AFFIRMATIVE INTEGRATED ENERGY DESIGN ACTION

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D3.1: Integrated energy design in municipal practice

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CONTENT

List of acronyms

NZEB	Net Zero Energy Building
nZEB	nearly Zero Energy Building
IED	Integrated Energy Desing
IEQ	Indoor Environmental Quality
IEA	International Energy Agency
SHC	Solar Heating and Cooling
ECBCS	Energy Conservation in Buildings and Community Systems
EPC	Energy Performance Certification
DHW	Domestic Hot Water
RES	Renewable Energy Sources

1. Summary

This document is a guideline for new nearly zero energy buildings (nZEBs) or renovations. The strategy proposed shows how to integrate energy performance requirements (nZEB target) in public design tenders as deciding criteria to win the competition. In order to win public tenders with mandatory energy performance criteria, an energy strategy called IED process is necessary.

The IED process (chapter 3 and Annex I) allows the (work) team to collaborate in order to discover the most appropriate solution, taking into consideration aesthetics, economic and energy aspects, during the early phases of the design process, at a time when most design changes do not impact the final cost.

Within AIDA project it was tried to understand and define a common nZEB definition starting from the EPBD[1] definition at European level to the implementation of the Directive 2010/31/EU at national/regional level of the member countries involved in AIDA. To clarify and define the method for the energy balance calculation some results obtained within the international project IEA SHC Task 40/ECBCS Annex 52[2] "Towards Net Zero Energy Solar Buildings" were used.
In order to realize high energy efficient buildings, able to produce on site (thermal and electric) energy from renewable energy, minimum energy performance requirements within AIDA project have been defined (Chapter 5).

On the other side, in order to understand the roles of the public administrative contracts, an overview of different public contracts (chapter 6 and 7) that regulate the process and the relations between the public and private sectors across different countries of Europe has been prepared.
The analysis of the design tenders finishes with the definition of some recommendations that will be used when the energy target of the new (or refurbishment) building is nZEB.

The final two chapters present technical, legislative and financial barriers found during the collaboration with the Municipalities involved in the AIDA project (chapter 9).

[1] Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings.
[2] IEA, International Energy Agency (http://task40.iea-shc.org/)

2. Introduction

The European Directive 2010/31/EU on energy performance of buildings defines a "*'nearly zero-energy building' (...) a building that has a very high energy performance (...).The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby*"[3] giving qualitative features and not quantitative values.

The European Directive 2010/31/EU requests that member States ensure that by December 2020 all new buildings are nearly zero-energy buildings. As this deadline is brought forward to December 2018 in the case of new buildings owned or occupied by public authorities, public authorities are in charge of promoting and setting up strategies to pursue the nZEB target. Thanks to the international project IEA SHC Task 40/ECBCS Annex 52[4] "Towards Net Zero Energy Solar Buildings", participants representing different countries in the world have been working together to define an international Net Zero Energy Building (NZEB) definition and method for energy balance calculations.

To clarify the difference between Net ZEB and nearly ZEB definition:

- „ NZEB", Net Zero Energy Building: a building using 0 kWh/(m² a) primary energy
- „nZEB", nearly (Net) Zero Energy Building: a building with a cost optimal energy use greater than 0 kWh/(m² a) primary energy [1].[5]

This work assists Municipalities introducing the nearly Zero Energy Buildings target (incl. method for energy balance calculations, ranking method and indexes) into public design tenders, and requiring the use of IED process, assists the design teams to integrate energy performance, renewable energies, indoor environmental quality and building liveability (effective functionality depending on the use) issues into the early phases of the design process.

Actually the Directive 2004/18/EC[6] is been adopted from all the European Members States (see Table 3). During the last year of AIDA project (2014), the European Parliament and the Council

[3] Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings

[4] IEA, International Energy Agency (http://task40.iea-shc.org/)

[5] A more simple definition is as follows:

- NZEB: a high energy performance building able to generate as much energy, on-site by RES, as it consumes in the same period;
- nZEB: a high energy performance building with nearly zero or very low amount of energy required covered by a significant on-site energy production from RES.

[6] Directive 2004/18/EC of the European Parliament and of the Council of 31 march 2004 on the coordination of procedures for the award of public works contracts, public supply contracts and public service contracts

have approved the Directive 2014/24/EU[7] of the 26 February 2014 on public procurement and repealed the Directive 2004/18/EC with effect from 18 April 2016 (art. 91).

3. Methodology proposed

The method used aims to overcome administrative issues for the integration of energy performance requirements into legislative procedures, through a participative process with different stakeholders (public authorities, energy experts, architects, engineers, builders, owners and tenants) during the all design process, from the planning to the construction phase.
The IED process is an innovative approach able to support and manage the growing complexity of the building market sector. Within AIDA project a 'Guideline about IED' to support the working group was elaborated, see Annex I.
In order to introduce and require the energy performance target, nZEB, the work done analyses the public contracts, the procedures (open, restricted, competitive…) and the layout of the contract notices (from legislative point of view, art. 49) and defines and proposes a common definition of the nZEB target, from the minimum energy performance indicators (energy balance, heating/cooling/electric demand, IEQ level, etc.) to the energy performance calculation tools. Furthermore, an efficient way to pursue the nZEB objective is to include in the energy performance contract award criteria and the relative weighting given to each of those criteria in the contracts notices.

4. Integrated Energy Design - IED

IED is a multidisciplinary and collaborative process where the work team is composed of different stakeholders with differing knowledge and experiences (detailed description see Annex I). They work together to define, analyse and evaluate different solutions and possible interactions [2]. The choices are no longer taken from a single profession, but from a work team through a participatory process; choosing from a wide range of possibilities to identify the best solution, taking into account the quantitative aspects (high energy performance efficiency and high indoor comfort), economic (cost/benefit), functional, aesthetical aspects and energy efficiency parameters to be achieved.

Thanks to this approach the work teams are composed of different professionals, specialized in different subjects, such as public administrative figures, able to write public design tenders and to untangle legislative procedures, and AIDA partners, technical experts specialised in nearly zero energy buildings.

The IED approach is an effective way to realize nZEBs because it involves different people to discuss energy performance issues in the early stages of the design process. Figure 1 shows the difference between a traditional approach (blue line) and an IED process (black line). With

[7] Directive 2014/24/EU of the European Parliament and of the Council of 26 February 2014
on public procurement and repealing Directive 2004/18/EC (Text with EEA relevance)

the integrated design process the design phase requires more effort than the construction and documentation phase. At the same time, the cost's curve trend changes with the decision making time phase, in the IED approach it is high during the design phases (red line) while in a traditional approach (green line) it is high during the costruction and operation phase due to project changes.

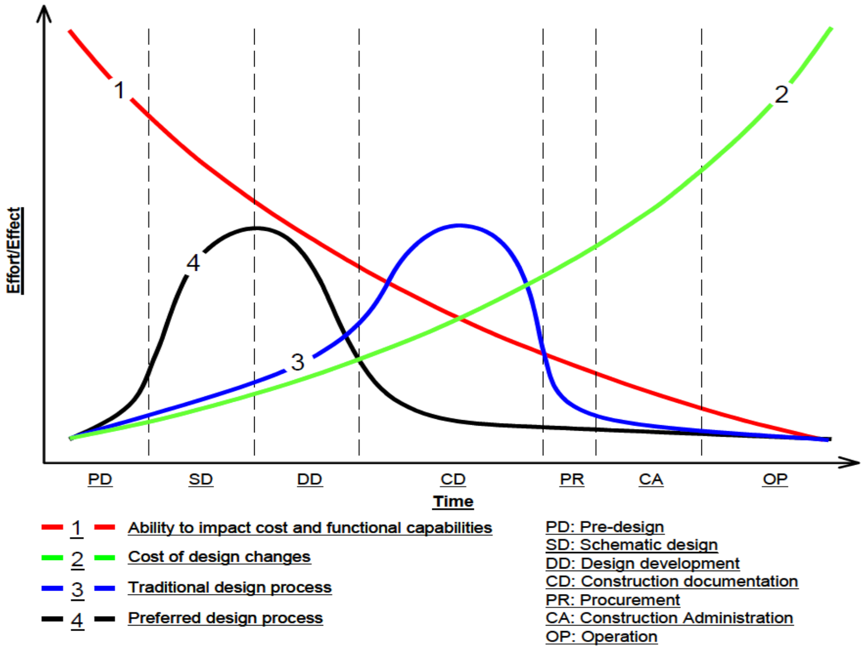

Figure 1: Difference between traditional design process and integrated design process. [15]

For this reason a close collaboration between public administrative figures, engaged to draw up public tenders and to untangle legislative procedures, and energy experts in nearly zero energy buildings, is a key to success in including rules into the design competition procedures. In particular, they explain 'where' and how energy performance requirements can be introduced. On top of this an IED involves different professionals with different knowledge to discuss the energy performance concept of the building, and allows the group to discover new methods and more alternative solutions.

5. nearly ZEB (and Net ZEB) concept and evaluation procedure

5.1 Definition

The European Directive defines only qualitative aspects of the nZEB definition, without fixing quantitative indicators.

The lack of a precise definition of NZEB [3] has led several member countries of the International Energy Agency to launch the research project "IEA SHC Task 40 – ECBCS Annex 52: Towards Net Zero Energy Solar Buildings" in order to clarify the precise meaning of Net ZEB and translate it in a common calculation methodology showing the implications of the latter on design solution sets. EURAC, IREC and AEE INTEC were partners of the project concluded in October 2013.

A result of the Task 40 – ECBCS Annex 52 project is the delineation of criteria and parameters able to define four different Net ZEB definitions (Figure 2).

A Net Zero Energy Building is the "building system" delimited by set physical boundaries, connected to any energy infrastructure, which balance between its weighted energy loads and supplies is zero.

		Net ZEB limited	Net ZEB primary	Net ZEB strategic	Net ZEB carbon
Building system boundary	Balance boundary	HEATING DHW COOLING VENTILATION AUXILIARIES BUILT-IN LIGHTING (only non residential buildings)	HEATING DHW COOLING VENTILATION AUXILIARIES BUILT-IN LIGHTING PLUG LOADS	HEATING DHW COOLING VENTILATION AUXILIARIES BUILT-IN LIGHTING PLUG LOADS	HEATING DHW COOLING VENTILATION AUXILIARIES BUILT-IN LIGHTING PLUG LOADS
Weighting system	Metric	PRIMARY ENERGY	PRIMARY ENERGY	Whichever metric desired	CARBON EMISSION
	Symmetry	SYMMETRIC	SYMMETRIC	SYMMETRIC or ASYMMETRIC	SYMMETRIC or ASYMMETRIC
	Time dependent accounting	STATIC OR QUASI-STATIC	STATIC OR QUASI-STATIC	STATIC OR QUASI-STATIC	STATIC OR QUASI-STATIC
Net ZEB balance	Energy efficiency	NATIONAL/LOCAL ENERGY EFFICIENCY REQUIREMENTS ARE FULFILLED	NATIONAL/LOCAL ENERGY EFFICIENCY REQUIREMENTS ARE FULFILLED	ANY NATIONAL/LOCAL ENERGY EFFICIENCY REQUIREMENTS HAS TO BE FULFILLED	ANY NATIONAL/LOCAL ENERGY EFFICIENCY REQUIREMENTS HAS TO BE FULFILLED
	Energy supply	ON SITE GENERATION DRIVEN BY ON/OFF SITE SOURCES	ON SITE GENERATION DRIVEN BY ON/OFF SITE SOURCES	ON/OFF SITE GENERATION DRIVEN BY ON/OFF SITE SOURCES	ON SITE GENERATION DRIVEN BY ON/OFF SITE SOURCES

Figure 2: Net ZEBs definitions defined by Task 40. Source: IEA SHC Task 40 – ECBCS Annex 52: Towards Net Zero Energy Solar Buildings

Net ZEB limited and *Net ZEB primary* definitions are very similar, the only difference is the parameters included in the energy balance; in the *Net ZEB primary* definition all plug loads are included. The *Net ZEB carbon* is the same as the *Net ZEB primary* definition, but the weighted balance is calculated on carbon emission. AIDA proposes to calculate the energy balance using the '*NET evaluation tool*' from Task 40 – ECBCS Annex 52 project[8]. In particular AIDA suggests focusing at least on the results of *Net ZEB primary or Net ZEB limited* and *Net ZEB carbon* definition.

8 http://task40.iea-shc.org/net-zeb

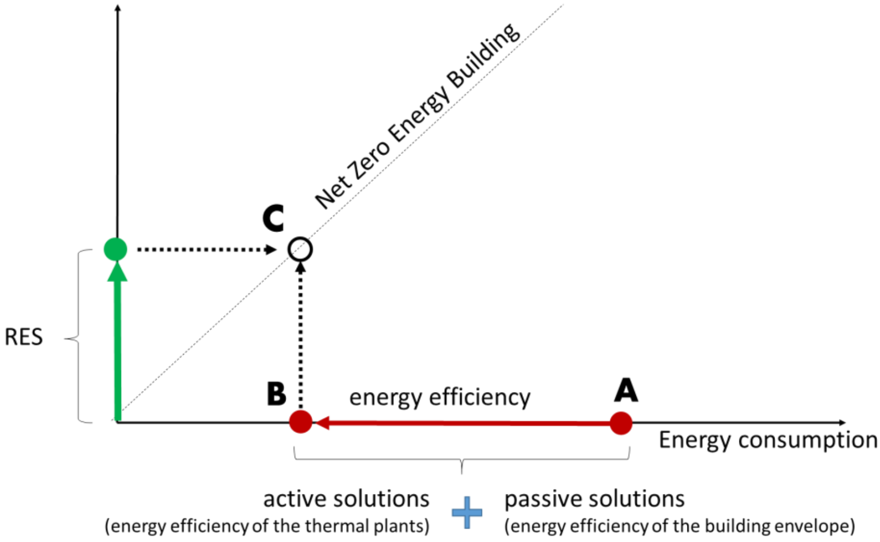

Figure 3: Energy balance calculation. (Source: L. Aelenei et al. Passive cooling approaches in net-zero energy solar buildings: lessons learned from demonstration buildings. CISBAT Conference 2011, Lausanne, CH.)

Figure 3 describes how increase the energy efficiency of the buildings starting from the state of the art of the actual building stock (point A). On the x-axis there is the energy consumption of the buildings and on the z-axis the on-site energy production (thermal and electric) from RES. Through active and passive solutions is possible to increase the energy efficiency of the buildings and move from point A to point B. To achieve the NET zero energy target (identify with the bisector, point C) it is necessary to cover the energy consumption from energy (thermal and electricity) on-site generation plants from RES. When the point is close to the Net zero energy building line, over or above, the building is called nearly Net zero energy. When the final point exceeds the bisector the building is called 'active building' because produce more than it consume.

5.2 Methodology for the energy balance calculation

The core of the energy balance calculation is determinated between delivered and exported energy. During the design phase the energy balance will be calculated considering the energy produced on-site, within the boundary system, by renewable energy sources and energy exported to the grid, as well as energy delivered to the building from off site (grid, etc) in order to achieve an appropriate level of internal environmental comfort.

In the energy balance will be included the determinated energy demands of the building (heating, cooling, domestic hot water, ventilation, auxiliaries, lighting and all plug loads) in relation with the chosen Net ZEB definition.

The energy balance must be calculated in terms of primary energy, using the weighting conversion factors included and defined in national/local energy laws. The energy balance between imported and exported energy is an approach used to evaluate the building-grid interaction, in particular for deducting the quantity of energy generated and directly used on-site.

The equation used to the energy balance calculation is:

$$\sum_i g_i \cdot w_{e,i} - \sum_i l_i \cdot w_{d,i} = G - L \geq 0$$

where:

i = energy carrier

gi = generation of the i-th energy carrier

li = load of the i-th energy carrier

we,i = weighting factor for exported i-th energy carrier

wd,i = weighting factor for imported i-th energy carrier

G = weighted generation

L = weighted load

The energy balance is a yearly balance and can be calculated by dynamic simulation* during the design phase or calculated by monitoring data. For the calculation of the energy balance there is a tool elaborated within Task 40 called „Net ZEB evaluation tool" that is able to evaluate the energy balance for each of the four Net ZEB definitions. The tool is based on different Excel sheets that collect the energy consumption and prodution data, calculated by other simulation tools or by monitoring data. Figure 4 shows a screenshot of the tool.

*__*A barrier found*__* *is the lacking knowledge of the dynamic tool for the energy performance calculation. Within AIDA project, in order to support the design team to develope an enegy strategy, to calculate the energy performance and the energy balance have been supplied common tools, like national tools used for the Energy Performance Certification, listed in Table 2.*

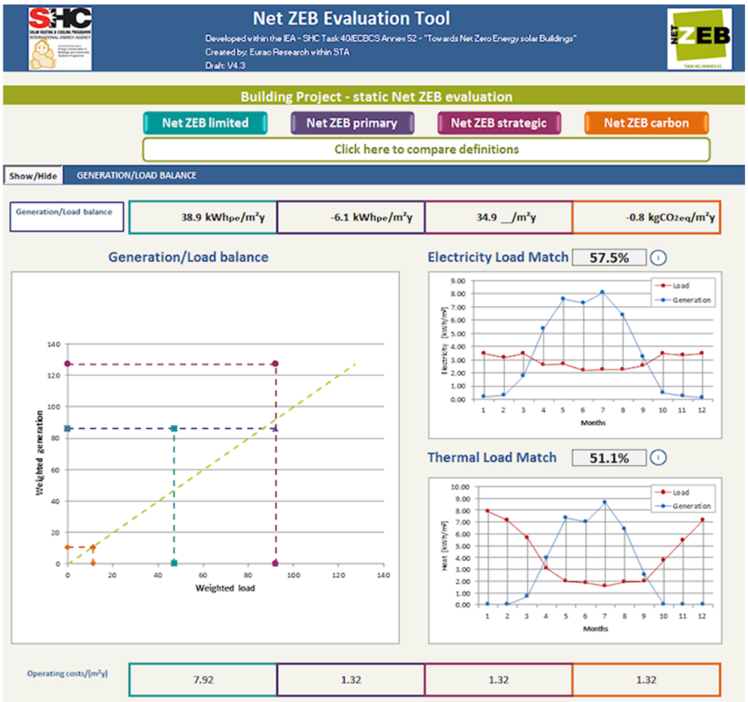

Figure 4: Net ZEB evaluation tool elaborated by Task 40– ECBCS Annex 52. Source: IEA SHC Task 40 – ECBCS Annex 52: Towards Net Zero Energy Solar Buildings

5.3 Physical boundary of the building data

The physical boundary of the building is used to identify the location of generation systems, so-called "on-site", and energy demands. A generation system within the boundary of the system is defined on-site.

Different definitions and possibilities of physical boundaries exist. Figure 5 shows an overview of the different possibilities of "on-site" energy generation.

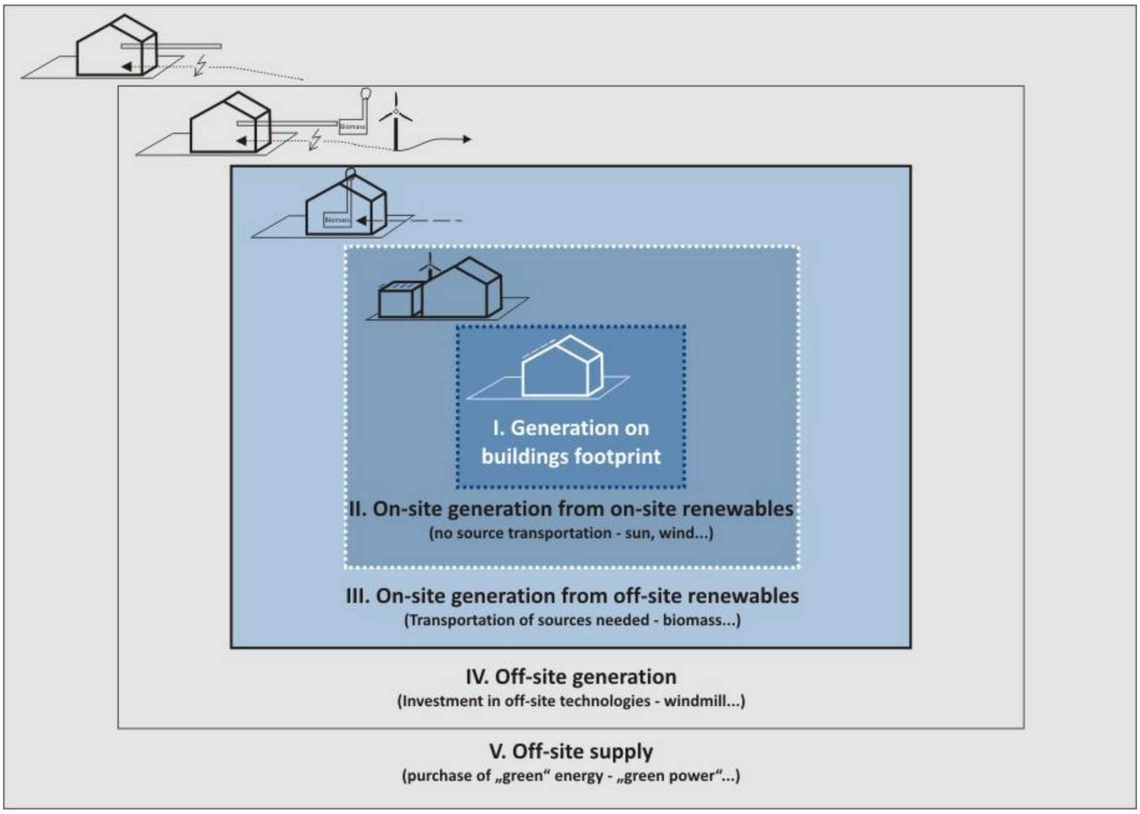

Figure 5: Physical boundary of the building in relation with the energy generation systems. Source: IEA SHC Task 40 – ECBCS Annex 52: Towards Net Zero Energy Solar Buildings

5.4 Integration of the energy generation systems

The energy production systems will be integrated into the building and/or into the boundary of the building system and renewable sources will be used. In order to guarantee a high aesthetic building value, the integration of energy generation systems is a necessary aspect to be evaluated from the beginning of the project. These systems can be integrated into the architectural elements of the building or in other elements located within the boundary system (for example integrated into a bus shelter or the parking area).

5.5 Weighting factors

Before calculating the energy balance that sums and subtracts different energy vectors (thermal and electric energy) produced on-site or imported from energy grids, it is necessary to define the measurement units. Such measurement units can be:

- Primary energy (kWh_{prim}/kWh_{end});
- CO_2 emissions (kg_{CO2}/kWh_{end});
- Energy costs in monetary units (€, £, $...).

Weighting factors convert the physical into metric units, for example accounting for the energy used (or emissions released) to extract, generate, and deliver the energy. Weighting factors may also reflect political preferences rather than purely scientific or engineering considerations. [4]

5.6 Proposed nZEB minimum criteria by AIDA project

To achieve the nearly zero energy targets it is necessary to design highly energy efficient buildings able to generate as much energy as needed.

Within the AIDA project it is proposed some minimum energy performance indexes should be achieved to reach the nZEB target, such as:

- To achieve the highest class of the national standard of the National or Local Energy Performance Classification of the building; usually called Standard/Class A.
- A minimum of 50% of the primary energy consumption should be covered by energy produced from renewable energy sources;
- Total primary energy consumption limit of 60 kWh/m^{2}year
- CO_2 emission limit of 8 kg CO_2/m^{2}year.

These are the minimum energy requirements that we would like to achieve within IEE-AIDA project, but sometime in the case studies developed within the project we are a far, in particular with the primary energy consumption (limit of 60 kWh/m^{2}year) and CO_2 emission (limit 8 kg CO_2/m^{2}year).

- **NOTE: In the total primary energy consumption calculation the energy demand for heating, DHW, cooling, ventilation, auxiliaries and built-in lighting (for non-residential buildings only) must be considered.**

In order to increase the energy efficiency of the buildings the design team should develop, from the early phases of the design process, an energy strategy able to reduce the energy demand (thermal and electric) using passive strategies, such as:

- Orientation for passive and active solar gains
- Building shape; a compact form of the buildings reduces the thermal energy losses (low surface-volume-ratio)
- Architectural solutions for day-lighting and natural ventilation
- Overheating control (automatic or fixed solar shadings system / night ventilation)
- Definition of the external envelope for PV and solar collector integration.

Performance indicators will be used and minimum requirements in compliance with the local energy policies and codes in force. Table 4 shows the status of the EU Directive 2010/31/EU implementation in each AIDA partner country

Table 1: Status of the national implementation of the EU directive 2010/31/EU

Country	Status yes/no	Comments on the state of implementation of 2010/31/EU in national legislation
Austria	Partly	Although building-related legislation falls under the competence of the nine regions (Bundesländer), the Austria Institute of Construction Engineering (OIB) published in April 2007 a guideline (OIB-Richtlinie 6), that defined four categories of limit values for heating/cooling demand of buildings, a first step in the right direction to nZEB. While *OIB-Richtlinie 6* may be considered as the building code currently in force, a new version published in 2011 includes stronger requirements that went into force in already all nine regions. In addition, the nine regions have agreed on a draft national plan in accordance with the EPBD recast that includes the definition of nZEB and the implementation of interim targets. It considers, both for new buildings and for major renovations, targets for heating needs, delivered energy, total efficiency factor, primary energy demand and CO2-emissions for the years 2014 (start of implementation 1.1.2015), 2016 (1.1.2017), 2018 (1.1.2019) and 2020 (1.1.2021).
France	Partly	In October 2010, France published a new building energy regulation (Réglementation Thermique 2012, or RT2012) that made mandatory «Low energy consumption» building (BBC – Bâtiment Basse Consommation) for all new constructions that partly transposes the Directive 2010/31/EU (art. 3, 4 and 6) and became compulsory as of 1st January 2013. The absolute limit value for consumption in housing is 50 kWh/sqm*year covering five energy uses: space heating and cooling, domestic hot water, lighting and auxiliary equipment (pumps, fans). The official calculation model was published in September 2011. Although there is currently no official definition of nZEB, the national State plans to introduce BEPOS (Bâtiment à Energie Positive or "positive energy building") as the required energy performance level in the future regulation scheduled for 2020. The professional association *Effinergie* who is at the origin of RT2012 is currently developing the BBC+ and BEPOS standards, which, based on previous experiences, will probably be taken as a working basis for the official definition of nZEB.
Greece	No	In Greece, the Law 4122/2013, which is the transposition of Directive 2010/31 into national legislation, was voted on February 2013, but it does not provide with a more precise definition on nZEB than the one appearing in the Directive. Furthermore, no nZEB definition existed either in the previous Building Law and Building Code Regulation (Law 3661/2008 and D6/5825/2010). According to Art, 9, paragraph 2 of Law 4122/2013 a national action plan to support the penetration of nZEB is foreseen. This action plan, among other things, will also provide with a precise definition on nZEB, as far as technical aspects are considered. The working group for the preparation of this action plan has not been allocated yet by the Ministry of Environment, Energy & Climate Change, but is expected to be allocated in the forthcoming months.

Hungary	No	The former Directive (2002/91/EC) expired on 01.02.2012, which should be replaced by 2010/31/EU. Hungary's Renewable Energy Utilisation Action Plan plans that significant legislative amendments are required to implement the Directive 2010/31/EU. Preparation work has already begun.
Italy	Yes	Law of 3 August 2013, n. 90 is converted into law, with amendments, of Decree-Law 4 June 2013, n. 63, on urgent measures for the transposition of Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings for the definition of infringement proceedings by the European Commission, as well as other provisions of social cohesion. (13G00133) (OJ 181 of 03.08.2013). The new law presents some clarifications, such as: - Definition of the nearly zero energy building - Definition the Action Plan to increase the number of nearly zero energy buildings to at national level, and deadline for the realization it by 30 June 2014; - Deadline for the Ministries for elaboration of the financial measures list to promote the energy efficiency and the nearly zero energy buildings by 31 December 2013; - Energy performance certificate of building for sales contract, the acts of transfer of properties in free of charge or for new leases; - tax deduction (or 55 percent) for documented expenses related to energy upgrading of buildings apply to the extent of 65 percent of the costs incurred from June 6, 2013 (date of entry into force of the measure) until 31 December 2013; ….
Spain	No	Spain does not have any nZEB definition yet. However, in the Energy Savings and Efficiency Action Plan 2011-2020 and in the Second National Energy Efficiency Action Plan under the EU Energy services Directive106, Spanish authorities have set up a preliminary roadmap for implementing nZEB, whose definition is likely to be based on the "energy class A" of the existing performance certification methodology (EPC), which means that all buildings constructed from 2021 onwards will have a primary energy consumption 70% lower than the current building codes requirements (Technical Building Code-TBC2006) and 85% lower than reference buildings for 2006 building stock. Specific provisions both for new buildings or refurbishment of existing buildings are foreseen, such as: - a definition of nZEB based on primary energy needs (kWh/m^2.yr) adjusted for each of the 12 climatic zones - definition of intermediate goals by 2015 in order to improve the energy performance of new buildings - the establishment of a package of policies and financial tools for implementing nZEB IDAE (Institute for Energy Diversification and Savings) will support the implementation of nZEB in Spain by coordinating several support mechanisms such as projects subsidies allocated on annual call basis and communication campaigns for promoting selected nZEB

United Kingdom / Scotland	No	The Scottish Government consultation on transposition of EU Directive 2010/31/EU is due to close on January 20th, 2012. The results of this will dictate how the requirements of the directive will be implemented in Scotland. Similar procedures are in place throughout the rest of the UK. The primary vehicle for addressing provisions within this Directive will be the English/Welsh/Scottish building regulations. Delivery of nearly zero energy new buildings will be addressed by the on-going building regulations review process, with recognition of similar review and research ongoing within the UK. The definitive definition of nZEB is still to be finalised but will be based on the UK zero carbon buildings policy triangle.

More detailed information on the progress of policy transition towards nZEBs and the implementation on 2010/31/EU can be found in the "Overview of the EU-27 countries buildings policy and programs", a report published in September 2014 by the IEE-project ENTRANZE (www.entranze.eu) [5].

5.7 Energy simulations and proposed tools

The choice of the energy simulation tool depends on the results looked for and on the level of the details of the design proposal. The field of energy simulation tools is very wide and grows day by day. Some building software tools for evaluating energy efficiency, renewable energy and sustainability in buildings can be found on these websites:
http://apps1.eere.energy.gov/buildings/tools_directory/subjects_sub.cfm
http://www.nrel.gov/analysis/models_tools.html
http://www.enob.info/en/software-and-tools/

A list of weather data for building energy simulation software:
http://gard.com/weather/index.htm
http://re.jrc.ec.europa.eu/pvgis/apps4/pvest.php

In Table 2 the tools used for the energy performance calculation in the member states involved in AIDA project are listed with the respective output that they can calculate (heating, cooling, electric, lighting, primary energy demand, …). This table supports stakeholders, design teams, public representatives in the choice of the simulation tool.

- *For example, in Italy in the Province of Bozen the local energy agency called CasaClima has created a tool to evaluate the EPCs. The tool calculates the energy performance of the buildings, such as heating load, cooling load, DHW load, primary energy demand, energy production by renewable sources and CO_2 emission, by a static calculation approach.*

Table 2: Energy Performance Simulation tools.

Country	Tool name	Is an Energy certification tool?	Certification mandatory for each country or region	Calculation approach	OUTPUT Heating energy load and DHW	Cooling energy load	Electric energy demand	Lighting	Primary energy demand	RES	Total CO2	Inter operability (file format)
				(static-dynamic)	(kWh/m²y)	(kWh/m²y)	(kWh/m²y)	(DA,DF, UDI, glare)	(kWh/m²y)			
IT	Regulatory algorithms designed by the state, all thermal regulations accredited software use these algorithms. A complete list of the available software is on the thermal regulations website: http://www.cti2000.it/index.php?controller=sezioni&action=show&subid=34											
IT	Proclima	X	Province of Bolzano (IT)	Static simulation	X				X	Contribution of PV Solar panel- Geothermal	X	web
IT	ProClima 2013/14/15	X	Province of Bolzano (IT)	Static/Dynamic simulation	X	X	X	X	X	Contribution of PV Solar panel- Geothermal	X	web
IT	DOCET	X	Italy	Static simulation	X	X			X	Contribution of PV Solar panel- Geothermal	X	.xml
AT	GEQ and others	X	Austria	Static simulation	X	X	X		X	Contribution of PV Solar panel- Geothermal..	X	
ES	LIDER CALENER	X	Spain	Static simulation	X	X	X	no	X	Solar thermal for hot water and PV contribution. Other RES are difficult to introduce	X	none
HU	ArchiPHYSIK	X	Hungary, mandatory since 01/01/2012		X	X	X	X	X	Solar-thermal, PV, wind, geothermal, heat-pumps, pellet	X	.xml
HU	WinWatt	X	Hungary	Dynamic simulation	X	X	X	X	X	Renewables are not specified, but applicable		.xls
FR	THBCE	Regulatory algorithms designed by the state, all thermal regulations accredited software use these algorithms. A complete list of the 6 accredited + 2 under evaluation software is available on the thermal regulations website : http://www.rt-batiment.fr/batiments-neufs/reglementation-thermique-2012/logiciels-dapplication.html										
FR	Pleiades+Comfie, module RT2012	X	France	Dynamic simulation	x	x	?			?		import via other software in format dwg, jpg, pdf
FR	CLIMAWIN	X	France	Static simulatoin	x		x		x	PV/solar thermal / heat pumps		Export .csv
FR	ArchWIZARD	X	France					x		X		Import → SKP, DWG, ATL, OBJ
FR	DesignBuilder+ Energyplus ou RT2012	X (under evaluation)	France	Dynamic simulation	x							Import pdf, jpg ou dx and then .idf
GR	TEE KENAK	X	Greece	Montly quasi steady state simulation method	X	X	X	X (only in tertiary buildings)	X	all RES	X	.xml
UK	Designbuilder V3.2		UK and Scotland	Dynamic Simulation	X	X	X	X	X	X	X	.idf
UK	gEnergyEPC	X	UK and Scotland	Static Simulation	X	X	X		X	Can be selected	X	.idf
UK	gEnergyAIDA		UK and Scotland	Dynamic Simulation	X	X	X	X	X	X	X	idf
	PHPP	X, for Passive House	Everywhere	Static Simulation	X	X	X	X	X	X	X	.xls
	EnergyPlus			Dynamic Simulation	X	X	X	X	X	X	X	idf
	Trnsys			Dynamic Simulation	X	X	X	X	X	X	X	.tpf

6. Design tenders

At the European level, the Directive 2004/24/EU defines technical, legislative and economics aspects that rule the process and the relations between public and private sector.

6.1 Analysis of the public contract

The Directive 2004/24/EU, art. 2, defines

(*5) ‘**public contracts**’ means contracts for pecuniary interest concluded in writing between one or more economic operators and one or more contracting authorities and having as their object the **execution of works, the supply of products or the provision of services**;*

*(6) ‘**public works contracts’** means public contracts having as their object one of the following:*

(a) the execution, or both the design and execution, of works related to one of the activities within the meaning of Annex II;

(b) the execution, or both the design and execution, of a work;

(c) the realisation, by whatever means, of a work corresponding to the requirements specified by the contracting authority exercising a decisive influence on the type or design of the work:

*(7) ‘**a work’** means the outcome of building or civil engineering works taken as a whole which is sufficient in itself to fulfil an economic or technical function;*

……

*(9) ‘**public service contracts’** means public contracts having as their object the provision of services other than those referred to in point 6;*

….

*(21) **‘design contests’** means those procedures which enable the contracting authority to acquire, mainly in the fields of town and country planning, architecture and engineering or data processing, a plan or design selected by a jury after being put out to competition with or without the award of prizes.*

Figure 6 shows an overview of the kind of contracts in relation with the design phases. Service contracts are usually used for the definition of the design works related to the building activities, design and execution work. On the other side, the works contracts are used to realized a work, work defined like ’an outcome of building or civil engineering works taken as a whole which is sufficient in itself to fulfill an economic or technical function’.

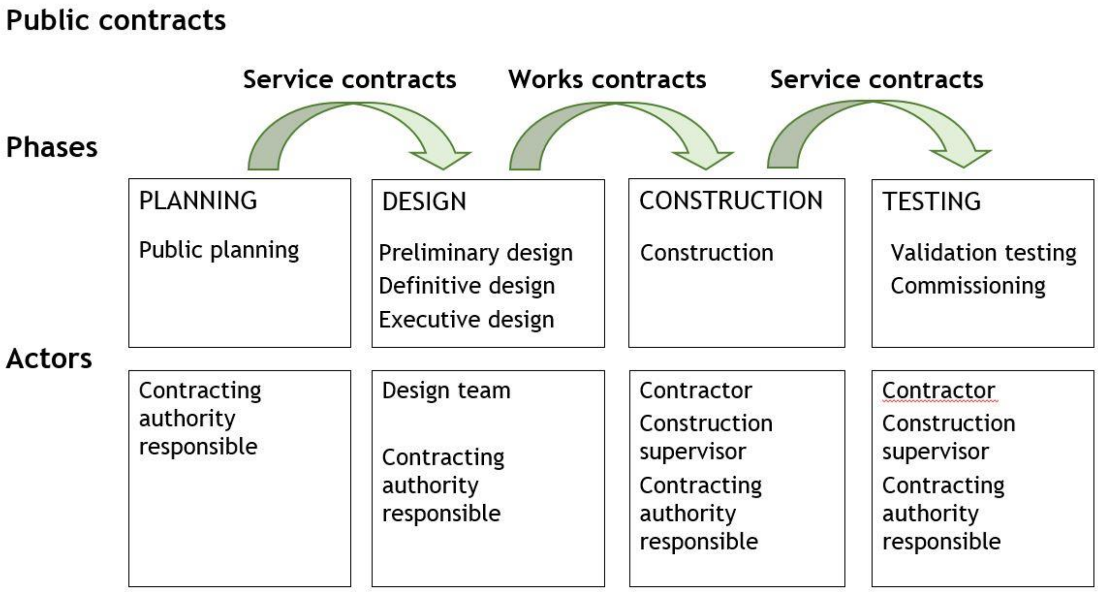

Figure 6: Overview of public contracts. Surce: G.Paoletti

Public tenders have the function to inform about a specific contract or agreement that the public administration intends to award, through different procedures (art.27-32 and Chapter II of the Directive 2014/24/EU).

In this moment, the European Member States are reviewing the national laws (reported in Table 3) adopted for the enforcement of the Directive 2004/18/CE with the updates of the Directive 2014/24/EU.

Table 3: National enforcements of the European Directives (2004/18/EC) in European Member States involved in AIDA project.

Coordination of procedures for the award of public works contracts, public supply contracts and public service contracts: national enforcements of the European Directives (2004/18/EC)	
Italy	D.Lgs 163/2006 and updates, implementation of Directive 2004/18/EC, are the Italian laws that rule the procedures for public competitions and the relations between public authorities and private companies for services, works and furniture.
pain	The tender's typologies used in public competitions are regulated in the *"texto refundido de la Ley de Contratos del sector público, Real Decreto 3/2011"* (consolidated version of Law of Contracts in Public Sector, Royal Decree 3/2011) and the modification of the thresholds of the applications of different contracts typologies in the "*Orden EHA 3479/2011"* (Order *EHA 3479/2011*) to complete the transposition of the European Regulation EU 1251/2011. The procedures can be subject to specific rules (*SARA- Sujetos a Regulación Armonizada*) at European Community level (2004/18/EC), depending on the threshold pre-established in EU1251/2011: or not be subject to specific rules (*No SARA- No Sujetos a Regulación Armonizada*).
Greece	In Greece the public tender typologies are regulated by PD60/2007 (GOG A'64/6-3-2007) which is the transposition law of Directive 2004/18/EC into national legislation.

France	The Decree n°2006-975 created the Public Contracts Code in France (code des marchés publics). This code integrates previous laws, decrees and ordinances regarding public tenders into one body of work, and specifically takes into account the transcription of the Directive 2004/18/EC into national law.
Austria	Federal Public Procurement Law 2006 (Bundesvergabegesetz 2006 – "BVergG 2006") is the law for public contracts and the implementation of the Directive 2004/18/EC.
United Kingdom	England and Wales Public Procurement - The Public Contract Regulations 2006 ref 2006/5 Scotland Public Procurement – The public Contracts[Scotland] Regulations 2012 ref 2012/88
Hungary	Law 2003/CXXIX About public procurement procedures. Law 2011/CVIII About public procurement procedures. Statutory rule 306/2011. (XII. 23.) About the detailed regulations of public procurement for building investments. Statutory rule 305/2011. (XII. 23.) About the rules of tendering procedures. Statutory rule 215/2010. (VII. 9.) About the contents of the mandatory documentation of the public procurement for building investments. 8001/2007. (MK. 102.) International duties of the Republic of Hungary and the European Commission regarding public procurement procedures. Statutory rule 137/2004. (IV. 29.) About the detailed rules of tendering procedures.

6.2 AIDA action

AIDA aimed to support the design teams and the public administrative part (municipalities) during all phases of the building realization, from the design to the construction; support planned before (blue box) and after (yellow box) public contracts or design contests, offered to Public part (above the dotted line) and to the design teams (below the dotted line).

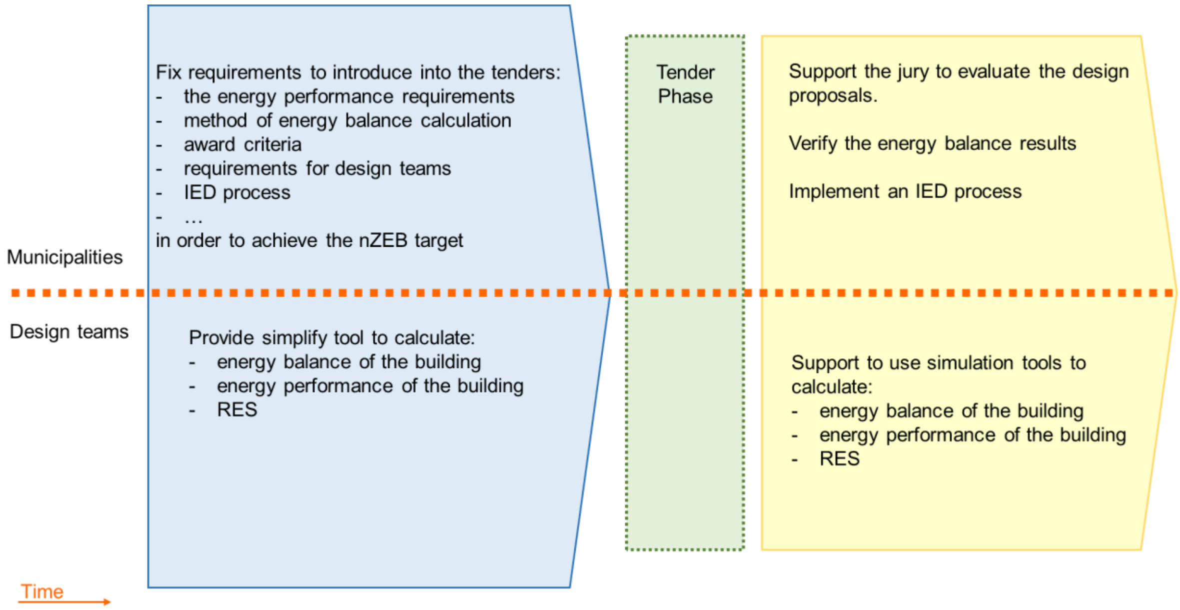

Figure 7: AIDA support to Municiapalities and design teams, before and after design tender.

➢ *Example: Public administrative parts (Municipalities) are supported by AIDA partners during writing phase of the tender notice (before the tender publication, blue box) in the definition of the energy performance requirements that will be introduced in the tender.*

7. Layout of public design tenders

This section shows how to introduce energy performance requirements into design tenders (or contests) in order to support the municipalities to achieve the EPBD objective. The energy performance requirements should be introduced into the tenders or added separately in a specific document linked to the public tender. Table 4 shows the structure of the contest tenders [6] and the energy requirements to be introduced for each point.

Table 4: Tender layout (on left column) as like defined by Directive 2014/18/EC and energy requirements defined within AIDA project (on right column) to introduce in contract notices.

Structure of contest notices (tender) (Necessary paragraphs from DIRECTIVE 2004/18/EC, Annex VII D)	**Energy requirements to introduce** (Necessary characteristics to introduce)
1. Name, address, fax number and email address of the contracting authority and those of the service from which the additional documents may be obtained.	
2. Description of the project	nZEB target or national implementation of 2012/31/EU
3. Type of contest: open or restricted	
4. In the event of an open contest: time limit for the submission of projects	
5. In the event of a restricted contest: (a) number of participants contemplated (b) names of the participants already selected, if any (c) criteria for the selection of participants (d) time limit for requests to participate	Participants requirements: within the work team at least an Architect or Engineer, specialized in energy efficiency of the buildings and documentation to guarantee it.
6. If appropriate, indicate that the participation is restricted to a specified profession	
7. Criteria which will be applied in the evaluation of the projects	Add into the ranking list criteria for: - nZEB criteria - energy expert Higher scores will be assigned to design proposals whith an energy balance that is nearly zero (nZEB). This point it is very important, but not sufficient to achieve the energy target. Furthermore this criteria can change with the tender typology.
8. Names of any members of the jury who have already been selected.	The evaluation commission is usually composed of different professionals able to analyse and evaluate different criteria (aesthetic, structural, costs…). To guarantee a correct evaluation of the energy performance requirements part, it is necessary that a technician with experience in high energy performance buildings is included in the jury. Otherwise, Municipalities should require specific technical training or particular experience to demonstrate that they have the competency of an Energy Certifier. Professional specialized in building energy efficiency and

	renewable energies.
9. Indicate whether the jury's decision is binding on the contracting authority	
10. Number and value of any prizes	Design teams can obtain a second money prize if, after one year of monitoring of the energy balance of the building, the nZEB target is achieved.
11. Payments to be made to all participants, if any	
12. Indicate whether any contracts following the contest will or will not be awarded to the winner or winners of the contest according to: *Directive 2004/18/EC, art.53 point 1, defines:* *1)…* *a) "the award is made to the tender most economically advantageous from the point of view of the contracting authority, various criteria linked to the subject-matter of the public contract in question, for example, quality, price, technical merit, aesthetic and functional characteristics, environmental characteristics, running costs, cost-effectiveness, after-sales service and technical assistance, delivery date and delivery period or period of completion* *b) or the lowest price only."* *2)"…the contracting authority shall specify in the contract notice or in the contract documents or, in the case of a competitive dialogue, in the descriptive document, the relative weighting which it gives to each of the criteria chosen to determine the most economically advantageous tender. Those weightings can be expressed by providing for a range with an appropriate maximum spread."*	There should be a possibility to assign points to the design team which best meets the energy performance requirements previously fixed.
13. Date of dispatch of the notice	

In Table 5 some articles extracted by the two public contracts' Directives and, in the third column, some points developed within AIDA project about suggestions and requirements to introduce in the design tender procedures when one of the objective is the nZEB target are reported. The suggestions of each points are reported in the Table 6.

Table 5: Comparison of the Directive 2004/18/EC and 2014/24/EU and some suggestions of requirements proposed within AIDA project .

DIRECTIVE 2004/18/EC	DIRECTIVE 2014/24/EU	AIDA
TITLE II: Rules on public contracts	TITLE II: RULES ON PUBLIC CONTRACTS	
CHAPTER IV: Specific rules governing specifications and contract documents	CHAPTER III: Conduct of the procedure	
	SECTION 1: PREPARATION	
Art. 23: Technical specifications shall be formulated: (b) or in terms of <u>performance</u> or functional requirements; the latter may include <u>environmental characteristics</u>. However, such parameters must be sufficiently precise to allow tenderers to determine the subject-matter of the contract and to <u>allow contracting authorities to award the contract</u>;	***Art. 42: Technical specifications*** shall be formulated: *3.a)* in terms of <u>performance</u> or functional <u>requirements</u>, including <u>environmental characteristics</u>, provided that the parameters are sufficiently precise to allow tenderers to determine the subject-matter of the contract and to <u>allow contracting authorities to award the contract</u>	**1. Tender objective** **2. Laws** **3. Design requirements**
CHAPTER VII *Conduct of the procedure*	SECTION 3: CHOICE OF PARTICIPANTS AND AWARD OF CONTRACTS	
Article 44: Verification of the suitability and choice of participants and award of contracts 1. Contracts shall be awarded on the basis of the criteria laid down in Articles 53 and 55, taking into account Article 24, after the suitability of the economic operators not excluded under Articles 45 and 46 has been checked by contracting authorities in accordance with the <u>criteria of economic and financial standing, of professional and technical knowledge or ability</u> referred to in Articles 47 to 52, and, where appropriate, with the non-discriminatory rules and criteria referred to in paragraph 3. 2. The contracting authorities may require candidates and tenderers to meet minimum capacity levels in accordance with Articles 47 and 48.	***Art. 58: Selection criteria (for the participation)*** *1.* Selection criteria may relate to: *(a)* suitability to pursue the professional activity; *(b)* economic and financial standing; *(c)* technical and professional ability	**4. Design team requirements**
Art.53: Contract award criteria: …award of public contracts shall be either: (a) when the award is made to the tender <u>**most economically advantageous**</u> from the point of view of the contracting authority, various criteria linked to the subject-matter of the public contract in question, for example, quality, price, technical merit, aesthetic and functional characteristics, environmental	***Article 67: Contract award criteria*** 1) …contracting authorities shall base the award of public contracts on the <u>**most economically advantageous tender.**</u> The most economically advantageous tender from the point of view of the contracting authority shall be identified on the basis of the price or cost, using a cost-effectiveness approach, such as life-cycle costing in accordance with	**5. General requirements**

characteristics, running costs, cost-effectiveness, after-sales service and technical assistance, delivery date and delivery period or period of completion, or (b) **the lowest price only**.	Article 68, and may include the best price-quality ratio, which shall be assessed on the basis of criteria, including qualitative, environmental and/or social aspects…. Member States may provide that contracting authorities **may not use price only or cost only** as the sole award criterion or restrict their use to certain categories of contracting authorities or certain types of contracts. ….	
	Art. 68: Life-cycle costing 1. Life-cycle costing shall to the extent relevant cover parts or all of the following costs over the life cycle of a product, service or works: (a) costs, borne by the contracting authority or other users, such as: (i) costs relating to acquisition, (ii) **costs of use, such as consumption of energy and other resources,** (iii) **maintenance costs,** (iv) end of life costs, such as collection and recycling costs (b) **costs** imputed to **environmental** externalities linked to the product, service or works during its life cycle, provided their monetary value can be determined and verified; such costs may include the **cost of emissions of greenhouse gases** and of other pollutant emissions and other climate change mitigation costs. ….	**5. General requirements**
TITLE IV Rules governing design contests	TITLE III: PARTICULAR PROCUREMENT REGIMES	
	CHAPTER II Rules governing design contests	
Art. 73 – Composition of the jury The jury shall be composed exclusively of natural persons who are independent of participants in the contest. Where a particular professional qualification is required from participants in a contest, at least a third of the members of the jury shall have that qualification or an equivalent qualification.	**Article 81: Composition of the jury** The jury shall be composed exclusively of natural persons who are independent of participants in the contest. Where a particular professional qualification is required from participants in a contest, at least a third of the members of the jury shall have that qualification or an equivalent qualification	**6. Composition of the jury**

Table 6: A list of common suggestions and requirements to introduce in the design tender procedures when one of the objective is the nZEB target.

TECHNICAL SPECIFICATION	
1-Tender objective	It is necessary to require that the new building (or refurbished building) meets nZEB targets such as defined by: • European Directive 2010/31/EU, article 2: • National-local energy laws
2. Laws	In addition to the list of construction laws (acoustics, structural, electrics laws…) that rule the building sector it is **necessary to introduce the laws relating to energy performance of buildings**, such as the **European Directive** (2010/31/EU) or **national and local laws** that adopt it. Energy efficiency indicators define the energy performance of the buildings in relation with the local climate. In Annex II a list of national and local laws that fix energy indicators, methods of energy calculation, weighting factors, energy performance requirements of the envelope and thermal plants is included. In the early phase of the design process, the Municipalities should decide whether to use the energy performance requirements fixed by national/local laws or other energy performance indexes, which may be even stricter. The objective is to make it mandatory to achieve the targets
3. Design requirements • architectural requirements • Functional requirements • Energy performance requirements	**Describe the energy strategy**: • Orientation, form, S/V... • Passive and active solutions • Daylighting • Integration of energy production systems • Heating/cooling plans **Require the energy balance calculation**, supplying to all particiapnts the simulation tool that they will use to analise the energy performance of the building and the production from RES. The input data utilized in the calculation will be transformed in technical solutions used in the construction phase.
SELECTION CRITERIA (FOR THE PARTICIPATION)	
4. Design team requirements	The public design tenders must require that there will be at least one person specialized in building energy efficiency and RES in the design team. In some countries this 'person' can be associated with the local energy efficiency certifier and should be able to use dynamic tools for the energy simulation and methods for the calculation of the building energy balance. At a minimum it is necessary to have one professional specialized in: • Energy efficiency of the building • RES • Energy Performance Certificate (EPC) The participants have to demostrate that they have the technical competence to calculate the energy performance of the building through dynamic simulation tools. It is necessary to document it, describing: • Name of the project • Energy performance analysis made • Tools used • Results obtained / used Any possible technical verification (Blower door test, thermography…) Design team, composed of different experts, permit to increase the qualitative aspects of the design proposals, because an higher numbers of possibilities is been considered and evaluated.

CONTRACT AWARD CRITERIA and LIFE-CYCLE COSTING	
5. General requirements 1. Costs for the building construction **2.** Operating costs	Cost optimality [7] [8] A necessary aspect that will be developed in the next future tenders is the building commissioning for minimum 2 yearss.monitoring of the building
COMPOSITION OF THE JURY	
6. Composition of the jury	Expert specialized in nZEB, building energy efficiency and RES. He/She will be able to check the energy performance results obtained by the participants

8. Barriers found

In the process of reinventing the common design process and developing a strategy able to support the Municipalities at introducing energy performance requirements, some technical, legislative and economic barriers have been ecountered. Table 7, Table 8 and Table 9 list these obstacles and some proposals to overcome them.

Table 7:Technical barriers found

<table>
<tr><th>TECHNICAL BARRIERS FOUND</th><th>PROPOSALS TO OVERCOME BARRIERS FOUND</th></tr>
<tr><td>Lack of nZEB knowledge in design team (architects, engineers, etc.), building contractors and jury commissions:
- poor level of technical innovation in building sector (creation and dissemination of new processes and techniques)
- lack of technical skills and know-how at all levels of the supply side and lack of generic skills and organized leadership to address the refurbishment process [9],
- complexity and uniqueness of most Energy Efficiency refurbishment projects (each case is unique, due to many causes, different possible renovation approaches. E.g., Heritage/cultural value of façades, etc.) [10]</td><td rowspan="2">Increase the knowledge on nZEB and high energy efficient buildings.

Within the work team of the public administration there will be, at least, one expert on nZEB or high energy efficient buildings able to manage and support the public and the private (design team) part during all the building process, from the planning, to the design to the construction phases.
On the other side , it is necessary to consult an external energy expert qualified on nZEB, high efficient buildings and RES, such as an energy certifier, able to transpose the energy goals into specification documents and later to the commissioning process.

At the same time, within the design team there will be an expert of high efficient buildings, able to integrate the energy performance in the building process. This expert shoud be an energy expert, able to calculate, check and support the design team in the energy performance part (energy balance calculation).

Depending on the public procedures choice, this expert can be a technical involved form the begining within the design team or an external one.</td></tr>
<tr><td>Low capacity of the technical municipalities to manage an IED process, in particular to use, require and check the energy performance requirements at the right moment. They usually check the energy target at the end of the design phases, just in the early phase of the building construction.
Often the public administrations don’t accept the initial over-cost of this kind of building, usually it increases of the 10-20% minimum (an increase of the 10% of the final cost is etimated for the Passive House, Source: Passive on Project, www.passiveon.org). [11]
Another difficulty is in the choice of the best technical solution on analysing the technical specifications.</td></tr>
</table>

Table 8: Legislative barriers found

LEGISLATIVE BARRIERS FOUND	PROPOSALS TO OVERCOME BARRIERS FOUND
In some countries a clear definition of nZEB is missing (i.e., the Spanish government has not defined energy performance targets for nZEBs). This leads to confusion in the building sector, and an inability to deliver a clear message to building professionals and municipalities	National laws about EPBD adoption
Urban laws can support the building refurbishment measures and create advantages or disadvantages.	After an energy refurbishment, if the building achieves the nZEB target, the Municipality should allow to increase the building volume.
Timing criteria is often used in the tenders. This criteria assigns extra points as the design phase of the proposals 'offers is reduced	This kind of criteria is counter-productive because it reduces the design phase allotted time and goes against the basis of the IED approach.

Table 9: Financial barriers found

FINANCIAL BARRIERS FOUND	PROPOSALS TO OVERCOME BARRIERS FOUND
How to stimulate the design team to reach the nZEB target?	The municipalities should introduce a money reward to the design team (tenants or building constructor) if, after two years of building consumption monitoring, the energy balance is nearly zero.
Reduced investment in the public building market due to economic crisis. The potential customers are short on money and face strong financing difficulties for any infrastructure and building projects, nZEB or not.	Present the nZEB opportunities for new buildings and renovations, such as the reduction of the energy consumptions, the building cost of the management and CO_2 emissions , increase of the thermal comfort, and more. Definition of the cost-optimal strategy during the design phases, using the template proposed within WP4 of AIDA project. Fit energy objectives and take advantage of premiums or bonus opportunities for refurbishment. Support the building owner or the financier to elaborate an energy-cost-optimal strategy.
Additional costs for nZEB design	Added value of the nearly zero energy building.
Lack of innovative financial tools for financing whole building renovations to nZEB standard.	
Accessing finance	

9. Case Studies

The municipalities involved in the AIDA project have close support from the AIDA partners, especially in these main tasks:

- to include the energy performance targets into the public tender design through an IED process. Case studies involved are:
    - Merano and Brixen Municipalities in Italy.
    - Barcelona Municipality in Spain;
    - Comhairle nan Eilean Siar Municipality in UK
    - Communauté de Communes Pays d'Amplepuis Thizy in France

- to development a feasibility/preliminary study for new or renovated public buildings through an IED process:
    - Municipality of Gleisdorf, Hartberg, Maiersdorf, Gutenstein, Austria
    - Municipality of Figueres, Ordis, Tarragona, Spain
    - Municipality of Farsala, Thessaloniki, Greece
    - Commune Les Olmes, Beaujolias Vert, France
    - Municipality of Isle of Lewis, UK

For more information about 'the results of the collaboration with the Municipalities see Deliverable D3.2.

Annex I

Integrated Energy Design (IED)

What is the IED?

IED is a multidisciplinary, collaborative process that analyzes and integrates different aspects and knowledge during all phases of the development of a building: the architectural concept, design, construction, commissioning, operation and maintenance of the building.

The ultimate goal is to achieve performance targets as defined by the customer (e.g. zero energy balance, high internal comfort, economy, functionality, aesthetic impact, etc.) through a collaboration process for determining the most advantageous solution.

The IED requires a multidisciplinary design team that includes or acquires the skills required to address all design issues flowing from the objectives. The IED work team consists of the contractor, architect, engineer, constructor, the financier and users, whose specific expertise, if effectively integrated, allow to define, analyze and evaluate different solutions and possible interactions.

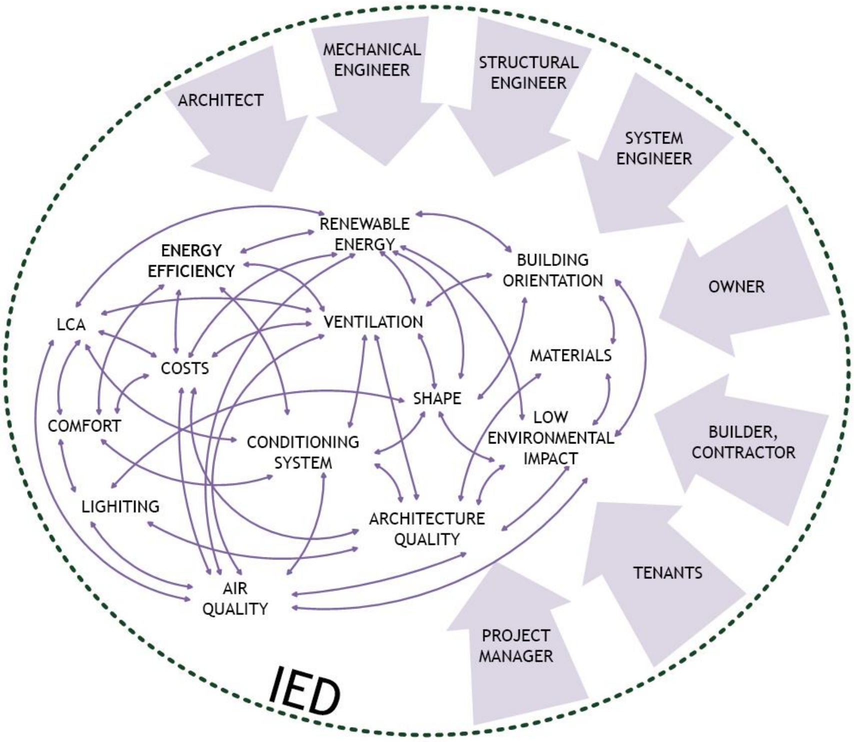

Figure 8: Design Team Organization

The choices are no longer taken from a single profession, but from a work team through a participatory process; choosing from a wide range of possibilities to identify the best solution, taking into account the qualitative aspects (high efficiency certification), economic (cost/benefit), functional and aesthetical aspects that should be achieved. This integrated approach is based on the team´s collective knowledge to evaluate all decision thanks to feedback mechanisms where different possibilities are considered.

Generally, IED is:

- an iterative process, not a linear or silo-based approach

- a flexible method, not a formula
- different each time, not pre-determined
- an iterative process with on-going learning and emergent features, not a preordained sequence of events and feedback loops. [12].

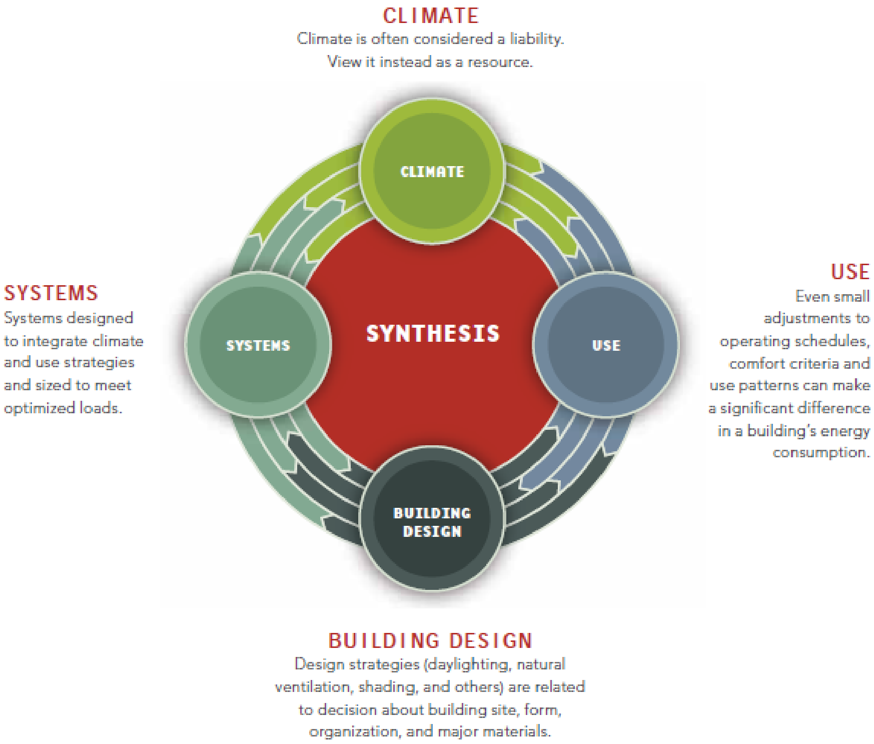

Figure 9: Integrated Design Synthesis (source ´Integrated Energy engineering & performance modeling into the design process´) [12]

Why choose IED?

The IED process can maximize energy benefits and improve thermal comfort (through temperature control, humidity, etc.), acoustic comfort, visual comfort (maximizing natural lighting, artificial lighting planning) and indoor air quality (optimization of control of ventilation).

- Benefits for the environment
- Reduction of energy consumption due to application of passive solutions
- Use of sustainable materials and renewable energies.
- Reduction of CO_2 emissions and fossil resources.
- Economic benefits

Through the IED, costs of construction, management and maintenance of the building can be reduced, since these issues are already tackled in the design phase.

How to apply IED?

The most important principle for a successful IED relates to the close collaboration of building professionals and the building owner (and/or tenants). Ideally, the team includes all relevant disciplines and stakeholders who remain involved from start to finish.

In contrast to a linear planning process an integrated design approach includes feedback mechanisms to evaluate all decisions. The iterative process with feedback loops not only considers several design steps, but also commissioning and post-occupancy evaluation. The process provides additional flexibility and dynamism, engages all team members and deliberates more opportunities for cross communication between team members.

Main actors of IED

An IED facilitator helps to develop and to maintain the right mindset. The facilitator manages the Integrated Design Process as well as the relations between the partners involved and promotes meetings and workshops.

The facilitator should have the following characteristics [9]:

- is the steward of the goals and targets, which are set during the meetings and workshops and updated throughout the process
- is skilled in the art of facilitation and group dynamics and will ensure a proper flow of information during the workshops and potentially energy efficient design matters
- has a good level of knowledge of both the integrated design process and nZEB building principles.
- manages the process, collects data and exchanges the information. It is recommended to adopt a Building Information Model, where all the actors can find, modify and update the different data of the project.

The **core project team´s** structure, composition and member roles will be adapted to every project. The core team members can be composed of the following organs: client, project manager, architect, IED facilitator, structural engineer, mechanical engineer with expertise in simulation and energy analysis, electrical engineer, green design specialist, civil engineer, facilities manager/building operator, cost consultant, landscape architect, general contractor or construction manager.

Additional members may be brought in for the duration of the project or only for a few workshops: ecologist, occupants or users, interior designer, lighting specialist, geotechnical engineer, marketing expert, and other experts as required.

IED Phases

In the integrated design process the design phase produces more effects than the construction documentation phase, because the positive outcomes are maximized and the cost of changes minimized. Figure 10 shows the IED process complete of phases, meetings and the feedback loops.

The IED also plans the management and maintenance of the building by establishing an Energy-manager able to monitor the performance of the building and assess user behaviour by adjusting the energy systems according to specific needs.

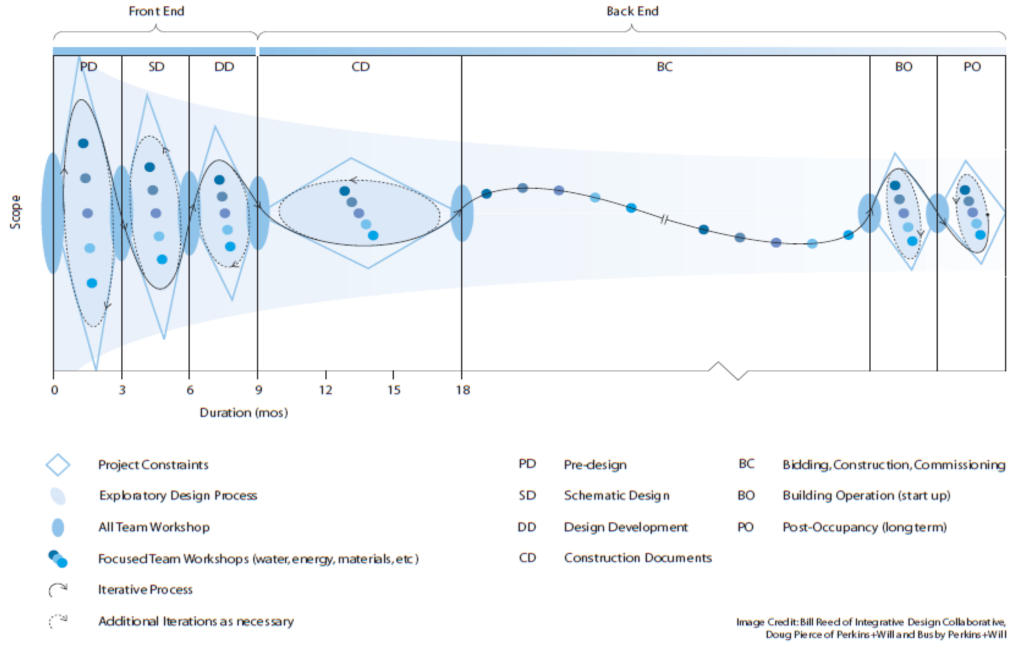

Figure 10: Integrated design process (source: ´Roadmap for the integrated design process´ [9])

How IED can contribute?

IED has the potential to:

- manage the relationship between project partners
- support iterative planning processes with feedback loops
- Organize design charrettes[9], with the aim to solicit the values, establish a shared vision and determine core objectives and environmental goals.
- Organize workshops focused on specific aspects of the building design, like energy efficiency and comfort concepts, simulation tools and evaluation of the proposed solutions depending on the fixed targets. The workshops should help to explore different strategies, technologies and opportunities.

The objective is to find the best balance between the needs of end users and the technical/functional requirements:

- aesthetics / architectural quality
- functionality
- energy and environmental impact
- indoor environmental quality (temperature, relative humidity, light, CO_2, acoustics, etc.)
- requests by end users / owner / investor, with regard to interior comfort and what the building must "communicate"
  - durability and maintenance.

[9] *Charrette* refers to a collaborative session in which a group of designers drafts a solution to a design problem. Source: http://en.wikipedia.org/wiki/Charrette

Support for reaching the nZEB targets

During the integrated design process, the use of energy simulations (static and dynamic simulations) can help to calculate and compare a large number of solutions in a very short time and according to the defined performance targets. The following two tables give an overview on tools, which can be used for different kinds of energy analysis and measures which can be used to analyze the comfort.

Software used for energy simulations - Italian Case		
	Type of analysis	**Software**
Energy balance	Static simulations	Docet (tool for Italian certification)
		XClima (tool for CasaClima certification)
		PHPP (Passive House certification)
	Dynamic simulations	DesignBuilder
		EnergyPlus
		Trnsys
Daylight and artificial lighting	DF/DA/DUI/ glare	Relux/ Dialux
		Radiance
		Daysim
Natural ventilation	Dynamic simulations	Contam
		EnergyPlus
		DesignBuilder
		TRNFlow

Measurements to analize the comfort		
Measurements	**Typo of sensor**	**unit**
Thermal transmittance	Thermocouple Heat flux sensor	°C W/m² K
Surface temperature	Thermocamera	°C
Illuminance	Luxmeter	lux
Luminance of light sources	Luminanzometer	cd/m^2
Air tightness	Blower door fan	n50= x [h^{-1}]
Air speed	Hot wire anemometer	m/s
Internal air quality	CO2 concentration	ppm
	Temperature	°C
	Relative humidity	%

Annex II

The following tables give an overview of the national and local laws about energy performance of the building. With this summary it is possible to know which laws describe the method for energy performance calculation and which laws define the energy performance indexes and minimum requirements for the energy performance of the buildings. Data contained in the tables below are dated September 2013.

Table 10: Italian energy performance requirements laws

ITALY											
		National Laws									Province of Bolzano Laws
TOPICS: Indexes and energy requirements		**UNI/TS 11300-1:2008**	**UNI/TS 11300-2:2008**	**UNI/TS 11300-3:2010**	**UNI/TS 11300-4:2012**	**DPR59/09**	**Raccomandazione CTI 14, February 2013**	**Legislative Decree n.28, 3 March 2011**	**ISTAT: Energy balance, 2009**	**Law n.93/2013 (Legislative Decree n. 63, 4 June 2013)**	**Legislative Decree n.63, 4 June 2013 Resolution decree of the Province of Bolzano n.362 (4th March 2013)**
Weighting factors equivalent for Primary Energy Factor and CO2 emissions. Source:							X		X		X
Method for energy calculation		X	X	X	X	X	X				
Envelope						X					X
Load kWh/(m²year)	Space Heating	X				X					X
	Space Cooling	X				X					
Final Energy demand kWh/(m²year)	Space Heating		X			X					X
	Space Cooling			X		X					X
	Total (DHW, Heating, Cooling, Auxiliary and Household Electricity)										X
Primary energy demand kWh/(m²year)	Space Heating		X			X					
	Space Cooling			X		X					
	Total EP or EP value (DHW, Heating, Cooling, Auxiliary and Household Electricity)					X	X				X
	Total CO_2emission (DHW, Heating, Cooling, Auxiliary and Household Electricity)						X				X
Energy Prodution	Minimum thermal Renewable Energy Generation						X	X			X
	Minimum electric Renewable Energy Generation							X			X
Description											

Table 11: Austrian energy performance requirements laws

AUSTRIA									
		National Laws				Regional Laws			
						province of: Lower Austria, Salzburg, Tyrol		province of: Burgenland, Carinthia, Styria, Upper Austria, Vienna, Vorarlberg	
TOPICS: Indexes and energy requirements		ÖN H 5056 ÖN H 5057 ÖN H 5058 ÖN H 5059	ÖN B 8110-6	ÖNORM EN ISO 13790	EAVG 2012	OIB Richtlinie 6 (2007)	OIB Richtlinie 6 – Berechnungs-leitfaden (2007)	OIB Richtlinie 6 (2011)	OIB Richtlinie 6 Berechnungs-leitfaden (2011)
Weighting factors equivalent for Primary Energy Factor and CO2 emissions. Source:								X	
Method for energy calculation		X	X	X			X		X
Envelope						X		X	
Load kWh/(m²year)	Space Heating					X		X	
	Space Cooling					X (only non-residential buildings)		X (only non-residential buildings)	
Final Energy demand kWh/(m²year)	Space Heating					X		X	
	Space Cooling					X (only non-residential buildings)		X (only non-residential buildings)	
	Total (DHW, Heating, Cooling, Auxiliary and Household Electricity)					X (except household electricity)		X	
Primary energy demand kWh/(m²year)	Space Heating							X	
	Space Cooling							X (only non-residential buildings)	
	Total EP or EP value (DHW, Heating, Cooling, Auxiliary and Household Electricity)							X	
	Total CO_2emission (DHW, Heating, Cooling, Auxiliary and Household Electricity)							X	
Energy Prodution	Minimum thermal Renewable Energy Generation								
	Minimum electric Renewable Energy Generation								
Description		Although building-related legislation falls under the competence of the nine regions (Bundesländer), the Austria Institute of Construction Engineering (OIB) published in April 2007 a Guideline (OIB-Richtlinie 6), that defined four categories of limit values for heating/cooling demand of buildings, a first step in the right direction to nZEB. While OIB-Richtlinie 6 may be considered as the building code currently in force, a new version published in 2011 includes stronger requirements that went into force in January 2013 in four regions (Carinthia, Styria, Vorarlberg and Vienna), in July 2013 also in Upper Austria, and likely to be implemented in all other regions in 2014. In addition, the nine regions have agreed on a draft national plan in accordance with the EPBD recast that includes the definition of nZEB and the implementation of interim targets, starting by 2014/15.							

Table 12: Hungarian energy performance requirements laws

HUNGARY								
		National Laws						
TOPICS: Indexes and energy requirements		ÖNORM H 5058	ÖNORM H 5059	EAVG 2012	244/2006. (XII. 5.) Korm. rendelet	176/2008. (VI. 30.) Korm. rendelet	7/2006. (V. 24.) TNM rendelet	1997. évi LXXVIII. Törvény
Weighting factors equivalent for Primary Energy Factor and CO2 emissions. Source:								
Method for energy calculation		X	X			X	X	
Envelope							X	
Load kWh/(m²year)	Space Heating							
	Space Cooling							
Final Energy demand kWh/(m²year)	Space Heating							
	Space Cooling							
	Total (DHW, Heating, Cooling, Auxiliary and Household Electricity)						X	
Primary energy demand kWh/(m²year)	Space Heating							
	Space Cooling							
	Total EP or EP value (DHW, Heating, Cooling, Auxiliary and Household Electricity)						X	
	Total CO_2emission (DHW, Heating, Cooling, Auxiliary and Household Electricity)							
Energy Prodution	Minimum thermal Renewable Energy Generation						no such values are defined	
	Minimum electric Renewable Energy Generation						no such values are defined	
Description		Although building-related legislation falls under the competence of the nine regions (Bundesländer), the Austria Institute of Construction Engineering (OIB) published in April 2007 a Guideline (OIB-Richtlinie 6), that defined four categories of limit values for heating/cooling demand of buildings, a first step in the right direction to nZEB. While OIB-Richtlinie 6 may be considered as the building code currently in force, a new version published in 2011 includes stronger requirements that went into force in January 2013 in four regions (Carinthia, Styria, Vorarlberg and Vienna), and are likely to be implemented in all other regions in 2014. In addition, the nine regions have agreed on a draft national plan in accordance with the EPBD recast that includes the definition of nZEB and the implementation of interim targets, starting by 2014/15.						

Table 13: Spanish energy performance requirements laws

SPAIN							
		National Laws				Regional (Catalunya) Laws	
TOPICS: Indexes and energy requirements		**REAL DECRETO 235/2013** (Royal Decree 235/2013).	**REAL DECRETO 314/2006.**	**REAL DECRETO 1027/2007**	**DECRETO 21/2006**	**DECRETO 316/1994**	**DECRETO 296/1998**
		The Basic Procedure for Efficiency Certifications on Buildings.	The Technical building code (Royal Decree)		Eco-efficiency in buildings Decree.	Environmental quality labelling for products and services.	
Weighting factors equivalent for Primary Energy Factor and CO2 emissions. Source:		X	X				
Method for energy calculation		X	X				
Envelope		X	X		X		
Load kWh/(m²year)	Space Heating	X	X				
	Space Cooling	X	X				
Final Energy demand kWh/(m²year)	Space Heating						
	Space Cooling						
	Total (DHW, Heating, Cooling, Auxiliary and Household Electricity)	X	X				
Primary energy demand kWh/(m²year)	Space Heating						
	Space Cooling						
	Total EP or EP value (DHW, Heating, Cooling, Auxiliary and Household Electricity)	X (Result of the total)	X (Result of the total)				
	Total CO_2emission (DHW, Heating, Cooling, Auxiliary and Household Electricity)	X (Total and differentiate result of each source; heating, cooling, DHW, lighting.)	X (Total and differentiate result of each source; heating, cooling, DHW, lighting.)				
Energy Prodution	Minimum thermal Renewable Energy Generation	X (Define only the minimum values only for Solar thermal Factor for DHW)	X (Define only the minimum values only for Solar thermal Factor for DHW)		X		
	Minimum electric Renewable Energy Generation	X (Define only the minimum values only for Solar electric contribution)	X (Define only the minimum values only for Solar electric contribution)				
Description		The Basic Procedure for Efficiency Certifications on Buildings (Real Decreto) is recently approved (Royal Decree 235/2013). The object of this basic procedure is the establishment of conditions for energy efficiency certification on new and existing buildings. This Decree repeals and extensive the Royal Decree 47/2007 which completed the transposition of the European legislation to existing buildings (Directive 2002/91 of EC and success modification as a 2010/31 of EC). Refer to the CTE Thecnical Building Code for new building and existing building.	The technical building code came into effect the 29.09.2006, including the Basic Energy Saving Document (DB HE), referring to energy saving in five areas. Its main aim is to achieve rational energy use in buildings, part of which generated by renewable energies. HE-1 Quality of the building's envelope (energy demand reduction) HE-2 Thermal installation performance (Royal Decree 1027/2007) HE-3 Indoor lighting performance HE-4 Minimum solar contribution to domestic water heating HE-5 Minimum solar contribution to electricity generation. There is a simplified and mandatory methodology CTE (Technical code of Certification) and also the simulation tools for calculation (LIDER and CALENER).	The Regulation on Heating/Ventilating/ Air-Conditioning Systems (RITE) (Royal Decree 1027/2007) came into effect the 1. March 2008 and "lays down the conditions that providing heating, air-conditioning, and hot water, so as to achieve a rational use of energy". Its main objective is a rational energy use by building systems. "The more stringent energy efficiency requirements laid down in RITE are specifically 54: - Improved energy performance from heating and cooling equipment - Improved temperature monitoring of air conditioned spaces - Employment of renewable energy sources (solar thermal and biomass), heat recovery systems	The most important regional law concerning energy efficiency in the building sector is the Eco efficiency Decree that regulates environmental criteria in the areas of energy efficiency, water use, renewable energy use, materials and waste management. As the CTE at State level, this legislation is mandatory for new construction and major refurbishment projects. In some particular aspects and for specific climate zones within Catalonia it goes further than the CTE (e.g. thermal insulation requirements, minimum solar thermal contribution for domestic water heating) and it provides a range of measures to comply with a score system concerning energy and environmental aspects.	Label to promote products and services that are respectful with the environment. The Resolution MAH/1899/2007, of 27th of April, establishes the criteria for the environmental quality certificate in the products of acoustic and thermal insulating with recycled materials, and The Resolution MAH/2405/2009, of 29th of April, for boilers and domestic gas heaters.	

Table 14: French energy performance requirements laws

FRANCE			
		National Laws	No regional Laws (regional/local specifications to benefit from regional/local government financing exist)
TOPICS: Indexes and energy requirements		RT2012 http://www.rt-batiment.fr/fileadmin/documents/RT2012/textes/joe_20130420_0009.pdf Does not apply to buildings with specific usages (for example agricultural, historical monument extensions, buildings not closed on all sides etc) Does not apply to refurbishments that do not require a planning authorisation	
Weighting factors equivalent for Primary Energy Factor and CO2 emissions. Source:		X	
Method for energy calculation		X	
Envelope		X	
Load kWh/(m²year)	Space Heating		
	Space Cooling		
Final Energy demand kWh/(m²year)	Space Heating		
	Space Cooling		
	Total (DHW, Heating, Cooling, Auxiliary and Household Electricity)		
Primary energy demand kWh/(m²year)	Space Heating		
	Space Cooling		
	Total EP or EP value (DHW, Heating, Cooling, Auxiliary and Household Electricity)	X (modulated depending on geographical site, Individual plug loads not included	
	Total CO_2emission (DHW, Heating, Cooling, Auxiliary and Household Electricity)		
Energy Prodution	Minimum thermal Renewable Energy Generation	X (either heat or electricity and only for individual or semi detached dwellings)	
	Minimum electric Renewable Energy Generation	X (either heat or electricity and only for individual or semi detached dwellings)	
Description		New thermal regulation (RT2012) came into force in July 2013. Although building professionals have been able to anticipate the evolutions, (building energy consumption must now be much lower than under previous thermal regulations, close to NZEB requirements) Reaching RT2012 targets already requires the acquisition of new design practice by building professionals, inciting them to acquire not only this new knowledge but getting them to go one step further to NZEB level can be asking a lot of these professionals.	

Table 15:Greek energy performance requirements laws

GREECE							
		National Laws					Regional Laws
TOPICS: **Indexes and energy requirements**		LAW 4122/2013 (Official Government's Gazette Issue A' 42/19.02.2013)	LAW 3851/2010 (Official Government's Gazette Issue A' 85/4.06.2010)	LAW 3855/2010 (Official Government's Gazette Issue A' 95/23.06.2010)	Ministerial Decision D6/B/5825 (Official Government's Gazette Issue B' 407/9.04.2010)	LAW 3661/2008 (Official Government's Gazette Issue A' 89/19.05.2008)	
Weighting factors equivalent for Primary Energy Factor and CO2 emissions. Source:					X		
Method for energy calculation		X		X	X	X	
Envelope					X		
Load kWh/(m²year)	Space Heating				X		
	Space Cooling				X		
Final Energy demand kWh/(m²year)	Space Heating				X (sets energy requirements for a reference building)		
	Space Cooling				X (sets energy requirements for a reference building)		
	Total (DHW, Heating, Cooling, Auxiliary and Household Electricity)				X (sets energy requirements for a reference building)		
Primary energy demand kWh/(m²year)	Space Heating				X (sets energy requirements for a reference building)		
	Space Cooling				X (sets energy requirements for a reference building)		
	Total EP or EP value (DHW, Heating, Cooling, Auxiliary and Household Electricity)				X (sets energy requirements for a reference building)		
	Total CO_2emission (DHW, Heating, Cooling, Auxiliary and Household Electricity)				X		
Energy Production	Minimum thermal Renewable Energy Generation		X (sets the requirement to cover 60% share of DHW needs by solar thermal or other RES)				
	Minimum electric Renewable Energy Generation						
Description		Transposition of Directive 2010/31/EC into national legislation	RES law which sets a target of 20% share of RES in 2020 for Greece. In this law among other issues (e.g. re-adjustment of feed-in tariff for RES-electricity etc) also RES use obligation for the building sector is set, Specifically, all new buildings from January 2011 should cover at least 60% of their needs for DHW from solar thermal systems or other RES systems.	Transposition of Directive 2006/32/EC into national legislation. This law among others sets measures for end-use energy efficiency to be improved.	This Ministerial Decision approves the national Buildings' code regulation on energy performance in the building sector, named KENAK.	Transposition of Directive 2002/91/EC into national legislation	

Table 16: English energy performance requirements laws

UNITED KINGDOM			
		National Laws	**Regional Laws**
TOPICS: Indexes and energy requirements		England and Wales The Building Regulations 2010 + Amendments Part L2A	**Scotland** **The Building[Scotland] Act 2003 part J + Amendments** **The Climate Change [Scotland] Act 2009**
Weighting factors equivalent for Primary Energy Factor and CO2 emissions. Source:		X	X
Method for energy calculation		National Calculation Method	National Calculation Method
Envelope		X	X
Load kWh/(m²year)	Space Heating	X	X
	Space Cooling	X	X
Final Energy demand kWh/(m²year)	Space Heating	X	X
	Space Cooling	X	X
	Total (DHW, Heating, Cooling, Auxiliary and Household Electricity)	Individual plug loads not included	Individual plug loads not included
Primary energy demand kWh/(m²year)	Space Heating	X	X
	Space Cooling	X	X
	Total EP or EP value (DHW, Heating, Cooling, Auxiliary and Household Electricity)	Individual plug loads not included	Individual plug loads not included
	Total CO_2emission (DHW, Heating, Cooling, Auxiliary and Household Electricity)	Individual plug loads not included	Individual plug loads not included
Energy Prodution	Minimum thermal Renewable Energy Generation	As a % against Notional Building	As a % against Notional Building
	Minimum electric Renewable Energy Generation	As a % against Notional Building	As a % against Notional Building
Description		Simplified Energy Building Model based on energy assessment	Simplified Energy Building Model based on energy assessment

References

[1] J. Kurnitski, F. Allard, D. Braham, G. Goeders, P. Heiselberg, L. Jagemar,Ri. Kosonen, J. Lebrun, L. Mazzarella, J. Railio, O. Seppänen, M. Schmidt, M. Virta, „How to define nearly net zero energy buildings nZEB," %1. kötet03/2011, May 2011.

[2] Larsson, N. and B. Poel, „"Solar Low Energy Buildings and the Integrated Design Process – An Introduction"," IEA-International Energy Agency, 2003.

[3] Kurnitski J, Allard F, Braham D, Goeders G, Heiselberg P, Jagemar L, Kosonen R, Lebrun J, Mazzarella L, Railio J, Seppänen O, Schmidt M, Virta M. .

[4] Annamaria Belleri, Assunta Napolitano, „Net ZEB evaluation tool - User guide," SHC - Task 40/Annex 52, 2012.

[5] B. Atanasiu, J.Maio, D. Staniaszek, I. Kouloumpi, T. Kenkmann, „Overview of the EU-27 building policies and programs. Fachsheets on the nine Entranze target countries," IEE-ENTRANZE Project, 2014.

[6] DIRECTIVE 2004/18/EC, Official Journal of the European Union, 2004.

[7] T.Boermans, K. Bettgenhäuser, A. Hermlink, S. Schimschar and other Ecofys international staff, "Cost optimal building performance requirements – Calculation methodology for reporting on national performance requirements on the basis of cost optimality within the framework of EPBD.", (european council for an energy efficient economy) with the financial support from Eurima and the European Climate Foundation (ECF), May 2011.

[8] European Parlament, „Regulations commission delegated regulation (EU) no. 244/2012 of 16 January 2012 supplementing Directive 2010/31/EU of the European Parliament and of the Council on the energy performance of buildings," Official Journal of the European Parlament, 2012.

[9] Busby Perkins, Will Stantec Consulting, „Roadmap for the integrated design process," in *Part one: summary guide*, BC Greenbuilding Roundtable.

[10] „"Build a new Energy Renovation Strategy around the Mediterranean"," [Online]. [Hozzáférés dátuma: 31 07 2013].

[11] „http://www.passive-on.org," [Online]. Available: http://www.passive-on.org. [Hozzáférés dátuma: 01 2014 12].

[12] Jeff Cole, Micheal Hatten, „Integrated Energy engineering & performance modeling into the design process," Betterbricks-An initiative of the Northwest Energy Efficiency Alliance.

[13] „The Integrated Design Process in practice - Demostration Projects Evaluated," June 2003.

[14] Giulia Paoletti, Annamaria Belleri, Roberto Lollini, „Nearly Zero Energy Buildings requirements in Public Design Tenders, experiences of two case studies.," Graz, 2013.

[15] „«Collaboration, Integrated Information, and the Project Lifecycle in Building Design, Construction and Operation," 2004. [Online]. Available: http://www.gnycuc.org/media/curt.pdf. [Hozzáférés dátuma: 2013 05 08].

[16] „Collaboration, Integrated Information, and the Project Lifecycle in Building Design, Construction and Operation," CURT , 2004.