ASSOCIATION OF HEAT, GAS AND WATER TECHNOLOGY ENGINEERS OF LATVIA

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Progress with national nZEB applications in the EU

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REHVA nZEB Task Force

- TF prepared nZEB technical definition and set of system boundaries for primary energy indicator and RER calculation in 2011
- in 2013 it was revised in cooperation with CEN, resulting in REHVA Report No:4
- TF is following nZEB technical, regulatory and policy progress
- Latest, ongoing analyses on RE contribution and RER indicator based on data from 8 nZEB office and school buildings across the EU

Screening of energy frames and nZEB in 2013

- **Differences in energy frames:**
  - Primary energy not yet used in all countries
  - Some countries (Germany, France) use reference building method, fixed values in other countries
  - Both simulation (Estonia, Finland) and monthly methods (Germany, Denmark) used
- **Inclusion of energy uses depends on country:**
  - Germany/residential – heating energy only (space heating, DHW and heating of ventilation air)
  - Germany/non-residential – cooling and lighting also included (appliances not)
  - Denmark – appliances and in residential also lighting not included
  - Sweden – appliances and user's lighting not included (facility lighting incl.)
  - Estonia, Finland, Norway – appliances and lighting included (all inclusive)
- **RES (on site renewable energy production) is not accounted in all countries or is accounted differently**

Map of European climatic zones

REHVA

Region	Country	nZEB Energy performance					RES	
		Values	Unit	Metric	Energy uses for:	Building type	EP calculation	nZEB req.
Zone 1-2 (Catania, Athens)	Cyprus	180 210	kWh/m²/y	Primary energy	heating, cooling, hot water, lighting	Residential Non-residential	No No	25% 25%
Zone 3 (Budapest, Bratislava, Ljubjana)	Slovakia	54 32 60	kWh/m²/y	Primary energy	Heating, hot water, ventilation, cooling (non-res), lighting (non-res)	Detached Apartment Offices	N.a. N.a. N.a.	50% 50% 50%
Zone 4 (Paris, Amsterdam Berlin, Brussels, Copenhagen, Dublin, London, Macon, Nancy, Prague, Warsaw)	Belgium BXL	45 95 - 2,5*(V/S)	kWh/m²/y	Primary energy	heating, cooling (non-res), hot water, lighting (non-res), auxiliary electricity	Residential Offices, educational	Yes Yes	- -
	Belgium Walloon	60	kWh/m²/y	Primary energy	heating, hot water, auxiliary electricity	Residential and non-res.	N.a.	50%
	Belgium Flemish	30 40	kWh/m²/y	Energy use	Heating, cooling, hot water, ventilation, auxiliary systems	Residential Office and school	Yes Yes	>10 kWh/m²y >10 kWh/m²y
	France	50 70 110	kWh/m²/y	Primary energy	heating, ventilation, cooling, hot water, lighting, auxiliary systems	Residential Office Office AC	No No No	- - -
	Ireland	45	kWh/m²/y	Energy load	heating, ventilation, hot water, lighting	Residential	N.a.	-
	Netherlands	0	[-]	Energy perform. coefficient (EPC)	heating, ventilation, cooling, hot water, lighting	Residential/ non-residential	Yes Yes	- -

Data from CA EPBD Oct 2013 (Kurnitski et al. REHVA Journal 2/2014)

Region	Country	nZEB Energy performance					RES	
		Values	Unit	Metric	Energy uses for:	Building type	EP calculation	nZEB req.
Zone 5 (Coopenhagen, Tallinn, Helsinki, Riga, Stockholm, Gdansk, Tovarene)	Denmark	20 25	kWh/m^2/y	Primary energy	heating, cooling, ventilation, hot water, lighting (non-res)	Residential Non-residential	Yes Yes	51-56% 51-56%
	Estonia	50 100 100 130	kWh/m^2/y	Primary energy	heating, ventilation, cooling, hot water, lighting, auxiliary electricity, appliances	Detached house Apartment Office Hotel	Yes Yes Yes Yes	- - - - -
	Latvia	95	kWh/m^2/y	Primary energy	heating, cooling, domestic hot water, ventilation, lighting	Residential/ non-residential	N.a.	-
	Lithuania	<0,25	[-]	Energy perfor-mance indicator C	heating	Residential/ not-residential	N.a.	50%

Data from CA EPBD Oct 2013 (Kurnitski et al. REHVA Journal 2/2014)

REHVA Journal 2/2014: nZEB case studies provide more reliable benchmarks than first national nZEB definitions

Energy data from four nZEB office buildings:

- Delivered heating is in first building a fuel and in last one district heat. Two other buildings have heat pumps, delivered heating is electricity.
- Delivered cooling is in all buildings electricity.
- On site electricity is PV in 3 buildings and bio-CHP in one building.
- All values in the table are in kWh/m^{2}y.

Appliances may be largest component in energy balance of nZEB buildings

Climate zone	City, country	Delivered energy					On site electricity	**Primary energy**
		Heating	Cooling	Fans&pumps	Lighting	Appliances		
4	Dion France	10.5	2.4	6.5	3.7	21.2	-15.6	**44**
4	Gland Switzerland	6	6.7	8.1	16.3	26.8	-30.9	**66**
4	Hoofddrop Holland	13.3	3.3	17.5	21.1	19.2	-40.4	**68**
5	Helsinki Finland	38.3	0.3	9.4	12.5	19.3	-7.1	**96**

For all buildings the following primary energy factors were applied:

- 0.7 for heating (district heat or biomass);
- 2.0 for electricity.

BPIE factsheet on nZEB definitions 2015 www.bpie.eu

					nZEB definition for new buildings						nZEB definition for existing buildings		
Country	**Status of the definition**	**Main reference(s)**	**Year of enforcement**		**EPBD scope of nZEB definition [1]**	**Numerical indicator**	**Maximum primary energy [kWh/m²y]**		**Share of renewable energy**	**Other indicators**	**Status of the definition**	**Maximum primary energy [kWh/m²y]**	
			Public	**Non-public**			**Residential buildings**	**Non-residential buildings**				**Residential buildings**	**Non-residential buildings**
Austria	✓	OIB Guidelines 6	1/01/2019	1/01/2021	✓ [7]	✓	160	170 (from 2021)	Minimum share proposed in the draft of OIB guidelines for all buildings	EP, CO_2	✓	200	250 (from 2021)
Belgium - Brussels	✓	Amended Decree of 21/12/2007	1/01/2015	1/01/2015	✓	✓	45	~90 [2]	✓ Qualitative	EP, OH	✓	54	~ 108 [2]
Belgium - Flanders	✓	Regulation of 29/11/2013	1/01/2019	1/01/2021	✓	✓	30% PE [5]	40% PE [5]	✓ Quantitative [4]	EP, OH	Under development		
Belgium - Wallonia	Under development	Consolidated report to EC	1/01/2019	1/01/2019	✓	Under develop-ment			Quantitative	EP	Under development		
Bulgaria	Still to be approved	National nZEB Plan, BPIE study	1/01/2019	1/01/2021	✓	Still to be approved	~30-50	~40-60	Quantitative	EP	As for new buildings	~30-50	~40-60
							Included in the calculation; building needs to comply with class A					Included in the calculation; building needs to comply with class A	
Croatia	✓	Regulation OG 97/14, National nZEB Plan	1/01/2019	1/01/2021	✓	✓	33-41[3]	Under de-velopment	Minimum share in current requirements for all buildings	EP	ND		
Cyprus	✓	Decree 366/2014, Law 210(I)/2012	1/01/2019	1/01/2021	✓	✓	100	125	✓ Quantitative	EP	✓ As for new buildings	100	125
Czech Republic	✓	Regulation 78/2013 Coll.	2016-2018 depending on size	2018-2020 depending on size	✓	✓	75-80% [2,5]	90% [5]	✓ Quantitative	EP, TS	✓ As for new buildings	75-80% [2,5]	90% [5]
Denmark	✓	Building Regulations 2010	1/01/2019	1/01/2021	✓	✓	20	25	✓ Qualitative	EP, OH, TS	✓ As for new buildings	20	25
Estonia	✓	Regulation 68:2012	1/01/2019	1/01/2021	✓ [7]	✓	50-100 [2]	90-270 [2]	✓ Qualitative		✗		
Finland	Under development	Consolidated report to EC	1/01/2018	1/01/2021	✓ [7]	ND			ND		ND		
France	Definition of Positive Energy Buildings under development [8]	Thermal Regulation 2012, National nZEB Plan	28/10/2011	1/01/2013	✓	✓	40-65 [2,3]	70-110 [2,3]	✓ Quantitative [4]	EP, OH, TS	✓	80 [3]	60% PE [2]
Germany	Under development	KfW Efficiency House, National nZEB plan	1/01/2019	1/01/2021	✓	Under develop-ment	40% PE [5]		Minimum share in current requirements for all buildings	EP	Under development	55% PE [5]	
Greece	Under development	Law 4122/2013	1/01/2019	1/01/2021	ND	ND			Minimum share in current requirements for all buildings		Under development		
Hungary	Under development	Amended decree 7/2006, study by University of Debrecen	1/01/2019	1/01/2021	✓	Under develop-ment	50-72 [2]	60-115 [2]	✓ Quantitative	EP	Under development		
Ireland	✓	Draft definition in National nZEB Plan	1/01/2019	1/01/2021	✓	✓	45	~60% PE [5]	✓ Quantitative [4]	CO_2	Under development	75-150	

BPIE factsheet on nZEB definitions 2015 www.bpie.eu

Country	nZEB definition for new buildings									nZEB definition for existing buildings		
	Status of the definition	Main reference(s)	Year of enforcement		EPBD scope of nZEB definition [1]	Numerical indicator	Maximum primary energy [kWh/m²y]		Share of renewable energy	Other indicators	Status of the definition	Maximum primary energy [kWh/m²y]	
			Public	Non-public			Residential buildings	Non-residential buildings				Residential buildings	Non-residential buildings
Italy	Still to be approved (under publication)	Draft of the new EPBD decree	1/01/2019	1/01/2021	✓	Still to be approved	Included in the upcoming updated version of the National nZEB Plan [2,3]		Quantitative	EP, TS	✓ As for new buildings	Included in the upcoming updated version of the National nZEB Plan [2,3]	
Latvia	✓	Regulation 383/2013	1/01/2019	1/01/2021	✓	✓	95	95	✓ Quantitative	EP	✓ As for new buildings	95	95
Lithuania	✓	Regulation STR 2.01.09 :2012	1/01/2019	1/01/2021	✓	✓	Included in the calculation; building needs to comply with class A++		✓ Quantitative	EP	✓ As for new buildings	Included in the calculation; building needs to comply with class A++	
Luxembourg	✓ Details to be fixed	National nZEB Plan	1/01/2019	1/01/2021	✗ [6]	✓	Included in the calculation; building needs to comply with class A-A-A		✓ Qualitative	EP, CO_2	ND		
Malta	Under development	National nZEB Plan	1/01/2019	1/01/2021	✓	Current values to be revised	40	60	Qualitative	EP	ND		
Netherlands	✓	National nZEB Plan	1/01/2019	1/01/2021	✓	✓	Included in the calculation; building needs to comply with energy performance coefficient = 0		✗	EP	ND		
Norway	Under development	Presentation by Research Centre on Zero Emission Buildings	1/01/2021	1/01/2021	✓	Under development			Minimum share in current requirements for all buildings	CO_2 (main indicator), EP, TS	ND		
Poland	Under development	Consolidated report to EC	1/01/2019	1/01/2021	✓	Under development	60-75 [2]	45-70 [2]	✗		ND		
Portugal	Under development	Law 118/2013	1/01/2019	1/01/2021	✓	In current requirements for buildings			✗		ND		
Romania	✓	National nZEB Plan	1/01/2019	1/01/2021	✓	✓	93-217 [2,3]	50-192 [2,3]	✓ Quantitative	CO_2	ND		
Slovakia	✓	Decree 364/2012	1/01/2019	1/01/2021	✗ [6]	✓	32-54 [2]	34-96 [2]	✓ Quantitative	EP	ND		
Slovenia	Still to be approved	Official Journal 17/14, National nZEB Plan	1/01/2019	1/01/2021	✓	Still to be approved	45-50 [2]	70	Under development	EP	Still to be approved	70-90 [2]	100
Spain	Under development	Decree 235/2013	1/01/2019	1/01/2021	✓	Under development	Included in the calculation; it is foreseen that buildings will need to comply with class A		Minimum share in current requirements for all buildings	CO_2 (main indicator)	Under development		
Sweden	Under development	National nZEB Plan	1/01/2019	1/01/2021	✓	Under development	30-75 [2,3]	30-105 [2,3]	✗		ND		
UK (England)	✓ Details to be fixed	National nZEB Plan, presentation by Zero Carbon Hub	1/01/2018 (from 2016 for residential buildings) [9]	1/01/2019 (from 2016 for residential buildings) [9]	✓	✓	~ 44 (2)	ND	✓ Qualitative	CO_2 (main indicator), EP, TS	ND		
							Included in the calculation; building will need to comply with carbon emissions ~ 0						

RES in energy frames and nZEB applications (2015 data)

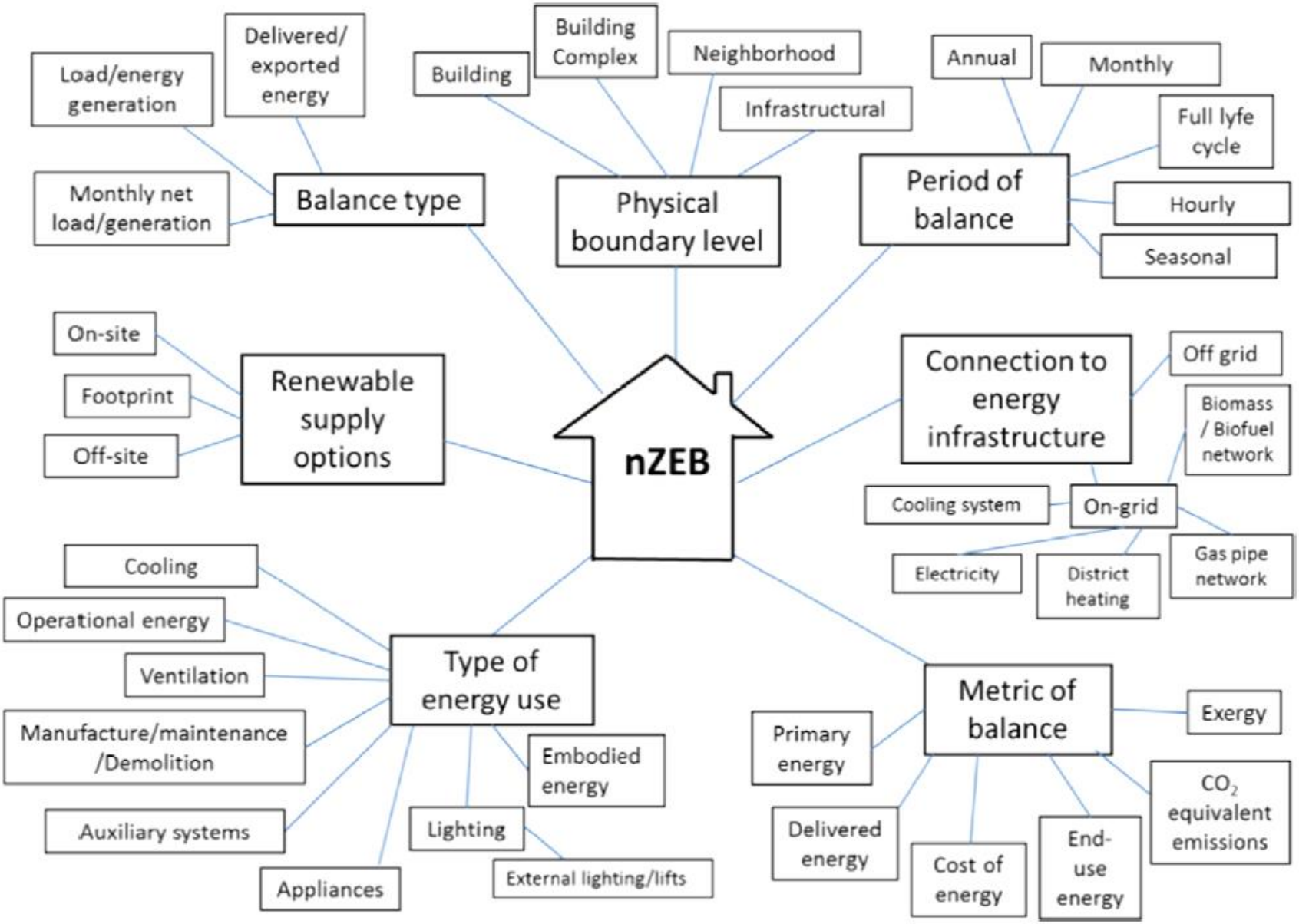
- In 2013 RES was not yet implemented in present calculation frames in 5 out of 10 countries with nZEB application
- Most of energy frames were not yet ready to support exported energy:
  - Full utilization on annual bases: Denmark, Estonia, net plus energy program in Germany
  - Monthly bases (limited to the amount of the delivered electricity each month and the rest of exported is not accounted): Germany
  - Not accounted: Finland, Norway, Italy, …
- 8 out of 13 countries have set specific indicator for RES in nZEB application (2015 data)
- There is no information that nearby RES has implemented in any country, however ongoing in DK, FI … – but mostly a future issue to be solved with RES inclusion and exported energy

nZEB requirements 4/2015

- Primary energy and % of minimum EP requirements are used as nZEB EP indicator in most of countries
- The range of values varies remarkably from positive energy buildings up to 270 kWh/m^2/y primary energy:
  - from to 20 kWh/m^2/y to160 kWh/m^2/y in residential buildings, but usually targets aim at 45 kWh/m^2/y or 50 kWh/m^2/y
  - Values from 25 kWh/m^2/y to 270 kWh/m^2/y are reported for non-residential buildings with higher values given for hospitals.
  - Remarkable differences caused mostly due to different energy uses included, but the methodologies/input data have an effect and evidently there are differences in the ambition level
- nZEB primary energy values show a **reduction by factor of 1.6 in Estonia and by 2 in Denmark** compared to current EP minimum requirements of office buildings (reduction of **40-50%**)

Open nZEB issues

1. Energy uses accounted:
   - major difference if accounting or not appliances & lighting
2. System boundary
   - onsite and nearby RES accounting (follows or not energy meters)
3. Time step: hourly vs. monthly calculation
4. Period and type of balance when accounting RES export
   - Annual or limitations for instance on monthly level
5. Numerical indicators of energy performance
   - Primary energy not yet fully established
   - Qualitative/quantitative RES accounting
6. Building categories
   - Standard uses and requirements for non-residential buildings



Main arguments around nZEBs to be established in definitions:

D. D'Agostino / Journal of Building Engineering 1 (2015) 20–32

Energy uses accounted

- 7 countries out of 13 account appliances (AT, BG, EE, FI, LV, LT, NL), the rest do not
- 6 countries account lighting in residential buildings (EE, FI, FR, LT, SE, UK)
- Appliances and lighting correspond to 50-60 kWh/m^{2}y primary energy in residential buildings

Inclusion of appliances and lighting – EE

- VV No 68: 2012 – Minimum requirements for energy performance
- Minimum requirements are given for 9 building types, for new buildings and for major renovation
- nZEB and low energy building requirements officially given together with cost optimal minimum requirements

Primary energy factors:

- Electricity 2.0, Fossil fuels 1.0, District heat 0.9 and Renewable fuels 0.75

	nZEB [kWh/m²y]	Low energy [kWh/m²y]	Min. req. NEW [kWh/m²y]	Min. req. Major REN [kWh/m²y]
EPC class	**A**	**B**	**C**	**D**
Detached houses	50 **(0[a])**	120	160 **(110[a])**	210
Apartment buildings	100 **(41[a])**	120	150 **(101[a])**	180
Office buildings	100 **(62[b])**	130	160 **(128[b])**	210

[a] without lighting and appliances, [b] without appliances

Building categories

- Steering to optimal design solutions: define standard use/ nZEB requirement for each building category
- Usages, intensities and operation times vary a lot between different building categories – optimal EE and RES measures differ accordingly
- EPBD Annex I building categories are relevant except hospitals
- Hospitals (EE nZEB=270) could be replaced with clinics/health-care centers (12/24 and 5/7 operation instead of 24/24 and 7/7 operation with high loads from hospital equipment)
- Industrial buildings (very often without significant heat gains from the process) will deserve a separate category
- Grocery stores another specific category because EP depends mostly on the refrigeration condensation heat utilization

The effect of building categories – EE

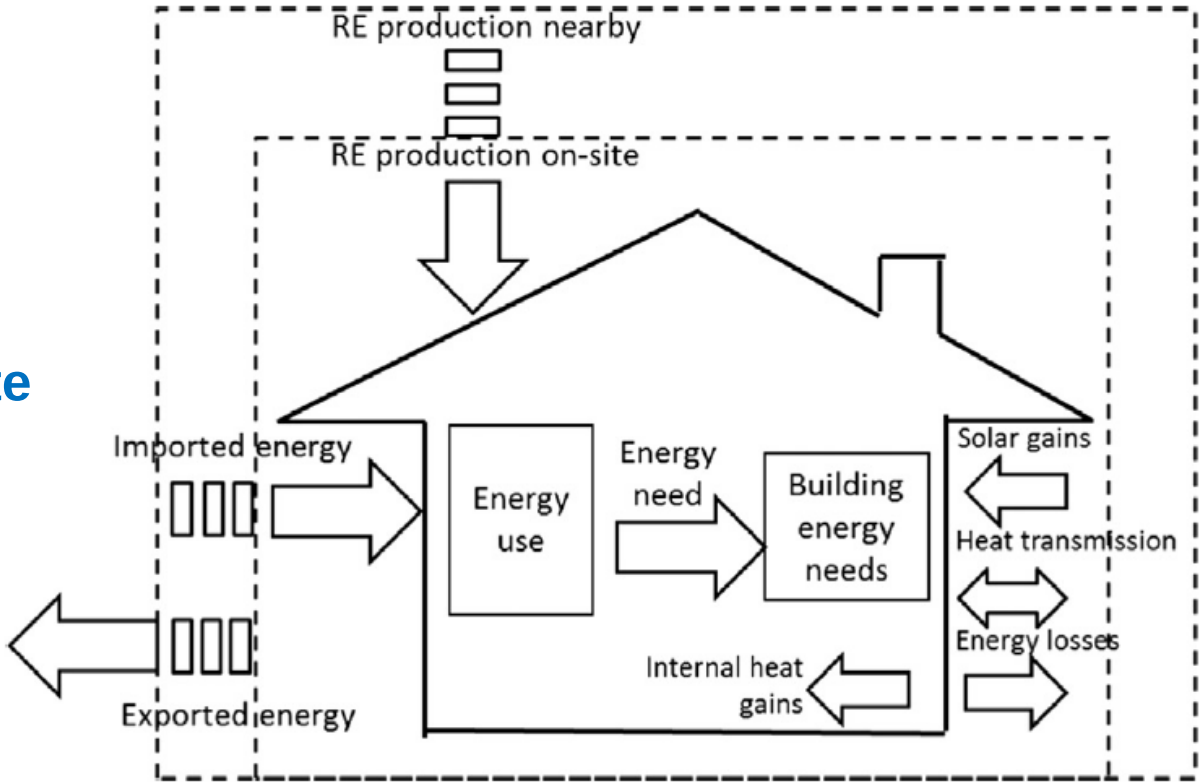
VV No 68: 2012 – Full set of EP requirements/standard use input data

EPC class Building category	nZEB A kWh/(m² y)	Low energy B kWh/(m² y)	Minimum req. NEW (cost opt.) C kWh/(m² y)	Minimum req. Major REN D kWh/(m² y)
Detached houses	**50**	120	160	210
Apartment buildings	**100**	120	150	180
Office buildings	**100**	130	160	210
Hotels and restaurants	**130**	160	210	270
Public buildings (theatres, sport halls, museums etc.)	**120**	150	200	250
Shopping malls	**130**	160	230	280
Schools	**90**	120	160	200
Day care centres	**100**	140	190	240
Hospitals	**270**	300	380	460

nZEB system boundaries

4-level system boundary needed to enable transparent calculation:

1. **Energy need**
2. **Energy use**
3. **Delivered and exported on-site**
4. **Nearby RE**



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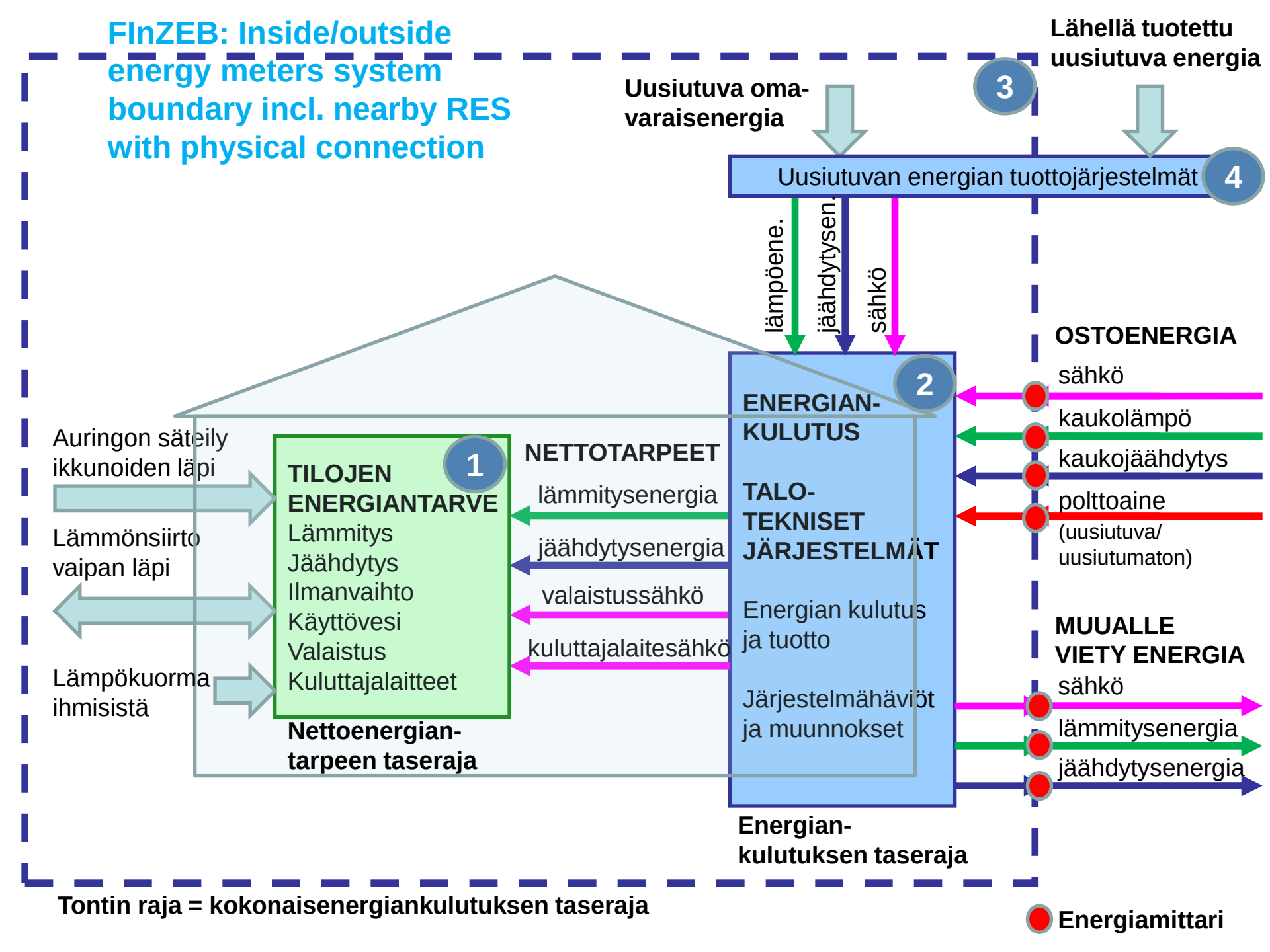

FInZEB: Inside/outside energy meters system boundary incl. nearby RES with physical connection
Lähellä tuotettu uusiutuva energia
Uusiutuva oma-varaisenergia
3
Uusiutuvan energian tuottojärjestelmät
4
lämpöene.
jäähdytysen.
sähkö
OSTOENERGIA
sähkö
kaukolämpö
kaukojäähdytys
polttoaine
(uusiutuva/ uusiutumaton)
2
ENERGIAN-KULUTUS
TALO-TEKNISET JÄRJESTELMÄT
Energian kulutus ja tuotto
Järjestelmähäviöt ja muunnokset
MUUALLE VIETY ENERGIA
sähkö
lämmitysenergia
jäähdytysenergia
Energian-kulutuksen taseraja
Auringon säteily ikkunoiden läpi
Lämmönsiirto vaipan läpi
Lämpökuorma ihmisistä
1
TILOJEN ENERGIANTARVE
Lämmitys
Jäähdytys
Ilmanvaihto
Käyttövesi
Valaistus
Kuluttajalaitteet
NETTOTARPEET
lämmitysenergia
jäähdytysenergia
valaistussähkö
kuluttajalaitesähkö
Nettoenergian-tarpeen taseraja
Tontin raja = kokonaisenergiankulutuksen taseraja
Energiamittari

Selected NZEB Examples in MS

CONCERTED ACTION
ENERGY PERFORMANCE
OF BUILDINGS

FOR A SUSTAINABLE FUTURE

Selected NZEB Examples in MS Analysis

CONCERTED ACTION
ENERGY PERFORMANCE
OF BUILDINGS

Costs: 52 % Total costs available, 33 % Additional costs available

	Additional costs of the selected examples of NZEBs compared to the energy level according to the current national requirements		
	Average	Lowest	Highest
% of total costs	11	0	25
€/m²	220	0	473

nZEB Task Force latest buildings (5-8 in the Table)

DSK-II school, Haarlem, the Netherlands

Construction year 2014

3 900 m²

Extra nZEB cost 250 €/m² estimated

General description: Primary school with zero energy consumption, meaning the total amount of energy used for the building itself on an annual basis is roughly equal to the amount of renewable energy produced on site.

Energy performance: **Net-zero energy building** without accounting small power equipment loads, achieved with large on-site PV, heat pumps and energy wells.

Entré Lindhagen office building, Sweden

Construction year 2014

65 000 m²

Extra nZEB cost 55 €/m² estimated (w/o wind farm investment)

General description: Skanska head office, Nordea office nZEB building, energy consumption 55 % less than code requirement, building demonstrates low speed ventilation and Skanska Deep Green Cooling, a ground cooling system without heat pump or chiller. Triple Leed Platinum. For core and shell, for Skanska interior design, for Nordea interior design.

Energy performance: **Net-zero energy building** (small power equipment loads accounted) without accounting district heat, achieved with nearby wind farm, district heating and boreholes. **Nearly zero energy building** if the share of wind farm is not accounted.

Väla Gård office building, Sweden

Construction year 2013

1 750 m²

Extra nZEB cost 230 €/m² estimated

General description: Skanska office in Helsingborg. A nZEB office building, energy consumption is nearly zero or plus including tenant power over the year. LEED certified Platinum.

Energy performance: **Net zero energy building** (small power equipment loads accounted) or **plus energy building** w/o small power, achieved with extensive on-site PV, ground source heat pump and boreholes.

Rakvere Smart Building Competence Centre office building, Estonia

Construction year 2014-2015

2 170 m²

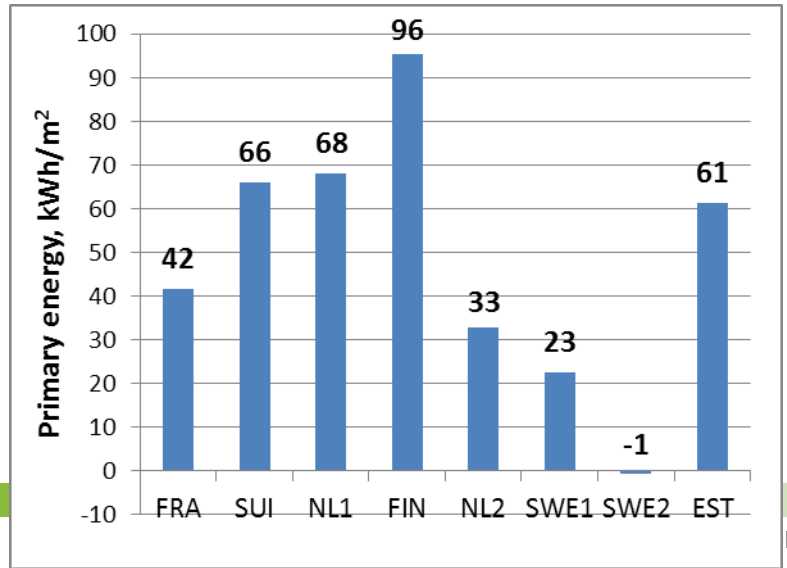
Extra nZEB cost 200-300 €/m² estimated

General description: Estonian first nZEB office building, primary energy consumption 60 % less than code requirement, building demonstrates smart building automation systems.

Energy performance: **Nearly zero energy building** (small power equipment loads accounted), achieved with on-site PV, district heating and energy wells.

Delivered, on-site and nearby generated, and primary energy

	FRA	SUI	NL1	FIN	NL2	SWE1	SWE2	EST
Heating	10,5	6,0	13,3	38,3	20,5	32,2	10,0	25,0
Cooling	2,4	6,7	3,3	0,3	3,2	1,3	0,5	2,0
Fans & pumps	6,5	8,1	17,5	9,4	11,8	13,2	3,0	9,7
Lighting	3,7	16,3	21,1	12,5	12,5	16,5	12,6	11,3
Appliances	21,2	26,8	19,2	19,3	5,0	16,9	12,6	18,5
On site electricity	-15,6	-30,9	-73,8	-7,1	-36,5		-39,0	-19,6
Nearby electricity						-47,9		
BioCHP fuel			184					
Exported heat			-50,0					
Primary energy	**42**	**66**	**68**	**96**	**33**	**23**	**-1**	**61**



	Primary energy factors		
	nren	ren	tot
Biofuel	**0.5**	0.5	1.0
District heat	**0.7**	0.3	1.0
Electricity	**2.0**	0.2	2.2

Conclusions

- To date, an official definition with numeric indicators is available in 15 MS (+ Brussels Capital Region and Flanders)
  - In 3 countries implementation in the legislation is in progress
  - In the remaining 9 MS (plus Norway and the Belgian Region of Wallonia), the definition is still under discussion
- The most urgent open nZEB issues to be harmonized are energy uses included (to be comparable), system boundaries and RES inclusion (to be transparent) and building categories (to be meaningful for design choices):
  - Exclusion of the energy uses may led to situation where calculated energy use represents only a small fraction of measured energy use in real buildings
  - Requirements set only for residential and non-residential show that majority of countries cannot tackle the eight building categories specified in EPBD recast Annex I
- nZEB extra cost of about +200 €/m^2 remains a challenge, however some examples of 55-100 €/m^2 do exist