CoNZ€Bs
Solution sets for the Cost reduction of new Nearly Zero-Energy Buildings

Solutions sets for cost optimisation of nearly zero energy buildings (NZEBs) in four European countries

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What is a solution set

- Solution sets are collections of energy efficient technologies that constitutes a building that meets the national NZEB requirements or beyond
- A CoNZEBs solution set reduces the overall investment cost for a NZEB either by introduction of less costly solutions or by implementing combinations of cost and performance reductions

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Report chapters

- NZEB solution sets – country specific analyses
  - Typical building description (real or artificial)
  - Calculation tool description
  - Solution set optimisation
- Technologies used in NZEB
  - Building envelope
  - Technical building systems
  - Renewable energy systems

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Typical buildings in the 4 countries

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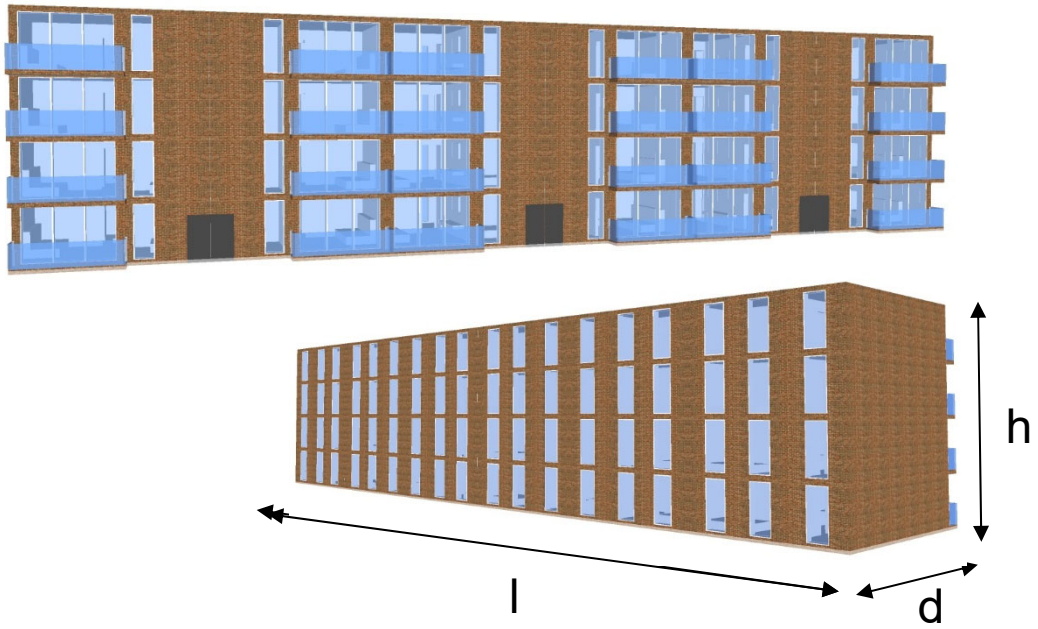
DK typical building



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DK typical building, key features

Parameter	Description / Choosing	Values
Gross Floor Area per dwelling	Average GFA- Gross Floor Area is the total floor area including external walls	80 m^2
Number of dwellings		24
Depth x Length of the building (d) x (l)	See drawing	10 m x 48 m
Number of floors		4 floors
Floor height	Distance between two floor finish levels	3 m
Total building height (h)	See drawing (inclusive insulation and finish layer of roof)	12.4 m
Floor slap above basement %		No basement

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DK typical building, key features

Parameter	Description / Choosing	Values
Distribution of windows area	% and/or m² of windows area per facade:	
	-South:	50 % / 211 m²
	-North:	50 % / 211 m²
	-West:	0 % / 0 m²
	-East:	0 % / 0 m²
U-values	Average U-value:	
	- Windows/doors inclusive frame (g = 0.53)	1.0 W/m²K
	- External wall of dwellings	0.15 W/m²K
	- Roof	0.10 W/m²K
	- Ground slab	0.10 W/m²K
Heat supply	District heating, w. radiators	
DHW	Water heated from 10 to 55 °C	250 l/m² per year
Type of ventilation system **- Mechanical vent. w. heat recovery (MVHR)**	Type: **MVHR**	
	- Ventilation rate	2.350 m³/h
	- Recovery efficiency	0.85%
	- Ventilation rate/ GFA	0.34 l/sm² ≈ 0,5 ACH
	- SPF, Specific fan power	1.5 kJ/m³

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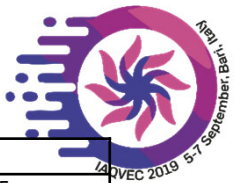
Solution sets for Denmark - summary



Solution set results summary Specific values relate to heated gross floor area[1)]				DK - SS1	DK-SS2	DK-SS3	DK-SS4	DK-SS5
				More efficient insulation material in external walls	DHW solar heating, reduced insulation in walls, roof and floor.	4 layer windows, natural ventilation heat recovery on grey wastewater.	Reduced insulation in walls, roof and floor, Decentral mechanical ventilation, energy efficient taps.	PV panels, reduced insulation in walls, roof and floor; Decentral mechanical ventilation.
Building envelope	Average U-value, (incl. windows).	W/m²K	0.26	Id.	0.31	0.21	0.31	0.31
Net energy	Total	kWh/(m²yr)	17.4	Id.	19.6	19.5	16.9	20.2
Final energy	Total EPBD	kWh/(m²yr)	29.0	Id.	28.2	30.0	28.5	30.4
	Total (incl. other energy uses)	kWh/(m²yr)	59.7	Id.	58.9	60.7	59.2	61.1
Primary energ		r)	26.3	Id.	25.9	25.9	25.9	26.0
		r)	84.6	Id.	84.2	84.2	84.2	84.3
Energy costs	Total (incl. other energy uses)	€/(m²yr)	11.8	Id.	11.8	11.7	11.7	11.7
	Difference to typical NZEB	€/m²	-	Id.	0.0	-0.1	-0.1	-0.1
Investment costs	Difference to typical NZEB	€/m²	-	-2.1	-5.5	-18.1	-15.0	-12.6

area refers to the reference floor area used in respective national calculations

average U-value of the building fabric [W/m²K]

energy cost is given in €/(m²yr) and investment cost is the difference compared to the typical NZEB in €/m²

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Solution sets Denmark - highlights

1. High efficiency insulation in exterior walls resulting in lower construction costs for foundations, window fittings and roofs
2. Reduced insulation in walls, roof and floor; roof PV panels; domestic hot water (DHW) solar heating; decentral mechanical ventilation, efficient water fixtures
3. Reduced insulation in walls, roof and floor; roof PV panels; DHW solar heating
4. Four-layer windows; water saving fixtures; natural ventilation (illegal as balanced mechanical ventilation is required in new multi-family houses)
5. Reduced insulation in walls, roof and floor; decentral mechanical ventilation; heat recovery on grey wastewater

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Solution sets Germany - highlights

1. Decentral direct electric heating (e.g. heated glass or marble plates) and decentral direct electric DHW system, decentral ventilation system with heat recovery, roof PV panels, heat recovery from shower wastewater and reduced insulation level
2. Central supply and exhaust ventilation and heating system with air-air heat pump, decentral electrical DHW heater and heat recovery from shower wastewater and reduced insulation level
3. Central combined heating and DHW system with district heating, central exhaust ventilation system and reduced insulation level
4. Central heating system with exhaust air-water heat pump in central exhaust ventilation system supported by condensing gas boiler, decentral DHW heat exchange modules, roof PV panels and reduced insulation level

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Solution sets Rome, Italy - highlights

1. Thermal driven solution with variations in the composition of the external walls and the technology of the windows. Use of condensing boiler for both heating and DHW production
2. Electricity driven solution with variations in the composition of the external walls and the technology of the windows. Heat pump for both heating and DHW supply
3. Electricity driven solution with variations in the composition of the external walls and the technology of the windows. Electric radiators for space heating mainly supplied by the PV panels (not compliant with energy performance (EP) requirements for using PV panels to feed electric directly into systems of heating).
4. Low-tech thermal driven solution with variations in the composition of the external walls and the technology of the windows. Use of condensing boiler for both heating and DHW production. Reduction of PV panels based on real needs

Solution sets Slovenia - highlights

1. District heating as generation for heating and DHW; use of mechanical ventilation with 85 % heat recovery; better airtightness
2. Air heat pump as generation for heating and DHW; use of mechanical ventilation with 85 % heat recovery; triple glazing windows; better airtightness
3. Air heat pump as generation for DHW; condensing gas boiler for heating; use of mechanical ventilation with 85 % heat recovery; triple glazing windows; better airtightness
4. Air heat pump as generation for heating and DHW; roof PV panels; use of hydro-sensible ventilation system; triple glazing windows; better airtightness

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	Danish solution sets						
	Typ. NZEB	DK-1	DK-2	DK-3	DK-4	DK-5	
Building envelope	0.26	0.26	0.31	0.21	0.31	0.31	W/m²K
Energy costs$_{(GFA)}$	11.8	11.8	11.8	11.7	11.7	11.7	€/m²
Investment costs$_{(GFA)}$	1247	-2.1	-5.5	-18.1	-15.0	-12.6	€/m²
	German solution sets						
	Typ. NZEB	GER-2	GER-3	GER-7	GER-8		
Building envelope	0.22	0.31	0.31	0.31	0.31		W/m²K
Energy costs$_{(NFA)}$	3.33	6.43	6.91	7.00	4.22		€/m²
Investment costs$_{(NFA)}$	1974	-84	-84	-83	-44		€/m²
	Italian solution sets, Rome						
	Typ. NZEB	ITR-1	ITR-2	ITR-3	ITR-4		
Building envelope	0,34	0.34	0.34	0.34	0.34		W/m²K
Energy costs$_{(NIA)}$	0.81	0.85	0.61	1.25	0.85		€/m²
Investment costs$_{(NIA)}$	1375	-78	-68	-92	-94		€/m²
	Italian solution sets, Turin						
	Typ. NZEB	ITT-1	ITT-2	ITT-3	ITT-4	ITT-5	
Building envelope	0.30	0.30	0.24	0.30	0.24	0.24	W/m²K
Energy costs$_{(NIA)}$	1.70	1.22	1.20	1.81	1.68	1.92	€/m²
Investment costs$_{(NIA)}$	1375	-63	-62	-65	-64	-56	€/m²
	Slovenian solution sets						
	Typ. NZEB	SI-1	SI-2	SI-3	SI-4		
Building envelope	0.413	0.413	0.333	0.333	0.333		W/m²K
Energy costs	3.19	3.42	2.39	2.43	1.1		€/m²
Investment costs	762	-65	-32	-18	-5		€/m²

Summary

- Investment cost reductions range from 1 €/m² (with a slightly better energy performance) to 94 €/m², with the highest cost savings in an Italian solution set
- Solution sets can obviously not be compared directly across climate zones and national legislation
- Some solutions in another country's solution set may inspire to new combinations and hence new solution sets

Thank you for your attention

Questions and Comments

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