Clean Energy Solutions Center
IEA Technology Roadmap: Energy Efficient Building Envelopes Launch

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International Energy Agency

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6°C Scenario – business-as-usual; no adoption of new energy and climate policies

2°C Scenario - energy-related CO₂-emissions halved by 2050 through CO₂-price and strong policies

ETP 2014 – Expected April 2014
Final Energy Consumption by Sector and Buildings Energy Mix, 2010

Buildings largest end-use sector!!
Importance of Building’s Sector

- 1/3 global carbon emissions
- 50% of electricity consumption
- Major portion of GDP, global economic crisis and decline was spurred by building sector collapse in many regions of the world
- Over 75% to 90% of OECD building stock will still be in service by 2050
- Large population growth, mostly in developing world (2.5 billion by 2050), will drive new floor area that needs to be efficient
The overall ETP strategy for buildings

Global and regional analysis, energy savings and emissions reduction forecasts

Technical opportunities and recommendations: envelope; heating and cooling; appliances, lighting and cooking

Policies to transform buildings
Technology Roadmaps and Policy Pathways

Technology Roadmaps
- Define and analyse available technologies
- Develop vision for R&D and technology deployment
- Assess policy, financial, and related needs

Policy Pathway
- Based on one of 25 IEA energy efficiency recommendations
- 10 step guide for policy planning, implementation, monitoring and evaluation
- Highlights best experience in countries
Technology Roadmap
Energy Efficient Building Envelopes

- Construction transformation strategy
- Provides technical, economic and strategic framework
- Assessment of high priority areas for 12 regions of the world
- Policy criteria and evaluation
Transformation to Low-Energy Buildings

Transforming construction to low energy buildings

Inefficient – still common and old stock
- Single pane windows.
- No insulation.
- High air leakage.

Typical building code in advanced regions
- Low-e double glaze windows.
- High levels of insulation.
- Low air leakage.

Zero-energy buildings
- Highly insulated windows and dynamic solar control.
- Optimised designs and orientations.
- Daylighting.

KEY POINT: the world needs to shift from very old buildings to modern buildings, and then to low-energy or zero-energy buildings.
Figure 8: Energy reductions from improvement in building envelopes between the 6DS and 2DS

KEY POINT: Building-envelope energy savings under the 2DS are significant, with heating savings around four times higher than cooling savings.
Insulation Opportunity

- Very stringent U-values for electric resistance heaters in Sweden, and Canada’s coldest climate zone
- IEA recommending goal for average wall and roof U-values ≤ 0.15 W/m²K cold climate, ≤ 0.35 W/m²K hot climate based on LCC


KEY POINT: levels of insulation vary widely for the existing stock of buildings, as well as for new construction.
Validated Air Sealing

- Validated air sealing is a critical measure for building codes and renovation
- Majority of energy performance certificates do not require validation
- More research needed to offer more affordable testing and solutions (mostly for developing markets)

Source: Oak Ridge National Laboratory
Figure 3: Most common types of windows in service and being sold today

Majority of world’s stock of windows

<table>
<thead>
<tr>
<th>Type</th>
<th>U-values (W/m²K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single glaze clear, non-metal frame</td>
<td>6.0</td>
</tr>
<tr>
<td>Double glaze clear, aluminum frame</td>
<td>5.0</td>
</tr>
<tr>
<td>Double glaze clear, wood frame</td>
<td>4.0</td>
</tr>
<tr>
<td>Double glaze low-e, low conductive frame</td>
<td>2.5</td>
</tr>
<tr>
<td>Triple glaze, double low-e, low conductive frame</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Recommendations

- World
  - Typical code in cold climates
  - Cold climate
    - Niche markets, cold climates

Note: U-values presented in this roadmap represent whole-window performance unless noted in accordance with ISO 15099, thus an ISO 10077 standard of 1.0 W/m²K is roughly equal to 1.1 W/m²K per ISO 15099.

KEY POINT: the majority of the world’s installed windows can be significantly improved and more work is needed to ensure that new sales meet more stringent performance criteria.
### Reflective Roof Opportunity

**Table 3: Performance characteristics and energy-savings potential for reflective roofs**

<table>
<thead>
<tr>
<th>Roof performance characteristics</th>
<th>SR of a dark roof</th>
<th>SR of a white roof</th>
<th>SR of a cool-coloured roof</th>
<th>Roof energy-saving potential (with high level of insulation)</th>
<th>Roof energy-saving potential (with low level of insulation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SR 5 (black) to SR 20 (grey)</td>
<td>SR 60 (soiled)</td>
<td>SR 25 (darker colour) to SR 50 (lighter colour)</td>
<td>13%</td>
<td>25%</td>
<td></td>
</tr>
</tbody>
</table>

Notes: High insulation refers to a U value of 0.29 W/m²K, and low level of insulation has a U value of 0.51 W/m²K or higher.

**Source:** LBNL, Heat Island Group
### Assessment of Advanced Envelope Components

<table>
<thead>
<tr>
<th>Market maturity/saturation</th>
<th>ASEAN</th>
<th>Brazil</th>
<th>China</th>
<th>European Union</th>
<th>India</th>
<th>Japan/Korea</th>
<th>Mexico</th>
<th>Middle East</th>
<th>Australia/New Zealand</th>
<th>Russia</th>
<th>South Africa</th>
<th>United States/Canada</th>
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<tbody>
<tr>
<td>Double-glazed low-e glass</td>
<td>✢</td>
<td>✢</td>
<td>✢</td>
<td>✢</td>
<td>✢</td>
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<td>Window films</td>
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<tr>
<td>Window attachments (e.g. shutters, shades, storm panel)</td>
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<td>Highly insulating windows (e.g. triple-glazed)</td>
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<td>Typical insulation</td>
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<td>Exterior insulation</td>
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<td>Advanced insulation (e.g. aerogel, VIPs)</td>
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<td>Cool roofs</td>
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<td>BIPV/advanced roofs</td>
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</table>

- ✢ Mature market
- ✢ Established market
- ✢ Initial market
Integrated Approach with Life-Cycle Cost

LCC analysis of efficiency options

- Base case
- Heating only
- Envelope only
- Integrated (no reduction in heating equipment)
- Integrated with smaller heating equipment

Energy savings (%)

LCC(USD)
R&D Areas

- Highly insulated windows (U value ≤ 0.6 W/m²K for ZEB) and dynamic solar control - integrated solution increase daylight and passive heating harvesting
- Lower air sealing approaches with validation testing
- Lower cost high performance “thin” insulation
- More durable and lower cost reflective surfaces

Source: Sage Electrochromics (St Gobain)  
Source: Aspen Aerogel  
Source: ORNL
## Criteria for Policy Assessments, IEA Perspective

<table>
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<th>Policies</th>
<th>ASEAN</th>
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Note: H: high, M: medium, L: low
Tracking Progress – Next Steps

- Much more data is needed (e.g. new technology adoption rates, market share of zero-energy buildings, etc)
- More specific performance criteria needed even for most advanced regions (e.g. EU specifications for renovation in public buildings)
- IEA is considering a new building’s partnership (for policy assessment, to improve data and modeling, and to enable deployment)
Key Focus for Action

- Greater deployment of proven technology in developed countries
- Introduction of mature products and technologies to developing markets (e.g. infrastructure – skills, product availability, performance metrics, etc)
- R&D to improve performance, reduce cost and provide greater overall return on investment
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Download Roadmap after launch
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