ESMAP
The Energy Sector Management Assistance Program

Mainstreaming Building Energy Efficiency Codes in Developing Countries

Global Experiences and Lessons from Early Adopters

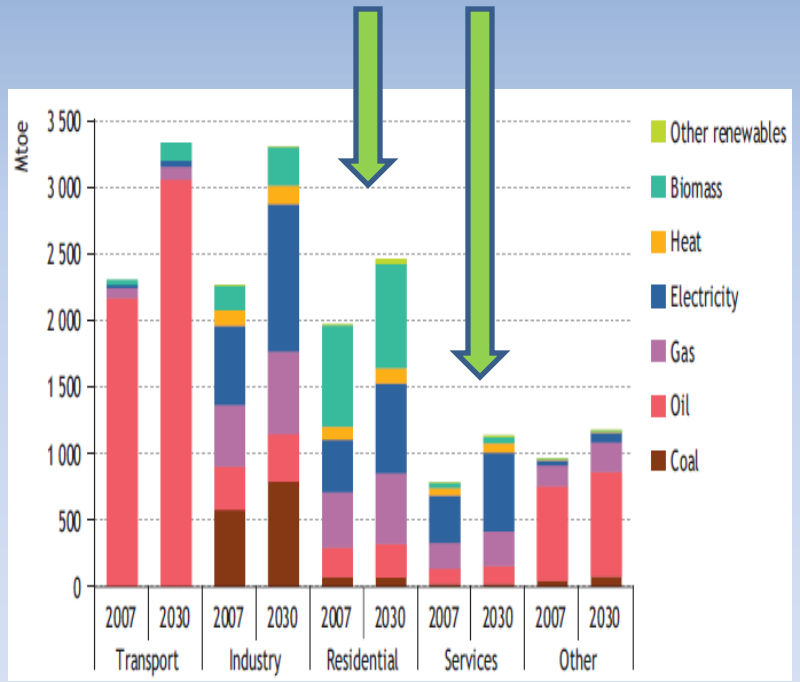
Energy Sector Management Assistance Program
The World Bank

Development and Implementation of Building Energy Efficiency Codes (BEECs)

1. Needs and Economics
2. Global Status and Trends
3. Lessons and Experiences
4. Issues and Options
5. Role of the World Bank Group

Why do we care about energy use in buildings?

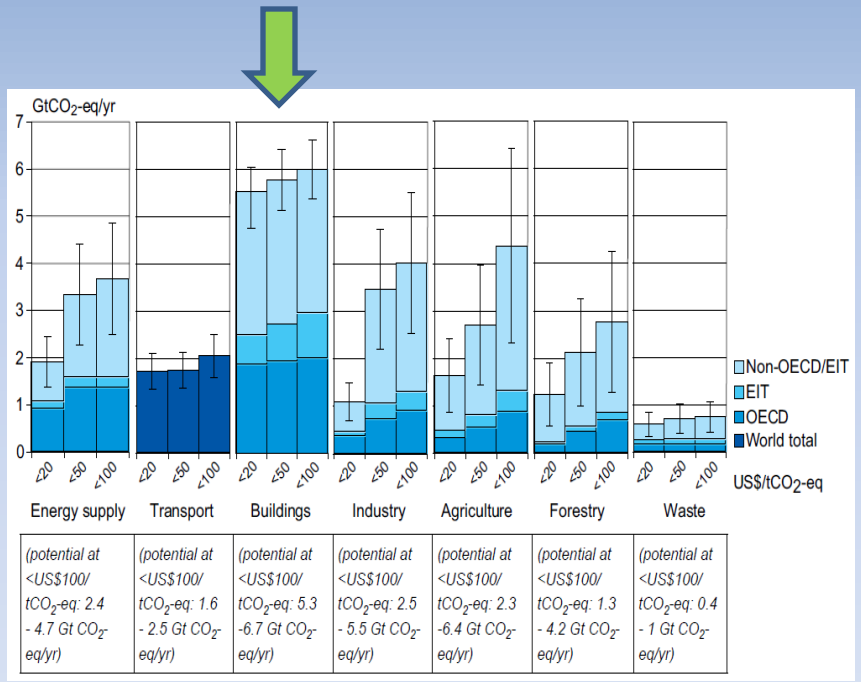
Buildings consume almost 40% of global final energy and generate 30% of GHG emissions worldwide



World final energy consumption by sector and by fuel in the reference scenario

Source: World Energy Outlook 2009, IEA

Buildings have the largest global potential for cost-effective green house gas mitigation



Estimated sectoral economic potential for global mitigation as a function of carbon price in 2030

Source: IPCC 4th Assessment Report – Summary for Policy Makers

Growing wealth in developing countries means greater demand for modern energy services

Lujiazui, Shanghai in 2009

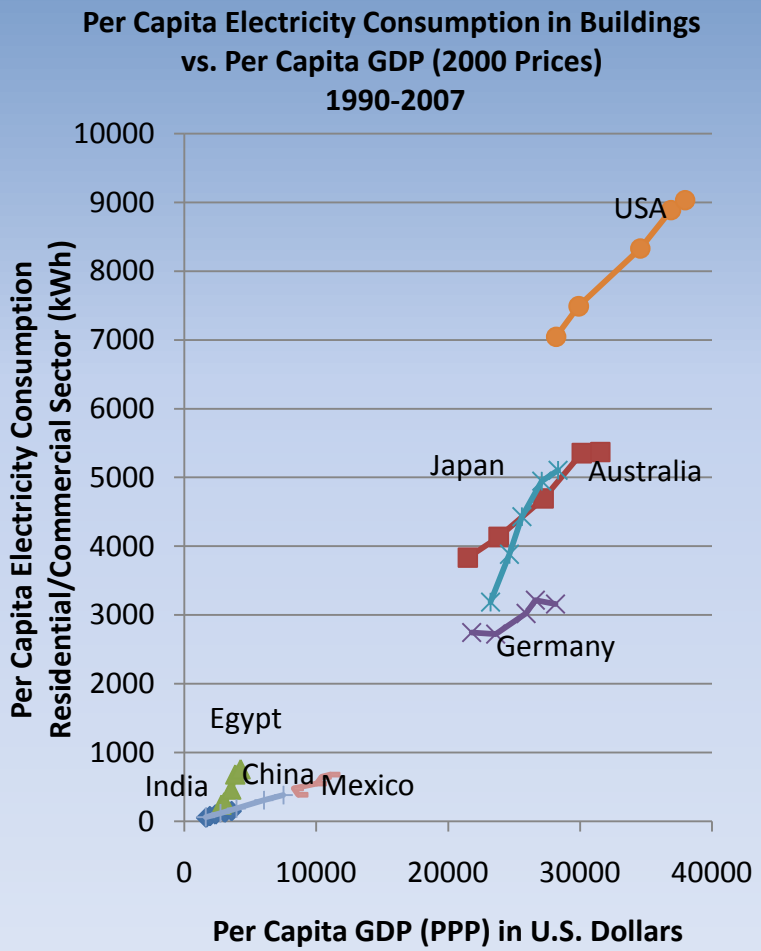
Lujiazui, Shanghai in the 1980s

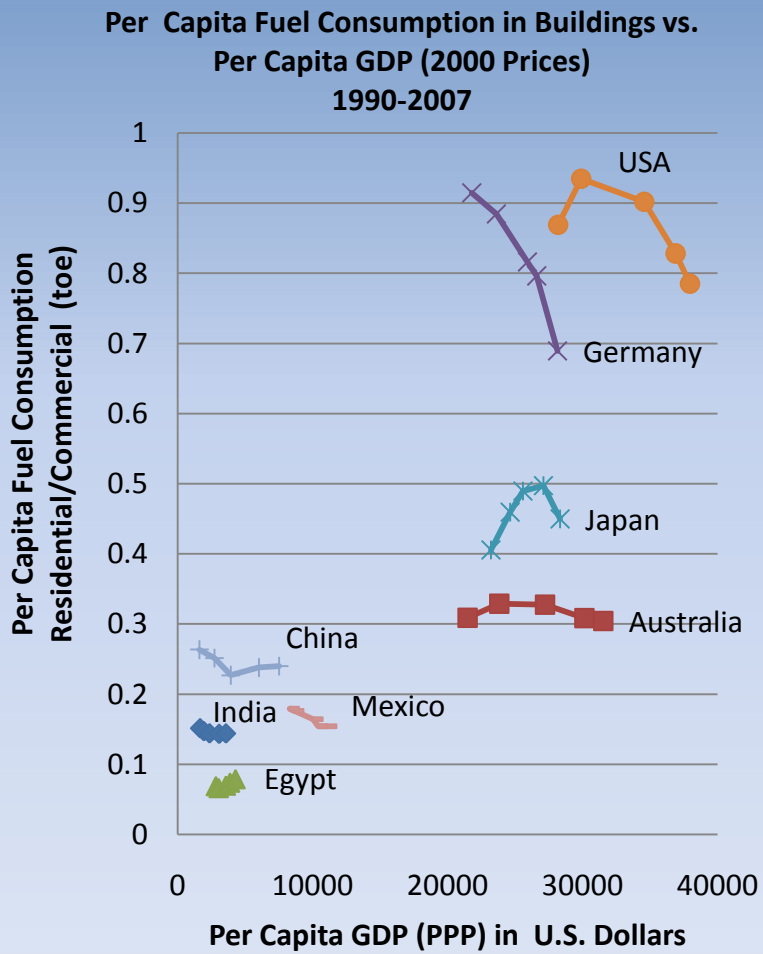
Leaving behind a low-carbon life?

Housing developments in China

Low-income housing developments in Mexico

How much energy do we need to keep warm, cool, lit, fed, productive and connected?





Source: IEA Energy Statistics

How to reduce buildings' lifecycle energy costs and/or carbon footprints?

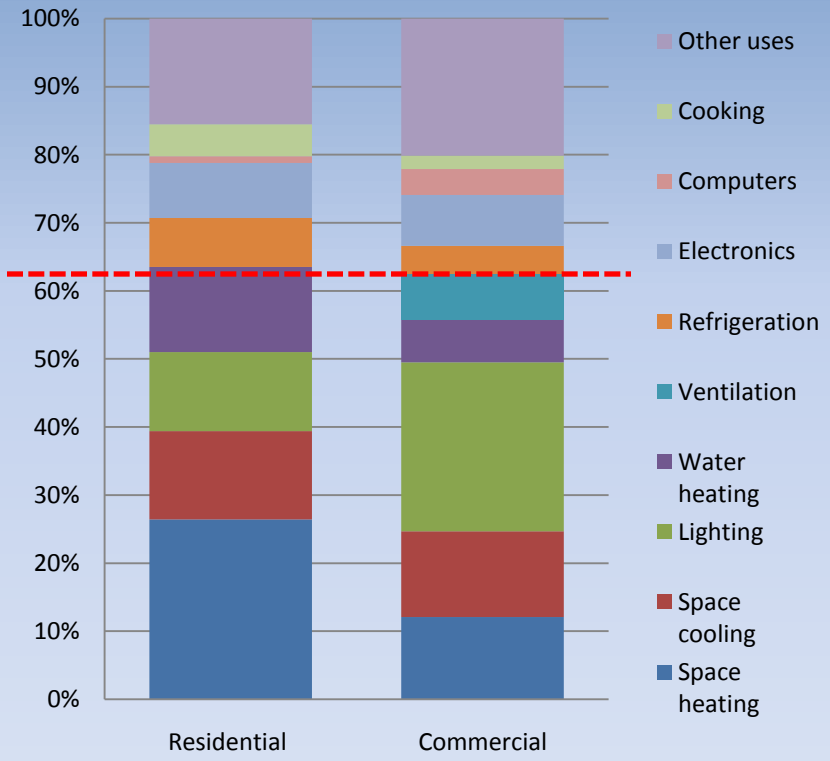
- **Operating energy accounts for about 80% of total energy use in a building's lifecycle**
- **Key strategies:**
  - Reducing embodied energy
  - Reducing energy load
  - Using efficient systems and equipment
  - Substituting renewable energy where feasible
  - Motivating owners and tenants to conserve

BEECs are mainly for reducing energy load of space conditioning, lighting, and water heating

- Prescriptive minimum thermal performance levels for building envelope components; sizing and minimum EE requirements for HVAC, service water heating/pumping, lighting
- Trade-offs and building performance approach - Fixed energy consumption (kWh/m^2), relative to reference building
- Others: day-lighting, shading, orientation, renewable energy, integrated design process, commissioning of energy systems,…

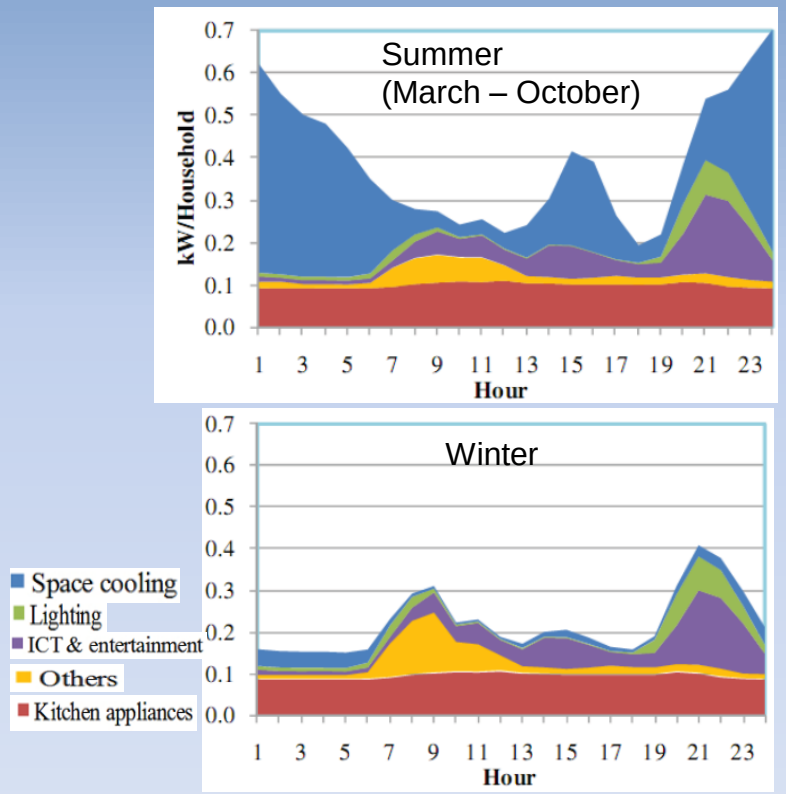
A large portion of energy use in buildings can be affected by BEECs

USA: 2006 Residential and Commercial End-Uses, Reported in Primary Energy



Source: Building Energy Data Book, http://buildingsdatabook.eren.doe.gov/ChapterView.aspx?chap=3

India: Gujarat DSM Load Research Survey Results

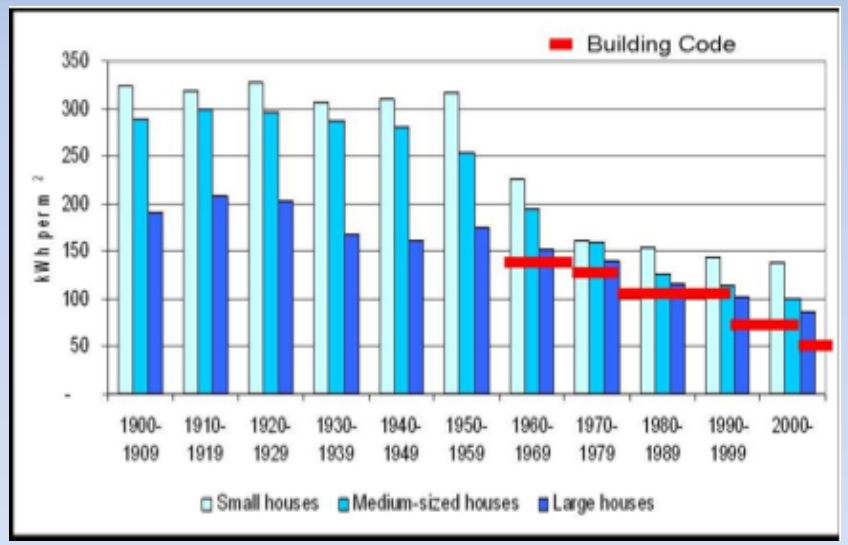


Source: Satish Kumar, An overview of energy efficiency in the built environment in India, July 7, 2010, presentation at the World Bank

BEECs have demonstrated their energy-saving and comfort-improving attributes

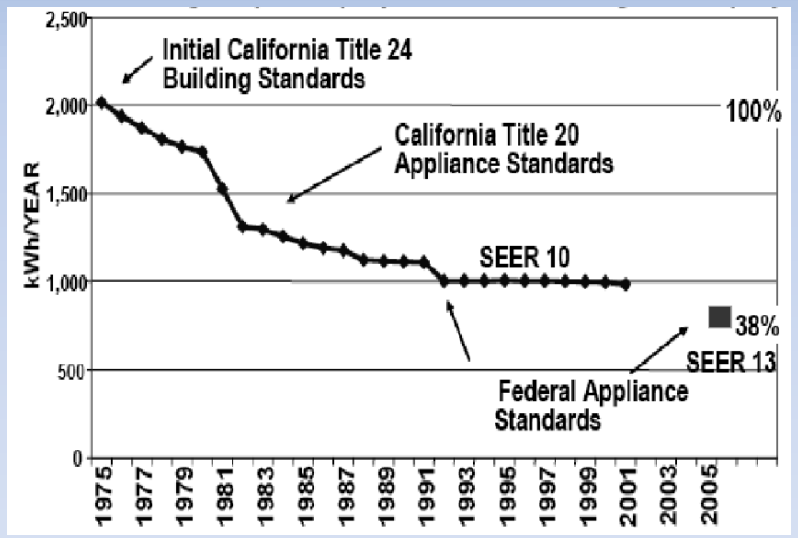
New buildings today consume much less energy than older buildings for space conditioning, lighting, and service water heating – in **EU** countries and the **U.S**. about 60% less than buildings from before the mid-1970s (predicted by BEECs)

Actual energy consumption in single family houses vs. levels implied by BEEC, Demark



Source: Energy efficiency requirements in building codes, Jens Laustsen, IEA information paper, 2008

Annual power usage of AC in new homes in California, 1976-2005



Source: California Energy Commission

But are BEECs cost-effective?

- The case is strong that the socio-economic benefits of BEECs outweigh their costs
- But economic and financial analyses based on post occupation data are still few and are not well publicized

Exhibition 1: A study of 146 green buildings in the US and several other countries in 2009 found that for **typical green office buildings** (Green buildings and communities: costs and benefits, 2009)

PV (20 years) of energy savings:	$7/sf (certified) to $14/sf (platinum)
Average additional cost of building green:	$3 to $8/sf

Exhibition 2: A recent analysis of Florida residential gas and electricity billing data from 2004 to 2006 for homes built before and after the 2002 BEEC change revealed (Are building codes effective at saving energy? Evidence from residential billing data in Florida, Jacobsen and Kotchen, draft paper, 2009)

Private payback period for **average residence**: 7.5 yrs, from gas and electricity savings
Social payback period: 6 yrs, also including avoided air-pollution costs
4 yrs, if CO_2 damages are included, too

- Situations in developing economies could be quite different from the above examples due to energy price subsidies and lower level of energy services. Unbiased and robust empirical analyses will help advance policy agenda

Why does the world need mandatory BEECs?

Market failures and barriers:

- Visibility and relevance of energy cost signals
- Split incentives among key stakeholders
- Flow of information and knowledge
- Complexity of delivering buildings

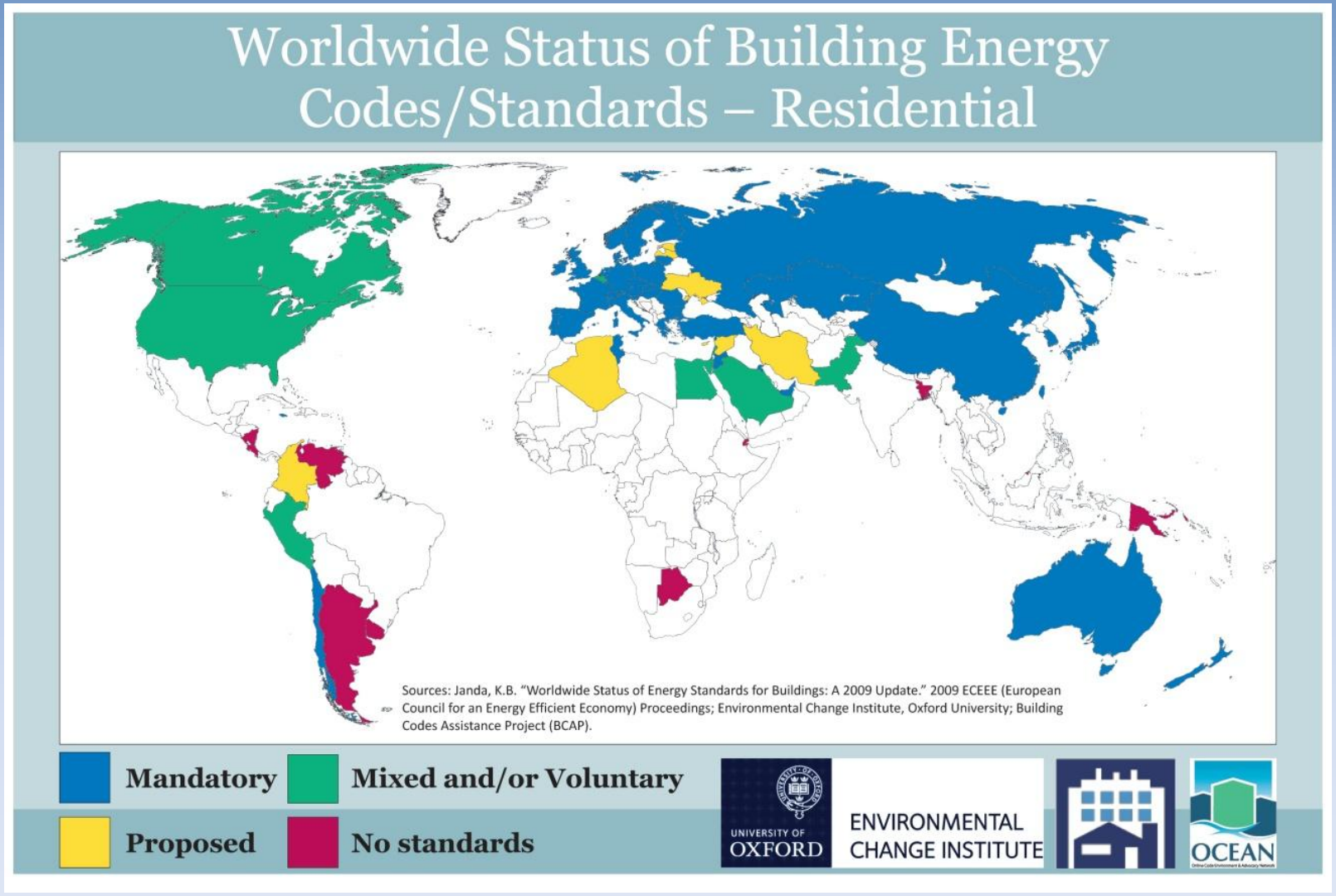
BEECs, along with appliances standards, have become a widely adopted energy efficiency policy

- The scope of BEECs may differ by country
- Mandatory BEECs are a norm in industrialized countries
- Significant increase of developing countries and economies in transition with mandatory or voluntary BEECs:

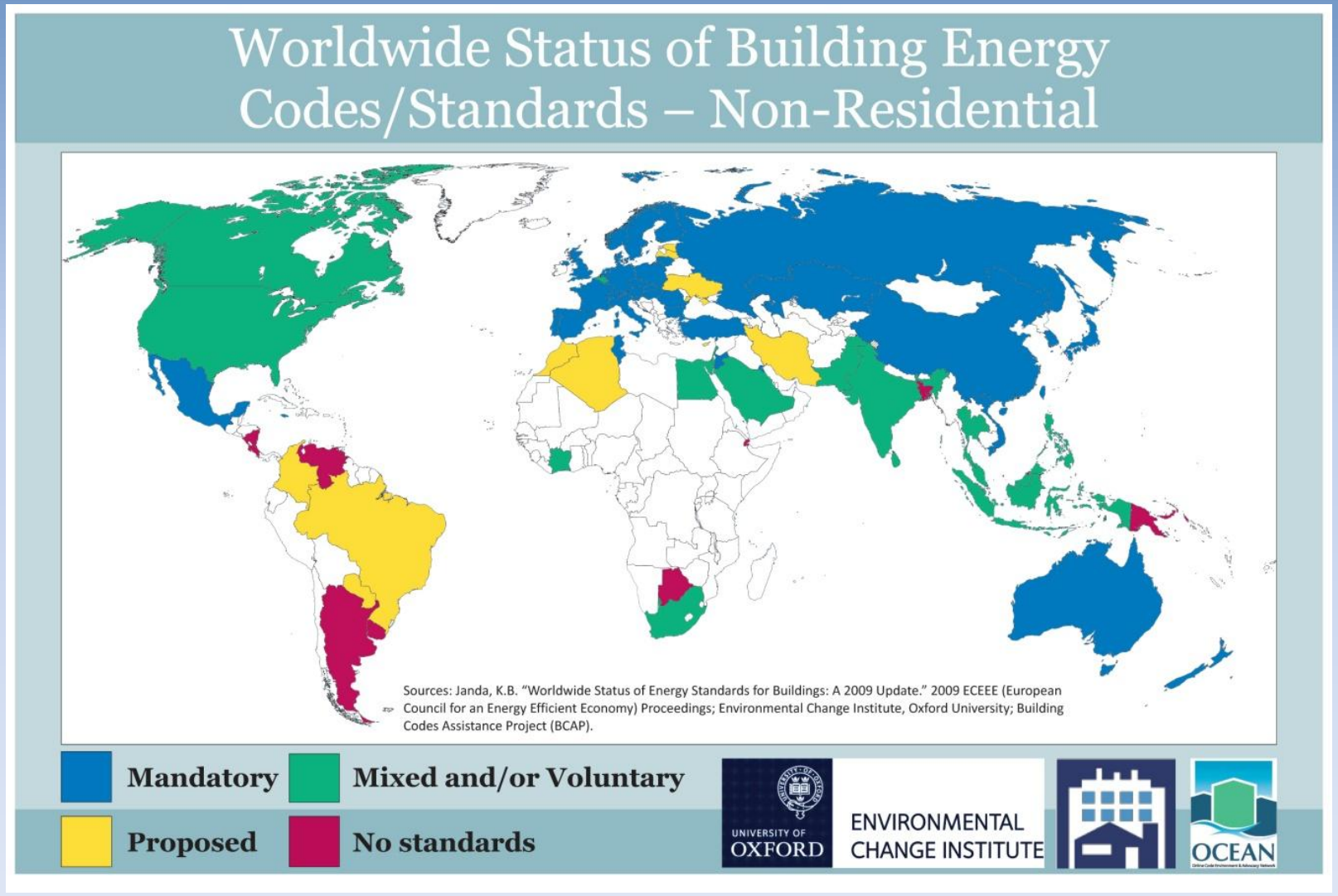
1994	15
2007	37

World Bank Region	Urban Population (Millions)		BEEC Status	Nature of Energy Demand
	2005	2030		
Sub-Saharan Africa	268	628	Voluntary BEECs in a few counties (Ivory Coast, South Africa,)	Mostly cooling demand
Middle East and North Africa	172	288	Mostly voluntary BEECs (Algeria, Egypt, Morocco, Tunisia)	Cooling demand
Europe and Central Asia	257	282	Mostly mandatory BEECs. (Armenia, Russia, Turkey, Ukraine)	Mostly heating demand,
Latin America and Caribbean	427	597	Mandatory BEECs in several countries (Chile, Jamaica, Mexico)	Mostly cooling demand
East Asia and Pacific	790	1337	Mandatory or voluntary BEECs in many countries (China, Mongolia, Thailand)	Mostly heating demand in NE Asia and cooling demand in SE Asia;
South Asia	433	858	Voluntary BEECs in a few countries (India, Pakistan,)	Mostly cooling demand

Much more so in cold-climate regions than in warm-climate regions, part 1



Much more so in cold-climate regions than in warm-climate regions, part 2



But there is a significant gap between code development and code compliance

Country	BEEC Compliance Situation (based on documented evidence)
Japan	In 2004, **1/3** of new residential buildings and **3/4** of new commercial buildings were deemed BEEC compliant.
England/Wales	A 2004 BRE study of new houses passed by building inspectors found that only **57%** of them were BEEC compliant.
United States	BEEC compliance rates in U.S. states range from less than **20%** to almost **100%**.
China	In 30 of the largest cities, **80%** of new buildings completed in 2008 were deemed BEEC compliant. The ratio is believed to be much lower in medium and small cities.

Source: Mainstreaming Building Energy Efficiency Codes in Developing Countries, forthcoming report, the World Bank

Reasons and attributes of noncompliance

Why is compliance mediocre?

- Lack of enforcement due to
  - Low priority placed on BEEC
  - Insufficient resources
  - Pressure from vested interests
- Knowledge gaps due to inadequate training and outreach efforts
  - Architects and designers
  - Builders
  - Third-party reviewers and inspectors
  - Consumers
- Inconsistency in interpretation and application of BEEC requirements; lack of standard protocols

California: Building Measure Noncompliance Estimates

Building Measure	Estimated Noncompliance rate
Residential	
Hardwired lighting	28%
Window replacement	68%
Duct improvement	73%
Nonresidential	
Lighting controls under skylights	44%
Cool roofs	50%
Bi-level lighting controls	n/a
Ducts in existing buildings	100%
Duct testing/sealing in new buildings	100%

Source: Statewide Codes and Standards, Market Adoption and Noncompliance Rates, 2007, Final Report CPUC Program No.1134-04 SCE0224.01

There are three basic institutional options for enforcement of BEECs

	Government Agency	Private Third Party	Self-certification to Owner or Public Agency
Key feature	Government agency wholly responsible	Certified private 3rd party held accountable	Compliance statement provided by builder
Support infrastructure	Government inspectors	Certified 3rd-party; trained officials for spot checking.	Verification of statement Certification of builder
Cost to government	High but recoverable from builder	Moderate	Low Moderate with certified builders
Cost to owner/ developer	Low unless agency charges	High	Low
Information and infrastructure needs	Trained government assessors	Trained private assessors Certification process	Energy certificates Officials for verification.
Noncompliance risk	Low, provided adequate funding	Low, if certification of 3rd party rigorous	High, unless owners care. Lower, if builders certified
Examples	United States: prevailing option	France, Mexico, China (with some public oversight)	Germany (to owner)

Source: Adapted from BRE (2008), p. 29 (based on Maine Public Utilities Commission (2004))

Key success factors of implementing BEECs in industrialized countries

- Government leadership at local, state, and national levels
- Adequate resources (fees, government budget, public utilities)
- Long history of incremental improvements
- Effective construction sector management and good governance in general

Dealing with construction permits (warehouse)

Region or Economy	Procedures (number)	Time (days)	Cost (% of income per capita)
East Asia & Pacific	18.6	168.6	139.6
Eastern Europe & Central Asia	22.6	264.2	536.9
Latin America & Caribbean	16.7	225	210.8
Middle East & North Africa	18.9	159.3	358.4
OECD	15.1	157	56.1
South Asia	18.4	241	2,310.6
Sub-Saharan Africa	17.3	260.5	1,955.6

Source: http://www.doingbusiness.org

Good practice in compliance enforcement: The City of Seattle, USA

- Seattle's BEEC compliance is practically universal.
- In 2005: 7,000 applications for plan review and 80,000 inspections.
- City Department of Planning and Development has 27 code officials, covering both general building code and BEEC.
- Plan review of multifamily and commercial projects is handled by specialized energy personnel, who also serve as a technical resource for other staff.
- Small residential projects and all construction inspections are handled by staff with similar specialties.
- On the job training for staff according to their specialties. Public workshops for architects, designers, and trade associations.
- Funding for BEEC review and inspection:
  - Initially, 20% of the overall building permit fee (0.5% of construction value, totaling US$10 million in 2005) to build up capacities and expertise for the new requirements
  - The publicly owned electric utility provides funds for additional BEEC compliance staff since Seattle's BEEC is 20% more stringent than Washington State's BEEC.
- Compliance is more likely when the same rules apply to everybody and requirements are enforced for everybody.

Emerging lessons of implementing BEECs from early-adopter developing countries

Lessons

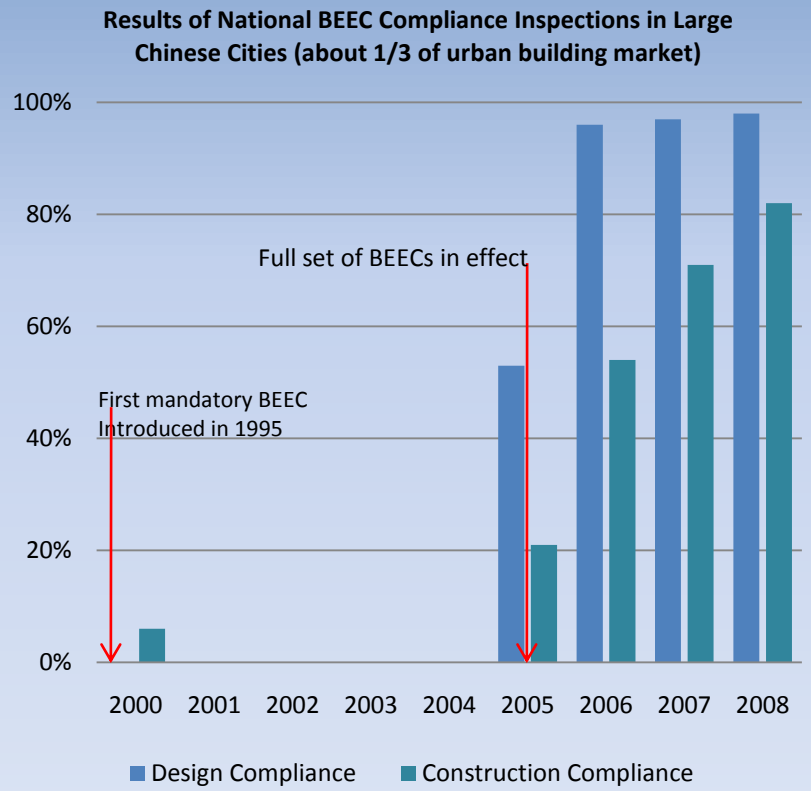
- It is a development issue, be practical
- It is a long journey, get organized and be persistent
  - Start early
  - Start simple and low cost
  - Start with a high impact market segment

Challenges

- Commitment to energy efficiency
- Construction sector management
- Market development and compliance capacity
- Incremental cost financing

China's efforts to increase BEEC compliance

Rapid improvement in recent years



Due to a convergence of critical factors

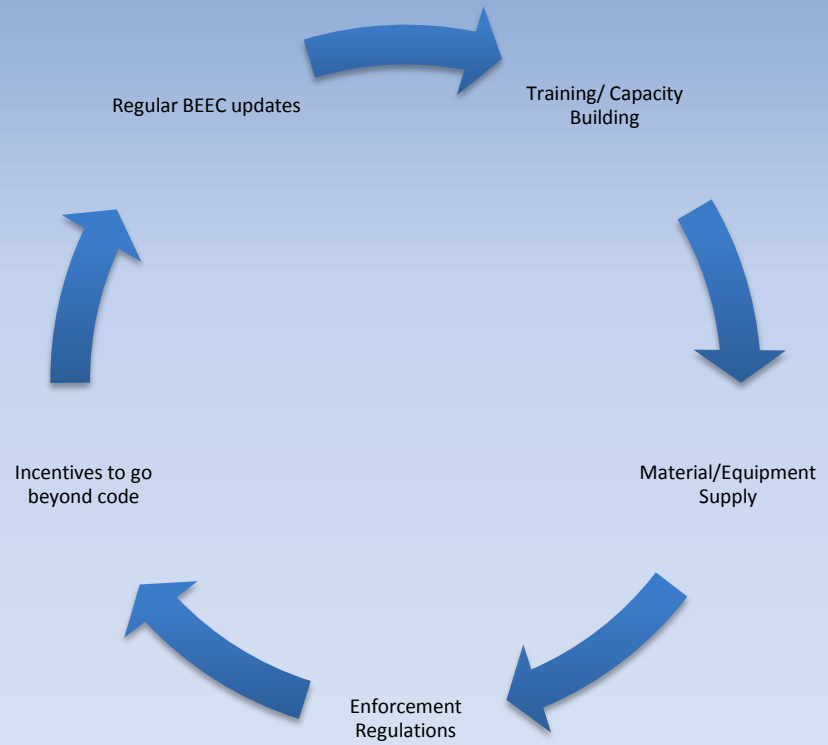
- *Governance of the urban building construction* has become more streamlined and transparent.
- The *system of BEEC compliance enforcement and procedures* has been improved and standardized.
- *Capacity of the construction industry* to meet the technical requirements of BEECs has become broad-based.
- *Quality building materials and components* for BEEC compliance have become widely available.
- The *ability to afford and willingness to pay* for the incremental costs of BEEC compliance have increased significantly.
- The *capacity and motivation of local governments to enforce BEECs* have been strengthened.

Market development and transformation

Four basic constraints must be addressed:

- Training and education of reviewers and inspectors
- Training and education of designers, engineers, and other construction trades
- Developing markets and necessary testing and certification capacity for materials and equipment
- Energy price signals and outreach to consumers

The virtual circle of incremental improvements:



Issues and options for reducing cooling load and energy in warm-climate developing countries

Issues

- Rapid growth in air conditioning demand
- Subsidized electricity in many countries
- Generally lagging in BEEC requirements and implementation, more so for residential buildings
- Changes in lifestyle and contrast between haves and have-nots

Options

- More efforts on strengthening mandatory AC equipment standards in the short to medium term
- Accelerating electricity pricing reform
- Quickly ramping up implementation of climate-appropriate BEECs
- Harnessing native concept of thermal comfort in building design and operation

Toward low-energy and green buildings
Fading role for BEECs?

Voluntary green building rating systems are a welcome market pull

- Green building rating systems could help address shortcomings of BEECs, which provide no incentives to improve beyond code requirements
- They should be encouraged and promoted by developing country governments
- Green building is a more complex undertaking than low-energy building

But they can not replace the role of mandatory BEECs

- Fundamental market failures and barriers require mandatory BEECs
- Government efforts and resources should focus on ensuring BEEC compliance
- Government must target policy instruments at clearly understood market failures and avoid overreaching

Key Messages

- Mandatory building energy codes are foundation for transforming the built environment toward energy sustainability
- Price incentives and market information are essential to achieving energy savings afforded by BEEC-compliant buildings
- Implementation of building energy codes is resource-intensive, takes time, and requires persistent government efforts
- Greater attention should be given to warm-climate developing countries where building energy codes are generally absent or not enforced
- New approaches must be adopted to make carbon financing and other clean technology financing mechanisms useful for mainstreaming building energy codes

Leverage financing for low-carbon growth for mainstreaming BEECs in developing countries

Middle and upper-middle income countries

- Examples: China, Mexico, Brazil, Russia, and South Africa
- Compliance cost is not likely a major barrier
- Focus on compliance and enforcement infrastructure for BEECs
- Help countries move quickly from voluntary to mandatory BEECs and reaching higher
- Explore opportunities for deep renovation of existing building stock

Low and lower-middle income countries

- Examples: India, Indonesia, Vietnam, and Egypt
- Compliance cost is likely a major barrier, especially for residential buildings
- Government oversight of building construction is likely to be weak
- Dual assistances to improving construction management and implementing suitable BEECs in targeted market segments
- Development of indigenous supply of materials and components

How Can the WBG Engage?

Tools and instruments

- **Trust funds:** ESMAP, ASTAE
- **GEF**: tried and learned
- **Carbon financing**: trying
- **CTF**: where to start?
- **IDA and IBRD**: possible through DPL?
- **IFC**: greening the supply chain; EE/green mortgages?

Engaging client countries

- **Country assistance strategy**: there is no escape of buildings if urban agenda is a centerpiece
- **Project/program development**: the need to work closely with national and local governments
- **Need proper incentives to managers and TTLs**: tedious and time-consuming work without large lending potential

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