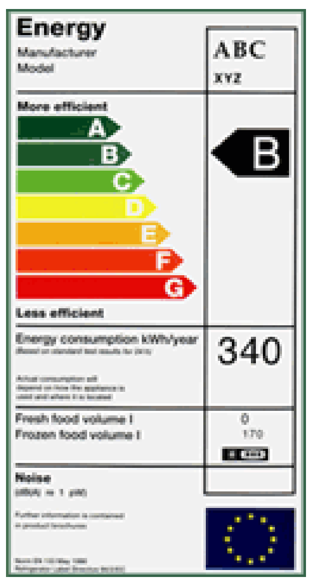
International Appliance Standards

CLASP

USAID







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ENERGY STAR Products Program

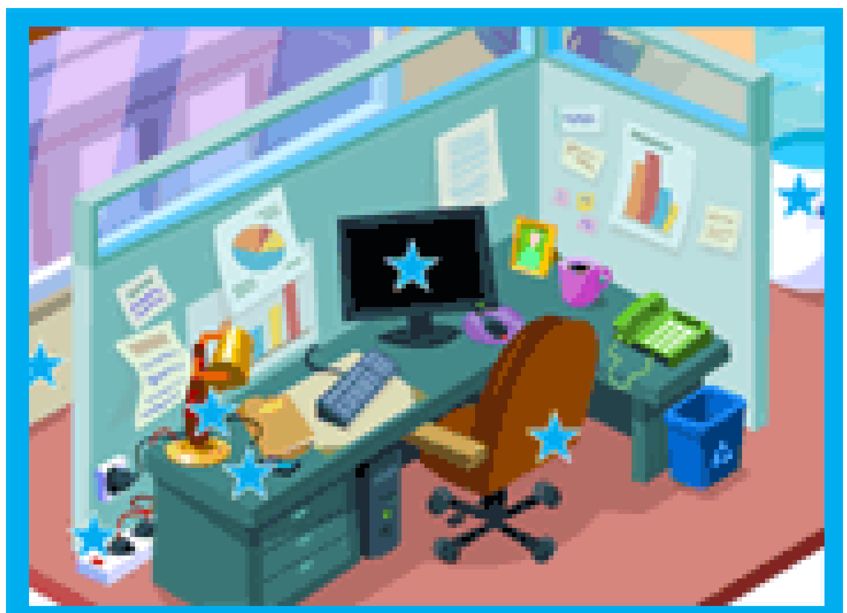
The Role of Market Education

- ENERGY STAR: 80% market recognition in 20 years
- Government-sponsored outreach and advertising
- Public service announcements (PSAs)
- Competitions
- Incentives
  - Local appliance rebates
  - Tax credits

Market Education

EPA and DOE resources such as ENERGY STAR for Homes and *Bring Your Green to Work* interactive graphics

http://www.energystar.gov/index.cfm?c=bygtw.view_showOffice



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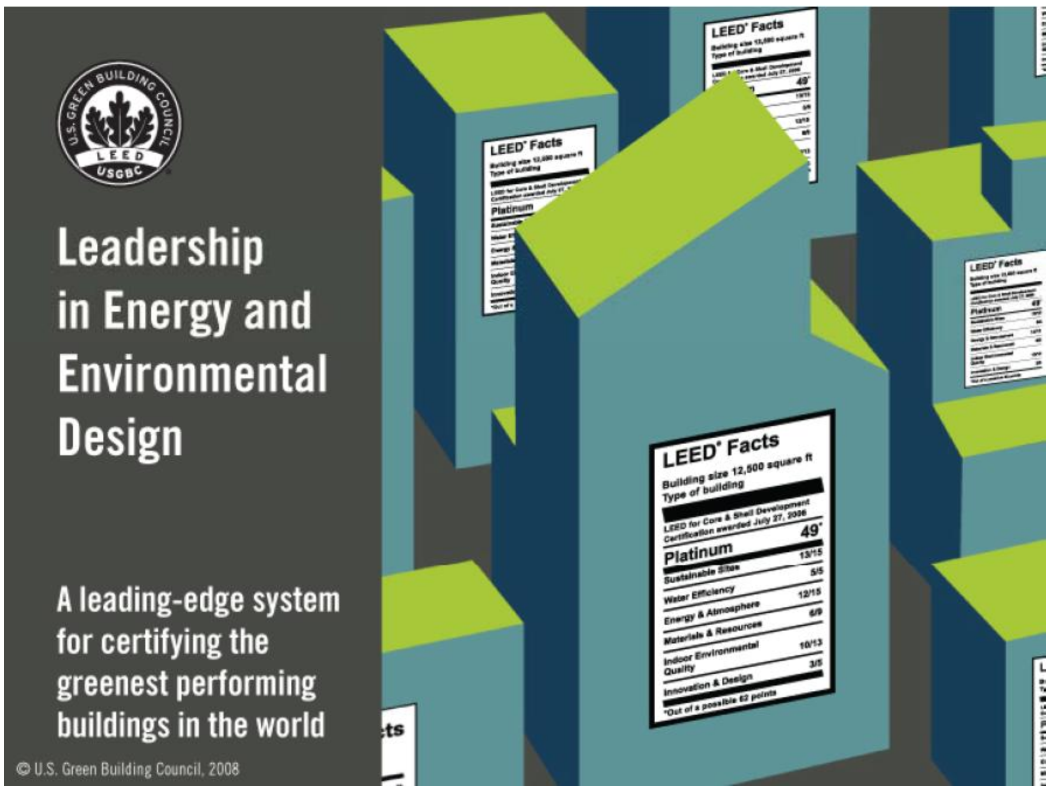
The LEED Rating Systems



- Green rating system for new and existing buildings and neighborhoods
- Third-party measure
- Combines standards and metrics from many disciplines
- Rewards building and product energy efficiency
- Prestigious “brand”
- International
- Regionalization efforts

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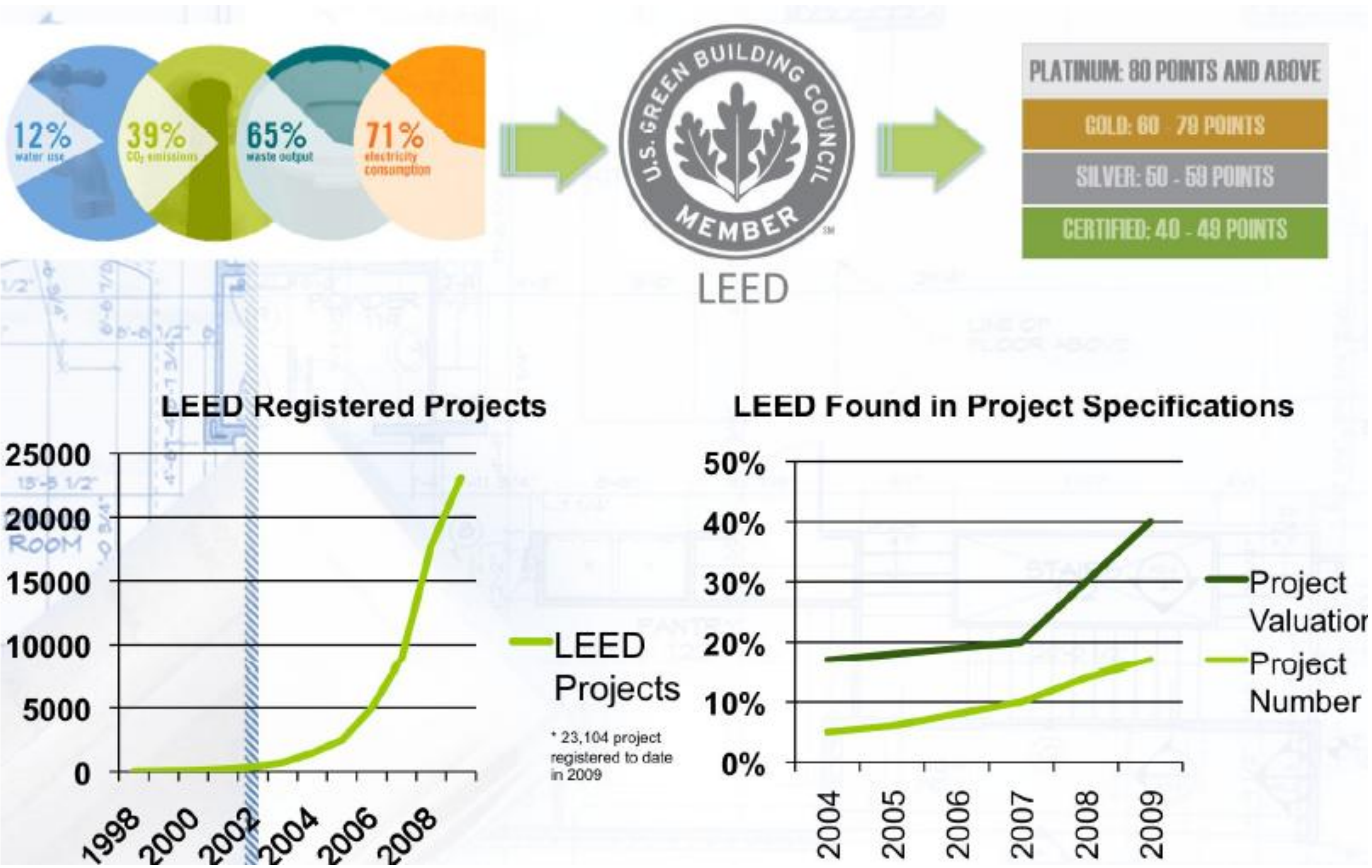
LEED Credit Categories

Council, 2008

LEED Categories	NC Points	EB:O&M Points	Description
Sustainable Sites	26	26	A building's impact on waterways, ecosystems, undeveloped sites; transportation choices; stormwater runoff; reduction of erosion, light pollution, heat island effect and construction-related pollution.
Water Efficiency	10	14	Encourages smarter use of water, through more efficient fixtures, water-wise landscaping outside, wastewater recycling, and water harvesting.
Energy & Atmosphere	35	35	Encourages a wide variety of energy strategies: commissioning; energy use monitoring; efficient design and construction; use of renewable & clean sources of energy, generated on or off-site.
Materials & Resources	14	10	Encourages the reduction of waste, resource reuse, recycling, the selection of sustainably grown, harvested, produced and transported products and materials.
Indoor Environmental Quality	15	15	Promotes strategies that can improve indoor air quality as well as providing access to natural daylight and views.
Innovation in Design	6	6	Provides additional points for projects that use innovative technologies and strategies beyond what is required by LEED credits or which achieve exemplary performance; one point for involving a LEED Accredited Professional on the team.
Regional Priority	4	4	Additional points for achieving LEED credits deemed most important to the distinct region of the project.
Total	**110**	**110**	Minimum 40 points for Certification; 50 points for Silver; 60 points for Gold; 80 points Platinum.

Meet prerequisites (no point value); earn minimum number of points across seven credit categories; energy performance carries most weight

LEED Market Uptake



Public Sector Role in LEED Adoption, Market Transformation

- Federal and local government lead by example
  - Federal agencies require LEED certification
- Local government incentives for LEED certification
  - Arlington County, VA: height restrictions lifted in exchange for LEED Platinum
  - Cincinnati, OH: 50% or greater property tax forgiveness for LEED Platinum

Questions

- What is useful and/or relevant for you?
- What are your needs? Your demographic trends?
- What are your challenges?
- What is your vision?
- What can the U.S. learn from you?

Thank you!

Victoria Kiechel, AIA, LEED AP
The Cadmus Group, Inc.
victoria.kiechel@cadmusgroup.com
703-247-6177

Cadmus in Latin America:

Julio Rovi, Vice President
julio.rovi@cadmusgroup.com
703-247-6128