Energy Efficiency in Buildings

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GTSP Technical Meeting
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Overview

• Where are we today?
  – Demand and policy

• Where are we going?
  – Reference scenario
  – Policy goals and plans
  – Technology development
Where are we today?

- Underlying trends re population, sprawl, services
- Lots of progress in efficiency compared to 30 years ago
- Lots of inefficiency still lingering (old stock, regions without much policy, etc.)
- Building stock turnover has big impact on current stock
Buildings account for 31% of global final energy use today. This share increases with the wealth of a country.
Some Challenges
New Construction and Building Energy Codes

- Energy codes increase likelihood of cost and energy savings (up to 50% in U.S.)
- Buildings last 30-50 years.
- Most cost-effective to install efficiency measures at construction
# History of Building Energy Standards

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Construction site inspection roles in China

- **Construction Company**: Quality control system
- **Construction Supervision Company**: Checks work onsite; orders tests; prepares documentation on compliance
- **Testing Labs**: Tests components from construction site
- **Quality Control and Testing Station**: Collects and reviews documentation; conducts periodic site inspections; prepares completion report
- **Developer**: Takes completion report to Construction Administration Dept.
- **Construction Administration Dept.**: Accepts and files documents; issues occupancy permit
Enforcement Monitoring in China

• Since 2005, MOHURD has conducted an annual inspection-based survey of building energy efficiency and mitigation in key Chinese cities across the country.
• A key component of the survey relates to enforcement of building energy codes. The selected cities are required to provide a complete inventory of the building projects submitted since the last survey.
• Local construction administration departments are scored based on the inspection results.
• Some provinces have conducted several provincial surveys on the enforcement of building energy codes annually since 2005.
U.S. Building Energy Codes Program

• Energy savings of nearly $1 billion per year
  – Improved energy efficiency for ~280 million m² of new commercial floor space and ~4 million new households

• By 2030:
  – Annual savings of $5.3 billion in energy costs for consumers
  – Annual reduction in carbon emissions of 13.2 MMton
California: Policy can have a measurable impact
Impacts pre-2001 programmes in CA

~ 14% of Annual Use in California in 2001

Utility Programs:
at a cost of ~1% of Electric Bill

Building Standards

Appliance Standards

Public Interest Energy Strategies – CEC #100-03-12F
Information: Impact of refrigerator labels in EU

**Energy Consumption kWh/year**
(Based on standard test results for 24h)

- **A+** 0-5
- **A** 5-10
- **B** 10-15
- **C** 15-20
- **D** 20-25
- **E** 25-30
- **F** 30-35
- **G** 35-40

**Actual consumption will depend on how the appliance is used and where it is located.**

**Fresh food volume I**
200

**Frozen food volume I**
80

**Noise (dB(A) re 1 pW)**
40

**Further information is contained in product brochures.**

- Norm EN 153 May 1990
- Refrigerator Label Directive 94/2/EC
Appliance standards force deployment of energy-efficient technology

For Top-Mount Auto-Defrost Refrigerator

- 1990 standard
- 1993 standard
- 2001 standard

- 1989 models (before standards)
- 1993 models
Example: US DOE Sub-CFL Procurement

- 1998-1999
- No subsidies
- Addressed two market barriers: price and size
- Two products already in the market met specifications
- Two RFPs issues for two phases; Multiple awards
- New products entered the market during both phases
National Account Partnerships

- DOE national labs teamed with 23 companies to:
  - Build **one new building at 50% less energy** than ASHRAE Standard 90.1.
  - Retrofit at least **one existing building at 30% less energy**.

- Labs provide technical assistance to biggest names in retail, commercial real estate, and financial sectors.
Where are we going?

- Reference scenario
- Policy goals and metrics
- Technology development
Reference Scenario: Growth in Demand

Building Total Final Energy by Region

CO2 Emissions from Building Energy Demand
Share of Demand/Emissions Shifts to Developing World

Building-Related CO2 Emissions, 2005 (MTCO2)

- OECD Asia
- North America
- Latin & South America
- Africa
- Europe
- Former Soviet Union
- Middle East
- India
- China
- Southeast Asia

Building-Related CO2 Emissions, 2095 (MTCO2)

- OECD Asia
- North America
- Latin & South America
- Africa
- Europe
- Former Soviet Union
- Middle East
- India
- China
- Southeast Asia

Joint Global Change Research Institute

Pacific Northwest National Laboratory

University of Maryland
Policy Goals: Building Energy Codes

- U.S.: zero net energy residential codes by 2025, 30% efficiency improvements in ~2010
- UK: zero carbon building regulations by 2016
- China: 50-65% efficiency improvement
- Russia: 40% improvement by 2020
- Denmark: further 25% efficiency improvements in code in both 2010 and 2015
- Germany: 30% improvement in 2009 code
U.S. Building Technologies Goal

Net-Zero Energy Buildings by 2025 (and in code by 2030)
Net-Zero Energy Homes by 2020 (and in code by 2025)
Low incremental cost

The American Recovery and Reinvestment of 2009 offers states additional funding if they adopt new codes and develop a plan for achieving 90% compliance within 8 years.
Net-Zero Energy Commercial Building Initiative

- Public-private partnerships to achieve continuous technology improvement and commercialization of advanced building technologies at an accelerated pace
- Aim is to enable market-ready net-zero energy commercial buildings no later than 2025 in all climate zones
- Technology examples: HVAC package, supermarket refrigerators, daylighting

Net-Zero-Energy Commercial Buildings:

Grid-integrated buildings capable of generating as much energy as they consume through advanced efficiency technologies and on-site generation systems such as solar power and geothermal energy.
How a Cool Roof Works

凉屋顶的原理

The sun’s radiation hits the roof surface.

Solar Reflectance: the fraction of solar energy that is reflected by the roof.

Thermal Emittance: the relative ability of the roof surface to radiate absorbed heat.

Some heat is absorbed by the roof and transferred to the building below.
Next Generation of Windows

• Highly Insulating
  – Goal U value 0.10 (SI U value 0.56)
  – Possible vacuum glazings

• Dynamic solar control
  – Passive heating
  – Dramatic peak cooling reduction
  – Market ready, prices will drop with more investment

Prototype – Concept Window
(Highly Insulating and Dynamic U Value 0.18 (SI U value 1.0)
SHGC 0.04 – 0.34)
Low cost unsealed center lite
Whole Building Design Guide
R&D in China, India and Russia

• Significant increase in funding for building efficiency R&D in past decade
• Relevant technologies → Faster deployment
• Focal areas: lighting, solar, heat pumps, fans, envelope, deployment strategies
• New pathways for commercialization, especially in China
Conclusions

• Substantial, highly cost-effective opportunities for improvements in building energy efficiency
• More and more aggressive policies to address
• New technologies coming on line at low cost, new features
• But population increasing, demand for space and services increasing
• So what are reasonable assumptions for the future?

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