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Energy savings potential in the Hungarian public buildings for space heating

Katarina Korytarova
and Diana Ürge-Vorsatz

13 April 2010

Overview

- **The urge to act - buildings as a part of the solution**
- **Energy savings potential – methodology & results:**
  - Component-based approach
  - Performance-based approach
- **Scenario analysis – “lock-in effect”**

January 12, 2010

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With Climate Change Comes Floods

by ANNA VIGRAN

AFP/Getty Images

Bangladeshi women make their way through flood water at Dhakuria in Sirajgonj district on Sept. 10, 2007.

January 14, 2008

text size A A A

Climate change is disturbing the delicate balancing act that people have with water. Water is critical to life — for drinking and irrigation, and as a source of food, transportation and recreation. But too much water — or water that comes at an unexpected time, or in unexpected places — can be a big problem.

As global temperatures rise, many places are threatened by flooding. A recent study looking at who is at risk shows many coastal cities could be hit hard, particularly heavily populated cities in Asia. But in terms of economic loss, the Organization for Economic Co-operation and Development found that the top 10 cities at risk are all in three industrialized countries: the United States, Japan and the Netherlands.

Warming water can cause rises in sea levels and strong storms, with the potential to impact people around the globe

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Giant iceberg spotted off Australia

A giant iceberg the length of seven football pitches has been spotted f

By Louise Gray, Environment Correspondent

Published: 6:52PM GMT 12 Nov 2009

A giant iceberg seen off Macquarie Island halfway between Antarctica and Australia Photo: EPA

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Science News

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Record Warm Summers Cause Extreme Ice Melt In Greenland

ScienceDaily (Jan. 16, 2008) — An international team of scientists, led by Dr Edward Hanna at the University of Sheffield, has demonstrated that recent warm summers have caused the most extreme Greenland ice melting in 50 years.

See Also:

Earth & Climate

- Global Warming
- Climate
- Ice Ages
- Geography
- Environmental

The new research provides further evidence of a key impact of global warming and helps scientists place recent satellite observations of Greenland's shrinking ice mass in a longer-term climatic context.

Dr Hanna of the University's Department of Geography, alongside

Large iceberg in Greenland. (Credit: iStockphoto/Rob Broek)

GENEVA, Feb. 25, 2009

Glaciers Melting Faster Than First Thought

Researchers Believe Ice Melting Across Wider Area, Threatens To Raise Sea Levels

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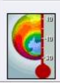
British Environment Minister Hilary Benn, last figure, in yellow parka, joins other ministers and representatives from a dozen nations, on a fact-finding visit to the area around Norway's Troll Research Station, Feb. 23, 2009. (AP Photo)



INTERACTIVE
Global Warming
The greenhouse effect, a look at the Kyoto Protocol and a history of the Earth's climate

(AP) Glaciers in Antarctica are melting faste wider area than previously thought, a devel to raise sea levels worldwide and force mill low-lying areas, scientists said Wednesday

Researchers once believed that the melting Antarctic Peninsula, a narrow tongue of lan South America. But satellite data and auton now indicate it is more widespread.

The melting "also extends all the way down Antarctica," said Colin Summerhayes, exec Britain-based Scientific Committee on Anta

"That's unusual and unexpected," he told T an interview.

By the end of the century, the accelerated m levels to climb by 3 to 5 feet - levels substar predicted by a major scientific group just tw

Making matters worse, scientists said, the i the glaciers back from the sea are also wea

The report Wednesday from Geneva was a years of research by scientists from 60 cou findings were released in earlier reports.

In Washington, as part of an overall update top researchers on Wednesday sounded a U.S. Senate about rising temperatures in th

The head of the Intergovernmental Panel or group set up by the United Nations, told law

NASA Earth Observatory

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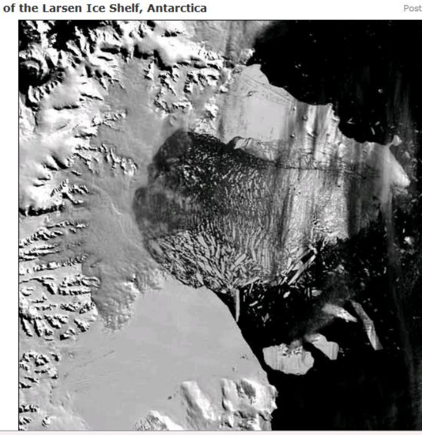
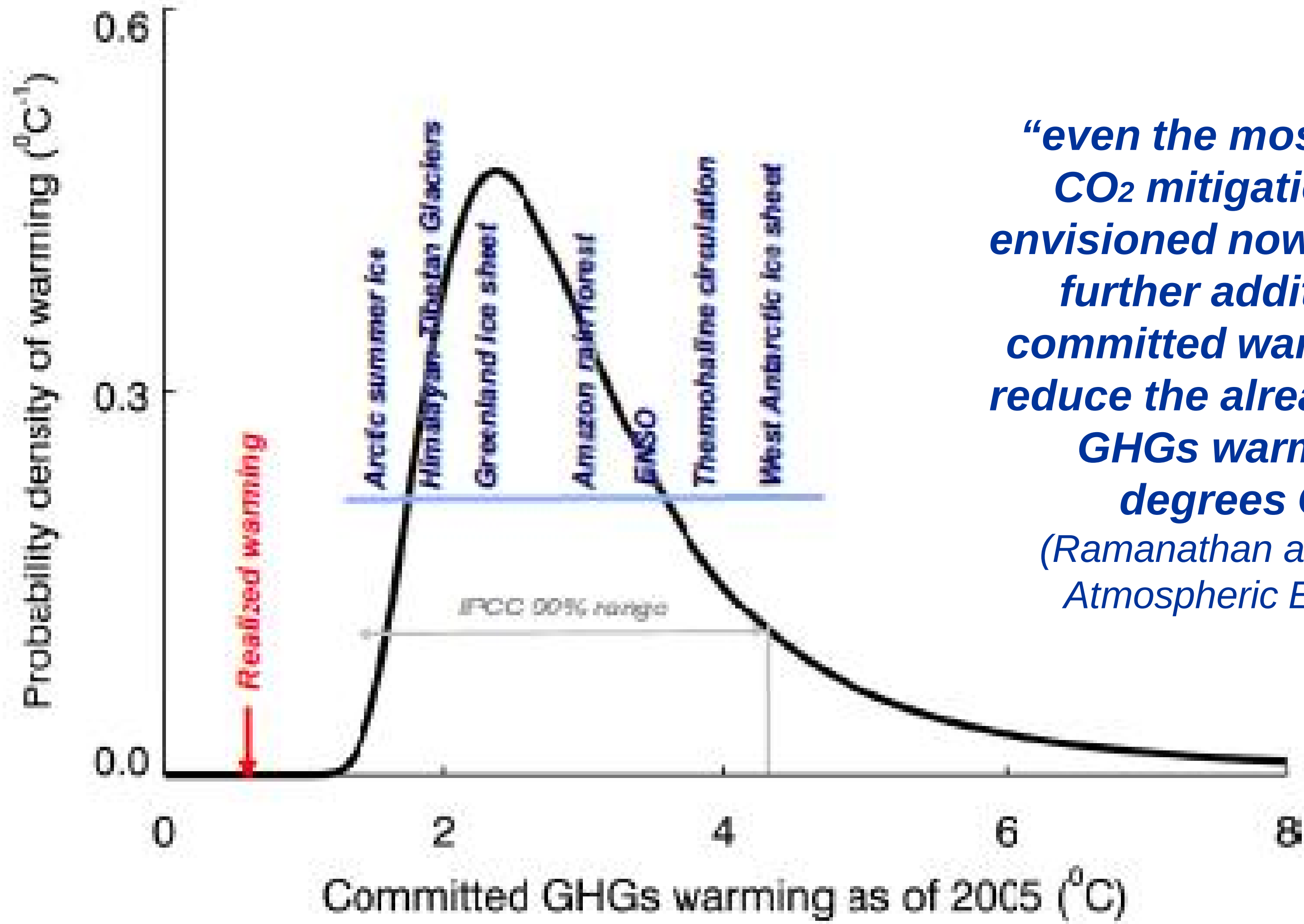
Breakup of the Larsen Ice Shelf, Antarctica

Posted March 20, 2002

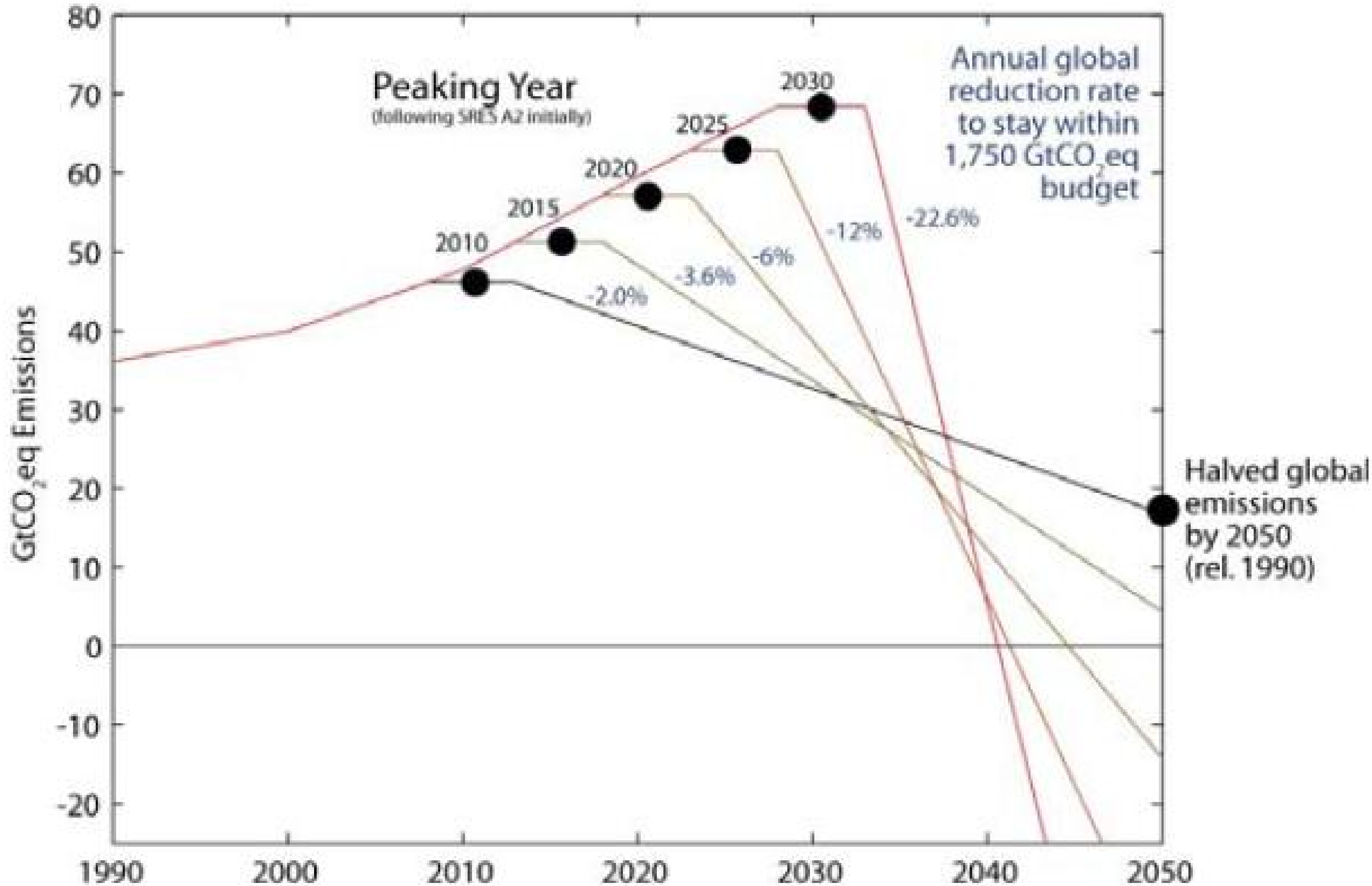


Probability distribution for the committed warming by GHGs between 1750 and 2005.
Shown are climate tipping elements and the temperature threshold range.



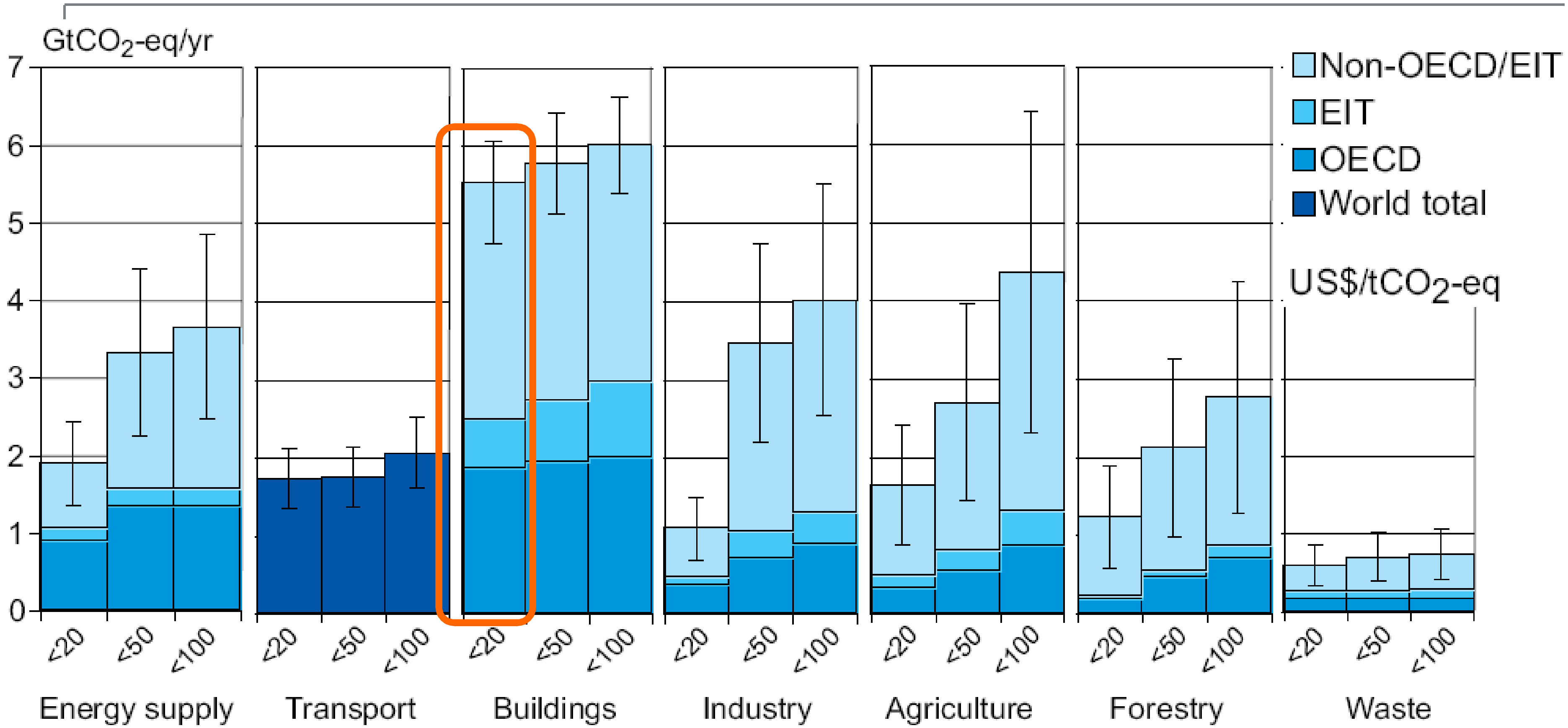
"even the most aggressive CO_2 mitigation steps as envisioned now can only limit further additions to the committed warming, but not reduce the already committed GHGs warming of 2.4 degrees Celsius"

(Ramanathan and Feng 2008, Atmospheric Environment).



Source: Meinshausen et al (2009)

The buildings sector offers the largest low-cost potential in all world regions by 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)*

Source: IPCC (2007) Summary for policy makers

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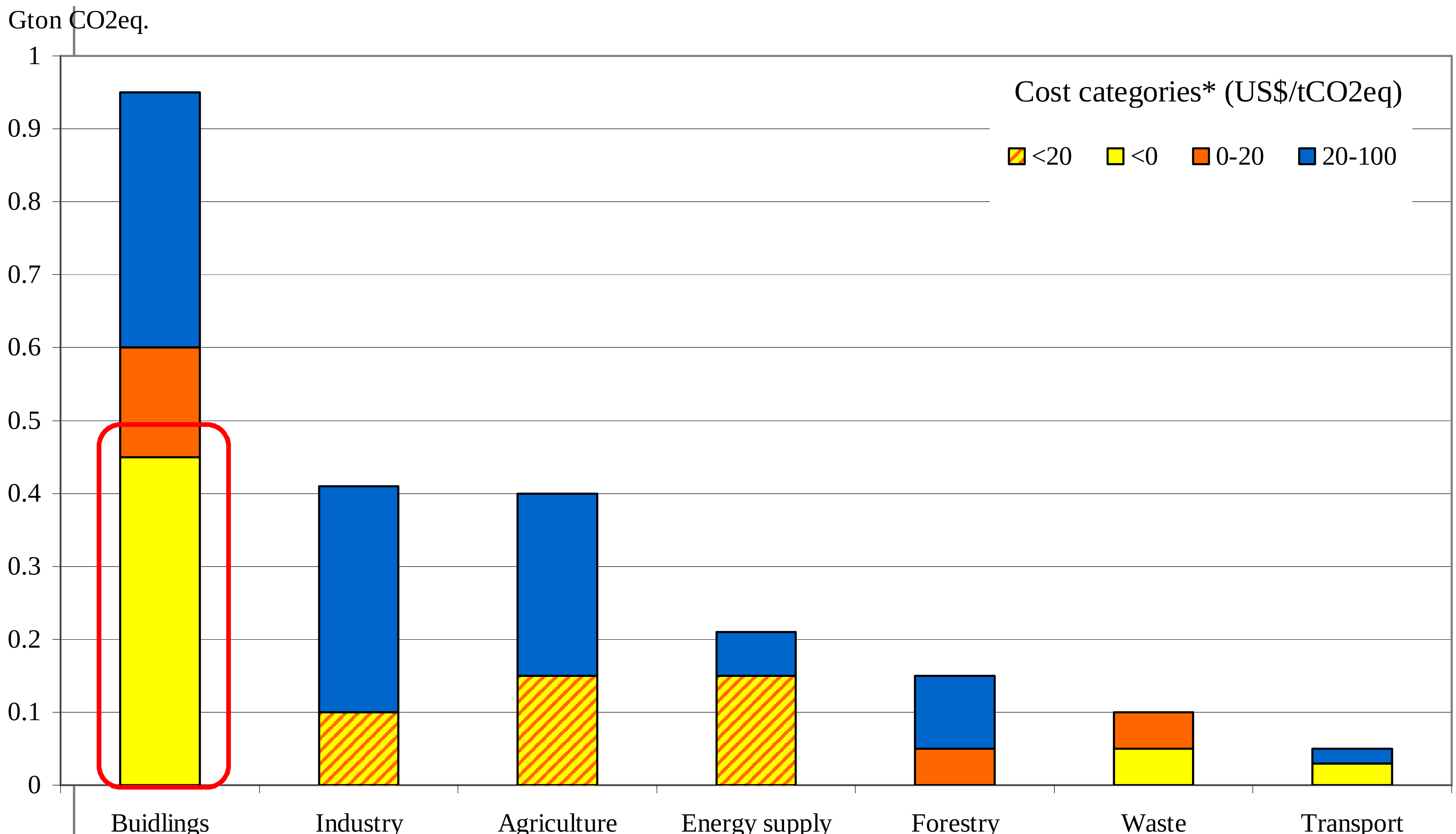
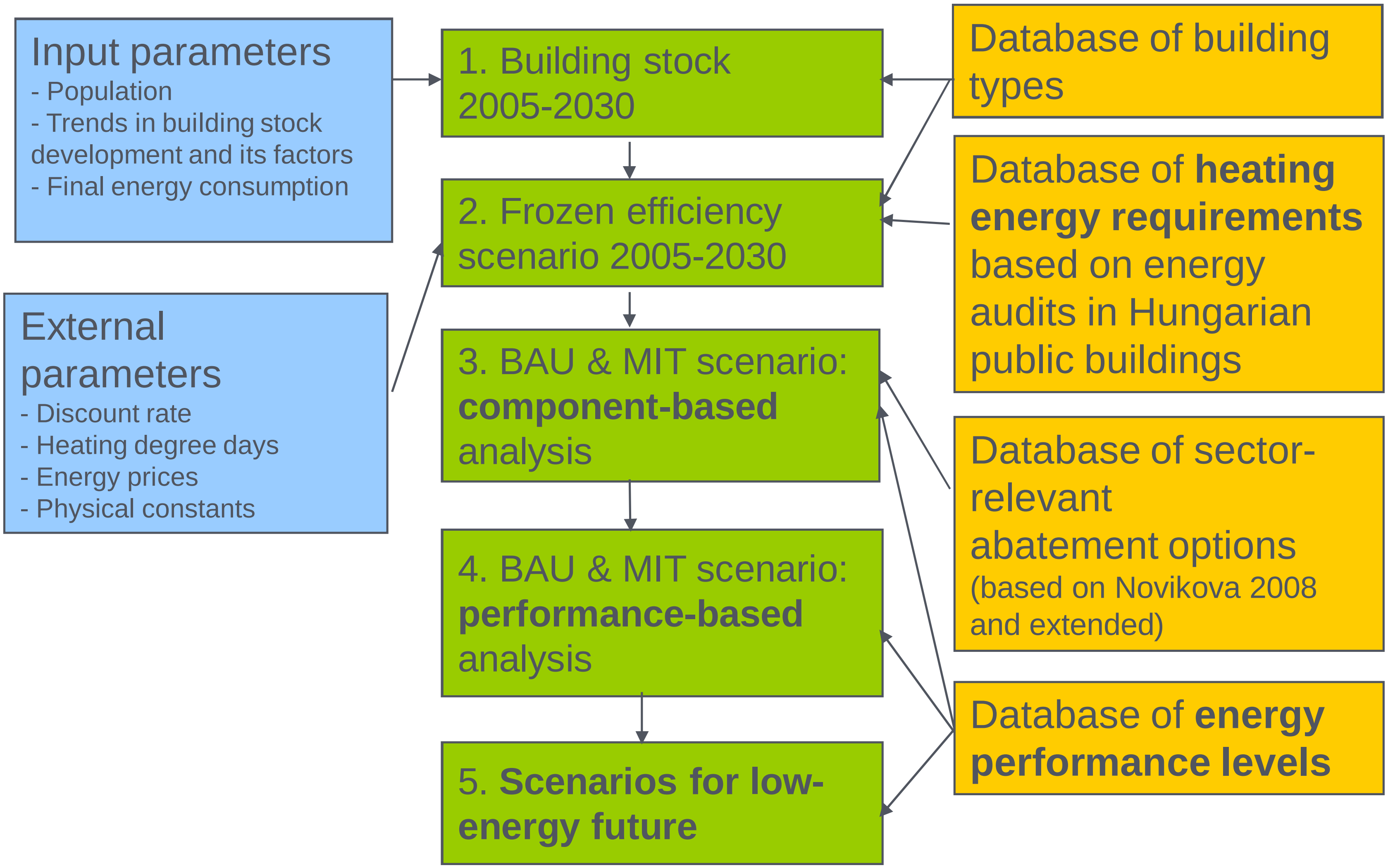
Estimated potential for GHG mitigation at a sectoral level in 2030 in different cost categories, transition economies



* 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.

Source: Urge-Vorsatz and Novikova (2008)

Research methodology



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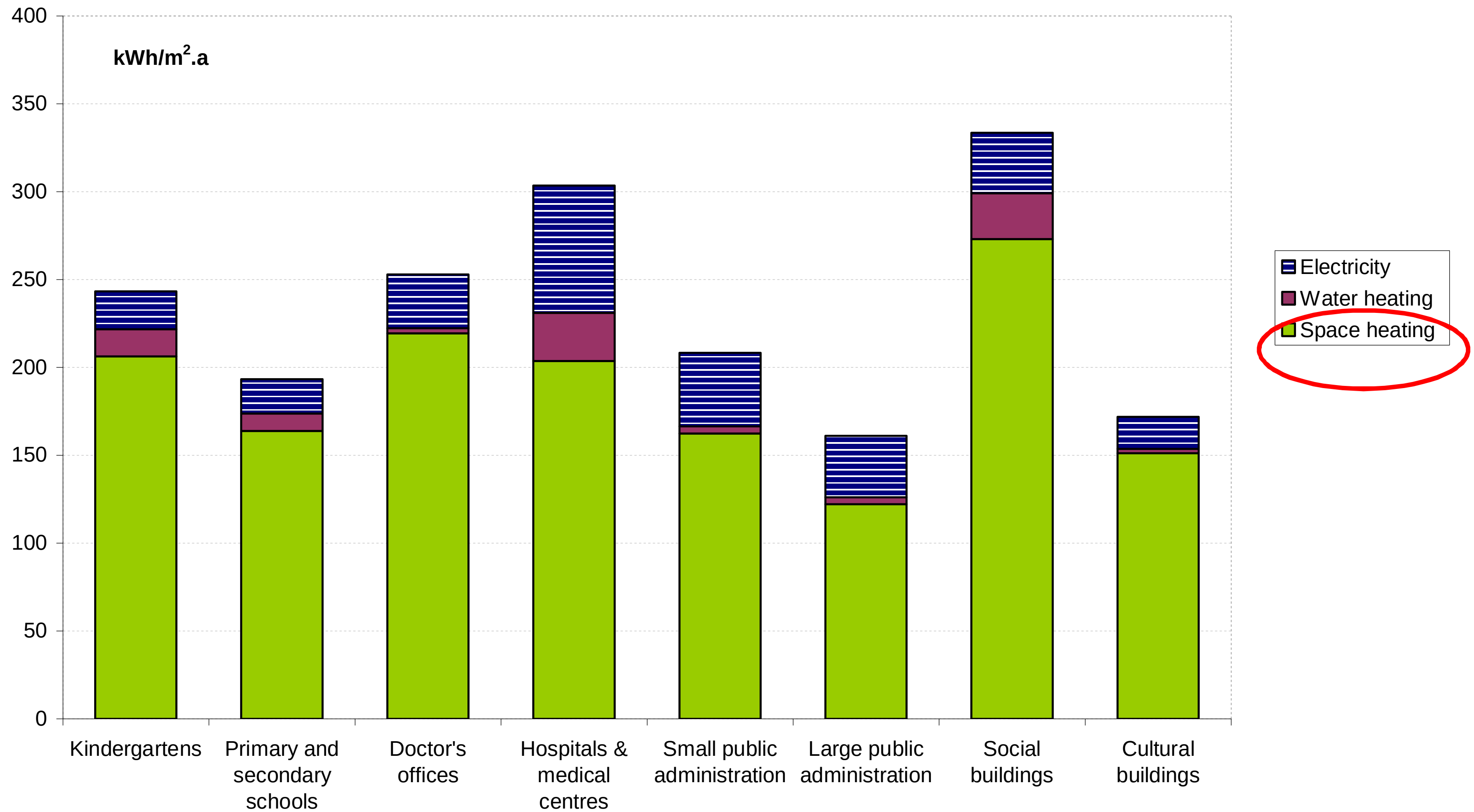
Specific heating energy requirements in Hungarian public buildings



Source: UNDP/Energy centre (2008), Nagy (2008), Csoknyai (2008)

Component-based analysis

Technical values for the retrofit*

U_{wall}=0.35
$U_{windows}$=0.95
U_{roof}=0.225
$U_{basement}$=0.23
ACH=0.5

Temperature management by 2ºC

Improving efficiency of heating systems
η=97%

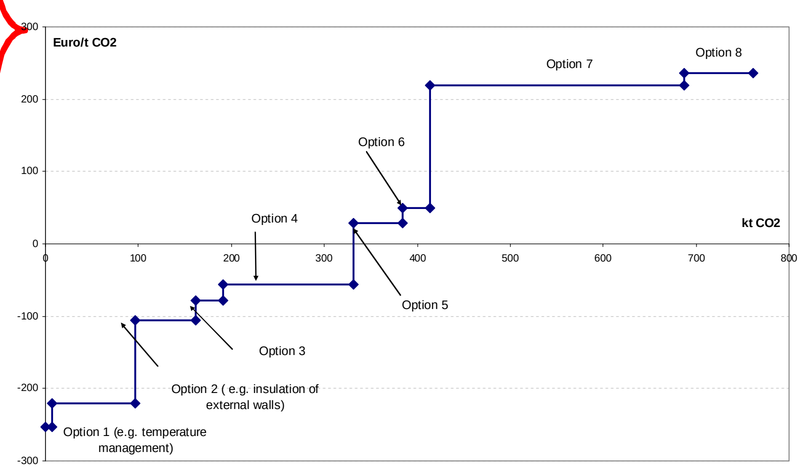
Costs of the components

- product catalogues
- consultations with experts
- international literature

Ranked by cost-effectiveness

"Cost curve" method

Avoiding double-counting



**based on Novikova (2008) and adjusted*

Performance-based analysis

- Windows
- Temperature management
- Heating system
- Roof
- Basement …

Source: images.google.com

Performance-levels: 60 kWh/(m^2.a), 30 kWh/(m^2.a), 15 kWh/(m^2.a)

Database of low-energy & passive house best practices

Denmark

Low energy class 1

< 35+1100/A kWh/m^2 year

= energy consumption for heating, cooling, ventilation and hot water

Switzerland

MINERGIE

< 42 kWh/m^2 year

= energy consumption for heating, cooling, ventilation and hot water

France

effinergie

< 50 kWh/m^2 year

= energy consumption for heating, cooling, ventilation and hot water + lighting

German Passive House

< 120 kWh/m^2 year

= energy consumption for heating, cooling, ventilation, hot water + lighting and electrical domestic appliances

&

German Passive House

< 15 kWh/m^2 year = energy need for heating

Source: Thomsen et al (2008)

Assumptions: component-based approach

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Component-based model		
BAU_{comp}	Existing buildings	▪ Rate of retrofit: 1% of existing buildings (built until 1990) ▪ Retrofitted: incremental application of energy efficient technologies ▪ Non-retrofitted: average energy consumption based on energy audits
	New buildings	• All new buildings are built to the level of 2006 Building code
$Mitigation_{comp}$	Existing buildings	▪ All existing buildings (built until 1990) are retrofitted by individual measures (insulation, windows exchange and efficient building boilers) by 2030 ▪ Accelerated rate of retrofit
	New buildings	▪ All new buildings are PH by 2020 ▪ The rest is assumed 2011 (phase-out in 2015) and low-energy (phase-out in 2020) ▪ Phase-out of 2006 Building code: 2011

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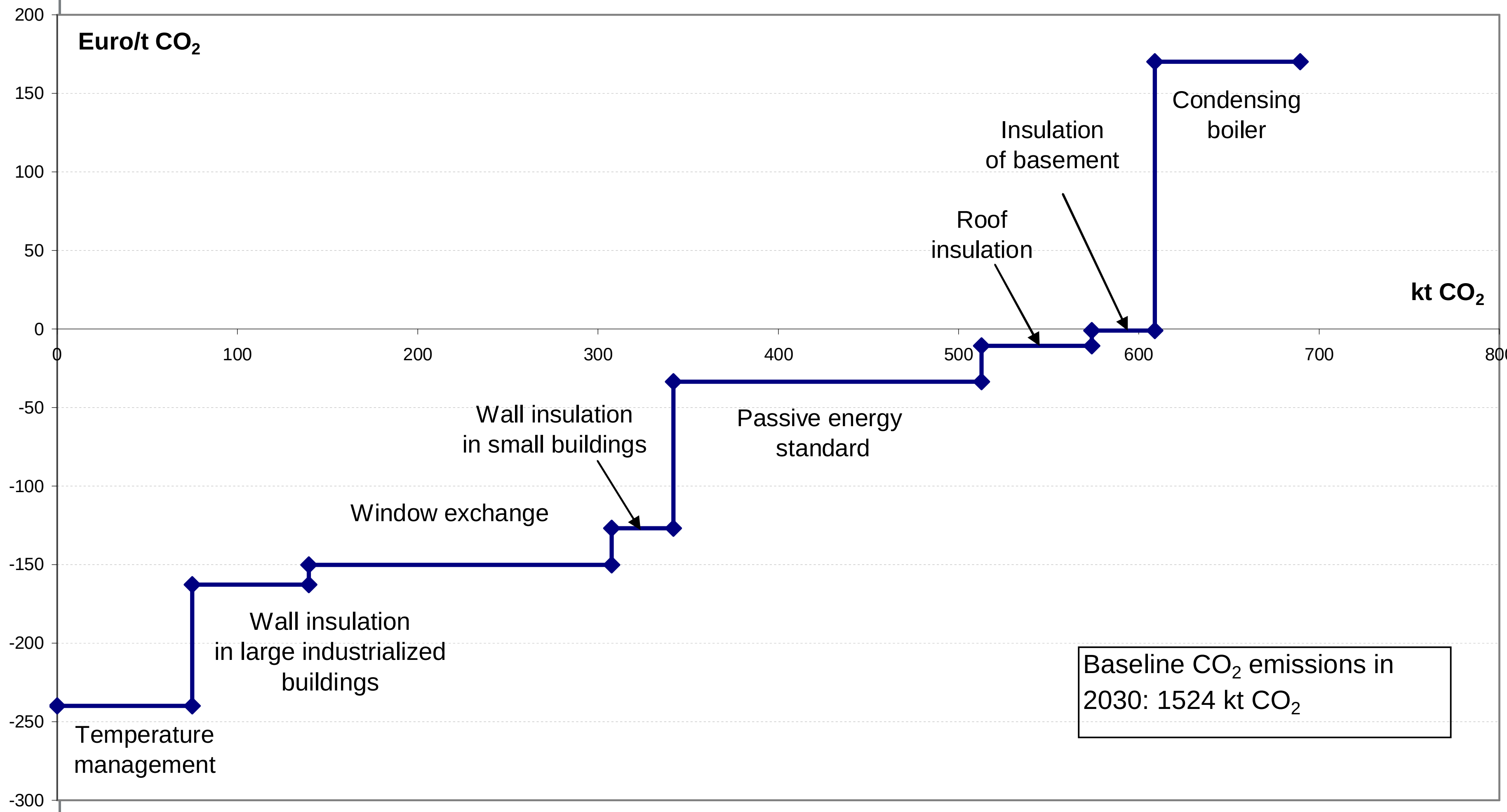
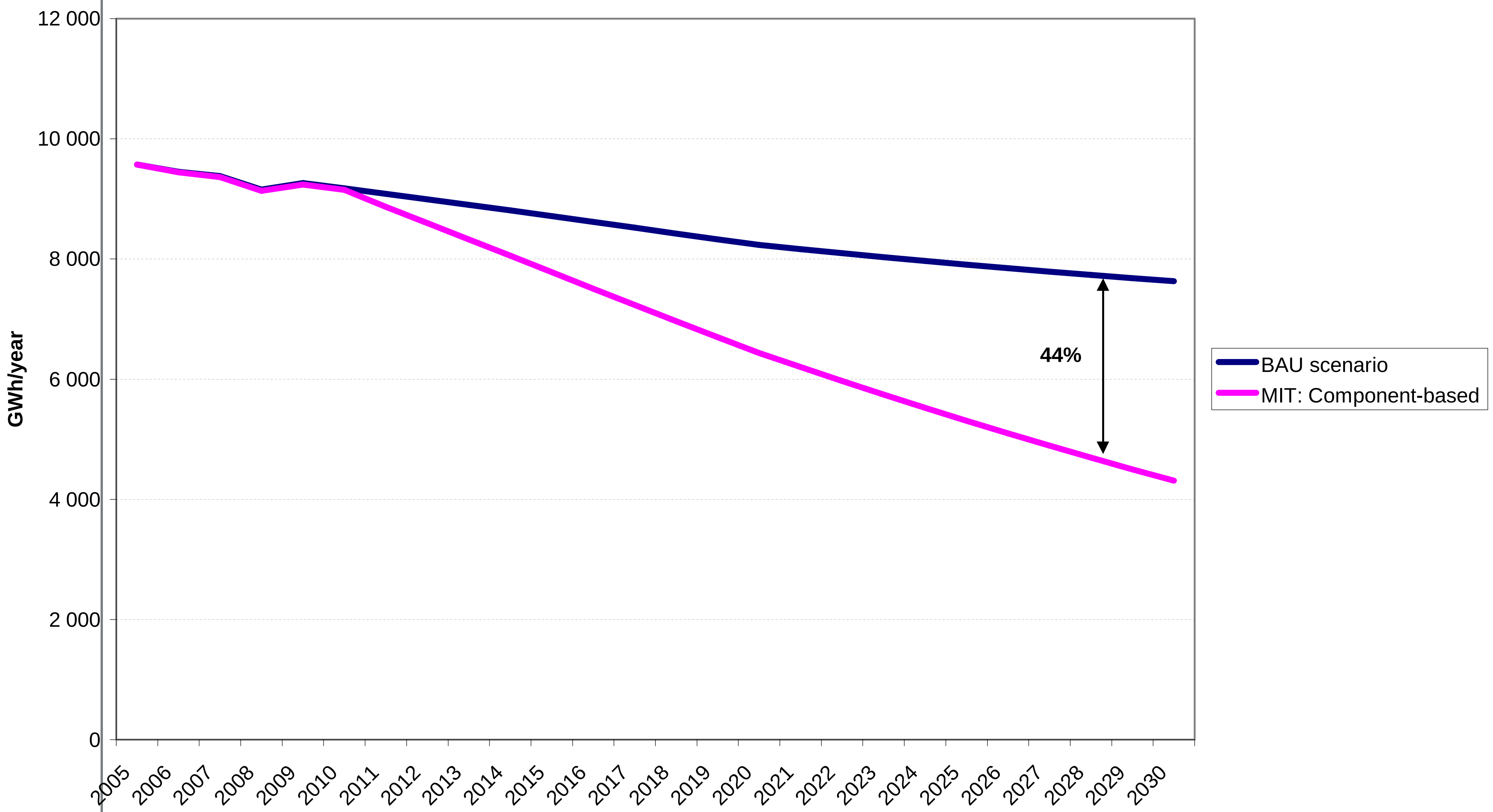
Results: component-based approach



Results: Component-based approach (2)



Assumptions: performance-based approach

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Performance-based model		
BAU_{perf}	Existing buildings	▪ Rate of retrofit: 1% of existing buildings (built until 1990) ▪ Retrofitted: to the level of currently prevailing **partial retrofit** (23% energy savings relative to building built before 1990) or to level of **2006 Building code** (50% energy reduction). • Non-retrofitted: average energy consumption based on energy audits
	New buildings	• All new buildings are built to the level of 2006 Building code
$Mitigation_{perf}$	Existing buildings	▪ All existing buildings (built until 1990) are retrofitted by 2030 •Out of the retrofitted buildings these performance levels are achieved by 2020: •85% PH (15 kWh//m²) •10% Low energy (30 kWh/m²) • 5% 2011 Building code (60 kWh/m²) •Phase-out of partial retrofit: 2011 •Phase-out of 2006 Building code: 2013 •Non-retrofitted: average energy use based on energy audits
	New buildings	▪ All new buildings are PH by 2020 ▪ The rest is assumed 2011 (phase-out in 2015) and low-energy (phase-out in 2020) ▪ Phase-out of 2006 Building code: 2011

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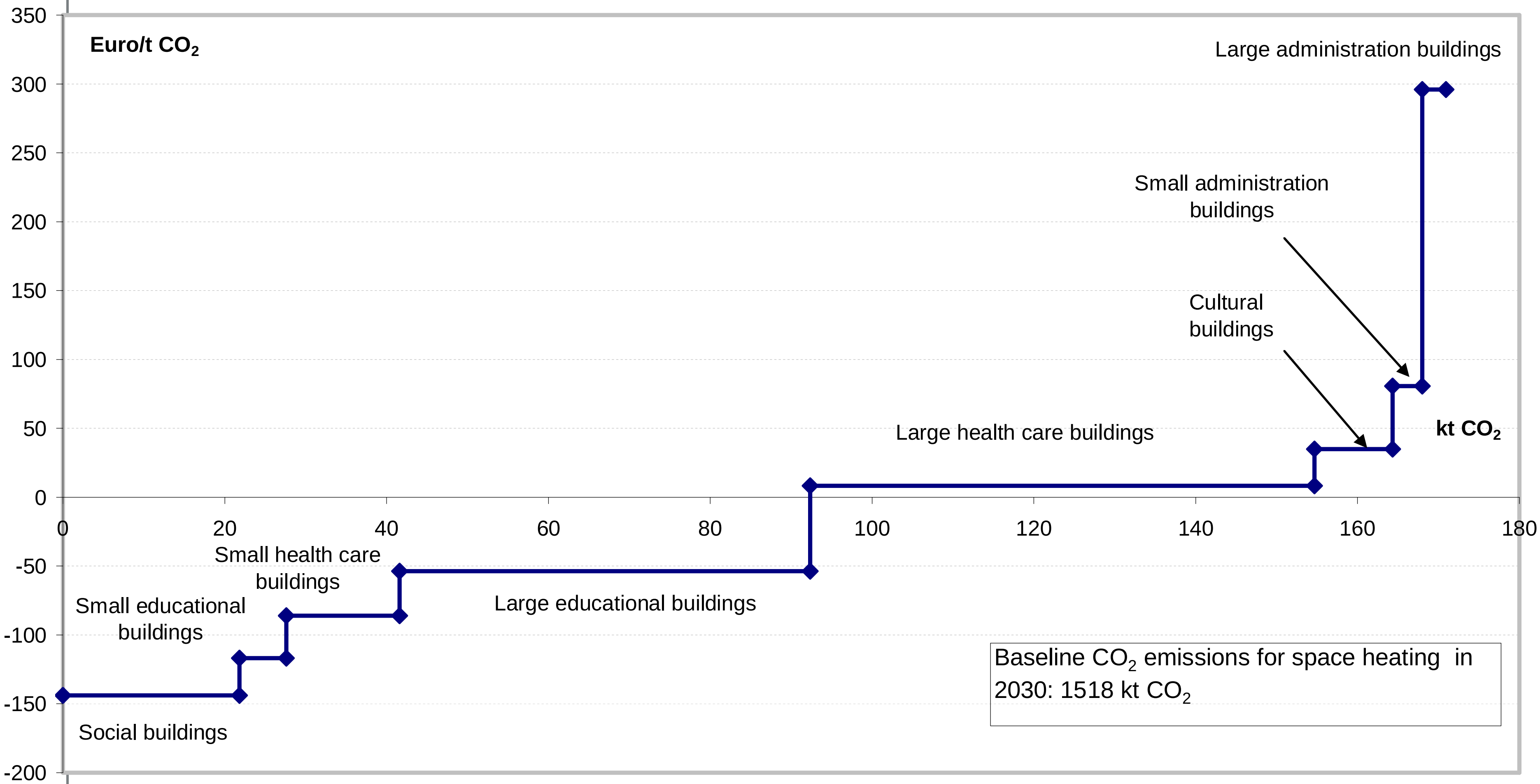
Results: performance-based approach (New)



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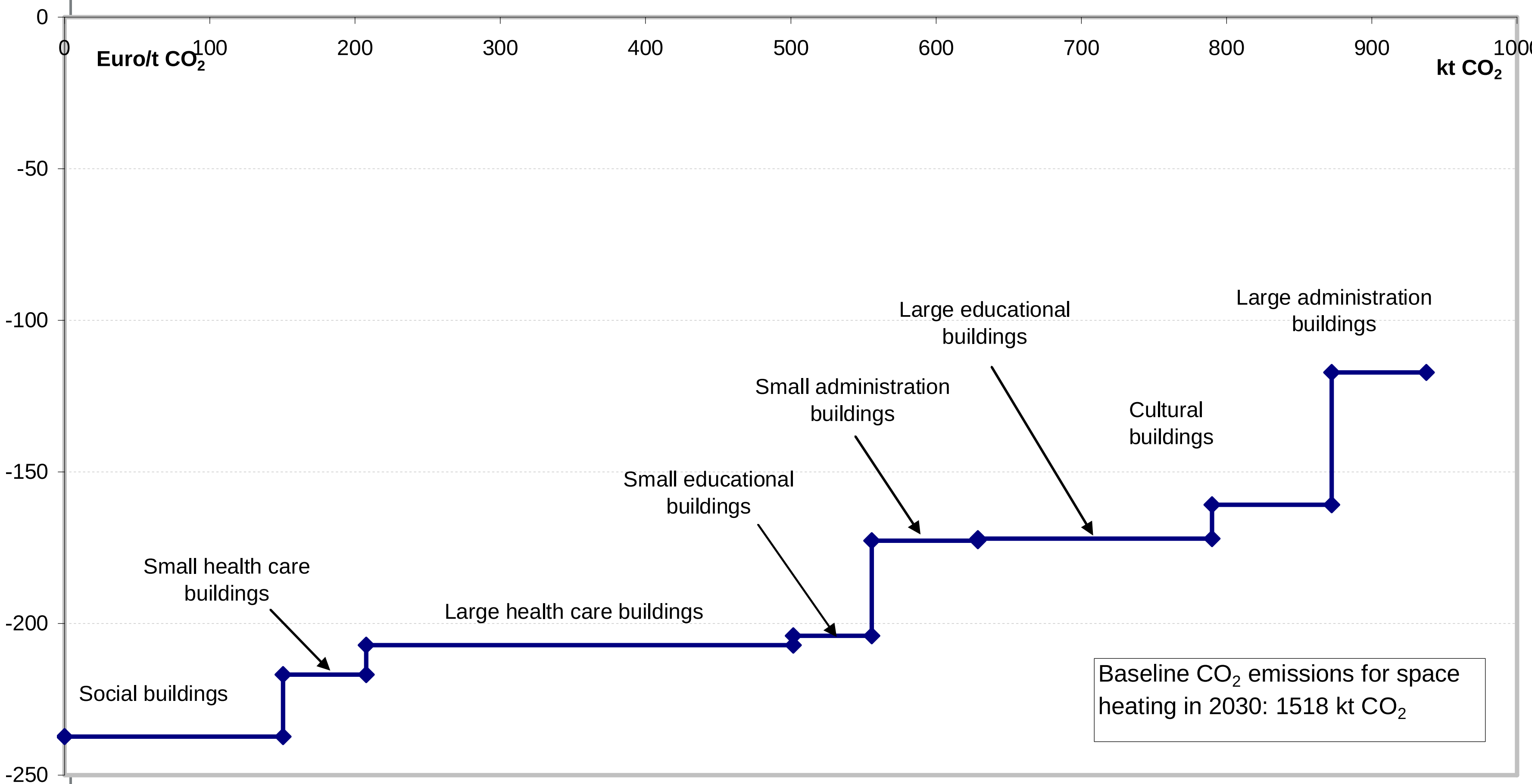
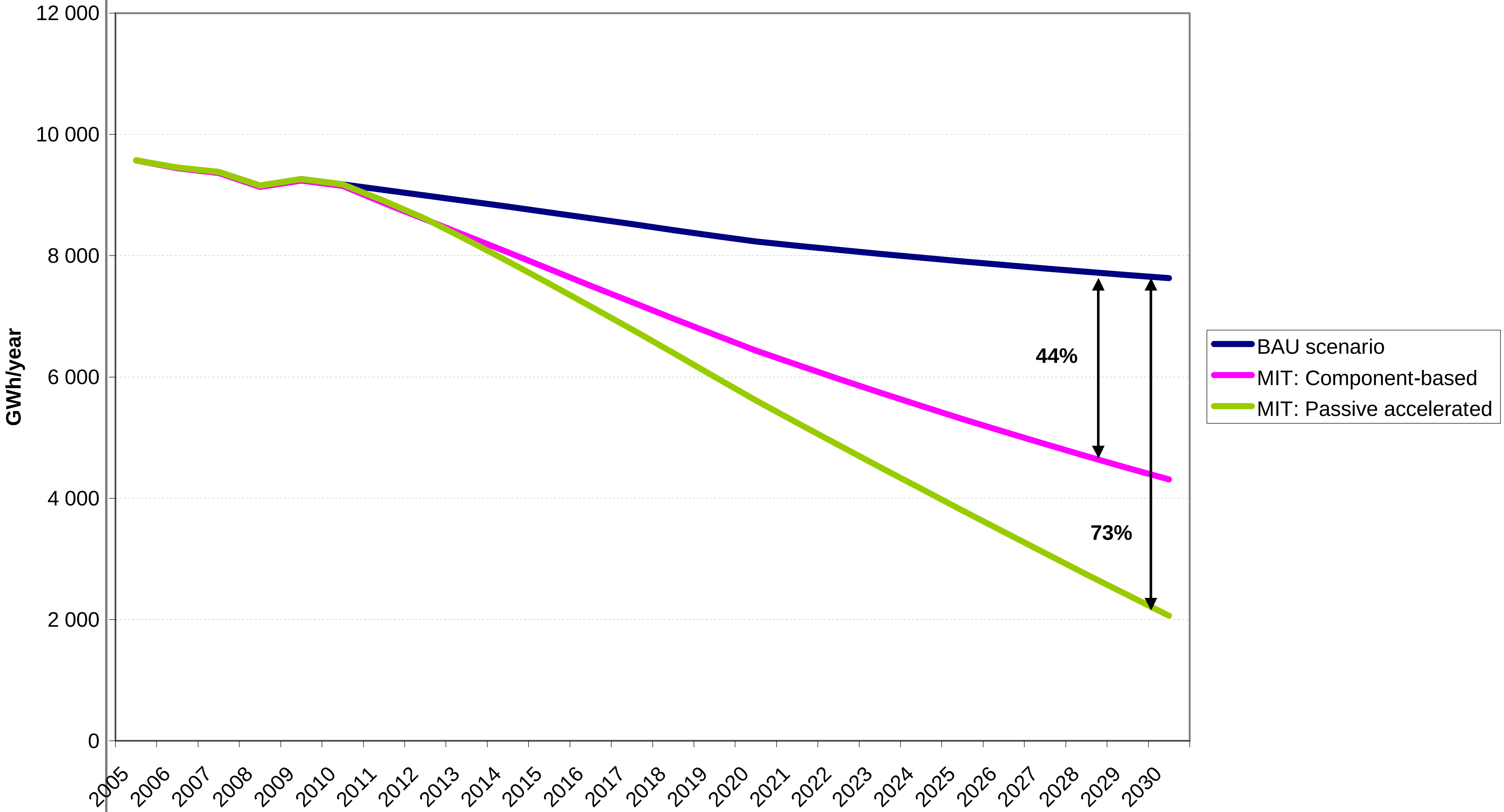
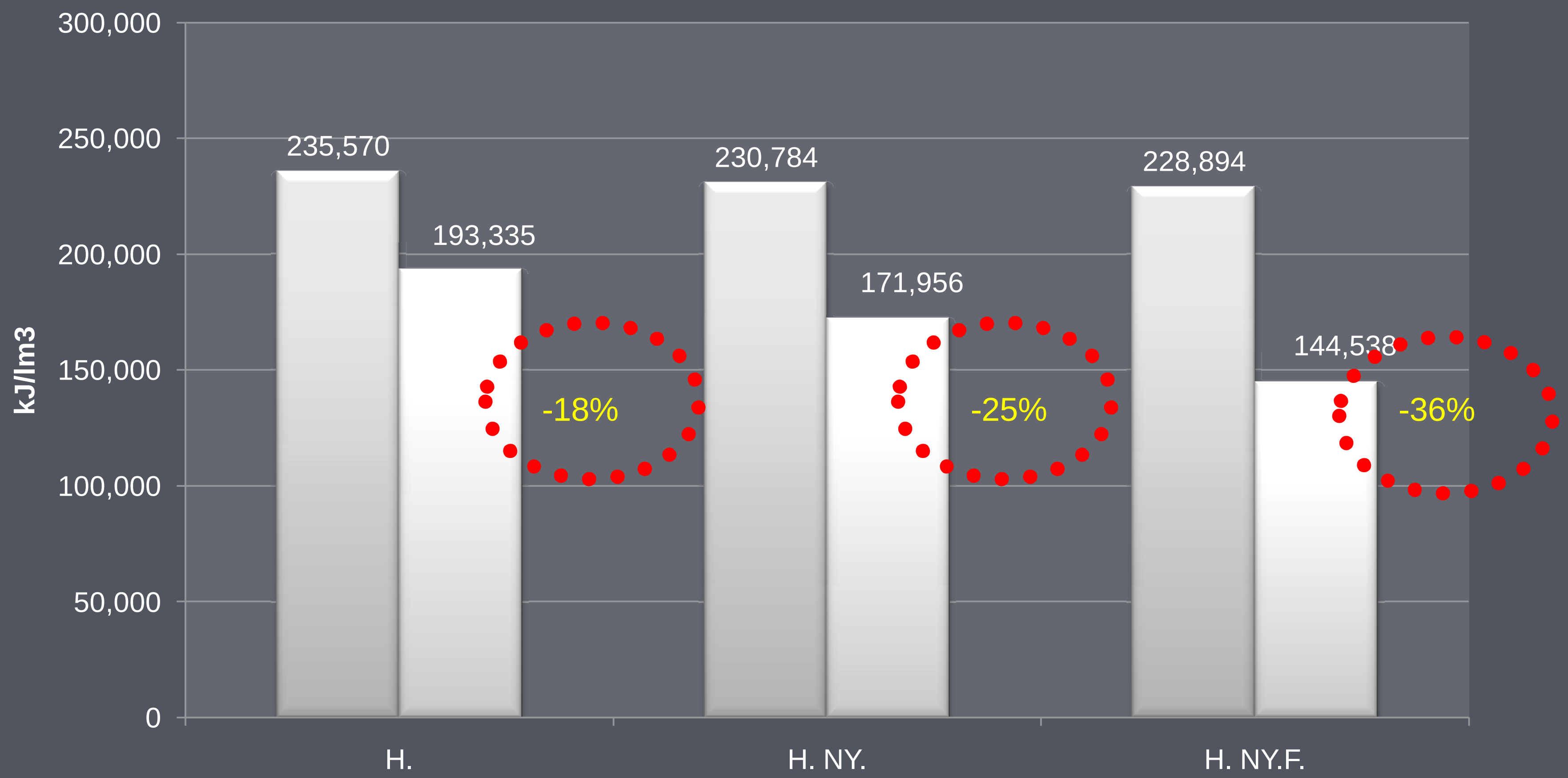
Results: performance-based approach (Retrofit)



Performance- vs. component-based approach



Panelfelújítási programban részt vevő épületek fűtési fajlagos hőfelhasználásának alakulása
Székesfehérvár



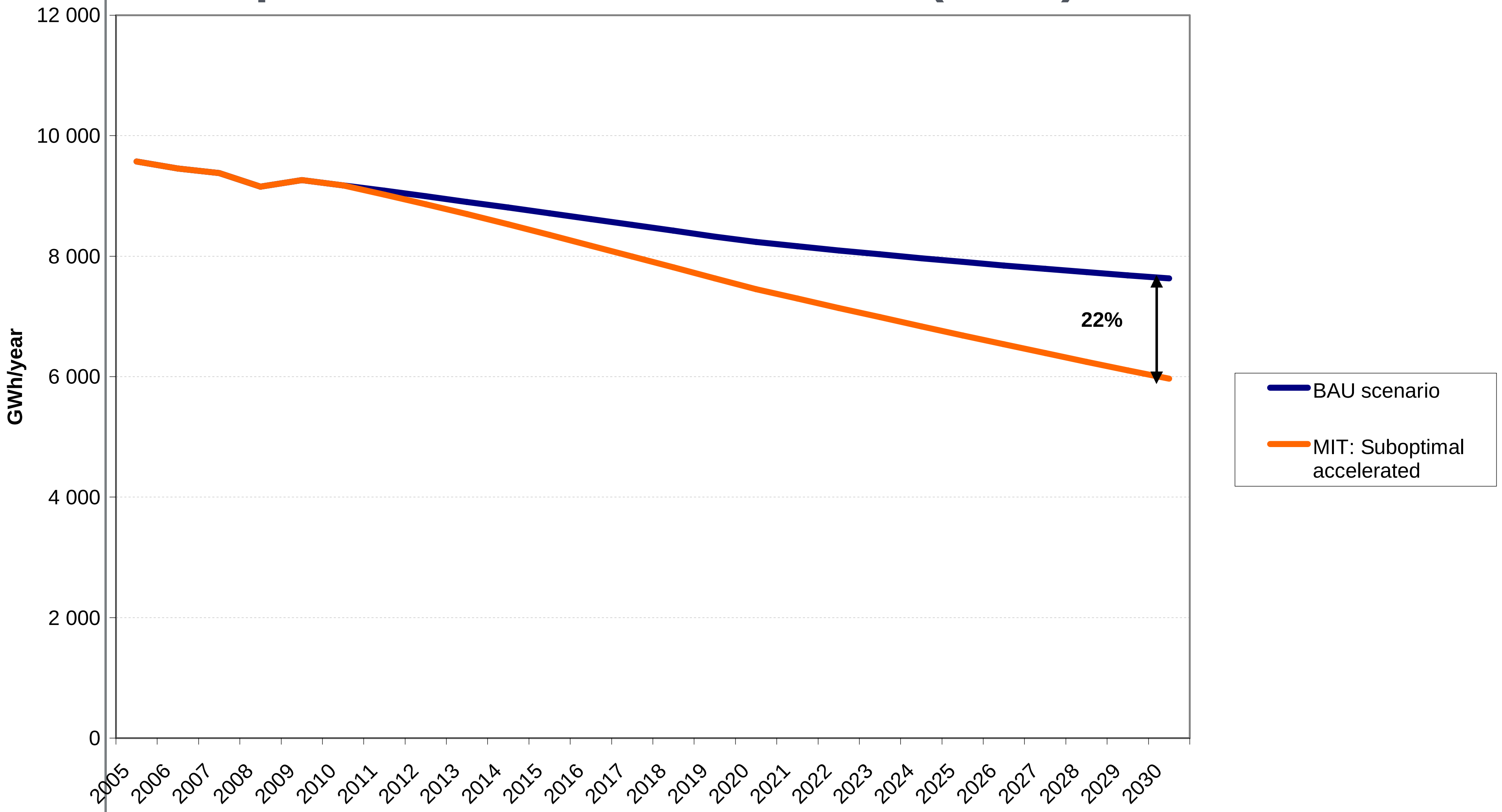
H: Homlokzati hőszigetelés
H: NY. Homlokzati hőszigetelés, nyílászáró csere
H: NY. F. Homlokzati hőszigetelés, nyílászáró csere, fűtéskorszerűsítés

3 éves átlag korrigált fajlagos
2007/2008. évi korrigált fajlagos

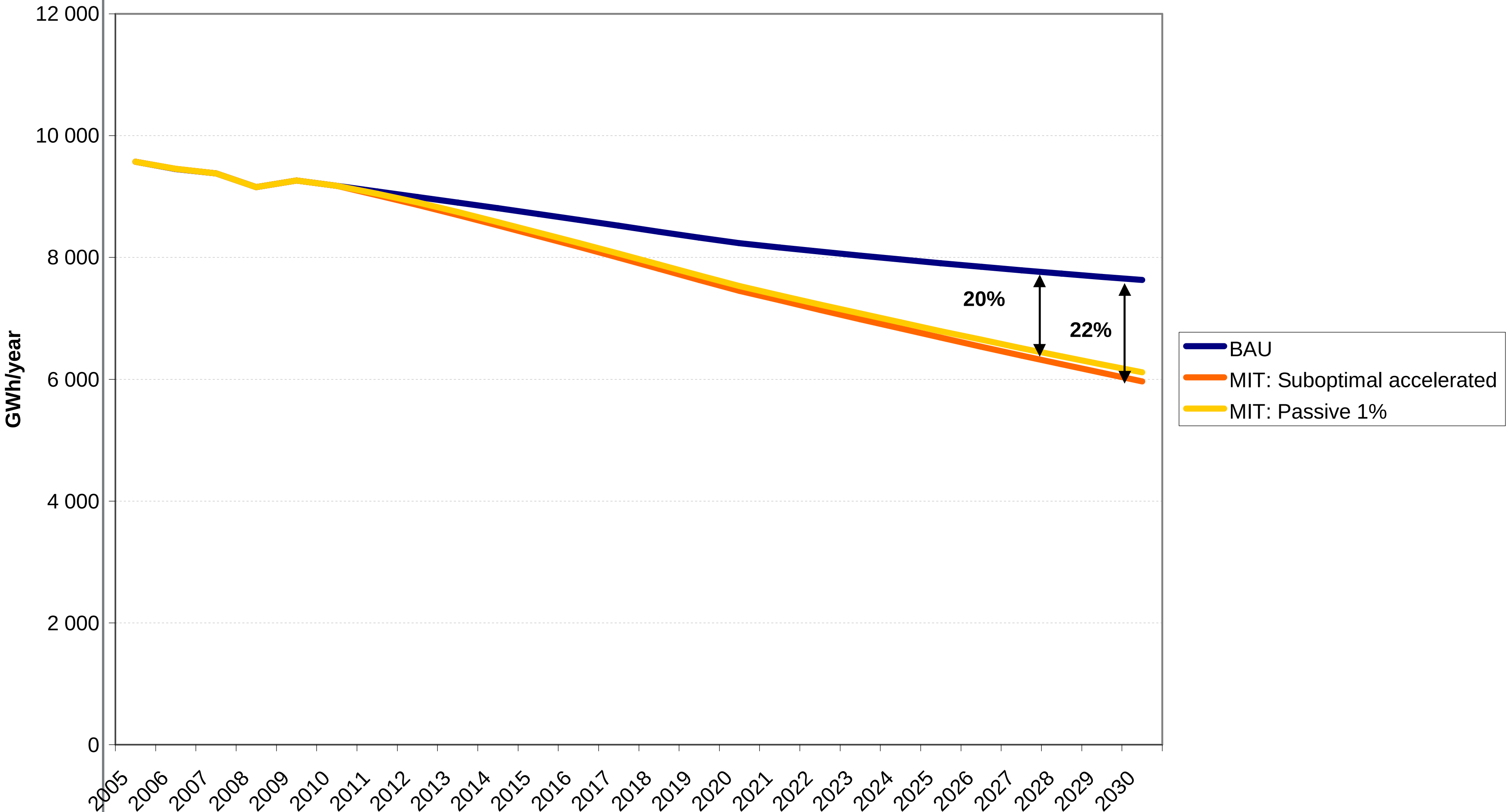
Source: Pájer Sándor, SZÉPHŐ Zrt., KLÍMAVÁLTOZÁS - ENERGIATUDATOSSÁG –ENERGIAHATÉKONYSÁG. V. Nemzetközi Konferencia, SZEGED, 2009. április 16-17.

Scenario assumptions	
BAU_{scen}	▪ Existing buildings: retrofitted at 1% p.a. to level of 23% energy savings (compared to buildings built before 1990)
	▪ New buildings: according to 2006 BC
All mitigation scenarios	▪ New buildings: ▪ All new buildings are PH by 2020 ▪ The rest is assumed 2011 (phase-out in 2015) and low-energy (phase-out in 2020) ▪ Phase-out of 2006 Building code: 2011
Passive accelerated scenario	▪ Existing: ▪ All existing buildings (built until 1990) are retrofitted by 2030 ▪ Out of the retrofitted buildings these performance levels are achieved by 2020: ▪ 85% PH (15 kWh/m^2.a) ▪ 10% Low energy (30 kWh/(m^2.a) ▪ 5% 2011 Building code (60 kWh/(m^2.a)
Passive 1% scenario	▪ Existing: ▪ Rate of retrofit: 1% p.a. of existing buildings ▪ Retrofitted: ▪ 85% PH (15 kWh/m^2.a) ▪ 10% Low energy (30 kWh/(m^2.a) ▪ 5% 2011 Building code (60 kWh/(m^2.a)
Suboptimal accelerated scenario	▪ Existing: ▪ All existing buildings (built until 1990) are retrofitted by 2030 ▪ Accelerated rate of retrofit ▪ Retrofitted: partial retrofit

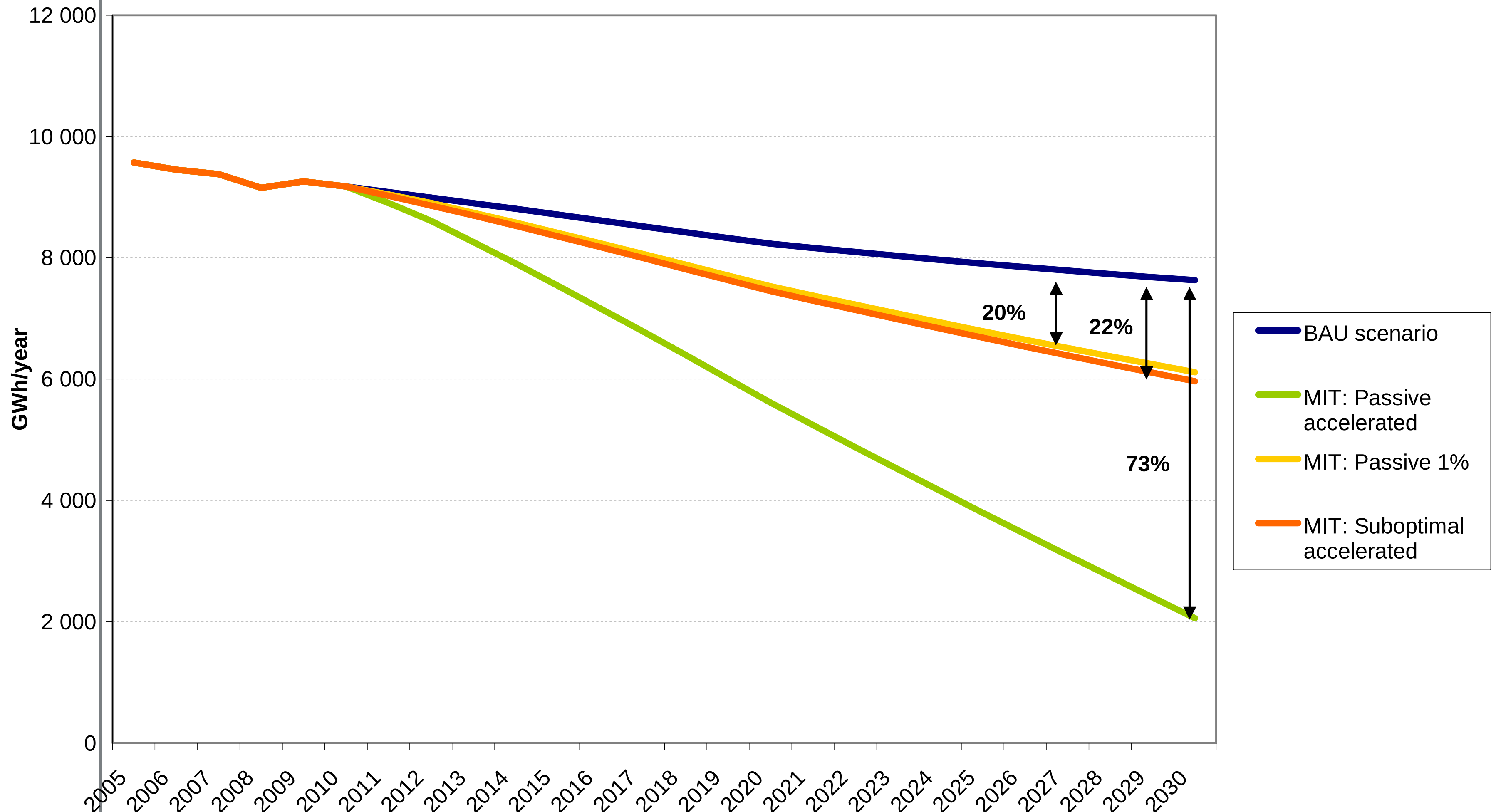
Suboptimal accelerated scenario (GWh)



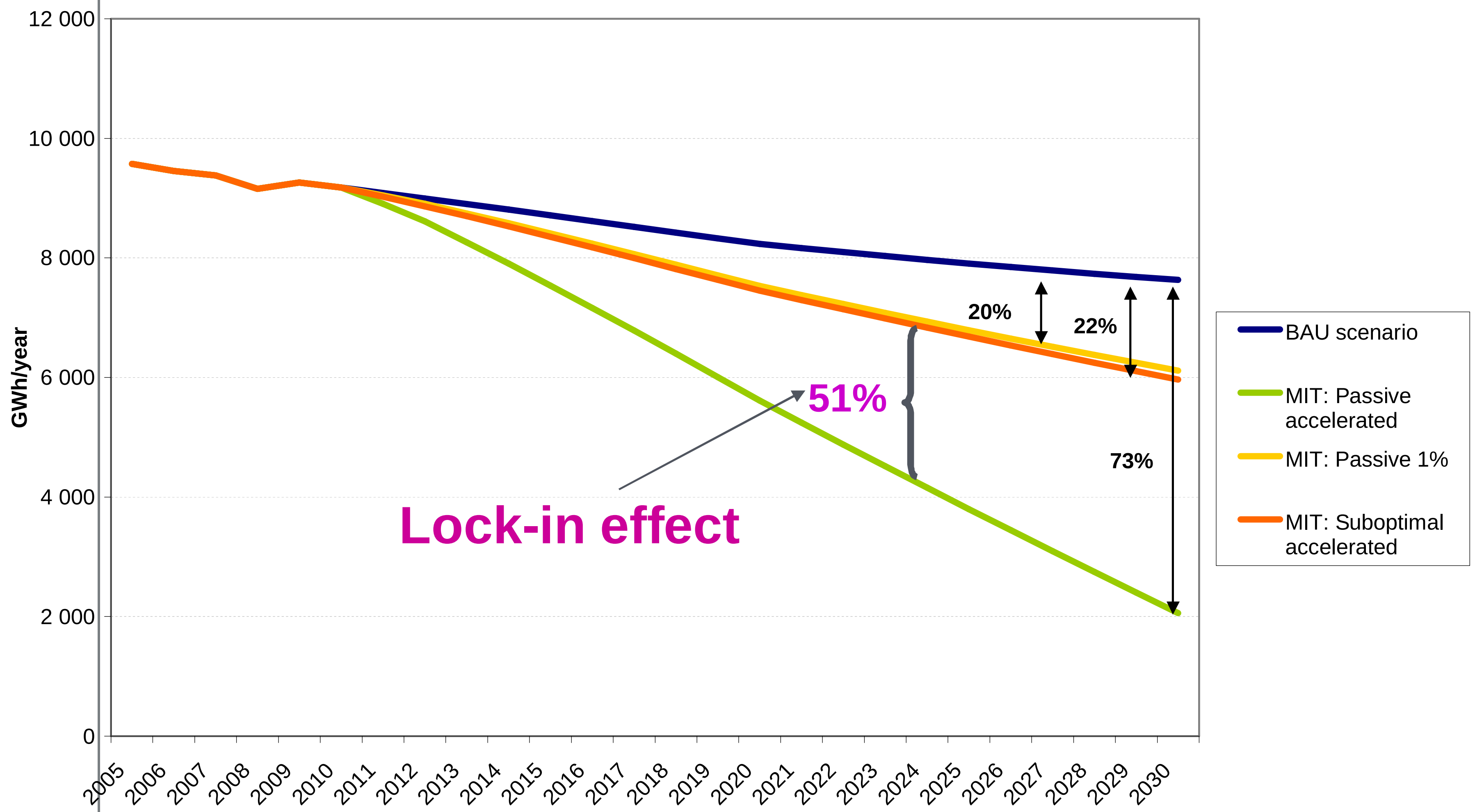
Passive 1% scenario (GWh)



Passive accelerated scenario (GWh)



Passive accelerated scenario (GWh)



	Energy savings			CO_2 emissions			Investment vs. savings	
	Business-as-usual in year 2030	Energy saving potential in year 2030	Energy saving potential in year 2030 (% of BAU)	Business-as-usual 2030	CO_2 mitigation potential 2030	CO_2 mitigation potential 2030 (% of BAU)	Total cumulative investment (2011-2030)	Cumulative energy cost savings (2011-2030)
	GWh	GWh	GWh	kt CO_2	kt CO_2	kt CO_2	Billion Euro	Billion Euro
Suboptimal accelerated	7 633	1 667	22%	1 518	331	22%	1.82	0.97
Passive 1%	7 633	1 518	20%	1 518	302	20%	0.84	0.88
Passive accelerated	7 633	5 572	73%	1 518	1 108	73%	2.62	3.24

Conclusions

- A need for deeper reductions in CO_2 emissions
- There is still a large low-cost potential in the building sector
- However, currently a large increase in number of retrofits to suboptimal levels
- Suboptimal retrofit at accelerated rate is not cost-effective and will only bring slightly more energy savings than applying PHS to 1% BS p.a.
- Applying PHS to the whole building stock (by 2030) will bring additional 50% energy savings and will pay back.
- This requires long-term strategy and support activities with about 10-year transition period for the industry to start up.
- Subsidies provided to suboptimal retrofit are counter-effective and suboptimal levels at accelerated rate of retrofit may result in a 50% lock-in effect (compared to 2030 BAU).

To reach 73% reduction compared to 2030 baseline:

>> NEW buildings:

– Phase-out 2006 in 2011
– Gradual phase-in of PH by 2020
– Transition through introducing 60 kWh/(m^2.a) and LE standards

>> EXISTING buildings:

– Phase-out of partial retrofit in 2011
– Gradual phase-in of PH retrofit by 2020
– Transition through 60 kWh/(m^2.a) and LE standards

Thank you for your attention!

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Back-up slides

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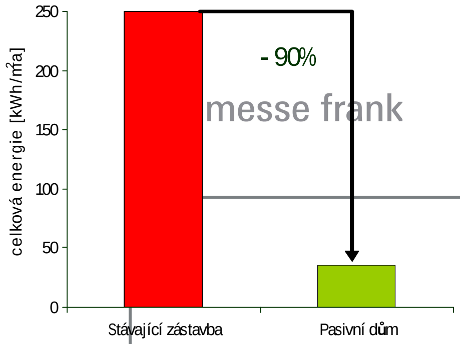
Planned introduction of different VLEB standards

Country/year	2013	2015	2016	2020
United Kingdom	Passive house level		Net zero energy buildings	
Netherlands		Passive house level		Energy neutral buildings
Germany				Non-fossil fuel buildings
France				Energy plus buildings
Denmark				-75% compared to 2006 requirements

Source: Dyrbøl et al (2009)

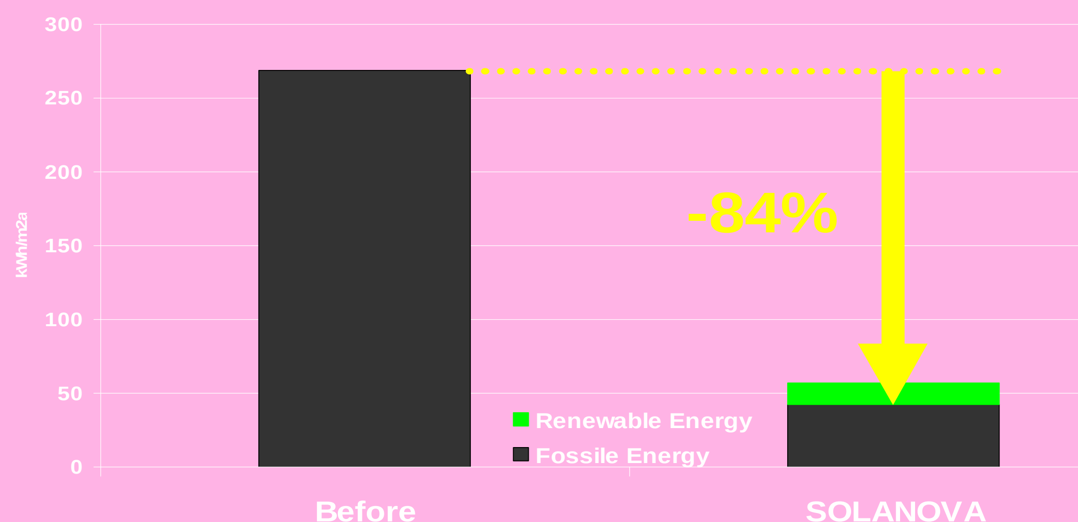
Buildings utilising passive solar construction (“PassivHaus”)



www.pasivnidomy.cz, www.passivhausprojekte.de, www.igpassivhaus.at

“EU buildings – a goldmine

for CO_2 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

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Before reconstruction

over 150 kWh/(m²a)

-90%

Reconstruction according to the passive house principle

15 kWh/(m²a)

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

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/(m^2.a) for space heat, DHW, household electricity and embodied energy,

~ the primary energy requirement for passive houses.

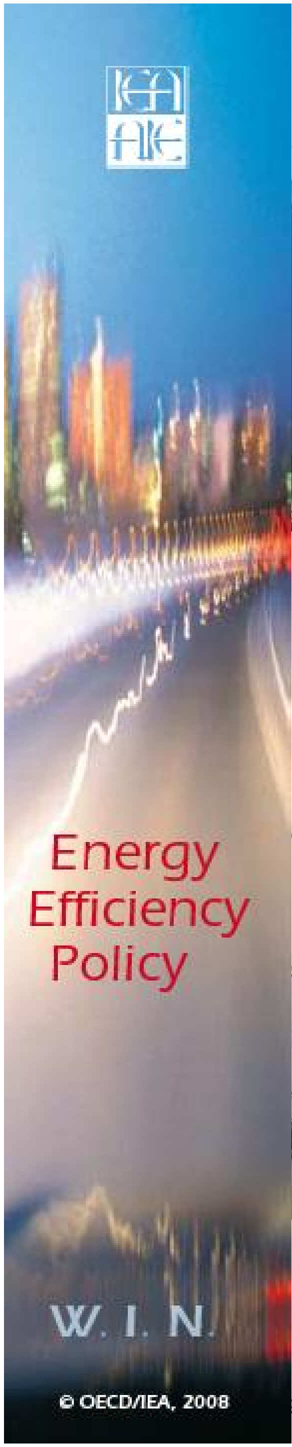
From an energy life-cycle perspective [Hermelink 2006] analyses which renovation level should be achieved in order to be better than a rebuild option. He concludes that "taking sustainability seriously, a space heat consumption between 25 and 40 kWh/(m^2.a) should be aimed at" in renovation.

= savings of 80% - 90%.

Characteristics of 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



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

Extra costs
= 3-5% of the total costs

Payback = 9 – 10 years

Can we afford this ?

Source: Jens Lausten, IEA