Promoting a High-growth,
Low-carbon Economy in Light of the Need
for Energy and Climate Security

Can we have the cake and eat it too?

CENTER FOR CLIMATE CHANGE
AND SUSTAINABLE ENERGY POLICY

CENTRAL EUROPEAN UNIVERSITY

Diana Ürge-Vorsatz

Outline

- Background: the CC mitigation challenge
- Can we afford mitigation in an econ crisis?
- The free lunch:
  - mitigating CC through improved efficiency
- How we are paid to have this free lunch:
  - Co-benefits
- Why it is difficult to get the free lunch:
  - The challenges
- Economic crisis – show-stopper or opportunity?
  - trigger for a paradigm change?

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Background: the climate change mitigation challenge

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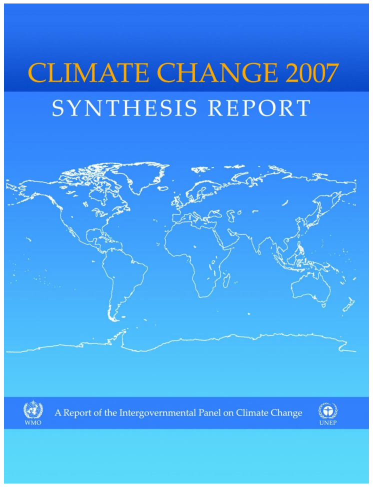
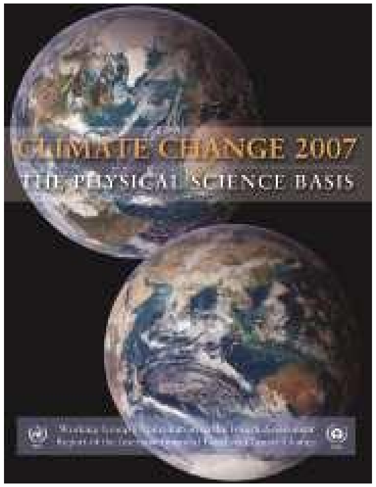
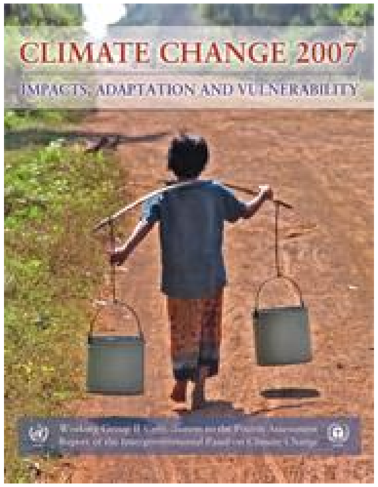
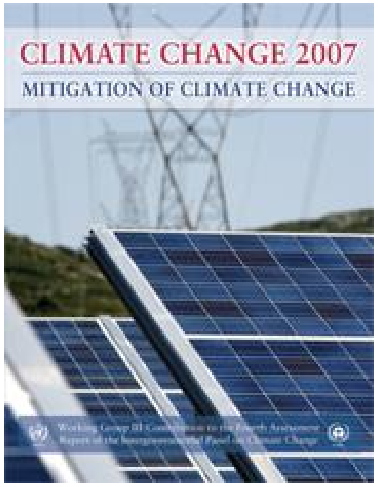




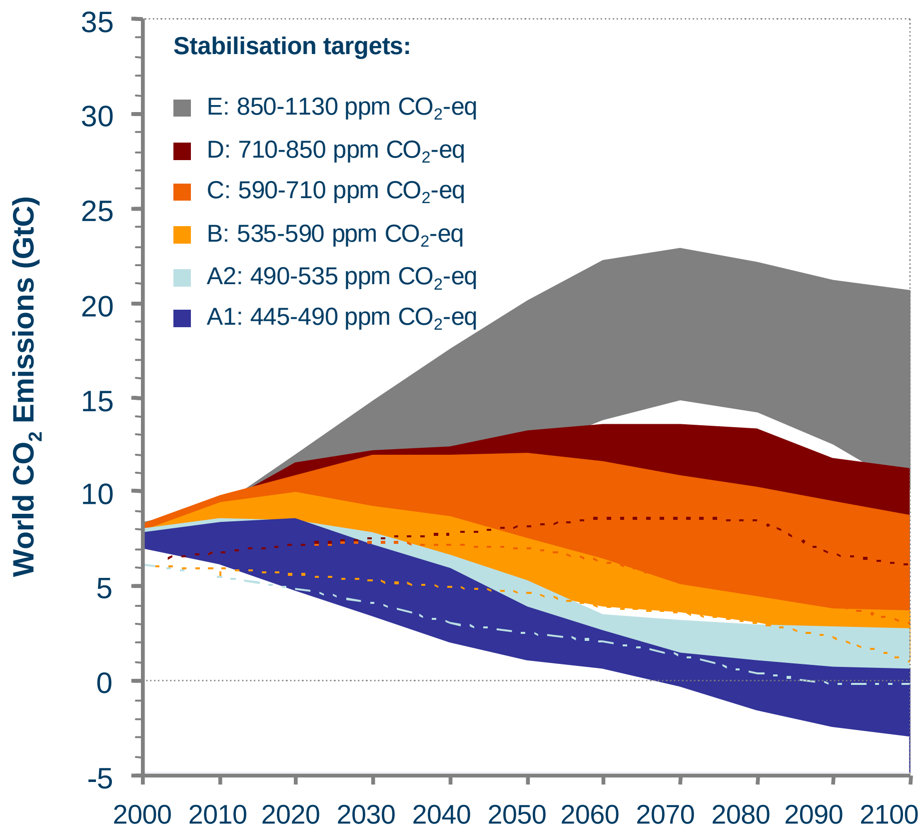




In order to limit the impacts of CC, GHG emissions have to be reduced significantly

- Stabilizing global mean temperature requires a stabilization of GHG concentrations in the atmosphere -> GHG emissions would need to peak and decline thereafter (SPM 18 WG III)
- The lower the target stabilisation level limit, the earlier global emissions have to peak.
- Limiting increase to 3.2 – 4°C requires emissions to peak within the next 55 years.
- Limiting increase to 2.8 – 3.2°C requires global emissions to peak within 25 years.
- Limiting global mean temperature increases to 2 – 2.4°C above pre-industrial levels requires global emissions to peak within 15 years and then fall to about 50 to 85% of current levels by 2050.

Based on SPM 7, WG III. Emission pathways to mitigation scenarios



Multigas and CO_2 only studies combined

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Concensus of the some 2500 scientists at the Copenhagen Climate Congress, March 10 – 12, 2009

- "*Temperature rises above 2C will be very difficult for contemporary societies to cope with, and will increase the level of climate disruption through the rest of the century*."
- "*Rapid, sustained, and effective mitigation based on coordinated global and regional action is required to avoid "dangerous climate change" regardless of how it is defined. Weaker targets for 2020 increase the risk of crossing tipping points and make the task of meeting 2050 targets more difficult. Delay in initiating effective mitigation actions increases significantly the long-term social and economic costs of both adaptation and mitigation.*"

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The Herculean task: stabilisation scenarios and the emission reduction needs

Category	Radiative forcing (W/m²)	CO_2 concentration[c)] (ppm)	CO_2-eq concentration[c)] (ppm)	Global mean temperature increase above pre-industrial at equilibrium, using "best estimate" climate sensitivity[b), c)] (°C)	Peaking year for CO_2 emissions[d)]	Change in global CO_2 emissions in 2050 (% of 2000 emissions)[d)]
I	2.5-3.0	350-400	445-490	2.0-2.4	2000-2015	-85 to -50
II	3.0-3.5	400-440	490-535	2.4-2.8	2000-2020	-60 to -30
III	3.5-4.0	440-485	535-590	2.8-3.2	2010-2030	-30 to +5
IV	4.0-5.0	485-570	590-710	3.2-4.0	2020-2060	+10 to +60
V	5.0-6.0	570-660	710-855	4.0-4.9	2050-2080	+25 to +85
VI	6.0-7.5	660-790	855-1130	4.9-6.1	2060-2090	+90 to +140
						Total

Source: IPCC AR4, WGIII, Table SPM5

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However, the task was proven to be doable (such as in IPCC2007):

- "*All stabilisation levels assessed can be achieved by deployment of a portfolio of technologies that are currently available or expected to be commercialised in coming decades*"

Can we afford mitigation in a global economic crisis?

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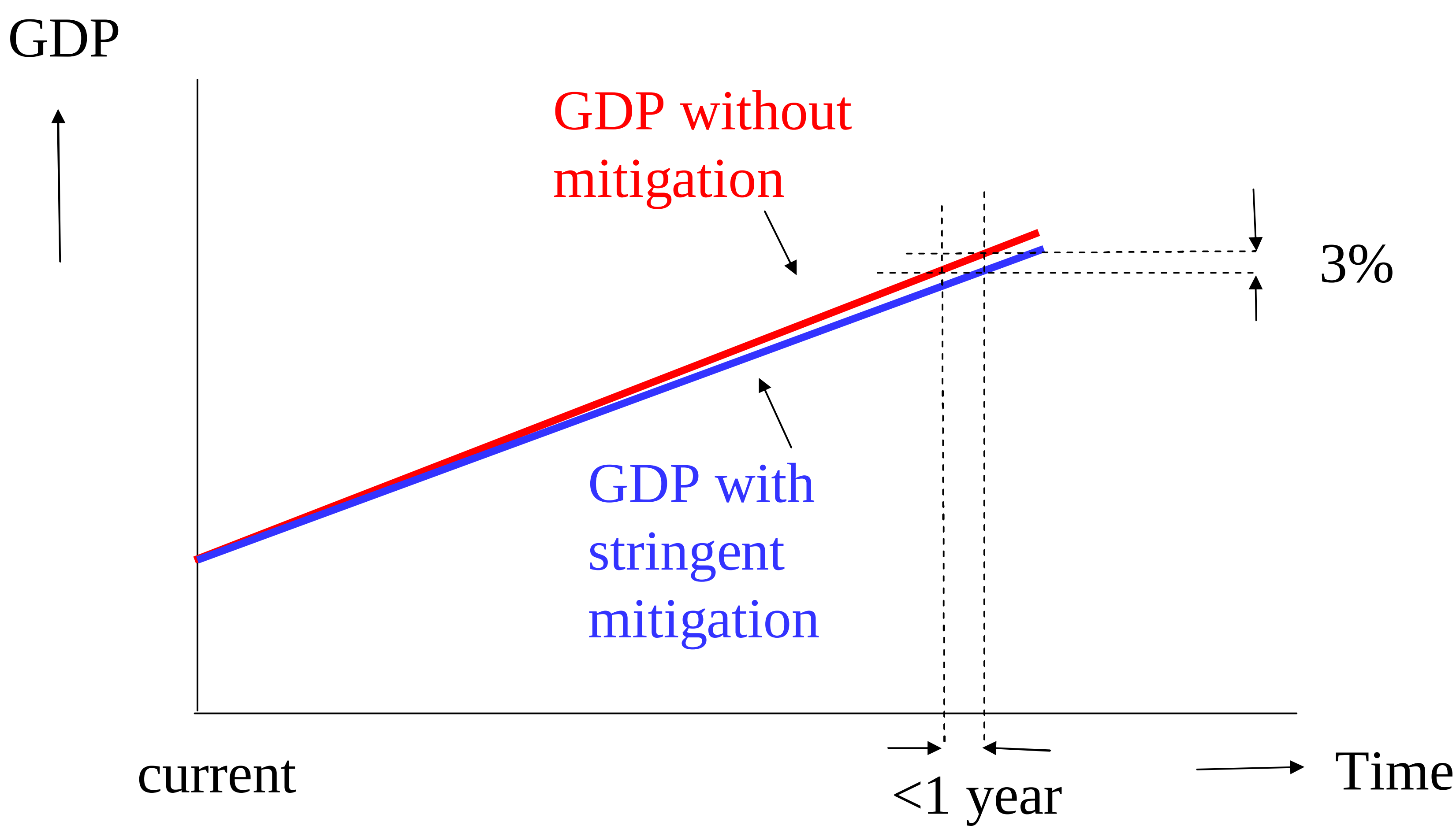
…even the costs are bearable

(for stabilisation scenario of 445-535 ppm CO2-eq)



Source: based on Bert Metz, SUN lecture 2008; IPCC 2007

The biggest free lunches: our buildings

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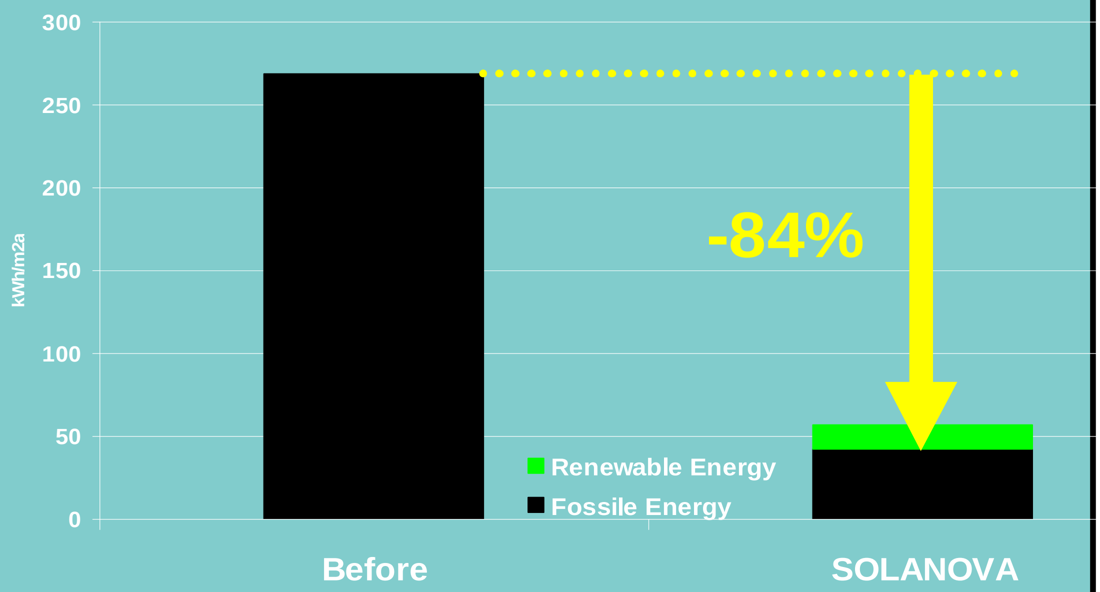
EU buildings – a goldmine

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

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Example of savings by reconstruction

Before reconstruction

Reconstruction according to the passive house principle

over 150 kWh/(m²a)

-90%

15 kWh/(m²a)

Source: Jan Barta, Center for Passive Buildings, www.pasivnidomy.cz, EEBW2006

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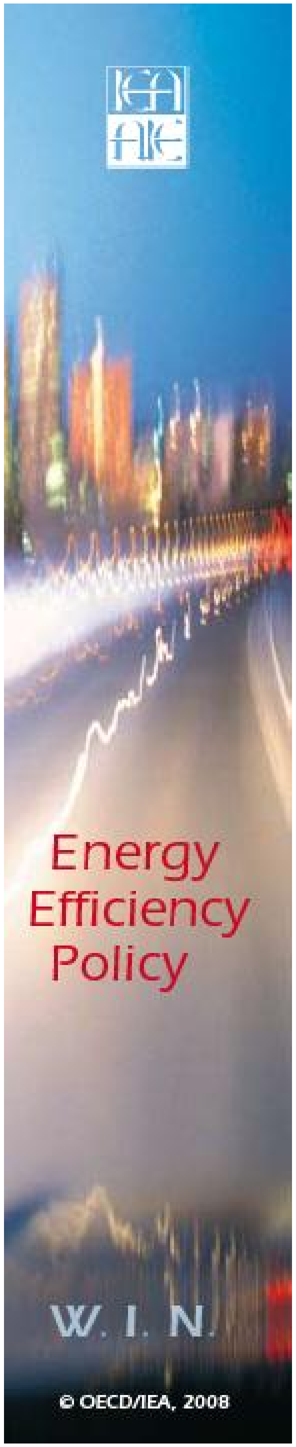
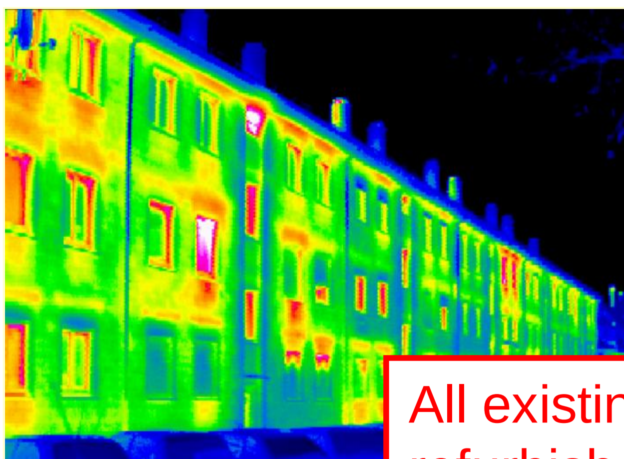
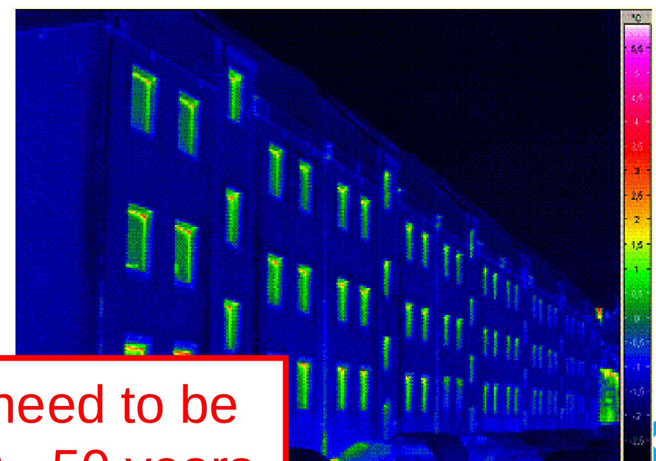


Factor 10 reduction possible in existing buildings

Frankfurt Refurbishment using Passive House Technology





All existing buildings need to be refurbished in next 40 - 50 years

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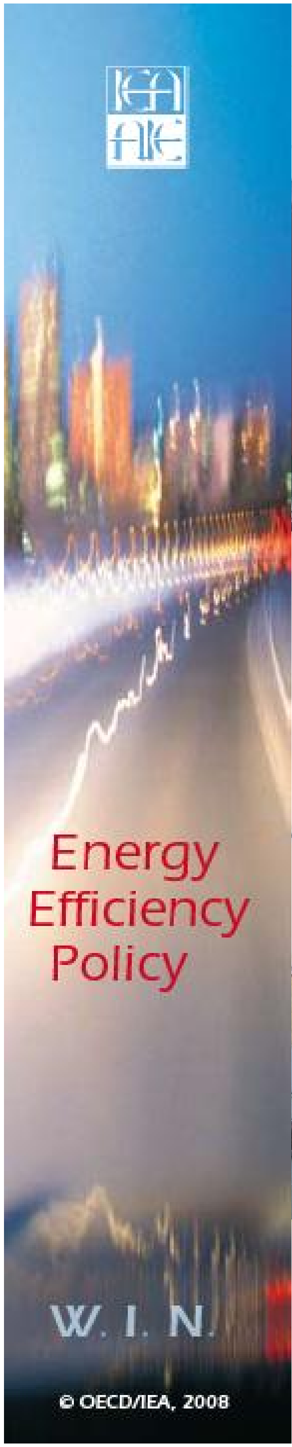

Frankfurt/M Germany Sophienhof
FAAG/ABG Frankfurt Architect Fuessler

Blocks of Flats

160 dwellings
14 767 m²
Passive House Technology
15 kwh / m² per year

Can we afford this ?

Extra costs
= 3-5% of the total costs

Payback = 9 – 10 years

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Which mitigation options to choose in an economic crisis?

- All mitigation options are not created equal
  - Costs
  - co-benefits
- Thus mitigation in an economic crisis should focus on **synergistic opportunities** (win-win)

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How we are paid to have this free lunch

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The win-wins (co-benefits) of CC mitigation through improved efficiency

Co-benefits of GHG mitigation through improved efficiency

- 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:
- Improved energy security
  - "Cost effective EE measures in EU buildings like better insulation, glazing and more efficient lighting could deliver savings equivalent to 500 million cubic meters of gas per day." [Eurima 2009] This is app. 5 times more than Nabucco will provide.
  - E.g. Nabucco's €8 bln, South Stream > €10 bln. This could be sufficient to perform high-efficiency refurbishment of 2/3 of all buildings in Hu/Sk/Slo/Cz (@50% financing). [Eurima/Ecofy 2007]

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Further key co-benefits (continued)

- **Improved social welfare**
  - “the direct cost of our inability to use energy efficiently amounts to more than 100 billion euros annually” [EC2006]
  - 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”.
  - 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
- **Others:**
  - Improved productivity, improved competitiveness, 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, reduced congestion

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Why is it difficult to get this free lunch?

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Challenges to realising the massive potentials

- Financial crisis: diversified energy options rely on high upfront investments and little (no) fuel costs -> financing is bigger challenge than for conventional systems
  - Obtaining financing for the average and low-income HHs is especially challenging
- However, energy infrastructure investments are expected to total > 20 trillion US$ globally until 2030. Redirecting some of these capital flows towards the demand-side could bring substantially higher economic benefits and cheaper mitigation
- Requires paradigm change in energy systems
  - Incremental improvements will not suffice
  - Shift from the supply-side to the demand-side
  - Reconceptualising energy as a service vs. a commodity
  - New business models are needed

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Financial crisis: show-stopper or opportunity? (cont'd)

- Crisis: opportunity to rethink fundamentals of economy – incl. our energy systems
- Efficiency is the best public investment to invigorate economy and mitigate social impacts
- Many companies & residents rethink their own consumption patterns and cut wasteful practices
- May trigger the refocusing of corporations on new business models and fundamentally different business directions

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Can the economic crisis be the catalist for the new (industrial) revolution required for the long-term survival of humanity…?

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Thank you for your attention

“All I’m saying is **NOW** is the time to develop the technology to deflect an asteroid”

Diana Ürge-Vorsatz

Center for Climate Change and Sustainable Energy Policy (3CSEP)

Central European University

http://3csep.ceu.hu

vorsatzd@ceu.hu

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Supplementary slides

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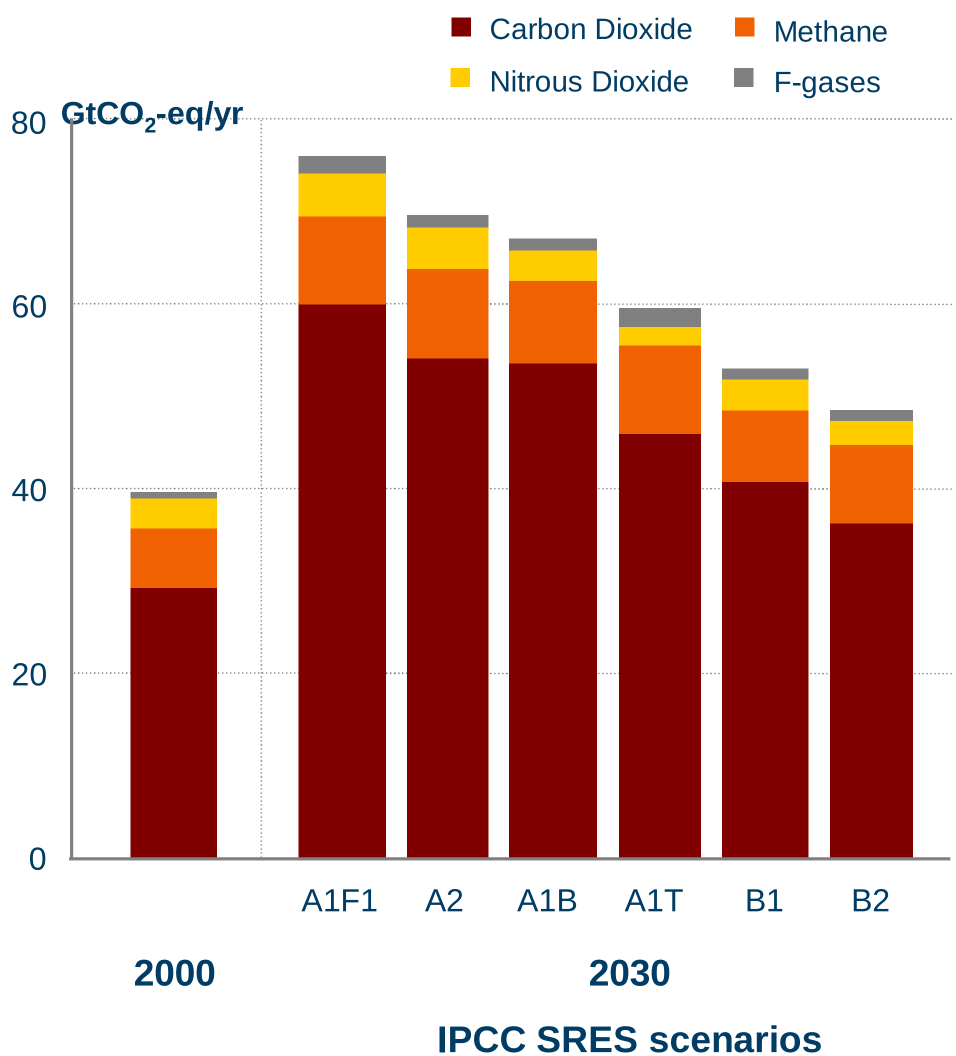
The mitigation challenge

SPM 4. Total GHG emissions



- Most of the T increase since the mid-20th century is *very likely* due to the increase in anthropogenic GHG concentrations (SPM WG I)
- Global GHG emissions have increased by 70% in 1970 – 2004 (SPM.2 WG III)
- By 2030 there will be a 25-90% increase in GHG emissions compared with 2000 unless additional policy measures are put in place (SPM.3 WG III)

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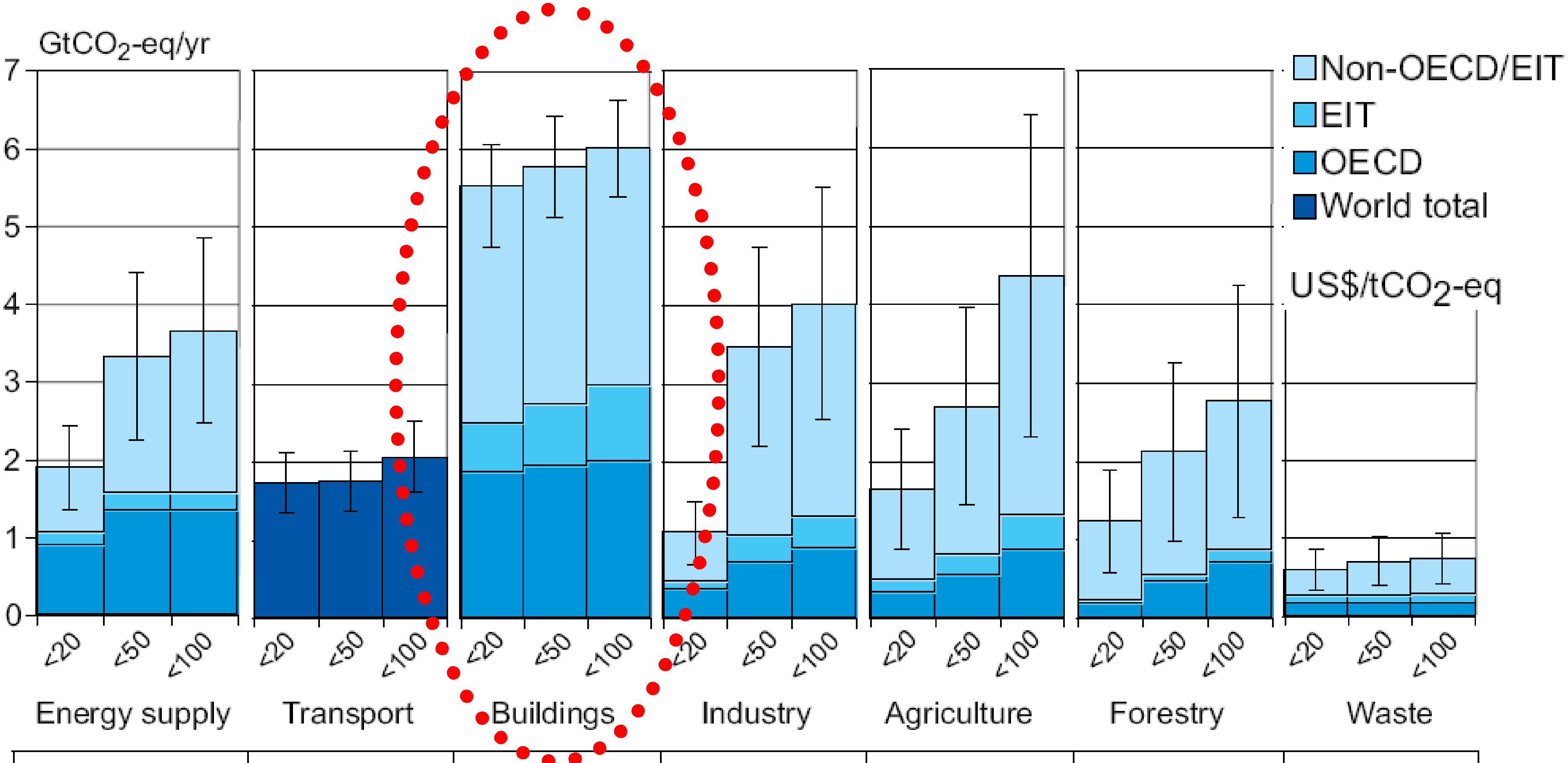
Barriers to energy efficiency

- imperfect information
- Energy pricing not reflecting true costs (subsidies and not internalised externalities)
- Lack of access to financing
- Lack of information, expertise, awareness, experts
- Misplaced incentives (agent/principal barrier)
  - Landlord/tenant, builder/occupant
  - Municipality/institute
- Transaction costs
- Limitations of the traditional building design process; fragmented industry
- others

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)*

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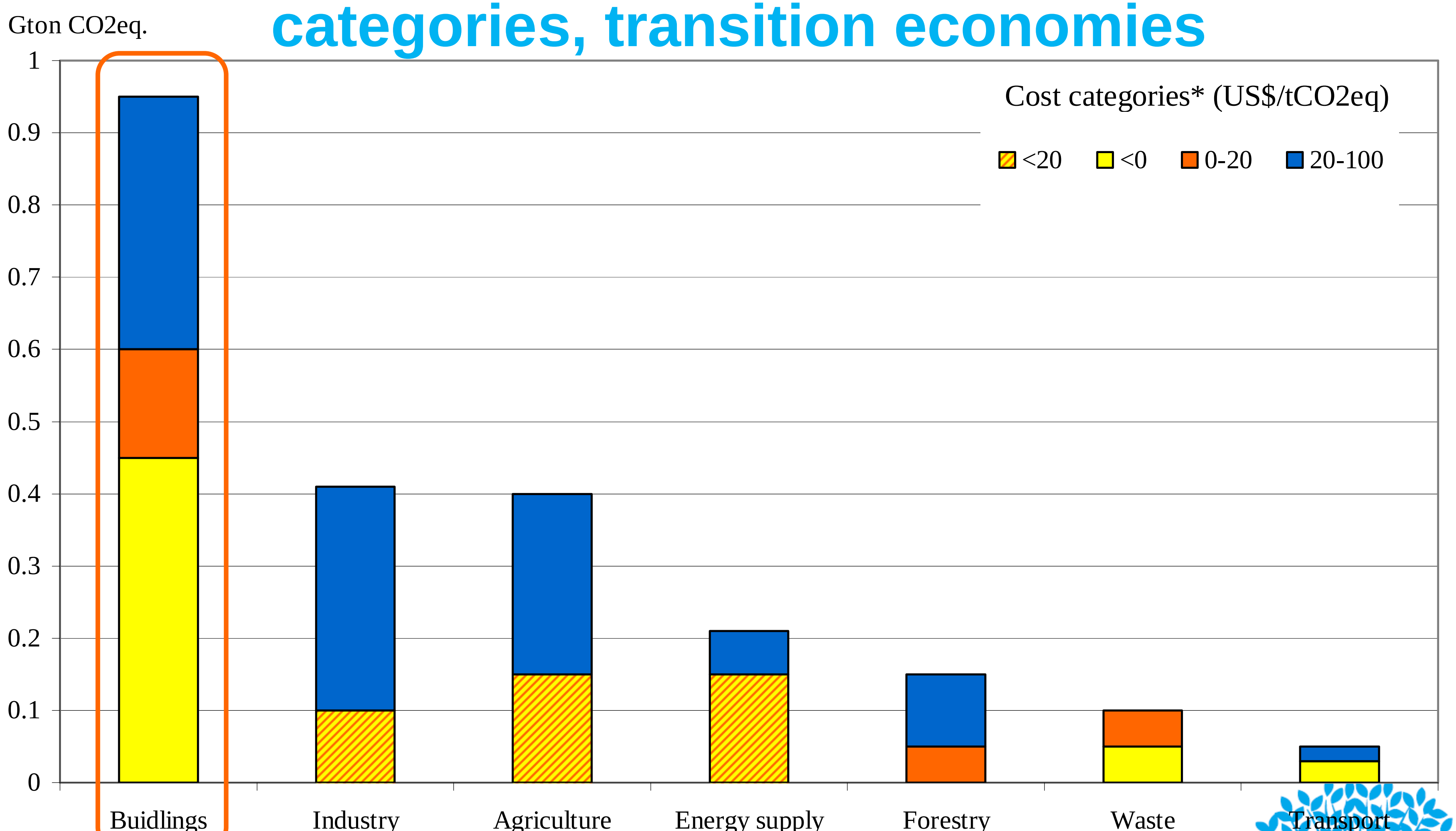
Estimated potential for GHG mitigation at a sectoral level in 2030 in different cost categories, transition economies



* 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.

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Buildings are a key lever for sustainable energy systems

- Buildings house the largest cost-effective potential for GHG mitigation
  - 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
- Buildings energy consumption can be effectively reduced to a fraction of standard buildings
  - New buildings can achieve the largest savings:
    - As much as 80% of the operational energy of standard new buildings can be saved through integrated design principles

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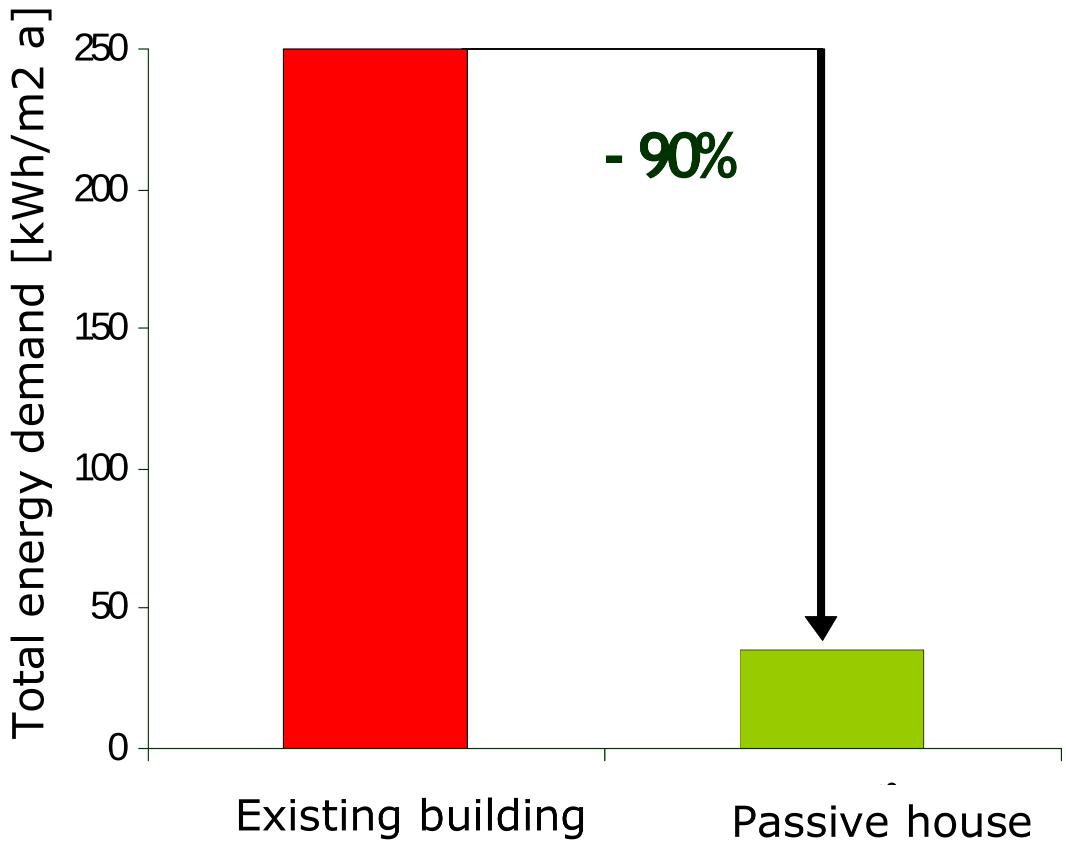
Passive house energy demand



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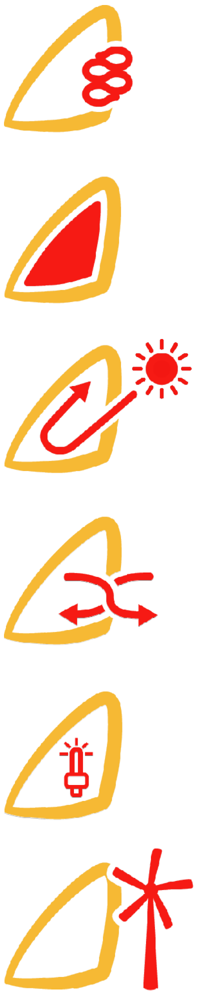
Basic principles



Thermal protection

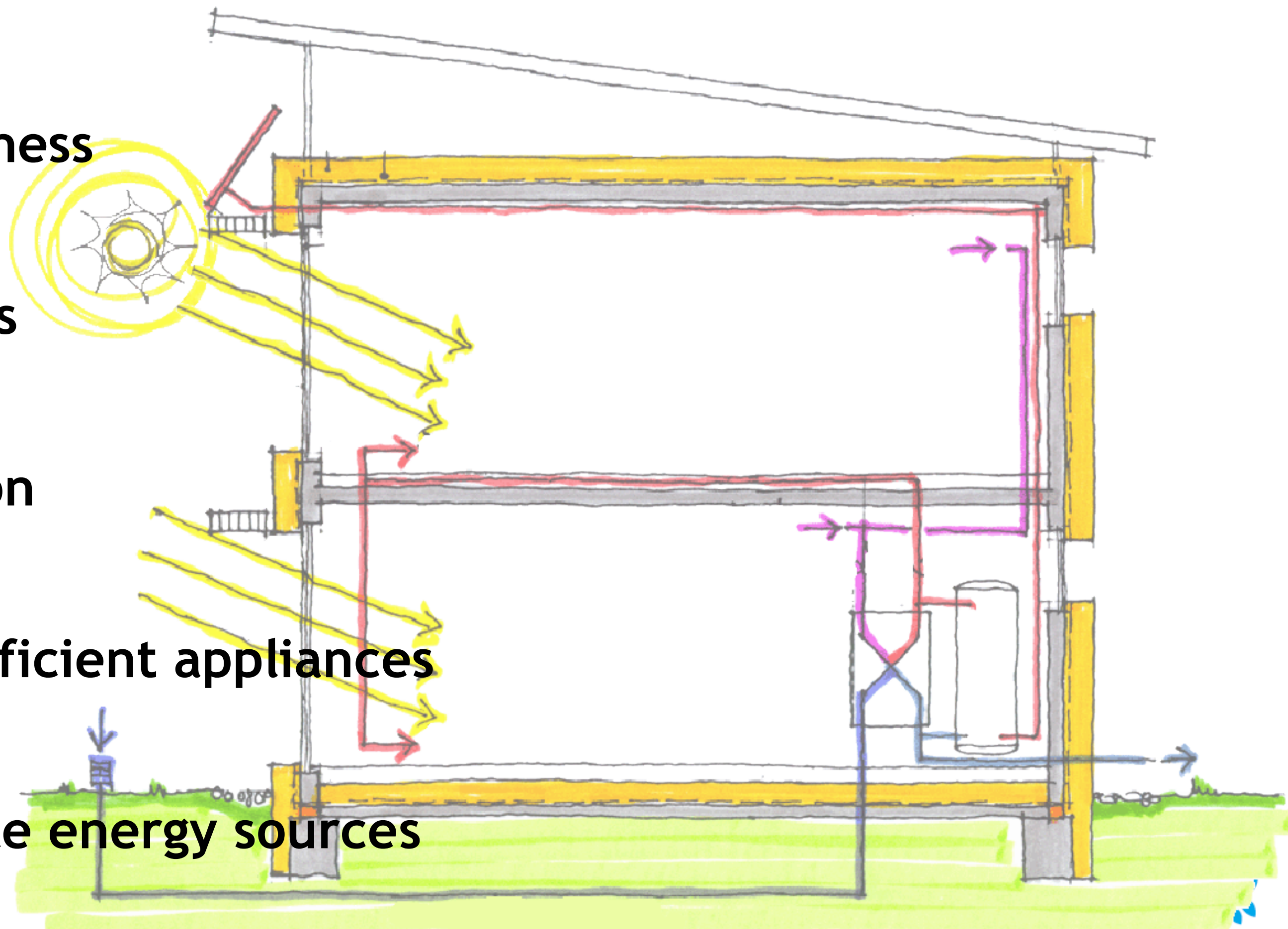
Air-proofness

Heat gains

Ventilation

Energy efficient appliances

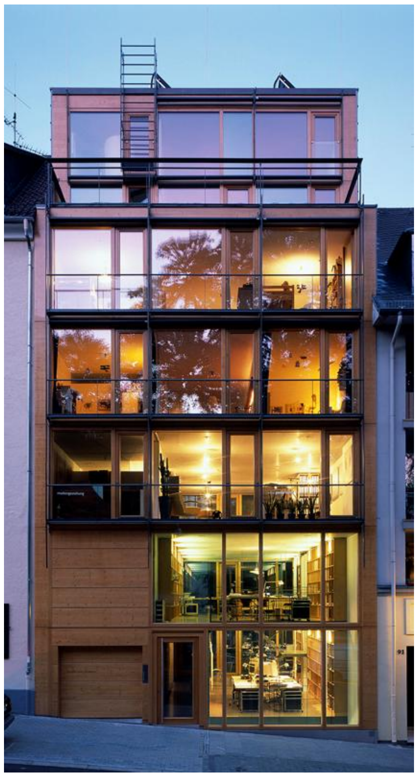
Renewable energy sources



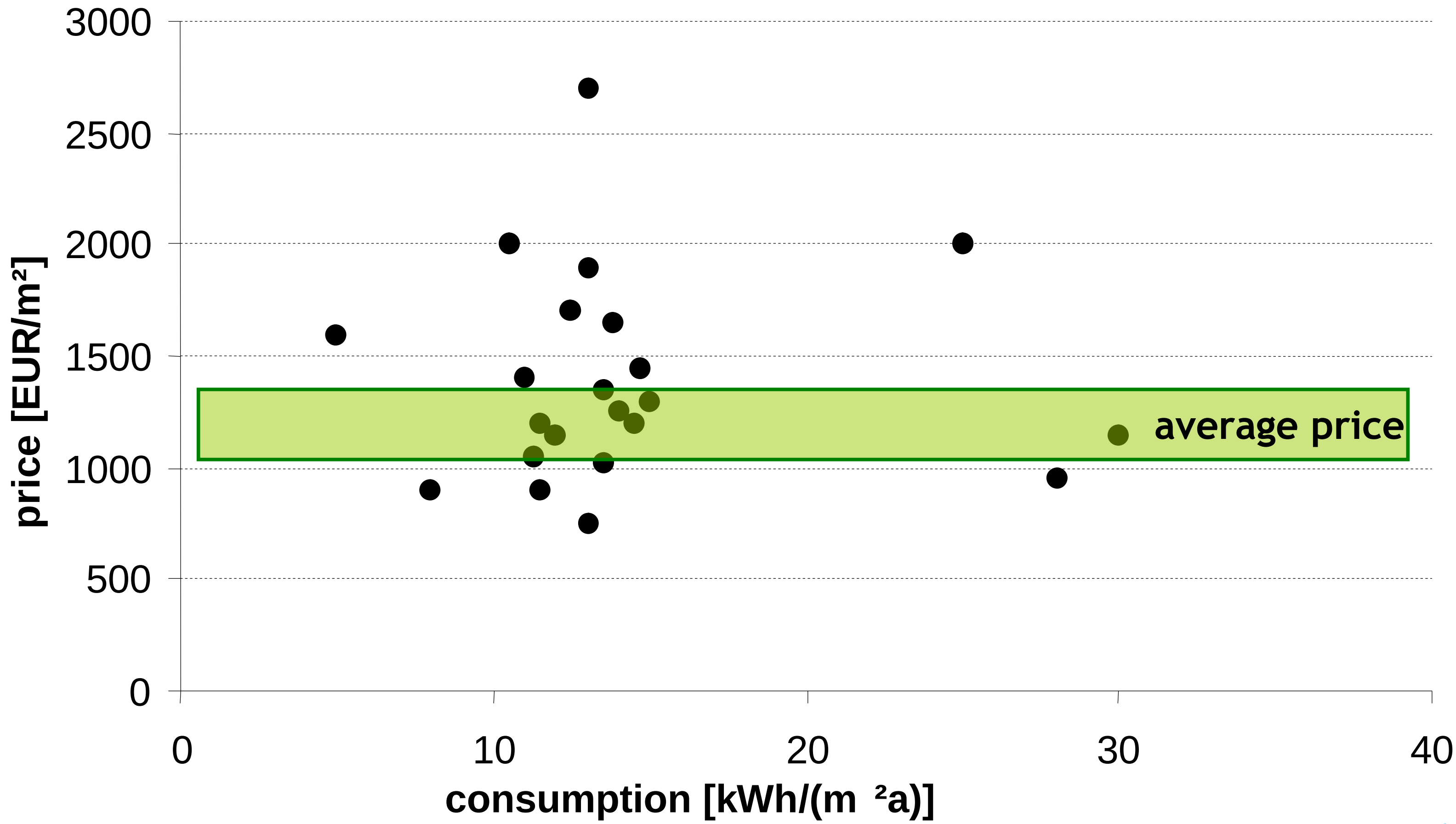
Source: Jan Barta, Center for Passive Buildings, www.pasivnidomy.cz, EEBW2006

Buildings utilising passive solar construction

examples



Are passive houses expensive?



Source: Berndgen-Kaiser: Studie Passivhäuser in NRW

Source: Jan Barta, Center for Passive Buildings, www.pasivnidomy.cz, EEBW2006

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Cost effective building practices, ex.1

Economics of the new Oregon Health and Science University building.

Item	
Total project cost	$145.4 million
Energy efficiency features	$975,000
PV system	$500,000
Solar thermal system	$386,000
Commissioning	$150,000
Total costs	**$2,011,000**
Savings in mechanical systems	**$3,500,000**
Value of saved space	**$2,000,000**
Net cost	**-$3,489,000**
Estimated annual operating cost savings	$600,000

Source: Interface Engineering (2005) as cited by Danny Harvey

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Cost effective building practices, ex. 2

•Comparison of component costs for a building with a conventional VAV mechanical system and conventional (double-glazed, low-e) windows with those for a building with radiant slab heating and cooling and high-performance (triple-glazed, low-e, argon-filled) windows, assuming a 50% glazing area/wall area ratio.
•Costs are in 2001 Canadian dollars for the Vancouver market in 2001, are given per m2 of floor area, and are based on fully costed and built examples over a 3-year period.

Building Component	**Conventional Building**	**High-performance Building**
Glazing	$\$140/m^2$	$\$190/m^2$
Mechanical System	$\$220/m^2$	$\$140/m^2$
Electrical System	$\$160/m^2$	$\$150/m^2$
Tenant finishings	$\$100/m^2$	$\$70/m^2$
Floor-to-floor height	4.0 m	3.5 m
Total	**$\$620/m^2$**	**$\$550/m2$**
Energy Use	$180\ kWh/m^2/yr$	$100\ kWh/m^2/yr$

Source: McDonell (2003) as cited by Danny Harvey.

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  - 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
- Buildings energy consumption can be effectively reduced to a fraction of standard buildings
  - 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
- A large share of these options have "negative costs" – i.e. represent profitable investment opportunities
- Zero-energy (energy-plus) and zero-carbon buildings exist all over the world and are spreading

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Our target is all buildings, everywhere

The EEB project will map out the transition to a 2050 world in which buildings use **zero net energy**. They must also be aesthetically pleasing and meet other sustainability criteria, especially for air quality, water use and economic viability.

World Business Council for Sustainable Development

The role of buildings in our energy challenges

- Activities in buildings are responsible for 35 – 45% of countries' TPES, and a majority of our energy services consumed
- Buildings are responsible for app. 1/3 of energy-related CO2 emissions and 2/3 of halocarbon emissions
- Indoor air pollution from cooking & heating & lighting kills app. 2 million people a year and makes many more sick
- App. 2 billion people do not have access to modern energy carriers, and many of those who have cannot afford adequate levels of energy services to meet basic human needs for nutrition, safe drinking water, shelter and thermal comfort (+education and breadwinning)
- Energy poverty is widespread even in developed countries:
  - In the UK app. 30,000 excess winter deaths occur; most of these attributable to poor heating

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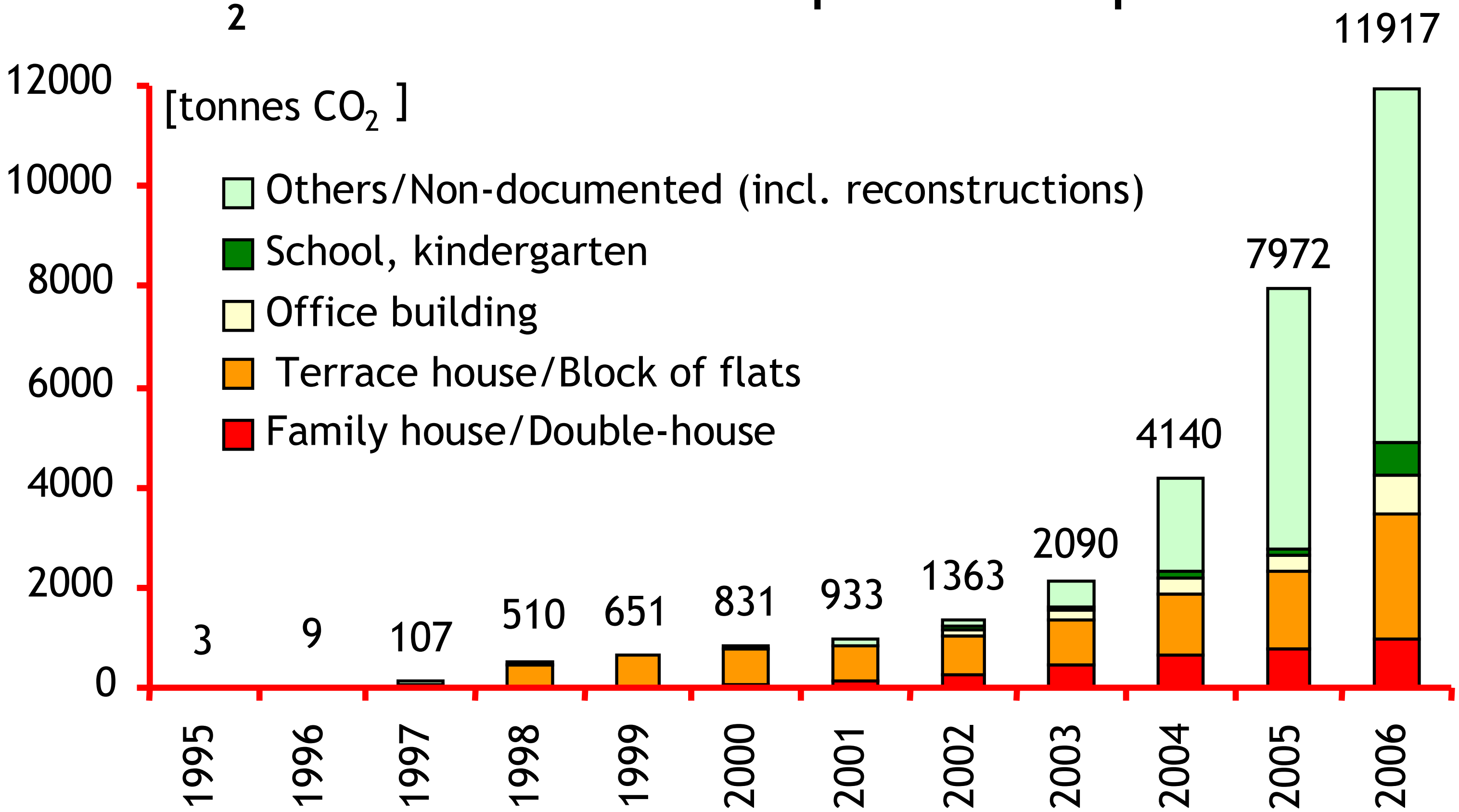
Recent developments in Austria

CO_2 reductions due to completed/built passive houses



Source: passive-house building database, www.HAUSderZukunft.at

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Catalising a transformation to a sustainable building energy future

- While there are substantial attractive opportunities for sustainable energy solutions in buildings, significant barriers exist
  - Such as split incentives, lack of knowledge and awareness, lack of qualified experts, fragmented industry, large role of informal construction sector, lack of financing, etc.
- Thus markets will not capture these opportunities alone, even with a high carbon price
- Strong public policies are needed
- Policy best practices exist all over the world
  - Building energy efficiency has been among the most economically attractive carbon mitigation instruments

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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-effectiveness	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

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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-effectiveness	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$

Catalising a transformation to a sustainable building energy future

- While there are substantial attractive opportunities for sustainable energy solutions in buildings, significant barriers exist
  - Such as split incentives, lack of knowledge and awareness, lack of qualified experts, fragmented industry, large role of informal construction sector, lack of financing, etc.
- Thus markets will not capture these opportunities alone, even with a high carbon price
- Strong public policies are needed
- Policy best practices exist all over the world
  - Building energy efficiency has been among the most economically attractive carbon mitigation instruments
  - Ambitious targets and standards are spreading

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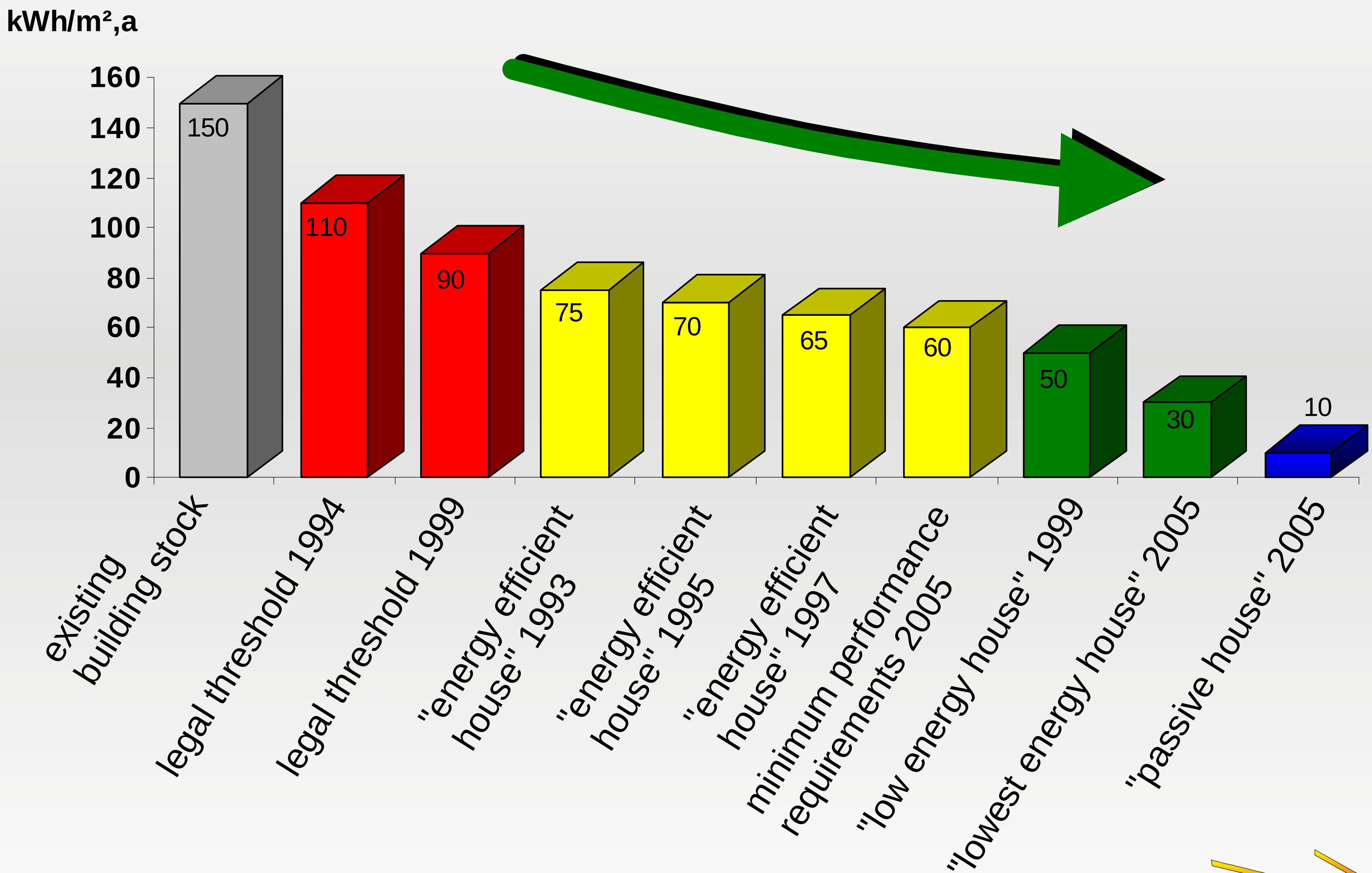
Building Trends in Upper Austria

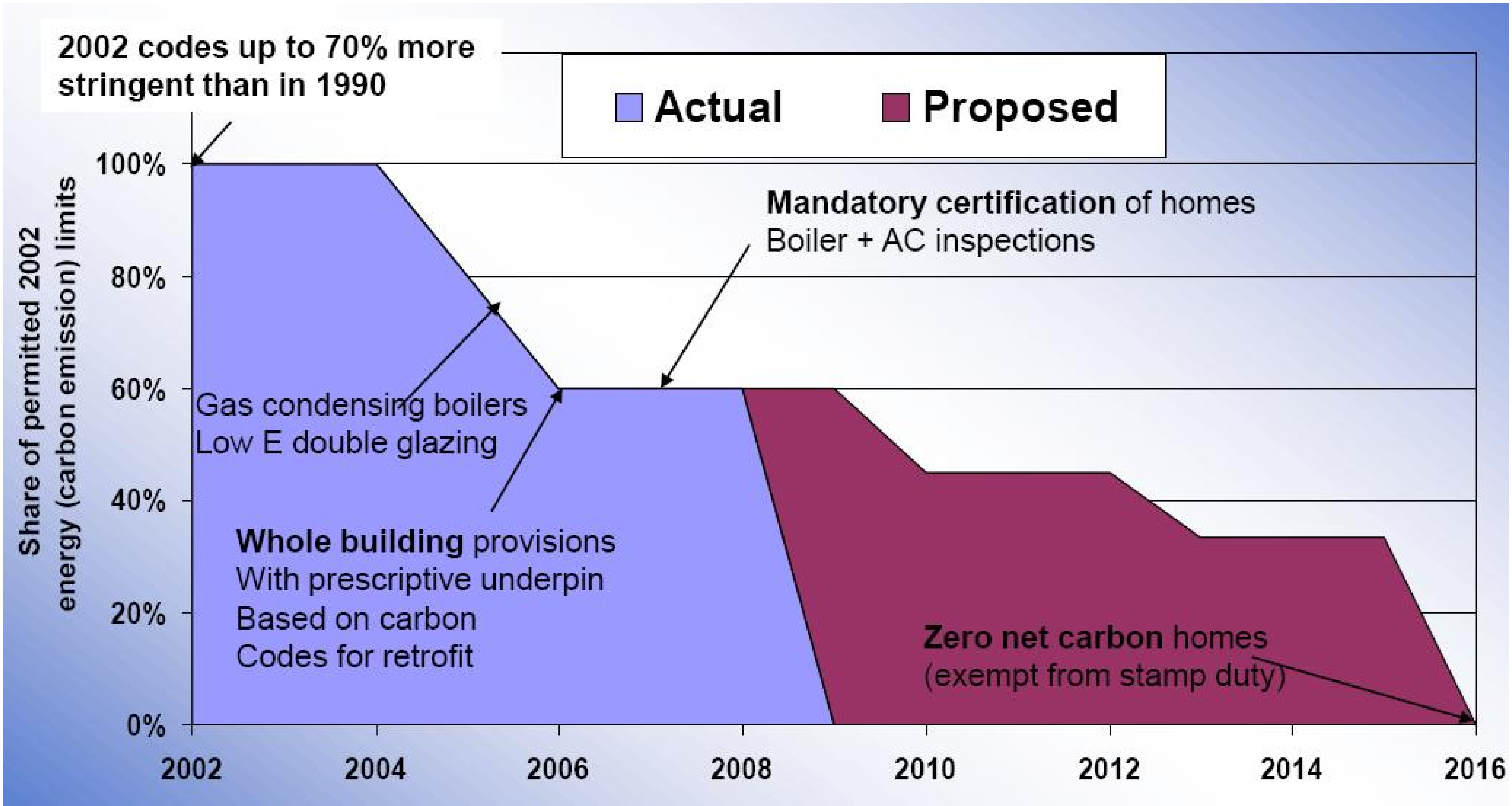


Source: Christine Egan, World Sustainable Energy Days, Austria, 2006

O.Ö. ENERGIESPARVERBAND

Progression in UK building code requirements for new homes

Source: Paul Waide, IEA



It is estimated that 30% of UK's projected 2050 building stock is yet to be built

Early investment are important

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

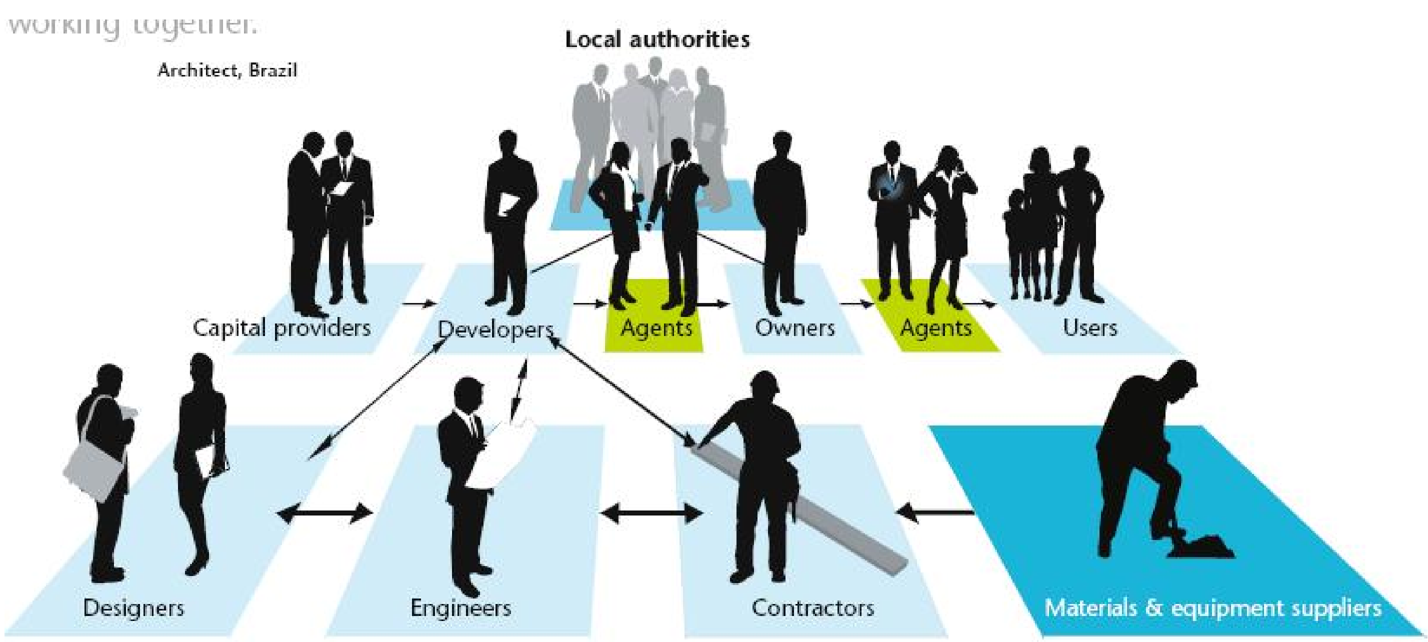
Typical lifetime of capital stock			**Structures with influence > 100 years**
less than 30 years	**30-60 years**	**60-100 years**	
Domestic appliances Water heating and HVAC systems Lighting Vehicles	Agriculture Mining Construction Food Paper Bulk chemicals Primary aluminium Other manufacturing	Glass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

18 typical power stations power the standby mode of US home appliances, costing $3 bn annually to consumers

Mar 9th 2006,The Economist print edition

3CSEP

Barrier: the fragmented industry



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Rhone glacier, Switzerland in 1859 vs 2001

Retreat of 2.5 km and 450 M elevation

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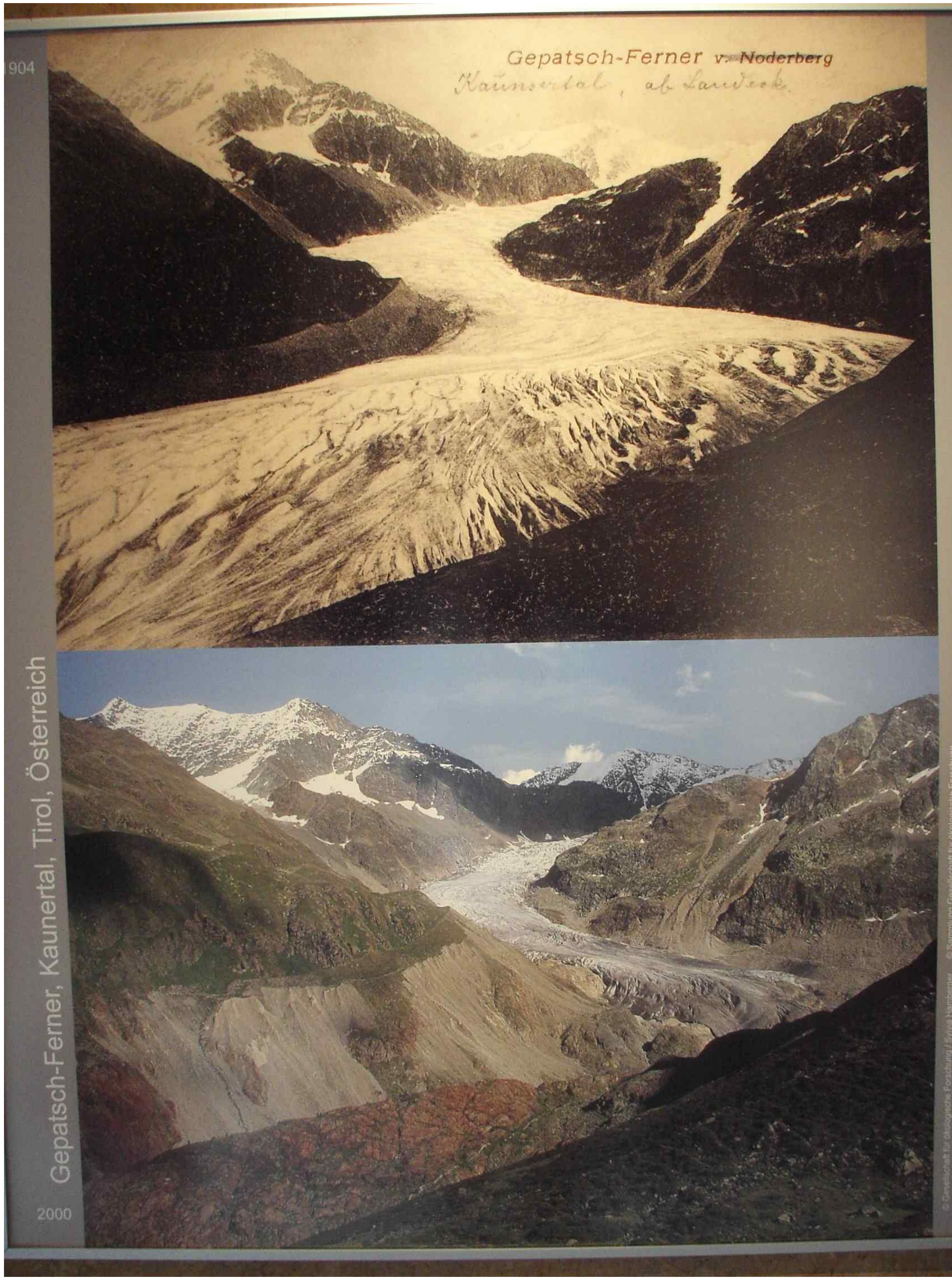
Gepatsch-Ferner v. Noderberg
1904
Gepatsch-Ferner, Kaunertal, Tirol, Österreich
2000

EP