Buildings: how far can they take us in mitigating climate change?

Diana Ürge-Vorsatz
director

Construction counts for climate
Side Event, COP 15, Copenhagen
Dec. 11, 2009
Key messages

- Buildings are (the?) key to reaching ambitious mitigation targets...
- ...but they can also lock us into high(er) GHG concentration levels for many decades
  - more focus on retrofit is needed
  - Suboptimal retrofits (and new construction) are a major climate risk
- Building energy-efficiency may also have the largest co-benefits among mitigation options
Buildings are key in climate change mitigation
Buildings sector: regional importance

In 2030: the share of building-related emissions in global will stay at approximately 1/3 of energy-related CO2 emissions including through the use of electricity, A1B scenario.
The buildings sector offers the largest low-cost potential in all world regions by 2030.
How far can buildings take us?

Recent research advances

Plus energy house settlement, Weiz, Arch. Erwin Kaltenegger
Few sectors can deliver the magnitude of emission reduction needed

- know-how has recently developed that we can build and retrofit buildings to achieve 60 – 90% savings as compared to standard practice in all climate zones (providing similar or increased service levels)
Buildings utilising passive solar construction ("PassivHaus")

Source: Jan Barta, Center for Passive Buildings, www.pasivnidomy.cz
Few sectors can deliver the magnitude of emission reduction needed

- Know-how has recently developed that we can build and retrofit buildings to achieve 60 – 90% savings as compared to standard practice in all climate zones (providing similar or increased service levels)

- Novel methods developed for mitigation potential assessment that considers buildings as complex systems rather than independent sums of components

- New scenarios are constructed under the Global Energy Assessment, with co-funding from UNEP SBCI, that reflect this new approach

Photos from Gunter Lang
Final thermal energy consumption in the world’s buildings, 2005-2050

Using state-of-the-art and cost-effective construction know-how

Work in progress – do not cite or quote

Exact numbers still changing

-55%
Opportunity or risk?

The size of the potential lock-in effect

CENTER FOR CLIMATE CHANGE AND SUSTAINABLE ENERGY POLICY

CENTRAL EUROPEAN UNIVERSITY
Before

-84%
The lock-in effect
Final OECD thermal energy consumption
State-of-the-art vs. suboptimal retrofits

TWh/yea

6000
5000
4000
3000
2000
1000
0


Work in progress – do not cite or quote
Exact numbers still changing
The lock-in effect, case study
Heating energy use in Hungarian public buildings

Source: Katarina Korytarova, draft dissertation, 2009

The lock-in effect, case study
Heating energy use in Hungarian public buildings

Source: Katarina Korytarova, draft dissertation, 2009
Perhaps the largest co-benefits among mitigation options

**selected highlights**

- (local) job creation: Danish study finds twice higher employment intensity than for other mitigation options
- Health: up to 2 million die due to poor indoor air quality
- Health: better buildings reduce flu by up to 20%, resulting in EUR 10 bln/yr savings in US alone
“From today, each new building constructed in an energy-wasting manner or retrofitted to a suboptimal level will lock us into a high climate-footprint future”
Thank you for your attention

Diana Ürge-Vorsatz Diana
Center for Climate Change and Sustainable Energy Policy (3CSEP), CEU

http://3csep.ceu.hu  www.globalenergyassessment.org

Email: vorsatzd@ceu.hu
Supplementary slides
Az üvegházhatású gázok mérséklésének 2030-ra becsült szektoronkénti potenciálja különböző költségkategóriákban, átmeneti gazdaságokban

* Az épületek, erdészeti, hulladék és közlekedés területein 3 kategóriába van osztva a potenciál: negatív nettó költség, 0-20 US$/tCO₂ és 20-100 US$/tCO₂. Az ipar, mezőgazdaság és energiaellátás területein 2 kategóriába van osztva: 20 US$/tCO₂ alatt és 20-100 US$/tCO₂.
## Quantified non-energy benefits of building energy-efficiency programs (1/5)

<table>
<thead>
<tr>
<th>Co-benefits</th>
<th>Country/region</th>
<th>Methodology</th>
<th>Impact of CO₂ emission reduction</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Physical indicator</td>
<td>Monetary indicator</td>
</tr>
<tr>
<td>Quantifiable health effects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Morbidity reduction | USA, New Zealand, Denmark | • A double-blind, multiple crossover intervention  
• Initial self-completed background questionnaires; then shorter weekly questionnaires assessing the outcomes  
• Environmental measurements  
• Statistical analysis  
• Cost-benefit analysis  
• Literature review  
• Authors’ adjustment/estimates | USA: A drop of concentration of the smallest airborne particles by 94% resulted in a decrease of confusion scale by 3.7%, fatigue scale by 2.5%, the feeling of “stuffy” air by 5.3%, of “too humid” by 7.0%, of “too cold” by 5.5% and “too warm” by 3.5%. 
USA: Cooler temperatures within the recommended comfort range resulted in a decrease of the chest tightness by 23.4% per each 1°C decrease. 
Denmark: Better thermal air quality led to better concentration of 15% of respondents and a 34% decrease “sick building syndrome” cases. | Mendell et al. 2002; Milton et al. 2000; Schweitzer and Tonn 2002; Wyon 1994; Stoecklein and Scunzat 2007; Fisk 1999; Fisk 2000a |
| Mortality reduction | Hungary; USA, Ireland, Norway | • Bottom-up study (with Monte Carlo simulation)  
• Statistic time-series analysis: semi-parametric log-linear model, a weighted 2-stage regression  
• Analysis of mortality statistics with a population of a similar country as the control group | USA: Every 10 g/m³ increase in ambient particulate matter (the day before deaths occurred) brings a 0.5% increase in the overall mortality. 
Ireland, Norway: The share of excess winter mortality attributable to poor thermal housing standards is 50% for cardiovascular disease and 57% for respiratory disease. | Aunan et al. 2000; Samet et al. 2000; Clinch and Healy 1999 |

USA: Improved ventilation may result in net savings of EUR 302/employee-yr. that on a national scale represents productivity gain of EUR 17 billion/yr.
USA: NPV** over the lifetime of improved ventilation can reach as high as EUR 1.57/bhp.
USA: Better ventilation and indoor air quality reduce influenza and cold by 9-20% (ca 16-37 million cases) that translates into savings of EUR 4.5-10.6 billion/yr.
New Zealand: Health benefits due to a weatherization program amount to EUR 35/hh-yr. or 18.5% of the total annual energy savings of a household.
Hungary: Energy saving program resulted in the total health benefit of EUR 489 million/yr. due to a decrease of chronic respiratory diseases and premature mortality.
Ireland, Norway: A total mortality benefit of a hypothetical thermal-improving program is EUR 1.5 billion (undiscounted) for a study in the left column.
Quantified non-energy benefits of building energy-efficiency programs (2/5)

<table>
<thead>
<tr>
<th>Co-benefits</th>
<th>Country/region</th>
<th>Methodology</th>
<th>Impact of CO₂ emission reduction</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental (ecological) co-benefits</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General environmental benefits</td>
<td>New Zealand</td>
<td>Direct computation</td>
<td>NZ: Benefits to the environment gained after the weatherization program amount to EUR 44/hh.-yr. in 2007 that accounts for around 18.7% of the total annual energy expenditures saved</td>
<td>Stoecklein and Scumatz 2007</td>
</tr>
</tbody>
</table>
|                                                  |                | Willingness to pay/to accept, contingent valuation, other survey-based methods                             | US: A sample considered a reduction of concentration of the smallest airborne particles by 94% US: The reduction in the emission/yr. of a green school as compared to the average practice:  
- 1,200 pounds of NOx - a principal component of smog  
- 1,300 pounds of SO2 - a principal cause of acid rain  
- 585,000 pounds of CO₂ - GHG and the principal product of combustion  
- 150 pounds of coarse particulate matter (PM10) – a principal cause of respiratory illness and an important contributor to smog. | Mendell et al. 2002; Kats 2005 |
| Cleaner indoor air                               | USA            | Literature review                  | USA: NPV of reduction in fish impingement over the lifetime of weatherization measures is EUR 17.6/hh. | Schweitzer and Tonn 2002 |
|                                                  |                | Data analysis                      |                                                                                                  |                         |
| Fish impingement                                 | USA            | Literature review                  | USA: NPV of reduction in waste water and sewage over the lifetime of weatherization measures is EUR 2.6 – 495.3/hh. | Schweitzer and Tonn 2002 |
|                                                  |                | Authors’ adjustment/estimates     |                                                                                                  |                         |
| Waste water and sewage                           | USA            | Literature review                  | USA: Construction and demolition diversion rates are 50-75% lower in green buildings (with the maximum of 99% in some projects) as compared to an average practice  
USA: A sample of 21 green buildings submitted for certification, 81% of such buildings reduced construction waste by at least 50%, 38% of such buildings reduced construction waste by 75% or more | SBTF 2001; Kats 2005    |
|                                                  |                | Authors’ adjustment/estimates     |                                                                                                  |                         |
| Construction and demolition waste benefits       | USA            | Statistical analysis              | USA: The study in the left column results in NPV EUR 0.4/ft² (~EUR 0.037/m²) over 20 yr.  
USA: NPV of air emission reduction (CO₂, SO₂, NOₓ, CO, CH₄, PM) over lifetime of the measures is (all in thousand EUR/hh.: a) from natural gas burning 30.2 - 37.7; b) from electricity consumption EUR 118-185; c) air emissions of heavy metals is 0.75-12.8 | Schweitzer and Tonn 2002; Kats 2005 |
| Reduction in air pollution (indoor + outdoor)    | USA            | Literature review                  | USA: A green school emits 544 kg of NOₓ, 590 kg of SO₂, 265 tonnes of CO₂, 68 kg of coarse particulate matter (PM10) less in comparison with the average practice |                         |
|                                                  |                | Authors’ adjustment/estimates     |                                                                                                  |                         |
|                                                  |                | Statistical analysis              |                                                                                                  |                         |
Quantified non-energy benefits of building energy-efficiency programs (3/5)

<table>
<thead>
<tr>
<th>Co-benefits</th>
<th>Country/region</th>
<th>Methodology</th>
<th>Impact of CO₂ emission reduction</th>
<th>Physical indicator</th>
<th>Monetary indicator</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic co-benefits and ancillary financial impacts</td>
<td>USA</td>
<td>• NPV analysis with a 7% DR over 20 years</td>
<td>USA: Efficiency-driven reductions in demand results in a long-term energy price decrease equal to 100% to 200% of direct energy savings; assuming the indirect price impact of 50% over 20 years from an efficient school design, the impact of indirect energy cost reduction for new and retrofitted schools has NPV EUR 0.21/m²</td>
<td></td>
<td></td>
<td>Kats 2006; Wiser et al. 2005; O'Connor 2004; Platts Research &amp; Consulting 2004</td>
</tr>
<tr>
<td>Indirect secondary impact from reduced overall market demand and resulting lower energy prices market-wide</td>
<td></td>
<td>• Literature review</td>
<td>USA: 1% decrease of the national natural gas demand through energy efficiency and renewable energy measures leads to a long-term wellhead price reduction of 0.8% - 2%; the indirect monetary savings from this price decrease amounted to 90% of the direct monetary savings that it EUR 14.6 million for all customers (cumulative 5-year impact, 1998-2002, over June-September peak hours) USA: 1% reduction in natural gas demand result in a 0.75-2.5% reduction in the long-term wellhead prices.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enhanced learning in 'greened' buildings</td>
<td>USA</td>
<td>• Review of the financial benefits of education</td>
<td>Better environmental condition lead to enhanced learning abilities; a 3-5% improvement in learning and test scores is equivalent to a 1.4% lifetime annual earnings increase; an increase in test scores from 50% to 84% is associated with a 12% increase in annual earnings.</td>
<td></td>
<td></td>
<td>Hanushek 2005</td>
</tr>
<tr>
<td>Employees' retention: avoided reduced-activity days</td>
<td>USA, The State of Washington, Ireland</td>
<td>• Statistical analysis</td>
<td>USA: The improved quality of schools increases teacher retention by 3% USA/The State of Washington: &quot;Greening&quot; schools could bring 5%/yr. of improvement in teacher retention</td>
<td></td>
<td></td>
<td>Buckley et al. 2005; Kats 2005; Paladino &amp; Company 2005; Clinic and Healy 2001</td>
</tr>
<tr>
<td>Improved productivity</td>
<td>USA</td>
<td>• Case studies on documented productivity gains</td>
<td>USA: In well day-lighted buildings: labor productivity rises by about 6–16%, students' test scores shows ~20–26% faster learning, retail sales rise 40%. USA: Students with the most day-lighting show 20% - 26% better results than those with the least day-lighting USA: The ventilation rates less than 100%</td>
<td></td>
<td></td>
<td>Lovins 2005; Fisk 2000a; Fisk 2000b; Heschong Mahone Group 1999; Federspiel 2002; Menzies</td>
</tr>
</tbody>
</table>

Ireland: The annual value of the morbidity benefits of the energy efficiency program is EUR 58 million excl. reduced-activity days and EUR 66.6 million incl. them.
### Quantified non-energy benefits of building energy-efficiency programs (4/5)

<table>
<thead>
<tr>
<th>Co-benefits</th>
<th>Country/region</th>
<th>Methodology</th>
<th>Impact of CO₂ emission reduction</th>
<th>Monetary indicator</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>analysis of student performance data</td>
<td>outdoor air and temperature higher than 25.4°C result in lower work performance</td>
<td>minutes/day) is equal to ~EUR 754/employee-yr. or EUR 0.35/m²-yr.</td>
<td>1997; Kats 2003; Pape 1998; Shades of Green 2002</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Log-linear regression model</td>
<td>Canada: A new ventilation system improved the productivity of co-workers by 11% versus reduced productivity by 4% in a control group.</td>
<td>USA: More comfortable temperature and lighting results in productivity increase by 0.5% - 5%; considering only U.S. office workers, such a change translates into an annual productivity increase of roughly EUR 15 – 121 billion.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Statistical analysis</td>
<td>USA: After building retrofitting, absenteeism rates dropped by 40% and productivity increased by more than 5%; after moving to a retrofitted facility two business units monitored 83% and 57% reductions in voluntary terminations versus a control group with 11% reduction in voluntary termination of employment</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Questionnaire</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• NPV analysis with a 7% DR over 20 years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avoided unemployment</td>
<td>USA</td>
<td>• Literature review</td>
<td>NPV of avoided unemployment over the lifetime of weatherization measures is EUR 0 – 137.9/hh.</td>
<td></td>
<td>Schweitzer and Tonn 2002</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Authors’ adjustment and calculations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower bad debt write-off</td>
<td>USA</td>
<td>• Literature review</td>
<td>NPV of lower bad debt write-off over the lifetime of weatherization measures is EUR 11.3 – 2,610 /hh.</td>
<td></td>
<td>Schweitzer and Tonn 2002</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Authors’ adjustment/estimates</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employment creation</td>
<td>USA</td>
<td>• NPV analysis with a 7% DR over 20 years</td>
<td>USA: Green schools create more jobs than conventional schools: the long-term employment impact of increased energy efficiency may provide EUR 0.21/m² of benefits</td>
<td>USA: NPV of direct and indirect employment creation over the lifetime of the measures is EUR 86.7 – 3.2 thousand/hh. (note: this benefit occurs only one time in year weatherization is performed)</td>
<td>Kats 2005; Schweitzer and Tonn 2002; O'Connor 2004; Kats 2005</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Literature review</td>
<td>USA: Energy efficiency investment of EUR 85.2 million in the Massachusetts economy in 2002 created 1780 new short-term jobs; in addition, lowered energy bills for participants and for Massachusetts resulted in additional spending, creating 315 new long-term jobs; energy efficiency jobs added EUR 104.8 million to the gross state product, including EUR 48.2 million in disposable income (in 2002 in Massachusetts)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Authors’ adjustment/estimates</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Statistical assessment of the 5-year the energy efficiency programs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rate subsidies avoided</td>
<td>USA</td>
<td>• Literature review</td>
<td>NPV of avoided rate-subsidies over the lifetime of weatherization measures is EUR 4.5 – 52.8 /hh.</td>
<td></td>
<td>Schweitzer and Tonn 2002</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Authors’ adjustment/estimates</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>National energy security</td>
<td>USA</td>
<td>• Literature review</td>
<td>NPV of enhanced national energy security over the lifetime of weatherization measures is EUR 56.5 – 2,488/hh.</td>
<td></td>
<td>Schweitzer and Tonn 2002</td>
</tr>
</tbody>
</table>
Quantified non-energy benefits of building energy-efficiency programs (5/5)

<table>
<thead>
<tr>
<th>Co-benefits</th>
<th>Country/region</th>
<th>Methodology</th>
<th>Impact of CO₂ emission reduction</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmission and distribution loss reduction</td>
<td>USA</td>
<td>Literature review; Authors’ adjustment/estimates</td>
<td>USA: NPV over the lifetime of weatherization measures installed ranges EUR 24.9 – 60.3/hh.</td>
<td>Schweitzer and Tonn 2002</td>
</tr>
<tr>
<td>Fewer emergency gas service calls</td>
<td>USA</td>
<td>Literature review; Authors’ adjustment/estimates</td>
<td>USA: NPV of fewer emergency gas service calls over the lifetime of weatherization measures is EUR 29.4 – 151.5/hh.</td>
<td>Schweitzer and Tonn 2002</td>
</tr>
<tr>
<td>Utilities’ insurance savings</td>
<td>USA</td>
<td>Literature review; Authors’ adjustment/estimates</td>
<td>USA: NPV of utilities insurance cost reduction over the lifetime of weatherization measures is EUR 0 – 1.5/hh.</td>
<td>Schweitzer and Tonn 2002</td>
</tr>
<tr>
<td>Decreased number of bill-related calls</td>
<td>New Zealand</td>
<td>Direct computation; Willingness to pay, willingness to accept, contingent valuation and other survey-based methods</td>
<td>Bill-related calls became less frequent after the implementation of weatherization program, which amounted savings of NZ$30 (~EUR 15.9/hh-yr.) that is 7% of the total saved energy costs</td>
<td>Stoecklein and Scumatz 2007</td>
</tr>
</tbody>
</table>

Social co-benefits

<table>
<thead>
<tr>
<th>Co-benefits</th>
<th>Country/region</th>
<th>Methodology</th>
<th>Impact of CO₂ emission reduction</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved social welfare and poverty alleviation</td>
<td>UK</td>
<td>Survey monitoring the impact of energy company schemes which were set up to fuel poverty</td>
<td>UK: Energy efficiency schemes applied to 6 million households in January-December 2003 resulted in the average benefit of EUR 12.7/hh-yr.</td>
<td>DEFRA 2005</td>
</tr>
<tr>
<td>Safety increase; fewer fires</td>
<td>USA</td>
<td>Literature review; Authors’ adjustment/estimates</td>
<td>USA: NPV over the lifetime of the measures installed is EUR 0 - 418 /hh.</td>
<td>Schweitzer and Tonn 2002</td>
</tr>
<tr>
<td>Increased comfort</td>
<td>Ireland; New Zealand</td>
<td>A computer-simulation energy-assessment model; Direct computation; Willingness to pay, willingness to accept, contingent valuation and other survey-based methods</td>
<td>Ireland: A household temperature once the energy efficiency program has been completed increased from 14 to 17.7 °C. The analysis showed that comfort benefits peak at year 7 and then decline gradually until year 20.</td>
<td>Clinch and Healy 2003; Stoecklein and Scumatz 2007.</td>
</tr>
</tbody>
</table>
Example of savings by reconstruction

Before reconstruction

Reconstruction according to the passive house principle

-90%

over 150 kWh/(m²a)

15 kWh/(m²a)

What is a sustainable level of retrofit?

- Ecofys (Hermelink: How deep to go?) 2009 finds:
  - For new buildings a primary energy level of appr. 140 kWh/m2a for space heat, DHW, household electricity and embodied energy,
    - ~ the primary energy requirement for passive houses.
  - From an energy life-cycle perspective [Hermelink 2006] analyses which renovation level should be achieved in order to be better than a rebuild option. He concludes that “taking sustainability seriously, a space heat consumption between 25 and 40 kWh/m2a should be aimed at” in renovation.
  - = savings of 80% - 90%.
### Characteristics of stabilisation scenarios and the emission reduction needs

<table>
<thead>
<tr>
<th>Category</th>
<th>Radiative forcing (W/m²)</th>
<th>CO₂ concentration&lt;sup&gt;c)&lt;/sup&gt; (ppm)</th>
<th>CO₂-eq concentration&lt;sup&gt;c)&lt;/sup&gt; (ppm)</th>
<th>Global mean temperature increase above pre-industrial at equilibrium, using “best estimate” climate sensitivity&lt;sup&gt;b), c)&lt;/sup&gt; (°C)</th>
<th>Peaking year for CO₂ emissions&lt;sup&gt;d)&lt;/sup&gt;</th>
<th>Change in global CO₂ emissions in 2050 (% of 2000 emissions)&lt;sup&gt;d)&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>2.5-3.0</td>
<td>350-400</td>
<td>445-490</td>
<td>2.0-2.4</td>
<td>2000-2015</td>
<td>-85 to -50</td>
</tr>
<tr>
<td>II</td>
<td>3.0-3.5</td>
<td>400-440</td>
<td>490-535</td>
<td>2.4-2.8</td>
<td>2000-2020</td>
<td>-60 to -30</td>
</tr>
<tr>
<td>III</td>
<td>3.5-4.0</td>
<td>440-485</td>
<td>535-590</td>
<td>2.8-3.2</td>
<td>2010-2030</td>
<td>-30 to +5</td>
</tr>
<tr>
<td>IV</td>
<td>4.0-5.0</td>
<td>485-570</td>
<td>590-710</td>
<td>3.2-4.0</td>
<td>2020-2060</td>
<td>+10 to +60</td>
</tr>
<tr>
<td>V</td>
<td>5.0-6.0</td>
<td>570-660</td>
<td>710-855</td>
<td>4.0-4.9</td>
<td>2050-2080</td>
<td>+25 to +85</td>
</tr>
<tr>
<td>VI</td>
<td>6.0-7.5</td>
<td>660-790</td>
<td>855-1130</td>
<td>4.9-6.1</td>
<td>2060-2090</td>
<td>+90 to +140</td>
</tr>
</tbody>
</table>

Total

Source: IPCC AR4, WGIII, Table SPM5
Can we afford this?

Source: Jens Lausten, IEA
The climate change mitigation challenge

“How on Earth do we turn it off?”
The later emissions peak, the more ambitious reductions needed

Source: Meinshausen et al 2009
In 2004, in buildings were responsible for app. 1/3 of global energy-related CO$_2$ (incl. indirect) and 2/3 of halocarbon emissions.
The Global Energy Assessment: Background and purpose

- The Global Energy Assessment aims at providing (a) blueprint(s) for the world how energy-related social, environmental, geopolitical and other challenges can be addressed this century.

- We all know that buildings are the key pillar to such a future, but **how much?**

- GEA constructs new scenarios (complementing IPCC-type scenarios) that attempt to take advantage of the really large and novel opportunities in buildings, hard-to-model by existing modeling frameworks.

- UNEP SBCI is a partner to further GEA efforts in the buildings scenarios (and WB is partner in GEA).
Main philosophy and assumptions

- Assumes that the world’s building stock will transform over to today’s known (and built) cutting edge in architecture
  - At the most affordable cost
  - At the natural rate of building construction and retrofit
  - Taking into account capacity and other limitations, but assuming ambitious and supportive (not financially but legally) policy environment.

- The main pillars of the model are existing best practices
  - Best practice from and energy and INVESTMENT COST perspective as well

- The world’s building stock is broken down by regions, climate zones and 3 building types

- Model eradicates energy poverty well before 2050, i.e. everyone has appropriate thermal comfort energy services by 2050

- several scenarios planned:
  - Very high efficiency with different modalities; +building-integrated renewables; +behavioural change
Final thermal energy consumption in the world’s buildings by region, 2005-2050

1.4%/yr retrofit rate

Work in progress – do not cite or quote
Conclusions

- Buildings are key to climate change mitigation in each world region
- Substantial opportunities exist; as much as 77% of 2005 final thermal energy consumption can be eliminated by 2050 by building codes, while living standards increase as BAU and energy poverty eliminated
- To reach ambitious values:
  - Building codes need to be universal and fully implemented
  - Most advanced (low-cost) know-how needs to be mandated
  - Construction industry needs to gear up soon (in app. a decade)
  - Codes need to cover major retrofit as well, not only newbuild
  - 2050 emissions extremely sensitive to retrofit rate: 77% energy savings for 3% retrofit rate drops to 37% for 1.4% rate!!
- Major lock-in risks exist
  - Suboptimal retrofit represents major climate lock-in risk
  - Present trends can lock in 23% – 35% of all 2005 emissions (increasing achievable low levels by 37 - 152%) for many decades
- Suboptimal retrofits should not be supported; rather wait if complex, deep retrofit is not possible yet
Panelfelújítási programban részt vevő épületek fűtési fajlagos hőfelhasználásának alakulása
Székesfehérvár

<table>
<thead>
<tr>
<th></th>
<th>KJ/m³</th>
<th>3 éves átlag</th>
<th>2007/2008. évi korrigált</th>
</tr>
</thead>
<tbody>
<tr>
<td>H. Homlokzati hőszigetelés</td>
<td>235,570</td>
<td>193,335</td>
<td>-18%</td>
</tr>
<tr>
<td>H. NY. Homlokzati hőszigetelés, nyilászáró csere</td>
<td>230,784</td>
<td>171,956</td>
<td>-25%</td>
</tr>
<tr>
<td>H. NY. F. Homlokzati hőszigetelés, nyilászáró csere, fűtéskorszerűsítés</td>
<td>228,894</td>
<td>144,538</td>
<td>-36%</td>
</tr>
</tbody>
</table>

“EU buildings – a goldmine for CO2 reductions, energy security, job creation and addressing low income population problems”

Source: Claude Turmes (MEP), Amsterdam Forum, 2006
More on Solanova: www.solanova.eu
Estimated potential for GHG mitigation at a sectoral level in 2030 in different cost categories, transition economies

* For the buildings, forestry, waste and transport sectors, the potential is split into three cost categories: at net negative costs, at 0-20 US$/tCO2, and 20-100 US$/tCO2. For the industrial, forestry, and energy supply sectors, the potential is split into two categories: at costs below 20 US$/tCO2 and at 20-100 US$/tCO2.
Estimated potential for GHG mitigation at a sectoral level in 2030 in different cost categories in developing countries

Cost categories (US$/tCO2eq)

- <20
- <0
- 0-20
- 20-100

Gton CO2eq.

- Buildings
- Industry
- Agriculture
- Energy supply
- Forestry
- Waste
- Transport

Constructed based on Chapter 11 results