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Climate Change Mitigation in the Buildings Sector

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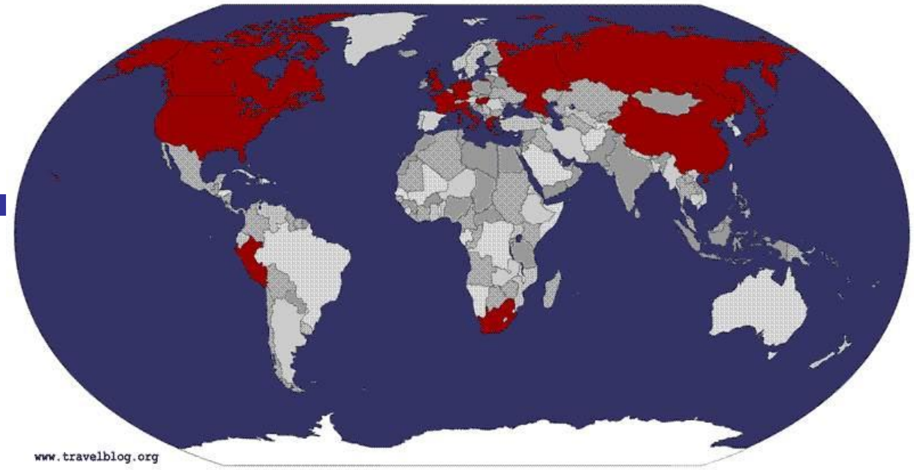
Acknowledgements: authors of Chapter 6



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Outline

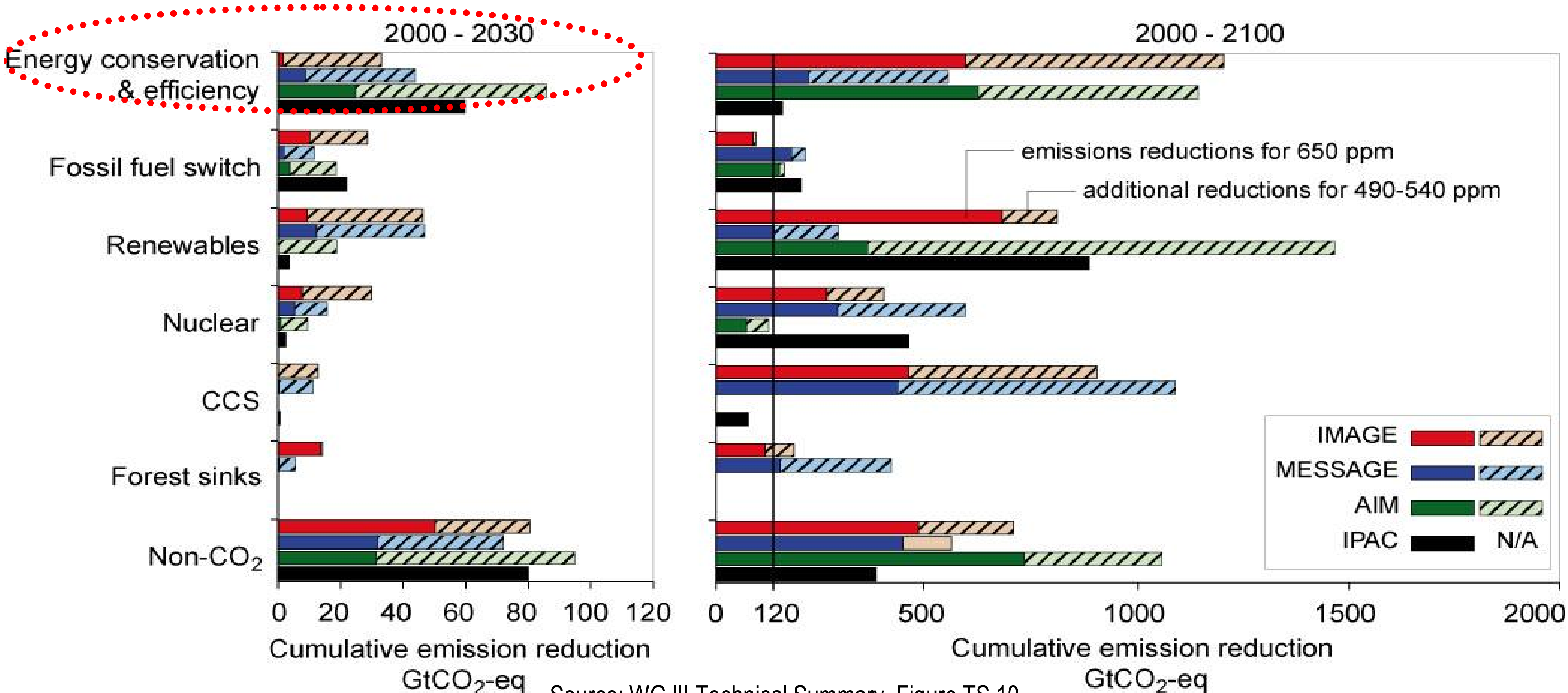
- The importance of improving energy efficiency in CC mitigation
- Mitigation in the buildings sector: global and regional importance
- Potential and costs of GHG mitigation in buildings
- Co-benefits of GHG mitigation in bldgs
- Policies to foster carbon-efficiency buildings
- Conclusions

The importance of improved energy efficiency in GHG mitigation

- Energy efficiency is one of the most important options to reduce GHG emissions worldwide in the short- to mid-term

Cumulative emission reductions for alternative mitigation measures for 2000–2030 and for 2000–2100

Illustrative scenarios from AIM, IMAGE, IPAC and MESSAGE aiming at the stabilization at 490–540 ppm CO2-eq (light bars) and at 650 ppm CO2-eq (dark bars)

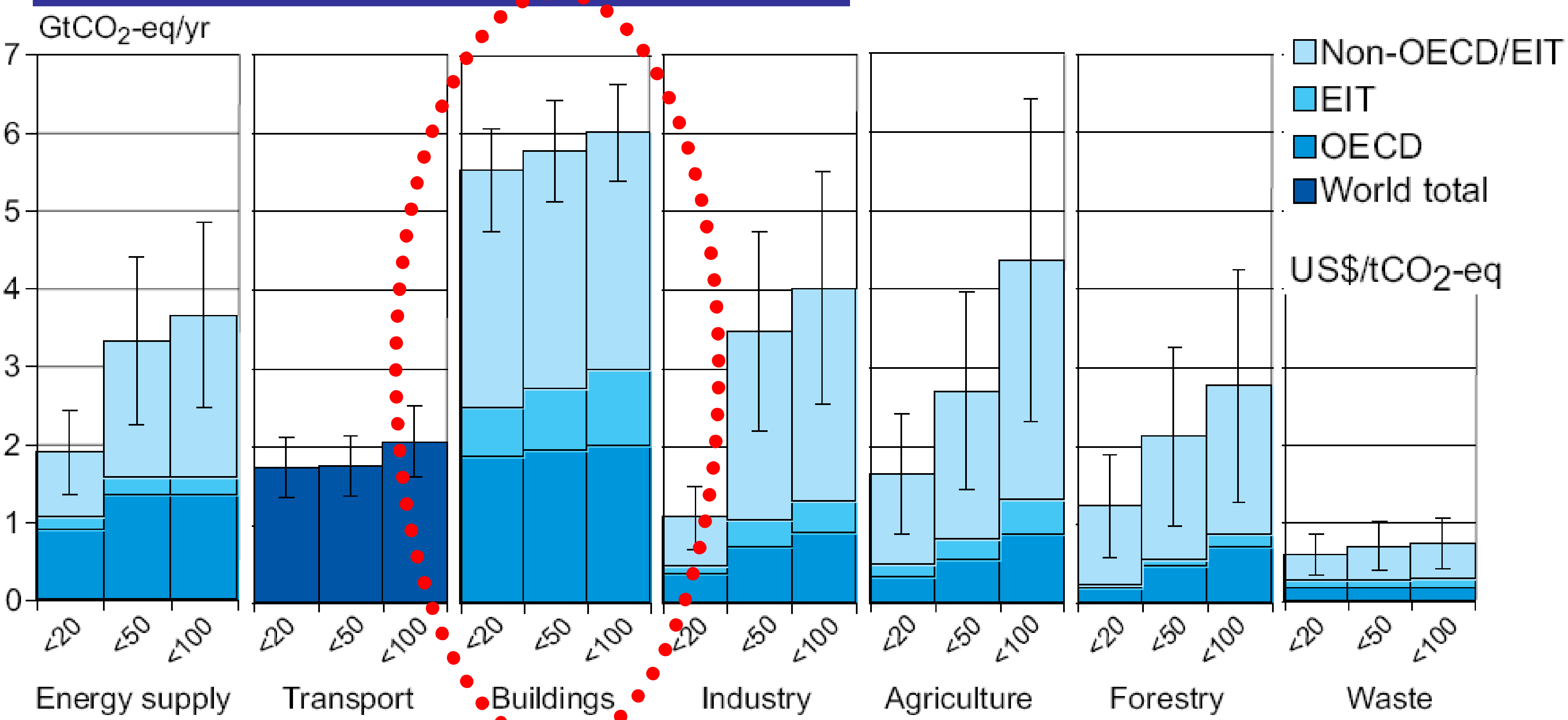


Source: WG III Technical Summary, Figure TS.10

The importance of improved energy efficiency in GHG mitigation

- Energy efficiency is one of the most important options to reduce GHG emissions worldwide in the short- to mid-term
- If costs are taken into account, improved efficiency becomes the most important instrument in our portfolio in the short- to mid-term

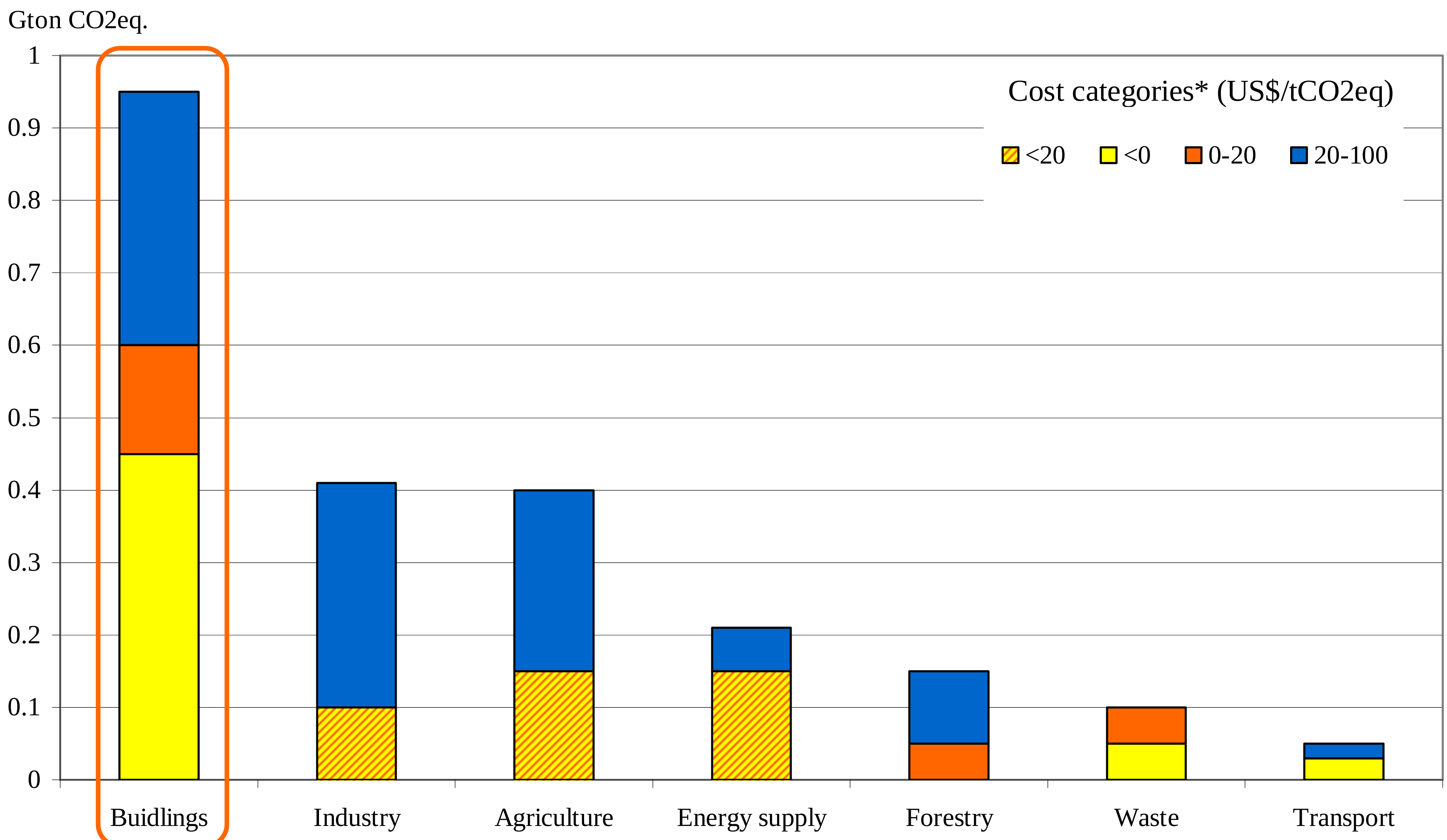
Sectoral economic potential for global mitigation for different regions as a function of carbon price, 2030



(potential at <US$100/ tCO$_2$-eq: 2.4 - 4.7 Gt CO$_2$-eq/yr)	*(potential at <US$100/ tCO$_2$-eq: 1.6 - 2.5 Gt CO$_2$-eq/yr)*	*(potential at <US$100/ tCO$_2$-eq: 5.3 -6.7 Gt CO$_2$-eq/yr)*	*(potential at <US$100/ tCO$_2$-eq: 2.5 - 5.5 Gt CO$_2$-eq/yr)*	*(potential at <US$100/ tCO$_2$-eq: 2.3 -6.4 Gt CO$_2$-eq/yr)*	*(potential at <US$100/ tCO$_2$-eq: 1.3 - 4.2 Gt CO$_2$-eq/yr)*	*(potential at <US$100/ tCO$_2$-eq: 0.4 - 1 Gt CO$_2$-eq/yr)*

IPCC AR4 WGIII Figure SPM.6.

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 suppy sectors, the potential is split into two categories: at costs below 20 US$/tCO2 and at 20-100 US$/tCO2.

Mitigation in the buildings sector: global importance

- Capturing *only the cost-effective potential in buildings* can supply app. 38% of total reduction needed in 2030 to keep us on a trajectory capping warming at 3˚C
- New buildings can achieve the largest savings
  - As much as 80% of the operational costs of standard new buildings can be saved through integrated design principles
  - Often at no or little extra cost
  - Hi-efficiency renovation is more costly, but possible
- The majority of technologies and know-how are widely available
- A large share of these options have “negative costs” – i.e. represent profitable investment opportunities

Co-benefits of GHG mitigation in buildings (selection)

- Co-benefits are often not quantified, monetized, or identified
- Overall value of co-benefits may be higher than value of energy savings
- A wide range of co-benefits, including:
- Reduced morbidity and mortality
  - **App. 2.2 million deaths attributable to indoor air pollution each year from biomass** (wood, charcoal, crop residues and dung) and coal burning for household cooking and heating, in addition to acute respiratory infections in young children and chronic pulmonary disease in adults
  - Gender benefits: women and children also collect biomass fuel, they can work or go to school instead

The key co-benefits for Hungary (continued)

- **Improved social welfare**
  - Fuel poverty: In the UK, about 20% of all households live in fuel poverty. The number of annual excess winter deaths is estimated at around 30 thousand annually in the UK alone.
  - Energy-efficient household equipment and low-energy building design helps households cope with increasing energy tariffs
- **Employment creation**
  - "producing" energy through energy efficiency or renewables is more employment intensive than through traditional ways
  - a 20% reduction in EU energy consumption by 2020 can potentially create 1 mil new jobs in Europe
- **new business opportunities**
  - for developed countries a market opportunity of € 5–10 billion in energy service markets in Europe
- **Reduced energy costs will make businesses more competitive**
- **Others:**
  - Improved energy security, reduced burden of constrained generation capacities, Increased value for real estate, Improved energy services (lighting, thermal comfort, etc) can improve productivity, Improved outdoor air quality

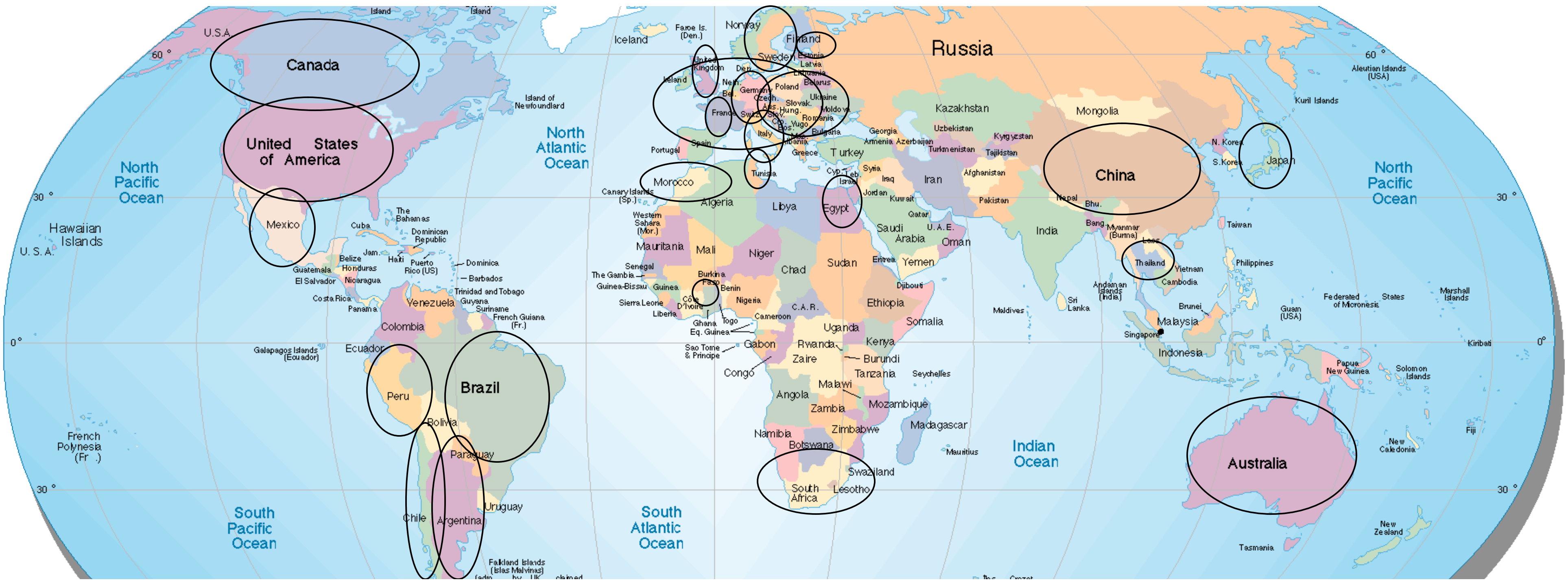
If so attractive, why is it not happening?

- The market barriers to energy-efficiency are perhaps the most numerous and strongest in the buildings sector
- These include:
  - imperfect information
  - Limitations of the traditional building design process
  - Energy subsidies, non-payment and energy theft
  - Misplaced incentives (agent/principal barrier)
  - Small project size, high transaction costs
  - others

Policies to foster GHG mitigation in buildings

Background: case studies reviewed

- Which policies achieve high energy savings and GHG reductions? Which are very cost-effective? What are the success factors?
- Over 80 studies were reviewed from over 52 countries



 Robinson Projection

The impact and effectiveness of various policy instruments
Part 1: Control and regulatory mechanisms- normative instruments

Policy instrument	Country examples	Effectiveness	Energy or emission reductions for selected best practices	Cost-effectiveness	Cost of GHG emission reduction for selected best practices
Appliance standards	EU, US, JP, AUS, Br, Cn	High	Jp: 31 M tCO_2 in 2010; Cn: 250 Mt CO_2 in 10 yrs US: 1990-1997: 108 Mt CO2eq, in 2000: 65MtCO_2 = 2.5% of el.use, Can: 8 MtCO_2 in total by 2010, Br: 0.38 MtCO_2/year AUS: 7.9 MtCO_2 by 2010	High	AUS: -52 \$/tCO_2 in 2020, US: -65 \$/tCO_2 in 2020; EU: -194 \$/tCO_2 in 2020 Mar: 0.008 \$/kWh
Building codes	SG, Phil, Alg, Egy, US, UK, Cn, EU	High	HkG: 1% of total el.saved; US: 79.6 M tCO_2 in 2000; EU: 35-45 MtCO_2, up to 60% savings for new bdgs UK: 2.88 MtCO_2 by 2010, 7% less en use in houses 14% with grants& labelling Cn: 15-20% of energy saved in urban regions	Medium	NL: from -189 \$/tCO_2 to -5 \$/tCO_2 for end-users, 46-109 \$/tCO_2 for Society
Procurement regulations	US, EU, Cn, Mex, Kor, Jp	High	Mex: 4 cities saved 3.3 ktCO_2eq. in 1year Ch: 3.6Mt CO_2 expected EU: 20-44MtCO_2 potential US:9-31Mt CO_2 in 2010	High/ Medium	Mex: \$1Million in purchases saves \$726,000/year; EU: <21\$/tCO_2
Energy efficiency obligations and quotas	UK, Be, Fr, I, Dk, Ir	High	UK: 2.6 M tCO_2/yr	High	Flanders: -216\$/tCO_2 for households, -60 \$/tCO_2 for other sector in 2003. UK: -139 \$ /tCO_2

The impact and effectiveness of various policy instruments
Part 2: Regulatory- informative instruments

Policy instrument	Country examples	Effec-tiveness	Energy or emission reductions for selected best practices	Cost-effective ness	Cost of GHG emission reduction for selected best practices
Mandatory labelling and certification programs	US, Jp, CAN, Cn, AUS, Cr, EU, Mex, SA	**High**	AUS: 5 Mt CO_2 savings 1992-2000, 81Mt CO_2 2000-2015, SA: 480kt/yr Dk: 3.568Mt CO_2	**High**	AUS:-30$/t CO_2 abated
Mandatory audit programs	US; Fr, NZL, Egy, AUS, Cz	**High, variable**	US: Weatherisation program: 22% saved in weatherized households after audits (30% according to IEA)	**Medium/ High**	US Weatherisation program: BC-ratio: 2.4
Utility demand-side management programs	US, Sw, Dk, Nl, De, Aut	**High**	US : 36.7 MtCO2in 2000, Jamaica: 13 GWh/ year, 4.9% less el use = 10.8 ktCO2 Dk: 0.8 MtCO2 Tha: 5.2 % of annual el sales 1996-2006	**High**	EU: - 255$/tCO2 Dk: -209.3 $/tCO2 US: Average costs app. -35 $/tCO2 Tha: 0.013 $/kWh

The impact and effectiveness of various policy instruments
Part 3: Economic and market-based instruments

Policy instrument	Country examples	Effec-tiveness	Energy or emission reductions for selected best practices	Cost-effective ness	Cost of GHG emission reduction for selected best practices
Energy performance contracting/ ESCO support	De, Aut, Fr, Swe, Fi, US, Jp, Hu	High	Fr, S, US, Fi: 20-40% of buildings energy saved; EU:40-55MtCO_2 by 2010 US: 3.2 MtCO_2/yr Cn: 34 MtCO_2	Medium/ High	EU: mostly at no cost, rest at <22$/t$CO_2$; US: Public sector: B/C ratio 1.6, Priv. sector: 2.1
Cooperative/ technology procurement	De, It, Sk, UK, Swe, Aut, Ir, US,Jp	High/Medium	US: 96 ktCO_2 German telecom company: up to 60% energy savings for specific units	Medium/ High	US: - 118 $/ t$CO_2$ Swe: 0.11$/kWh (BELOK)
Energy efficiency certificate schemes	It, Fr	High	I: 1.3 MtCO_2 in 2006, 3.64 Mt CO_2 eq by 2009 expected	High	Fr: 0.011 $/t$CO_2$ estimated
Kyoto Protocol flexible mechanisms	Cn, Tha, CEE (JI &AIJ)	Low	CEE: 220 K tCO2 in 2000 Estonia: 3.8-4.6 kt CO_2 (3 projects) Latvia: 830-1430 tCO_2	Low	CEE: 63 $/t$CO_2$ Estonia: 41-57$/t$CO_2$ Latvia: -10$/t$CO_2$

The impact and effectiveness of various policy instruments
Part 4: Fiscal instruments and incentives

Policy instrument	Country examples	Effec-tiveness	Energy or emission reductions for selected best practices	Cost-effective ness	Cost of GHG emission reduction for selected best practices
Taxation (on CO2 or household fuels)	Nor, De UK, NL, Dk, Sw	**Low/ Medium**	De: household consumption reduced by 0.9 % 2003: 1.5 MtCO2 in total Nor: 0.1-0.5% 1987-1991 NL:0.5-0.7 MtCO2 in 2000 Swe: 5% 1991-2005, 3MtCO2	**Low**	
Tax exemptions/ reductions	US, Fr, Nl, Kor	**High**	US: 88 MtCO2 in 2006 FR: 1Mt CO2 in 2002	**High**	US: B/C ratio commercial buildings: 5.4 New homes: 1.6
Public benefit charges	BE, Dk, Fr, Nl, US states	**Medium/ Low**	US: 0.1-0.8% of total el. sales saved /yr, 1.3 ktCO2 savings in 12 states NL: 7.4TWh in 1996 = 2.5 MtCO2 Br: 1954 GWh	**High in reported cases**	US: From -53$/tCO2 to - 17$/tCO2
Capital subsidies, grants, subsidised loans	Jp, Svn, NL, De, Sw, US, Cn, UK, Ro	**High/ Medium**	Svn: up to 24% energy savings for buildings, BR: 169ktCO2 UK: 6.48 MtCO2 /year, 100.8 MtCO2 in total Ro: 126 ktCO2/yr	**Low sometim es High**	Dk: – 20$/ tCO2 UK:29$/tCO2 for soc, NL: 41-105$/tCO2 for society

The impact and effectiveness of various policy instruments
Part 5: Support, information and voluntary action (cont.)

Policy instrument	Country examples	Effec-tiveness	Energy or emission reductions for selected best practices	Cost-effective ness	Cost of GHG emission reduction for selected best practices
Awareness, education, information	Dk, US, UK, Fr, CAN, Br, Jp, Swe	**Low/ Medium**	UK: 10.4ktCO2 annually Arg: 25% in 04/05, 355 ktep Fr: 40tCO2/ year Br: 2.23kt/yr, 6.5-12.2 MtCO2/ year with voluntary labeling 1986-2005 Swe: 3ktCO2/ year	**Medium/ High**	Br: -66$/tCO2; UK: 8$/tCO2 (for all programs of Energy Trust)/ Swe: 0.018$/kWh
Detailed billing & disclosure programs	Ontario, It, Swe, Fin, Jp, Nor, Aus, Cal, Can	**Medium**	Max.20% energy savings in households concerned, usually app. 5-10% savings UK: 3% Nor: 8-10 %	**Medium**	

Country name abbreviations: Alg - Algeria, Arg- Argentina, AUS - Australia, Aut - Austria, Be - Belgium, Br - Brazil, Cal - California, Can - Canada, CEE - Central and Eastern Europe, Cn - China, Cr - Costa Rica, Cz - Czech Republic, De - Germany, Ecu - Ecuador, Egy - Egypt, EU - European Union, Fin - Finland, GB-Great Britain, Hkg -Hong Kong, Hu - Hungary, Ind - India, Irl - Ireland, It - Italy, JP - Japan, Kor - Korea (South), Mar- Morocco, Mex - Mexiko, NL - Netherlands, Nor - Norway, Nzl – New Zealand, Phil - Philippines, Pol - Poland, Ro- Romania, SA- South Africa, SG - Singapore, Sk - Slovakia, Svn - Slovenia, Sw - Switzerland, Swe - Sweden, Tha - Thailand, US - United States.

Conclusion

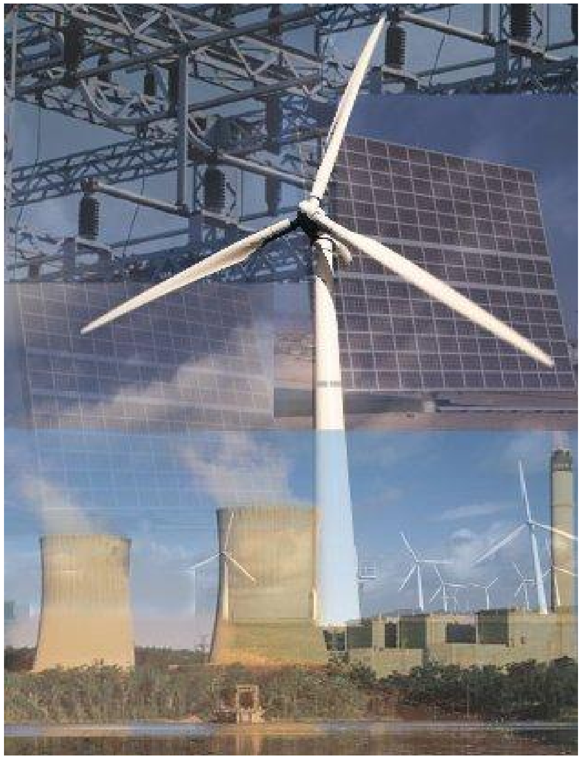
- **Improved energy-efficiency could contribute the largest share in our mitigation task in the short- and mid-term**
- **Capturing the economic potential in buildings alone can contribute app. 38% of reduction needs in 2030 for a 3˚C-capped emission trajectory**
- **In addition to climate change benefits, improved energy-efficiency can advance several development goals as well as strategic economic targets**
  - E.g. improving social welfare, employment, energy security
- **However, due to the numerous barriers public policies are needed to unlock the potentials and to kick-start or catalise markets**
- **Several instruments have already been achieving large emission reductions at large net societal benefits, often at double or triple negative digit cost figures all over the world**
- **However, each new building constructed in an energy-wasting manner will lock us into high climate-footprint future buildings – action now is important**

Why is immediate action important?

Table 11.17: *Observed and estimated lifetimes of major GHG-related capital stock*

Typical lifetime of capital stock			Structures with influence > 100 years
Less than 30 years	30-60 years	60-100 years	
Domestic appliances Water heating and HVAC systems Lighting Vehicles	Agriculture Mining Construction Food Paper Bulk chemicals Primary aluminium Other manufacturing	Glass manufacturing Cement manufacturing Steel manufacturing Metals-based durables	Roads Urban infrastructure Some buildings

Thank you for your attention!



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