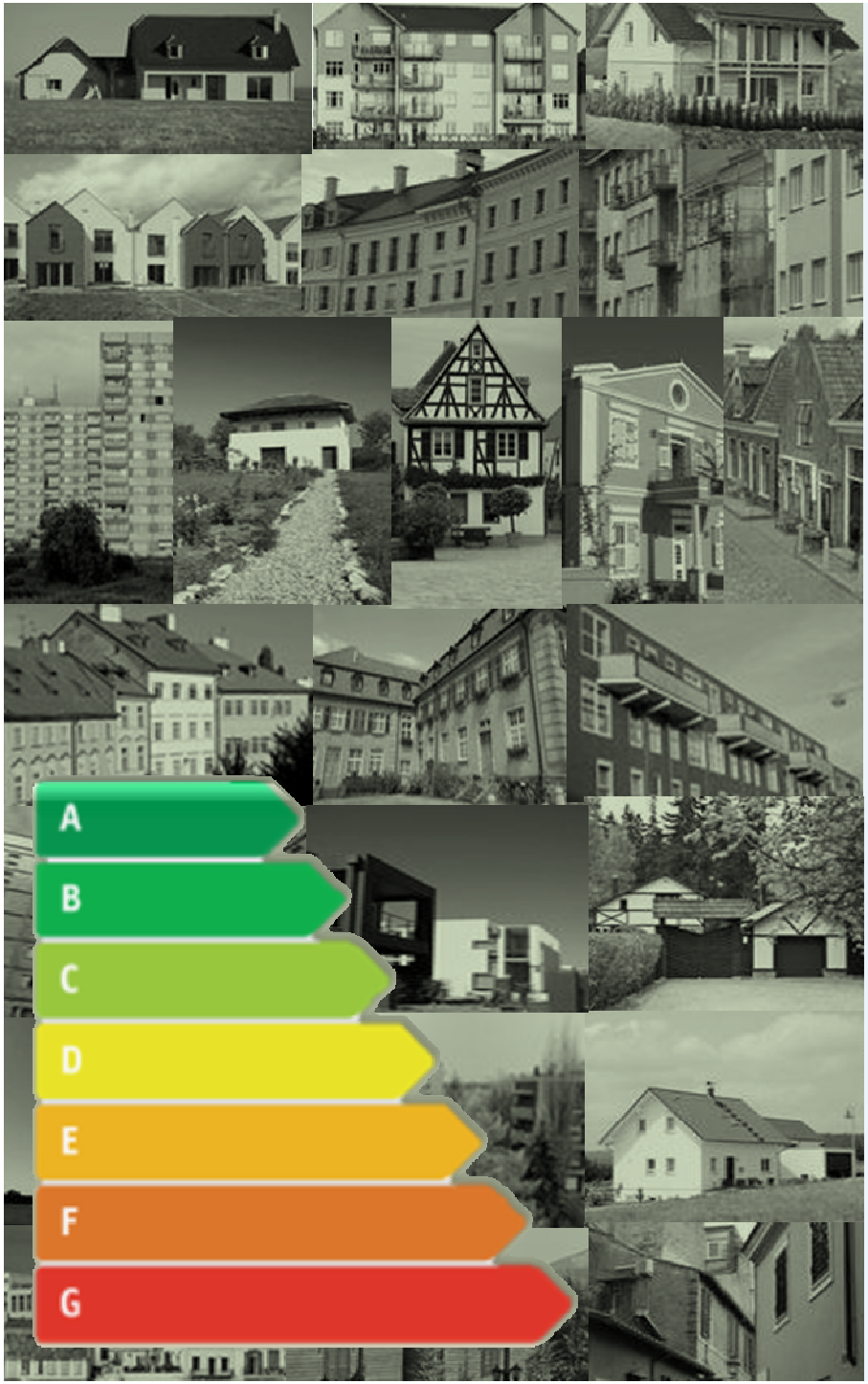


IEPEC 2012

European Survey of the Energy Performance of Buildings and Relevant Policies

Marina Economidou
Buildings Performance Institute Europe

June 12-14 2012

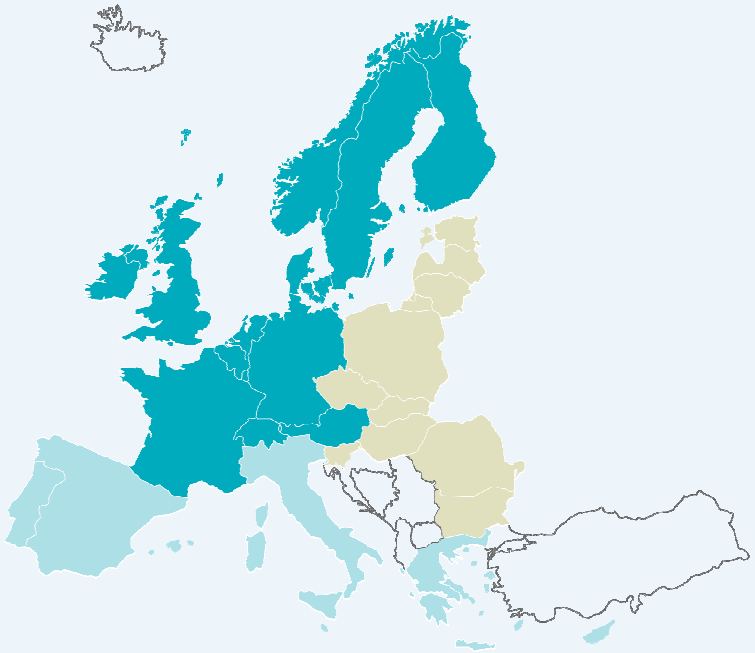
BPIE

Overview

- The BPIE survey
- Energy building codes
- Other measures/instruments
  - Financial incentives
  - EPCs
- Conclusions

BPIE survey

- Survey template covering statistical and policy data regarding the energy performance of buildings
  - Stock Inventory
  - Performance levels of existing buildings
  - Financial instruments
  - Building codes
  - EPCs, H&AC systems
- Countries covered: EU27, plus NO & CH
- Building types: single and multi-family houses, offices, educational buildings, hospitals, hotels and restaurants, sports facilites and wholesale and retail trade buildings
- 3 regions considered: N&W, C&E, S



North & West	AT, BE, CH, DE, DK, FI, FR, IE, LU, NL, NO, SE, UK	Population: 281 mil
Central & East	BG, CZ, EE, HU, LT, LV, PL, RO, SI, SK	Population: 102 mil
South	CY, EL, ES, IT, MT, PT	Population: 129 mil

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Thanks to:

Steering Committee: BPIE, EuroACE, Eurima, Glass for Europe, PU Europe

Country experts

Advisory Committee

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Energy building codes

Why does it matter?

- With today's technologies, new buildings can be constructed with **70%*** better energy efficiency than existing buildings
- Energy building codes can be pivotal in ensuring that new technologies are in reality deployed at the building level
- Cost effective policy measure →e.g. for compliance cost-benefit is very high **(1:6)****
- New buildings, but...

* Based on IEA report "Energy technology perspectives - Scenarios & strategies to 2050" (IEA, 2006)

** Based on IMT analysis "Value of code compliance and its cost-effectiveness" presented at ACEEE

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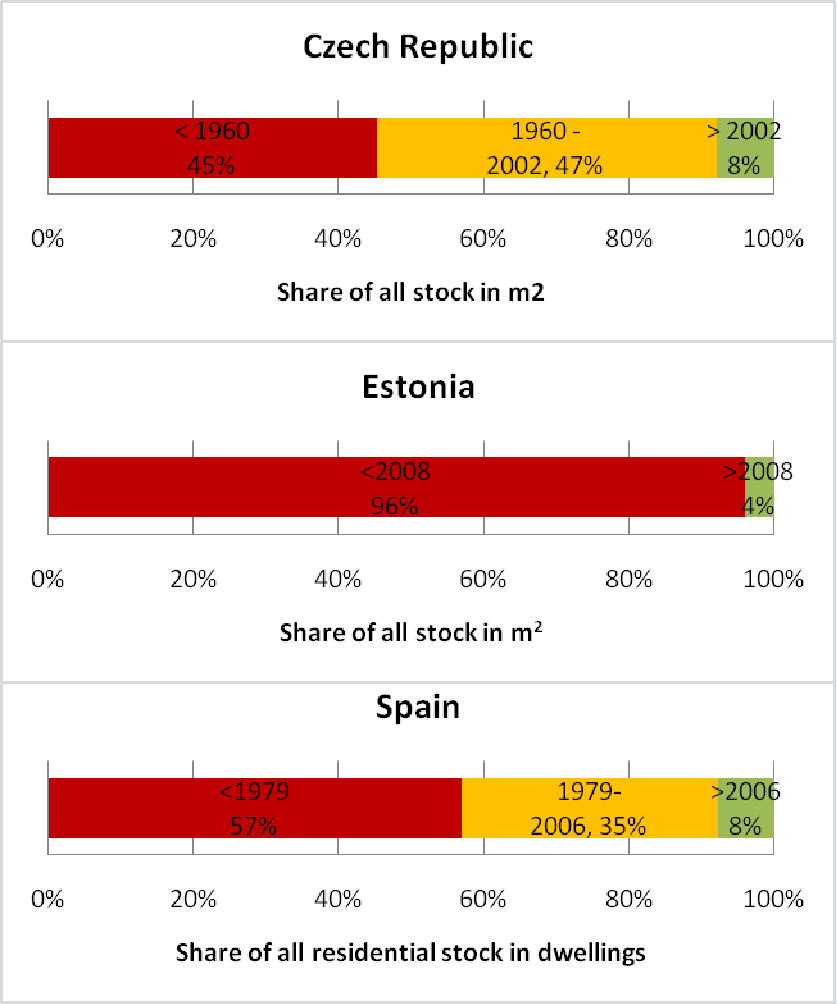
Why does it matter?



No regulations

Regulations on thermal protection (e.g. U values of building envelope)

Regulations on heating demand/energy performance

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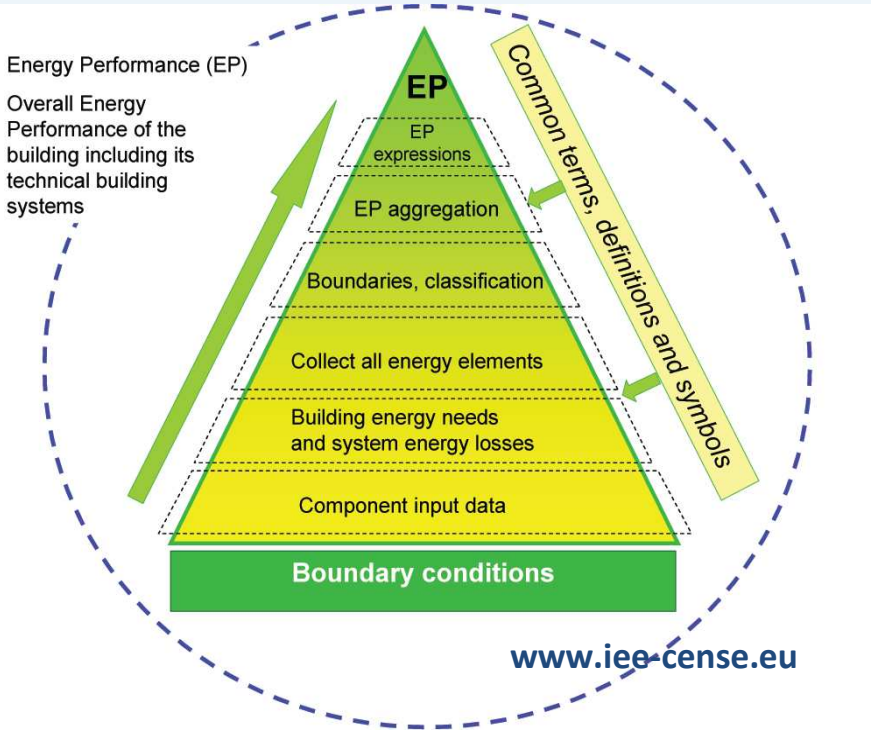
** Figures are approximate numbers; Based on BPIE data*

Where are we now?

EPBD recast Articles 4, 7 Min EP requirments & existing buildings	- Min EP reqmts to be set with view of achieving CO levels - Reqmts may differ: new & existing, different building types - Min EP reqmts in major renovations for whole building or renovated part (1000m^2 threshold removed - 2002/91/EC)

✓ **HOLISTIC APPROACH**
Assessment of the overall energy performance of a building



Questions covered in the BPIE survey

- What requirements are set in relation to the energy performance of buildings, how these are compared with older requirements?

- What are the specific required EP values in representative buildings for new constructions and renovations?

- What other requirements apply in relation to:
  - thermal Insulation;
  - airtightness and ventilation;
  - heating and AC systems;
  - orientation, size and shape;
  - lighting;
  - indoor climate?
- What are the permit requirements for renovations? What are in practice the actual performance levels?

Energy performance requirements

	Performance based requirements[1]				
	New build	Renov.		New build	Renov.
AT	✓	✓	HU	✓	✓
BE-Wl	✓	X	IE	✓	X
BE-Br	✓	X	IT	✓	✓
BE-Fl	✓	X	LT	✓	✓
BG	✓	✓	LV	X	X
CH	✓	✓	MT	X	X
CY	✓	✓	NL	✓	X
CZ	✓	✓	NO	✓	✓
DE	✓	✓	PL	✓	✓
DK	✓	X	PT	✓	✓
EE	✓	✓	RO	X	X
EL	✓	✓	SE	✓	✓
ES	✓	✓	SI	✓	✓[3]
FI	✓	P[2]	SK	✓	✓
FR	✓	✓	UK	✓	✓

- The approach shifted from one typically expressed as a maximum permitted U-value to one based on overall building performance, including requirements for technical systems such as HVAC plant and lighting;
- Nearly all countries have adopted a national methodology setting performance/based requirements for new buildings
- In some cases, two approaches exist in parallel (e.g. NO, ES, PL, CH): 1st on holistic approach and 2nd on performance of single elements
- Many different approaches have been applied and no direct comparison can be made (see next slide)

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Energy performance requirements

	Single Family Houses	Apartment Blocks	Offices	Educational Buildings	Hospitals	Hotels & Restaurants	Sports facilities	Wholesale & retail trade
AT	H: 66 kWh/m²a	H: 66 kW/m²a	H:22.75 kWh/m³a	H:22.75 kWh/m³a	H:22.75 kWh/m³a	H:22.75 kWh/m³a	H:22.75 kWh/m³a	H:22.75 kWh/m³a
			C: 1 kWh/m³a	C: 1kWh/m³a	C: 1kWh/m³a	C: 1kWh/m³a	C: 1kWh/m³a	C: 1kWh/m³a
BE - Fl	From 2012 E70; from 2014, E60	From 2012, E70; from 2014, E60	From 2012, E70; from 2014, E60	From 2012, E70; from 2014, E60				
CH	Space heating demand (effective energy): 5 litre heating oil equivalent per m² (based on MuKEn 2008)							
	H: 54 kWh/m²a	H: 42 kWh/m²a	H: 46 kWh/m²a	H: 43 kWh/m²a	H: 44 kWh/m²a	H: 58 kWh/m²a	H: 40 kWh/m²a	H: 36 kWh/m²a
CY	A or B category on the EPC scale							
CZ	F: 142 kWh/m²a	F: 120 kWh/m²a	F: 179 kWh/m²a	F: 130 kWh/m²a	F: 310 kWh/m²a	F: 294 kWh/m²a	F: 145 kWh/m²a	F: 183 kWh/m²a
DK	P: 52.5+1650/A kWh/m²a	P: 52.5+1650/A kWh/m²a	P: 71.3+1650/A kWh/m²a	P: 71.3+1650/A kWh/m²a	P: 71.3+1650/A kWh/m²a	P: 71.3+1650/A kWh/m²a	P: 71.3+1650/A kWh/m²a	P: 71.3+1650/A kWh/m²a
EE	P: 180 kWh/m²a	P: 150 kWh/m²a	P: 220 kWh/m²a	P: 300 kWh/m²a	P: 400 kWh/m²a	P: 300 kWh/m²a	P: 300 kWh/m²a	P: 300 kWh/m²a
FR-H1	P_{FF}: 130kWh/m²a P_{ESH}: 250kWh/m²a	P_{FF}: 130kWh/m²a P_{ESH}: 250kWh/m²a	n/a	n/a	n/a	n/a	n/a	n/a
IE	MPEPC – 0.6 & MPCPC – 0.69	MPEPC – 0.6 & MPCPC – 0.69	MPEPC & MPCPC should not exceed 1	MPEPC & MPCPC should not exceed 1				
LT	Min Class C buildings: 80 kWh/m²a for buildings over 3000m², 100 kWh/m²a for buildings between 501 and 3000m², 115 kWh/m²a for buildings up to 500m².							
NO	N: 120-173 kWh/m²a	N: 115 kWh/m²a	N: 150 kWh/m²a	N: 120-160 kWh/m²a	N: 300-335 kWh/m²a	N: 220 kWh/m²a	N: 170 kWh/m²a	N: 210 kWh/m²a
SE	F_E: 55-95	F_E: 55-95	F_E: 55-95	F_E: 55-95	F_E: 55-95	F_E: 55-95	F_E: 55-95	F_E: 55-95
	F_{NE} 110-150 kWh/m²a	F_{NE} 100-140 kWh/m²a	F_{NE} 100-140 kWh/m²a	F_{NE} 100-140 kWh/m²a	F_{NE} 100-140 kWh/m²a	F_{NE} 100-140 kWh/m²a	F_{NE} 100-140 kWh/m²a	F_{NE} 100-140 kWh/m²a
UK	17-20 kgCO2	16-18 kgCO2	Other values apply for non-domestic buildings					

All footnotes are listed under the table 2B7 in BPIE study Europe's buildings Under the Microscope

Diverse landscape

Energy Performance Indicators

- **Energy units:** Typically expressed in kWh/m^{2}a. Others: CH - litre heating oil equivalent per m^2
- **CO_2 units**: UK with TER (Target carbon dioxide Emission Rate) , IE with MPCPC
- **Dimensionless**: 0-100 E value scale (e.g. BE), Maximum Permitted Energy Performance coefficient (e.g. IE, NL)
- **Class level**: A to G scale (e.g. IT, CY)

End uses

- Heating
- Heating & Cooling
- Heating, cooling, ventilation, DHW

Floor areas

- Gross floor area, heated gross floor area (AT), gross heated floor area
- AT: Energy units per m3 in non residential

Energy type

- Most cases in primary energy; Useful energy demand (AT, NO); effective energy (CH); DK moved from final to primary in 2006

Other

- Climatic zones - e.g. FR, ES, GR, ..
- Based on heating system (electricity/fossil fuel) - e.g. FR, SE

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Air tightness levels in building codes

AT	In naturally ventilated buildings, maximum n_{50} is 3.0. In mechanically ventilated buildings, maximum n_{50} is 1.5.
BE	Default value of 12 m^3/hm^2 is used in methodology if no pressure test is available. Actual test result is used in the calculation if available
BG	In apartments with high airtightness, n_{50} <2.0 h^{-1}, with medium airtightness n_{50}=2.0-5.0 h^{-1} and with low n_{50}>5h^{-1}. In SFH with high airtightness, n_{50}<4.0h^{-1}, with medium airtightness n_{50}=4.0-10.0 h^{-1} and low airtightness n_{50}>10.0 h^{-1}
CY	Not regulated in building codes
CZ	Recommended maximum for common buildings is 4.5 h^{-1}, low energy buildings 1.5 h^{-1} and passive houses 0.6 h^{-1}. For mechanically ventilated buildings w/o heat recovery 1.5 h^{-1}, with heat recovery 1.0 h^{-1}
DE	For naturally ventilated buildings, n_{50} is 3.0h^{-1} and for mechanically ventilated buildings, n50 is 1.5h^{-1}
DK	Airtightness must be better than 1.5 l/sm^2, tested @ 50 Pa
ES	Air permeability of windows and doors depend on the climatic zone. For zones A and B (Class 1, 2, 3 and 4), maximum air permeability is 50m^3/hm^2. For zones C, D and E (class 2, 3 and 4), maximum air permeability is 27 m^3/hm^2.
EL	Air penetration for the reference building, is taken equal to 5.5 m^3/hm^2 frame.
EE	For small buildings, maximum airtightness is 6 m^3/hm^2 (for new buildings) and 9 m^3/hm^2 (for existing buildings). For large buildings, maximum airtightness is 3 m^3/hm^2 (for new buildings) and 6 m^3/hm^2 (for existing buildings).
FI	n_{50} equal to 2.0 is used for reference building heat loss in Finnish Building Code. For EPC, n_{50} of 4 is considered unless the measured value is different. Air change rate in new apartments should be at least 0.5 h^{-1}.
FR	Airtightness under 4Pa of building envelope is limited to 0.8 m^3/hm^2 for SFH, 1.2 m^3/hm^2 for other residential buildings, offices, hotels educational and health care buildings and 2.5 m^3/hm^2 for other buildings.
HU	Not regulated in building codes
LT	For naturally ventilated building, maximum n50=3 1/h, for mechanically ventilated buildings, maximum n50=1.5 1/h
LV	Maximum n50 in dwellings is 3 m^3/hm^2, 4 m^3/hm^2 in public buildings, 6m^3/hm^2 for industrial buildings. For ventilated buildings, maximum n_{50} is 3m^3/hm^2.
MT	Not regulated in building codes
NL	For residential buildings, 200 dm^3/s @10 Pa and for non-residential buildings 200 dm^3/s per 500m^3 @10 Pa
NO	Maximum n_{50} is 3
PT	For residential buildings, the requirement is 0.6h-1. Requirements for non residential buildings with mechanical ventilation exist depending on type of use
SI	For naturally ventilated buildings, maximum n_{50} is 3.0, for mechanically ventilated buildings, maximum n_{50} is 2.0
SK	For SFH with high quality windows, maximum n_{50} is 4 h^{-1} and for all other buildings is 2 h^{-1}. Other values apply for buildings with double glazed windows with seals or single glazed windows without seals.
UK	Maximum n_{50}=10 m^3/hm^2

- Thermal performance of buildings directly related to air tightness
- Increasingly important issue as stricter requirements are put in place but not always considered
- Air permeability normally measured using pressure test typically ay 50 Pa (4Pa in FR and 10 Pa in NL)
- Units: m^3/hm^2, h^{-1}. l/sm^2

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Building envelope insulation requirements

	MT	CY	PT	EL	ES	IT	LV [1]	FR	BG	BE	NL	IE	HU	SI
HDD[5]	560	782	1282	1663	1842	1907	1970	2483	2686	2872	2902	2906	2922	3053
Roof	0.59	0.85	0.9-1.25	0.35-0.5	0.45-0.65	0.32-0.65	0.2κ-0.35κ	0.2-0.25	0.3	0.3	0.4	0.25	0.25	0.2
Walls	1.57	0.85	1.45-1.8	0.4-0.6	0.57-0.94	0.33-0.62	0.25κ-0.5κ	0.36-0.40	0.35	0.4	0.4	0.37	0.45	0.28
Floor	1.57	2		0.45-0.5	0.62-0.69	0.29-0.38	0.2κ-0.35κ	0.37-0.40	0.5	0.6	0.4	0.37	0.45	0.9
Window/ Door	5.8	3.8		2.6-3.2	3.1-5.7	1.3-3.7	1.8κ-2.4κ	1.7-1.9	1.8	2.5	4.2	2.2	1.6	1.1 -1.6

	UK[3]	RO	DE	SK	CH[2]	DK	CZ	AT	PL	LT	EE	SE[4]	NO	FI
HDD	3115	3129	3239	3453	3482	3503	3571	3573	3616	4094	4444	5444	5646	5850
Roof	0.2	0.2	0.24	0.19	0.17 or 0.2	0.2	0.24	0.2	0.25	0.16	0.15-0.2	0.4-0.6	0.18	0.09
Walls	0.3	0.56	0.24	0.32	0.17 or 0.2	0.3	0.3	0.35	0.3	0.2	0.2-0.25		0.22	0.17
Floor	0.25	0.35	0.3		0.17 or 0.2	0.2	0.45	0.4	0.45	0.25	0.15-0.2		0.18	0.16
Window/ Door	2	1.3		1.7	1.3	1.8	1.7	1.4	1.7	1.6	0.7-1.4		1.6	1.0

- U values against HDD to reflect the climatic impact

- In some countries, multiple reqs exist to reflect different climates

- Comparison with **Ecofys 2007 cost optimality line:**

1. Current reqs still higher than CO levels
2. Mild/warm climates – higher effort is needed

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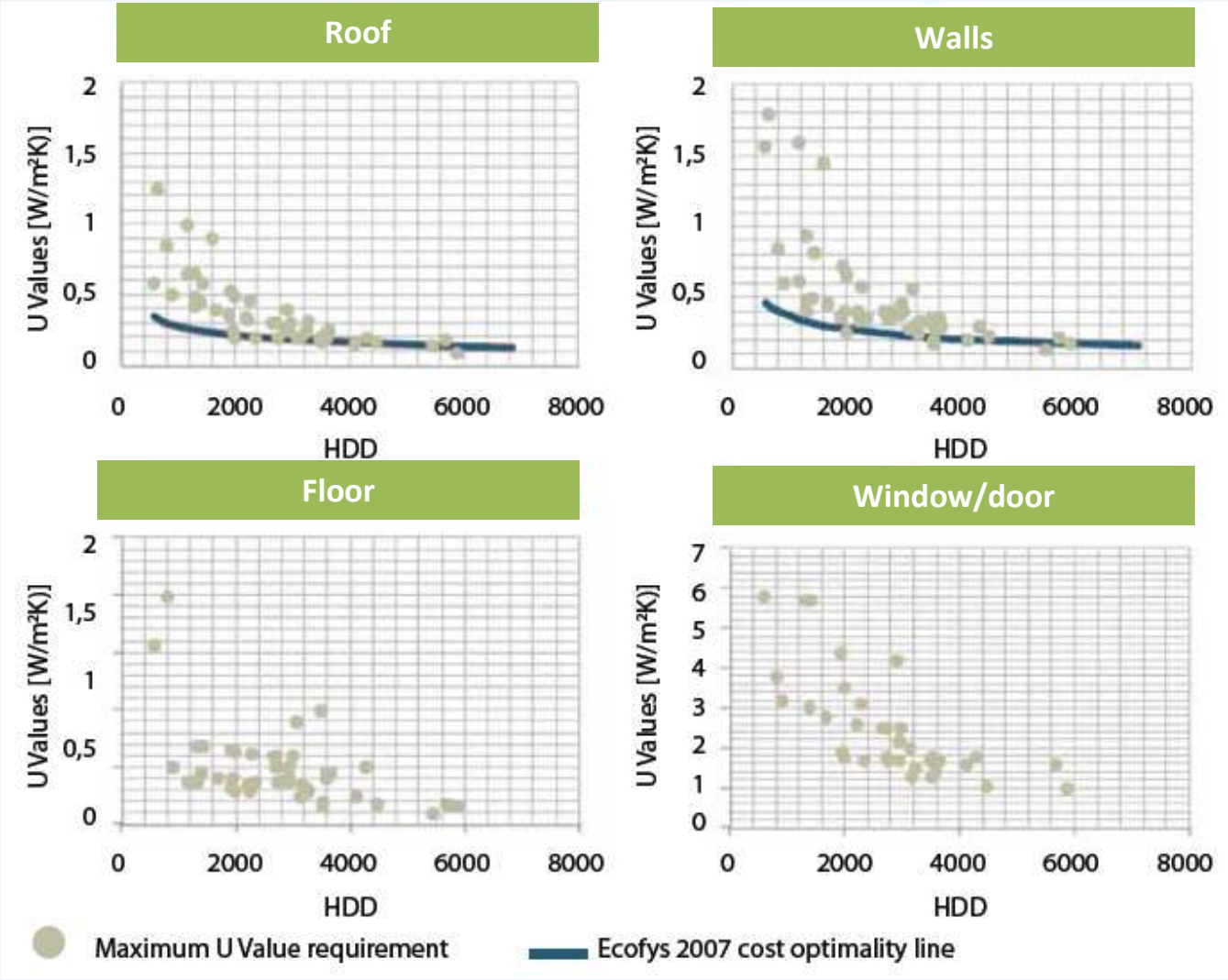
Building envelope insulation requirements



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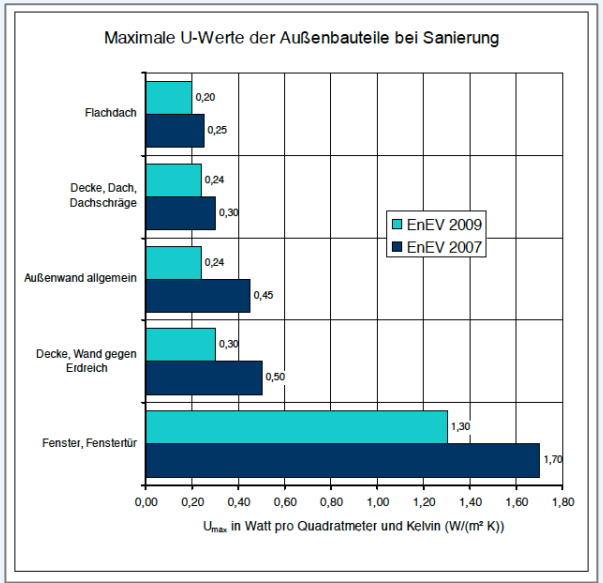
How about renovations?

➡ Different approaches, e.g.:

Germany



Maximum U-values of exterior components in case of renovation - Source: Tuschinski (2009)

- The **changed components** of the building envelope must require **minimum standards of heat protection** (respective U-values for building components are shown in the figure).

- Alternatively, the **expert is free to choose** the energy efficiency of the whole renovated building → renovated building doesn't exceed the requirement for new buildings **by more than 40%**

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How about renovations?

➡ Different approaches, e.g.:

Estonia

Building type	New building kWh in annum per heated floor area	Existing building, kwh in annum per heated floor area
Small residential house	180	250
Apartment block	150	200
Office buildings	220	290
Hotels/restaurant Commercial building/	300	390
Hospital	400	520
School/ University/Science building	300	390
Swimming pool	800	1000

- Performance-based requirements for all building types when buildings **are major renovated???**
- Values for **renovated buildings** are around 25-38% higher than new build requirements.

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How about renovations?

- Two options

CH Renovated buildings are required to use no more than 125% of the space heating demand of an equivalent new building. A single element approach may also be applicable for renovations.

- Holistic based performance

ES Existing buildings over 1,000 m2 must comply with the same minimum performance requirements as new buildings if more than 25% of the envelope is renovated.

- Component based requirements

FI Reference transmittance/heat loss (in W/K) requirements apply. New energy performance regulations will be launched in 2012.

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What does major renovation mean?

DE

- Modifications of the building envelope (wall, roof, windows, doors, ceiling – renovations, modernisations
- Extensions of the building (new rooms or building parts, etc.)
- Upgrading of the building (previously not heated building parts etc.)

CH

- complete replacement of heating and the DHW systems
- interventions on improving energy district heating networks of small scale count for a single building, part of which the shells of a or more buildings are being rehabilitated by more than 75 percent.

HU

- Retrofits and renovations of buildings of a floor area above 1,000 m^2 if more than 25% of the building shell surface is affected by the renovation or the HVAC and lighting systems of the building are significantly altered

ES

- Modifications, alterations or renovations of existing buildings with a floor area exceeding 1000 m^2 which is renewed more than 25% of their enclosures

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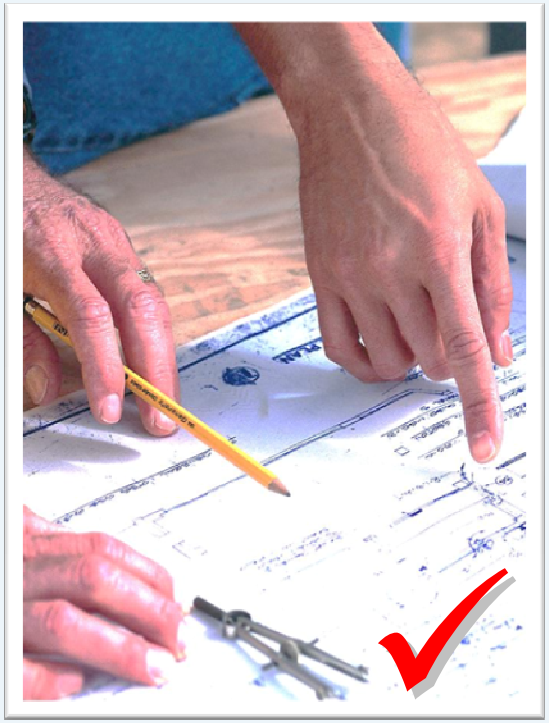
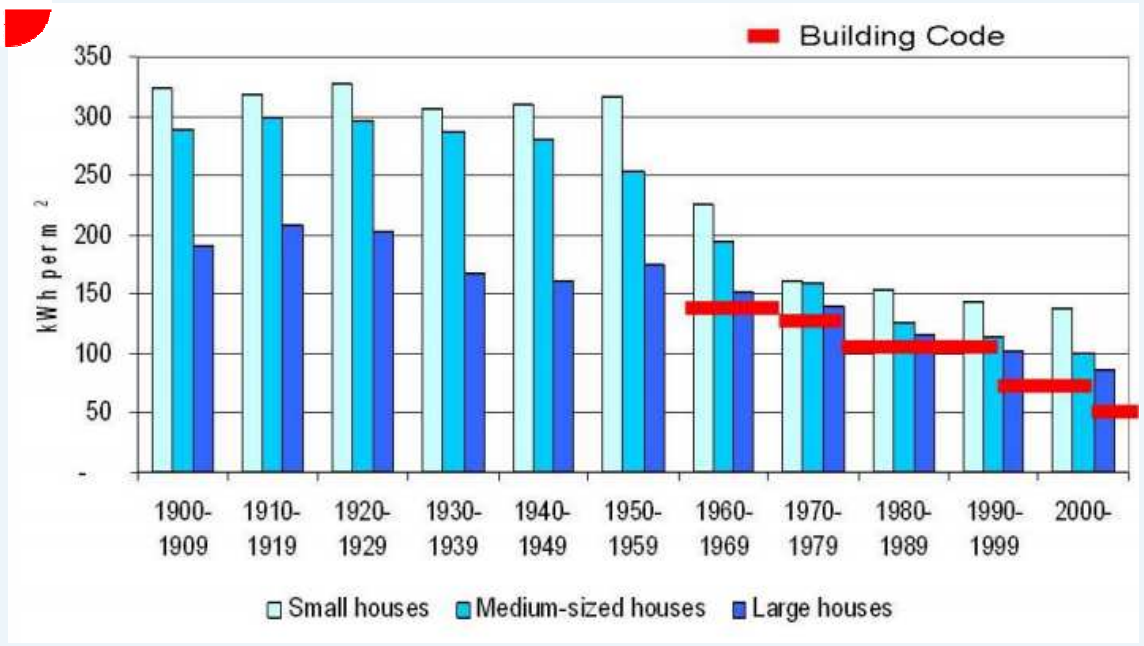
Enforcement & compliance

- Control:prior, during, upon completion of construction
- Process involves: Announcement to authorities, application for permits, approval, inspection, completion of certification
- Building permit requirements: Not all MS have requirements for permit;
- Compliance & enforcement less rigorous compared to regulations on structural integrity or fire safety
- Evidence of performance gap between design and actual performance in use – one or more issues: calculation methodology flaws, no rigorous enforcement regimes, designer/builder fail to deliver intended outcome;
- Performance gap to grow as more demanding/stringent requirements are implemented



Enforcement & compliance

- An impact analysis undertaken by Ecofys and Fraunhofer Institute estimated that non-compliance levels 25-50% and 20-33% between 45% and 55% for renovations and 70% for new buildings (Wesselink, Harmsen, & Eichhammer, 2010)

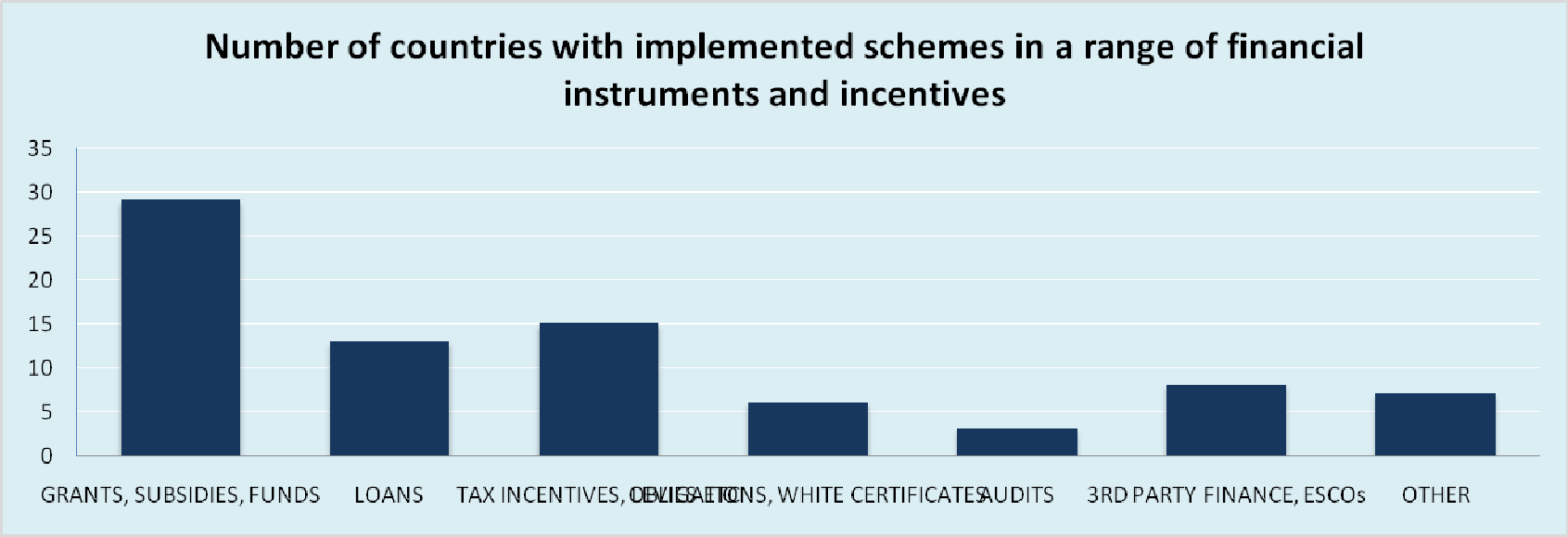


Actual energy consumption in single family houses in Denmark, relative to energy efficiency requirements in building codes – Laustsen 2008 (IEA)

Other instruments

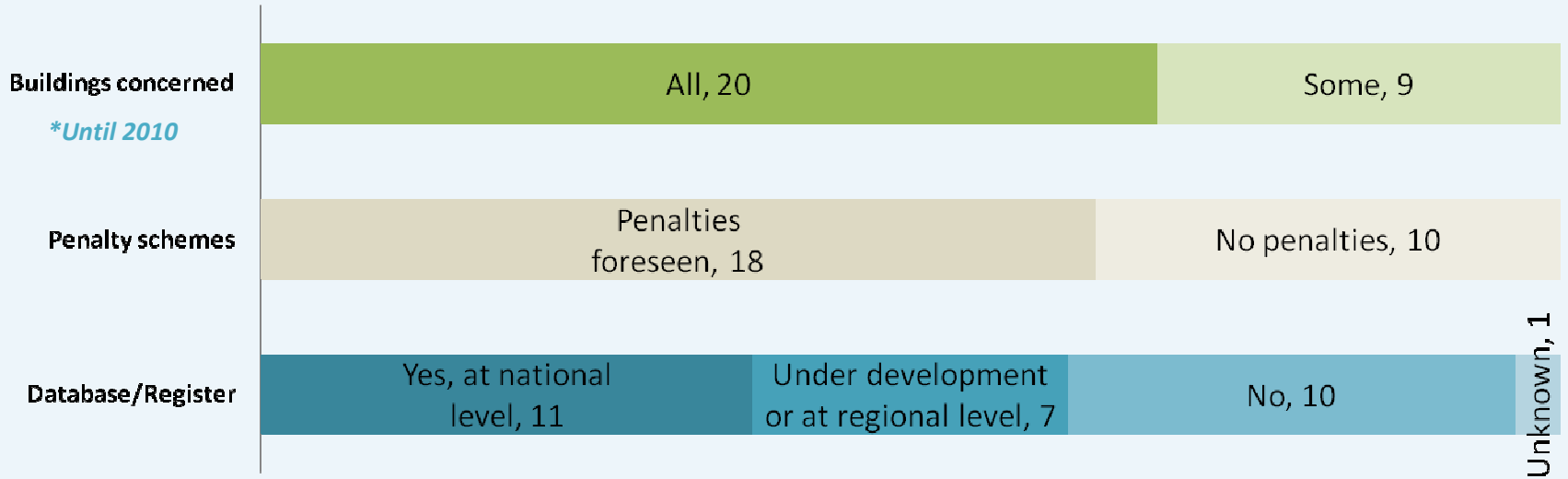
Financial instruments for EE in buildings

- Financial support varies considerably from around €1M/a to in excess of €1b/a
- Many schemes targeting specific technologies, such as insulation, boiler scrapage, renewables, and also new passive buildings.
- Various forms of loans and taxes are usually available. Less popular schemes: audits, third party financing and energy supplier obligations/white certificate schemes
- The surveyed measures are encouraging, but many of them are only modest in their ambition, achieving the BAU case with very few on deep renovations.



EPC schemes

Implementation status



Countries concerned: EU27, CH, NO

Existing EPC registers/databases have proven to be extremely useful in monitoring and analysing the opportunities for energy performance improvement.

In the longer term, they will also prove invaluable in assessing trends in energy performance.

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Public acceptance

	Use of certificates at sale/rent	Perception of usefulness by the public	Main "discussion points"
AT			Transparency of the certificate, not showing total energy performance, recommendations not always presented (clearly).
BE (Flanders)			Non-residential stil under development.
CZ			Perception of general public as new expression of bureaucracy. Information on EPC not very useful. Only EPC for new buildings and major renovations. Main group of existing buildings not effected.
DK			For new buildings EPCs are issued more than for transaction moments for existing buildings.
FR			Use of EPCs high in social renting market, but low in private rental market. EPC still often only regarded as an 'informative instrument'.
DE			The quality of the cheaper version based on measured rating. Registration and practical enforcement.
HU			The costs of the certificate and mandatory character are a discussion point for the general public. EPCs not mandatory yet for existing buildings.
IE			Recommendations for energy saving measures not in actual EPC but in advisory report.
NL			Actual use of EPCs high for social housing, but low for private market. A public discussion on the transparency, reliability and reproducibility of the certificates lead to adaptations in the scheme.
PL			The EPC provides little useful information for the building owner for improvements. In practice EPCs are only issued at transactions when demanded by both parties.
PT			Use of EPCs is lower in the rental market than in the sale market.
ES			EPCs are only in practice for new buildings, public awareness is low.

 Improvement desirable

 Room for improvement

 Good

 Very good

Conclusions

Conclusions

- **EPBD**: important step forward for strengthening energy performance requirements; implementation and enforcement should be given higher priority
- **Political willingness**: Energy codes are often downplayed (in comparison to structural
- **Compliance**: Compliance mechanisms should not be overlooked → it is typically more cost effective to improve compliance, rather than strengthening further the requirements (e.g. Flanders)
- **Capacity building:** Need to overcome understaff/underfund issues in the context of compliance mechanisms and construction sector as a whole.
- **Education & training:** Training inspectors for control & verification procedures, architects, engineers and building value chain actors.

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Thank you

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