nZEB definitions in Europe

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Within European neZEH project*, national nZEB definitions were collected. Ten available definitions revealed to be remarkably different by content and ambition level. Not all of them were based on primary energy, and values between 20 and 200 do not allow meaningful comparison. The situation calls for European level guidance and shows the need to harmonize basic principles of energy calculations.

Keywords: nearly zero energy buildings, cost optimality, energy use, energy performance, energy targets.

* **Nearly Zero Energy Hotels (neZEH)** is a 3-years long project supported by the Intelligent Energy Europe (IEE) program started in April 2013, involving a consortium of 7 European Countries (Croatia, France, Greece, Italy, Romania, Spain, Sweden) and 10 partners. The project aims at accelerating the refurbishment rate of existing buildings into nZEB in the hospitality sector and promoting the front runners. Focusing particularly on the SME hotels. http://www.nezeh.eu/

From cost optimal performance to nZEB

Cost optimal calculations according to European methodology [1] were reported in last year and presented in EPBD Concerted Action meeting in October. The results were consistent as the performance levels of optimal solutions were quite similar in countries with similar climate. The coherence among results obtained by different institutions in different countries demonstrates the power of European delegated regulation that provided a common calculation methodology at the EU level – harmonization happened immediately and most of Member States (MS) were capable to conduct a large set of demanding calculations with many combinations. However, the philosophy of cost optimality as a first step towards nZEB seems not fully utilized in MS. Cost optimal calculations included high efficiency and renewable energy cases, relevant for the definition of nZEB, but the results of the calculations and analysis have not had much effect on the national nZEB defintions. In fact, the similar coherency cannot be found among the national applications of the definition of nZEB submitted by MS in last year. This was done as a part of national plans for increasing the number of nZEBs where MS were required to report the detailed application of the definition of nZEB including a numerical indicator of primary energy expressed in kWh/m² per year. Based on these national plans, the Commission published a progress report of nZEB 7.10.2013 [2] highlighting that 10 MS had more or less a full definition in place. More detailed information was available from the report of the EPBD Concerted Action meeting [3] and also from national codes, where some countries have already included nZEB values.

Based on these references, the available data of nZEB definitions was grouped according to ECOFYS classification [4] into five European climate zones as shown in **Figure 1**, in order to study the variation in primary energy values and other relevant parameters within comparable climate zones.

National nZEB definitions

An overview of the currently available definitions is shown in **Table 1**. The data covers primary energy and renewable energy share (RES) indicators, as well as inclusion of energy flows in different building types. The majority of countries (7 out of 10) are using primary energy indicator, but in some cases it covers only heating. In 3 countries out of 10, all major energy flows are included, i.e. in these countries the calculated energy use is comparable to measured energy use. In the rest of countries, mainly appliances and also lighting

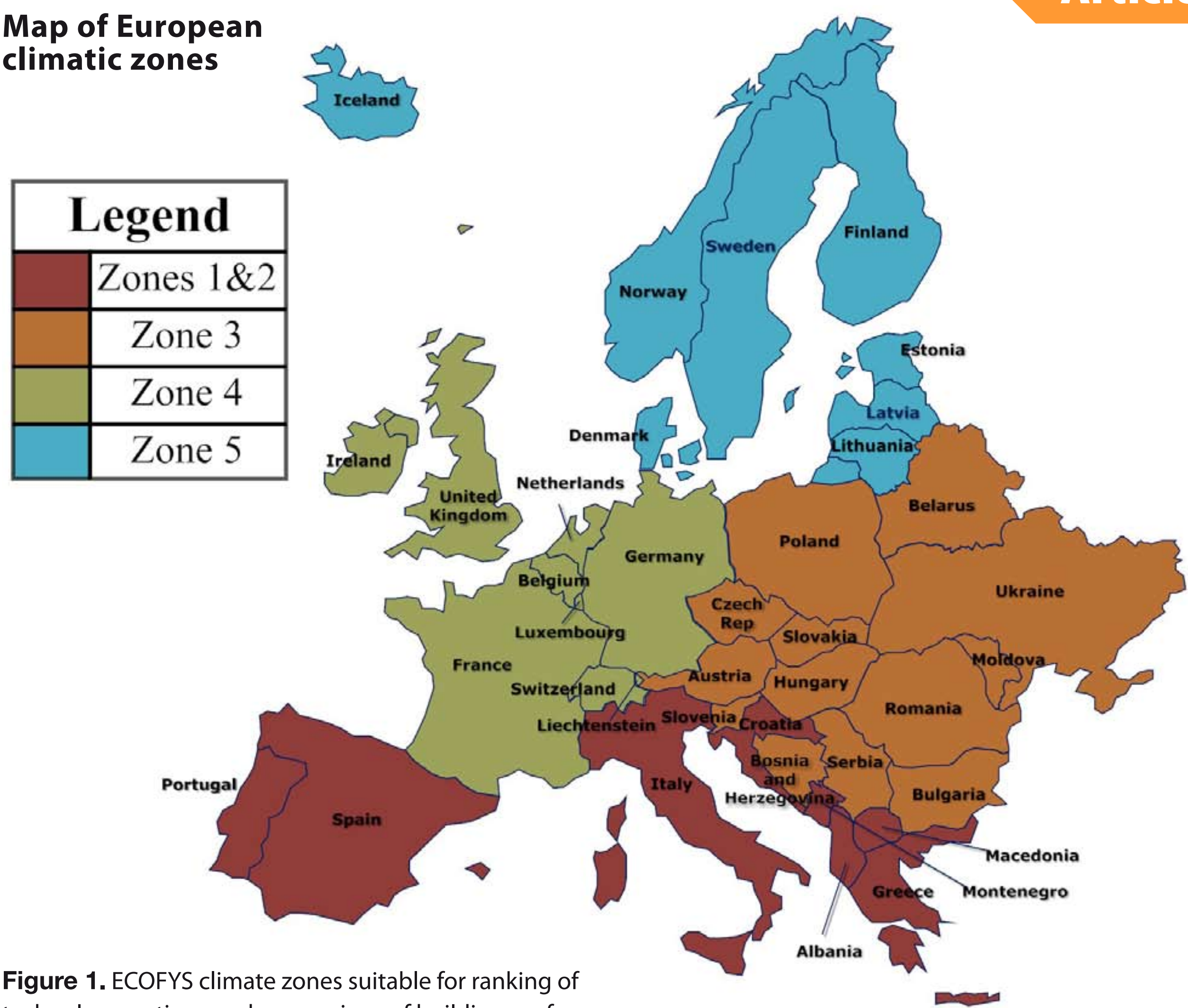

Figure 1. ECOFYS climate zones suitable for ranking of technology options and comparison of building performance.

in residential buildings were not included, despite of increasing importance of these components in the energy balance. In nZEB non-residential case studies (some examples are shown in **Table 2**) the appliances have become a major component in energy balance, often accounting for 40–50 kWh/m²y primary energy. Some countries have not yet implemented RES calculation (on site renewable energy production) to present calculation frames, and half of countries have set specific indicator for RES in nZEB definition.

The ambition of nZEB definitions may be assessed with comparison to current minimum energy performance requirements. Such comparison was straightforward for Denmark and Estonia, where current EP requirements are:

- Denmark 71.3 + 1650/A kWh/m²y for non-residential buildings, where A is gross floor area;
- Estonia 160 kWh/m²y for office buildings.

In Estonia, nZEB value of 100 kWh/m²y means the reduction by factor of 1.6. In Denmark, changes in primary energy factors are also to be taken into account. Current factors of 2.5 and 1.0 for electricity and district heat will change to 1.8 and 0.6 respectively in 2020. This results as the reduction by factor of about 2.0.

nZEB definitions were set in most countries for residential and non-residential buildings, i.e. based only on two primary energy values. Considering non-residential buildings as a single category it means that all buildings are calculated with same occupancy, ventilation rate, lighting, appliances and operation time. This approach will make no difference between offices, hospitals, schools or retail buildings, which easily show a variation in energy use by factor 3 because of different uses. If design solutions would be selected based on nZEB primary energy requirements and standard "non-residential" use of a building, in many cases optimal solutions will not be found. Such "non-residential" use will eliminate for instance the effect of lighting in shopping malls (the highest energy use component in reality) as well as the effect of demand control ventilation in schools and other rooms with high occupancy and ventilation rate. Consequently the calculated heating and cooling loads

Table 1. Overview of the NZEB numerical definition currently available in Europe.

Zone	Country	NZEB definition								Reference		
		Energy Performance (EP)							RES	National legislation providing the nZEB definition	References used for the table	
		EP-value	Unit	RES in the EP calc.	Metric	Energy uses included	Building type				Ref. for EP	Ref. for RES
Zone 1-2	Cyprus	180	kWh/m^{2}y	NO	Primary energy	heating, cooling, DHW, lighting		Residential	25%	NZEB Action Plan	[5]	[5]
		210	kWh/m^{2}y	NO	Primary energy			Non-residential	25%		[5]	[5]
Zone 3	Slovakia	32	kWh/m^{2}y	N.D.	Primary energy	heating, DHW	Apartment buildings	Residential	50%	-	[3]	[3]
		54	kWh/m^{2}y	N.D.	Primary energy		Family houses		50%	-	[3]	[3]
		60	kWh/m^{2}y	N.D.	Primary energy	heating, cooling, ventilation, DHW, lighting	Office	Non-residential	50%	-	[3]	[3]
		34	kWh/m^{2}y	N.D.	Primary energy		Schools		50%	-	[3]	[3]
Zone 4	Belgium BXL	45	kWh/m^{2}y	YES	Primary energy	heating, DHW, appliances	Individual dwellings	Residential	-	Brussels Air, Climate and Energy Code	[5]	-
		95 - 2,5*(V/S)	kWh/m^{2}y	YES	Primary energy	heating, cooling, DHW, lighting, appliances	Office buildings	Non-residential	-		[5]	-
		95 - 2,5*(V/S)	kWh/m^{2}y	YES	Primary energy	heating, cooling, DHW, appliances	Schools		-		[5]	-
	Belgium Walloon	60	kWh/m^{2}y	N.D.	Primary energy	heating, DHW, appliances	Residential buildings, schools office and service buildings	Residential/ Non-residential	50%	Regional Policy Statement	[2]	[5]
	Belgium Flemish	30	kWh/m^2/y	YES	Primary Energy	heating, cooling, ventilation, DHW, auxiliary systems		Residential	>10 kWh/m^{2}y	Energy Decree	[5]	[5]
		40	kWh/m^{2}y	YES	Primary Energy		Office buildings, schools	Non-residential	>10 kWh/m^{2}y		[5]	[5]
	France	50	kWh/m^{2}y	NO	Primary energy	heating, cooling, ventilation, DHW, lighting, auxiliary systems		Residential	-	RT2012	[5]	
		70	kWh/m^{2}y	NO	Primary energy		Office buildings non-air-cond.	Non-residential	-		[5]	
		110	kWh/m^{2}y	NO	Primary energy		Office buildings air-cond.		-		[5]	
	Ireland	45	kWh/m^{2}y	N.D.	Energy load	heating, ventilation, DHW, lighting		Residential	-	Building Regulation Part L amendement	[5]	
	Netherlands	0	[-]	YES	Energy performance coefficient (EPC)	heating, cooling, ventilation, DHW, lighting		Residential/ Non-residential	not quantified, but necessary	EPG 2012	[5]	
Zone 5	Denmark	20	kWh/m^{2}y	YES	Primary Energy	heating, cooling, ventilation, DWH		Residential	51% - 56%	BR10	[5]	[2]
		25	kWh/m^{2}y	YES	Primary Energy	heating, cooling, ventilation, DHW, lighting		Non-residential	51% - 56%		[5]	[2]
	Estonia	50	kWh/m^{2}y	YES	Primary Energy	heating, cooling, ventilation, DHW, lighting, HVAC auxiliary, appliances	Detached houses	Residential	-	VV No 68:2012	[6]	-
		100	kWh/m^{2}y	YES	Primary Energy		Apartment buildings		-		[6]	-
		100	kWh/m^{2}y	YES	Primary Energy		Office buildings	Non-residential	-		[6]	-
		130	kWh/m^{2}y	YES	Primary energy		Hotels and restaurants		-		VV No 68:2012	
		120	kWh/m^{2}y	YES	Primary energy		Public buildings		-		VV No 68:2012	
		130	kWh/m^{2}y	YES	Primary energy		Shopping malls		-		VV No 68:2012	
		90	kWh/m^{2}y	YES	Primary energy		Schools		-		VV No 68:2012	
		100	kWh/m^{2}y	YES	Primary energy		Day care centres		-		VV No 68:2012	
		270	kWh/m^{2}y	YES	Primary energy		Hospitals		-		VV No 68:2012	
	Latvia	95	kWh/m^{2}y	N.D.	Primary energy	heating, cooling, ventilation, DHW, lighting		Residential/ Non-residential	-	Cabinet Regulation N° 383 from 09.07.2013	[3]	-
	Lithuania	<0,25	[-]	N.D.	Energy performance indicator C	heating		Residential/ Non-residential	50%	Building Technical Regulation STR 2.01.09:2012	[5]	[3]

Table 2. 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, and delivered heating is electricity. Delivered cooling is in all buildings electricity. On site electricity generation is with PV in three buildings and bio-CHP in one building. All values in the table are in kWh/m²y.

Climate zone	City, country	Delivered energy Heating	Cooling	Fans&pumps	Lighting	Appliances	On site electricity	Primary energy
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**

and energies can be very far from reality. The wide gap in energy use between different non-residential building types is illustrated in the **Table 1** with the Estonian values, showing a variation between 100 and 270 kWh/m²y for seven non-residential building types.

In setting nZEB targets the experience from nZEB pilot buildings is worth to utilize. In the following, detailed energy data of four nZEB office buildings located in climate zones 4 and 5, published in [7], are reported with the aim to compare national nZEB values to the values of real case studies. **Table 2** shows a summary of delivered and primary energy of these buildings. From the first building, measured data is used, from others simulated energy use is reported. To be comparable, for all buildings the following primary energy factors were applied:

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

Remarks and conclusions

The review of available national nZEB definitions shows remarkably high variation in nZEB primary energy values being between 20 and 200 kWh/m²y in ten countries. The high variation applied even within the same building type in countries with similar climate. It is partly due to different energy uses included and partly due to different level of ambition in the definitions.

Energy data reported in available nZEB case studies of office buildings was supporting with some reservations Belgian and French (zone 4) and Estonian (zone 5) nZEB values. Generally, energy data of nZEB case studies seem to provide more reliable benchmarks than that from first national nZEB definitions, which in many cases seem suffering under inconsistent calculation methodologies and do not account all energy flows. The latter leads to situation where calculated energy use could represent only a small fraction of measured energy use in real buildings.

Compared to current energy performance minimum requirements of office buildings, nZEB primary energy values showed a reduction by factor of 1.6 in Estonia and by about 2 in Denmark if changes in primary energy factors were also accounted. For other countries, enough detailed data to calculate the reduction percentage was not available.

It can be concluded that Member States need more guidance in order to set consistent and comparable nZEB values with equal ambition levels. For some reason, the European cost optimal methodology seems not utilized in all countries when defining nZEB – it could be speculated that existing energy calculation frames and methodologies are too different to enable easy implementation of those calculation principles.

Very limited number of building types used in national nZEB definitions, often just residential and non-residential, was alarming and shows that majority of countries cannot tackle the eight building types specified in EPBD recast Annex [8].

Definition of standard uses for common building types would be an important task for European standardisation, which can be addressed in ongoing revision of EPBD standards, expected to be completed due 2015. Hourly profiles for occupancy, appliances, lighting and domestic hot water would be required to calculate how much of on site renewable energy production could be utilized in the building and how much needs to be exported. Without this information, alternative design solutions cannot be adequately compared in nZEB buildings. ■

References

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