Cutting the energy use of buildings: How deep can the planet go?

CENTER FOR CLIMATE CHANGE
AND SUSTAINABLE ENERGY POLICY

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Ksenia Petrichenko,
Diana Urge-Vorsatz

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- Background: the role of buildings in tackling energy and climate change issues
- Goals and methodology of the study and 3CSEP-HEB Model
- Key global and regional findings: potentials for reducing energy use and GHG emissions
- Conclusions

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Background: the role of buildings in tackling energy and climate change issues

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The buildings sector offers the largest low-cost potential in all world regions by 2030

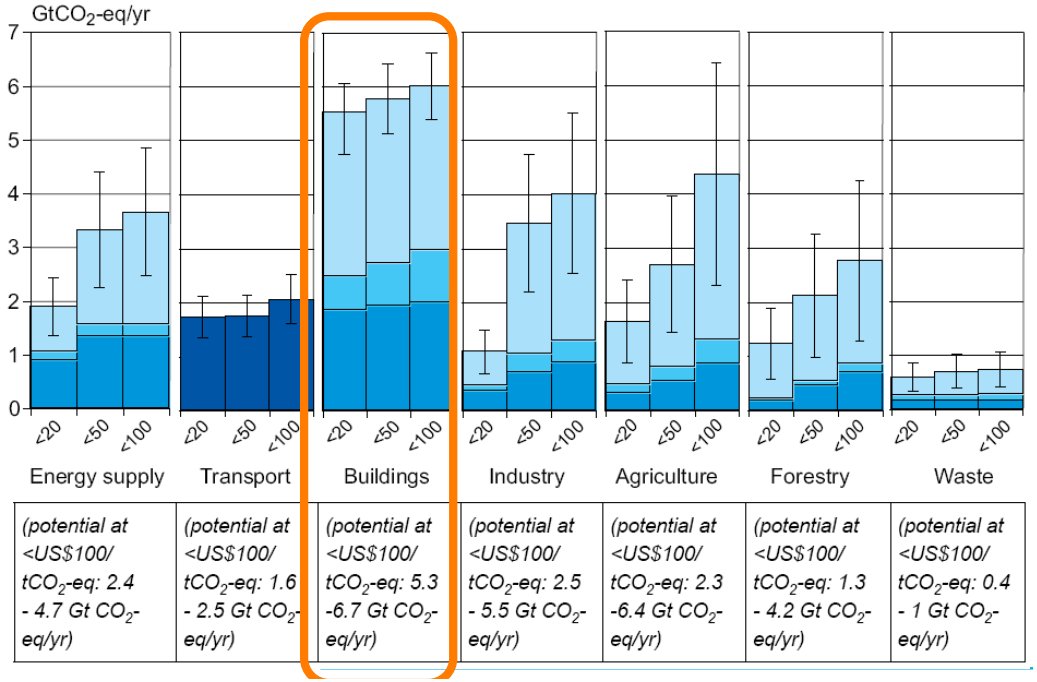
Global greenhouse gas (GHG) emissions have grown by about 70% between 1970 and 2004

The global building sector accounts for about 25-40% of total global energy demand and about 30% of global energy-related CO_2-emissions

Operation stage is usually the most emission-intensive, accounting for nearly 80% of the total CO_2 emissions in residential buildings

- **EE +**
- **switching from fossil fuels to RES and energy carriers with lower a CO2- emission factor, +**
- **behavioural changes +**
- **strong policy support**

Buildings provide the largest cost-effective potential



Source: IPCC 2007, AR4, Chapter 10

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Global study conducted

"everyone knows the potential is big…"

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This report presents a novel effort to evaluate the importance of the global and regional building sectors in mitigating climate change by means of scenario analysis, to provide a scientific basis for developing policy instruments in order to realize energy savings potentials in the mid-term future

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Goals and methodology of the study and 3CSEP-HEB Model

3CSEP-HEB Model - the Centre for Climate Change and Sustainable Energy Policy – High Efficiency Building Model

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The success of the project - team work

Project Team and Roles

- **Diana Ürge-Vorsatz** — Project Leader
- **Ksenia Petrichenko** — Researcher, SH&C, GIS
- **Miklos Antal** — Researcher, WH, technologies

- **Maja Staniec** — Researcher, model comparison, CO2
- **Michael Labelle** — Project Manager
- **Eren Ozden** — Data collection
- **Elena Labzina** — Software development

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Further key credit to:

- **Godfathers**

- **Jens Laustsen**
- **Peter Graham**
- **Adam Hinge**
- **Rod Janssen**

- Reviewers:
- Stephan Thomas
- Satish Kumar
- Oliver Rapf
- Bogdan Atanasiu
- Constant Van Aerschot
- Ryan Meres
- Smita Chandiwala
- Kevin Mo
- Yamina Saheb
- Aurelien Saussay

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A novel approach to global building energy modeling: main pillars

- **Considers** buildings as complete systems rather than sums of components -> performance-based approach
- **Assumes** that existing best practices become the standard (both in new construction AND renovation) after a certain transition time
- **Focuses** on existing best practices from and energy and investment costs perspective
- **Analyses** the global building stock broken down by regions, climate zones, building types and building vintages

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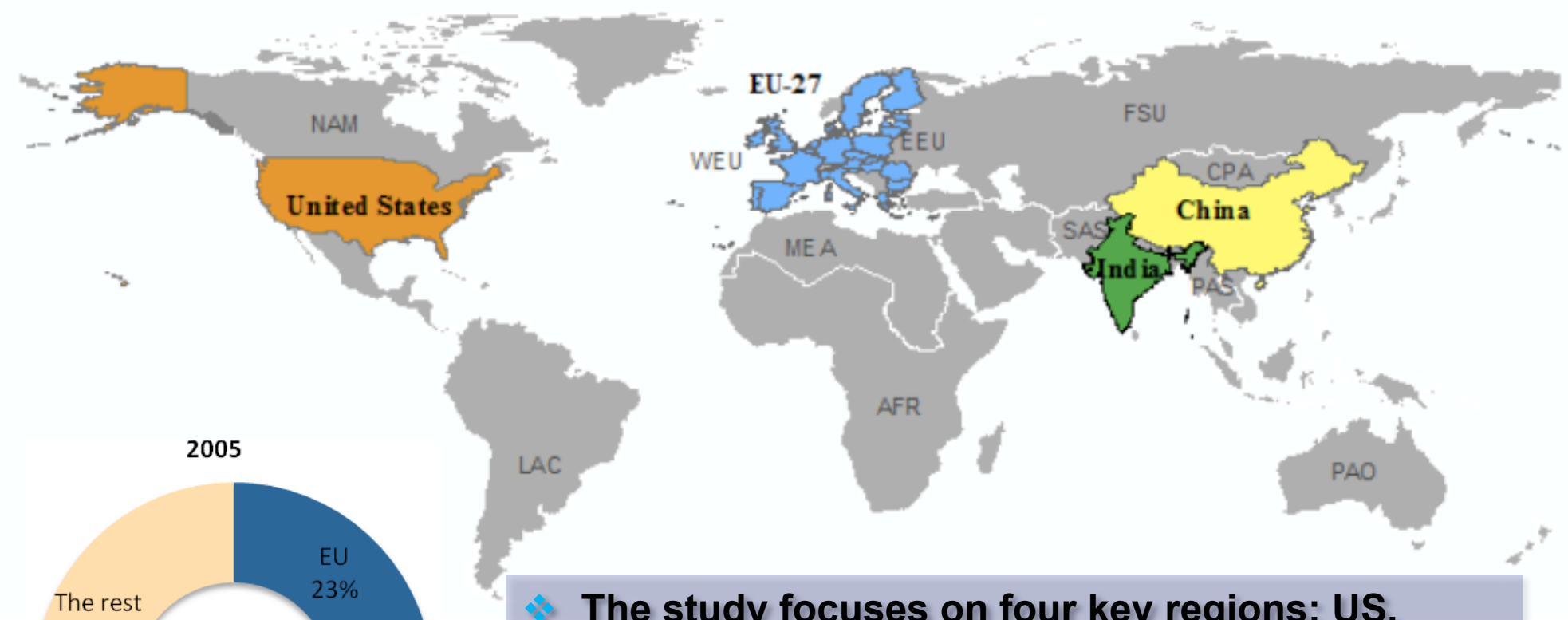
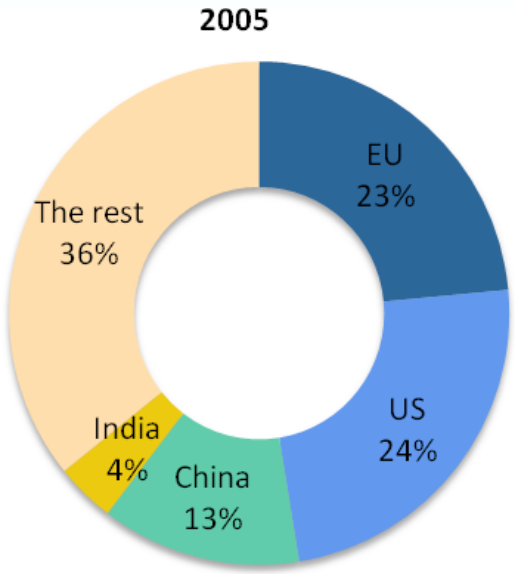
Geographic scope for 3CSEP-HEB model





- The study focuses on four key regions: US, EU-27, China and India
- Together, these regions are responsible for more than 60% of the 2005 global final building thermal energy use
- The model also analyses 11 big regions, which together cover the glob

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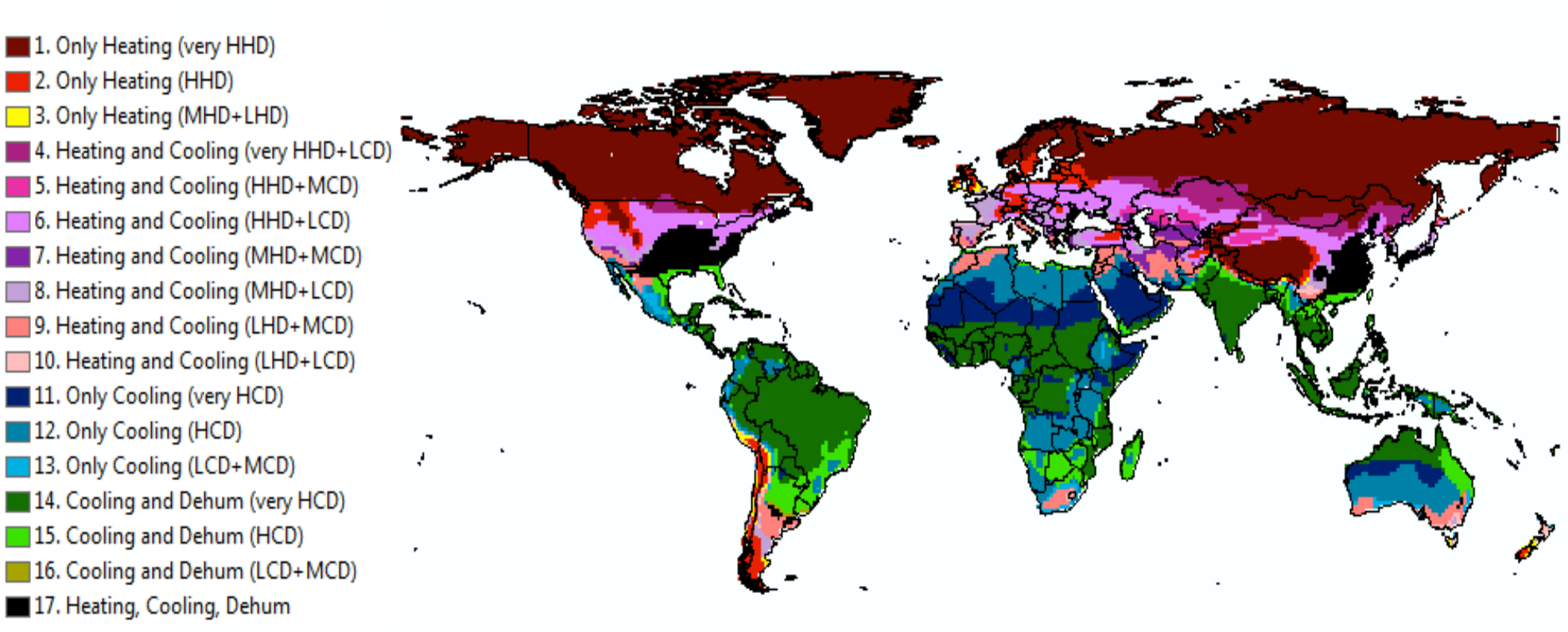
Climate Types

NASA climatic data + GIS spatial analysis



Main parameters: HDD, CDD, Relative Humidity, Average Temperature of the Warmest Month

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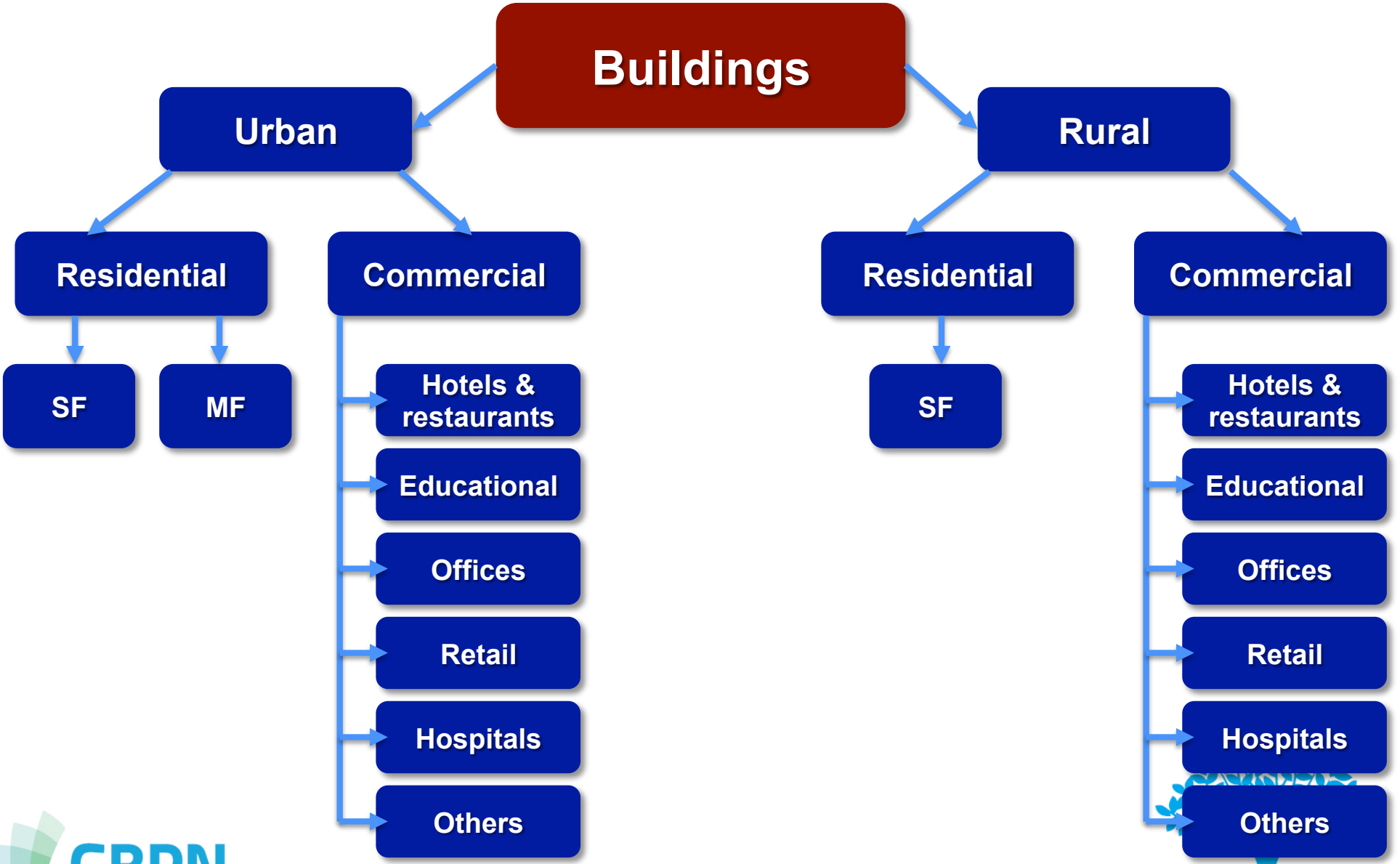
Key Assumptions on Building Types



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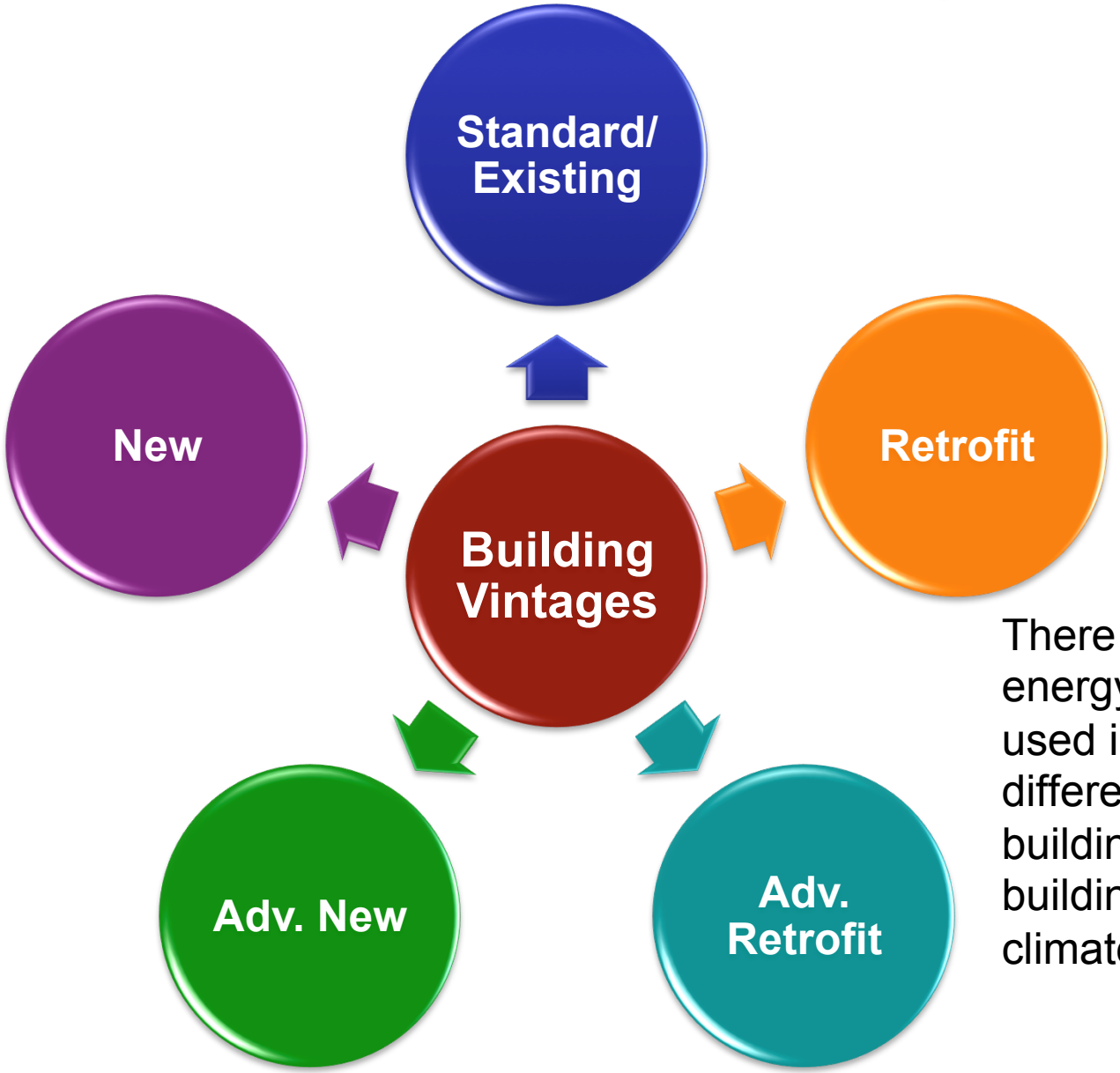
Key Assumptions on Building Vintages



There are different energy intensities used in the model for different regions, building vintages, building types and climate zones

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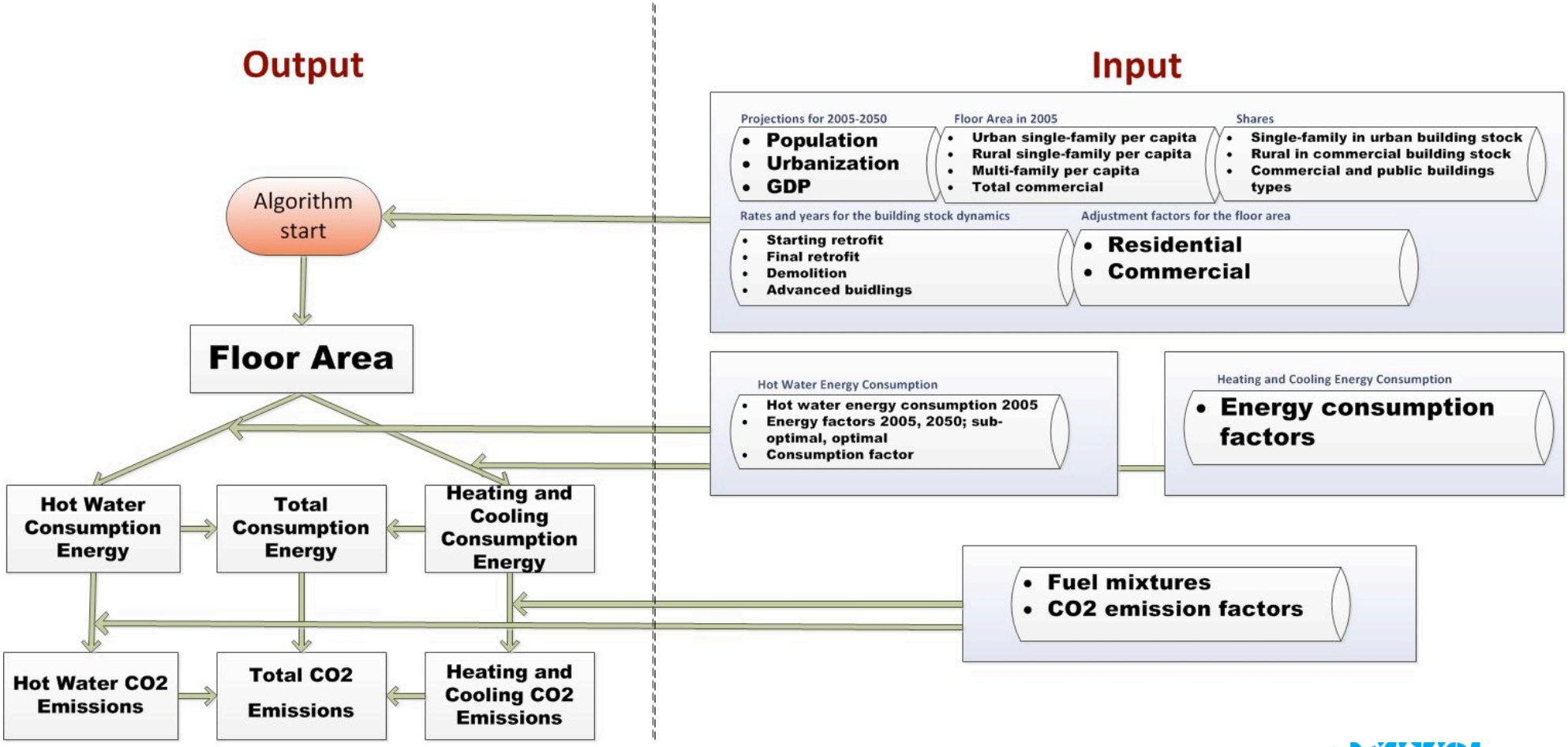
Modeling logic for 3CSEP-HEB model



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Policy-relevant techno-economic scenarios

Deep Efficiency

State-of-the-art technologies

Full thermal comfort

Accelerated retrofit rate – from 1.4 to 3% by 2020

New buildings are built to regional standards

Renovations achieve app. 30% energy savings

After 2022 today's building best-practices will become the standard

The energy efficiency of WH increases rapidly

Moderate Efficiency

Recent policy trends (e.g. EPBD in the EU)

Global retrofit rate = 1.4%

Accelerated retrofit rate – from 1.4 to 2.1% in EU and US, 1.6 in China, 1.5 in India by 2020

New buildings are built to regional standards

Renovations achieve app. 30% energy savings

WH efficiency measures are not more ambitious than current

Frozen Efficiency

Hypothetical future - without policy and market developments

Fixed retrofit rate = 1.4%

Energy performance of new and retrofit buildings does not improve as compared to their 2005 levels

Renovations achieve app. 10% energy savings

Advanced buildings introduced only in Western Europe (1% of New BS)

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Key global and regional findings:

potentials for reducing energy use and GHG emissions

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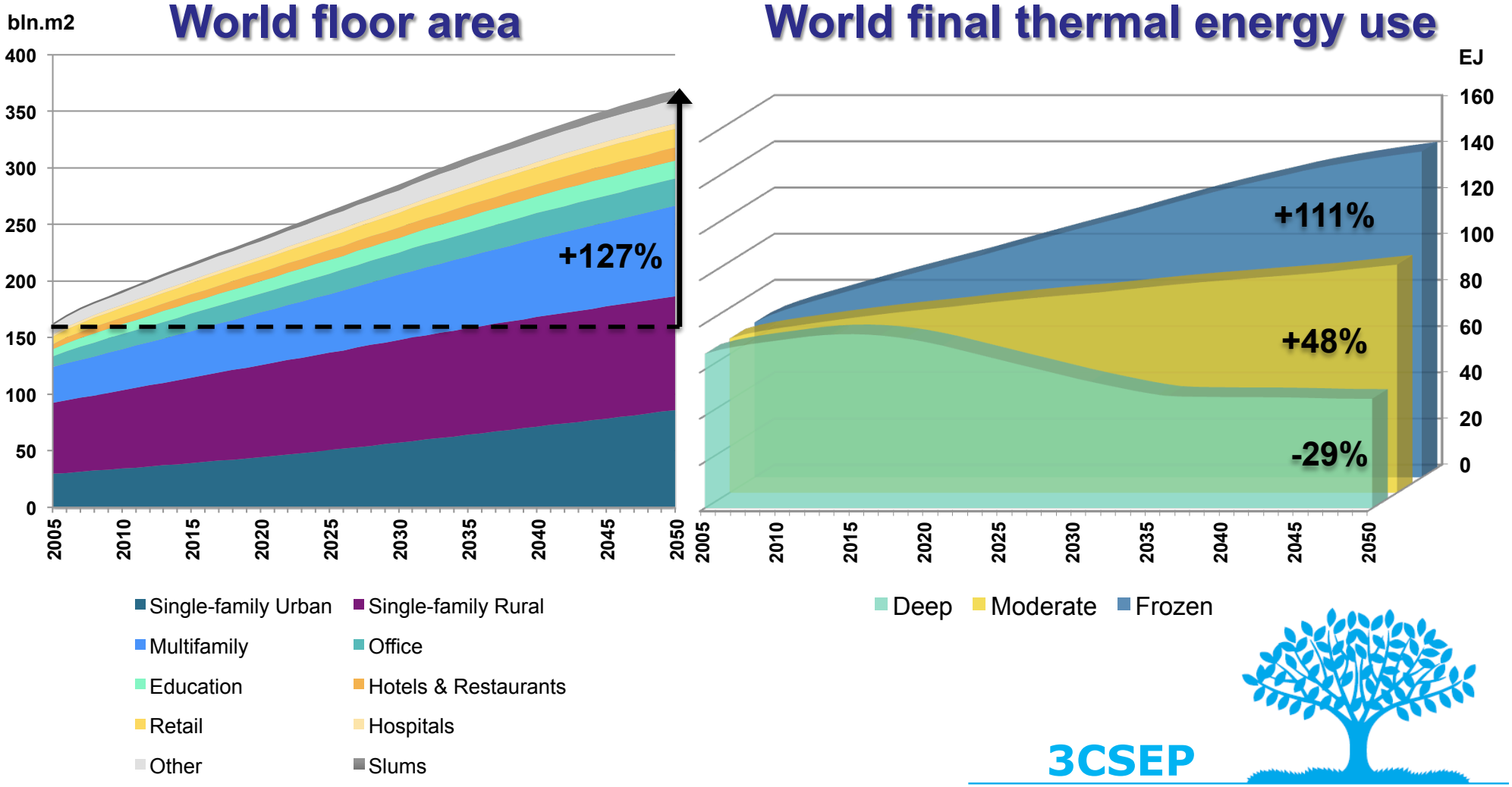
Key finding 1: by 2050 global building final thermal energy use can be reduced by about one-third, (-34% for SH&C) as compared to 2005



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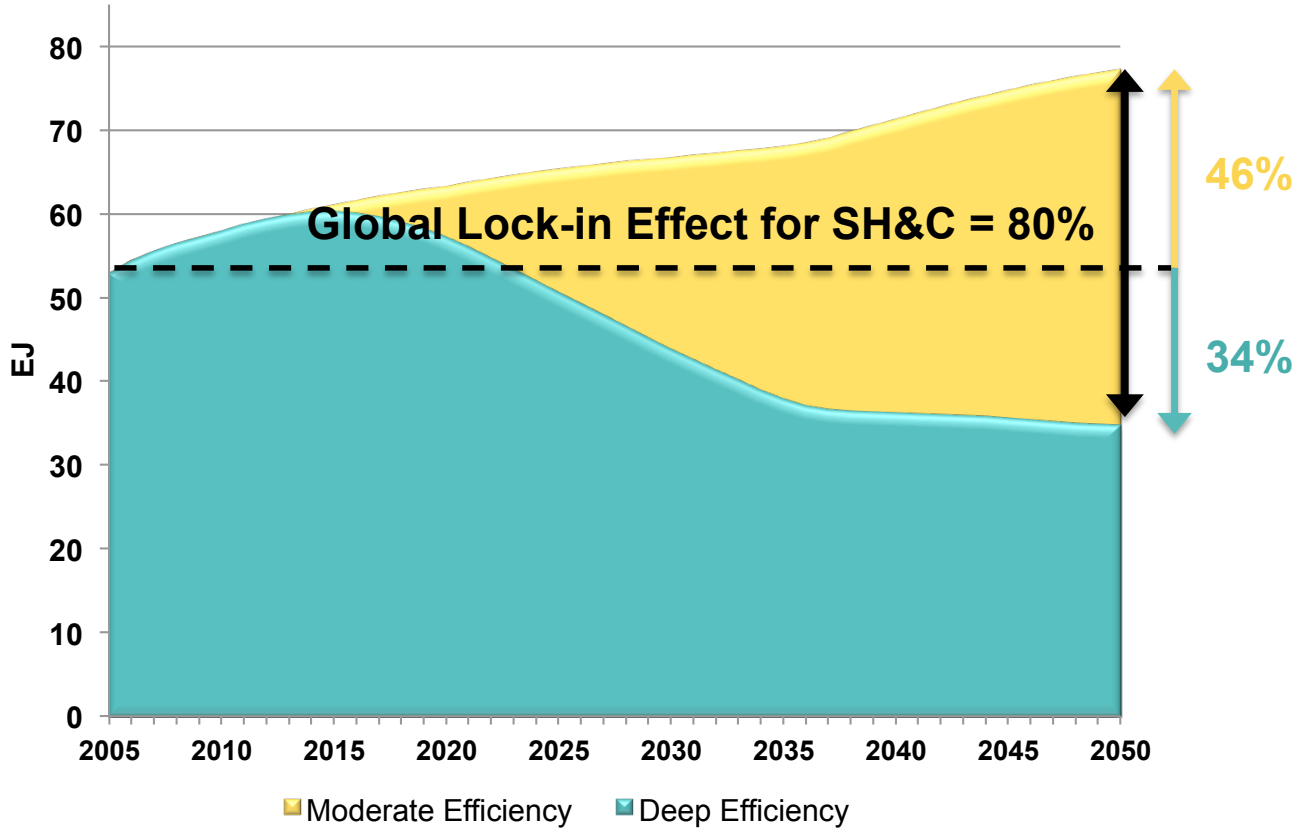
Key finding 2: Urgent and ambitious policy actions are crucial

Unlocking this energy savings potential in the future will either be extremely expensive, or technologically unfeasible for several more decades



Even if **today's policy** trends and ambitions are implemented, global building **energy use will** still **almost double** by 2050 in relation to 2005

80% of potential energy savings will be **locked in** the building sector for uncertain time

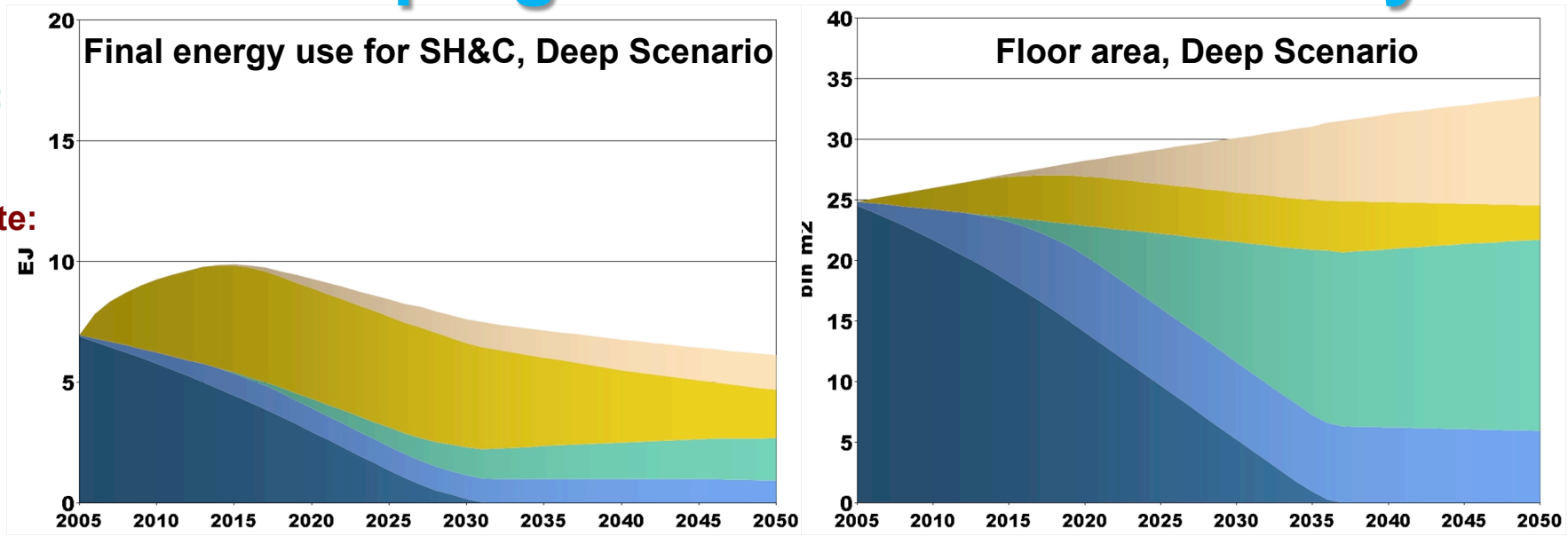
Early action, strategic policy planning, ambitious energy performance levels in building codes for new construction and retrofits are crucial

Key finding 3: Focus on new buildings in developing countries is necessary

China

Deep: -12%

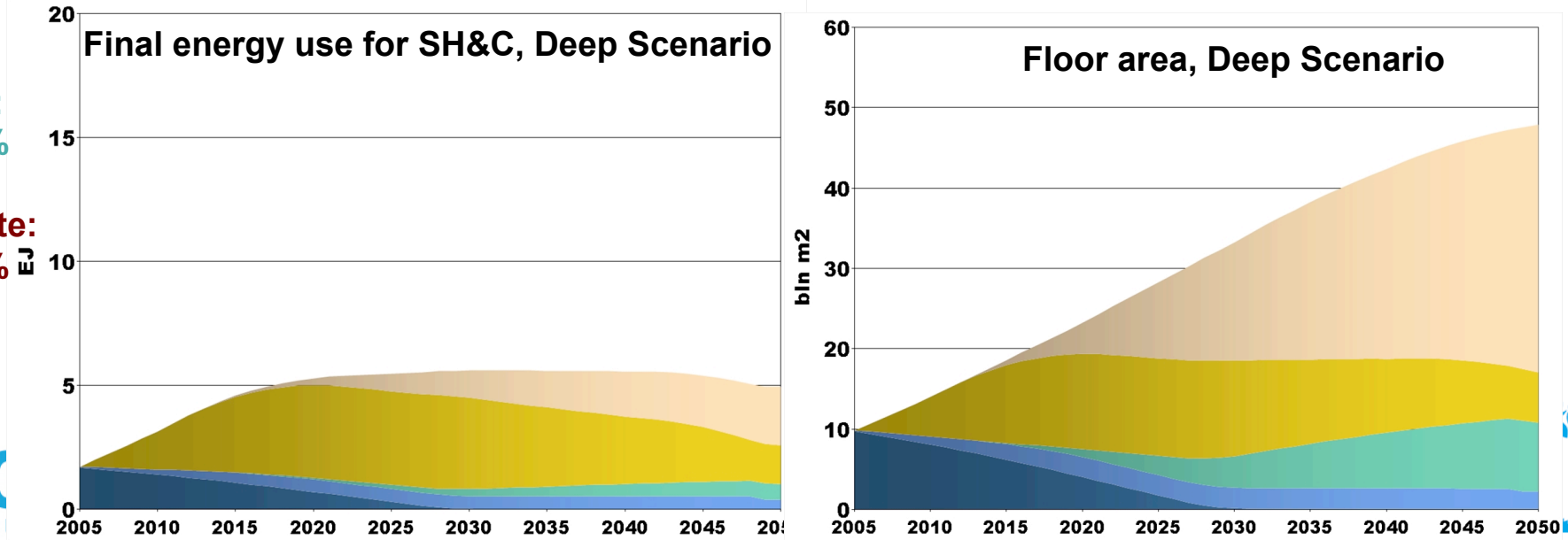
Moderate: +68%



India

Deep: +188%

Moderate: +680%



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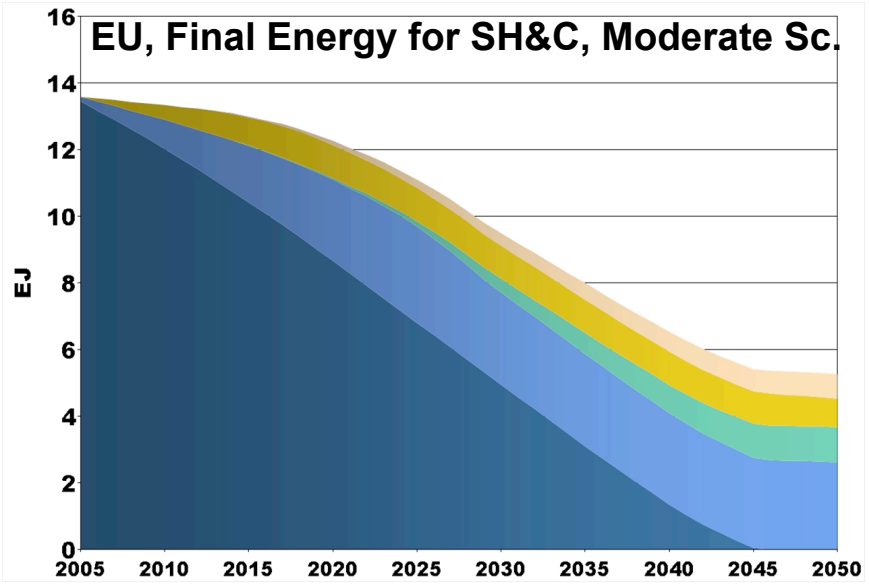
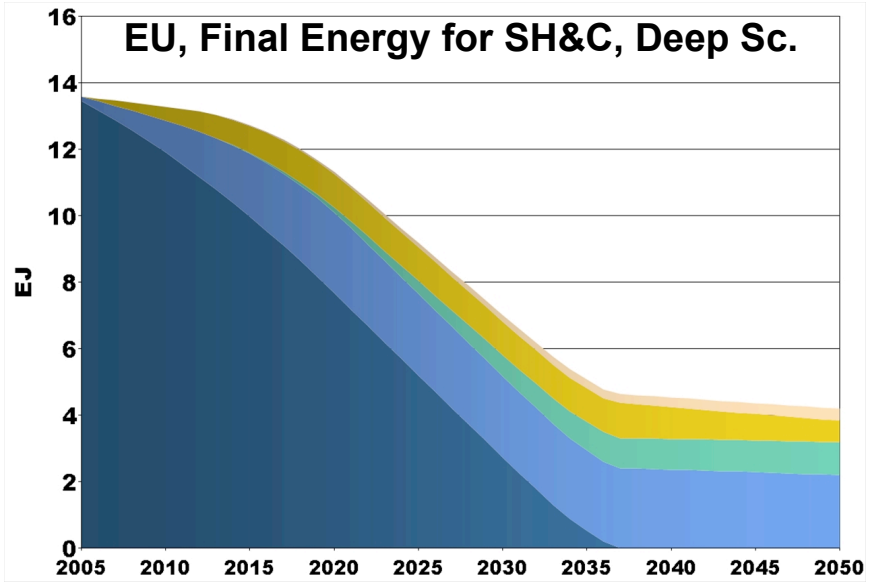
Key finding 4: Focus on existing buildings in developed countries is essential

EU-27

Deep:
-69%

Moderate:
-61%



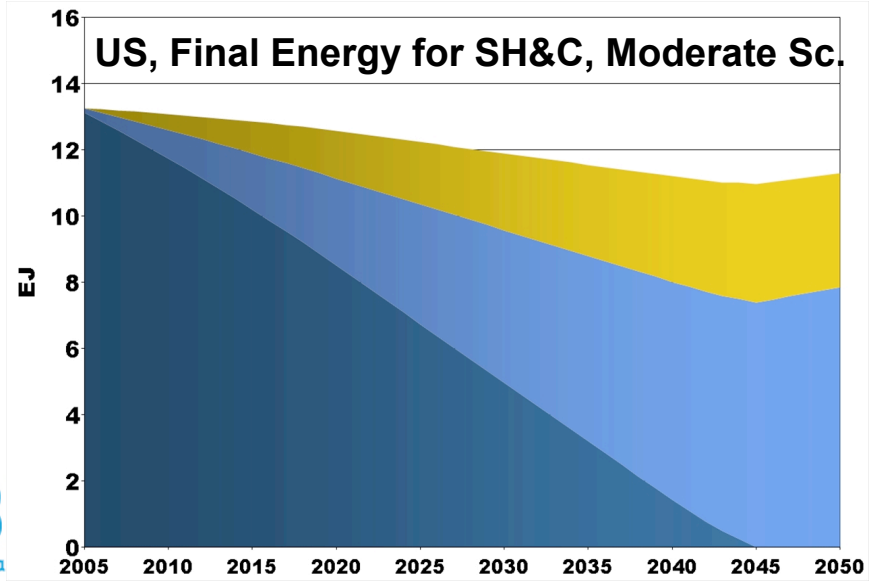


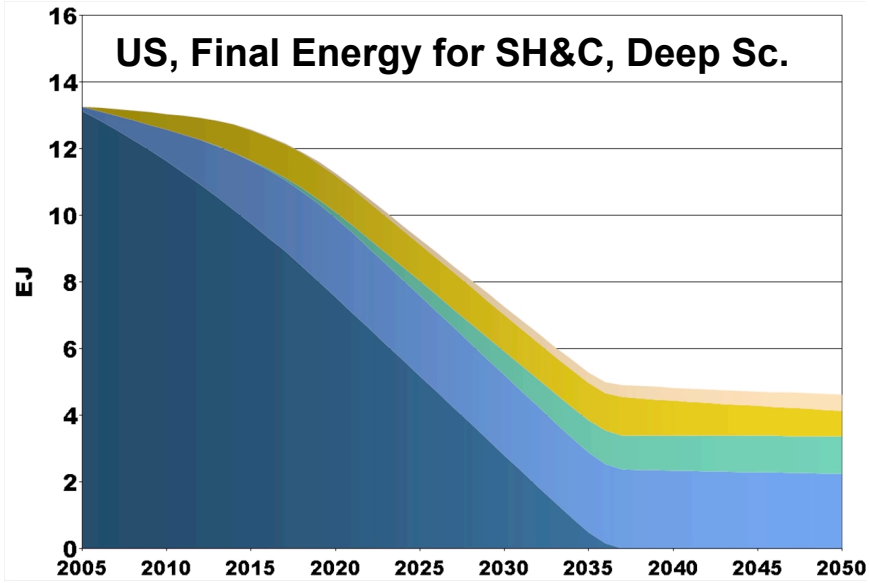
Standard Retrofit Advanced Retrofit New Advanced New

US

Deep:
-65 %

Moderate:
-15%





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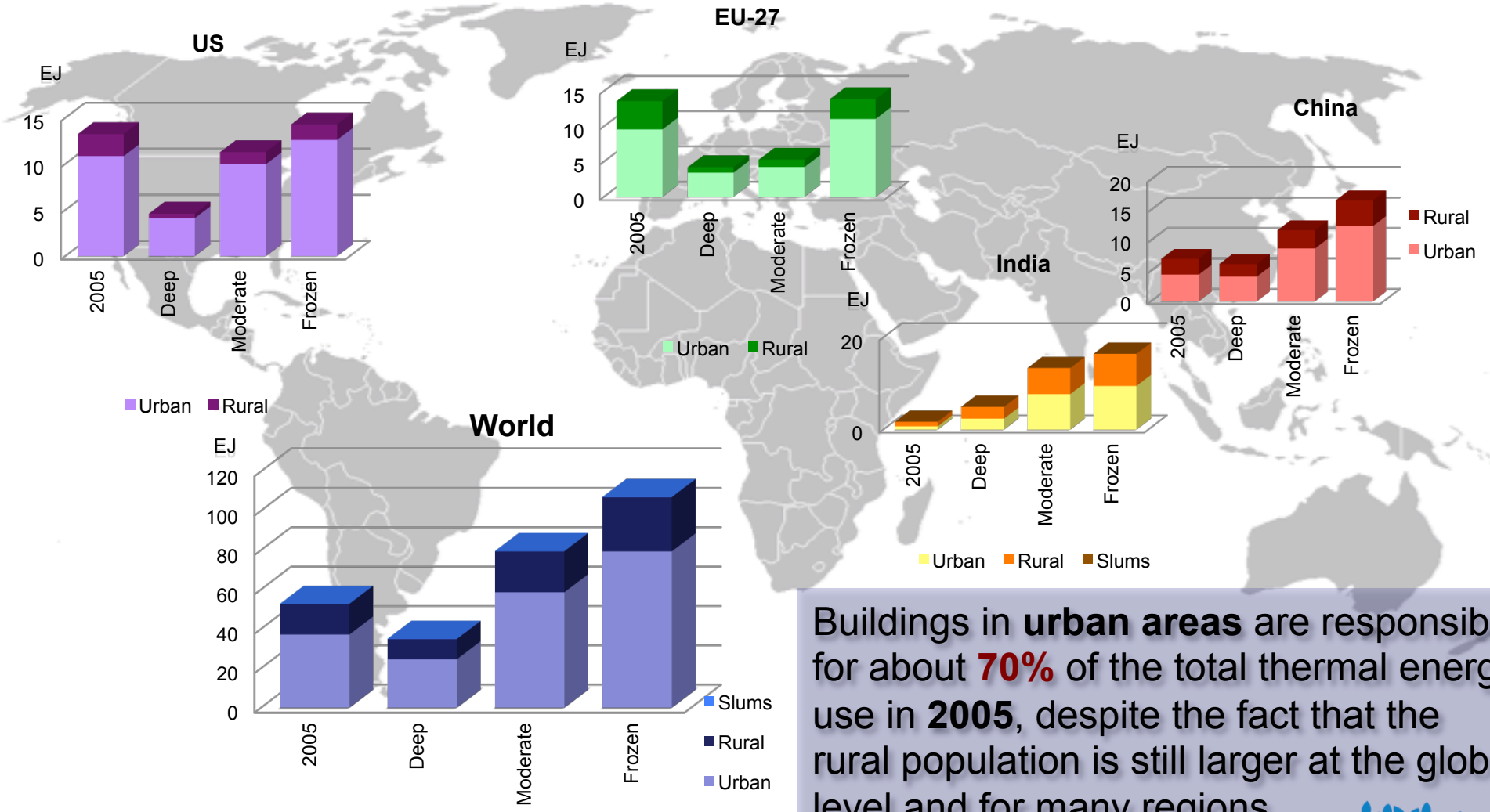
Key finding 5: Focus on efforts in cities



Buildings in **urban areas** are responsible for about **70%** of the total thermal energy use in **2005**, despite the fact that the rural population is still larger at the global level and for many regions

By the end of the analysed period **85%** of growth in building energy use will come from **urban areas**, **70%** of which - from **developing countries**

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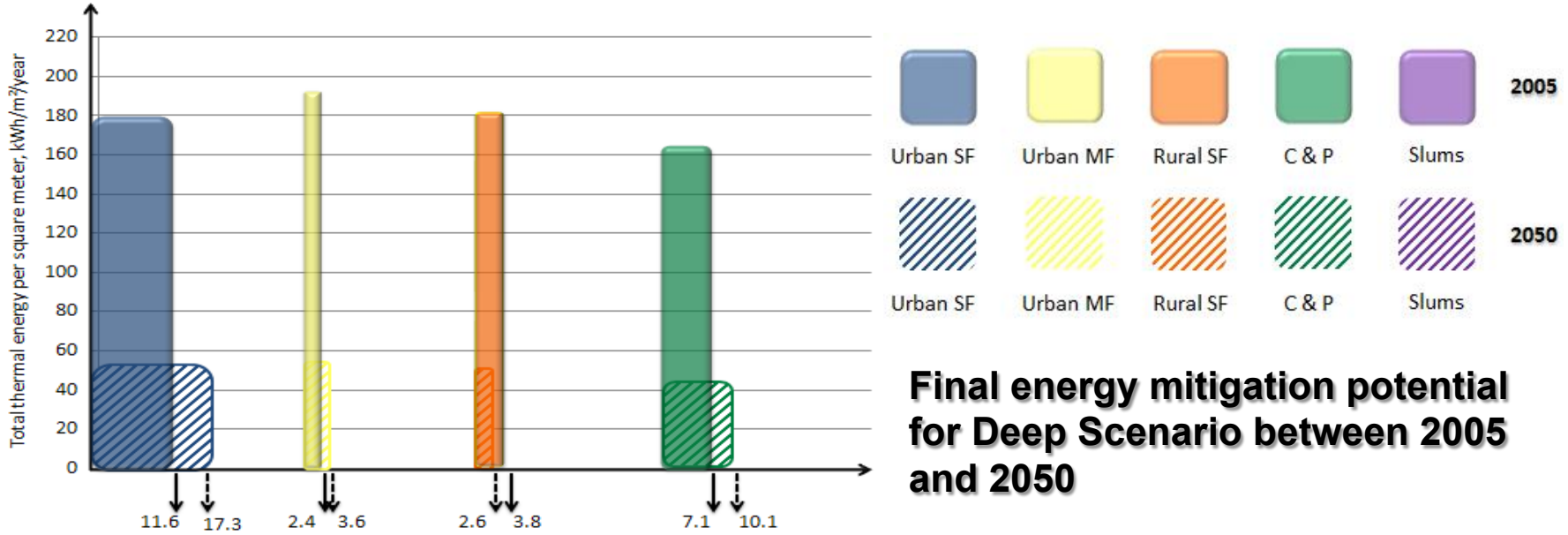
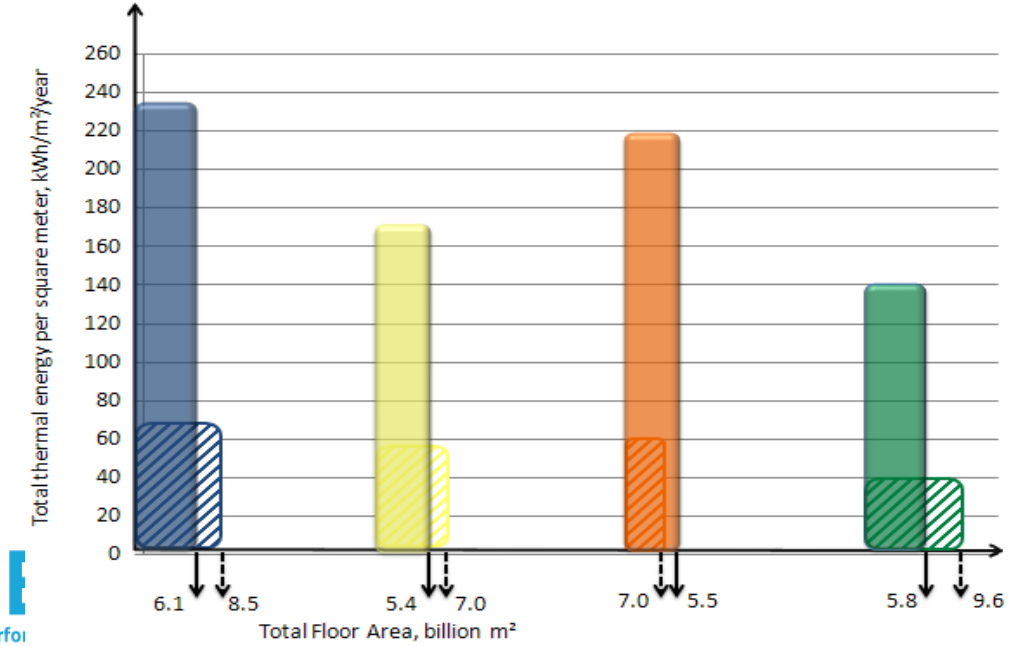
Key finding 6: Actions targeting specific building types are vital (1)

USA



Final energy mitigation potential for Deep Scenario between 2005 and 2050

EU-27



Residential buildings are key for developed regions

Global level

- 2005 building thermal energy: SF – 54%, MF – 21%
- 2050 (Deep) Energy saving potential : SF - 37%, MF – 22%

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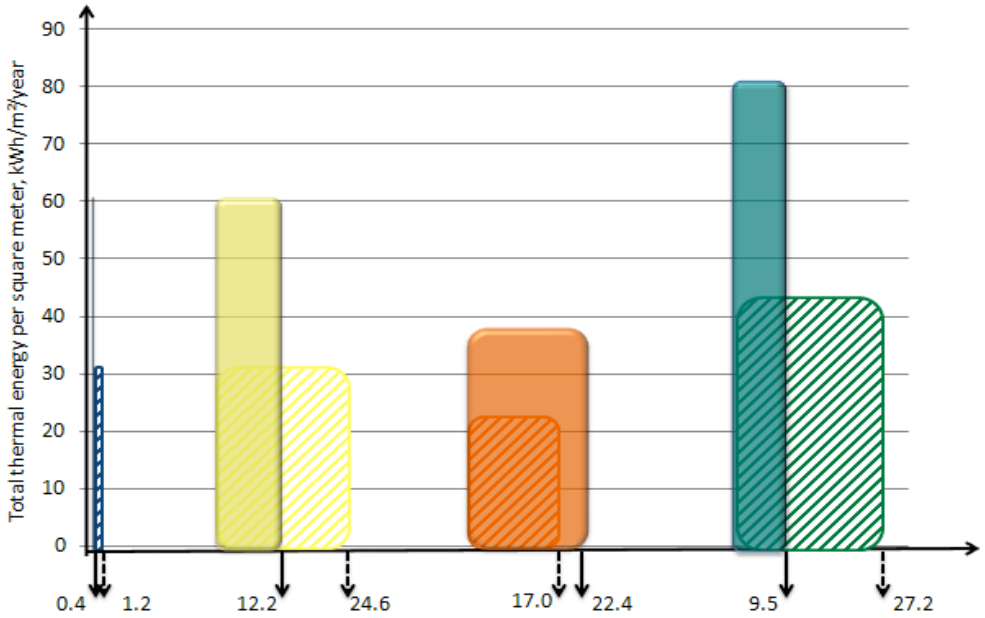
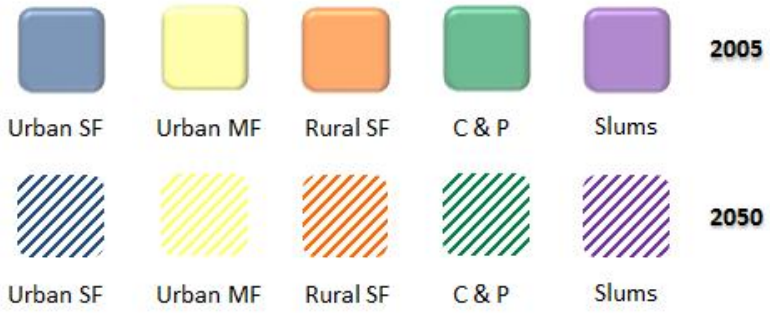
Key finding 6: Actions targeting specific building types are vital (2)

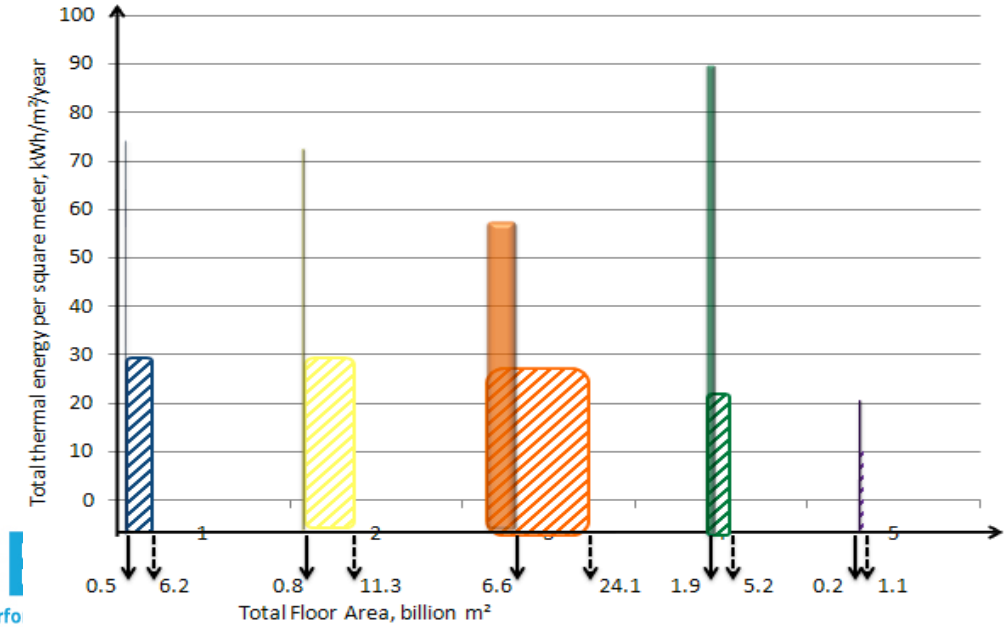
China





Final energy mitigation potential for Deep Scenario between 2005 and 2050

India



In developing regions the importance of multifamily and commercial buildings is growing by 2050

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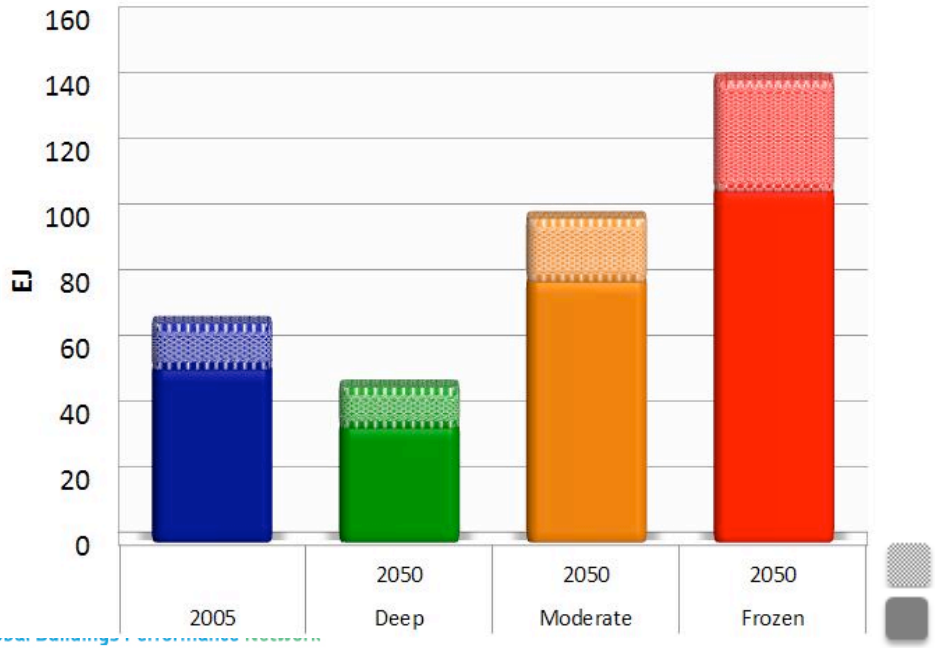
Summary results for energy use –

About 30% of global final thermal energy use in buildings can be saved by 2050

Region	Baseline	Deep Efficiency		Moderate Efficiency		Frozen Efficiency	
	EJ 2005	EJ 2050	Δ% to 2005	EJ 2050	Δ% to 2005	EJ 2050	Δ% to 2005
US	16.0	6.2	-61%	13.7	-14%	17.9	12%
EU-27	15.7	5.4	-65%	6.6	-58%	16.5	5%
China	8.6	8.6	-1%	15.5	80%	22.3	158%
India	2.6	5.9	131%	15.2	491%	20.6	701%
Rest of the world	23.9	21.3	-11%	47.8	100%	63.6	166%
World	66.7	47.3	-29%	98.7	48%	141.0	111%

World final thermal building energy use for 3 scenarios, by end-use



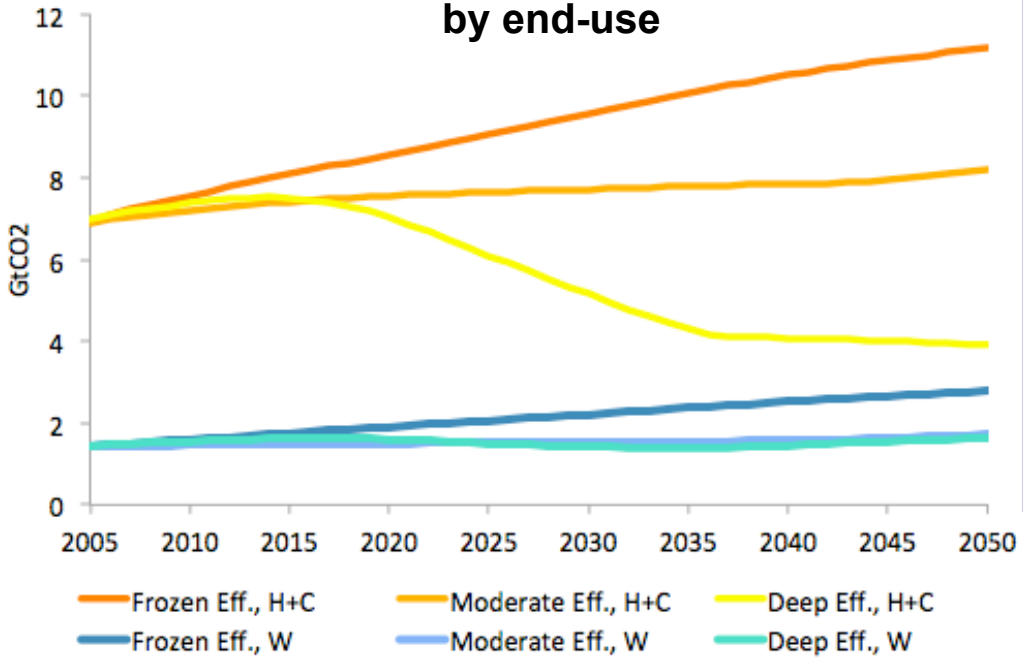
The global **energy saving potential** by 2050 in relation to 2005 for total final thermal energy use under **Deep** scenario is **29%**. **Moderate** pathway will bring **48% increase** in total thermal energy use, while under **Frozen** Efficiency scenario this **growth** is immense - **111%** by 2050

Summary results for CO2 emissions –

About 40% of global CO_2 emissions from thermal energy use in buildings can be avoided by 2050

Region	Baseline	Deep Efficiency		Moderate Efficiency		Frozen Efficiency	
	GtCO2 2005	GtCO2 2050	Δ% to 2005	GtCO2 2050	Δ% to 2005	GtCO2 2050	Δ% to 2005
US	2.8	1.0	-63%	2.3	-17%	3.1	11%
EU-27	2.0	0.7	-66%	0.8	-61%	2.1	4%
China	0.6	0.7	11%	1.2	90%	1.6	164%
India	0.2	0.6	200%	1.4	564%	1.7	701%
Rest of the world	2.8	2.3	-18%	4.8	73%	6.0	118%
World	8.3	5.1	-38%	9.9	20%	14.0	68%

World CO2 emissions for 3 scenarios, by end-use



About **40%** of global CO_2 emissions from thermal energy use in buildings can be avoided by 2050 in case of ambitious **proliferation of state-of-the-art energy efficient building technologies**, which corresponds to almost **3 Gt of CO_2** emissions

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Conclusions

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Conclusion

There is a significant potential: by 2050 building final energy use can be cut by 1/3rd as compared to 2005 through very high performance buildings. In Europe, this value is 2/3rd only with efficiency gains.

Even today's most ambitious policy trends will leave us far from this potential – policy gap

Significant lock-in risk: 80% of 2005 H&C energy use by 2050

Immediate action, strategic planning and ambitious performance levels in codes and retrofits can only avoid the lock-in

Heating & cooling energy use offers the greatest saving potential

Energy efficiency improvements alone are not enough for large reductions: RES, behavioural change and low C supply

Reduction potentials in the EU and the US are above 60%. In China, floor space growth can be offset by efficiency. In India, success is if thermal energy use just doubles

Urban policies, esp. In developing country cities are key: 85% of growth is from urban areas

Acceleration of retrofit rates brings climate benefits only with very ambitious performance levels; and only to a limit

Thank you for your attention

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Center for Climate Change and Sustainable Energy Policy

Central European University

Ksenia Petrichenko

Diana Ürge-Vorsatz

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

http://3csep.ceu.hu http://www.gbpn.org/reports

Email: vorsatzd@ceu.hu, Petrichenko_Ksenia@ceu-budapest.edu