Low-energy buildings in Europe – Building envelope peformance and energy standards

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Introduction – Why low energy houses?

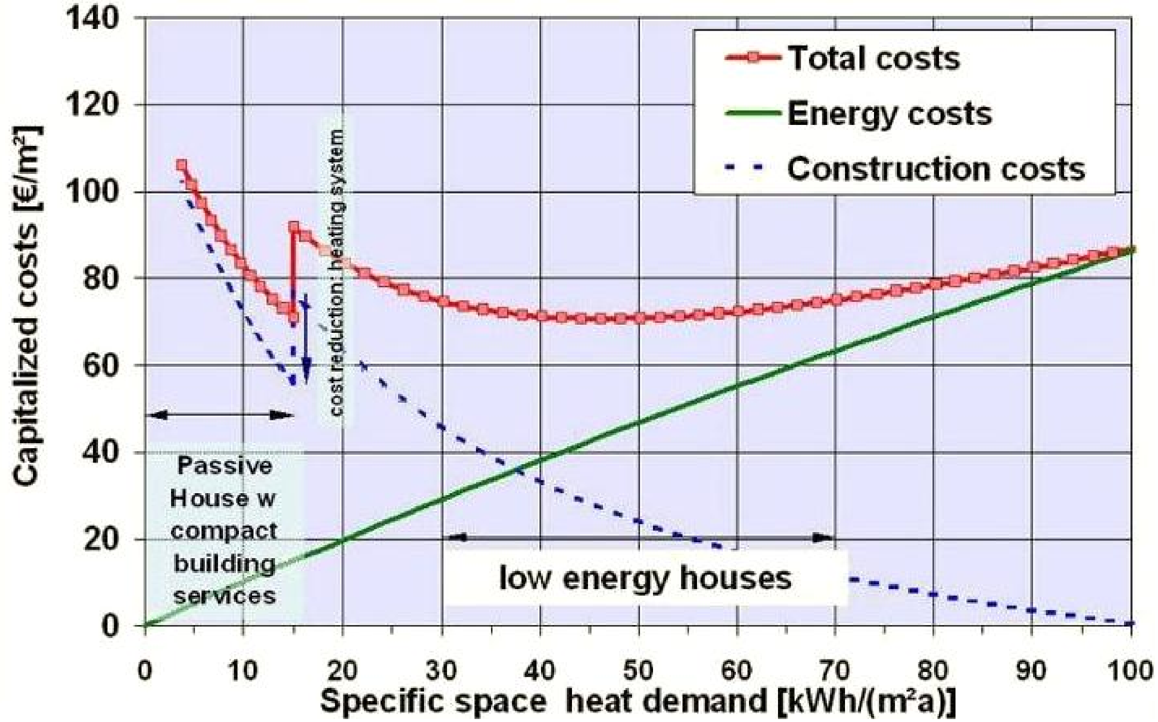
- 40% energy, 36% CO_2
- EPBD, 2020, 2050
- Resources
- National incentives
- Indoor climate
- Economy?
- New versus old buildings

Initiatives on low energy houses

- Improved building codes
  - Swedish BBR
    - functional demands
    - improving over time
- Life cycle analysis – life cycle economics
- Green building, BREEAM, LEED
- Low energy houses
- Passive houses
- (Net) zero energy houses

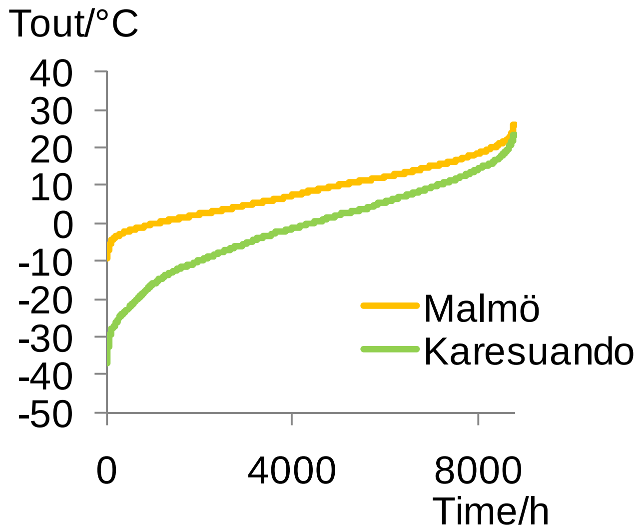
Passive houses

- 'Very low' heating demand
- Air heating
  – Air exchange efficiency
- Heat recovery of ventilation
- 'Air tight'
- Under-pressure
- Solar gains
  – 'Continental'



Why compare standards?

- Why have different standards?
  - Outdoor climate, resources, inhabitant behaviour, optimisation, opinions
- What differs?
  - Design
  - Components
  - Process – prediction, verification
  - Relevance



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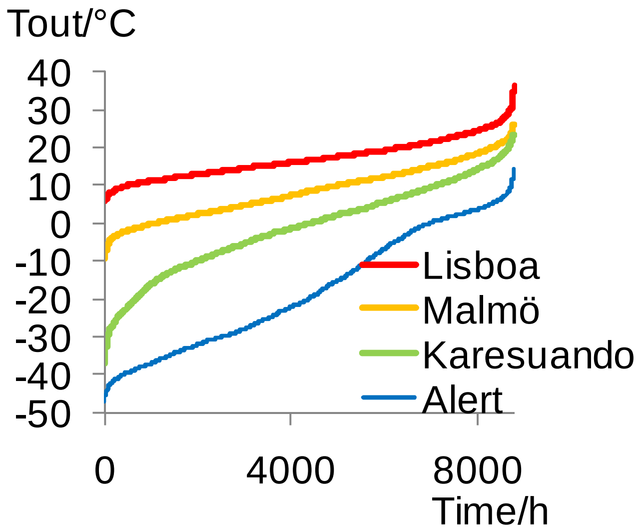

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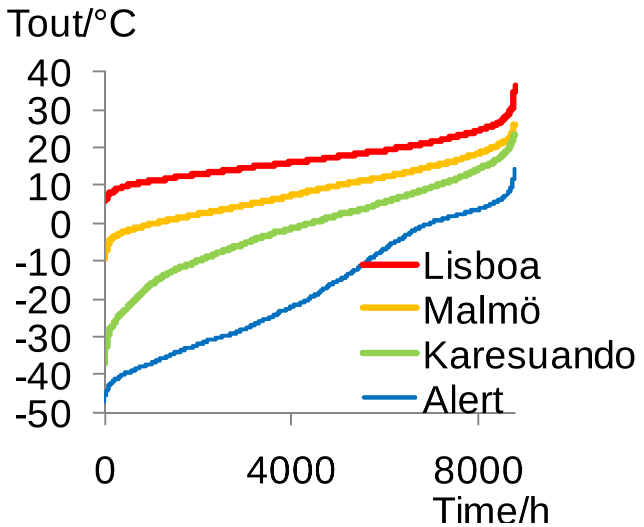
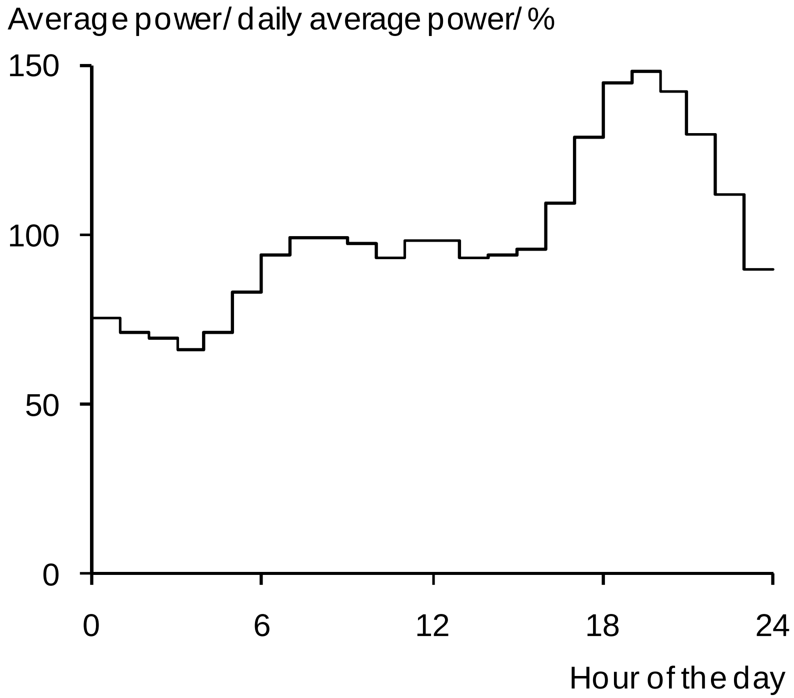


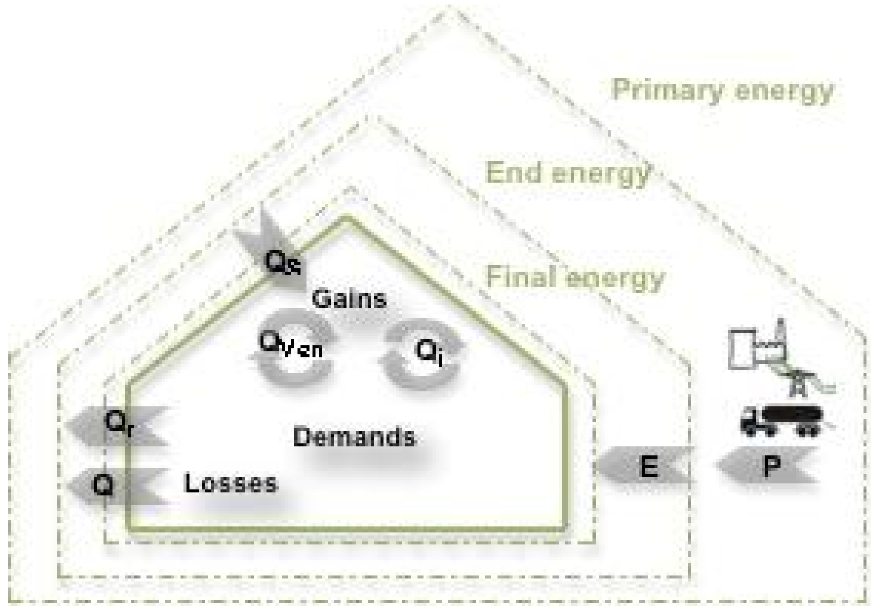


Objectives

- Explore, compare and compile the different types and definitions of low energy buildings in Europe
  - Sweden, Denmark, Norway, Finland, Germany, Austria, Switzerland, Great Britain and Poland
- Present part of the result
- More comprehensive in thesis of Thullner

What to standardize?

- Design of details
- Power demand
- Energy use
- Primary energy use
- Inhabitant behaviour
- Indoor climate



P	*Energy needed for generation, conversion and transportation*
E	*Supplied, delivered energy*
Q_T	*Heat losses by transmission*
Q_V	*Heat losses by ventilation and air leakage*
Q_S	*Gained solar energy*
Q_{Ven}	*Gained energy by heat exchanger*
Q_i	*Internal heat gains by persons, appliances, electronic devices and lighting*

- Different kinds of low energy houses 1st January 2010
  - Of: Official
  - SO: Semi official
  - UO: Unofficial
  - Ce: Certified

Location	Issuer	St	Ce
EU			
Low-energy building	EU Green Building	SO	✓
SWEDEN			
Low-energy "Minienergi"	FEBY	SO	✓
Passive house	FEBY	SO	✓
Zero-energy house	FEBY	SO	✓
NORWAY			
Low-energy house class 1	Standard Norge	*Of*	-
Low-energy house class 2	Standard Norge	*Of*	-
Passive house	Standard Norge	*Of*	-
Passive house	PHI Darmstadt	SO	✓
DENMARK			
Low-energy house class 1	Bygningsreglement	Of	-
Low-energy house class 2	Bygningsreglement	Of	-
Passive house	PHI Darmstadt	SO	✓
FINLAND			
Low-energy house	RIL	SO	-
Passive house	RIL	SO	-

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GERMANY			
RAL Low-energy house	RAL	SO	✓
RAL Passive house	RAL	SO	✓
Passive house	PHI Darmstadt	SO	✓
3-litre-house	Fraunhofer Institut	UO	-
Effizienzhaus 70	KfW	SO	-
Effizienzhaus 85	KfW	SO	-
AUSTRIA			
Low-energy (state-aided)	MA 25	Of	-
Passive house (state-aided)	MA 25	Of	-
3-litre house	3-Liter-Haus	SO	✓
Klima:aktiv Passive house	Klima:aktiv	SO	✓
Klima:aktiv house	Klima:aktiv	SO	✓
SWITZERLAND			
Low-energy (Minergie)	MINERGIE	SO	✓
Passive house (Minergie-P)	MINERGIE	SO	✓
Minergie-ECO / P-ECO	MINERGIE	SO	✓
GREAT BRITAIN			
Passive house	PHI Darmstadt	SO	✓
POLAND			
Passive house	PHI Darmstadt	UO	-

	Uwalls/ (W/(m^2K))	Air tightness at Δ50 Pa	Peak load (W/m^2)	Primary energy (kWh/m^2year)	End energy (kWh/m^2year)		Final energy (kWh/m^2year)
EU							
Low-energy Green-Building	-	-	-	-	25% < national building regulation		-
SWEDEN (Limit values for U-vıponents mean value) [3]							
Low-energy "Minienergi"	-	≤ 0.3 l/s m^2	16-20	*80-88*	-		-
Low-e "Minienergi" < 200 m^2	-	≤ 0.3 l/s m^2	20-24	*80-88*	-		-
Passive house	-	≤ 0.3 l/s m^2	10-12	*60-68*	-		-
Passive house < 200 m^2	-	≤ 0.3 l/s m^2	12-14	*60-68*	-		-
Zero-energy house	-	≤ 0.3 l/s m^2	Same as passive	≤ produced energy	-		-
NORWAY (Limit values for U-vnponents mean value)					[4]		
For buildings < 250 m^2 the ene building of 110 m^2					θ_{ym}≥6.3°C	θ_{ym}<6.3 °C e.g. 3°C	
Low-e class 1 < 250 m^2	≤ 0.18	≤ 1.0 h^{-1}	-	-	41.2	56	-
> 250 m^2	≤ 0.18	≤ 1.0 h^{-1}	-	-	30	41	-
Low-e class 2 < 250 m^2	≤ 0.22	≤ 3.0 h^{-1}	-	-	59	80	-
> 250 m^2	≤ 0.22	≤ 3.0 h^{-1}	-	-	45	61	-
Passive house < 250 m^2	≤ 0.15	≤ 0.6 h^{-1}	-	-	22.6	32	-
> 250 m^2	≤ 0.15	≤ 0.6 h^{-1}	-	-	15	22	-
Passive house current	*≤ 0.15*	≤ 0.6 h^{-1}	German	German	German		German

	Uwalls/ (W/(m²K))	Air tightness at Δ50 Pa	Peak load (W/m²)	Primary energy (kWh/m²year)	End energy (kWh/m²year)	Final energy (kWh/m²year)
DENMARK					5	
Low-energy house class 1	-	≤ 1.5 h^{-1}	-	-	(35+110/A)	-
Low-energy house class 2	-	≤ 1.5 h^{-1}	-	-	(50+1600/A	-
Passive house	≤ 0.15	≤ 0.6 h^{-1}	10 **or** final energy	120	-	15 **or** peak load
FINLAND					6	
Low-energy house M30	0.12-0.14	≤ 0.8 h^{-1}	-	180	30-38	-
Low-energy house M35	0.12-0.14	≤ 0.8 h^{-1}	-	180	35-45	-
Low-energy house M40	0.12-0.14	≤ 0.8 h^{-1}	-	180	40-50	-
Low-energy house M40	0.12-0.14	≤ 0.8 h^{-1}	-	180	45-58	-
Low-energy house M45	0.12-0.14	≤ 0.8 h^{-1}	-	180	50-64	-
Passive house P15	0.08-0.12	≤ 0.6 h^{-1}	-	135-140	15-20	-
Passive house P20	0.08-0.12	≤ 0.6 h^{-1}	-	135-140	20-27	-
Passive house P25	0.08-0.12	≤ 0.6 h^{-1}	-	135-140	25-33	-

- 3:Sweden is divided into three climate zones.
- 4:Norway depending on the yearly mean outdoor temperature θ_{ym}.
- 5:A is related area

	Uwalls/ ($W/(m^2K)$)	Air tightness at Δ50 Pa	Peak load (W/m^2)	Primary energy (kWh/m^2year)	End energy (kWh/m^2year)	Final energy (kWh/m^2year)
GERMANY						
RAL Low-energy house	-	≤ 1.0 h^{-1}	-	-	-	40
RAL Passive house	-	≤ 0.6 h^{-1}	-	120	-	15
Passive house	*≤ 0.15*	≤ 0.6 h^{-1}	10 **or final energy**	120	-	15 **or peak load**
3-litre-house	-	-	-	33.3	-	-
Effizienzhaus 70	-	-	-	70% of the building reg	-	85% of the building reg
Effizienzhaus 85	-	-	-	85% of the building reg	-	100% of the building reg
AUSTRIA						
Low-energy (state-aided)	≤ 0.35	≤ 3 h^{-1}	-	-	-	11x(1+2.5 l_c)
Buildings with mechanical ventilation		≤ 1.5 h^{-1}	-	-	-	15x(1+2.5 l_c)
Passive house (state-aided)	*≤ 0.15*	≤ 0.6 h^{-1}	10	120 **or** 40 for the building services	-	15
3-litre house	-	≤ 1.0 h^{-1}	-	-	-	30
Klima:aktiv Passive house	See state-aided low-e	≤ 0.6 h^{-1}		65 for building services	-	15
Klima:aktiv house	See state-aided low-e	≤ 1.5 h^{-1}	-	-	-	20-45 (relating to l_c)
Buildings with mechanical ventilation with heat recovery	See state-aided low-e	≤ 1.0 h^{-1}	-	-	-	-

	Uwalls/ (W/(m²K))	Air tightness at Δ50 Pa	Peak load (W/m²)	Primary energy (kWh/m²year)	End energy (kWh/m²year)	Final energy (kWh/m²year)
SWITZERLAND [8]						
Low-energy (Minergie, -ECO)	≤ 0.15	-	-	-	38	90% of building reg
Passive house (Minergie-P, P-ECO)	-	0.6	10	-	30	60% of building reg or 15
GREAT BRITAIN						
Passive house	*≤ 0.15*	0.6	10 **or final energy**	120	-	15 **or peak load**
POLAND						
Passive house	*≤ 0.15*	0.6	10 **or final energy**	120	-	15 **or peak load**

- 6:Finland depending on climate zones.
- 7:Outer walls in general
- 8:U-value regards on of two methods

Conclusions

- Many definitions of low-energy buildings
  - comparing is hard due to the different initial parameters as calculation methods, areas and climate zones.
- Many different terms - adjusting these would simplify the understanding between the countries.
- A common definition?
  - based on the same criteria levels, related areas and included energy-posts
  - national variations can still exist
- Air-tightness, ventilation and indoor climate is crucial and is not being considered in most of today's definitions of low-energy buildings.
- Low-energy buildings is a step towards requirements of nearly-zero energy in EPBD II, year 2020

Thank you for your attention!

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