ePANACEA

Smart European Energy Performance Assessment & Certification

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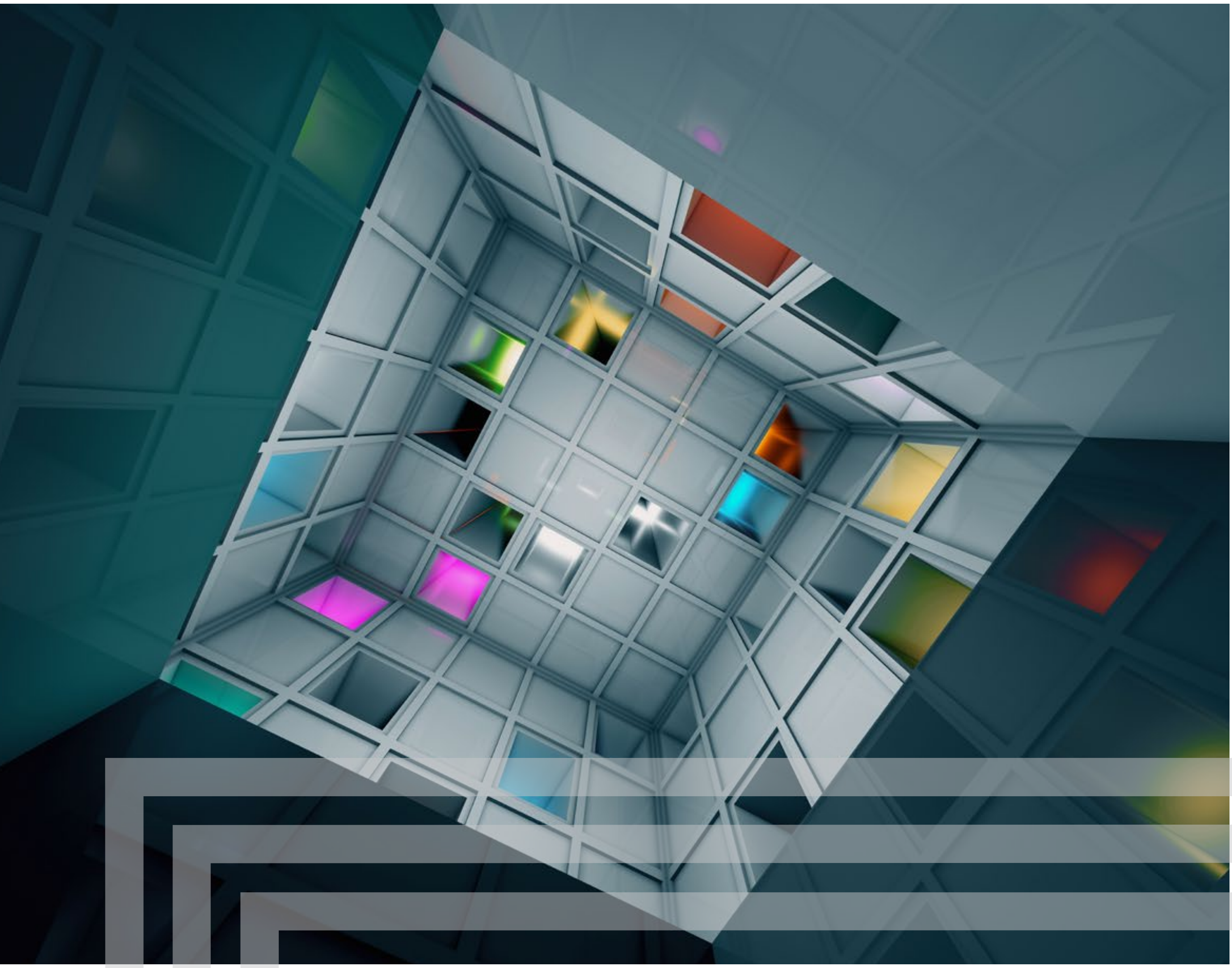

Next Generation of EPCs and Quality Convergence across the EU: Implementation of Innovative Certification Schemes

Report on the use of innovative certification schemes and its implementation

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HISTORY OF CHANGES

Version	Month Year	Organisation	Comments
v1	16.11.20	CENER	Version for internal review
v1.1	23.11.20	CENER	Version after review
v1.2	30.11.20	CENER	Final version after English language review

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OVERVIEW OF ePANACEA PROJECT

After 10 years of track record, the current EPC schemes across the EU face several challenges which have led to a not full accomplishment of their initial objectives: lack of accuracy, a gap between theoretical and real consumption patterns, absence of proper protocols for inclusion of smart and novel technologies, little convergence across Europe, lack of trust in the market and very little user awareness related to energy efficiency.

The objective of the ePANACEA project is to develop a holistic methodology for energy performance assessment and certification of buildings that can overcome the above-mentioned challenges. The vision of ePANACEA is to become a relevant instrument in the European energy transition through the building sector.

ePANACEA comprises the creation of a prototype (the Smart Energy Performance Assessment Platform) making use of the most advanced techniques in dynamic and automated simulation modelling, big data analysis and machine learning, inverse modelling or the estimation of potential energy savings and economic viability check.

A relevant part of the project is to have a fluent dialogue with European policy makers, certification bodies, end-users and other stakeholders through two types of participatory actions: a feedback loop with policy makers, carried out through the so-called Regional Exploitation Boards (REBs) covering EU-27+UK+Norway on the one hand, and dialogue with end-users, established by means of specific thematic workshops, on the other.

Thanks to these participatory actions, the acceptance of the ePANACEA approach will be tested and validated in order to become aligned with and meet the needs of national public bodies, end-users and other stakeholders..

ePANACEA will demonstrate and validate reliability, accuracy, user-friendliness and cost-effectiveness of its methodology through 15 case studies in 5 European countries.

EXECUTIVE SUMMARY

This report on the use of innovative certification schemes of the ePANACEA (Smart European Energy Performance Assessment and Certification) project, funded by the European Union's HORIZON 2020 research and innovation programme under grant agreement No 892421, aims to tackle current EPC challenges by proposing new features for implementation within existing schemes.

The document first summarises the state-of-the-art regarding European and international certification schemes, followed by a more detailed description of each key aspect to be taken into account within a building certification process. The review is mainly based on three pillars: (i) Current certification schemes in the five pilot countries of ePANACEA, (ii) International certification schemes and (iii) Standardised energy audit methodologies.

The last two sections include a modular approach and ePANACEA's proposals, respectively. The modular approach consists of a list of individual features that could be added to the current EPC schemes for possible improvement in terms of accuracy, reliability, user-friendliness and cost effectiveness. The ePANACEA approach section proposes the most suitable combinations or packages of such features to be evaluated and validated from the end-user perspective and be included into the final ePANACEA methodology and its pilot Smart European Energy Performance Assessment and Certification Platform (SEPAP).

GLOSSARY

ISO 52000-1: Energy performance of buildings - Overarching EPB assessment. Part 1. General framework and procedures

ISO 52003-1: Energy performance of buildings - Indicators, requirements, ratings and certificates. Part 1. General aspects and application to the overall energy performance

Actual measured energy – measured energy without any correction for standard climate and use

As built energy performance – energy performance calculated with data for the building after construction (prior to or during operation) and standard use data set.

Design energy performance – energy performance calculated with design data for the building and standard use and climate data set

DHW – Domestic Hot Water

DSM – Demand Side Management

Energy performance indicator – calculated or measured numerical quantity that characterises an energy feature of an assessed object

Energy rating – evaluation of the value of an energy performance indicator by comparison against one or more reference values, possibly including a visualisation of the position on a continuous or discrete scale.

Energy performance requirement – minimum level of the energy performance that is to be achieved to obtain a right or an advantage

Measured energy indicator – energy performance indicator based on measured energy performance

Numerical indicator of primary energy use – primary energy use per unit of reference floor area (non-renewable primary energy use and total primary energy use)

Reference value – standard legal or calculated value against which an energy indicator is compared

Standard energy performance – energy performance using actual data for a building and a standard use and climate data set (if calculated) or corrected for deviating conditions (if measured)

Tailored energy performance – calculated energy performance using actual data for a building and actual climate and occupancy data

Building automation and control system (BACS) – system comprising all products, software and engineering services that can support energy efficient, economical and safe operation of technical building systems through automatic control and by facilitating the manual management of those technical building systems

EEM – energy efficiency measure

Inverse modelling (model calibration) – inverse uncertainty analysis for determination of unknown variables through mathematical models from measurement data.

1. INTRODUCTION

The European Green Deal establishes a common framework for transforming the EU's economy for a sustainable future. Among others, one of the new measures to achieve the European Green Deal objectives is increasing the EU's climate ambition for 2030 and 2050. The EU has already started to modernise and transform the economy with the aim of achieving climate neutrality.

Energy Performance Certificates (EPCs) have the opportunity to play an important role in achieving the environmental objectives of the EU, as a useful element to support the energy transition in the buildings sector, motivating investment in new and existing buildings oriented to energy efficiency, integration of renewable energy sources and smart technologies that allow optimisation of buildings' performance.

However, for the EPC to reach its full potential, several current challenges need to be overcome:

- Most of the current energy assessments for Energy Performance Certification across the EU are based on theoretical calculation procedures, including standard "operational conditions and weather data" as reference for calculation, which is required for meeting Energy Performance of Buildings Directive (EPBD) requirements and developing an objective comparison of the building stock. However, occupant behaviour on itself can imply an increase of the energy consumption in the order of two or more. Weather data also implies a high impact over the heating and cooling demands. The result is a gap between standard outcomes and real consumption patterns that could imply inaccurate energy savings estimations for the implementation of energy efficiency measures (EEMs) in building renovations.
- Apart from the above-mentioned problem, there is also a lack of accuracy of the energy assessment results (i.e., a gap between results of the energy assessment and real energy use) due to other issues. For instance: the use of methodologies or tools is not appropriate for the specific characteristics of the assessment object, expert knowledge for carrying out detailed energy assessments is lacking, while there is a poor quality of the assessments, etc. Simplified assessment methods (e.g., using yearly, seasonal or monthly calculation intervals) cannot be appropriated if certain building characteristics are present (e.g., simultaneous demand for both heating and cooling, missing zone thermostats, innovative installations that require a dynamic analysis, etc.).
- EPCs are currently recognised as one of the most important sources of information on the energy performance of the EU's building stock, a key policy instrument that can assist the government in reducing energy consumption in the building sector and an important element of climate policies. User awareness around energy efficiency in buildings is key in order for EEMs to be successful, however EPCs have not been successful in attracting the final users' (owners or tenants) interest in most of EU's Member States.
- EPCs were introduced in the framework of European legislation for the first time in 2002. Following the requirement of the Energy Performance of Buildings Directive (EPBD - Directive 2002/91/EC), all Member States had to introduce, at latest by 4 January 2009, an effective certification scheme. The mechanism was new for the majority of countries and needed to be designed from scratch. Thus, under the common general framework for the calculation of energy performance of buildings established by the EPBD in 2002 and 2010, Member States developed their own assessment methods, giving rise to the lack of convergence across EU (e.g., regarding calculation intervals, ratings, assessment tools, EPC report minimum requirements, etc.).
- Smart and novel technologies, based on energy efficiency, renewable sources and automatisation, are key aspects for enabling the energy transition within the buildings sector. For instance, services related to on-site energy generation and demand side management (e.g., for maximising self-consumption) could accelerate the energy transition when massively implemented. Current energy assessment and certification schemes lack the proper protocols for the inclusion of smart and novel technologies, which is a handicap to the EPC to become an instrument in the energy transition.
- Finally, lack of trust in the market regarding EPCs and difficulty to access financial support for building renovation are additional challenges of the current EPCs. On the one hand, the referenced gap between EPC outputs and real consumption patterns implies that there is a financial estimation of EEMs that does not represent reality. On the other hand, most of the time, EPC schemes are not accompanied by a quality viability analysis from the economic point of view.

2. STATE OF THE ART

This section will review current certification schemes and some of their particularities in order to identify relevant and/or innovative aspects that can be used in an EU common framework for EPC schemes.

Apart from official certification schemes and mandatory requirements by the EPBD in all Member States, there are other European and international (generally private) initiatives for building certification that can involve not only energy performance, but also other relevant aspects like comfort, indoor air quality and other environmental parameters.

The review is mainly based on three pillars: (i) Current certification schemes in the five pilot countries of ePANACEA, (ii) International certification schemes and (iii) Standardised energy audit methodologies.

2.1. EU members – focus countries

Despite the fact that all EPC schemes developed by EU's Member States have to follow the requirements included in the respective updates of the Energy Performance of Buildings Directive (EPBD)[1], there are significant differences. This section includes an overview of each of the current EPC schemes in the five pilot countries involved in the ePANACEA project, namely Austria, Belgium, Finland, Greece and Spain.

In order to carry out a cross-analysis, an overview of each scheme is shown below according to key aspects of energy certification schemes addressed in the context of ISO 52000 series, especially the standard ISO 52003-1.

2.1.1. Austria

AUSTRIA/STYRIA

Implementation	National
Start of EPCs	National law since 2006/2007 / Regional law in Styria since 2008
Legislation Force	National: Energieausweis-Vorlage-Gesetz 2009 (EAVG 2012, BGBl. 27/2012); Regional: Styrian building law and construction regulation based on OIB regulations
EPC databases	National level (GWR central building and dwelling register of Austria) and regional level (e.g. in Styria: ZEUS database)

	RESIDENTIAL		NON RESIDENTIAL	
	 NEW BUILDINGS	 EXISTING BUILDINGS	 NEW BUILDINGS	 EXISTING BUILDINGS
On-site visit	Optional	Optional	Optional	Optional
Recommendation	Optional	Mandatory	Optional	Mandatory

[1] Directive 2002/91/EC on the energy performance of buildings, Directive 2010/31/EU (recast) and Directive 2018/844 amending Directive 2010/31&EU and Directive 2012/27/EU

of energy retrofit measures				
Economic feasibility of retrofit measures	Optional	Mandatory (the recommendation of energy retrofitting measures should be feasible from an economic perspective- however no specific economic calculation is required)	Optional	Mandatory (the recommendation of energy retrofitting measures should be feasible from an economic perspective- however no specific economic calculation is required)
Energy Services				
Calculated energy rating	YES		YES	
Measured energy rating	NO		NO	
Software / Tools	ArchiPHYSIK, AX3000, ecoline, Ecotech Gebäuderechner, GEQ, Grüner GmbH, Gebäudeprofi			
Complexity	Dynamic methods (hourly) to quasi stationary (monthly or hourly) possible, however quasi stationary method is implemented in common EPC software			
Multi-zone	YES		YES	
Global Energy Performance Indicators	• Specific energy needs for space heating (HWB Ref,RK) based on given standardised climatic conditions [kWh/m² year] • Specific energy needs for space heating (HWB Ref,SK) based on the local climate conditions [kWh/m² year] • Primary energy demand (energy required to provide heating, hot water and electricity for a building), in total and separated for renewable and non-renewable energy [kWh/m² year] • CO_2 emissions created to meet the overall energy demand of the building [kg/year or kg/m² year]			

<table>
<tr><td></td><td colspan="2">• total energy efficiency factor (fGEE) (ratio between the final energy demand of the present building and the final energy demand of a reference building)</td></tr>
<tr><td>Label classes</td><td colspan="2">A++, A+, A, B, C, D, E, F, G</td></tr>
<tr><td>Energy performance rating scales</td><td colspan="2">A++ (max. 10 kWh/m²year), A+ (max. 15 kWh/m² year), A (max. 25 kWh/m² year), B (max. 50 kWh/m² year), C (max. 100 kWh/m² year), D (max. 150 kWh/m² year), E (max. 200 kWh/m² year), F (max. 250 kWh/m² year), G (250 kWh/m² year)

Related to specific energy needs for space heating ($HWB_{Ref,SK}$) based on standardised room temperature for local climate where the building is situated; in addition indicators like primary energy demand (kWh/m² year), equivalent CO_2 emissions (kg/m² year) and a special energy efficiency factor ($f_{GEE,SK}$) are also assigned to a certain class

m²...gross building area</td></tr>
<tr><td>Additional indicators</td><td>All indicators calculated for standardised climate conditions and local climate conditions of the building. The following are expressed in kWh/year and/or kWh/m² year:

• “WWWB”: Hot water demand

• “HEB”: Energy requirements for heating and hot water preparation taking into account losses from generating, storing, distribution and transfer and possible auxiliary energy

• “HHSB”: Household electricity demand

• “EEB”: final energy demand (incl. electricity demand; delivered energy)</td><td>Same indicators as for residential buildings. Additional factors for non-residential buildings:

• “KB”: energy needs for cooling

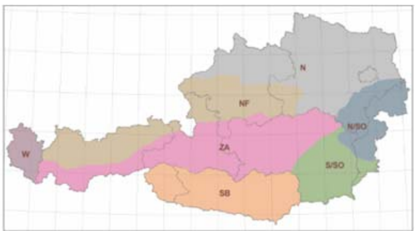
• “KEB”: energy needs separated for the heating, cooling and ventilation system

• “BefEB”: humidification energy demand

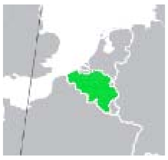
• “BelEB”:energy demand for lighting

• “BSB”: operational electricity consumption</td></tr>
<tr><td>Climatic Zones</td><td colspan="2">Austria is divided into 7 climatic zones (north zone, north - southeast zone, south - southeast zone, south zones located in basins, central alpine zone, north with foehn winds influence, west zone);

the relevant zones for Styria: central alpine, north - southeast zone, south - southeast zone


</td></tr>
<tr><td>Weather data</td><td colspan="2">Reference climate conditions and local climate conditions are defined in guideline ÖNORM B8110 - 5.</td></tr>
</table>

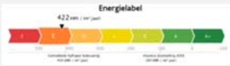
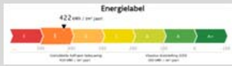
2.1.2. Belgium



Implementation	Regional
Start of EPCs	2006 / 2007
Legislation Force	Energy Performance of Buildings Decree of 22/12/2006: EPC in new residential buildings in force. Energy Decree of Flemish government of 8/5/2009; Energy Decision of Flemish government of 19/11/2010; Decision of Ministry of 21/8/2008: EPC existing residential buildings (sale and rent) in force; EPC for public buildings: Energy Decree of Flemish government of 8/5/2009; Energy Decision of Flemish Government19/11/2010; Decision of Ministry of 1/12/2010
EPC databases	Regional level

	RESIDENTIAL		NON RESIDENTIAL	
	 NEW BUILDINGS	 EXISTING BUILDINGS	 NEW BUILDINGS	 EXISTING BUILDINGS
On-site visit	Mandatory	Mandatory	Mandatory	Mandatory
Recommendation of energy retrofit measures	N/A	Mandatory	N/A	For small non-residential buildings: mandatory For large non-residential buildings: method in development For public buildings: mandatory
Economic feasibility of retrofit measures	N/A	N/A	N/A	N/A
Energy Services				
Calculated energy rating	YES		YES	YES (exception: public buildings)

Measured energy rating	NO		NO	NO (exception: public buildings)
Software / Tools	EPB 3G (official tool)	EPC (official tool) (online accessible after registration)	EPN (official tool)	For small non-residential buildings: official tool (online accessible after registration) For large non-residential buildings: in development For public buildings: official tool (online accessible after registration)
Complexity	Monthly	Monthly	Monthly	Monthly
Multi-zone	NO (except for ventilation for air flow per room and ventilation sectors (per system type) and for heating and cooling by definition of energy sectors)	NO (except for heating subdivision in clusters and for cooling: share of volume that is actively cooled)	NO (except subdivision for functional units and further subdivision for ventilation for air flow per room and ventilation sectors (per system type) and for heating, cooling and humidification by definition of energy sectors)	For small non-residential buildings: NO (except for heating and for cooling subdivision in clusters) For large non-residential buildings: in development For public buildings: NO
Global Energy Performance Indicators	• E-peil (Energy Performance level; normalised characteristic, primary, annual specific energy use) • Specific annual primary characteristic energy use • Annual CO_2-emission • Share of renewable energy sources	• Annual, characteristic, primary, specific energy use, annual CO_2 emission	• E-peil (Energy Performance level; normalised characteristic, primary, annual specific energy use) • Specific annual primary characteristic energy use • Annual CO_2-emission • Share of renewable energy (Energy Performance level denominator based on concept of national building approach)	For small non-residential buildings: Annual, characteristic, primary, specific energy use, annual CO_2 emission For large non-residential buildings: in development For public buildings: Annual, characteristic, primary, specific energy use, annual CO_2 emission

Label classes	None	A+, A, B, C, D, E, F	None	For small non-residential buildings: label classes in development For large non-residential buildings: method in development For public buildings: none
Energy performance rating scales	Coloured bar for benchmarking Energy Performance indicator 	A+<0; A≤100; B≤200; C≤300; D≤400; E≤500; F>500; comparison with Energy Performance indicator of comparable building and 2050 objective	Coloured bar for benchmarking Energy Performance indicator 	For small non-residential buildings: Coloured bar for benchmarking Energy Performance indicator For large non-residential buildings: method in development For public buildings: Coloured bar for benchmarking Energy Performance indicator [kWh annual, primary/m²]; comparison with comparable building
Additional indicators	• Net energy demand, gross, final and primary energy consumption for heating, humidification, cooling, lighting, domestic hot water, auxiliary systems. • Specific net energy demand for space heating • Specific annual renewable energy produced and or used (renewable energy originating from heat pumps, solar thermal system, PV, biomass, external thermal energy delivery) • K-peil (Global thermal insulation of building),	Net energy demand, gross, final and primary energy consumption for heating, cooling, domestic hot water, auxiliary systems. Specific net energy demand for space heating S-peil (Indicator for energy efficiency of building envelope) Efficiency of systems for heating and cooling Indicator for risk for overheating	• Net energy demand, gross, final and primary energy consumption for heating, humidification, cooling, lighting, domestic hot water, auxiliary systems. • Specific net energy demand for space heating • Specific annual renewable energy produced and or used (renewable energy originating from heat pump, solar thermal system, PV, biomass, external thermal energy delivery) • K-peil (Global thermal insulation of building),	For small non-residential buildings: net energy demand, gross, final and primary energy consumption for heating, cooling, domestic hot water, auxiliary systems; Specific net energy demand for space heating; S-peil (Indicator for energy efficiency of building envelope); Efficiency of systems for heating and cooling; Indicator for risk for overheating For large non-residential buildings: method in development For public buildings: None

	thermal insulation of building envelope parts • Ventilation system and flow rates • Energy balance on an annual basis	thermal insulation of building envelope parts • Ventilation system and flow rates • Energy balance on an annual basis
Climatic Zones	1 climatic zone	
Weather data	Monthly values	

2.1.3. Finland

FINLAND

Implementation	National
Start of EPCs	2008
Legislation Force	•Decree of the Ministry of the Environment on Energy Performance Certificate of Buildings 1048/2017 •Act on Energy Certificates for Buildings (50/2013, in Finnish, Finlex). •Government Decree on the competence of the party preparing a building's energy certificate and on the requirements for a more lenient energy certification process (170/2013, in Finnish, Finlex). •Ministry of the Environment Decree on the energy certificates of buildings (176/2013, in Finnish, Finlex)
EPC databases	National

	9 different categories	
	 NEW BUILDINGS	 EXISTING BUILDINGS
On-site visit	Mandatory	Mandatory
Recommendation of energy retrofit measures	N/A	Mandatory
Economic feasibility of retrofit measures	N/A	Not required (but implies that recommended measures are cost-efficient)

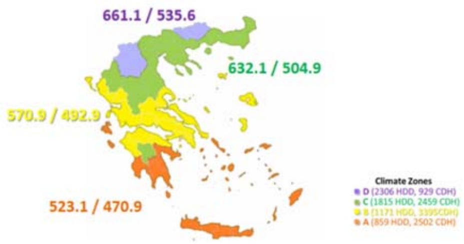
Energy Services		
Calculated energy rating	YES	YES
Measured energy rating	NO	NO
Software / Tools	All that fulfil requirements of the decree	All that fulfil requirements of the decree
Complexity	Hourly dynamic simulation for the buildings with cooling systems / otherwise monthly calculation allowed	Hourly dynamic simulation for the buildings with cooling systems / otherwise monthly calculation allowed
Multi-zone	NO (YES allowed)	NO (YES allowed)
Global Energy Performance Indicators	• primary energy [kWh/m² year]	• primary energy [kWh/m² year]
Label classes	A, B, C, D, E, F, G	A, B, C, D, E, F, G
Energy performance rating scales	Based on kWh/m² (primary energy): • Scales for single-family houses depends on floor area (m²) • Other 8 categories have fixed scales	
Additional indicators	N/A	N/A If measured history exists, it must be reported
Climatic Zones	 Four zones for energy calculation (for building permits), but to keep the EPCs comparable to each other, they are always calculated with the Southern Finland zone (I) data	
Weather data	Hourly data (regulation). The official climate files, provided for all EPC procedures, are referring to synthetic climate data files for each climatic zone which include hourly external temperatures, solar radiation, and humidity, wind speed and direction. There are data for all four zones but only one zone (and its data) is used for EPC calculation.	

2.1.4. Greece

GREECE

Implementation	National
Start of EPCs	2011
Legislation Force	"Regulation of Energy Performance of Buildings (KENAK)" Ministerial decision D6/B/5825 National Gazette 407, April 2010 / Decision on the Approval of the Regulation on the Energy Efficiency of Building (2017) Decision No DEPEA/oik. 178581/2017
EPC databases	National

	RESIDENTIAL		NON RESIDENTIAL	
	NEW BUILDINGS	EXISTING BUILDINGS	NEW BUILDINGS	EXISTING BUILDINGS
On-site visit	Mandatory	Mandatory	Mandatory	Mandatory
Recommendation of energy retrofit measures	Optional	Optional	Optional	Optional
Economic feasibility of retrofit measures	Optional	Optional	Optional	Optional
Energy Services				
Calculated energy rating	YES		YES	
Measured energy rating	NO		NO	
Software / Tools	Official tool (named TEE KENAK)  Software companies can integrate it into existing tools but it has to be verified by the Secretariat of the Environment and Energy Inspectorate of the Ministry of Environment and Energy			
Complexity	Monthly		Monthly	

Multi-zone	YES	YES
Global Energy Performance Indicators	• Non-renewable primary energy of reference building [kWh/m² year] • Non-renewable primary energy [kWh/m² year] • CO_2 emissions [kgCO_2/m² year]	• Non-renewable primary energy of reference building [kWh/m² year] • Non-renewable primary energy [kWh/m² year] • CO_2 emissions [kgCO_2/m² year]
Label classes	A+, A, B+, B, C, D, E, F, G	A+, A, B+, B, C, D, E, F, G
Energy performance rating scales	The energy rating is granted as compared to a reference building.	
Additional indicators	• Non-renewable primary energy for heating [kWh/m² year] • Non-renewable primary energy for cooling [kWh/m² year] • Non-renewable primary energy for DHW [kWh/m² year] • Non-renewable primary energy for lighting [kWh/m²year] (only non-residential) • Renewable and CHP primary energy [kWh/m² year]	• Non-renewable primary energy for heating [kWh/m² year] • Non-renewable primary energy for cooling [kWh/m² year] • Non-renewable primary energy for DHW [kWh/m² year] • Non-renewable primary energy for lighting [kWh/m² year] (only non-residential) • Renewable and CHP primary energy [kWh/m² year]
Climatic Zones	4 climatic zones based on the Heating Degree Days (HDDs)  	
Weather data	Monthly data (regulation). The official climatic files, provided for all EPC procedures, are referring to synthetic climate data files for various cities of Greece which include hourly outside temperatures, solar radiation, and humidity.	

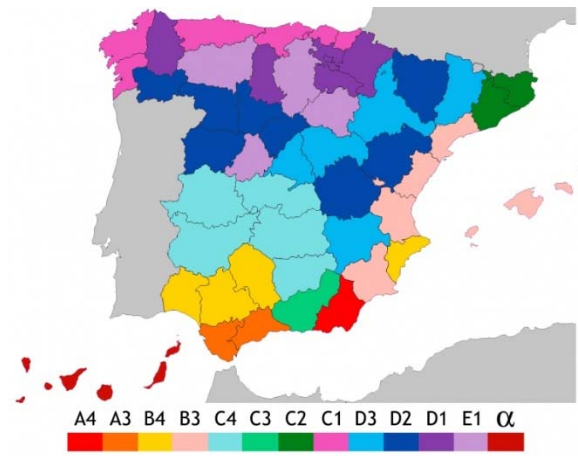
2.1.5. Spain

SPAIN

Implementation	National
Start of EPCs	2007
Legislation Force	Royal Decree 235/2013 of the Ministry of Industry on Energy Performance certification procedures for buildings
EPC databases	Regional level

	RESIDENTIAL		NON RESIDENTIAL	
	NEW BUILDINGS	EXISTING BUILDINGS	NEW BUILDINGS	EXISTING BUILDINGS
On-site visit	N/A	Mandatory	N/A	Mandatory
Recommendation of energy retrofit measures	N/A	Mandatory	N/A	Mandatory
Economic feasibility of retrofit measures	N/A	Optional	N/A	Optional
Energy Services				
Calculated energy rating	YES		YES	
Measured energy rating	NO		NO	
Software / Tools	Official tools named HULC other methods of private initiative which have overcome an	Official tools named HULC, CE3X and CE3	Official tools named HULC other methods of private initiative which have overcome an official	Official tools named HULC, CE3X and CE3

	official approval procedure SG SAVE, CYPETHERM HE Plus, CERMA, CE3X	other methods of private initiative which have overcome an official approval procedure SG SAVE, CYPETHERM HE Plus, CERMA	approval procedure SG SAVE, CYPETHERM HE Plus, CE3X	other methods of private initiative which have overcome an official approval procedure SG SAVE, CYPETHERM HE Plus
Complexity	HULC, SG SAVE and CYPETHERM HE Plus are dynamic methods CE3X and CERMA are simplified methods based on indirect dynamic calculations.	HULC, SG SAVE and CYPETHERM HE Plus are dynamic methods CE3X, CE3 and CERMA are simplified methods based on indirect dynamic calculations.	HULC, SG SAVE and CYPETHERM HE Plus are dynamic methods CE3X is a simplified method based on indirect dynamic calculations.	HULC, SG SAVE and CYPETHERM HE Plus are dynamic methods CE3X and CE3 are simplified methods based on indirect dynamic calculations.
Multi-zone	Dynamic methods: YES (No Mandatory) Simplified Methods: NO		Dynamic methods: YES (No Mandatory) Simplified Methods: NO	
Global Energy Performance Indicators	• Non-renewable primary energy [kWh/m² year] • CO_2 emissions [kgCO_2/m² year]		• Non-renewable primary energy [kWh/m² year] • CO_2 emissions [kgCO_2/m² year]	
Label classes	A, B, C, D, E, F, G		A, B, C, D, E, F, G	
Energy performance rating scales	Single-family houses: 13 energy rating scales (one for each climatic zone) + Apartment blocks: 13 energy rating scale (one for each climatic zone)		Energy rating is granted as compared to a reference building.	
Additional indicators	• Energy need for heating [kWh/m² year] • Energy need for cooling [kWh/m² year] • Non-renewable primary energy for heating [kWh/m² year] • Non-renewable primary energy for cooling		• Energy need for heating [kWh/m² year] • Energy need for cooling [kWh/m² year] •Non-renewable primary energy for heating [kWh/m² year] • Non-renewable primary energy for cooling[kWh/m² year]	

	[kWh/m² year] • Non-renewable primary energy for DHW [kWh/m² year] • CO_2 emissions for heating [$kgCO_2$/m² year] • CO_2 emissions for cooling [$kgCO_2$/m² year] • CO_2 emissions for DHW [$kgCO_2$/m² year]	• Non-renewable primary energy for DHW [kWh/m² year] • Non-renewable primary energy for lighting [kWh/m² year] (only non-residential) • CO_2 emissions for heating [$kgCO_2$/m² year] • CO_2 emissions for cooling [$kgCO_2$/m² year] • CO_2 emissions for DHW [$kgCO_2$/m² year] • CO_2 for lighting [$kgCO_2$/m² year] (only non-residential)
Climatic Zones	13 climatic zones based on climate severity indexes (winter(words) and summer(numbers)) α3 A3 A4 B3 B4 C1 C2 C3 C4 D1 D2 D3 E1  	
Weather data	Hourly data (regulation). The official climate files, provided for all EPC procedures, are referring to synthetic climate data files for each climatic zone which include hourly outside temperatures, solar radiation, and humidity.	

2.2. International certification schemes

During the past 30 years, many building performance certificates have emerged across the world in order to promote buildings that consume less energy, are more respectful of the environment and more comfortable for their users.

Most of current building certificates are not new but include, among their methodologies and procedures, aspects that can be considered innovative within the context of current national EPC schemes in compliance with the EPBD.

Prior to the development of this report, a cross-analysis of 38 (complete list in Annex II) international and European schemes has been conducted. A brief overview of the most relevant building certificates taken into account in the context of this ePANACEA report is shown below.

2.2.1. BREEAM ®

Building Research Establishment Environmental Assessment Method (BREEAM®), first published by the Building Research Establishment (BRE) in 1990 is the world's longest established method of assessing, rating, and certifying the sustainability of buildings. BREEAM® emerged in the United Kingdom and is currently present all over the world becoming an international standard that is locally adapted, operated and applied. Building on its original approach developed for new buildings, the scheme has been made more flexible by defining procedures for new buildings, existing buildings, refurbishment projects and large developments.

Certification must be done through a qualified assessor. The BREEAM® certification methodology is as follows. A qualified Assessor is selected who will lead the BREEAM® evaluation process in which all building partners will work together to achieve the final building rating and therefore the label. This label could be PASS, GOOD, VERY GOOD, EXCELLENT or OUTSTANDING.

The certification method is based on the awarding of points according to the degree of compliance with the requirements established in each of the 10 categories evaluated or environmental issues. The points obtained within each category, after an environmental weighting factor has been applied that takes into account the relative importance of each impact area, are added and finally expressed as a single certified BREEAM® rating.

Focusing on the application of BREEAM® to buildings schemes, among the categories included Energy is the most relevant. Energy evaluation in BREEAM® not only includes energy efficiency in building operation (energy efficient building design and systems) but also all issues to improve the inherent energy efficiency of the building: management, construction, equipment, renewable energy production, etc.

Other, also important, topics are included and evaluated in other categories of this assessment method, among others: comfort, indoor air quality, and daylighting.

2.2.2. Passive House

Passive House buildings combine high comfort with very low energy consumption. The first pilot project under the Passive House standard was built in 1990 in Germany. It is the objective of the Passive House Institute (PHI) to base the standard of comfort and energy requirements on the physically or physiologically verifiable, objectively determinable criteria. All criteria can be expressed by using measurable quantities and tested by using established methods.

There are two Standards: Passive House buildings, for new buildings, and EnerPHit that is the established Standard for refurbishment of existing buildings using Passive House components. Both of them have three classes: CLASSIC, PLUS or PREMIUM depending on the use of renewable energy sources. All standards can be applied in all climate zones worldwide. They apply for residential buildings as well as for most non-residential building uses.

Certification must be done through an accredited Building Certifier.

The main objective of Passive House buildings is to combine unparalleled thermal comfort with very low energy consumption. Passive House describes a performance standard and not a specific construction method: while Passive House buildings must meet specific energy demand targets, building designers are free to choose how to best meet them. The Standard is international, remaining both applicable and economically feasible in almost all inhabited climates of the globe. The requirements that a building must meet to be certified Passive House Planning Package (PHPP) are five:

Space Heating Demand	not to exceed 15 kWh annually OR 10 W (peak demand) per square metre of usable living space.
Space Cooling Demand	roughly matches the heat demand with an additional, climate-dependent allowance for dehumidification.
Primary Energy Demand	not to exceed 120 kWh annually for all domestic applications (heating, cooling, hot water, and domestic electricity) per square metre of usable living space.
Airtightness	maximum of 0.6 air changes per hour at 50 Pascal pressure (as verified with an onsite pressure test in both pressurised and depressurised states).
Thermal comfort	must be met for all living areas year-round with not more than 10% of the hours in any given year over 25°C.

The PHPP assessment does not consider any additional issues among its requirements.

The PHPP is the energy balance design tool for the planning of Passive Houses and other highly efficient buildings. Excel-based, the PHPP makes use of tested algorithms to yield a building's heating, cooling, and primary energy demand, a building's heating and cooling loads and its tendency to overheat.

2.2.3. H.Q.E.™

Established in France in 1996 HQE™ is a recognised non-profit public utility association and a trademark that is internationally registered.

HQE™ certification covers the entire lifecycle of a building (i.e., construction, renovation and operation): non-residential buildings, residential buildings and detached houses as well as urban planning and development.

The certification is delivered by Cerway, Cerqual or Certivea after audits that consider, among others, the environmental performance of the building that is assessed against 4 themes: 1) Energy and Saving, 2) Environment, 3) Health and Safety and 4) Comfort.

Themes	*	**	***	****
Energy and Savings Targets: 4, 5 and 7	1 P	1 HP+1 P	2 HP	2 HP+1 P
Comfort Targets: 8, 9, 10 and 11	2 P	1 HP+2 P	2 HP+1 P	3 HP+1 P
Health and Safety Targets: 12, 13 and 14	1 P	1 HP+1 P	1 HP+2 P	2 HP+1 P
Environment Targets: 1, 2, 3 and 6	2 P	1 HP+2 P	2 HP+1 P	3 HP+1 P

Within each theme, there are different targets with three levels of compliance: prerequisite, performing (P) and high performing (HP). The number of points obtained in each target will assign the level obtained in it: prerequisite level (PR), performing level (P) or high performing level (HP). The number of performing (P) or high performing (HP) define the number of stars achieved in each theme, and the number of stars in each theme establishes the final score. There are five possible classes according to the overall score achieved (i.e., the total of stars obtained in each of the 4 domains): PASS, GOOD, VERY GOOD, EXCELLENT and EXCEPTIONAL.

Although optional, the involvement of a HQE™ Certification "Référent" (accredited professional) is recommended.

2.2.4. LEED ®

LEED (Leadership in Energy and Environmental Design) is a green building rating system, initiated in 1993 in the U.S.A. By 1998, United States Green Building Council (USGBC) had successfully developed LEED 1.0, and it began pilot testing projects.

LEED is available for virtually all building types and all building phases including new construction, interior fit outs, operations and maintenance, core and shell.

The topics related to the energy consumption of the building and its efficiency are concentrated in the category Energy and Atmosphere but there are additional categories in the certification. Applied to building construction schemes, the existing credit categories are: Integrative process, Location and Transportation (LT), Sustainable Sites (SS), Water Efficiency (WE), Energy and Atmosphere (EA), Material and Resources (MR), Indoor Environmental Quality (IEQ), Innovation (IN) and Regional Priority (RP).

All consumptions of the building, energy and non-energy related, as well as renewable energy production, are taken into account in the LEED certification. The consumptions are based on thermal dynamic simulations that are made with simulation programmes independents of LEED.

The operation of the certification is as follows: in all categories there are prerequisites and credits. Prerequisites are mandatory compliance to certificate the building and credits let obtain points. Each credit is associated with a number of points to be achieved. The global score obtained in each category is not important; the final score is obtained directly based on the number of points obtained in all the credits. There are four rating levels: CERTIFIED (40-49 points), SILVER (50-59 points), GOLD (60-79 points) and PLATINUM (≥ 80 points).

Improving the energy performance of buildings can provide the highest number of points in the same credit, such as "Optimize Energy Performance" credit, included in Energy and Atmosphere category, with a score up to 18 points for LEED BD+C rating system or in LEED BD+C: Residential-Single Family "Annual Energy Use" where it is possible to gain up to 36 points.

Though not mandatory, it is strongly recommended to certify a building through a LEED AP, a credential that distinguishes those people with advanced knowledge in green building, plus expertise in a particular LEED rating system.

Other important topics included and evaluated in this building rating system concern, among others: Comfort, Indoor air quality or Daylighting.

2.2.5. ENERGY STAR ®

ENERGY STAR® is a voluntary U.S. Environmental Protection Agency (EPA) programme that delivers environmental benefits and financial value through superior energy efficiency. Tens of thousands of buildings and plants have earned EPA's ENERGY STAR® since 1999.

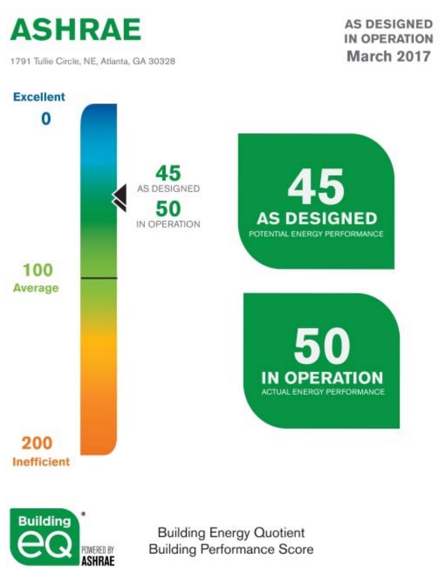
ENERGY STAR® is available for the following building types (both new and existing): homes, commercial buildings and industrial plants.

To be eligible for ENERGY STAR® certification, a building must earn an ENERGY STAR® score of 75 or higher, indicating that it performs better than at least 75th percentile of similar buildings nationwide. Unlike other certificates, certification is given on an annual basis of actual consumption data, so a building must maintain its high performance to be certified year after year.

ENERGY STAR® has its own platform. The information submitted in the certification application must be verified by a licensed Professional Engineer (PE) or Registered Architect (RA) to be eligible for approval.

The ENERGY STAR® label only considers building's energy consumption issues (heating, ventilation and cooling system, as well as lighting and appliances), ensuring that the building meets industry standards for acceptable indoor air quality, thermal environmental conditions and illumination.

2.2.6. Building EQ ®



Building EQ is a web-based portal that compares your building's performance with similar building types. Building EQ is the only tool that includes both In Operation (operational) and As Designed (asset) rating.

The redesigned label shows Building EQ Performance Score on a barometer/scale. The building's scale value ranges from 0 to 200, with an efficient building having a score lowerless than 100.

Building EQ In Operation compares metered energy use to a baseline median Energy Use Intensity (EUI) and provides recommendations for improvement. The building owner receives guidance on how to improve the building's energy performance. In Operation rating also includes an ASHRAE Level 1 Energy Audit that complies with ASHRAE Standard 211 for Commercial Building Audits.

Building EQ As Designed evaluates potential energy use through standardised energy models.

Building EQ allows for the comparison of a building's actual energy use (In Operation) to the building's potential energy use (As Designed).
As in ENERGY STAR® , Building EQ benchmarks a building against a baseline of other similar buildings.

Anyone can use the Portal to get the Building EQ Performance Score once the required data is entered, however, projects must be submitted by a credentialed practitioner for an official Building EQ rating.

2.2.7. WELL ®

WELL Building Standard is a standard exclusively focused on the way in which buildings, and everything in them, can improve our comfort, drive better choices, and generally enhance, not compromise, our health and wellness. Improvement of energy performance of buildings is not one of the WELL certification goals.

At this moment, the available version of WELL Certified is WELL v2. The WELL v2 Building Standard measures a building's impact on human health by focussing on ten Concepts: Air, Water, Nourishment, Light, Movement, Thermal Comfort, Sound, Materials, Mind and Community.

WELL v2 projects fall into one of two main groups, determined primarily by ownership type:

- Owner-occupied: The project is mainly occupied by the project owner (which may be different than the building owner).
- WELL Core: The project owner occupies a small portion of the project area and rents/leases most of the space to one or more tenants.

Multifamily residential projects may pursue WELL if they contain at least five dwelling units in a single building with common structural elements.

As with LEED Certification, WELL v2 operates on a points-based system, with 110 points available in each project scorecard. Projects must fulfil all preconditions, as well as a certain number of points towards different levels of WELL Certification

Total points achieved	WELL Certification		WELL Core Certification	
	Minimum points per concept	Level of certification	Minimum points per concept	Level of certification
40 pts	0	WELL Bronze	0	WELL Core Bronze
50 pts	1	WELL Silver	0	WELL Core Silver
60 pts	2	WELL Gold	0	WELL Core Gold
80 pts	3	WELL Platinum	0	WELL Core Platinum

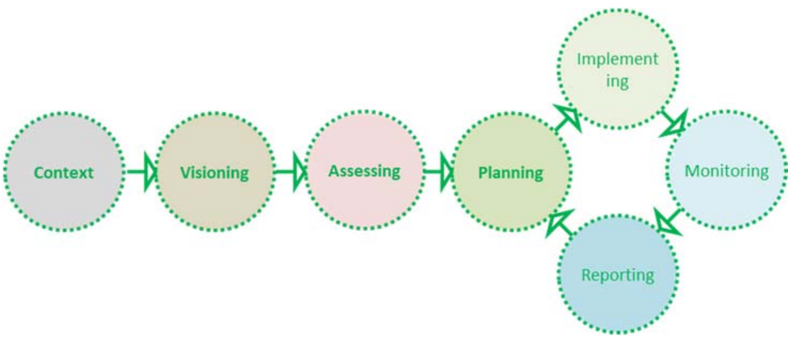
All WELL Certification types require renewal of certification every three years.

The Green Business Certification Inc. (GBCI) was the only organisation that could conduct onsite performance testing for WELL v1 projects. For WELL v2, a qualified individual who is employed by an approved WELL Performance Testing Organisation and who does not have a conflict of interest with the WELL Certification for the project, may execute performance testing as the WELL Performance Testing Agent of record.

2.2.8. One Planet Living ®

One Planet Living is not a certification scheme, it is a sustainability framework created by Bioregional in 2003 that provides a range of sustainability consultancy services.

The One Planet Living sustainability framework comprises ten simple principles and detailed goals: Health and happiness, Equity and local economy, Culture and community, Land and nature, Sustainable water, Local and sustainable food, Travel and transport, Materials and products, Zero waste and Zero carbon energy.



Anyone can use the One Planet Living framework.

Once, the One Planet Action Plan is created, it can be submitted for leadership recognition by Bioregional. If the Action Plan is submitted Bioregional will need to conduct a thorough review of the plan. This is called 'peer review'.

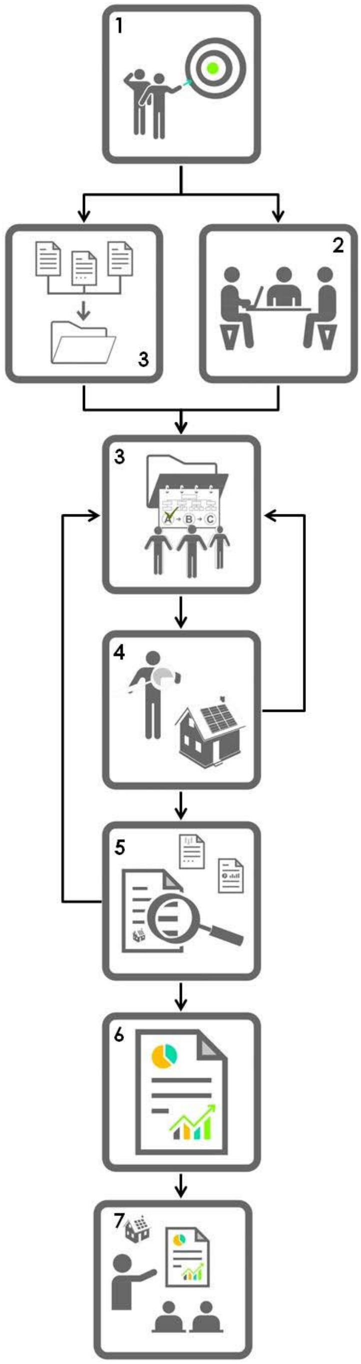
For an Action Plan to be approved by Bioregional, it must contain a complete and exemplary set of

Actions to promote the objectives of each of the ten principles. It will need to set a goal for Zero Carbon Energy (100% renewable energy sources) at a reasonable date (depending on the development context) and a goal for Zero waste (that is, zero or close to zero waste to landfill).

2.2.9. WOSHIE

WOSHIE is an organisation with the objective to spread and promote health protection to people in indoor environments. WOSHIE's new building certification emerged during the global COVID-19 pandemic and its proceedings and certification are focused on protecting all kinds of entire buildings against virus infection (office buildings, shopping centres, residential buildings, etc.), interior spaces (offices, supermarkets, commercial premises, etc.) and means of transport (buses, trains, planes, etc.). The first building to be WOSHIE certified was in June 2020.

2.3. Energy audit methodology



The definition of an Energy Audit according to the EN 16247 standard is the "systematic inspection and analysis of energy use and energy consumption of a site, building, system or organisation with the objective of identifying energy flows and the potential for energy efficiency improvement and reporting them". Energy Audits could be applied to different sectors: buildings, processes and transport. The building sector is the one which concerns the ePANACEA project.

According to the UNE-EN 16247-1 "the scope of the audit should be agreed to cover technical interaction of the system within the building, and the interaction of the system with the building. Optimisation of a specific sector to the exclusion of others may give misleading results." The energy audit process shall be appropriate, complete, representative, traceable, useful and verifiable.

The energy audit methodology consists of a logical development that includes the steps that are briefly described below in time sequence:

1. **Preliminary contact.** The energy auditor shall identify all parties/organisations, their roles and their respective impacts on energy use and consumption. The scope, objectives, needs and boundaries of the audit should be agreed, as should the energy audit degree of thoroughness, taking into account the impact it may have on issues like time on site, level of modelling, etc. In this step, the energy auditor shall request the needed information and inform the organisation about the special needs to carry out the audit or data that may influence conclusions or recommendations.

2. **Start-up meeting.** At this meeting, the energy auditor shall agree with the organisation on issues as, e.g., timing of the site visits, restricted access areas, etc. The organisation shall then also give the necessary information or inform where relevant data, e.g. indoor environmental conditions, occupancy level, energy certificates, etc. are available

3. **Collecting data.** The energy auditor shall collect all the energy related data as required. The data collection and frequency of the data should be appropriate to the scope of the energy audit. Data shall include for example: energy consumption data, delivered, produced and exported energy for each energy carrier, factors that influence

energy consumption, e.g. climatic data, occupancy, existing design, operation and maintenance, information on important changes in the period covered by the available operational data, and other.

The data collected shall be analysed and, if there is sufficient information, an initial energy baseline or a plan for further data collection and measurement, to be carried out during field work, shall be established.

4. Field work. The energy auditor shall inspect the site against the data collected, evaluating the actual and future level of building services and looking for energy efficiency improvement opportunities.

5. Analysis. The energy saving potential of the building shall be analysed comparing each building service, technical system, etc. against a suitable reference. The analysis also shall contain the building's envelope evaluation. The energy auditor shall identify energy improvement opportunities and, in these improvements, shall take into account the interaction between different elements, the possible impacts for all delivered energy and evaluate potential impact that energy saving interventions will have on the ratings in the energy performance certificates.

6. Report. The different measures included in the report should be organised all follows: high cost measures, low cost measures, training and awareness of end-users and review requirements of comfort, health and well-being.

7. Final meeting. In this meeting, the energy auditor shall present and explain the results of the energy audit in a way that makes decisions easier.

As mentioned in the first step of the methodology, there are different degrees of thoroughness for energy audits. These levels will determine the level of effort dedicated to conducting the audit (site inspection days, time taken to prepare the report, etc.) as well as the accuracy of costs and savings or the feasibility and financial study of the measures proposed.

3. NEW FEATURES

Based on the review of current EPC schemes, other international certification schemes and standard methodologies to conduct energy audits across the ePANACEA pilot countries, a detailed list of new and innovative features for EPC schemes are proposed in this section. The features proposed have been selected with the objective of meeting the ISO 52000 series requirements as well as of improving current EPC schemes across the EU in terms of accuracy, convergence of quality, reliability, trust and user friendliness from the end-user point of view.

The proposed new features have previously been grouped into eleven categories, according to the main key aspects to be taken into account within a building certification scheme (Figure 1).

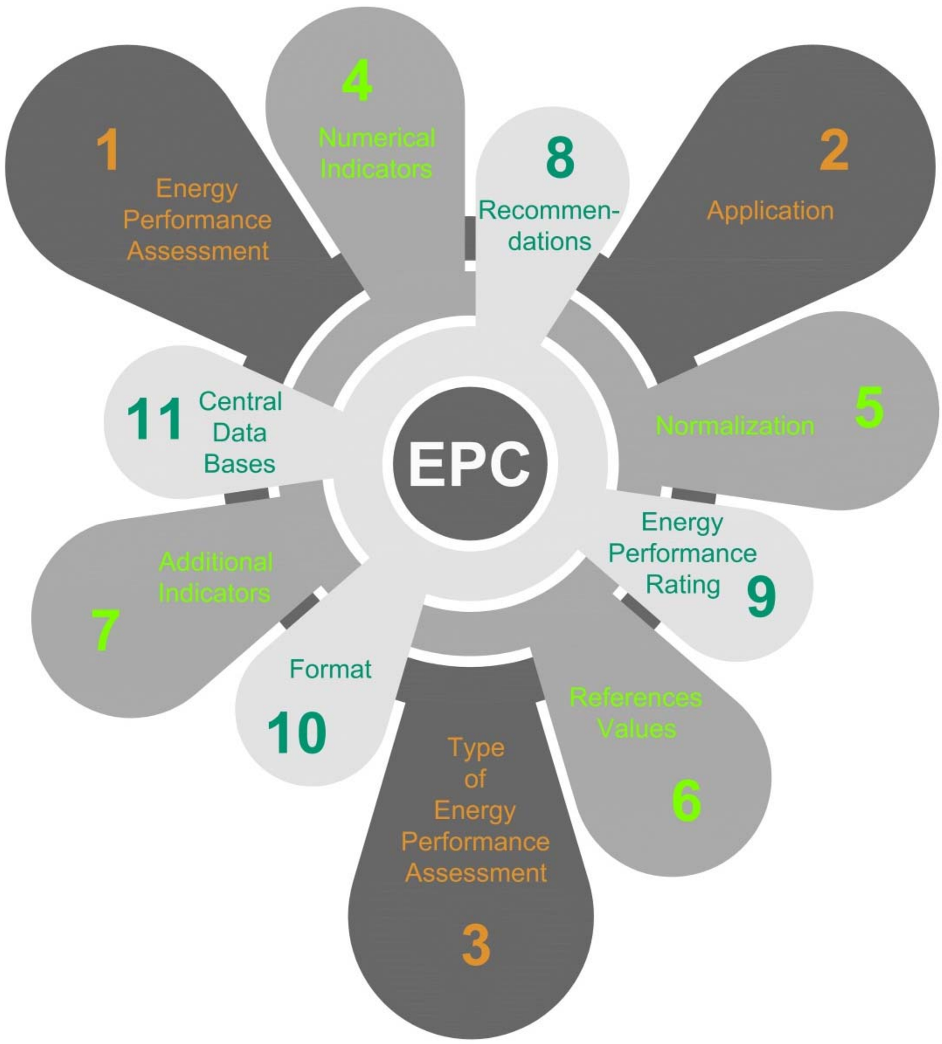


Figure 1: Categorisation. Eleven key aspects of the EPC.

The catalogue of different individual features, enables the individual evaluation of each feature and its prioritisation for inclusion into current certification schemes at MS level. In parallel, it allows the definition of those combinations of measures which are most suitable and feasible to be integrated under the ePANACEA methodology. At the same time, the conclusions elaborated from this process will be used as valuable inputs for discussion on the feasibility of their integration into current EPC schemes with relevant stakeholders, in the context of the first round of the ePANACEA Regional Exploitation Boards meetings.

New features arise from studies and analyses carried out within the ePANACEA project context. Among these tasks, it is worth to highlight:

- A detailed study of the current EPCs in the five pilot countries (Austria, Belgium, Finland, Greece and Spain): see section 2.1 and ANNEX I: EPC Reports of the ePANACEA pilot countries
- The individual and semi-structured interviews with EPC stakeholders conducted by project´s partners on the topic of end-users perceptions regarding current EPC schemes in the five pilot countries plus Germany.
- The analysis of international (generally private) certification schemes. For instance: their application, main indicators, evaluation system, energy services included, energy performance rating, format, etc.
- Relevant reports from other sister projects under the H2020 call "Next-generation of Energy Performance Assessment and Certification" (e.g. "Exploring innovative indicators for the next-generation energy performance certificate features. June 2020" and "Energy performance certificates. Assessing their status and potential. March 2020")

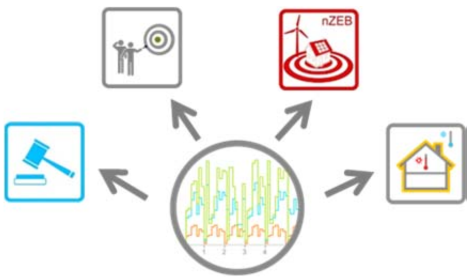
Based on this information, different aspects are detected to be further analysed in view of their potential for implementation into current EPCs, in order to enable EPCs to become a more useful tool for administrations, technicians (i.e., EPC assessors, energy auditors, etc.), building end users and other stakeholders alike.
The current challenge of harmonising EPCs at EU level has also been explored in order to contribute to improving quality convergence across the EU and instilling trust in the market. Then, although some of the features examined below may not be directly innovative, they have been included for evaluation in order to meet this specific objective.

3.1. Energy Performance Assessment

The energy performance assessment and how it is conducted is the first key aspect of an energy certification scheme to be taken into account. The ISO 52000-1 standard establishes a general common framework for developing building energy assessments. This common framework includes several options for the evaluation of the overall energy performance of buildings (e.g., calculated and measured overall energy performance, zoning, energy balance, etc.).

The proposals to be included within EPC schemes within this category are listed below.

3.1.1. Multi-purpose energy assessment



A building energy assessment employs valuable information with different purposes. This information can be properly post-processed to meet several different objectives (e.g., mandatory energy requirements, objective comparison, knowledge about the existing building sector, recommendations about EEMs, etc.).

Depending on the target audience, the energy assessment and the EPC would cover different needs:

- For the central administration, the main objective is to improve knowledge regarding the current buildings sector in order to promote policies for renovation. In this case, all information currently included within the EPC is necessary (e.g., overall indicators of primary energy and CO_2 emissions, sizes, buildings categorisation, etc.). In this context, it would be useful if certain parameters of the energy assessment were dynamic (e.g., continuous updating of primary energy conversion factors and rating system (scales) should be possible in order to be in line with European targets).
- For energy auditors, manufactures and companies that are trying to introduce some products into the market, besides the total energy use, it is necessary to include partial indicators (e.g., the energy use for one specific purpose, the energy need for space heating and cooling, the characteristics of the fabric or of the technical building systems).
- The information most relevant to building end users are the energy class (label) and the accompanied tailored recommendations which show how much their buildings' energy efficiency can be improved. An important part of the information in the EPC is for end-users not understandable without the correct interpretation by an EPC assessor. It is therefore necessary to improve the information provided to end users, to include partial and overall indicators that are easily understandable by an inexperienced end user (e.g., overall annual energy costs).

A flexible and accurate energy assessment that caters for multiple purposes (e.g., energy audit, regulation requirements, tailored recommendations, energy use forecasting, user oriented, etc.) through a common backbone but with data post-processing and tailor-made outputs, would be able to cover the whole range of stakeholders' needs.

3.1.2. Calibrated energy model

The inverse uncertainty analysis (also called model calibration) determines unknown variables through mathematical models from measurement data. Therefore, model calibration enables fine-tuning of model input parameters so that the simulation results can closely match the actual performance (Figure 3).

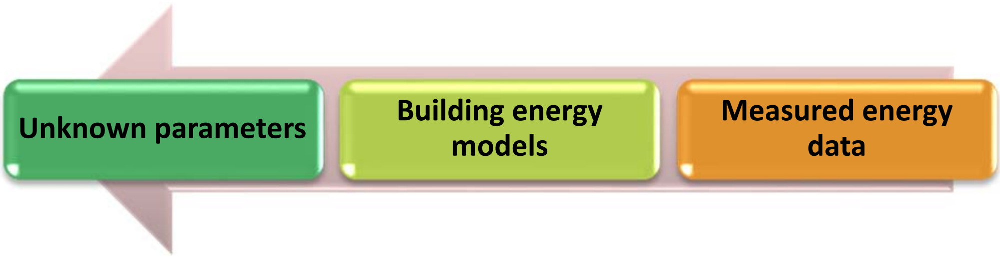


Figure 2: Inverse uncertainty analysis in building performance analysis scheme (model calibration).

Prior to inverse uncertainty analysis, sensitivity analysis is often used to select important variables because it is difficult and computationally inefficient to infer a large number of uncertain parameters in model calibration.

Despite the multiple benefits of using dynamic and calibrated simulation modelling for energy assessment, traditional calibration procedures are time intensive and require specially trained personnel with expert knowledge. To reduce the computational effort of these methods, the ePANACEA project aims to develop an auto-calibrated procedure that will allow developing the model faster than traditional approaches. This auto-calibrating procedure will be based on the use of artificial intelligence and machine learning techniques (Figure 3).

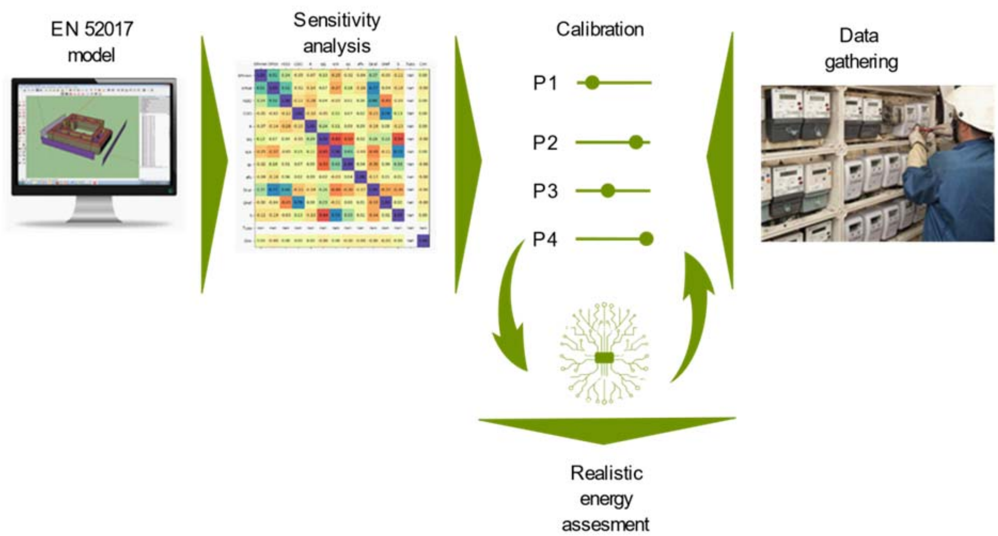


Figure 3: Semi-autocalibration scheme.

3.1.3. Dynamic Simulation

Advanced dynamic simulation techniques allow a high level of accuracy as well as qualitative outputs for any assessment object, including; (1) prediction of building energy performance (e.g., corrected by climate), (2) disaggregation of consumption per energy service and/or type of fuel (energy balance), (3) identification of energy efficiency measures (tailored recommendations) and (4) estimation of potential energy savings and economic viability calculation.

Reducing the calculation time step (to one hour or less) implies a higher computational cost but also a higher accuracy and an broader range of results. This could allow evaluation and recommendations based on complex and smart technologies, depending on hourly behaviour (e.g., based on real-time-pricing, Demand Side Management, on-site generation, self-consumption, etc.).

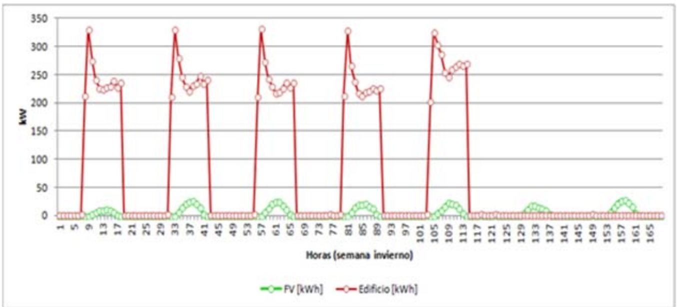


Figure 4: Example of dynamic simulation's results for a PV installation

The highest accuracy level is achieved with the use of dynamic simulation in combination with calibrated simulation modelling, using actual consumption data and other measured data (e.g., indoor temperatures, weather data, etc.) to adjust the model.

Nowadays, there is a high number of dynamic simulation engines with proven functionalities available. Some of the main handicaps to carry out high quality dynamic simulations are: (1) high quality input data and expert knowledge about the software tool are required and (2) manual post-processing of results for each purpose can be extremely time consuming.

Besides, the ISO 52017 standard establishes a common framework for the calculation of energy demands with several calculation intervals, including hourly interval calculation.

3.1.4. Automated data gathering from available servers

Accurate results need accurate models but also access to good quality data. Two key data flows available from current servers are identified: weather data (i.e., from meteorological agencies) and energy consumption data (i.e., from utilities).

One of the main barriers when carrying out energy performance assessments is the acquisition of data, specifically, for model calibration and measured overall energy performance:

- weather data for the assessed period
- actual energy consumption data of the building for the assessed period.

The ePANACEA project aims to propose the development of standardised formats for the information exchange necessary for the energy analysis of buildings. If such standardised formats were imposed by regulation across the European Union, an important obstacle for the energy assessment of buildings in real conditions would be overcome.

In this way, a standardised computer file format for the exchange of information between all meteorological servers in Europe will be proposed in order to prevent that each technician has to post-process this information to obtain the climatic data needed for any energy analysis related to ISO 52000, both in monthly and hourly values.

Accordingly, the different utility companies offer information about the actual consumption of their customers, but they do it in a very different way. The ePANACEA project will develop and propose a standardised format for this information. This innovation opens the door to an automatic communication for the energy audits and for the monitoring and alerting services of the energy consumption in buildings.

3.1.5. Use of on-board monitored data

With appropriate methods, the use of on-board monitored (OBM) data in energy performance certification schemes could allow to:

- derive input parameters (e.g., U-values, thermostat set points, DHW demand, occupant behaviour profiles, etc.) for EPC calculations to improve or provide missing input parameters for both simplified and dynamic energy performance simulation methods;
- verify (and potentially directly certify) the energy performance of buildings, building components or specific energy flows comprising the building energy balance.

For both potential usages, data processing techniques are needed to post process OBM data, e.g., to disaggregate energy use over building fabric, systems and occupant influences, or to derive parameter information through inverse modelling approaches. In recent years, a great body of academic research has focused on the topic of inverse modelling and data processing, e.g., in the work of IEA EBC Annex 71. The ePANACEA project will evaluate their suitability in the framework of EPC assessments. This includes considerations on representativeness and robustness of the characterisation, required resources and viability of the data gathering (e.g., number and sensitivity of sensors required) and uncertainty on the characterisation outcomes.

The use of OBM data (e.g., zone temperatures, ventilation flow rates, energy use for each service, etc.) obtained for instance via the building management system (BMS) enables fine-tuning of the building model (model calibration) with different levels of accuracy (Figure 5).

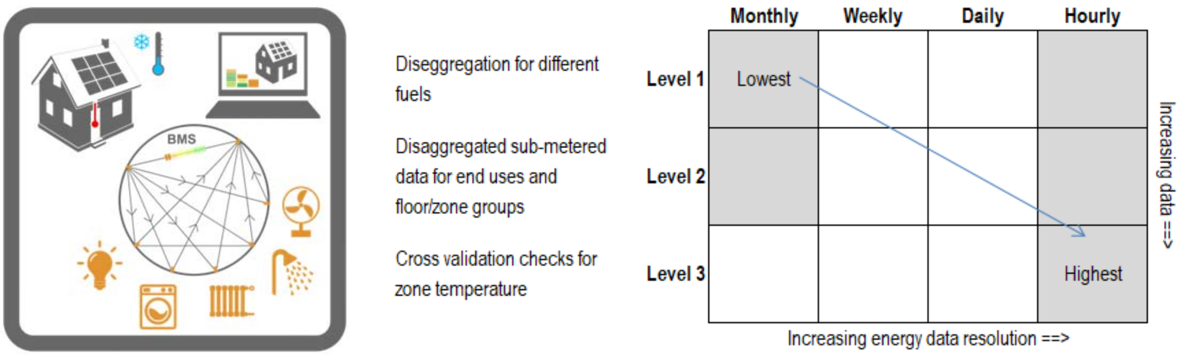


Figure 5: On board monitored data scheme / levels of calibration's accuracy according to available data

3.1.6. Energy use forecasting

An accurate and calibrated energy model is able to predict the future energy use under different hypotheses of user behaviour and weather forecasts (Figure 6). The energy use forecasting can allow the operational optimisation of the building, providing several benefits, e.g., energy efficiency, user comfort and energy costs optimisation. However, this feature probably goes beyond the EPC requirements and could be better used in the context of energy performance contracts.

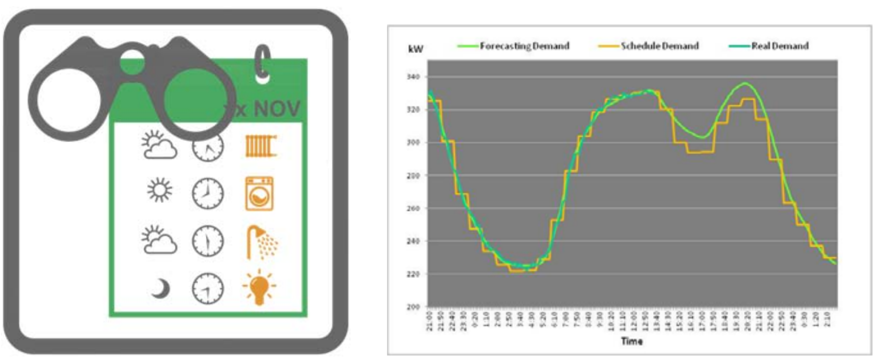


Figure 6: Energy forecasting

3.1.7. Uncertainty and parametric analysis

An uncertainty analysis implies the addition to the energy assessment of some probability distribution for uncertain parameters, which also implies carrying out a parametric analysis.

A number of factors which are influencing the buildings' energy use are inherently uncertain (e.g., assumptions regarding occupancy and building use, among others). Forward uncertainty analysis propagates input uncertainty through building energy models to obtain variations of energy use. Adding the impact of uncertainty in building performance simulation can aid decision making (Figure 7).

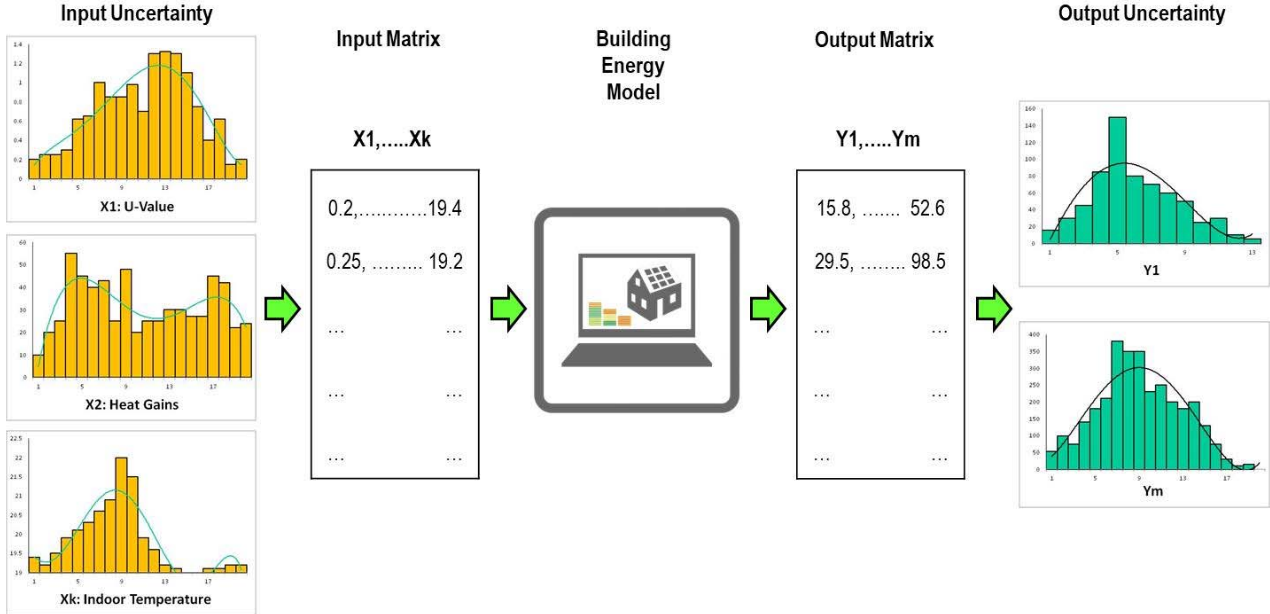


Figure 7: Uncertainty assessment scheme.

3.1.8. Implementation of semi-automated tools for including the impact of smart and novel technologies

Smart and novel technologies such as energy flexibility to the grid, on-site energy generation, storage, demand side management and electric vehicle charging infrastructures, are key aspects for meeting the objective of the EU (100% renewable energy sources in 2050). The implementation of these aspects (example in Figure 8) into the energy assessment and EPC schemes will allow quantification of their impacts, mobilise investment in such technologies and allow for their mass introduction into the EU buildings stock.

Energy transition implies implementation of new technologies and their proper combination, mainly focusing on electricity-based technologies (e.g. heat pumps, RES and control strategies like DSM).

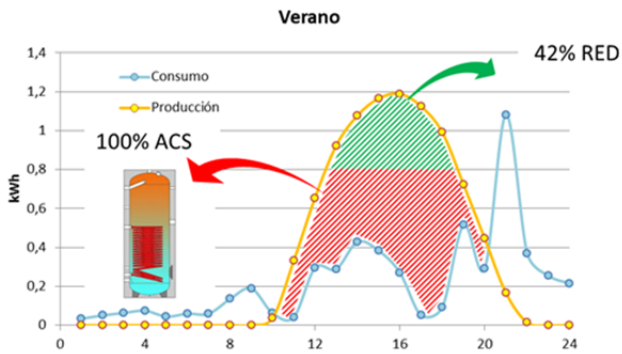


Figure 8: Example of DSM with on-site electricity production and thermal storage

3.1.9. As built energy use measurement and/or monitoring (new buildings)

Including in the EPC scheme and energy assessment the as built (in use) energy use measurement could be used as a verification measure after retrofitting of existing buildings, helpful to instill trust in the market regarding the EPC, or for an as-built (in use) calibration in the case of new buildings.

3.1.10. Advancing occupant modeling for dynamic energy assessments

The occupant behaviour may result in a difference in energy use by a factor of two or more, even in buildings with a high degree of automation. Common current occupant modelling approach is based on standardised schedules. This implies: (1) model predictions are inaccurate compared to measured performance and (2) inaccurate model predictions lead designers, policymakers, and other decision-makers towards non-optimal decisions.

Latest research development in occupant modelling includes: IEA-EBC Annex 66 "Definition and simulation of occupant behaviour in buildings" and Annex 79 "Occupant-centric building design and operation". According to recent research the next generation of occupant models should be dynamic, stochastic, agent-based and data-driven models.

The exploration of the impact and possible inclusion of advanced occupant models could be focused on six occupant-related domains: (1) occupancy (presence), (2) lighting, (3) plug-in equipment, (4) window shade, (5) operable window and (6) thermostat.

3.2. Application

This section addresses the application range of EPC procedures, e.g. whether the EPC applies for sale, rent, new building design or after construction, public or other buildings, etc.

In this context two more ambitious proposals to the current national requirements are suggested below, although 3.2.1 is sometimes present at regional level.

3.2.1. Mandatory with Technical Building Inspection

Most citizens and end-users are unfamiliar with the EPC, its possibilities and use. A way to maximise end user awareness is to widen the EPC application beyond the current scope of rent, sale or major renovation of buildings (when the decision is already taken). It could at least be mandatory when a technical building inspection is required because of functional and security reasons.

3.2.2. Mandatory for all buildings

The most ambitious option would be to establish a mandatory requirement for all buildings, gradually covering the whole building stock from older buildings to more recent ones.

3.3. Type of energy performance assessment

This key aspect of EPC schemes is related to the specification of the type of the assessment used according to ISO 52000-1 standard, covering the options included in Table 1.

Table 1: Types of energy performance assessment and their application

Type	Subtype	Input data			Type of application
		Use	Climate	Building	
Calculated	Design	Standard	Standard	Design	Building permit, certificate under conditions
	As built	Standard	Standard	Actual	Energy performance certificate, regulation
	Actual	Actual	Actual	Actual	Validation
	Tailored	Depending on purpose			Optimisation, validation, retrofit planning, energy audit
Measured	Actual	Actual	Actual	Actual	Monitoring
	Climate corrected	Actual	Corrected to standard	Actual	Monitoring or energy audit
	Use corrected	Corrected to standard	Actual	Actual	Monitoring
	Standard	Corrected to standard	Corrected to standard	Actual	Energy performance certificate, regulation

The type or types or assessment can be specified depending on the application and/or building category. If the measured energy performance assessment is not corrected to cover the same building services and assumed operational conditions for the calculated option, these two types of energy performance assessment cannot be compared.

Then, the possible options to be evaluated within the project context are listed below.

3.3.1. Calculated

The assessment is mainly based on calculation under standard operational conditions. It usually shows a poor level of accuracy but it is the only manner for EPC development in the case of new buildings at the design phase without actual consumption data available. The calculation intervals (e.g., hourly, monthly, seasonal or yearly) will be consistent throughout the whole calculation.

3.3.2. Measured actual

The assessment is based on actual consumption data. It is only valid for existing buildings in use and needs a specific associated rating system, since it does not imply any data correction (i.e., neither by weather nor operation). The output of the method is in principle the same as the output from the calculated energy performance (e.g., primary energy use) but with restrictions regarding parameters that cannot be measured (e.g., contribution of renewable energy sources).

This method could be supported by a calibrated model for better understanding of energy flows inside the building.

3.3.3. Measured standard

Within the measured standard method, the assessment is again based on actual consumption data but this time, the measured energy needs corrections and /or extrapolations in order to correct actual to standard operational conditions. Although this method presents the best potential in relation to accuracy and multi-target assessments, it also requires a tailored approach and expert knowledge in order to develop corrections with a reasonable accuracy.

3.4. Numerical indicators (overall energy performance indicators)

This key aspect of the EPC implies the specification of what the overall numerical indicator represents, and specifically, which services are included and if renewable energy produced on site is part of delivered energy or not, and if exported energy is taken into account. The overall energy performance is represented by one or more overall indicators, which are weighted delivered energy minus the weighted exported energy, determined according to ISO 52000-1.

The weighted energy performance can be calculated for primary energy (which can be non-renewable (E_{Pnren}), renewable (E_{Pren}) and total (E_{Ptot})), greenhouse gas emissions, costs and other overall indicators.

According to the EPBD 2018 (Annex I):

> *The energy performance of a building shall be determined on the basis of* **calculated or actual energy use** *and shall reflect typical energy use for* **space heating, space cooling, domestic hot water, ventilation, built-in lighting** *and other technical building systems.*
>
> *The energy performance of a building shall be expressed by a numeric indicator of* **primary energy use in kWh/m²·y** *for the purpose of both energy performance certification and compliance with minimum energy performance requirements.*

Then, the most typical overall energy performance indicators for EPCs at the moment are based on non-renewable primary energy use (see Figure 9) and greenhouse gas emissions, normalised to building size (reference floor area). Services included are typically heating, cooling, domestic hot water, ventilation and lighting only for tertiary buildings.

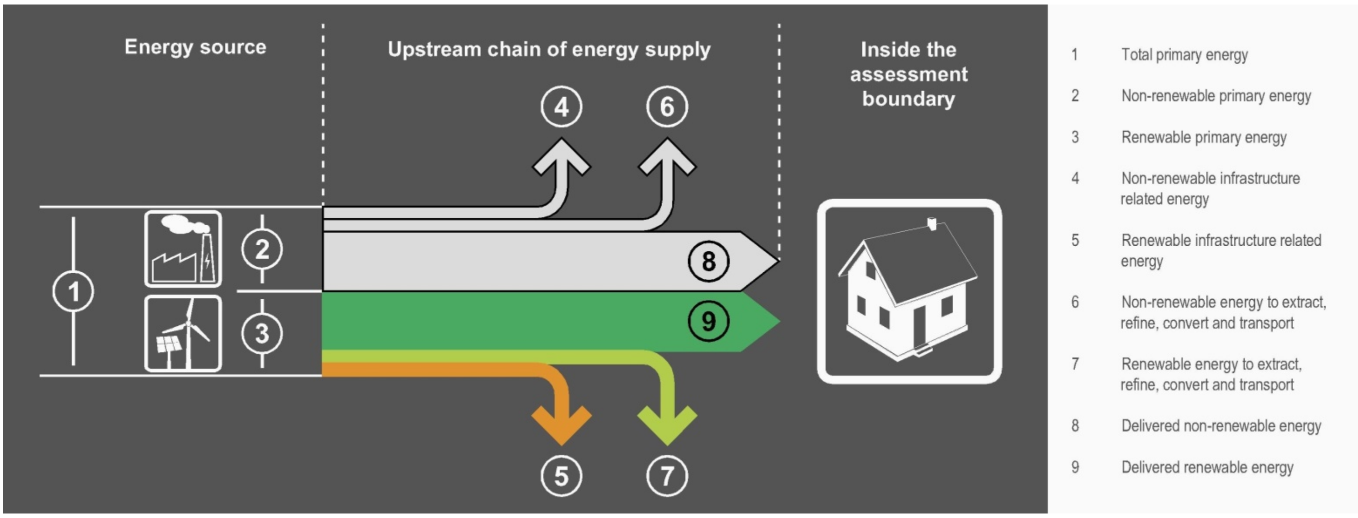


Figure 9 : From energy source (primary energy) to energy use inside the assessment boundary

Taking all of this into account, several strategies to overcome the challenge of the gap between overall energy performance indicator for EPCs and actual energy performance and to improve user friendliness of the EPC, are proposed below.

3.4.1. Energy performance Services + Appliances

The fact that the main indicator of the EPC does not include all building's services is one of the reasons (although not the only one) that explains the big gap between calculated indicators and the actual energy consumption of the building. Including the rest of equipment and services could provide a major understanding from the building end user perspective and allow the identification of new recommendations for energy savings. For instance, this section proposes an indicator that not only includes energy performance services according to EPBD 2018 but also the energy consumption related to residential appliances and/or office equipment.

3.4.2. Energy performance Services + Appliances + eMobility

The scenario of energy transition with a high penetration of e-mobility implies that e-vehicle charging infrastructure becomes relevant in the building sector. Besides, vehicle batteries could be used as an energy backup, allowing the optimisation of renewable energy use in buildings and homes. In this way, this service should be included in the overall energy performance

3.4.3. Electric energy from RES used on-site and exported to the market

An important aspect to support the energy transition is the implementation of EEMs based on on-site renewable electricity production (inside the building boundaries or in the neighbourhood).

Therefore, the quantification of the fraction from on-site electricity production which is consumed inside the building and the fraction that is exported to the grid is relevant so that it should be included within the main numerical indicators. These values are important from both a regulatory (i.e., improvement of the knowledge about the building stock and allowing an objective comparison), a technical (e.g., energy auditors which need these values in order to carry out a feasibility analysis) and an economic point of view.

The energy flows related to these concepts (i.e., electric energy from RES used on-site and primary energy associated with energy exported to the market) are highlighted in Figure 10.

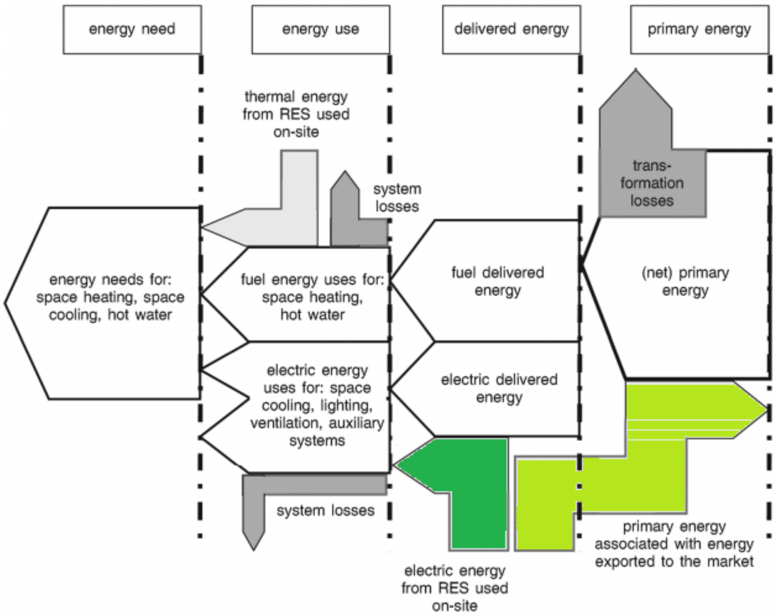
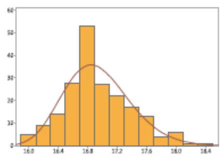


Figure 10: Primary energy use calculation scheme. Source: Guidelines accompanying DR (EU) Nº244/2012

3.4.4. Energy cost [€/m² year or €/year] [€/m² month or €/month]

End users do not usually understand the practical meaning of current overall energy performance indicators (i.e., primary energy use, greenhouse gas-emissions, etc.). These types of indicators are useful for the objective comparison of the building stock carried out by the Administration, but it is not user-friendly from a non-expert end user's point of view. An indicator based on energy costs (e.g., per year, per month or per day) will be much more intuitive and engaging for end users. The cost weighting factors will be in line with EN 15459-1 and will be expressed in currency unit per kWh.

3.4.5. Uncertainty



If an uncertainty analysis is carried out (see section 3.1.7), the overall energy performance indicator could be expressed as a probabilistic instead of a deterministic result as is usually done. This approach could justify the gap between calculated and actual energy performance due to intrinsic uncertainties of the calculation procedure. This approach is very interesting from a scientific point of view but on the other hand includes a complexity that will hardly be understandable from an end user's perspective.

3.4.6. Based on actual energy use

With this approach, the main indicator oriented towards building end users (non-experts) should be based on actual consumption data, since this information is understandable and useful for decision making. This indicator should be based on actual energy costs or another parameter that can easily be translated to the national currency by end users (e.g., energy use).

3.5. Normalisation

Normalisation means the specification of how the overall numerical indicators are normalised for the size of the building.

3.5.1. Common definition for m2 of building area

Sometimes, a clear definition for the reference floor area is missing and different terms are used to indicate this, among which build area, habitable area, useful area, conditioned area, etc. Since the reference floor area has a big influence over energy performance indicators, the fact that different terms are used directly implies interferences in the objective comparison between buildings.

ISO 52000-1

$$Y = \frac{X}{S} = \frac{X}{\sum(f_{ref;cat,j} Ssp, i}$$

Where:

X	quantity to be normalised
S	reference size of the assessed object
Y	normalised quantity
$S_{sp,i}$	size of the space i in the assessment object
$f_{ref;cat,i}$	the fraction of contribution of the reference size, for the space category j to which space i belongs

Establishment of common and clear criteria, and their definition for the normalisation procedure according to the building size would contribute to harmonisation across the EU.

All Member States have competences to develop their own definitions for calculating the reference size of the assessed object. However, ISO 52000-1 provides a default definition through Annex B (informative) and tables B.20, B.21 and B.22. The adoption of this definition is proposed and will be used within the whole ePANACEA project context and its methodology development for normalisation purposes.

3.6. Reference Values

Within the context of European EPCs and following the ISO 52000 series guidelines, each Member State can develop its own procedure to define reference values. The number of the reference values (i.e., one or two) and the procedure implemented for their calculation enable the definition of a rating system. The references for the (overall or partial) energy performance can be basically fixed values or variable values. The choice of the type of reference values and the hypothesis to develop them need special attention since they have an important impact over the final EPC outcomes, associated policies and energy performance regulations.

A common choice about this key aspect at EU level would contribute to EPC harmonisation and comparison of the building stock across the European Union.

3.6.1. Fixed values

The reference values are fixed (constant) numeric values, regardless of specific characteristics of each individual project.

3.6.2. Variable value

The reference value is a variable numeric value (a function) tailored to the specific characteristics of each individual project.

For instance, this is the case within the current Spanish EPC scheme for the tertiary sector. Each project (or assessed object), is evaluated against a specific reference building with the same geometry and use characteristics as these of the assessed object but meeting the minimum energy performance requirements of the current regulation (i.e., thermal transmittances for the envelope, efficiency of technical building systems, etc).

3.6.3. Average of the building stock

The reference value could be based on the average of the current building stock, for instance the median value (50th percentile). This approach implies a dynamic rating system due to the possible evolution of the building stock but a minimum of five years between changes is recommended by the Standard ISO 52003.

Different reference values could be defined (and highly recommended) according to the building class, for instance single-family houses, apartment blocks, offices, education buildings, hospitals, hotels and restaurants, sport facilities, wholesale and retail trade service buildings, and other types.

These reference values could be (i) directly extracted from a statistically significant sample of the current building stock (i.e., measured energy performance) or (ii) calculated (simulated) through a parametric analysis with a sample of reference buildings with different characteristics of the fabric and the technical building systems, according to their building age.

It is necessary to highlight that the first option (i) would need corrections (e.g., by climate, operational conditions and services) if the rating system used is based on standard conditions instead of actual conditions or if it only includes energy performance services instead of all services.

3.7. Additional Indicators

The next generation of EPCs could be complemented with other relevant information associated with the sustainability of the building and its environment, going beyond the energy performance. Several additional aspects can be taken into account through both approaches: calculated (e.g., building modelling) and measured.

3.7.1. Comfort

Comfort is a key aspect, directly linked to the building's energy performance. It is, among others, directly related to the temperature inside the building that impacts the overall energy performance.

Providing information about thermal comfort is mainly associated with the operative temperature (i.e. the mean of air temperature and mean radiant temperature), humidity ratio and air speed.

The information can be analysed and provided through numerical thermal comfort indicators based on current comfort models (e.g., Fanger) or through a graphic area over the psychrometric chart (Figure 11) where the operational conditions (i.e. temperature and humidity) for each hour are included in order to check their compliance with the comfort model (i.e., region highlighted). Data required to provide information about IEQ could be extracted from building models or via on-site measurements.

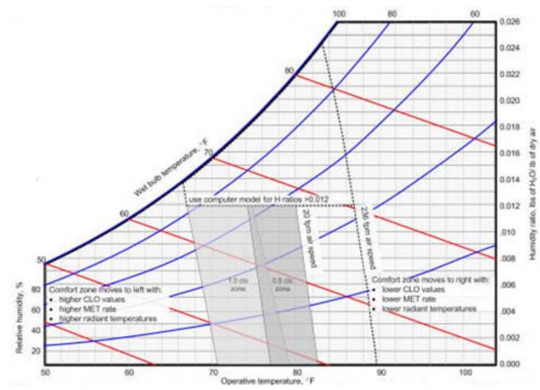


Figure 11: Example of representation of the comfort region over the psychrometric chart

3.7.2. Indoor Air Quality (IAQ)

Indoor air quality is associated with human health and healthy buildings. Indoor air quality is influenced by outdoor air quality but also by different sources of indoor air pollutants, e.g., construction materials and human breathing.

Today, indoor air quality takes a vital position as an effect of the COVID-19 pandemic. Monitoring of certain contaminants inside the building would enable the establishment of minimum air flow rates for ventilation.

Indoor air quality implies, among others, providing information about concentration of main indoor air pollutants, i.e. carbon monoxide (CO), nitrogen dioxide (NO_2), asbestos, radon (Rn), formaldehyde, etc.

3.7.3. Smart Readiness Indicator (SRI)

Directive 2018/844/EU establishes a common framework for the voluntary adoption of the Smart Readiness Indicator (SRI) at MS level. The smart readiness indicator should be used to measure the capacity of buildings to use information and communication technologies and electronic systems to adapt the operation of buildings to the needs of the occupants and the grid, and to improve the energy efficiency and overall performance of buildings. The integration of this new indicator (SRI) within current EPC schemes could be a good option in order to optimise the effort dedicated to data gathering and provide relevant information to mobilise building renovation based on building automation and control systems.

The methodology referenced in the Delegated and Implementing Regulation supplementing Directive 2010/31/EU published by the European Commission in October 2020, is defined as a rating system based on a matrix of weighted factors according to a catalogue of intelligent services, classified in nine domains (i.e., heating, DHW, cooling, ventilation, lighting, dynamic building envelope, electricity, electric vehicle charging, and monitoring and control) and assessed under seven impact criteria (i.e., energy saving on-site, maintenance and fault prediction, comfort, convenience, health and wellbeing, information to occupants, grid flexibility, and storage) (Figure 12).

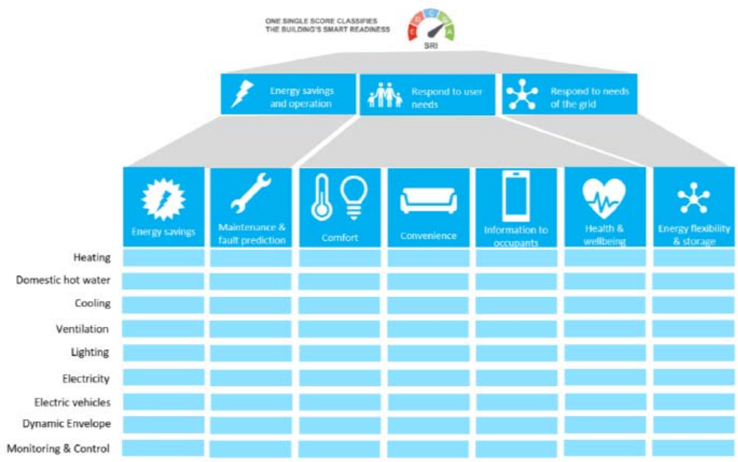


Figure 12: SRI scheme - 2nd SRI study (June 2020)

3.7.4. Water Consumption

Information on water consumption (e.g., m^3/month, m^3/day, etc.) could contribute to the understanding of energy consumption related to domestic hot water and is also a relevant environmental factor.

3.7.5. Daylighting

An aspect that is continually included in international certification schemes is the assessment of daylighting access inside the building since this issue directly impacts both energy performance and human comfort (i.e., visual comfort).

Then, providing information regarding the availability of daylighting, e.g., number of hours per year with sufficient daylighting to reach the set point of mean luminance appropriate for the space use (e.g., 500 lux in office spaces), could be interesting.

3.7.6. Partial energy performance indicators

Besides overall energy performance indicators, partial energy performance indicators are needed for the identification of the most efficient energy efficiency measures. Overall energy performance indicators provide useful insights into the potential for achieving global energy efficiency , but partial indicators allow quick prioritisation.

Partial energy performance indicators most commonly used are related to:

- the energy use of one specific service (e.g., heating, cooling, domestic hot water, lighting, ventilation, humidification and dehumidification);
- the energy need for space heating and space cooling;
- the characteristics of the fabric or of the technical building systems considered as a whole (e.g., heat transfer coefficient of the thermal envelope, efficiency of heating, hot water or cooling systems, efficiency of lighting systems);
- the characteristics of elements of the building fabric or of the technical building systems (e.g., thermal transmittance of walls, efficiency of boilers or heat pumps, insulation of heating and/or hot water pipes, specific fan power, efficiency of auxiliary equipment).

3.8. Recommendations

This section includes possible options for procedures and criteria to assess the recommendations which will finally be included in the EPC report in order to promote energy efficiency and support technicians and end users to evaluate and understand the energy efficiency potential of their projects or buildings/homes.

3.8.1. Based on cost-optimal analysis

In order to instil trust in the market and mobilise investments, EPC schemes should include harmonised economic and viability analysis based on energy saving estimation. The integration of the cost-optimal methodology as a reference (DR 244/2012) into the certification schemes would allow the systematic evaluation of packages of efficiency measures instead of isolated measures and the identification of the optimal choice for each assessment object.

However, individual implementation of the whole procedure could be too time consuming and increase the EPC costs. This issue will be covered by next tasks within the project.

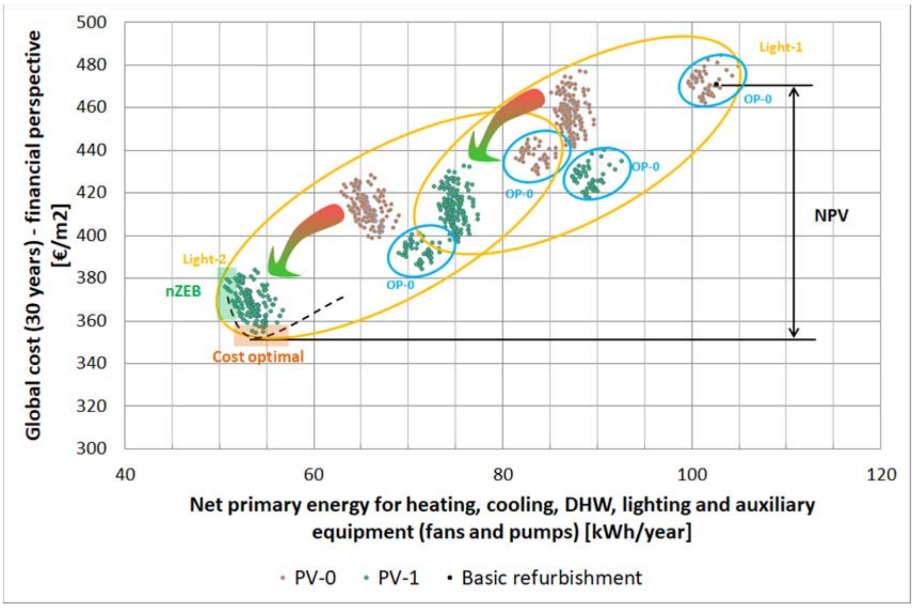


Figure 13: Application of the cost-optimal methodology in a refurbishment project.

3.8.2. According to a specific target

In line with the cost-optimal methodology, tailored recommendations could not only be based on the assessment object but also on meeting a specific target. For instance:

1. Cost-optimal target or combination of measures which imply the minimum global cost (i.e., refurbishment investment plus operational costs like energy costs and maintenance costs)

2. Nearly zero-energy building (nZEB) target or minimum consumption of non-renewable primary energy consumption

3. Plus Energy Building (PEB) target or when a building generates more energy than it consumes within the annual energy balance.

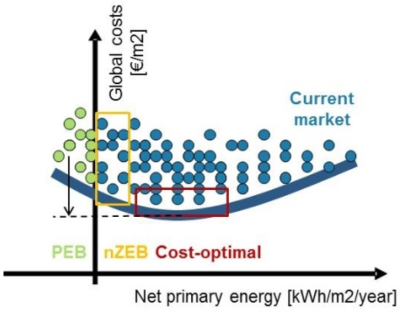


Figure 14: Graphical representation of targets over the cost-optimal chart

3.8.3. Roadmap

In relation to building passports, EPC recommendations could include a tailored roadmap for each assessment object in order to meet energy efficiency targets through staged deep renovations (Figures 17 and 18).

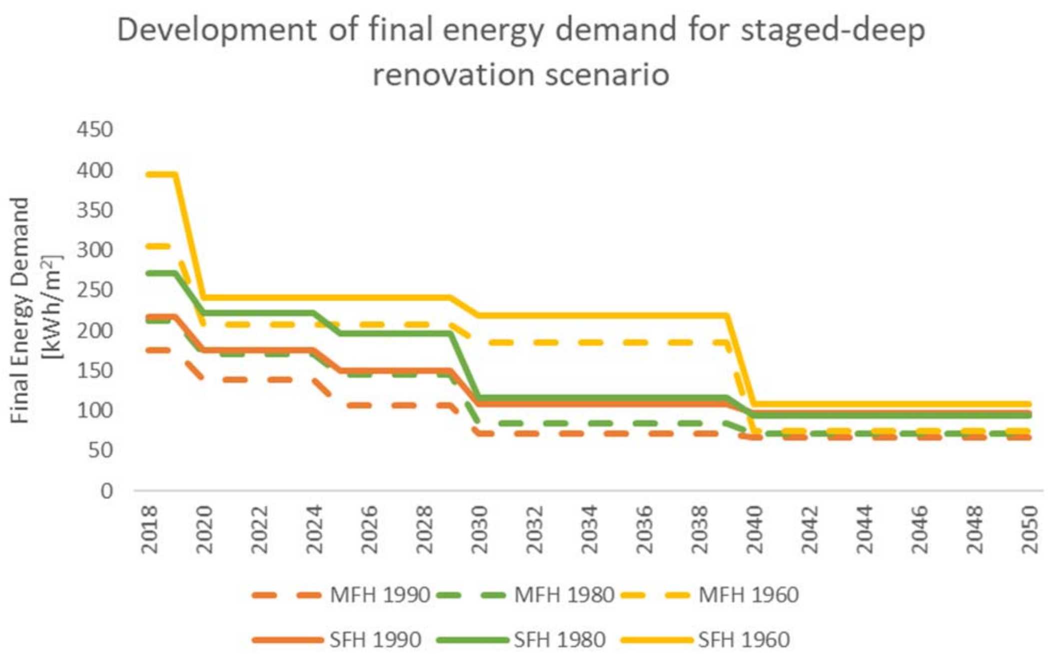


Figure 15: Development of final energy demand for staged deep renovation scenario. Source: [Fritz et al., Planned staged deep renovations as the main driver for a decarbonised European building stock, in eceee Summer Study proceedings 2019](#) .

	ENERGY CLASS G	ENERGY CLASS E	ENERGY CLASS D	ENERGY CLASS B	ENERGY CLASS A
	Your Building Moment of delivery	Renovation Step 1 When Boiler needs to be exchanged	Renovation Step 2 2025 - 2030	Renovation Step 3 2030 - 2035	Renovation Step 4 2035 - 2040
Measures		**Measures** • Add a thermal solar system	**Measures** • External Wall insulation	**Measures** • Substitution of the old windows • Roof insulation	**Measures** • Installation of a heat recovery unit • Substitution of the heating system by a heating pump
Energy Use	**Primary Energy Demand** 250 kWh/m²a	**Primary Energy Demand** 210 kWh/m²a	**Primary Energy Demand** 160 kWh/m²a	**Primary Energy Demand** 100 kWh/m²a	**Primary Energy Demand** 100 kWh/m²a
	Main Energy Source Natural Gas	**Main Energy Source** Natural Gas	**Main Energy Source** Natural Gas	**Main Energy Source** Natural Gas	**Main Energy Source** Electricity
	Final Energy Demand Main Source 200 kWh/m²a	**Final Energy Demand Main Source** 200 kWh/m²a	**Final Energy Demand Main Source** 150 kWh/m²a	**Final Energy Demand Main Source** 80 kWh/m²a	**Final Energy Demand Main Source** 30 kWh/m²a
	Final Energy Demand second Source 0 kWh/m²a	**Final Energy Demand second Source** 15 kWh/m²a	**Final Energy Demand second Source** 15 kWh/m²a	**Final Energy Demand second Source** 15 kWh/m²a	**Final Energy Demand second Source** 15 kWh/m²a
	Auxiliary Energy Source Electricity	**Auxiliary Energy Source** Electricity	**Auxiliary Energy Source** Electricity	**Auxiliary Energy Source** Electricity	**Auxiliary Energy Source** Electricity
	Final auxiliary Energy Demand 30 kWh/m²a	**Final auxiliary Energy Demand** 15 kWh/m²a	**Final auxiliary Energy Demand** 15 kWh/m²a	**Final auxiliary Energy Demand** 15 kWh/m²a	**Final auxiliary Energy Demand** 15 kWh/m²a
	Energy Bill 4600 €/a	**Energy Bill** 2300 €/a	**Energy Bill** 1800 €/a	**Energy Bill** 1100 €/a	**Energy Bill** 900 €/a

Figure 16: Sample detailed roadmap. Source: [iBRoad training toolkit]

3.8.4. Based on user behaviour

Provide recommendations about energy efficiency measures based on the end user behaviour (e.g., reduce the temperature of the thermostat setpoint), and its respective impact (i.e., energy and related cost savings). These measures would, in most cases, not imply any investment but would instead involve end users and allow at the same time their engagement with energy efficiency issues, since they will verify that their behaviour directly impacts the energy bill.

3.8.5. Indoor Air Quality (IAQ)

Recommendations based on the improvement of indoor air quality (e.g., advice about ventilation flow rates or specific filtration for indoor air like adding HEPA filters). This could be especially relevant during the current pandemic where indoor air quality basically means healthy and safe buildings where humans live and work.

3.9. Energy performance rating

Each energy performance indicator needs to be compared to reference values in order to evaluate the good or poor performance of the feature under consideration (e.g., the overall energy performance indicator based on primary energy).

According to ISO 52003, there are three default options to express the energy rating on the basis of the value of the energy performance indicator compared to reference values:

1. Default energy rating method with **two reference points** (i.e., the energy performance regulation reference (Rr) and the building stock reference (Rs). For instance:

Class	Example
A+	EP ≤ 0
A	0< EP <0.5·Rr
B	0.5·Rr ≤ EP < Rr
C	Rr ≤ EP <0.5·(Rr+Rs)
D	0.5·(Rr+Rs) ≤ EP < Rs
E	Rs ≤ EP < 1.25·Rs
F	1.25·Rs ≤ EP < 1.5·Rs
G	1.5·Rs ≤ EP

2. Default energy rating method with a **single reference point** with classes' boundaries based on a nonlinear scale

$$Y = \sqrt{2}^{(n-nref)}$$

For instance:

Class	Example
A+	EP ≤ 0
A	0< EP <0.35·Ref
B	0.35·Ref ≤ EP < 0.5·Ref
C	0.5·Ref ≤ EP <0.71·Ref
D	0.71·Ref ≤ EP < 1.00·Ref
E	1.00·Ref ≤ EP < 1.41·Ref
F	1.41·Ref ≤ EP < 2.00·Ref
G	2.00·Ref ≤ EP

3. Any **other method** for energy rating.

3.9.1. Benchmarking based on actual energy use of the building stock

In line with the above third choice, another option for a valid rating system for an energy performance assessment based on measured overall energy performance is proposed below.

This concerns a dynamic rating system based on actual consumption data of the building sector, according to an appropriate classification per building typology and use. Percentiles identified for each class can provide a valid reference scale for rating (see Figure 17).

Percentile	Primary Energy [kWh/m2]	
0.2	74.8	
0.25	86.2	*25th Percentile*
0.3	93.6	
0.5	128.6	*50th Percentile*
0.7	169.6	
0.75	184.1	*75th Percentile*
0.8	200.2	

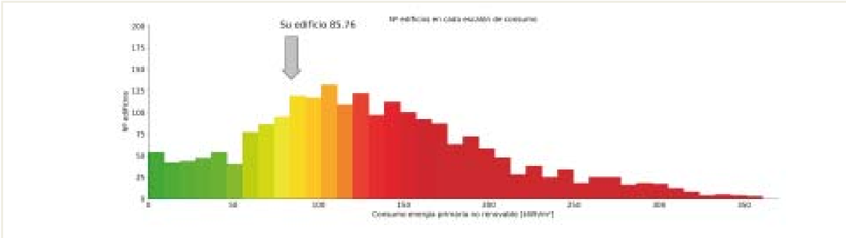


Figure 17: Example of an overall energy performance scale based on percentiles of actual consumption of the building stock.

3.10. Format

3.10.1. Target audience oriented

Based on a common energy assessment (1.1), the outcomes or results (mainly indicators) can be adapted according to the target audience (e.g., primary energy indicator for the administration, energy cost indicator for building end-users, economic feasibility of the EEMs for the energy auditor, etc.).

3.10.2. Double certificate

Double certificate: one oriented to the administration (legal requirement) that allows the understanding of the building stock, based on energy performance assessment type calculated or measured standard (section 3.3.1 and 3.3.3) and another one, actual use oriented, based on energy performance assessment type measured actual), that enables to show information that is understandable and user-friendly from the building end user perspective.

3.10.3. Common EPC report template for MSs

The development and use of a common template for the EPC report based on a similar procedure could contribute to facilitate convergence of quality of EPCs across the EU.

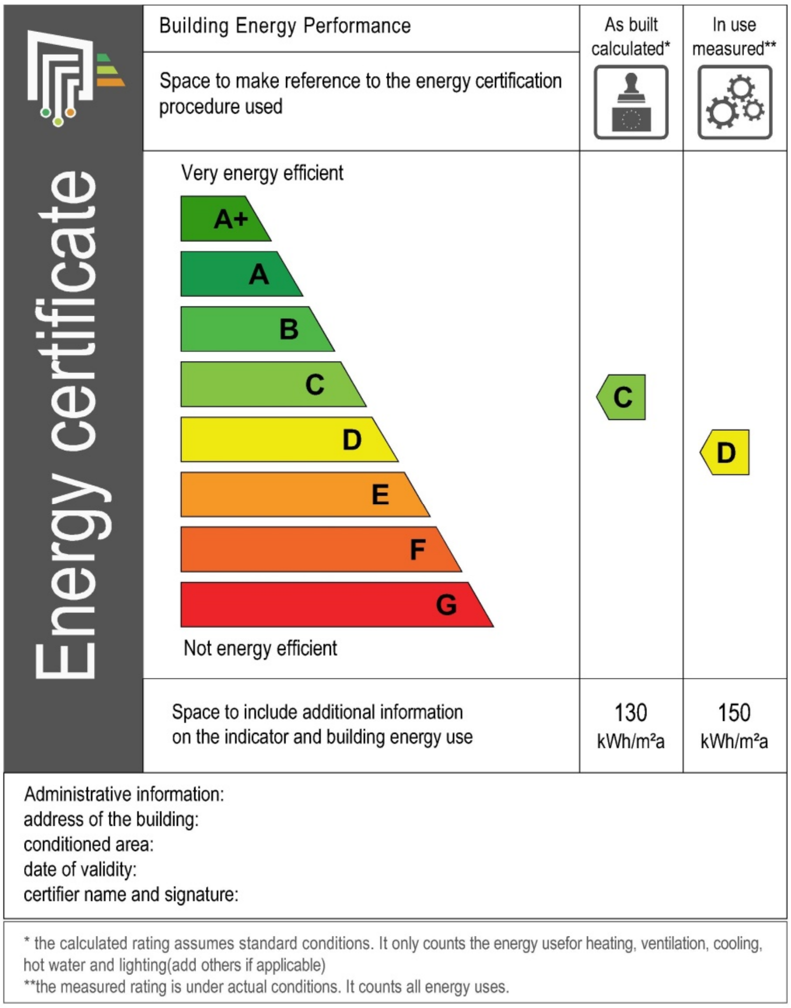


Figure 18: Example with two indicators: as build calculated and in use measured.

3.11. Central database and web tools

One of the most important parts of the certification procedure is to ensure that the data obtained from the energy performance certificates, which enable the description of the building stock, are stored in a structured way and in a centralised location (i.e., a database). Extending this concept, going beyond the database definition, a centralised web platform would allow to manage the whole EPC procedure, integrating all steps.

Some suggestions aligned with this approach are listed below.

3.11.1. Energy assessment and certification platform

This feature is based on the availability of a scalable software platform (and its related web tools) for enabling the Energy Performance Certification of buildings, in order to manage the whole energy assessment and certification procedure online. This platform will allow data storage which is helpful for feedback on the procedure itself (e.g., machine learning for energy model calibration, fine tuning of scales for the rating system, etc.).

The ePANACEA project aims to develop a prototype platform called SEPAP (Smart Energy Performance Assessment Platform) which will be a cloud platform for integration of the ePANACEA energy assessment and certification methodology, including artificial intelligence and machine learning techniques in order to improve the cost-effectiveness of the energy modelling.

3.11.2. Data base related to EEMs implementation

Databases, at MS level, including contacts related to EEMs implementation and their classification, i.e. energy efficiency assessors, builders, installers, etc.

3.11.3. Central cost database and description of EEMs

Databases, at MS level, including a detailed description and investment cost estimation for the implementation of the main EEMs for new buildings and major renovations of existing buildings.

4. EPANACEA APPROACH

4.1. Evaluation and prioritisation of new features

The new and innovative features proposed, as well as the features that have been included in the assessment for harmonisation purposes across the EU, have been already evaluated across the five ePANACEA pilot countries plus Germany and will next be discussed across the EU through the so-called Regional Exploitation Boards, whose members are stakeholders from all Member States.

The features proposed have been evaluated from five different perspectives and a weighted methodology has been implemented in order to prioritise the combination of the most suitable features to be included into the next generation of energy assessment and certification under the ePANACEA approach.

The weighted factors shown below have been defined according to the call's objectives and more specifically the ePANACEA project's objectives as follows:

- Harmonization (10%): Do you consider the feature helpful to meet the EPC's harmonization target at EU level?

  (High helpful – 1 / Medium helpful – 0.5 / Low helpful – 0)

- Implementation feasibility (20%): Do you think the implementation of this new feature within the current EPC scheme at your Member State is feasible? (High feasibility - 1 / Medium feasibility – 0.5 / Low feasibility – 0)
- Innovation level (10%): Do you think this new feature is innovative?

  (High innovative - 1 / Medium innovative – 0.5 / Low innovative – 0)

- Trust (20%): Do you think this new feature could contribute to instil trust in the market regarding the EPC and incite investments in energy efficient buildings? (Yes – 1 / No – 0)
- User friendliness (40%)

  (20%) Do you think this new feature improves the energy auditor's work in terms of user friendliness and quality?

  (Yes – 1 / No – 0)

  (20%) Do you think this new feature could contribute to user friendliness (better understanding of EPC and motivate decisions regarding energy efficiency) from the building end user point of view? (Yes – 1 / No – 0)

These aspects have been evaluated by ePANACEA's project partners (Figure 19) which are representatives from six different Member States: Austria, Belgium, Finland, Germany, Greece and Spain.

Partial and total scores obtained after the weighted assessment is shown in Table 2, where best scores have been highlighted according to a colour scale (from dark green-highest score to red/lowest score), allowing prioritisation of features.

Figure 19: Partners involve the internal assessment

Table 2: *Partial and total features' scores after being evaluated across the five pilot countries plus Germany.*

			Weighting factors						
Nº	MODULAR APPROACH		0.1	0.2	0.1	0.2	0.2	0.2	
	KEY ASPECT OF THE EPC SCHEME	Cod.	Harmonization	Implementation feasibility	Innovation level	Trust improvement	User-friendliness improvement		
							EPC Assessor	Building end user	Global score
1	ENERGY PERFORMANCE ASSESSMENT	3.1.1	0.36	0.42	0.50	1.00	0.50	0.50	0.57
		3.1.2	0.50	0.25	0.58	1.00	0.67	0.17	0.53
		3.1.3	0.25	0.58	0.50	0.83	0.17	0.17	0.43
		3.1.4	0.75	0.33	0.50	0.83	0.83	0.33	0.59
		3.1.5	0.50	0.25	0.92	1.00	1.00	0.50	0.69
		3.1.6	0.33	0.25	0.83	0.67	0.33	0.17	0.40
		3.1.7	0.08	0.17	0.50	0.67	0.00	0.17	0.26
		3.1.8	0.54	0.71	1.00	0.83	1.00	0.67	0.80
		3.1.9	0.46	0.38	0.50	0.83	0.83	0.83	0.67
2	APPLICATION	3.2.1	0.61	0.79	0.03	0.67	0.33	0.50	0.52
		3.2.2	0.53	0.19	0.03	0.67	0.50	0.33	0.39
3	TYPE OF EP ASSESSMENT	3.3.1	0.88	0.96	0.08	0.33	0.50	0.33	0.52
		3.3.2	0.46	0.38	0.58	0.67	0.17	0.50	0.45
		3.3.3	0.42	0.19	0.69	0.67	0.33	0.83	0.52
4	NUMERICAL INDICATORS (main energy indicators)	3.4.1	0.42	0.25	0.42	0.67	0.33	0.67	0.47
		3.4.2	0.33	0.17	0.75	0.50	0.33	0.50	0.41
		3.4.3	0.63	0.78	0.63	0.83	0.83	0.67	0.75
		3.4.4	0.36	0.61	0.33	0.83	0.50	0.83	0.62
		3.4.5	0.17	0.25	0.46	0.33	0.17	0.00	0.21
		3.4.6	0.36	0.28	0.36	0.33	0.17	0.33	0.29
5	NORMALIZATION	3.5.1	0.67	0.75	0.13	0.67	0.67	0.50	0.60
6	REFERENCE VALUES	3.6.1	0.67	0.50	0.17	0.33	0.83	0.33	0.48
		3.6.2	0.50	0.58	0.25	0.33	0.33	0.17	0.36
		3.6.3	0.42	0.25	0.25	0.50	0.33	0.33	0.35
7	ADDITIONAL INDICATORS	3.7.1	0.58	0.42	0.71	1.00	0.50	0.67	0.65
		3.7.2	0.61	0.28	0.61	0.33	0.33	0.50	0.41
		3.7.3	0.71	0.46	0.88	0.67	0.83	0.83	0.72
		3.7.4	0.50	0.58	0.25	0.50	0.50	0.67	0.53
		3.7.5	0.50	0.67	0.33	0.50	0.33	0.50	0.48
8	RECOMMENDATIONS	3.8.1	0.54	0.46	0.58	0.83	0.50	0.67	0.60
		3.8.2	0.88	0.71	0.50	1.00	0.83	1.00	0.85
		3.8.3	0.50	0.50	0.79	0.83	0.67	1.00	0.73
		3.8.4	0.33	0.33	0.50	1.00	0.33	1.00	0.62
		3.8.5	0.67	0.25	0.42	0.50	0.50	0.50	0.46
9	EP RATING	3.9.1	0.61	0.28	0.71	0.83	0.83	0.83	0.69
10	FORMAT	3.10.1	0.63	0.29	0.42	0.67	0.67	0.83	0.60
		3.10.2	0.46	0.29	0.58	0.33	0.50	0.67	0.46
		3.10.3	0.86	0.44	0.50	0.67	0.33	0.17	0.46
11	CENTRAL DATA BASE	3.11.1	0.79	0.38	0.83	0.83	1.00	0.50	0.70
		3.11.2	0.69	0.53	0.33	0.50	0.50	0.50	0.51
		3.11.3	0.53	0.28	0.53	0.50	0.33	0.50	0.43

4.2. ePANACEA scheme

The overall methodology concept for the ePANACEA methodology at the proposal phase is represented in Figure 22.

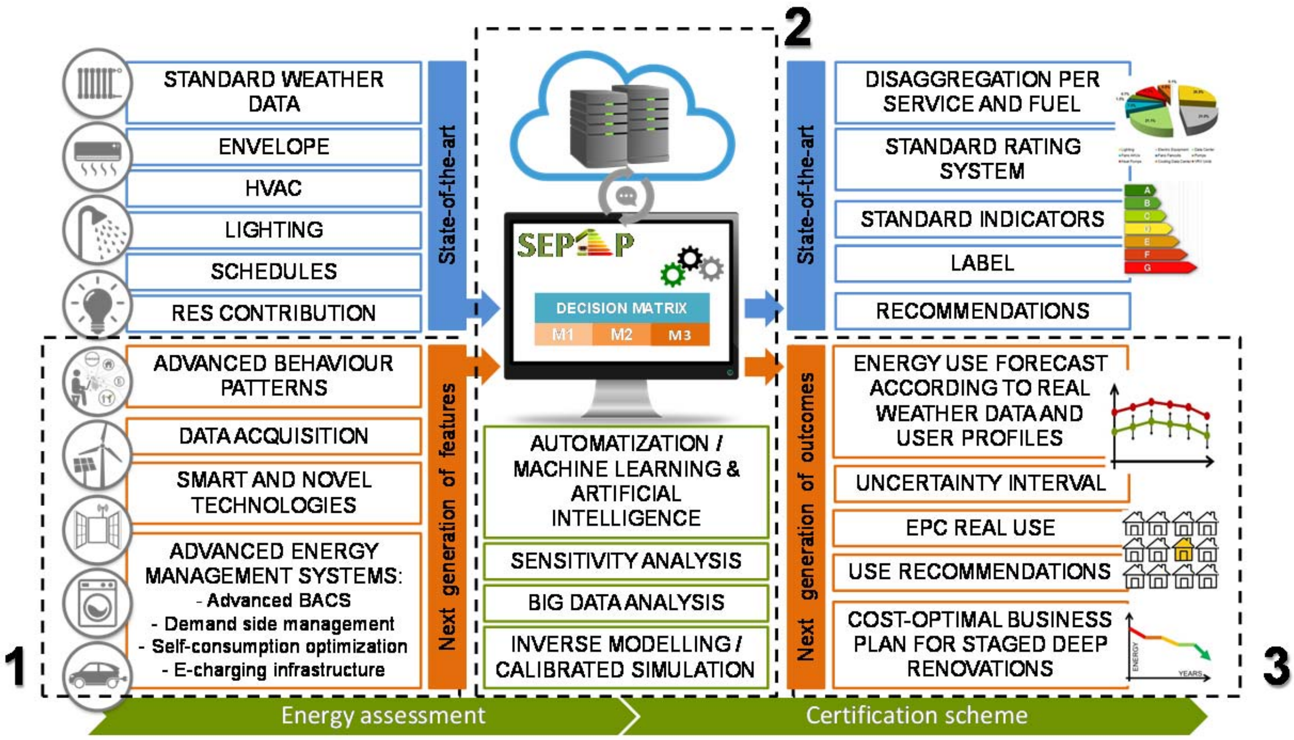


Figure 20: Overall concept for the ePANACEA methodology at the proposal phase.

This concept originally covered the issues listed below.

1. Next generation of buildings' features which have to be included within energy assessment and certification schemes:
    a. Advanced behaviour patterns
    b. Data acquisition
    c. Smart and novel technologies
    d. Advanced energy management systems
2. Next generation of tools (and their innovative capabilities) need to be web-based, modular, flexible, customisable and allow the exchange of relevant information (e.g., benchmarking database stock). Besides, they should be able to incorporate innovative procedures based on:
    a. Sensitivity analysis
    b. Big data analysis
    c. Inverse modelling / calibrated simulation
    d. Machine learning and artificial intelligence
3. Next generation of outcomes
    a. Energy use forecast according to real weather data and user profiles
    b. Calculation of uncertainty intervals
    c. EPC real use approaches
    d. Recommendations related to user behaviour
    e. Cost-optimal business plan for staged deep renovations (linked to building passport)

After this first assessment of new possible features for a modular approach, a new EPC workflow is proposed as part of the upcoming ePANACEA methodology in Figure 23.

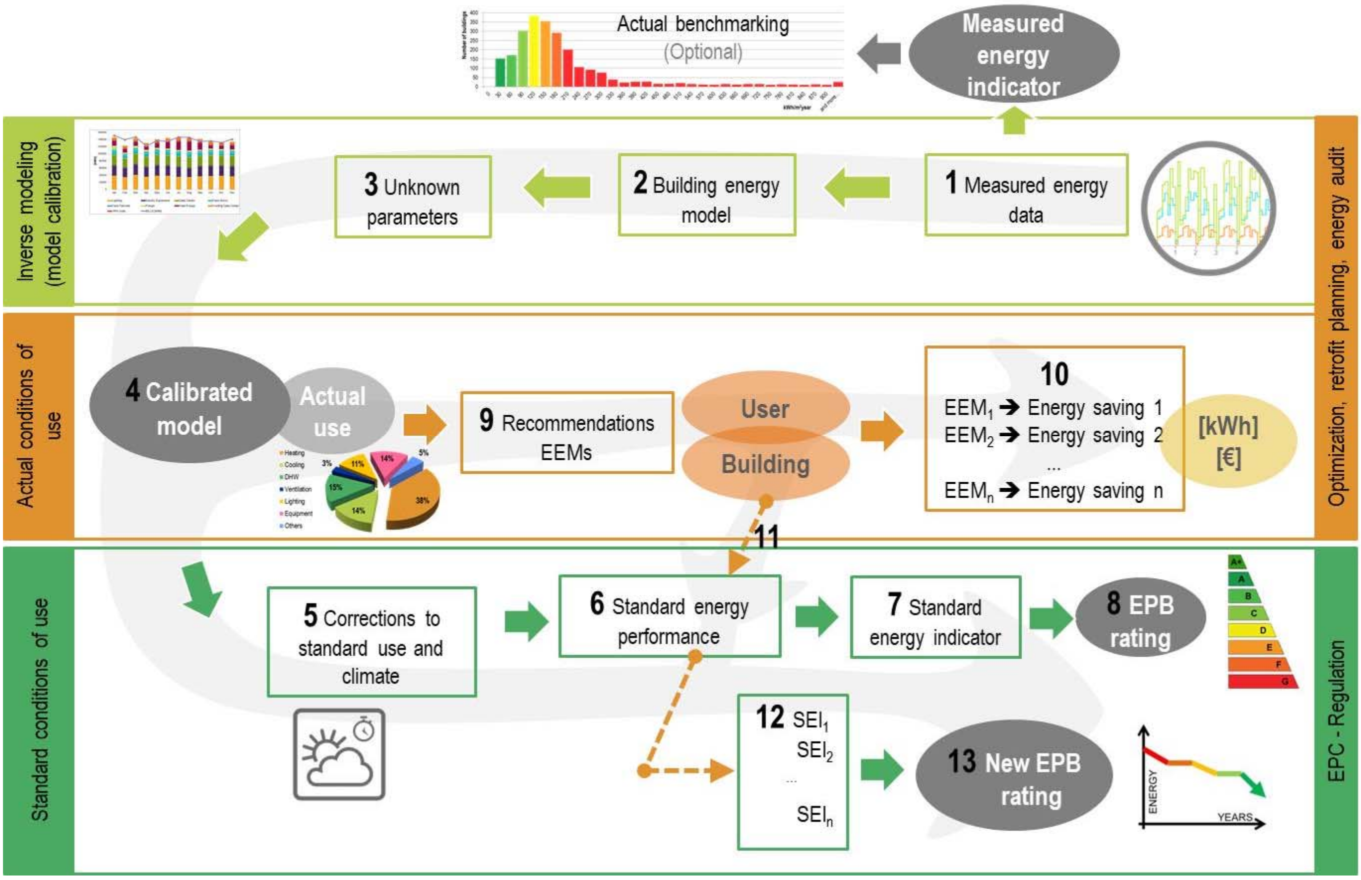


Figure 21: ePANACEA proposed methodology.

Overall workflow overview

Starting at step 1 and ending at step 13, the overall workflow is presented in a numerical chronological order in Figure 21, which includes the use of a multi-purpose energy assessment approach (3.1.1.) and a scalable web platform to manage the whole process (3.11.1.).

The workflow is divided into three sections: inverse modeling, actual conditions of use and standard conditions of use. This division allows the implementation of different calculation procedures with the final objective of improving accuracy, instilling trust in the market and covering different target audiences.

1. Inverse modeling (1>2>3):

This section implies the use of on-board monitored data (3.1.5.) and automated data gathering via servers (3.1.4.)

Actual benchmarking based on actual measured consumption data could be possible if an appropriate actual consumption data base of the current building stock is available (3.9.1.).

The use of actual measured data and other OBM data could allow an accurate calibrated model of the assessment object. From this point onwards, any approach is possible with a high level of accuracy.

2. Actual conditions of use (4>9>10):

From an end user's perspective, taking actual operational conditions of use into account is relevant in order to improve their understanding of EPCs. It means that they are able to compare the EPC with their actual energy bills and find a feasible explanation for their energy use.

This section involves the use of a calibrated energy model (3.1.2.), recommendations tailored according to a specific target (3.8.2.), use of oriented recommendations (3.8.4.), and energy costs indicators (3.4.4.).

3. Standard conditions of use:

This section aims to meet administration and policy makers' needs, basing the calculation on standard conditions of use, which is needed in order to allow the objective comparison of the building stock.

5>6>7>8: type of assessment based on measured standard (3.3.3.), and energy performance rating system based on an overall energy performance indicator (non-renewable primary energy) and fixed reference values (3.6.1.).

9>11>12>13: EEMs based on building renovation (step 9) can be evaluated under standard operational conditions again and conclude the new standard energy indicator (SEI) and the associated new standard energy class, providing information regarding roadmaps (and policies) to the administration.

Besides the above detailed overview, a legend of each step is given below for better interpretation of the workflow included in Figure 21.

1. Measured energy data. The actual energy consumption of the building is registered for a representative period of time (e.g., one year).
2. Building energy model. An energy model of the building is developed.
3. Unknown parameters. Based on the energy model and the known parameters used in it (geometry, climate, schedules, etc.) as well as the measured data, unknown parameters (e.g., internal heat gains) can be inferred.
4. Calibrated model. After clearing the unknown parameters, a calibrated model is obtained based on the actual conditions of use. This calibrated model enables the disaggregation by services of the actual energy consumption.
5. Corrections to standard use and climate. The calibrated model that represents the actual use is corrected using standard operation conditions (i.e., schedules, temperature set points, occupancy, etc.) and standardised weather data.
6. Standard energy performance. Standard energy performance for regulatory purposes is calculated from the calibrated model with corrections (i.e., by use, weather data and energy performance services).
7. Standard energy indicator. Standard energy indicators are obtained from the standard energy performance step plus the normalisation (i.e., the overall numerical value is normalised to the size of the building, taking the reference floor area of the assessment object into account).
8. Energy performance rating. Comparison of the standard energy indicator with the reference values according to the building typology and climate, obtaining an energy class (i.e., energy label).
9. Recommendations for EEMs. Based on the calibrated model (i.e., actual use), a feasibility assessment can be developed for the implementation of different energy efficiency measures.
10. Energy savings. Calculation of energy savings for the main recommendations, based on energy use and energy costs, including investment and operational costs (e.g., maintenance costs), in order to choose the most suitable ones.
11. Recommendations for EEM under standard energy performance. Correction by standard conditions could be applied again in order to obtain the possible energy class to be achieved after renovation.
12. Standard energy indicators after EEMs. Assuming the application of energy efficiency measures, indicators can be updated under standard conditions in order to elaborate a cost-effective renovation plan over time (e.g., to obtain grant for building renovation).
13. New energy performance rating. At the end of the process, the new energy class can be obtained taking into account EEMs that imply building renovation.

4.3. ePANACEA report

According to the research conducted so far and conclusions exposed above, a common template for the summary pages of the EPC report within ePANACEA is proposed within this section.

The proposal implies two different formats with very different information according to the target audience: (1) for the administration/regulation/policy makers, based on standard conditions and (2) for end users, based on actual operational conditions.

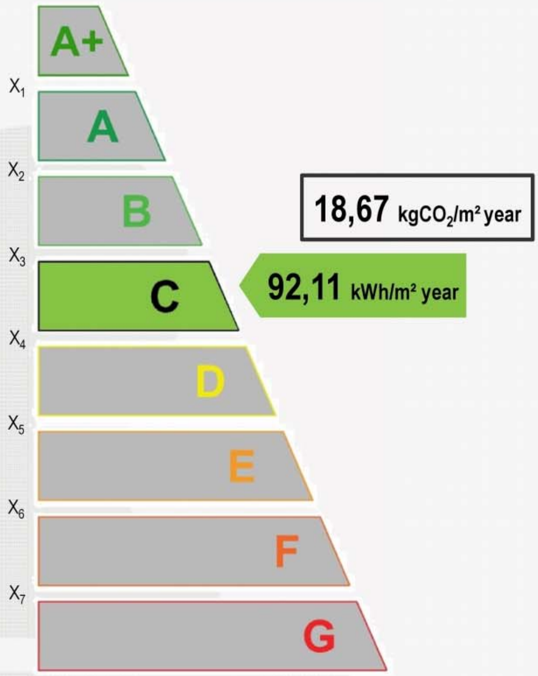
This approach will be evaluated and discussed with main EPC stakeholders through the five Regional Exploitation Boards, as well as through the 1st workshop on user perceptions that will be conducted in the five pilot countries by the end of the year, in order to consolidate a common approach,

Energy certificate

As built calculated*

Building ID	IES Plaza de la Cruz
Address	Cruz square (Pamplona)
Country	SPAIN
Reference floor area	10.062 m²
Climatic Zone	D1
Building use	Education building
Date of Validity	15/11/2030
Certifier name	Albert McGiber
Certifier signature	

Non renewable primary energy

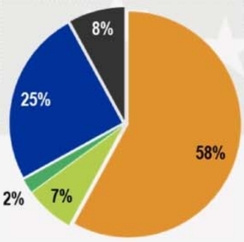


Partial energy performance indicators (weighted average)

Heat transfer coefficient	**U_Walls (W/m²K):**	1,34
	U_Roofs (W/m²K):	0,13
	U_Floors (W/m²K):	0,72
	U_Windows (W/m²K):	1,4
Solar Heat Gain Factor (SHGC):		0,75
Efficiency of heating systems (η):		0,65
Efficiency of DHW systems (η):		0,78
Efficiency of cooling systems (η):		2,70
Efficiency of lighting systems:		2,90
Contributions from renewable sources (%):		0

Energy balance EPBD services [kWh/m²year]

Energy use for Heating	41,1
Energy use for Cooling	5,0
Energy use for DHW	1,4
Energy use for Lighting (if applicable)	17,7
Energy use for Auxiliary equipments (if applicable)	5,7



Other partial indicators [kWh/m²year]

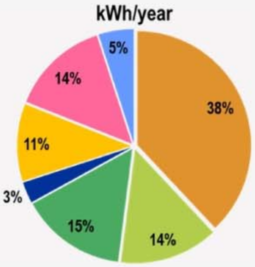
Heating energy need	39,5
Cooling energy need	3,0
Electric energy from RES used on-site	0
Electric energy from RES exported to the market	0

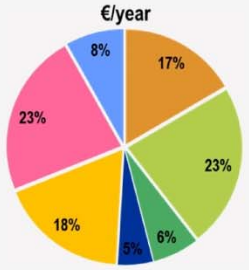
* the calculated rating assumes standard conditions. It only counts the energy use for heating, ventilation, cooling, hot water and lighting(add others if applicable)

Energy certificate In use**

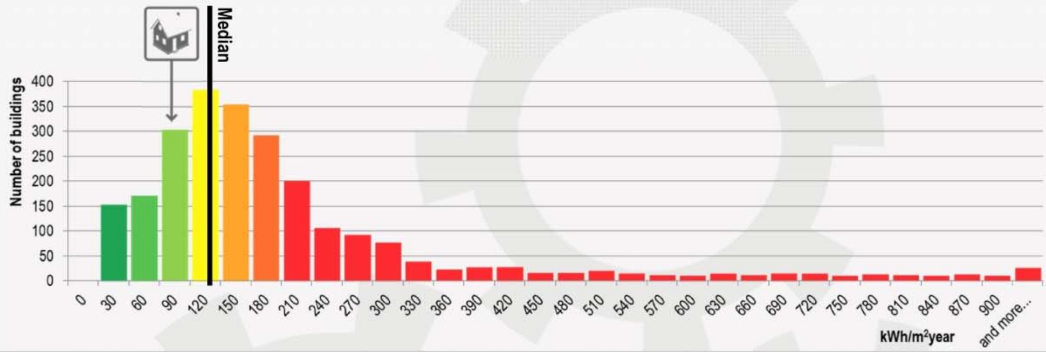
Energy use

	kWh/m²y	€/m²y	kWh/year	€/year
Total Energy use	89,8	8,2	903.567,6	82.857,1
Fuels	47,6	1,9	478.890,8	19.155,6
Electricity	42,2	6,3	424.676,8	63.701,5
Heating	34,1	1,4	343.355,7	13.734,2
Cooling	12,6	1,9	126.499,5	18.974,9
DHW	13,5	0,5	135.535,1	5.421,4
Ventilation	2,7	0,4	27.107,0	4.066,1
Lighting	9,9	1,5	99.392,4	14.908,9
Equipment	12,6	1,9	126.499,5	18.974,9
Others	4,5	0,7	45.178,4	6.776,8



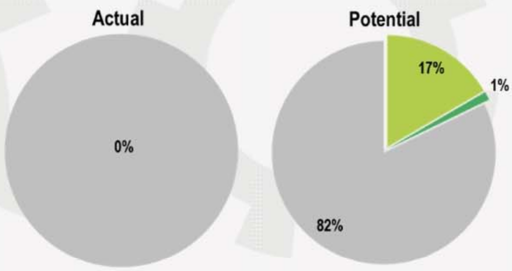


Benchmarking



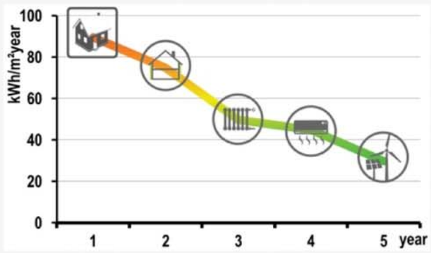
Renawable energy systems [kWh/year]

	Actual	Potencial
Photovoltaic	0	150.000
Solar Thermal	0	10.897
Wind power	0	0,0
Others	0	0,0



Roadmap towards ZEB

Investment [€/m²]	180	60	40	100
EUI [kWh/m²year]	75	50	45	30
Energy cost [€/m²year]	--	--	--	--
NPV [€]	--	--	--	--



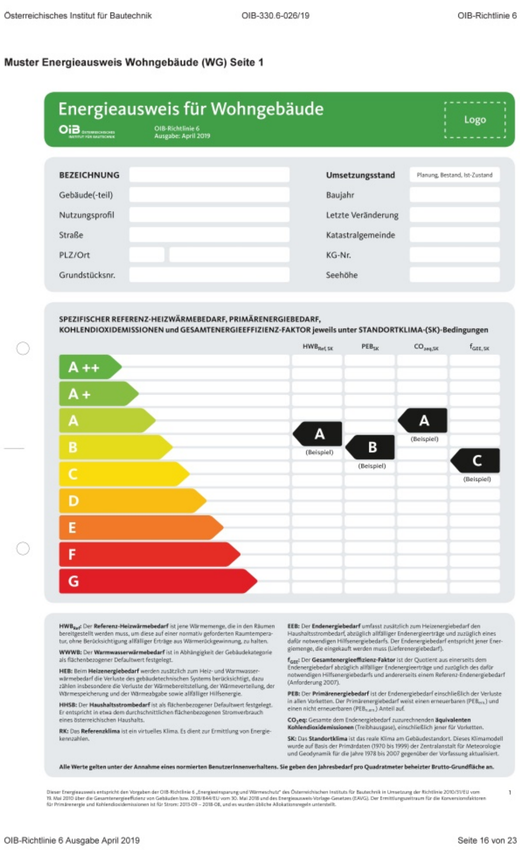
** the measured rating is under actual conditions. It counts all energy uses.

ANNEX I: EPC REPORTS OF THE ePANACEA PILOT COUNTRIES

AUSTRIA/STYRIA

Implementation	National
Start of EPCs	National law since 2006/2007 / Regional law in Styria since 2008
Legislation Force	National: Energieausweis-Vorlage-Gesetz 2009 (EAVG 2012, BGBl. 27/2012); Regional: Styrian building law and construction regulation based on OIB regulations
EPC databases	National level (GWR central building and dwelling register of Austria) and regional level (e.g. in Styria: ZEUS database)

EPC Report



Österreichisches Institut für Bautechnik OIB-330.6-026/19 OIB-Richtlinie 6

Muster Energieausweis Wohngebäude (WG) Seite 1

Energieausweis für Wohngebäude

OIB-Richtlinie 6
Ausgabe: April 2019

Logo

BEZEICHNUNG		**Umsetzungsstand**	Planung, Bestand, Ist-Zustand
Gebäude(-teil)		Baujahr	
Nutzungsprofil		Letzte Veränderung	
Straße		Katastralgemeinde	
PLZ/Ort		KG-Nr.	
Grundstücksnr.		Seehöhe	

SPEZIFISCHER REFERENZ-HEIZWÄRMEBEDARF, PRIMÄRENERGIEBEDARF, KOHLENDIOXIDEMISSIONEN und GESAMTENERGIEEFFIZIENZ-FAKTOR jeweils unter STANDORTKLIMA-(SK)-Bedingungen

	$HWB_{Ref,SK}$	PEB_{SK}	$CO_{2eq,SK}$	$f_{GEE,SK}$
A ++				
A +				
A			A (Beispiel)	
B	A (Beispiel)	B (Beispiel)		C (Beispiel)
C				
D				
E				
F				
G				

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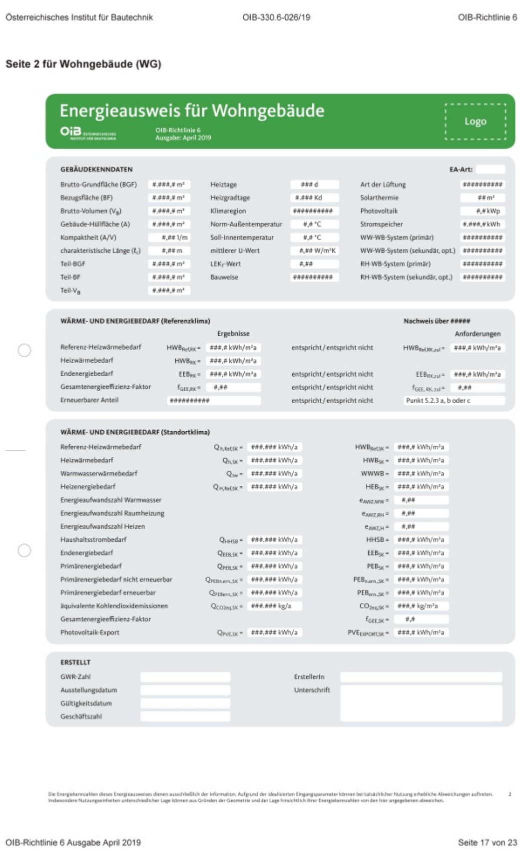


Österreichisches Institut für Bautechnik OIB-330.6-026/19 OIB-Richtlinie 6

Seite 2 für Wohngebäude (WG)

Energieausweis für Wohngebäude

OIB-Richtlinie 6
Ausgabe: April 2019

Logo

GEBÄUDEKENNDATEN EA-Art:

Brutto-Grundfläche (BGF)	#.###,# m²	Heiztage	### d	Art der Lüftung	##########
Bezugsfläche (BF)	#.###,# m²	Heizgradtage	#.### Kd	Solarthermie	## m²
Brutto-Volumen (V_B)	#.###,# m³	Klimaregion	##########	Photovoltaik	#,# kWp
Gebäude-Hüllfläche (A)	#.###,# m²	Norm-Außentemperatur	#,# °C	Stromspeicher	#.###,# kWh
Kompaktheit (A/V)	#,## 1/m	Soll-Innentemperatur	#,# °C	WW-WB-System (primär)	##########
charakteristische Länge (ℓ_c)	#,## m	mittlerer U-Wert	#,## W/m²K	WW-WB-System (sekundär, opt.)	##########
Teil-BGF	#.###,# m²	LEK_T-Wert	#,##	RH-WB-System (primär)	##########
Teil-BF	#.###,# m²	Bauweise	##########	RH-WB-System (sekundär, opt.)	##########
Teil-V_B	#.###,# m³				

WÄRME- UND ENERGIEBEDARF (Referenzklima) Nachweis über #####

	Ergebnisse			Anforderungen
Referenz-Heizwärmebedarf	$HWB_{Ref,RK}$ =	###,# kWh/m²a	entspricht / entspricht nicht	$HWB_{Ref,RK,zul}$ = ###,# kWh/m²a
Heizwärmebedarf	HWB_{RK} =	###,# kWh/m²a		
Endenergiebedarf	EEB_{RK} =	###,# kWh/m²a	entspricht / entspricht nicht	$EEB_{RK,zul}$ = ###,# kWh/m²a
Gesamtenergieeffizienz-Faktor	$f_{GEE,RK}$ =	#,##	entspricht / entspricht nicht	$f_{GEE,RK,zul}$ = #,##
Erneuerbarer Anteil		##########	entspricht / entspricht nicht	Punkt 5.2.3 a, b oder c

WÄRME- UND ENERGIEBEDARF (Standortklima)

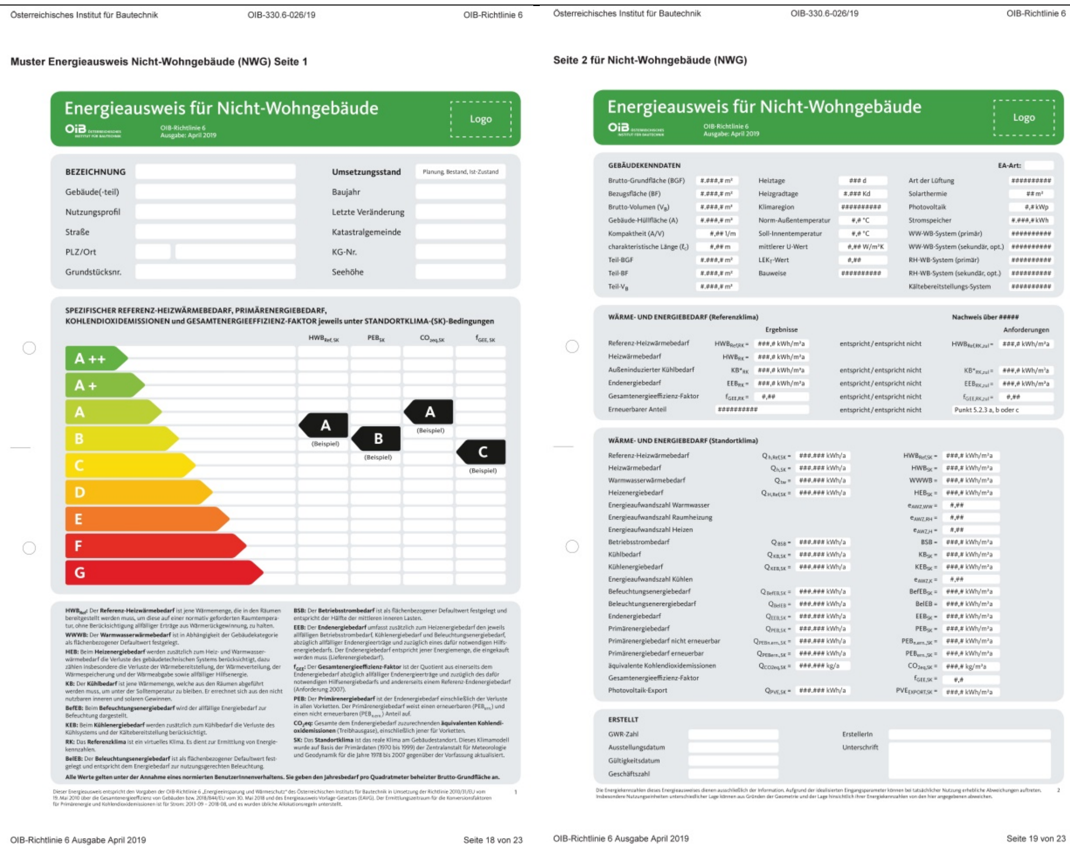
Referenz-Heizwärmebedarf	$Q_{h,Ref,SK}$ =	###.### kWh/a	$HWB_{Ref,SK}$ =	###,# kWh/m²a
Heizwärmebedarf	$Q_{h,SK}$ =	###.### kWh/a	HWB_{SK} =	###,# kWh/m²a
Warmwasserwärmebedarf	Q_{tw} =	###.### kWh/a	WWWB =	###,# kWh/m²a
Heizenergiebedarf	$Q_{H,Ref,SK}$ =	###.### kWh/a	HEB_{SK} =	###,# kWh/m²a
Energieaufwandszahl Warmwasser			$e_{AWZ,WW}$ =	#,##
Energieaufwandszahl Raumheizung			$e_{AWZ,RH}$ =	#,##
Energieaufwandszahl Heizen			$e_{AWZ,H}$ =	#,##
Haushaltsstrombedarf	Q_{HHSB} =	###.### kWh/a	HHSB =	###,# kWh/m²a
Endenergiebedarf	$Q_{EEB,SK}$ =	###.### kWh/a	EEB_{SK} =	###,# kWh/m²a
Primärenergiebedarf	$Q_{PEB,SK}$ =	###.### kWh/a	PEB_{SK} =	###,# kWh/m²a
Primärenergiebedarf nicht erneuerbar	$Q_{PEBn.ern.,SK}$ =	###.### kWh/a	$PEB_{n.ern.,SK}$ =	###,# kWh/m²a
Primärenergiebedarf erneuerbar	$Q_{PEBern.,SK}$ =	###.### kWh/a	$PEB_{ern.,SK}$ =	###,# kWh/m²a
äquivalente Kohlendioxidemissionen	$Q_{CO2eq,SK}$ =	###.### kg/a	$CO_{2eq,SK}$ =	###,# kg/m²a
Gesamtenergieeffizienz-Faktor			$f_{GEE,SK}$ =	#,#
Photovoltaik-Export	$Q_{PVE,SK}$ =	###.### kWh/a	$PVE_{EXPORT,SK}$ =	###,# kWh/m²a

ERSTELLT

GWR-Zahl		ErstellerIn	
Ausstellungsdatum		Unterschrift	
Gültigkeitsdatum			
Geschäftszahl			

Die Energiekennzahlen dieses Energieausweises dienen ausschließlich der Information. Aufgrund der idealisierten Eingangsparameter können bei tatsächlicher Nutzung erhebliche Abweichungen auftreten. Insbesondere Nutzungseinheiten unterschiedlicher Lage können aus Gründen der Geometrie und der Lage hinsichtlich ihrer Energiekennzahlen von den hier angegebenen abweichen. 2

OIB-Richtlinie 6 Ausgabe April 2019 Seite 17 von 23


Österreichisches Institut für Bautechnik OIB-330.6-026/19 OIB-Richtlinie 6

Muster Energieausweis Nicht-Wohngebäude (NWG) Seite 1

Energieausweis für Nicht-Wohngebäude

Seite 2 für Nicht-Wohngebäude (NWG)

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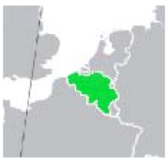
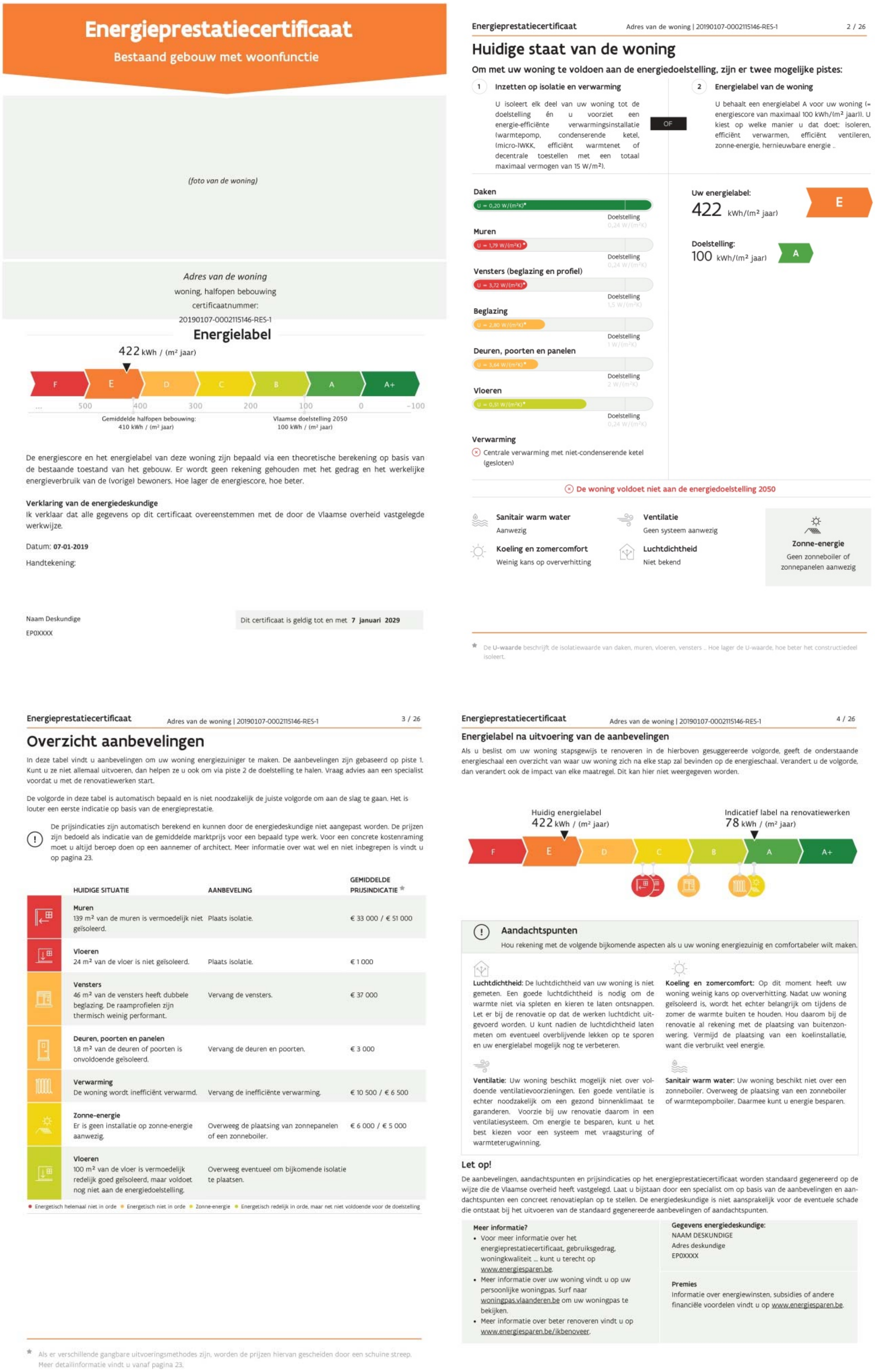
OIB-Richtlinie 6 Ausgabe April 2019 Seite 19 von 23

Implementation	Regional
Start of EPCs	2006 / 2007
Legislation Force	Energy Performance of Buildings Decree of 22/12/2006: EPC in new residential buildings in force. Energy Decree of Flemish government of 8/5/2009; Energy Decision of Flemish government of 19/11/2010; Decision of Ministry of 21/8/2008: EPC existing residential buildings (sale and rent) in force; EPC for public buildings: Energy Decree of Flemish government of 8/5/2009; Energy Decision of Flemish Government19/11/2010; Decision of Ministry of 1/12/2010
EPC databases	Regional level


BELGIUM

EPC Report



Energieprestatiecertificaat

Bestaand gebouw met woonfunctie

(foto van de woning)

Adres van de woning
woning, halfopen bebouwing
certificaatnummer:
20190107-0002115146-RES-1

Energielabel

422 kWh / (m² jaar)

F | E | D | C | B | A | A+
... 500 400 300 200 100 0 -100
Gemiddelde halfopen bebouwing: 410 kWh / (m² jaar)
Vlaamse doelstelling 2050 100 kWh / (m² jaar)

De energiescore en het energielabel van deze woning zijn bepaald via een theoretische berekening op basis van de bestaande toestand van het gebouw. Er wordt geen rekening gehouden met het gedrag en het werkelijke energieverbruik van de (vorige) bewoners. Hoe lager de energiescore, hoe beter.

Verklaring van de energiedeskundige
Ik verklaar dat alle gegevens op dit certificaat overeenstemmen met de door de Vlaamse overheid vastgelegde werkwijze.

Datum: **07-01-2019**
Handtekening:

Naam Deskundige
EPOXXXX

Dit certificaat is geldig tot en met **7 januari 2029**

Energieprestatiecertificaat Adres van de woning | 20190107-0002115146-RES-1 2 / 26

Huidige staat van de woning

Om met uw woning te voldoen aan de energiedoelstelling, zijn er twee mogelijke pistes:

1 **Inzetten op isolatie en verwarming**
U isoleert elk deel van uw woning tot de doelstelling én u voorziet een energie-efficiënte verwarmingsinstallatie (warmtepomp, condenserende ketel, (micro-)WKK, efficiënt warmtenet of decentrale toestellen met een totaal maximaal vermogen van 15 W/m²).

OF

2 **Energielabel van de woning**
U behaalt een energielabel A voor uw woning (= energiescore van maximaal 100 kWh/(m² jaar)). U kiest op welke manier u dat doet: isoleren, efficiënt verwarmen, efficiënt ventileren, zonne-energie, hernieuwbare energie ...

Daken: U = 0,20 W/(m²K)* — Doelstelling 0,24 W/(m²K)
Muren: U = 1,79 W/(m²K)* — Doelstelling 0,24 W/(m²K)
Vensters (beglazing en profiel): U = 3,72 W/(m²K)* — Doelstelling 1,5 W/(m²K)
Beglazing: U = 2,80 W/(m²K)* — Doelstelling 1 W/(m²K)
Deuren, poorten en panelen: U = 3,44 W/(m²K)* — Doelstelling 2 W/(m²K)
Vloeren: U = 0,31 W/(m²K)* — Doelstelling 0,24 W/(m²K)

Verwarming
Centrale verwarming met niet-condenserende ketel (gesloten)

Uw energielabel: 422 kWh/(m² jaar) E
Doelstelling: 100 kWh/(m² jaar) A

De woning voldoet niet aan de energiedoelstelling 2050

Sanitair warm water — Aanwezig
Ventilatie — Geen systeem aanwezig
Koeling en zomercomfort — Weinig kans op oververhitting
Luchtdichtheid — Niet bekend
Zonne-energie — Geen zonneboiler of zonnepanelen aanwezig

* De U-waarde beschrijft de isolatiewaarde van daken, muren, vloeren, vensters ... Hoe lager de U-waarde, hoe beter het constructiedeel isoleert.

Energieprestatiecertificaat Adres van de woning | 20190107-0002115146-RES-1 3 / 26

Overzicht aanbevelingen

In deze tabel vindt u aanbevelingen om uw woning energiezuiniger te maken. De aanbevelingen zijn gebaseerd op piste 1. Kunt u ze niet allemaal uitvoeren, dan helpen ze u ook om via piste 2 de doelstelling te halen. Vraag advies aan een specialist voordat u met de renovatiewerken start.

De volgorde in deze tabel is automatisch bepaald en is niet noodzakelijk de juiste volgorde om aan de slag te gaan. Het is louter een eerste indicatie op basis van de energieprestatie.

De prijsindicaties zijn automatisch berekend en kunnen door de energiedeskundige niet aangepast worden. De prijzen zijn bedoeld als indicatie van de gemiddelde marktprijs voor een bepaald type werk. Voor een concrete kostenraming moet u altijd beroep doen op een aannemer of architect. Meer informatie over wat wel en niet inbegrepen is vindt u op pagina 23.

HUIDIGE SITUATIE	AANBEVELING	GEMIDDELDE PRIJSINDICATIE *
Muren 139 m² van de muren is vermoedelijk niet geïsoleerd.	Plaats isolatie.	€ 33 000 / € 51 000
Vloeren 24 m² van de vloer is niet geïsoleerd.	Plaats isolatie.	€ 1 000
Vensters 46 m² van de vensters heeft dubbele beglazing. De raamprofielen zijn thermisch weinig performant.	Vervang de vensters.	€ 37 000
Deuren, poorten en panelen 1,8 m² van de deuren of poorten is onvoldoende geïsoleerd.	Vervang de deuren en poorten.	€ 3 000
Verwarming De woning wordt inefficiënt verwarmd.	Vervang de inefficiënte verwarming.	€ 10 500 / € 6 500
Zonne-energie Er is geen installatie op zonne-energie aanwezig.	Overweeg de plaatsing van zonnepanelen of een zonneboiler.	€ 6 000 / € 5 000
Vloeren 100 m² van de vloer is vermoedelijk redelijk goed geïsoleerd, maar voldoet nog niet aan de energiedoelstelling.	Overweeg eventueel om bijkomende isolatie te plaatsen.	

● Energetisch helemaal niet in orde ● Energetisch niet in orde ● Zonne-energie ● Energetisch redelijk in orde, maar net niet voldoende voor de doelstelling

* Als er verschillende gangbare uitvoeringsmethodes zijn, worden de prijzen hiervan gescheiden door een schuine streep. Meer detailinformatie vindt u vanaf pagina 23.

Energieprestatiecertificaat Adres van de woning | 20190107-0002115146-RES-1 4 / 26

Energielabel na uitvoering van de aanbevelingen

Als u beslist om uw woning stapsgewijs te renoveren in de hierboven gesuggereerde volgorde, geeft de onderstaande energieschaal een overzicht van waar uw woning zich na elke stap zal bevinden op de energieschaal. Verandert u de volgorde, dan verandert ook de impact van elke maatregel. Dit kan hier niet weergegeven worden.

Huidig energielabel 422 kWh / (m² jaar)
Indicatief label na renovatiewerken 78 kWh / (m² jaar)

F | E | D | C | B | A | A+

Aandachtspunten
Hou rekening met de volgende bijkomende aspecten als u uw woning energiezuinig en comfortabeler wilt maken.

Luchtdichtheid: De luchtdichtheid van uw woning is niet gemeten. Een goede luchtdichtheid is nodig om de warmte niet via spleten en kieren te laten ontsnappen. Let er bij de renovatie op dat de werken luchtdicht uitgevoerd worden. U kunt nadien de luchtdichtheid laten meten om eventueel overblijvende lekken op te sporen en uw energielabel mogelijk nog te verbeteren.

Koeling en zomercomfort: Op dit moment heeft uw woning weinig kans op oververhitting. Nadat uw woning geïsoleerd is, wordt het echter belangrijk om tijdens de zomer de warmte buiten te houden. Hou daarom bij de renovatie al rekening met de plaatsing van buitenzonwering. Vermijd de plaatsing van een koelinstallatie, want die verbruikt veel energie.

Ventilatie: Uw woning beschikt mogelijk niet over voldoende ventilatievoorzieningen. Een goede ventilatie is echter noodzakelijk om een gezond binnenklimaat te garanderen. Voorzie bij uw renovatie daarom in een ventilatiesysteem. Om energie te besparen, kunt u het best kiezen voor een systeem met vraagsturing of warmteterugwinning.

Sanitair warm water: Uw woning beschikt niet over een zonneboiler. Overweeg de plaatsing van een zonneboiler of warmtepompboiler. Daarmee kunt u energie besparen.

Let op!
De aanbevelingen, aandachtspunten en prijsindicaties op het energieprestatiecertificaat worden standaard gegenereerd op de wijze die de Vlaamse overheid heeft vastgelegd. Laat u bijstaan door een specialist om op basis van de aanbevelingen en aandachtspunten een concreet renovatieplan op te stellen. De energiedeskundige is niet aansprakelijk voor de eventuele schade die ontstaat bij het uitvoeren van de standaard gegenereerde aanbevelingen of aandachtspunten.

Meer informatie?
- Voor meer informatie over het energieprestatiecertificaat, gebruiksgedrag, woningkwaliteit ... kunt u terecht op www.energiesparen.be.
- Meer informatie over uw woning vindt u op uw persoonlijke woningpas. Surf naar woningpas.vlaanderen.be om uw woningpas te bekijken.
- Meer informatie over beter renoveren vindt u op www.energiesparen.be/ikbenoveer.

Gegevens energiedeskundige:
NAAM DESKUNDIGE
Adres deskundige
EPOXXXX

Premies
Informatie over energiewinsten, subsidies of andere financiële voordelen vindt u op www.energiesparen.be.

Energieprestatiecertificaat (EPC) in detail

Elk gebouw bestaat uit verschillende onderdelen die met elkaar verbonden zijn. Als u renoveert, kunt u het best al rekening houden met de werken die u later nog gaat uitvoeren.
Dit deel van het energieprestatiecertificaat gaat dieper in op de aanbevelingen van uw woning. Samen met uw architect of andere vakman kunt u op basis hiervan een renovatieplan opstellen.

Inhoudstafel

10 goede redenen om nu al te BENOveren

BENOveren is BEter reNOveren dan gebruikelijk is, met hogere ambities op het vlak van energieprestaties, goed gepland en met deskundig advies, zodat ook latere renovatiestappen haalbaar blijven (zie ook www.energiesparen.be/ikbenoveer). Een geBENOveerde woning biedt veel voordelen:

1. Een lagere energiefactuur
2. Meer comfort
3. Een gezonder binnenklimaat
4. Esthetische meerwaarde
5. Financiële meerwaarde
6. Nodig voor ons klimaat
7. Uw woning is klaar voor uw oude dag
8. Minder onderhoud
9. Vandaag al haalbaar
10. De overheid betaalt mee

Renoveren of slopen: let op voor asbest!

Asbest is een schadelijke stof die nog regelmatig aanwezig is in gebouwen. In veel gevallen kunnen asbesttoepassingen op een eenvoudige en vooral veilige manier verwijderd worden. Deze werken en eventuele bijhorende kosten zijn niet inbegrepen in die van het EPC. Voor meer informatie over (het herkennen van) asbest en asbestverwijdering kunt u terecht op www.ovam.be.

Hoe wordt het EPC opgemaakt?

De eigenschappen van uw woning zijn door de ener giedeskundige ingevoerd in software die door de Vlaamse overheid is opgelegd. De energiedeskundige mag zich alleen baseren op zijn vaststellingen tijdens het plaatsbezoek en op bewijsstukken die voldoen aan de voorwaarden die de Vlaam se overheid heeft opgelegd. Op basis van de invoergegevens berekent de software het energielabel en genereert automatisch aanbevelingen en kostprijzen. Bij onbekende invoergegevens gaat de software uit van veronderstellingen, onder meer op basis van het (ver)bouw- of fabricagejaar. Om zeker te zijn van de werkelijke samenstelling van uw muur, dak of vloer kunt u ervoor kiezen om verder (destructief) onderzoek uit te voeren (losschroeven stopcontact, gaatje boren in een voeg, binnenafwerking tijdelijk verwijderen ...).
Voor meer informatie over de werkwijze, de bewijs stukken en de voorwaarden kunt u terecht op www.energiesparen.be.

Slopen?

Voor oudere woningen of woningen in slechte staat, is het soms interessant om het gebouw te slopen en opnieuw te beginnen. Als u sloop overweegt, kunt u voor meer informatie terecht op www.energiesparen.be.

Energiedoelstelling 2050

De energiedoelstelling van de Vlaamse Regering is om tegen 2050 alle woningen en appartementen in Vlaanderen minstens even energiezuinig te maken als een energetisch performante nieuwbouwwoning van 2017.
Ten tijde van de opmaak van dit EPC is het nog niet verplicht om aan die energiedoelstelling te voldoen. Denk echter vooruit! Hou nu al zo veel mogelijk rekening met die energiedoelstelling en streef zelfs naar beter.

Algemene gegevens

Datum plaatsbezoek	11/12/2018
Referentiejaar bouw	1966
Beschermd volume (m^3)	713
Bruikbare vloeroppervlakte (m^2)	235
Verliesoppervlakte (m^2)	417
Infiltratiedebiet ($m^3/(m^2h)$)	Onbekend
Thermische massa	Half zwaar/matig zwaar
Niet-residentiële bestemming	Geen

Berekende energiescore (kWh/(m^2 jaar))	422
Karakteristiek jaarlijks primair energieverbruik (kWh/jaar)	99.085
CO_2-emissie (kg/jaar)	19.321
Indicatief S-peil	98
Gemiddelde U-waarde gebouwschil (W/(m^2K))	1,22
Gemiddeld installatierendement (%)	42

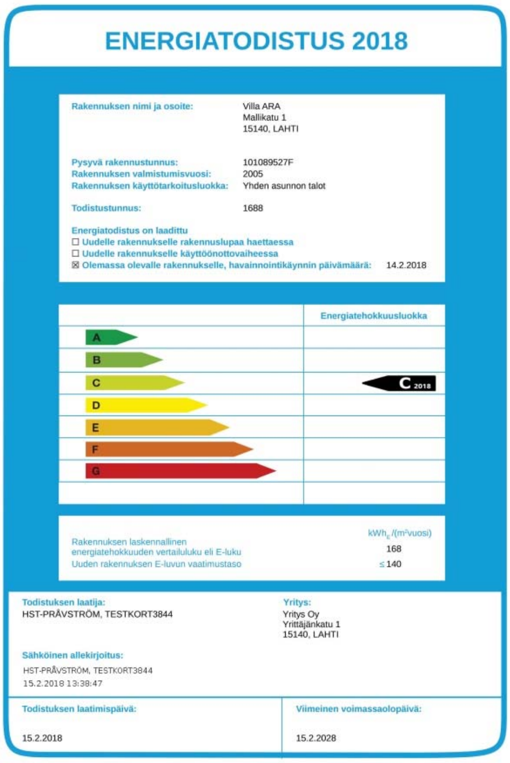
Verklarende woordenlijst

Beschermd volume	Het volume van alle ruimten die men wenst te beschermen tegen warmteverlies naar buiten, de grond en aangrenzende onverwarmde ruimten.
Bruikbare vloeroppervlakte	De vloeroppervlakte binnen het beschermd volume die beloopbaar en toegankelijk is.
U-waarde	De U-waarde beschrijft de isolatiewaarde van daken, muren, vensters ... Hoe lager de U-waarde, hoe beter de constructie isoleert.
R-waarde	De warmteweerstand van een materiaallaag. Hoe groter de R-waarde, hoe beter de materiaallaag isoleert.
Lambdawaarde	De warmtegeleidbaarheid van een materiaal. Hoe lager de lambdawaarde, hoe beter het materiaal isoleert.
Spouw	Een laag in de constructie tussen twee andere materiaallagen die al dan niet (volledig) gevuld is met isolatie of lucht.
Karakteristiek jaarlijks primair energieverbruik	De berekende hoeveelheid primaire energie die gedurende één jaar nodig is voor de verwarming, de aanmaak van sanitair warm water, de ventilatie en de koeling van een woning. Eventuele bijdragen van zonneboilers en zonnepanelen worden in mindering gebracht.
Berekende energiescore	Een maat voor de totale energieprestatie van een woning. De berekende energiescore is gelijk aan het karakteristiek jaarlijks primair energieverbuik, gedeeld door de bruikbare vloeroppervlakte.
S-peil	Een maat voor de energieprestatie van de gebouwschil van een woning. Het S-peil houdt rekening met de isolatie, de luchtdichtheid, de oriëntatie, de zonnewinsten en de vormefficiëntie. Hoe lager het S-peil, hoe energie-efficiënter de gebouwschil.

FINLAND

Implementation	National
Start of EPCs	2008
Legislation Force	•Decree of the Ministry of the Environment on energy Performance Certificate of Buildings 1048/2017 •Act on Energy Certificates for Buildings (50/2013, in Finnish, Finlex). •Government Decree on the competence of the party preparing a building's energy certificate and on the requirements for a more lenient energy certification process (170/2013, in Finnish, Finlex). •Ministry of the Environment Decree on the energy certificates of buildings (176/2013, in Finnish, Finlex)
EPC databases	National

EPC Report



ENERGIATODISTUS 2018

Rakennuksen nimi ja osoite: Villa ARA
Mallikatu 1
15140, LAHTI

Pysyvä rakennustunnus: 101089527F
Rakennuksen valmistumisvuosi: 2005
Rakennuksen käyttötarkoitusluokka: Yhden asunnon talot

Todistustunnus: 1688

Energiatodistus on laadittu
☐ Uudelle rakennukselle rakennuslupaa haettaessa
☐ Uudelle rakennukselle käyttöönottovaiheessa
☒ Olemassa olevalle rakennukselle, havainnointikäynnin päivämäärä: 14.2.2018

	Energiatehokkuusluokka
A	
B	
C	C 2018
D	
E	
F	
G	

	kWh$_E$/(m²vuosi)
Rakennuksen laskennallinen energiatehokkuuden vertailuluku eli E-luku	168
Uuden rakennuksen E-luvun vaatimustaso	≤ 140

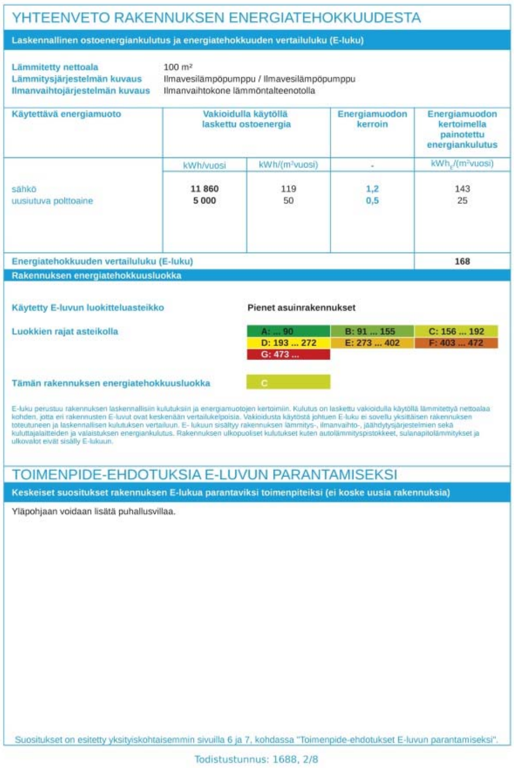
Todistuksen laatija:
HST-PRÅVSTRÖM, TESTKORT3844

Yritys:
Yritys Oy
Yrittäjänkatu 1
15140, LAHTI

Sähköinen allekirjoitus:
HST-PRÅVSTRÖM, TESTKORT3844
15.2.2018 13:38:47

Todistuksen laatimispäivä: 15.2.2018

Viimeinen voimassaolopäivä: 15.2.2028



YHTEENVETO RAKENNUKSEN ENERGIATEHOKKUUDESTA

Laskennallinen ostoenergiankulutus ja energiatehokkuuden vertailuluku (E-luku)

Lämmitetty nettoala: 100 m²
Lämmitysjärjestelmän kuvaus: Ilmavesilämpöpumppu / Ilmavesilämpöpumppu
Ilmanvaihtojärjestelmän kuvaus: Ilmanvaihtokone lämmöntalteenotolla

Käytettävä energiamuoto	Vakioidulla käytöllä laskettu ostoenergia		Energiamuodon kerroin	Energiamuodon kertoimella painotettu energiankulutus
	kWh/vuosi	kWh/(m²vuosi)	-	kWh$_E$/(m²vuosi)
sähkö	11 860	119	1,2	143
uusiutuva polttoaine	5 000	50	0,5	25
Energiatehokkuuden vertailuluku (E-luku)				168

Rakennuksen energiatehokkuusluokka

Käytetty E-luvun luokitteluasteikko: Pienet asuinrakennukset

Luokkien rajat asteikolla: A: ... 90 | B: 91 ... 155 | C: 156 ... 192 | D: 193 ... 272 | E: 273 ... 402 | F: 403 ... 472 | G: 473 ...

Tämän rakennuksen energiatehokkuusluokka: C

E-luku perustuu rakennuksen laskennallisiin kulutuksiin ja energiamuotojen kertoimiin. Kulutus on laskettu vakioidulla käytöllä lämmitettyä nettoalaa kohden, jotta eri rakennusten E-luvut ovat keskenään vertailukelpoisia. Vakioidusta käytöstä johtuen E-luku ei sovellu yksittäisen rakennuksen toteutuneen ja laskennallisen kulutuksen vertailuun. E- lukuun sisältyy rakennuksen lämmitys-, ilmanvaihto-, jäähdytysjärjestelmien sekä kuluttajalaitteiden ja valaistuksen energiankulutus. Rakennuksen ulkopuoliset kulutukset kuten autolämmityspistokkeet, sulanapitolämmitykset ja ulkovalot eivät sisälly E-lukuun.

TOIMENPIDE-EHDOTUKSIA E-LUVUN PARANTAMISEKSI

Keskeiset suositukset rakennuksen E-lukua parantaviksi toimenpiteiksi (ei koske uusia rakennuksia)

Yläpohjaan voidaan lisätä puhallusvillaa.

Suositukset on esitetty yksityiskohtaisemmin sivuilla 6 ja 7, kohdassa "Toimenpide-ehdotukset E-luvun parantamiseksi".

Todistustunnus: 1688, 2/8

E-LUVUN LASKENNAN LÄHTÖTIEDOT

Rakennuskohde

Rakennuksen käyttötarkoitusluokka	Yhden asunnon talot			
Rakennuksen valmistumisvuosi	2005	Lämmitetty nettoala	100	m^2

Rakennusvaippa

	A	U	U×A	Osuus lämpöhäviöistä
Ilmanvuotoluku q_{50}	4,0	$m^3/(h\ m^2)$		
	m^2	$W/(m^2 K)$	W/K	%
Ulkoseinät	105,0	0,25	26,3	26 %
Yläpohja	100,0	0,16	16,0	16 %
Alapohja	100,0	0,20	20,0	20 %
Ikkunat	10,7	1,40	15,0	15 %
Ulko-ovet	8,0	1,40	11,2	11 %
Kylmäsillat	-	-	12,8	13 %

Ikkunat ilmansuunnittain

	A	U	$g_{kohtisuora}$-arvo
	m^2	$W/(m^2 K)$	-
Pohjoinen	2,1	1,40	0,73
Koillinen			
Itä	0,5	1,40	0,73
Kaakko			
Etelä	7,6	1,40	0,73
Lounas			
Länsi	0,5	1,40	0,73
Luode			

Ilmanvaihtojärjestelmä

Ilmanvaihtojärjestelmän kuvaus: Ilmanvaihtokone lämmöntalteenotolla

	Ilmavirta tulo/poisto	Järjestelmän SFP-luku	LTO:n lämpötilasuhde	Jäätymisenesto
	(m^3/s) / (m^3/s)	kW / (m^3/s)	-	°C
Pääilmanvaihtokoneet	0,04 / 0,04	0,94	78 %	-5,00
Erillispoistot	0,00 / 0,00	0,00	-	-
Ilmanvaihtojärjestelmä	0,04 / 0,04	0,94	-	-
Rakennuksen ilmanvaihtojärjestelmän LTO:n vuosihyötysuhde:			74 %	

Lämmitysjärjestelmä

Lämmitysjärjestelmän kuvaus: Ilmavesilämpöpumppu / Ilmavesilämpöpumppu

	Tuoton hyötysuhde	Jaon ja luovutuksen hyötysuhde	Lämpökerroin[1]	Apulaitteiden sähkönkäyttö[2]
	-	-	-	$kWh/(m^2 vuosi)$
Tilojen ja iv:n lämmitys		80 %	3,7	2,5
Lämpimän käyttöveden valmistus		92 %	2,7	0,0

[1] vuoden keskimääräinen lämpökerroin lämpöpumpulle
[2] lämpöpumppujärjestelmissä voi sisältyä vuoden keskimääräiseen lämpökertoimeen

	Määrä	Tuotto
	kpl	kWh
Varaava tulisija	1	3 000
Ilmalämpöpumppu		

Jäähdytysjärjestelmä

	Jäähdytyskauden painotettu kylmäkerroin
Jäähdytysjärjestelmä	-

Lämmin käyttövesi

	Ominaiskulutus	Lämmitysenergian nettotarve
	$dm^3/(m^2 vuosi)$	$kWh/(m^2 vuosi)$
Lämmin käyttövesi	600	35

Sisäiset lämpökuormat eri käyttöasteilla

	Käyttöaste	Henkilöt	Kuluttajalaitteet	Valaistus
	-	W/m^2	W/m^2	W/m^2
Henkilöt ja kuluttajalaitteet	60 %	2,0	3,0	
Valaistus	10 %			6,0

Todistustunnus: 1688, 3/8

E-LUVUN LASKENNAN TULOKSET

Rakennuskohde

Rakennuksen käyttötarkoitusluokka	Yhden asunnon talot
Rakennuksen valmistumisvuosi	2005
Lämmitetty nettoala, m^2	100
E-luku, kWh_E / (m^2vuosi)	168

E-luvun erittely

Käytettävät energiamuodot	Vakioidulla käytöllä laskettu ostoenergia	Energiamuodon kerroin	Energiamuodon kertoimella painotettu energiankulutus	
	kWh/vuosi	-	kWh_E/vuosi	$kWh_E/(m^2 vuosi)$
sähkö	11 860	1,2	14 232	143
uusiutuva polttoaine	5 000	0,5	2 500	25
YHTEENSÄ	**16 860**		**16 732**	**168**

Rakennuksen ympäristössä olevasta energiasta otettu energia, hyödynnetty osuus (kuukausitason erittely lisätiedoissa)

	kWh/vuosi	$kWh/(m^2 vuosi)$
Lämpöpumpun lämmönlähteestä ottama energia	5 570	56

Rakennuksen teknisten järjestelmien energiankulutus

	Sähkö	Lämpö	Kaukojäähdytys
	$kWh/(m^2 vuosi)$	$kWh/(m^2 vuosi)$	$kWh/(m^2 vuosi)$
Lämmitysjärjestelmä			
Tilojen lämmitys[1]	2,5	96,8	-
Tuloilman lämmitys	2,8	0,9	-
Lämpimän käyttöveden valmistus	0,0	44,5	
Ilmanvaihtojärjestelmän sähköenergiankulutus	3,3	-	-
Jäähdytysjärjestelmä	0,0	0,0	0,0
Kuluttajalaitteet ja valaistus	21,0	-	-
YHTEENSÄ	30,0	143,0	0,0

[1] ilmanvaihdon tuloilman lämpeneminen tilassa ja korvausilman lämmitys kuuluu tilojen lämmitykseen

Energian nettotarve

	kWh/vuosi	$kWh/(m^2 vuosi)$
Tilojen lämmitys[2]	10 746	108
Ilmanvaihdon lämmitys[3]	612	7
Lämpimän käyttöveden valmistus	3 500	35
Jäähdytys	0	0

[2] sisältää vuotoilman, korvausilman ja tuloilman lämpenemisen tilassa
[3] laskettu lämmöntalteenoton kanssa

Lämpökuormat

	kWh/vuosi	$kWh/(m^2 vuosi)$
Aurinko	3 353	34
Henkilöt	1 051	11
Kuluttajalaitteet	1 577	16
Valaistus	526	6
Lämpimän käyttöveden kierrosta ja varastoinnin häviöistä	325	4

Laskentatyökalun nimi ja versionumero

Laskentatyökalun nimi ja versionumero

Todistustunnus: 1688, 4/8

TOTEUTUNUT ENERGIANKULUTUS

Saatavilla olevat ostoenergian määrät ilmoitetaan sellaisenaan ilman lämmitystarvelukukorjausta. Ostoenergian määrät ilmoitetaan energiatodistuksen laatimista edeltävältä täydeltä kalenterivuodelta.

Toteutunut ostoenergiankulutus

Lämmitetty nettoala 100 m²

Energiaverkoista ostettu energia	kWh/vuosi	$kWh/(m^2 vuosi)$
Kaukolämpö		
Kokonaissähkö	10 800	108
Kiinteistösähkö		
Käyttäjäsähkö		
Kaukojäähdytys		

Ostetut polttoaineet[1]	polttoaineen määrä vuodessa	yksikkö	muunnos-kerroin kWh:ksi	kWh/vuosi	$kWh/(m^2 vuosi)$
Kevyt polttoöljy		litra	10		
Pilkkeet (havu- ja sekapuu)		pino-m^3	1300		
Pilkkeet (koivu)		pino-m^3	1700		
Puupelletit		kg	4,7		
Pilkkeet	2	pino-m3	1300	2 600	26

[1] Selostus ostettujen polttoaineiden määrän arvioinnista (yksikköä vuodessa) tulee esittää kohdassa "Lisämerkintöjä".

Toteutunut ostoenergia yhteensä	kWh/vuosi	$kWh/(m^2 vuosi)$
Sähkö yhteensä	10 800	108
Kaukolämpö yhteensä	0	0
Polttoaineet yhteensä	2 600	26
Kaukojäähdytys	0	0
YHTEENSÄ	**13 400**	**134**

Toteutunut energiankulutus riippuu mm. rakennuksen käyttäjien lukumäärästä ja käyttötottumuksista, käyttöajoista, sisäisistä kuormista, rakennuksen sijainnista ja vuotuisista sääolosuhteista. Todistusta laadittaessa energiankulutus lasketaan Etelä-Suomen säätiedoilla ja siten, että rakennuksen käyttö on vakioitu.

Yllä olevassa taulukossa ilmoitetut luvut saattavat sisältää kulutusta, joka ei sisälly laskennalliseen ostoenergiankulutukseen. Taulukosta voi myös puuttua energiankulutuksia, joiden kulutustietoja ei ollut saatavilla todistusta laadittaessa. Näiden syiden vuoksi toteutunut ostoenergiankulutus ei ole verrattavissa laskennalliseen ostoenergian kulutukseen.

Todistustunnus: 1688, 5/8

TOIMENPIDE-EHDOTUKSET E-LUVUN PARANTAMISEKSI

Toimenpide-ehdotukset tähtäävät E-luvun parantamiseen, joten ne arvioidaan rakennuksen vakioidulla käytöllä. Osio ei koske uusia rakennuksia.

Huomiot - ulkoseinät, ulko-ovet ja ikkunat

Ei toimenpide-ehdotuksia.

Toimenpide-ehdotukset ja arvioidut ostoenergian muutokset

1	
2	
3	

	Lämpö, ostoenergian muutos	Sähkö, ostoenergian muutos	Jäähdytys, ostoenergian muutos	E-luvun muutos
	kWh/vuosi	kWh/vuosi	kWh/vuosi	$kWh_E/(m^2 vuosi)$
1				
2				
3				

Huomiot ylä- ja alapohja

Yläpohjaan voidaan lisätä puhallusvillaa.

Toimenpide-ehdotukset ja arvioidut ostoenergian muutokset

1	Yläpohjien lisäeristäminen uudisrakentamisen vertailuarvoiksi (lämmin tila)
2	
3	

	Lämpö, ostoenergian muutos	Sähkö, ostoenergian muutos	Jäähdytys, ostoenergian muutos	E-luvun muutos
	kWh/vuosi	kWh/vuosi	kWh/vuosi	$kWh_E/(m^2 vuosi)$
1	0	-676	0	-8
2				
3				

Huomiot - tilojen ja käyttöveden lämmitysjärjestelmät

Ei toimenpide-ehdotuksia.

Toimenpide-ehdotukset ja arvioidut ostoenergian muutokset

1	
2	
3	

	Lämpö, ostoenergian muutos	Sähkö, ostoenergian muutos	Jäähdytys, ostoenergian muutos	E-luvun muutos
	kWh/vuosi	kWh/vuosi	kWh/vuosi	$kWh_E/(m^2 vuosi)$
1				
2				
3				

Todistustunnus: 1688, 6/8

Huomiot - ilmanvaihto- ja ilmastointijärjestelmät

Ei toimenpide-ehdotuksia.

Toimenpide-ehdotukset ja arvioidut ostoenergian muutokset

1				
2				
3				
	Lämpö, ostoenergian muutos	Sähkö, ostoenergian muutos	Jäähdytys, ostoenergian muutos	E-luvun muutos
	kWh/vuosi	kWh/vuosi	kWh/vuosi	$kWh_E/(m^2vuosi)$
1				
3				

Huomiot - valaistus, jäähdytysjärjestelmät, sähköiset erillislämmitykset ja muut järjestelmät

Ei toimenpide-ehdotuksia.

Toimenpide-ehdotukset ja arvioidut ostoenergian muutokset

1				
2				
3				
	Lämpö, ostoenergian muutos	Sähkö, ostoenergian muutos	Jäähdytys, ostoenergian muutos	E-luvun muutos
	kWh/vuosi	kWh/vuosi	kWh/vuosi	$kWh_E/(m^2vuosi)$
1				
2				
3				

Suosituksia rakennuksen käyttöön ja ylläpitoon (eivät vaikuta E-lukuun)

Suositellaan ikkunoiden ja ovien tiivisteiden vaihtoa.

Lisätietoja energiatehokkuudesta

Motiva Oy - Asiantuntija energian ja materiaalien tehokkaassa käytössä, www.motiva.fi

Todistustunnus: 1688, 7/8

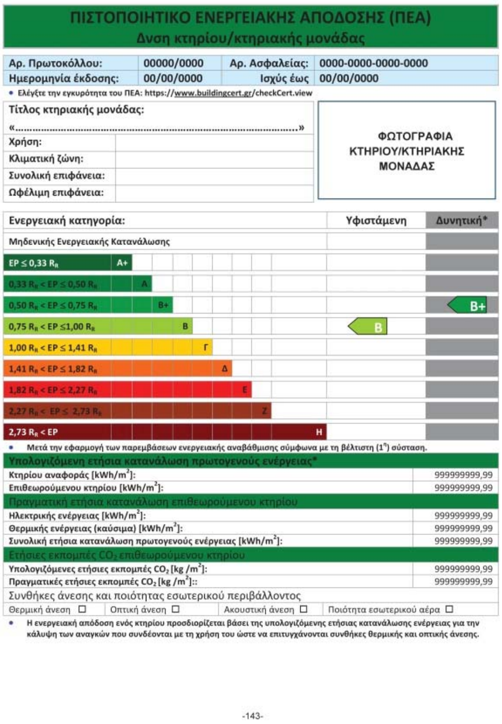
LISÄMERKINTÖJÄ

Todistustunnus: 1688, 8/8

GREECE

Implementation	National
Start of EPCs	2011
Legislation Force	"Regulation of Energy Performance of Buildings (KENAK)" Ministerial decision D6/B/5825 National Gazette 407, April 2010 / Decision on the Approval of the Regulation on the Energy Efficiency of Building (2017) Decision No DEPEA/oik. 178581/2017
EPC databases	National

EPC Report



ΠΙΣΤΟΠΟΙΗΤΙΚΟ ΕΝΕΡΓΕΙΑΚΗΣ ΑΠΟΔΟΣΗΣ (ΠΕΑ)
Δνση κτηρίου/κτηριακής μονάδας

Αρ. Πρωτοκόλλου:	00000/0000	Αρ. Ασφαλείας:	0000-0000-0000-0000
Ημερομηνία έκδοσης:	00/00/0000	Ισχύς έως	00/00/0000

- Ελέγξτε την εγκυρότητα του ΠΕΑ: https://www.buildingcert.gr/checkCert.view

Τίτλος κτηριακής μονάδας:
«…………………………………………………………»

Χρήση:	
Κλιματική ζώνη:	
Συνολική επιφάνεια:	
Ωφέλιμη επιφάνεια:	

ΦΩΤΟΓΡΑΦΙΑ ΚΤΗΡΙΟΥ/ΚΤΗΡΙΑΚΗΣ ΜΟΝΑΔΑΣ

Ενεργειακή κατηγορία:		Υφιστάμενη	Δυνητική*
Μηδενικής Ενεργειακής Κατανάλωσης			
$EP \leq 0{,}33\ R_R$	A+		
$0{,}33\ R_R < EP \leq 0{,}50\ R_R$	A		
$0{,}50\ R_R < EP \leq 0{,}75\ R_R$	B+		B+
$0{,}75\ R_R < EP \leq 1{,}00\ R_R$	B	B	
$1{,}00\ R_R < EP \leq 1{,}41\ R_R$	Γ		
$1{,}41\ R_R < EP \leq 1{,}82\ R_R$	Δ		
$1{,}82\ R_R < EP \leq 2{,}27\ R_R$	E		
$2{,}27\ R_R < EP \leq 2{,}73\ R_R$	Z		
$2{,}73\ R_R < EP$	H		

- Μετά την εφαρμογή των παρεμβάσεων ενεργειακής αναβάθμισης σύμφωνα με τη βέλτιστη (1η) σύσταση.

Υπολογιζόμενη ετήσια κατανάλωση πρωτογενούς ενέργειας*	
Κτηρίου αναφοράς [kWh/m²]:	999999999,99
Επιθεωρούμενου κτηρίου [kWh/m²]:	999999999,99
Πραγματική ετήσια κατανάλωση επιθεωρούμενου κτηρίου	
Ηλεκτρικής ενέργειας [kWh/m²]:	999999999,99
Θερμικής ενέργειας (καύσιμα) [kWh/m²]:	999999999,99
Συνολική ετήσια κατανάλωση πρωτογενούς ενέργειας [kWh/m²]:	999999999,99
Ετήσιες εκπομπές CO_2 επιθεωρούμενου κτηρίου	
Υπολογιζόμενες ετήσιες εκπομπές CO_2 [kg /m²]:	999999999,99
Πραγματικές ετήσιες εκπομπές CO_2 [kg /m²]::	999999999,99

Συνθήκες άνεσης και ποιότητας εσωτερικού περιβάλλοντος
Θερμική άνεση ☐ | Οπτική άνεση ☐ | Ακουστική άνεση ☐ | Ποιότητα εσωτερικού αέρα ☐

- Η ενεργειακή απόδοση ενός κτηρίου προσδιορίζεται βάσει της υπολογιζόμενης ετήσιας κατανάλωσης ενέργειας για την κάλυψη των αναγκών που συνδέονται με τη χρήση του ώστε να επιτυγχάνονται συνθήκες θερμικής και οπτικής άνεσης.

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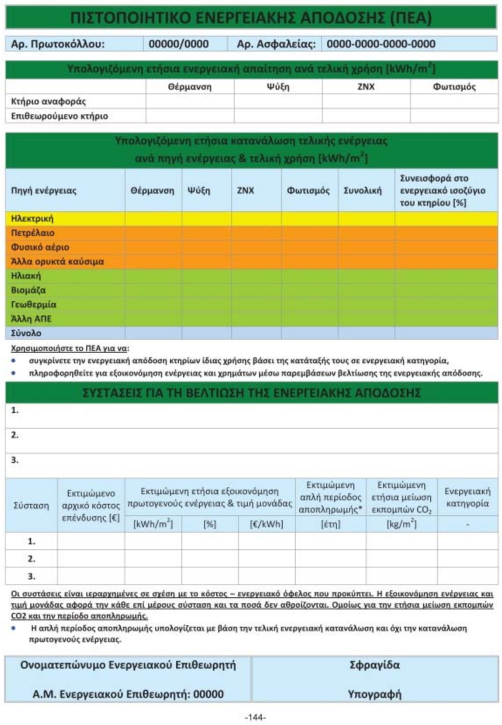

ΠΙΣΤΟΠΟΙΗΤΙΚΟ ΕΝΕΡΓΕΙΑΚΗΣ ΑΠΟΔΟΣΗΣ (ΠΕΑ)

Αρ. Πρωτοκόλλου:	00000/0000	Αρ. Ασφαλείας:	0000-0000-0000-0000

Υπολογιζόμενη ετήσια ενεργειακή απαίτηση ανά τελική χρήση [kWh/m²]

	Θέρμανση	Ψύξη	ZNX	Φωτισμός
Κτήριο αναφοράς				
Επιθεωρούμενο κτήριο				

Υπολογιζόμενη ετήσια κατανάλωση τελικής ενέργειας ανά πηγή ενέργειας & τελική χρήση [kWh/m²]

Πηγή ενέργειας	Θέρμανση	Ψύξη	ZNX	Φωτισμός	Συνολική	Συνεισφορά στο ενεργειακό ισοζύγιο του κτηρίου [%]
Ηλεκτρική						
Πετρέλαιο						
Φυσικό αέριο						
Άλλα ορυκτά καύσιμα						
Ηλιακή						
Βιομάζα						
Γεωθερμία						
Άλλη ΑΠΕ						
Σύνολο						

Χρησιμοποιήστε το ΠΕΑ για να:
- συγκρίνετε την ενεργειακή απόδοση κτηρίων ίδιας χρήσης βάσει της κατάταξής τους σε ενεργειακή κατηγορία,
- πληροφορηθείτε για εξοικονόμηση ενέργειας και χρημάτων μέσω παρεμβάσεων βελτίωσης της ενεργειακής απόδοσης.

ΣΥΣΤΑΣΕΙΣ ΓΙΑ ΤΗ ΒΕΛΤΙΩΣΗ ΤΗΣ ΕΝΕΡΓΕΙΑΚΗΣ ΑΠΟΔΟΣΗΣ

1.

2.

3.

Σύσταση	Εκτιμώμενο αρχικό κόστος επένδυσης [€]	Εκτιμώμενη ετήσια εξοικονόμηση πρωτογενούς ενέργειας & τιμή μονάδας			Εκτιμώμενη απλή περίοδος αποπληρωμής*	Εκτιμώμενη ετήσια μείωση εκπομπών CO_2	Ενεργειακή κατηγορία
		[kWh/m²]	[%]	[€/kWh]	[έτη]	[kg/m²]	-
1.							
2.							
3.							

Οι συστάσεις είναι ιεραρχημένες σε σχέση με το κόστος – ενεργειακό όφελος που προκύπτει. Η εξοικονόμηση ενέργειας και τιμή μονάδας αφορά την κάθε επί μέρους σύσταση και τα ποσά δεν αθροίζονται. Ομοίως για την ετήσια μείωση εκπομπών CO2 και την περίοδο αποπληρωμής.
- Η απλή περίοδος αποπληρωμής υπολογίζεται με βάση την τελική ενεργειακή κατανάλωση και όχι την κατανάλωση πρωτογενούς ενέργειας.

Ονοματεπώνυμο Ενεργειακού Επιθεωρητή	Σφραγίδα
Α.Μ. Ενεργειακού Επιθεωρητή: 00000	Υπογραφή

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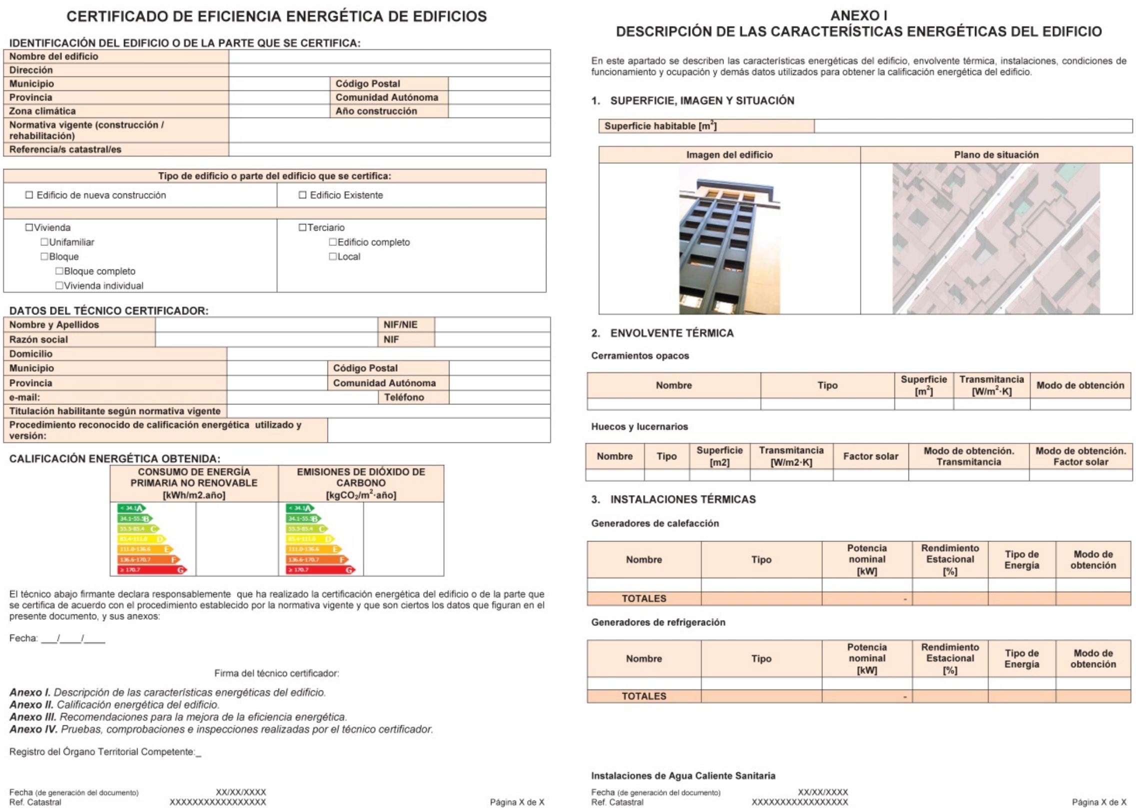
SPAIN

Implementation	National
Start of EPCs	2007
Legislation Force	Royal Decree 235/2013 of the Ministry of Industry on Energy Performance certification procedures for buildings
EPC databases	Regional level

EPC Report



CERTIFICADO DE EFICIENCIA ENERGÉTICA DE EDIFICIOS

IDENTIFICACIÓN DEL EDIFICIO O DE LA PARTE QUE SE CERTIFICA:

Nombre del edificio			
Dirección			
Municipio		Código Postal	
Provincia		Comunidad Autónoma	
Zona climática		Año construcción	
Normativa vigente (construcción / rehabilitación)			
Referencia/s catastral/es			

Tipo de edificio o parte del edificio que se certifica:	
☐ Edificio de nueva construcción	☐ Edificio Existente
☐Vivienda ☐Unifamiliar ☐Bloque ☐Bloque completo ☐Vivienda individual	☐Terciario ☐Edificio completo ☐Local

DATOS DEL TÉCNICO CERTIFICADOR:

Nombre y Apellidos		NIF/NIE	
Razón social		NIF	
Domicilio			
Municipio		Código Postal	
Provincia		Comunidad Autónoma	
e-mail:		Teléfono	
Titulación habilitante según normativa vigente			
Procedimiento reconocido de calificación energética utilizado y versión:			

CALIFICACIÓN ENERGÉTICA OBTENIDA:

CONSUMO DE ENERGÍA PRIMARIA NO RENOVABLE [kWh/m2.año]		EMISIONES DE DIÓXIDO DE CARBONO [$kgCO_2/m^2$·año]	
< 34.1 A 34.1-55.5 B 55.5-85.4 C 85.4-111.0 D 111.0-136.6 E 136.6-170.7 F ≥ 170.7 G		< 34.1 A 34.1-55.5 B 55.5-85.4 C 85.4-111.0 D 111.0-136.6 E 136.6-170.7 F ≥ 170.7 G	

El técnico abajo firmante declara responsablemente que ha realizado la certificación energética del edificio o de la parte que se certifica de acuerdo con el procedimiento establecido por la normativa vigente y que son ciertos los datos que figuran en el presente documento, y sus anexos:

Fecha: ___/____/____

Firma del técnico certificador:

Anexo I. *Descripción de las características energéticas del edificio.*
Anexo II. *Calificación energética del edificio.*
Anexo III. *Recomendaciones para la mejora de la eficiencia energética.*
Anexo IV. *Pruebas, comprobaciones e inspecciones realizadas por el técnico certificador.*

Registro del Órgano Territorial Competente:_

Fecha (de generación del documento) XX/XX/XXXX
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ANEXO I
DESCRIPCIÓN DE LAS CARACTERÍSTICAS ENERGÉTICAS DEL EDIFICIO

En este apartado se describen las características energéticas del edificio, envolvente térmica, instalaciones, condiciones de funcionamiento y ocupación y demás datos utilizados para obtener la calificación energética del edificio.

1. SUPERFICIE, IMAGEN Y SITUACIÓN

Superficie habitable [m^2]	

Imagen del edificio	Plano de situación

2. ENVOLVENTE TÉRMICA

Cerramientos opacos

Nombre	Tipo	Superficie [m^2]	Transmitancia [$W/m^2·K$]	Modo de obtención

Huecos y lucernarios

Nombre	Tipo	Superficie [m2]	Transmitancia [W/m2·K]	Factor solar	Modo de obtención. Transmitancia	Modo de obtención. Factor solar

3. INSTALACIONES TÉRMICAS

Generadores de calefacción

Nombre	Tipo	Potencia nominal [kW]	Rendimiento Estacional [%]	Tipo de Energía	Modo de obtención
TOTALES		-			

Generadores de refrigeración

Nombre	Tipo	Potencia nominal [kW]	Rendimiento Estacional [%]	Tipo de Energía	Modo de obtención
TOTALES		-			

Instalaciones de Agua Caliente Sanitaria

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Demanda diaria de ACS a 60ºC (litros/día)	

Nombre	Tipo	Potencia nominal [kW]	Rendimiento Estacional [%]	Tipo de Energía	Modo de obtención

Sistemas secundarios de calefacción y/o refrigeración (sólo edificios terciarios)

Nombre			
Tipo			
Zona asociada			
Potencia calor [kW]	Potencia frío [kW]	Rendimiento estacional calor [%]	Rendimiento estacional frío [%]
Enfriamiento gratuito	Enfriamiento evaporativo	Recuperación de energía	Control

Torres de refrigeración (sólo edificios terciarios)

Nombre	Tipo	Servicio asociado	Consumo de energía [kWh/año]
TOTALES			

Ventilación y bombeo (sólo edificios terciarios)

Nombre	Tipo	Servicio asociado	Consumo de energía [kWh/año]
TOTALES			

4. INSTALACIÓN DE ILUMINACIÓN (sólo edificios terciarios)

Espacio	Potencia instalada [W/m²]	VEEI [W/m²·100lux]	Iluminancia media [lux]	Modo de obtención
TOTALES	-			

5. CONDICIONES DE FUNCIONAMIENTO Y OCUPACIÓN (sólo edificios terciarios)

Espacio	Superficie [m²]	Perfil de uso

6. ENERGÍAS

Térmica

Nombre	Consumo de Energía Final,cubierto en función del servicio asociado [%]			Demanda de ACS cubierta [%]
	Calefacción	Refrigeración	ACS	
Paneles solares				
Caldera de biomasa				
TOTAL				

Eléctrica

Nombre	Energía eléctrica generada y autoconsumida [kWh/año]
Panel fotovoltaico	
TOTAL	

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ANEXO II
CALIFICACIÓN ENERGÉTICA DEL EDIFICIO

Zona climática		Uso	

1. CALIFICACIÓN ENERGÉTICA DEL EDIFICIO EN EMISIONES

INDICADOR GLOBAL		INDICADORES PARCIALES			
< 34.1 A 34.1-55.5 B 55.5-85.4 C 85.4-111.0 D 111.0-136.6 E 136.6-170.7 F ≥ 170.7 G		CALEFACCIÓN		ACS	
		Emisiones calefacción [$kgCO_2/m^2 \cdot año$]		Emisiones ACS [$kgCO_2/m^2 \cdot año$]	
		REFRIGERACIÓN		ILUMINACIÓN	
Emisiones globales [$kgCO_2/m^2 \cdot año$][1]		Emisiones refrigeración [$kgCO_2/m^2 \cdot año$]		Emisiones iluminación [$kgCO_2/m^2 \cdot año$]	

La calificación global del edificio se expresa en términos de dióxido de carbono liberado a la atmósfera como consecuencia del consumo energético del mismo.

	kgCO2/m2.año	kgCO2/año
Emisiones CO2 por consumo eléctrico		
Emisiones CO2 por otros combustibles		

2. CALIFICACIÓN ENERGÉTICA DEL EDIFICIO EN CONSUMO DE ENERGÍA PRIMARIA NO RENOVABLE

Por energía primara no renovable se entiende la energía consumida por el edificio procedente de fuentes no renovables que no ha sufrido ningún proceso de conversión o transformación.

INDICADOR GLOBAL		INDICADORES PARCIALES			
< 34.1 A 34.1-55.5 B 55.5-85.4 C 85.4-111.0 D 111.0-136.6 E 136.6-170.7 F ≥ 170.7 G		CALEFACCIÓN		ACS	
		Energía primaria calefacción [$kWh/m^2 \cdot año$]		Energía primaria ACS [$kWh/m^2 \cdot año$]	
		REFRIGERACIÓN		ILUMINACIÓN	
Consumo global de energía primaria no renovable [$kWh/m^2 \cdot año$][1]		Energía primaria refrigeración [$kWh/m^2 \cdot año$]		Energía primaria iluminación [$kWh/m^2 \cdot año$]	

3. CALIFICACIÓN PARCIAL DE LA DEMANDA ENERGÉTICA DE CALEFACCIÓN Y REFRIGERACIÓN

La demanda energética de calefacción y refrigeración es la energía necesaria para mantener las condiciones internas de confort del edificio.

DEMANDA DE CALEFACCIÓN		DEMANDA DE REFRIGERACIÓN	
< 34.1 A 34.1-55.5 B 55.5-85.4 C 85.4-111.0 D 111.0-136.6 E 136.6-170.7 F ≥ 170.7 G		< 34.1 A 34.1-55.5 B 55.5-85.4 C 85.4-111.0 D 111.0-136.6 E 136.6-170.7 F ≥ 170.7 G	
Demanda de calefacción [$kWh/m^2 \cdot año$]		Demanda de refrigeración [$kWh/m^2 \cdot año$]	

[1] El indicador global es resultado de la suma de los indicadores parciales más el valor del indicador para consumos auxiliares, si los hubiera (sólo ed. terciarios, ventilación, bombeo, etc…). La energía eléctrica autoconsumida se descuenta únicamente del indicador global, no así de los valores parciales.

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ANEXO III
RECOMENDACIONES PARA LA MEJORA DE LA EFICIENCIA ENERGÉTICA

Denominación

CALIFICACIÓN ENERGÉTICA GLOBAL

CONSUMO DE ENERGÍA PRIMARIA NO RENOVABLE [kWh/m2.año]		EMISIONES DE DIÓXIDO DE CARBONO [$kgCO_2/m^2 \cdot año$]	
< 34.1 A 34.1-55.5 B 55.5-85.4 C 85.4-111.0 D 111.0-136.6 E 136.6-170.7 F ≥ 170.7 G		< 34.1 A 34.1-55.5 B 55.5-85.4 C 85.4-111.0 D 111.0-136.6 E 136.6-170.7 F ≥ 170.7 G	

CALIFICACIONES ENERGÉTICAS PARCIALES

DEMANDA DE CALEFACCIÓN [$kWh/m^2 \cdot año$]		DEMANDA DE REFRIGERACIÓN [$kWh/m^2 \cdot año$]	
< 34.1 A 34.1-55.5 B 55.5-85.4 C 85.4-111.0 D 111.0-136.6 E 136.6-170.7 F ≥ 170.7 G		< 34.1 A 34.1-55.5 B 55.5-85.4 C 85.4-111.0 D 111.0-136.6 E 136.6-170.7 F ≥ 170.7 G	

ANÁLISIS TÉCNICO

Indicador	Calefacción		Refrigeración		ACS		Iluminación		Total	
	Valor	ahorro respecto a la situación original	Valor	ahorro respecto a la situación original	Valor	ahorro respecto a la situación original	Valor	ahorro respecto a la situación original	Valor	ahorro respecto a la situación original
Consumo Energía final [$kWh/m^2 \cdot año$]										
Consumo Energía primaria no renovable [$kWh/m^2 \cdot año$]										
Emisiones de CO_2 [$kgCO_2/m^2 \cdot año$]										
Demanda [$kWh/m^2 \cdot año$]										

Nota: Los indicadores energéticos anteriores están calculados en base a coeficientes estándar de operación y funcionamiento del edificio, por lo que solo son válidos a efectos de su calificación energética. Para el análisis económico de las medidas de ahorro y eficiencia energética, el técnico certificador deberá utilizar las condiciones reales y datos históricos de consumo del edificio.

DESCRIPCIÓN DE MEDIDA DE MEJORA
Características técnicas de la medida (modelo de equipos, materiales, parámetros característicos) *(Según anexo …)*
Coste estimado de la medida
Otros datos de interés

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ANEXO IV
PRUEBAS, COMPROBACIONES E INSPECCIONES REALIZADAS POR EL TÉCNICO CERTIFICADOR

Se describen a continuación las pruebas, comprobaciones e inspecciones llevadas a cabo por el técnico certificador durante el proceso de toma de datos y de calificación de la eficiencia energética del edificio, con la finalidad de establecer la conformidad de la información de partida contenida en el certificado de eficiencia energética.

Fecha de realización de la visita del técnico certificador	

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ANNEX II: INTERNATIONAL CERTIFICATION SCHEMES

First to select the certification schemes describes in section 2.2. a broader search has been carried out. Below are the certifications studied for this deliverable.

	Start Year	Origin Country	Website
Passive House	1990	German	https://passivehouse.com
BREEAM	1990	U.K.	https://www.breeam.com/
H.Q.E.	1996	France	https://www.behqe.com/
BREEAM-HK	1996	Hong Kong	https://www.hkgbc.org.hk/eng/
LEED	1998	U.S.A.	https://www.usgbc.org/leed
National Australian Built Environment Rating System (NABERS)	1998	Australia	https://www.nabers.gov.au/
ENERGY STAR	1999	U.S.A.	https://www.energystar.gov/
Green Globes	2000	Canada	http://www.greenglobes.com/
GBTool	2000	Canada	http://iisbe.org/gbc2k/gbtool/gbtool-main.htm
Comprehensive Assessment System for Built Environment Efficiency (CASBEE)	2001	Japan	http://www.ibec.or.jp/CASBEE/english/
Green Star	2002	Australia	https://new.gbca.org.au/rate/green-star/
One Planet Living	2003	U.K.	https://www.bioregional.com/one-planet-living
BCA Green Mark	2005	Singapore	https://www.bca.gov.sg/greenmark/green_mark_buildings.html
LiderA	2005	Portugal	http://www.lidera.info/?p=index&RegionId=3&Culture=en
Living Building Challenge	2006	U.S.A.	https://living-future.org/lbc/
Estidama	2008	Abu Dhabi	https://www.dmt.gov.ae/en/Urban-Planning/Pearl-Building-Rating-System
Qatar Sustainability Assessment System (QSAS)	2009	Qatar	https://sasintgroup.com/info-hub/environmental-accreditation-statements/gsas/

IGBC	2009	India	https://igbc.in/igbc/
DGNB	2009	Germany	https://www.dgnb-system.de/en/buildings/
Green Building Index	2009	Malaysia	https://www.greenbuildingindex.org/
BERDE	2010	Philippines	https://berdeonline.org/#about-berde
GREEN	2010	Sri Lanka	https://srilankagbc.org/greensl-rating-system/
LOTUS	2010	Vietnam	https://vgbc.vn/en/lotus-en/rating-systems/
GreenShip	2010	Indonesia	https://www.gbcindonesia.org/greenship
ARZ	2011	Lebanon	http://www.arzrating.com/
WELL	2014	U.S.A.	https://www.wellcertified.com/
Building EQ	2016	U.S.A.	https://www.ashrae.org/technical-resources/building-eq
WOSHIE	2020	Ireland	https://www.woshie.org/