Energy Efficiency for Buildings

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Building Energy Demand Challenge: End Use Energy Consumption

Buildings consume 39% of total U.S. energy
- 71% of electricity and 54% of natural gas

- Industry 33%
- Transportation 28%
- Buildings 39%
- Commercial 18%

- Residential 21%

- Cooking 5%
- Electronics 5%
- Wash 5%
- Refrigeration 9%
- Cooling 10%
- Lights 12%
- Water Heat 13%
- Heating 32%
- Other 4%

- Cooking 2%
- Computers 3%
- Refrigeration 4%
- Office Equipment 7%
- Ventilation 7%
- Water Heat 7%
- Cooling 13%
- Heating 16%
- Lights 28%
- Other 10%
Energy Efficiency Offers Low or No-Cost Carbon Reduction Options

Global cost curve for greenhouse gas abatement measures beyond ‘business as usual’; greenhouse gases measured in GtCO₂e¹

Approximate abatement required beyond ‘business as usual,’ 2030

Component by component analysis (e.g., “insulation”) understates value of “whole-building” systems approach

Source: McKinsey Global Institute, 2007

¹ GtCO₂e = gigaton of carbon dioxide equivalent; “business as usual” based on emissions growth driven mainly by increasing demand for energy and transport around the world and by tropical deforestation.
² tCO₂e = ton of carbon dioxide equivalent.
³ Measures costing more than €40 a ton were not the focus of this study.
⁴ Atmospheric concentration of all greenhouse gases recalculated into CO₂ equivalents; ppm = parts per million.
⁵ Marginal cost of avoiding emissions of 1 ton of CO₂ equivalents in each abatement demand scenario.
The three levers to improve energy efficiency for buildings

Life-cycle Processes & Methods

Building Technologies & Materials
e.g., smart glazing

e.g., 3D model + Energy Plus

e.g., EISA 2007

Policies
How to address energy efficiency for buildings

- Should a building be built or retrofitted?
- Where should the building be built?
- How does energy efficiency relate to the building’s business purpose?
- How should the building and its program be oriented on site?
- What is the best envelope for the building?
- What is the best energy system?
- What are the best materials?
- How should energy be managed over the building’s lifecycle?
- How should the user and other important stakeholders be informed?
- How can we document and learn about the process, decisions, and systems used?
- What are the tradeoffs with other sustainability goals?
Some current issues and questions

• Buildings are rarely built as designed
  – Malmö: Non-tight buildings hinder sustainability goals

• Buildings are rarely used as assumed by the designers
  – Occupancy, plug loads

• What to measure during building design, construction, commissioning, operation
  – Too much, too little data
  – Methods to handle, make sense of data in building life-cycle context
Comparing actual with predicted use

Space level

System level

Component level

Value

Cost

Intervention

relate

aggregate

compare

Data from Global Ecology Building