



# Cost-efficient Nearly Zero-Energy Buildings (NZEBs)

## Speaker:

Heike Erhorn-Kluttig  
Fraunhofer Institute for Building  
Physics (IBP)

## Authors:

H. Erhorn-Kluttig, H. Erhorn, M. Illner (Fraunhofer IBP)  
K. Engelund Thomsen, K. Wittchen (AAU-SBi)  
O. Mørck, M. Sanchez Mayoral Gutierrez (Kuben Management)  
M. Zinzi, B. Mattoni, G. Fasano (ENEA)  
M. Šijanec-Zavrl, M. Jacimovic (GI ZRMK)

# The CoNZEBS project



- Solution sets for the **Cost** reduction of new **Nearly Zero-Energy Buildings – CoNZEBS**
  - GA no. 754046, project period 06/17 – 11/19
  - EU Horizon 2020 call EE-13-2016: Cost reduction of new Nearly Zero-Energy buildings
  - Focus on multi-family houses and technical solution sets that result in lower investment costs for NZEBs bringing the costs close to those of conventional new buildings
- Here in this IAQVEC session: 6 presentations of different CoNZEBS project outcomes

# The CoNZEBS team

- Research/engineer offices:
  - Fraunhofer IBP, DE (CO)
  - Aalborg University/SBi, DK
  - Kuben Management, DK
  - ENEA, IT
  - GI-ZRMK, SI
- Housing organisations:
  - ABG Frankfurt Holding, DE
  - Danmarks Almene Boliger – BL, DK
  - ACER Reggio Emilia, IT
  - Stanovanjski sklad RS – SSRS, SI



DANISH BUILDING RESEARCH INSTITUTE  
AALBORG UNIVERSITY COPENHAGEN



BL DANMARKS ALMENE BOLIGER



# Nearly Zero-Energy Buildings and cost gap



- **Energy Performance of Buildings Directive (EPBD):**  
 Nearly zero-energy buildings (NZEBs) are the minimum energy performance requirements for new public buildings by 2019 / for all new buildings by 2021
  - General NZEB definition included in Article 2 of the EPBD:
  - Building that has a **very high energy performance**
  - **Amount of energy** required should be **nearly zero or very low**
  - Energy required should be **covered to a very significant extent by energy from renewable sources (RES)** (incl. RES produced on-site or nearby)
  - Each Member State required to set up detailed application in practice of the NZEB definition (Article 8)
- Built examples of high performance buildings available in the EU countries, e.g. presented in a report issued by the **Concerted Action EPBD**:
- Still considerable **cost gap** between buildings built according to the current minimum requirements and NZEB buildings:
  - Additional investment costs: 0 - 25% of the total building costs,  $\emptyset = 11\%$ .
  - Absolute investment costs: 0 - 473 €/m<sup>2</sup> floor area additional costs,  $\emptyset = 208 \text{ €/m}^2$



## NZEB definitions in the four participant countries in 2017



- **Italy:** *Decreto interministeriale 26 giugno 2015*  
Primary energy requirements based on comparison with reference (notional) building NZEB with lower U-values for reference building and higher renewable energy coverage (50%)  
Additional requirements as for all new buildings
- **Denmark:** *BR2015: Voluntary Building Class 2020. Primary energy limit:*  
Residential buildings: 20 kWh/m<sup>2</sup>yr  
Non-residential buildings: 25 kWh/m<sup>2</sup>yr  
Additional requirements as for all new buildings
- **Slovenia:** *AN sNES, 2015*  
Maximum heating energy need: 25 kWh/m<sup>2</sup>yr  
Maximum primary energy need: 80 kWh/m<sup>2</sup>yr  
Minimum share of RES: 50% of final energy
- **Germany:** *EnEV 2014/2016: No detailed definition available*  
NZEB requirements for CoNZEBs project based on German country report of Concerted Action: KfW efficiency house 55 level (27% tighter primary energy requirements than minimum energy performance of new buildings of EnEV 2016)

# NZEB definitions in the four participant countries in 2017



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Primary energy requirements based on comparison with reference (notional) building NZEB with lower U-values for reference building and higher renewable energy coverage (50%)  
Additional requirements as for all new buildings
- **Denmark:** *BR2015: Vilkår for bygninger*  
Residential  
Non-residential  
Additional  
AN sNES, Maximum  
Maximum  
Minimum sNES  
-> Different minimum EP requirements  
-> Different NZEB requirements  
-> Different climates  
-> Different building culture and mainstream technologies  
-> Different technology costs and energy costs  
-> Different cost gap between NZEB and minimum EP
- **Slovenia:** *AN sNES, Maximum, Minimum sNES*
- **Germany:** *EnEV 2014/2016: No detailed definition available*  
NZEB requirements for CoNZEBs project based on German country report of Concerted Action: KfW efficiency house 55 level (27% tighter primary energy requirements than minimum energy performance of new buildings of EnEV 2016)



# First step: Analysis of national cost gaps

• Collection of multi-family houses (built examples) on 3 different building levels with detailed cost data

• Minimum energy performance

• NZEBs

• Beyond NZEBs

• Calculation of average additional investment costs for construction and building service systems



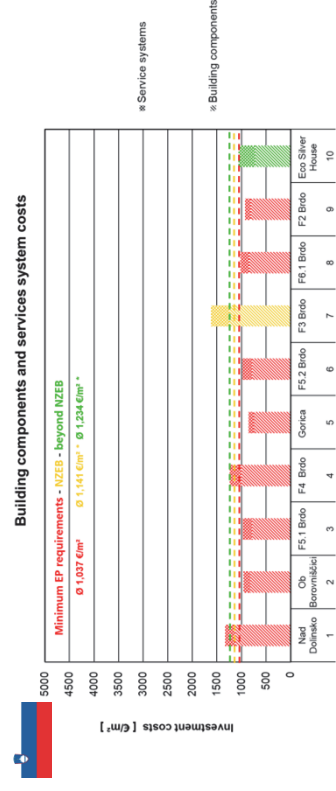
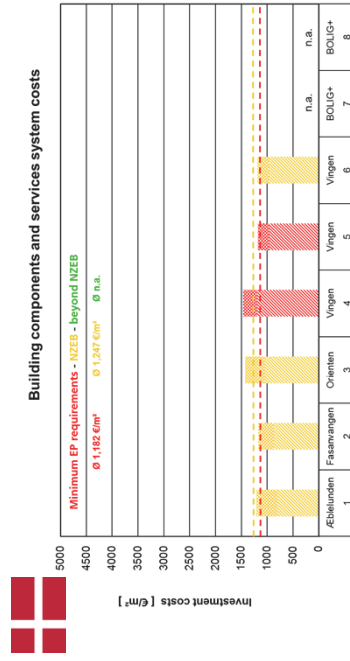
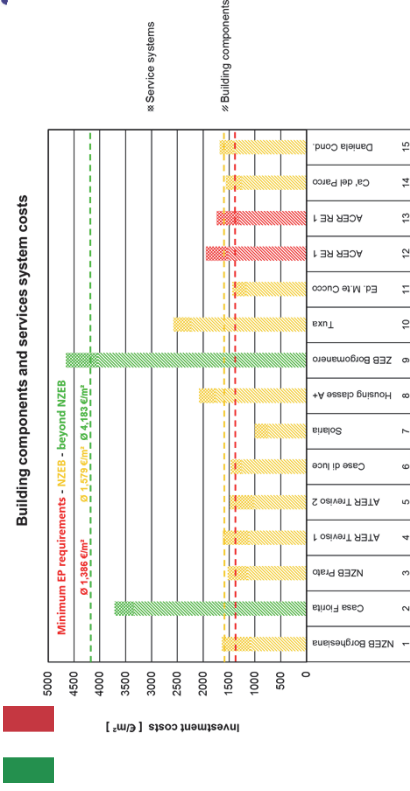
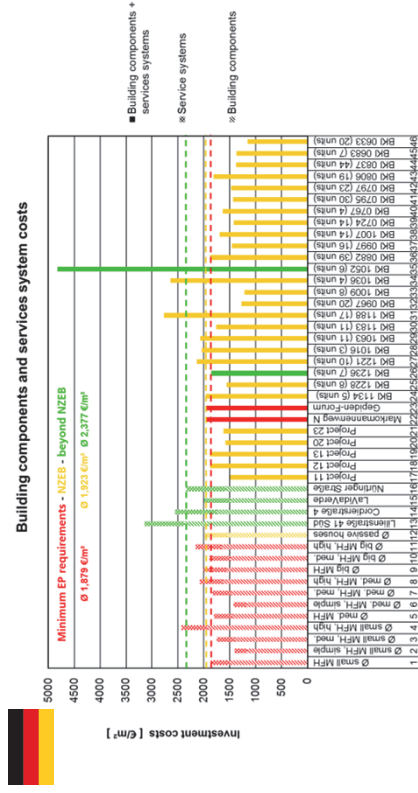
Name of data	Sources	Year	Location	Size: Floor building area	Level	Investment costs (BC and Δ costs compared to requirements)				Energy costs				Remarks							
						Total	Building components (BC) and services systems (SS) costs			Δ costs compared to requirements	(1) Building related	Electricity			(3) District heating	(4) Gas	(5) Biomass	(7) Others			
							Excl. ground	CB SFB	CB SSB			(6) + (5)	(2) Household						(3) Total: (1) + (2)	(4) Gas	(5) Biomass
10 small MFH, simple	[06.14.2016]	Germany	n.a.	X	NZEB	n.a.	1,505	356	1,861	0	0	n.a.	n.a.	n.a.	n.a.	n.a.	(1) + (4) + (5) + (6) + (7)				
20 small MFH, med.	[06.14.2016]	Germany	n.a.	X	Beyond NZEB	n.a.	1,405	243	1,408	0	0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	(1) + (4) + (5) + (6) + (7)			
30 small MFH, high	[06.14.2016]	Germany	n.a.	X	Beyond NZEB	n.a.	1,433	490	1,433	0	0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	(1) + (4) + (5) + (6) + (7)			
50 med. MFH, simple	[06.14.2016]	Germany	n.a.	X	NZEB	n.a.	1,449	355	1,804	0	0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	(1) + (4) + (5) + (6) + (7)			
50 med. MFH, med.	[06.14.2016]	Germany	n.a.	X	NZEB	n.a.	1,279	248	1,427	0	0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	(1) + (4) + (5) + (6) + (7)			
50 med. MFH, high	[06.14.2016]	Germany	n.a.	X	NZEB	n.a.	1,441	433	2,074	0	0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	(1) + (4) + (5) + (6) + (7)			
90 big MFH	[06.14.2016]	Germany	n.a.	X	NZEB	n.a.	1,560	444	2,004	0	0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	(1) + (4) + (5) + (6) + (7)			
200 big MFH, med.	[06.14.2016]	Germany	n.a.	X	NZEB	n.a.	1,889	400	1,889	0	0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	(1) + (4) + (5) + (6) + (7)			
100 passive houses	[06.14.2016]	Germany	n.a.	X	NZEB	n.a.	1,549	432	1,981	265	0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	(1) + (4) + (5) + (6) + (7)			
13 Liefrstraße 41	[06.15.2014]	Munich	1,010	X	NZEB	n.a.	2,370	777	3,147	n.a.	0,52	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.			
14 Cordierstraße 4	[06.15.2013]	Frankfurt	1,238	X	NZEB	n.a.	2,651	793	2,551	228	17	n.a.	n.a.	6,46	4,80	n.a.	n.a.	n.a.			
15 Cordierstraße 1	[06.15.2013]	Frankfurt	661	X	NZEB	n.a.	2,528	752	2,528	0	0	n.a.	n.a.	6,46	4,80	n.a.	n.a.	n.a.			
16 Mariages Straße	[06.15.2013]	Hofheim	661	X	NZEB	n.a.	2,688	1,569	764	2,333	n.a.	2,46	3,75	9,15	n.a.	n.a.	n.a.	n.a.			
17 Project 11	[06.19.2013]	Frankfurt	17,088	X	NZEB	n.a.	n.a.	n.a.	n.a.	1,492	n.a.	2,31	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.			
18 Project 12	[06.19.2012]	Frankfurt	17,265	X	NZEB	n.a.	n.a.	n.a.	n.a.	1,878	n.a.	0,42	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.			
19 Project 20	[06.19.2012]	Frankfurt	4,176	X	NZEB	n.a.	n.a.	n.a.	n.a.	1,586	n.a.	2,82	n.a.	3,50	n.a.	n.a.	n.a.	n.a.			
21 Project 23	[06.19.2014]	Frankfurt	9,680	X	NZEB	n.a.	n.a.	n.a.	n.a.	1,619	n.a.	3,90	n.a.	3,60	n.a.	n.a.	n.a.	n.a.			
22 Hansmannweg 10	[06.19.2014]	Frankfurt	2,772	X	NZEB	n.a.	n.a.	n.a.	n.a.	1,955	0	0,78	n.a.	4,02	n.a.	n.a.	n.a.	n.a.			
24 BM 13.14.15	[06.14.2016]	Dresden	5,278	X	NZEB	n.a.	n.a.	n.a.	n.a.	1,957	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.			
25 BM 12.28	[06.14.2016]	Potsdam	516	X	NZEB	n.a.	n.a.	n.a.	n.a.	1,556	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.			
26 BM 12.11	[06.14.2016]	Berlin	1,516	X	NZEB	n.a.	n.a.	n.a.	n.a.	1,556	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.			
27 BM 12.11	[06.14.2016]	Berlin	1,516	X	NZEB	n.a.	n.a.	n.a.	n.a.	1,556	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.			
28 BM 10.67	[06.14.2016]	Dresden	351	X	NZEB	n.a.	n.a.	n.a.	n.a.	2,043	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.			
29 BM 10.63	[06.14.2016]	Berlin	1,334	X	NZEB	n.a.	n.a.	n.a.	n.a.	2,071	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.			
30 BM 11.17	[06.14.2016]	Berlin	2,634	X	NZEB	n.a.	n.a.	n.a.	n.a.	2,762	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.			
31 BM 11.88	[06.14.2016]	Berlin	2,634	X	NZEB	n.a.	n.a.	n.a.	n.a.	2,762	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.			
32 BM 0.967	[06.14.2016]	Freiburg	1,900	X	NZEB	n.a.	n.a.	n.a.	n.a.	1,277	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.			
33 BM 10.09	[06.14.2016]	Karlsruhe	1,442	X	NZEB	n.a.	n.a.	n.a.	n.a.	1,212	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.			
34 BM 10.16	[06.14.2016]	Freiburg	1,284	X	NZEB	n.a.	n.a.	n.a.	n.a.	1,277	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.			
35 BM 10.95	[06.14.2016]	Freiburg	3,084	X	NZEB	n.a.	n.a.	n.a.	n.a.	6,834	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.			
36 BM 0.882	[06.14.2016]	Münster	3,050	X	NZEB	n.a.	n.a.	n.a.	n.a.	1,878	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.			
37 BM 0.997	[06.14.2016]	Freiburg	2,128	X	NZEB	n.a.	n.a.	n.a.	n.a.	1,460	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.			
38 BM 0.974	[06.14.2016]	Freiburg	2,238	X	NZEB	n.a.	n.a.	n.a.	n.a.	1,432	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.			
39 BM 0.924	[06.14.2016]	Dresden	3,677	X	NZEB	n.a.	n.a.	n.a.	n.a.	1,412	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.			
40 BM 0.967	[06.14.2016]	Lindeau	3,677	X	NZEB	n.a.	n.a.	n.a.	n.a.	1,936	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.			
41 BM 0.959	[06.14.2016]	Hamburg	3,424	X	NZEB	n.a.	n.a.	n.a.	n.a.	1,433	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.			
42 BM 0.882	[06.14.2016]	Berlin	2,286	X	NZEB	n.a.	n.a.	n.a.	n.a.	1,310	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.			
43 BM 0.866	[06.14.2016]	Berlin	2,286	X	NZEB	n.a.	n.a.	n.a.	n.a.	1,310	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.			
44 BM 0.837	[06.14.2016]	Darmstadt	3,977	X	NZEB	n.a.	n.a.	n.a.	n.a.	1,374	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.			
45 BM 0.835	[06.14.2016]	Freiburg	1,078	X	NZEB	n.a.	n.a.	n.a.	n.a.	1,371	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.			
46 BM 0.831	[06.14.2016]	Stuttgart	3,860	X	NZEB	n.a.	n.a.	n.a.	n.a.	1,155	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.			
Average of minimum EP requirements										1,879	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.			
Average of NZEB										1,923	44										
Average of Beyond NZEB										2,577	468										



• 1119 – Cost-efficient Nearly Zero-Energy Buildings (NZEBs)

• Erhorn-Kluttig, Erhorn, Illner, Engelund Thomsen, Wittchen, Mørck, Sanchez Mayoral Gutierrez, Zinzi, Mattoni, Fasano, Šijanec-Zavrl, Jacimovic

# First step: Analysis of national cost gaps



1119 – Cost-efficient Nearly Zero-Energy Buildings (NZEBS)

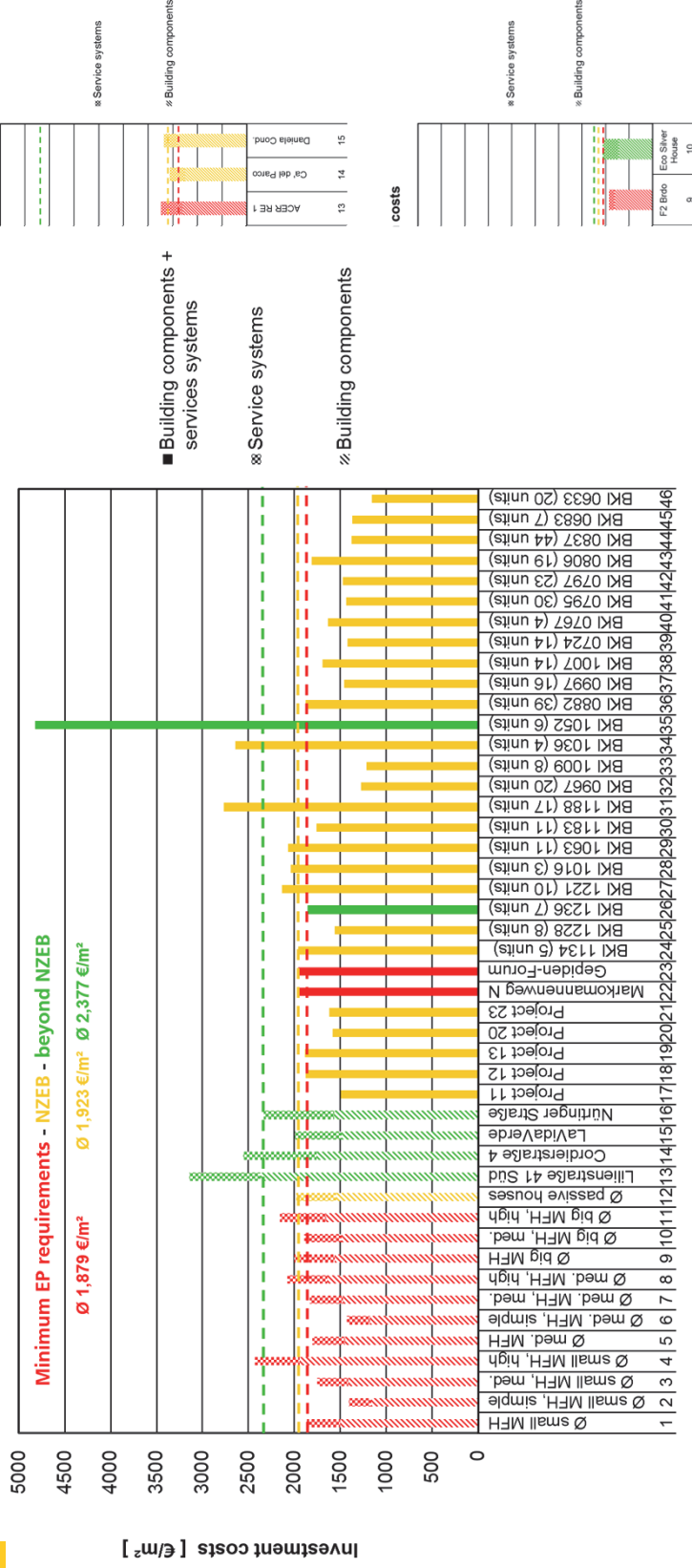
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# First step: Analysis of national cost gaps







## Building components and services system costs







# First step: Analysis of national cost gaps

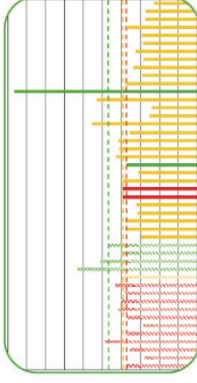


Country	Difference of the average investment costs for building components and building services systems of the NZEB and the minimum energy performance building level
 Germany	45 €/m <sup>2</sup> net floor area (44 €/m <sup>2</sup> living area)
 Denmark	72 €/m <sup>2</sup> net floor area (65 €/m <sup>2</sup> GFA)
 Italy	229 €/m <sup>2</sup> net floor area / useful area
 Slovenia	104 €/m <sup>2</sup> conditioned net floor area

# First step: Analysis of national cost gaps




Country	Difference of the average investment for building components and building sets of the NZEB and the minimum energy performance
 Germany	45 €/m <sup>2</sup> net floor area (44 €/m <sup>2</sup> liv)
 Denmark	72 €/m <sup>2</sup> net floor area (65 €/n
 Italy	229 €/m <sup>2</sup> net floor area / usefu
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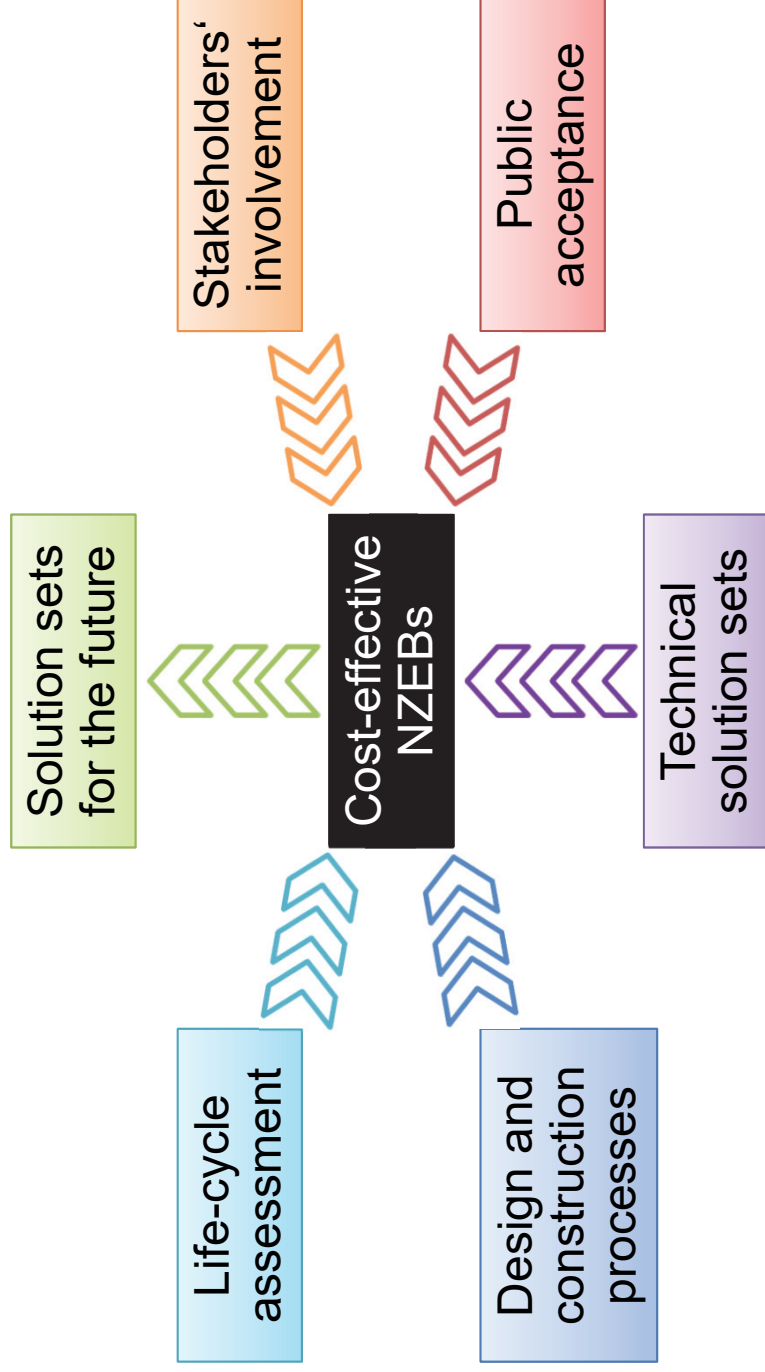
Solution sets for the cost reduction of new Nearly Zero-Energy Buildings – CoNZEBs  
EU Horizon-ER-2016-CSA  
Project ID: 754046

**Overview of Cost Baselines for three Building Levels**  
Deliverable D2.1

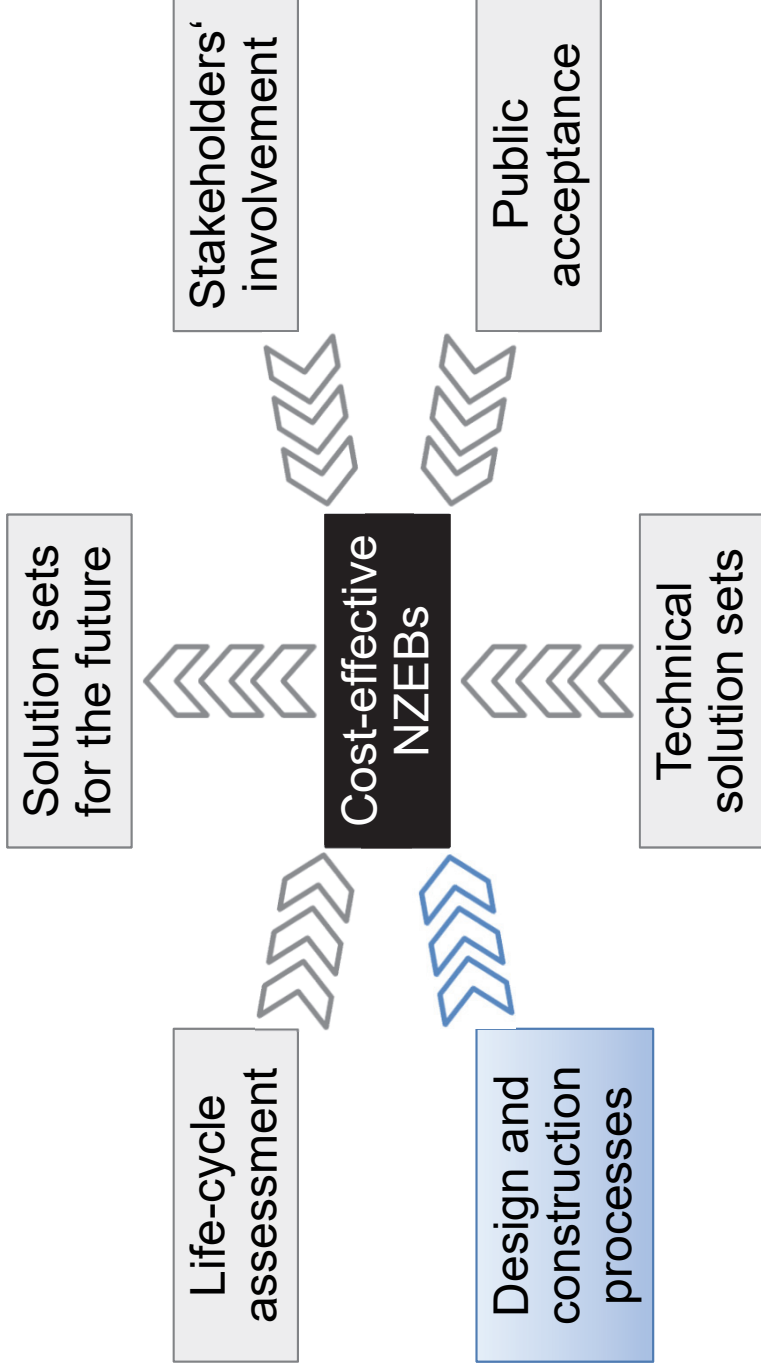
Authors:  
Helke Erhorn-Kluttig, Hans Erhorn (Fraunhofer Institute for Building Physics), Bernd Utsch (ABG Frankfurt Holding), Kim Wittchen, Kirsten Engelund Thomsen (SB/AAU), Ove Mørck, Ole Besler-Olsen (Kolan Management), Mikkel Jungshoved (BL), Michele Zini, Benedetta Mattoni (ENEA), Marijana Šijanec-Zavrl (IZ ZMMK), Dimpleja Varick (SRM)



# The CoNZEBS approach

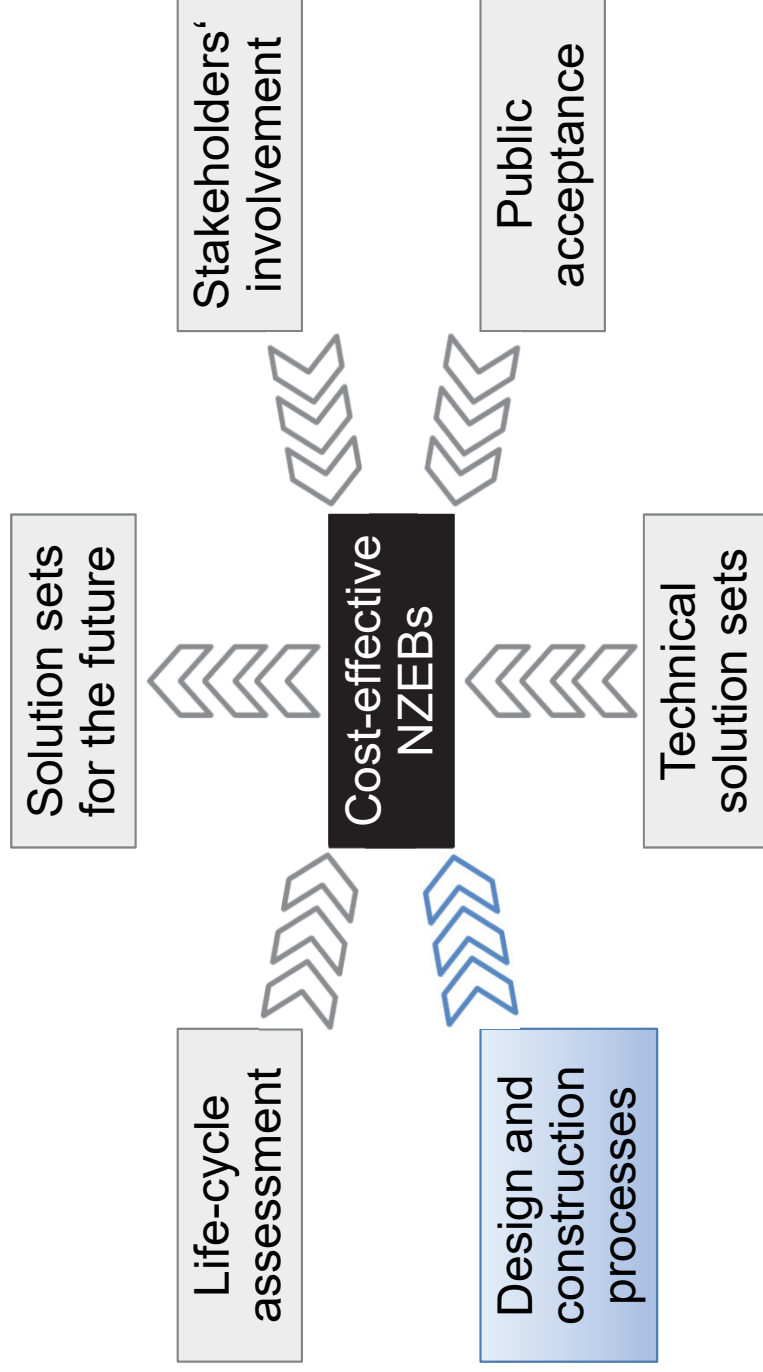


# The CoNZEBS approach



- Prefabrication
- BIM

# The CoNZEBS approach





**Solution sets for the Cost reduction of new Nearly Zero-Energy Buildings – CoNZEBS**  
EU H2020-IE-2018-CSA  
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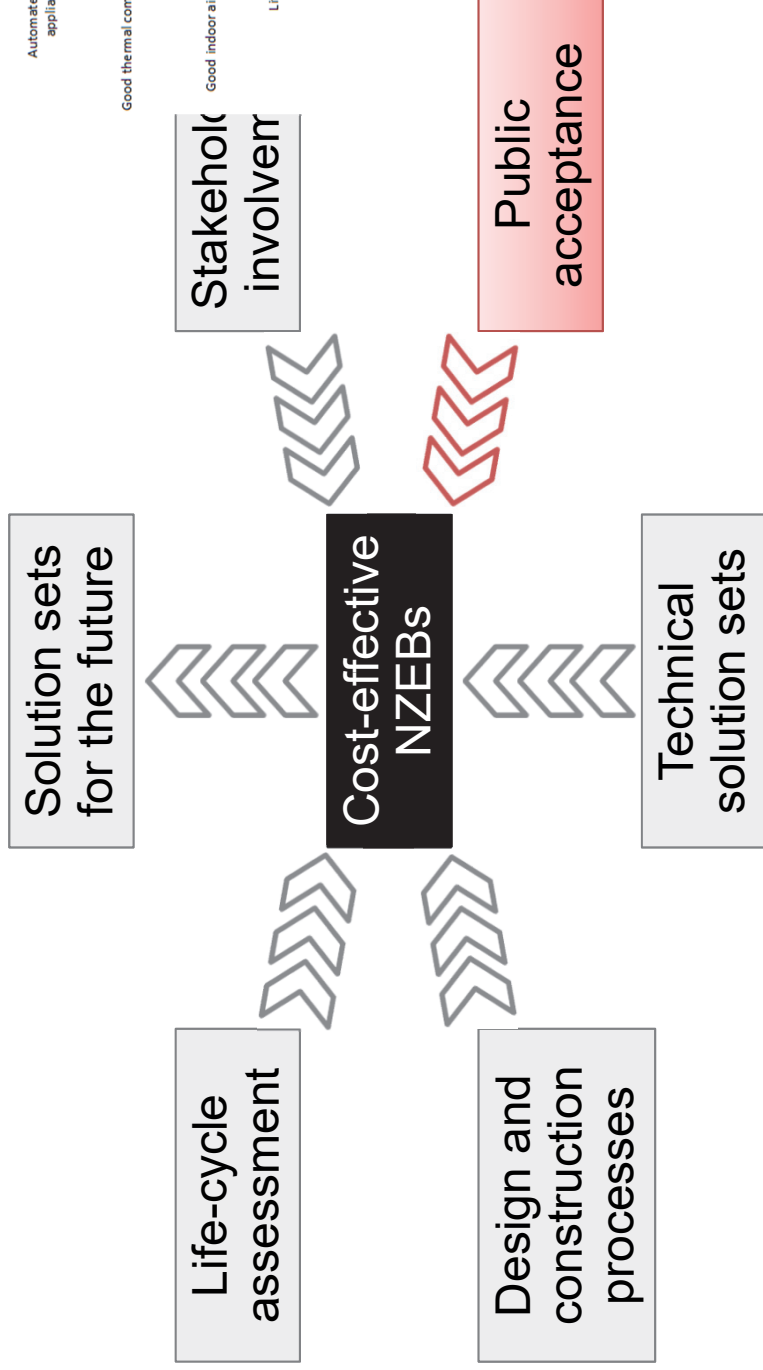
**Assessment and exemplary solutions for cost reduction in the design and construction process**

Deliverable 03.1

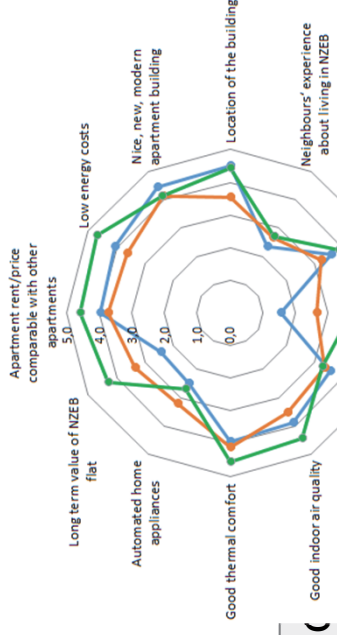
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 Heike Erhorn-Kluttig, Micha Illner, Anja Bergmann, Hans Erhorn (Fraunhofer IPT)  
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 Kirsten Englund Thomsen, Kim B. Wittchen (SRI/AAU)  
 Marijana Šijanec-Zavrl, Nera Jajić, Marko Jajčević (ZMM)



# The ConZEBs approach



## Decision triggers for moving into an NZEB

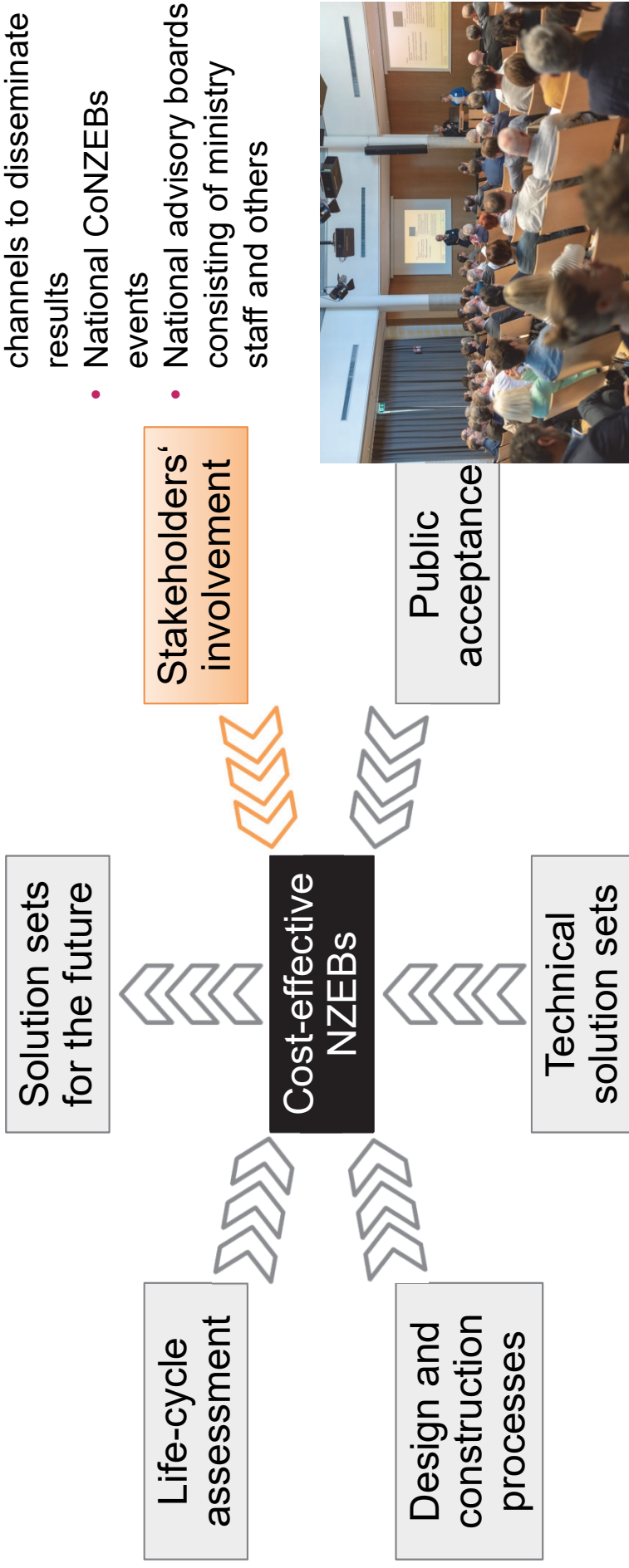


**Why Nearly Zero Energy Buildings are the Right Choice**

Experiences, expectations, and co-benefits of living in NZEBs

**ConZEBs**  
Cost-effective Nearly Zero Energy Buildings

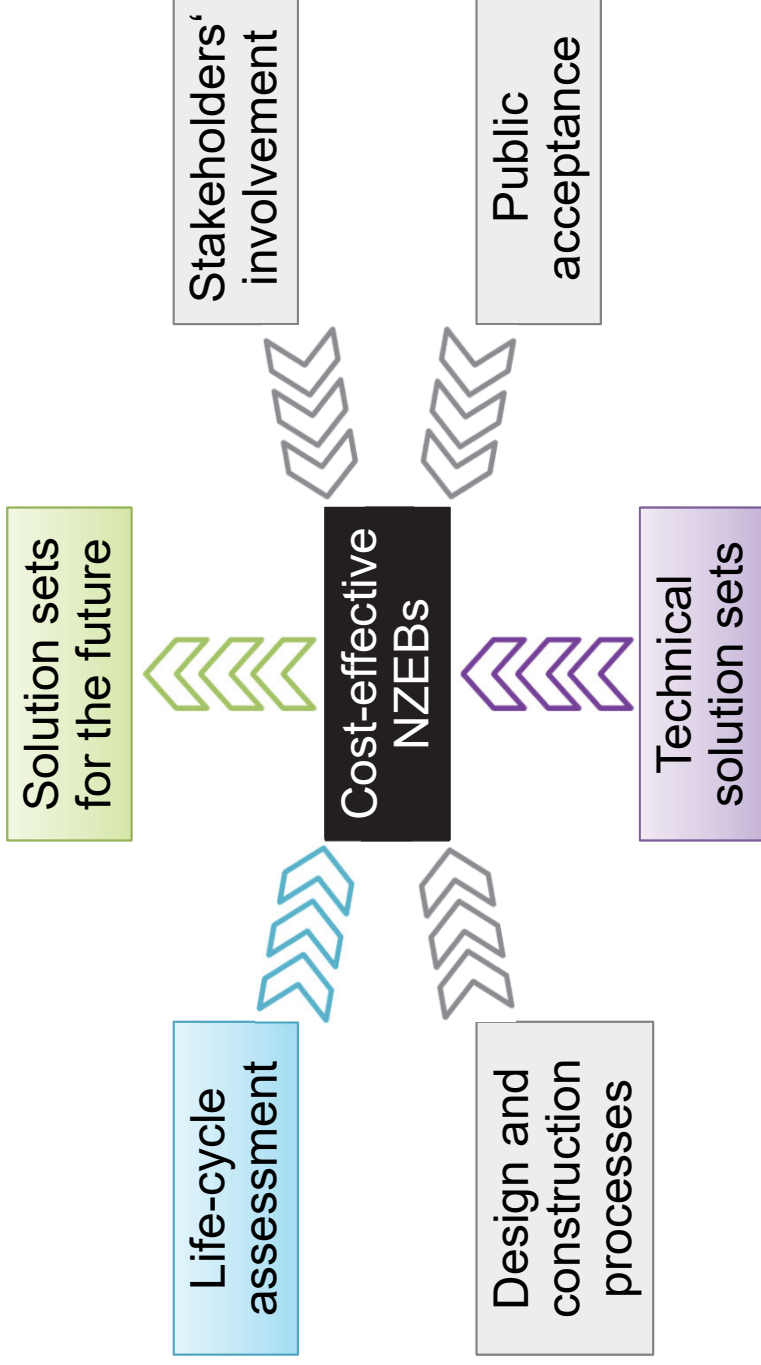
# The CoNZEBS approach



- Housing organisations as partners in CoNZEBS
- Use of their media channels to disseminate results
- National CoNZEBS events
- National advisory boards consisting of ministry staff and others



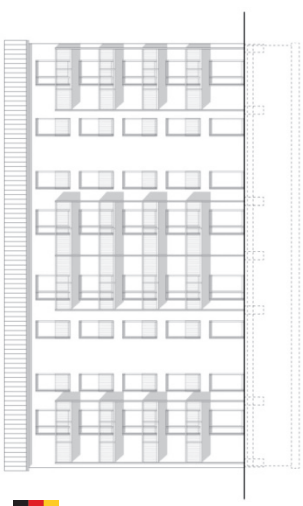
# The CoNZEBS approach



## Methodology

1. National typical building
2. National typical NZEB solution
3. Alternative solution sets with lower investment costs. Assessment of
  - Final energy
  - Primary energy
  - Investment costs
  - Energy costs
4. Life-cycle costs (30 yr)
5. Global warming potential (30 yr)
6. Future: Evolving factors

# The CoNZEBS approach



Solution sets for the future



Cost-effective NZEBs

Stakeholders' involvement



Public acceptance



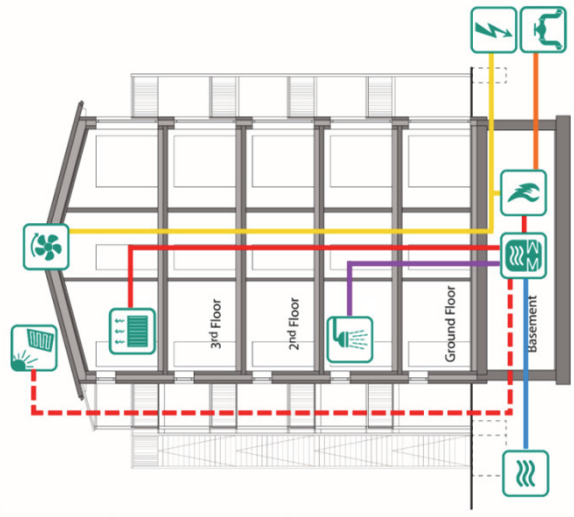
Technical solution sets



Life-cycle assessment



Design and construction processes





## Acknowledgements

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Project website with all reports: [www.conzebs.eu](http://www.conzebs.eu)

## Questions and Comments?