DOI: 10.24427/978-83-65596-71-0_5

5. ENERGY CERTIFICATION

The efficient use of energy resources and reduction of environmental pollution are priority tasks today. Certification of energy performance of buildings is one of the ways to reach these tasks.

5.1. Energy performance certification of buildings

The certification of building energy performance is a process that determines the energy consumption of a building and classifies the building on an energy performance scale.

The certification process is based on the Directive of the European Parliament and the European Council "On Energy Performance of Buildings" (the recast Directive 2010/31; STR1, 2011; STR2, 2016).

The aim of the certification is to facilitate more efficient energy use because it is an important part of the policy and of the applied measures necessary to comply with the "Kyoto Protocol to the United Nations Framework Convention on Climate Change" (STR1, 2011; STR2, 2016).

Energy performance certification is one of the ways of reducing the CO_2 emissions into the environment by implementing the European Council directive on limitation of carbon dioxide emissions by increased efficiency of energy consumption in the building sector (STR3, 2016).

On 30 November 2016 the Commission proposed an update to the Energy Performance of Buildings Directive to help promote the use of smart technology in buildings and to streamline the existing rules.

Finally, on 19 December 2017 a political agreement was reached on the proposals. Among the updates we could find provisions on smart technologies and technical building systems, including automation and e-mobility. The legal text of this political agreement is expected to be published in 2018 (WEB-1).

Buildings in Spain are classified in six categories according to energy efficiency scale: A, B, C, D, E, F, G. Buildings in Lithuania are classified in nine classes according to energy efficiency scale: A++, A+, A, B, C, D, E, F, G (REG-1, REG-2). A++ class is the highest, it indicates an almost no-energy-consuming building (REG-1, REG-2).

Class G refers to an energy-efficient building. Methodology of evaluation of energy efficiency in Poland is significantly different. The Polish legislation (REG-9, REG-10) introduced an obligation to compare the calculated values of energy indicators with the maximum values delivered by regulations. Contrary to many other EU countries, no energy classes were recommended. The final result is presented in the graph (Fig. 5.1) showing if the EP factor in the evaluated building is lower or higher than the maximum value recommended for a new structure, according to the Polish law. Maximum values are depicted in a Polish regulation (REG-11).

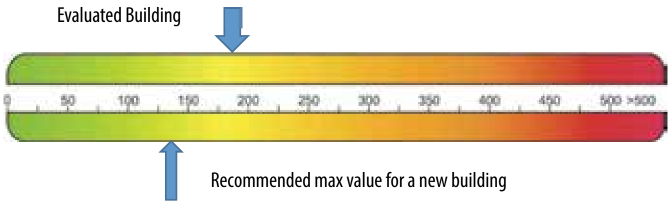


Fig. 5.1. A part of the Polish Energy Certificate presenting the EP values (Source: own elaboration)

Participants in the Spanish Energy Efficiency Certification Process are (REG-3):

- a certification customer (owner of a residential house, flat or building),
- a recognized expert by the Spanish Administration authorized to certify buildings,
- an institution appointed by the Spanish Administration supervising the certification process and registering the energy efficiency certificate of the building.

When renting or buying real estate, the owner of the property is obliged to submit the certificate of energy efficiency of the house (flat or building) to the tenants or new owners.

Participants in the Lithuanian certification process are:

- a certification customer,
- an expert with a licence to certify buildings,
- an institution appointed by the Ministry of Environment supervising the certification process.

In Poland, according to REG-11, parties participating in the certification process are similar to those in other countries.

5.2. Methodology for evaluation of energy performance of a building

Energy efficiency indicators of a building are the indicators according to which the building energy efficiency class is determined.

5.2.1 Energy efficiency indicators in Lithuania

Energy efficiency indicator C1 describes the energy efficiency for heating, ventilation and cooling. The C2 value of the energy efficiency indicator describes (REG-2, STR2, 2016):

- thermal properties of the walls and structure of the building and the building envelope for calculating specific heat loss,
- thermal energy consumption for the heating of the building,
- the efficiency of energy consumption for the preparation of hot domestic water,
- technical indicators of the mechanical ventilation system with recuperation,
- the energy from renewable resources.

Calculation of C1 energy efficiency indicator (STR2, 2016):

If
$$\frac{\sum_{m=1}^{12} Q_{PRn.H,m} + Q^{I}_{PRn.E}}{\sum_{m=1}^{12} Q_{R.PRn.H,m} + \sum_{m=1}^{12}(Q_{R.E.\lg,m} \cdot f_{R.PRn.E})} \geq 1,$$

then
$$C_1 = 1 + \frac{\sum_{m=1}^{12} Q_{PRn.H,m} + Q^{I}_{PRn.E}}{\sum_{m=1}^{12} Q_{R.PRn.H,m} + \sum_{m=1}^{12}(Q_{R.E.\lg,m} \cdot f_{R.PRn.E})} \tag{5.1}$$

If
$$\frac{\sum_{m=1}^{12} Q_{PRn.H,m} + Q^{I}_{PRn.E}}{\sum_{m=1}^{12} Q_{N.PRn.H,m} + \sum_{m=1}^{12}(Q_{N.E.\lg,m} \cdot f_{N.PRn.E})} \leq 1,$$

then
$$C_1 = \frac{\sum_{m=1}^{12} Q_{PRn.H,m} + Q^{I}_{PRn.E}}{\sum_{m=1}^{12} Q_{N.PRn.H,m} + \sum_{m=1}^{12}(Q_{N.E.\lg,m} \cdot f_{N.PRn.E})} \tag{5.2}$$

Other cases: $$C_1 = 1 + \frac{\sum_{m=1}^{12} Q_{PRn.H,m} + Q^I_{PRn.E} - \sum_{m=1}^{12} Q_{N.PRn.H,m} - \sum_{m=1}^{12} (Q_{N.E.\lg,m} \cdot f_{N.PRn.E})}{\sum_{m=1}^{12} Q_{R.PRn.H,m} - \sum_{m=1}^{12} Q_{N.PRn.H,m}} \quad (5.3)$$

where:

$Q_{N.PRn.H,m}$ – the standard monthly non-renewable primary energy consumption for the heating of the building, kWh / (m² month),

$Q_{R.PRn.H,m}$ – non-renewable primary energy consumption for the heating of the building, kWh/(m²· month);

$Q_{PRn.H,m}$ – the calculated monthly non-renewable primary energy consumption for the heating of the building, kWh/(m²· month);

$Q^I_{PRn.E}$ – calculation according to Equ. 5.4-5.5 (STR2, 2016):

$$Q^I_{PRn.E} = \sum_{m=1}^{12} Q^I_{PRn.E,m} \quad (5.4)$$

$$Q^I_{PRn.E,m} = (Q_{E.\lg,m} + Q_{E.vent,m} + Q_{C.E,m} - Q_{E.SK+WE+HE,m}) \cdot f_{PRn.E} + Q_{PRn.E.SK+WE+HE,m} \quad (5.5)$$

where:

$Q_{E.lg,m}$ – monthly calculated electrical energy consumption for the heating, kWh/(m²·month);

$Q_{E.vent,m}$ – monthly calculated electrical energy consumption for fans of mechanical ventilation systems of the building, kWh/(m²·month);

$Q_{C.E,m}$ – monthly calculated energy consumption for cooling, kWh/(m²·month);

$Q_{E.SK+WE+HE,m}$ – monthly calculated consumption of electricity produced by solar collectors, wind power plants and hydro-power plants in the building, kWh/(m²·month);

$Q_{PRn.E.SK+WE+HE,m}$ – monthly calculated consumption of primary energy supplied to the building from solar collectors, wind power plants and hydro-power plants, kWh / (m² month);

$f_{PRn.E}$ – primary energy factor for electricity.

Calculation of energy efficiency indicator C2 (STR2, 2016):

$$C_2 = \frac{\sum_{m=1}^{12} Q_{PRn.hw,m}}{\sum_{m=1}^{12} Q_{N.PRn.hw,m}} \quad (5.6)$$

where:

$Q_{N.PRn.hw,m}$ – the standard monthly non-renewable primary energy consumption for the preparation of hot water, kWh / (m² month);

$Q_{PRn.hw,m}$ – monthly calculation of non-renewable primary energy consumption for DHW, kWh/(m²· month).

A building shall be marked with a certain energy performance class considering the values of the qualifying indicators C1 and C2 as follows (REG-2; STR2, 2016):

- B class: $0.5 \leq C_1 < 1$ ir $C_2 \leq 0.99$,
- A class: $0.375 \leq C_1 < 0.5$ ir $C_2 \leq 0.85$,
- A+ class: $0.25 \leq C_1 < 0.375$ ir $C_2 \leq 0.80$,
- A++ class: $C_1 < 0.25$ ir $C_2 \leq 0.70$.

5.2.2 Energy efficiency indicators in the Spanish legislation

The energy rating is expressed through several indicators that explain the reasons for a good or bad energy behaviour of the building (REG-3, REG-5, REG-6). These indicators have been obtained from the energy consumption of the building in the climatic conditions determined for normal operating and occupancy, which include the energy consumed by heating, cooling, ventilation, production of hot water and, where appropriate (only for non-residential buildings), lighting in order to maintain thermal and lighting comfort conditions as well as indoor air quality (REG-4, REG-7, REG-8).

The indicators are obtained on an annual basis and refer to a unit of useful surface of the building. The main or global indicators of energy efficiency are:

- annual emissions of CO_2, expressed in kg CO_2/(m^2year),
- annual consumption of non-renewable primary energy, expressed in kWh/(m^2year).

These main indicators include the impact of heating, cooling, production services of sanitary (domestic) hot water and lighting – for purposes other than private residential, as well as reduction of emissions or non-renewable primary energy consumption derived from the use of renewable energy sources.

Spanish rating scale for buildings for private residential use (housing)

Buildings destined for private residential use (housing) are classified, for each of the indicators of energy efficiency, using a scale of seven letters, which goes from letter A (the most efficient building) to letter G (the least efficient one), according to Table 5.1 (REG-3).

Table 5.1. Energy rating and indices for private residential buildings use (Source: REG-3)

Class			Index		
A			C1	<	0.15
B	0.15	≤	C1	<	0.5
C	0.5	≤	C1	<	1.00
D	1.00	≤	C1	<	1.75
E	1.75	≤	C1		
			C2	<	1.00
F	1.75	≤	C1		
	1.00	≤	C2	<	1.50
G	1.75	≤	C1		
	1.50	≤	C2		

C_1 and C_2 indices expressing the energy rating of single-family homes and blocks of flats are obtained through the following formulas:

$$C_1 = \frac{\left(R \cdot I_o / \bar{I}_r\right) - 1}{2\left(R - 1\right)} + 0.6 \tag{5.7}$$

$$C_2 = \frac{\left(R' \cdot I_o / \bar{I}_s\right) - 1}{2\left(R' - 1\right)} + 0.5 \tag{5.8}$$

where:

I_o – the value of the indicator of the analysed building (annual emissions of CO_2, annual consumption of non-renewable primary energy),

$\bar{I}_r$ – the average value of the reference park indicator of new buildings for private residential use (living place).

R – the ratio between the value of $\bar{I}_r$ and the value of the indicator corresponding to the 10th percentile of the park of reference of new buildings for private residential use (housing).

$\bar{I}_s$ – the average value of the reference indicator of existing private residential buildings (living place).

R_o – the ratio between the value of $\bar{I}_s$ and the value of the indicator corresponding to the 10th percentile of the park of reference of existing buildings for private residential use (housing).

The values of I_r, R, $\bar{I}_s$, R_o corresponding to different Spanish climatic zones are included in Regulation 9 .

Energy efficiency indicators in Poland

According to law (REG-11), in Poland there are 3 main energy indicators: EP, EK, EU and one ecological indicator E_{CO2}. The relation between them is shown in Fig. 5.2.

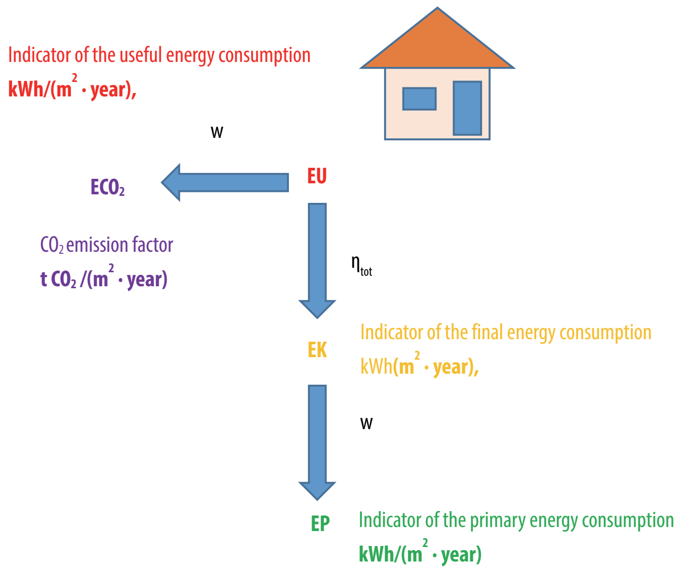


Fig. 5.2. Schema of the relation between EP, EK and EU (Source: own elaboration)

The EU is the indicator of the useful energy consumption that is estimated based on standards and regulations. To obtain the EK (indicator of final energy consumption), it is necessary to take into account total efficiency of the systems (heating, hot water and cooling) that is calculated based on equation 5.9:

$$\eta_{tot} = \eta_g \text{ (or COP)} \cdot \eta_d \cdot \eta_s \cdot \eta_e \qquad (5.9)$$

where:

η_g (or COP) – eficiency of generation (–),
η_d – efficiency of distribution (–),
η_s – efficiency of storage (–),
η_e – efficiency of regulation (–).

Moreover, after including the factor depending on the fuel type, we will estimate the EP (indicator of primary energy consumption).

Besides, the Polish regulation (REG-12) sets the maximum value of the EP. Total EP consists of 3 main components (equation 5.10, Table 5.2):

$$EP = EP_{H+W} + \Delta EP_C + \Delta EP_L;\ [kWh/(m^2 \cdot year)] \tag{5.10}$$

where
EP_{H+W} is part of EP connected with heating, ventilation and hot water,
ΔEP_C is part of EP connected with cooling (kWh/(m²·year),
ΔEP_L is part of EP connected with lighting (kWh/(m²·year).

Table 5.2. Maximum $EP_{H+W,}$ ΔEP_C, ΔEP_L

Type of building	EP_{H+W} kWh/(m²·year)	EP_{H+W} kWh/(m²·year)	ΔEP_C kWh/(m²·year)	ΔEP_C kWh/(m²·year)	ΔEP_L kWh/(m²·year)	ΔEP_L kWh/(m²·year)
	2017	2020	2017	2020	2017	2020
Single family houses	95	70	$\Delta EP_C = 10\ A_{f,C}/A_f$	$\Delta EP_C = 5\ A_{f,C}/A_f$	$\Delta EP_L = 0$	$\Delta EP_L = 0$
Residential buildings	85	65				
Health centres	290	190	$\Delta EP_C = 25\ A_{f,C}/A_f$	$\Delta EP_C = 25\ A_{f,C}/A_f$	$t_0 < 2500$ $\Delta EP_L = 50$ $t_0 \geq 2500$ $\Delta EP_L = 100$	$t_0 < 2500$ $\Delta EP_L = 25$ $t_0 \geq 2500$ $\Delta EP_L = 50$
Public buildings	60	70				

$A_{f,C}$ – heated or cooled area in m², A_f – cooled area in m², t_0 – time of system usage in h.

5.3. THE CERTIFICATE OF ENERGY PERFORMANCE OF A BUILDING

The energy performance certification of a building is needed to assess the energy performance of a specific building by classifying it as an energy efficiency class.

Certificate is a document, which contains the following data (STR2, 2016):
- address of the building,
- purpose of the building,
- useful area of the building,
- energy performance class of the building,
- estimated sum of energy inputs per one square metre of the useful area of the building,
- data about the main source of heating of the building by specifying one of heating sources,
- reference number of the certificate of the building,
- date of issuing of the certificate,
- validity date of the certificate,

- name, certificate number and signature of the expert who issued the certificate of the building (Fig. 5.3).

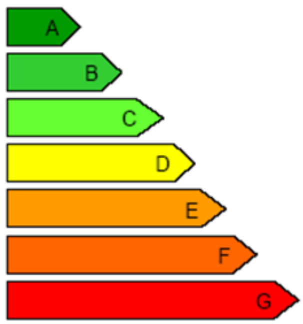
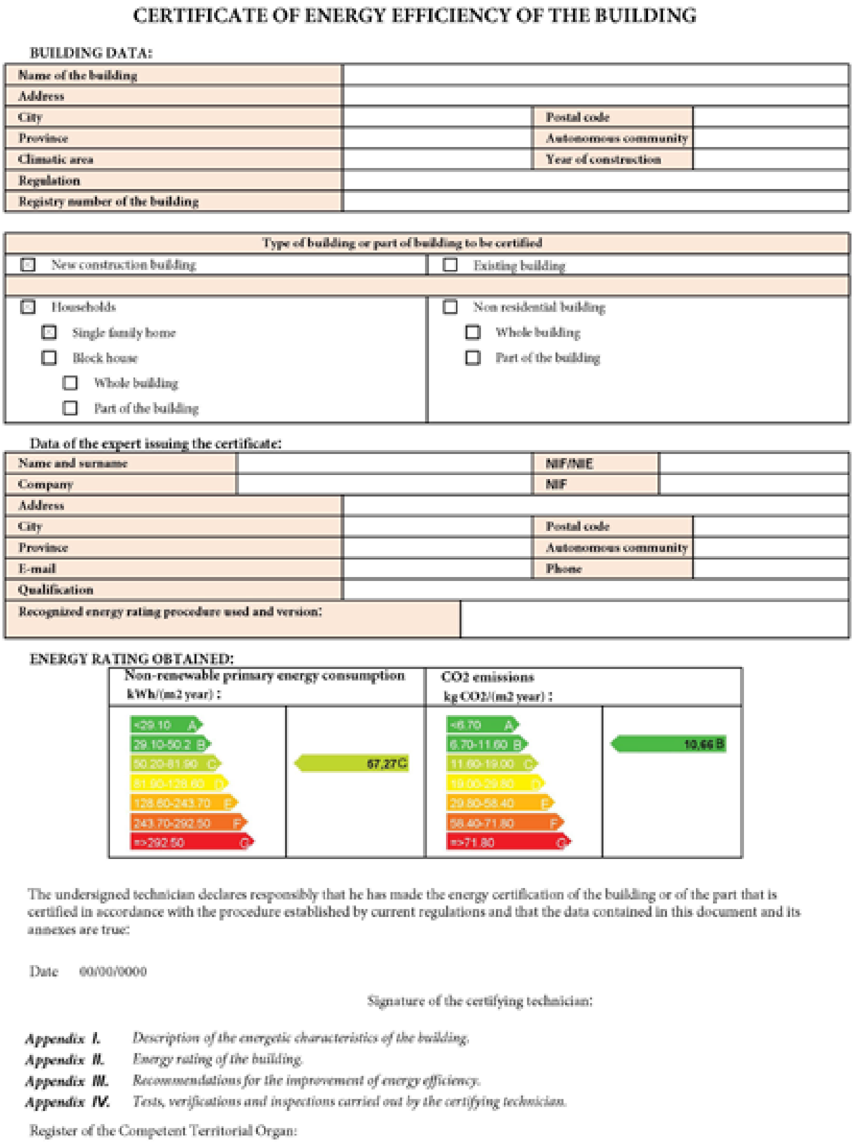
CERTIFICATE OF ENERGY PERFORMANCE OF THE BUILDING No. __________			
Address of the building:			
Purpose of the building:			
Useful area of the building, m^2:			
Classification of energy performance of buildings*:			Energy performance class of the building:
 * Class A indicates a highly energy-efficient building, Class G indicates an energy-inefficient building			C
Estimated sum energy inputs per one square metre of useful area of the building, $kWh/(m^2 \cdot year)$:			
The main source of heating of the building:			
Certificate issued on:			
Certificate valid before:			
Certificate issued by the expert:	________________ name	________________ certificate No.	___________ signature

Fig. 5.3. An example of a Certificate issued in Lithuania (Source: STR2, 2016)

The Spanish energy efficiency certificate shall conform to the model (REG-9), and may contain additional annexes, when these prove necessary. Fig. 5.4 shows a typical Spanish Certificate of Energy Efficiency in Buildings.

Data presented in the Spanish Certificate:

- building data,
- type of building to be certified,
- data of the expert issuing the certificate,
- energy rating obtained, expressed in non-renewable primary energy consumption and CO_2 emissions,
- four appendices including additional data of the certification process.



CERTIFICATE OF ENERGY EFFICIENCY OF THE BUILDING

BUILDING DATA:

Name of the building			
Address			
City		Postal code	
Province		Autonomous community	
Climatic area		Year of construction	
Regulation			
Registry number of the building			

Type of building or part of building to be certified	
☒ New construction building	☐ Existing building
☒ Households	☐ Non residential building
☒ Single family home	☐ Whole building
☐ Block house	☐ Part of the building
☐ Whole building	
☐ Part of the building	

Data of the expert issuing the certificate:

Name and surname		NIF/NIE	
Company		NIF	
Address			
City		Postal code	
Province		Autonomous community	
E-mail		Phone	
Qualification			
Recognized energy rating procedure used and version:			

ENERGY RATING OBTAINED:

Non-renewable primary energy consumption kWh/(m2 year) :		CO2 emissions kg CO2/(m2 year) :	
<29.10 A		<6.70 A	
29.10-50.2 B		6.70-11.60 B	10,66 B
50.20-81.90 C	67,27 C	11.60-19.00 C	
81.90-128.60 D		19.00-29.80 D	
128.60-243.70 E		29.80-58.40 E	
243.70-292.50 F		58.40-71.80 F	
=>292.50 G		=>71.80 G	

The undersigned technician declares responsibly that he has made the energy certification of the building or of the part that is certified in accordance with the procedure established by current regulations and that the data contained in this document and its annexes are true:

Date 00/00/0000

Signature of the certifying technician:

Appendix I. *Description of the energetic characteristics of the building.*
Appendix II. *Energy rating of the building.*
Appendix III. *Recommendations for the improvement of energy efficiency.*
Appendix IV. *Tests, verifications and inspections carried out by the certifying technician.*

Register of the Competent Territorial Organ:

Fig. 5.4. An example of a Certificate issued in Spain (Source: M. R. de Adana's private archive)

The main results of calculation of energy inputs, the assessment of measures to improve energy performance of a building and the calculation results of energy inputs are shown in table 5.3 (STR2, 2016).

Table 5.3. Fragments of calculation results of energy inputs of a building (Source: STR2, 2016)

No.	Energy inputs	Estimated annual energy inputs per one square metre of the useful area of a building, kWh/(m^2·year)
1.	Loss of heat through the walls of a building	
2.	Loss of heat through the roof of a building	
3.	Loss of heat through the external ceilings of a building	
4.	Loss of heat through partitions touching the soil	
5.	Loss of heat through the windows of a building	
6.	Loss of heat through the external entrance door of a building except for the loss when the door is open	
7.	Loss of heat through the linear thermal bridges of a building	
8.	Loss of energy through the ventilation of a building	
…		
12.	Heat inflow to a building from the outside	
13.	Internal heat emissions in a building	
14.	Electricity consumption in a building	
15.	Energy inputs for hot water preparation	
…		

Energy-consuming buildings are buildings complying with the requirements of the A ++ energy performance class (very high energy performance buildings, where energy consumption is almost zero or energy consumption is very low; most of the energy consumed comes from renewable sources, either local or non-local) (REG-2, STR2 2016). Low-energy buildings are buildings matching the requirements of the B, A and A+ energy performance class (STR1, 2011; STR2, 2016).

An example of the main page of Polish Energy Certificate is shown in Fig. 5.5.

ENERGY EFFICIENCY CERTIFICATE FOR A RESIDENTIAL BUILDING a single family house			
VALIDITY DATE	10.10.2028	CERTIFICATE NUMBER	1/2018
THE EVALUATED BUILDING			
TYPE OF BUILDING	residential		
ADDRESS	Bialystok		
WHOLE / PART OF THE BUILDING	whole building		
YEAR OF CONSTRUCTION	2017		
YEAR OF COMMISSIONING	2017		
YEAR OF FITTING INSTALLATIONS	2017		
NUMBER OF FLATS	1		
USABLE AREA (A_f, m²)	110.00		
PURPOSE OF THE EVALUATION	○ **NEW BUILDING** ○ RENTAL/SALE ○ EXISTING BUILDING ○ EXTENSION OF BUILDING		

COMPUTATIONAL DEMAND FOR NON-RENEWABLE PRIMARY ENERGY [1)]

EP – the evaluated building 144.3 kWh (m² • year)

WT 2014[2)] technical conditions for a new building

CONFIRMATION OF COMPLIANCE WITH WT 2014[2)] CONDITIONS			
DEMAND FOR PRIMARY ENERGY (EP)		DEMAND FOR FINAL ENERGY (EK)	
THE EVALUATED BUILDING	144.3 kWh (m² year)	THE EVALUATED BUILDING	48.1 kWh (m² year)
A BUILDING ACCORDING TO WT 2014	125.0 kWh (m² year)		

1) Energy performance is established by comparing a single unit of non-renewable primary energy EP necessary to meet the energy demand of the building for heating, cooling, ventilation and usable hot water (overall effectiveness) with reference value.
2) The regulation of the Minister of Infrastructure of 12 April 2002 concerning technical conditions to be met by buildings and their location (Dz.U. Nr 75. pos. 690, with later amendments); complying with the conditions is obligatory only for a new building.

Attention: energy performance is established for climatic conditions in place of reference: Bialystok and for normal conditions of use defined on page 2.

EXPERT ISSUING THE CERTIFICATE	
FIRST NAME AND SURNAME	Dorota Krawczyk
CONSTRUCTION LICENCE NUMBER OR REGISTRATION NUMBER	
DATE OF ISSUE	10.10.2018
DATE, STAMP AND SIGNATURE	

Fig. 5.5. The Polish energy certificate, page 1 (Source: D.A.Krawczyk's private archive)

5.4. An example of energy certificate

To show differences between national methodologies and final documents, a single-family house has been analysed.

5.4.1. A Certificate for a house in Spain

A single-storey residential building is located in the city of Cordoba. The house is L-shaped. Fig. 5.6-5.7 show different views of the house.

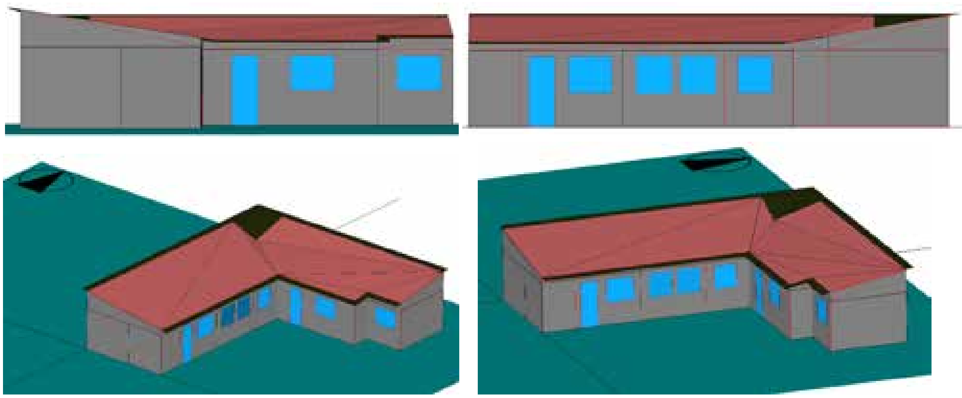


Fig. 5.6. Views of the residential house prepared in HULC (Source: M.R.de Adana's private archive)

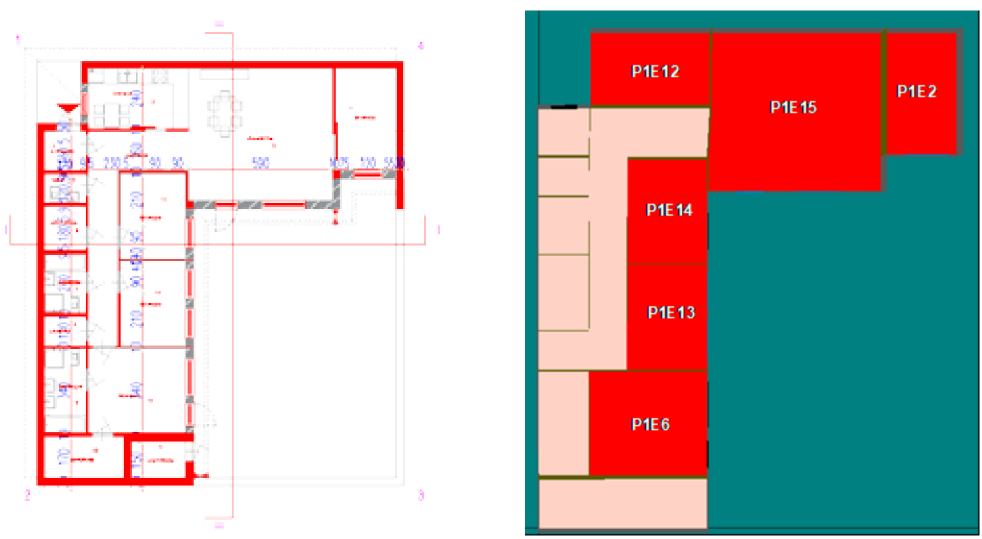


Fig. 5.7. The plan of the residential house in AUTOCAD and HULC (Source: M.R.de Adana's private archive)

Living room, kitchen and four bedrooms of the house are identified as rooms equipped with HVAC systems. Fig. 5.8 shows the air-conditioned rooms of the house.

Room	Hulc	HVAC system
Bedroom 1	P1E2	YES
Living room 2	P1E15	YES
Kitchen 3	P1E12	YES
Bedroom 12	P1E6	YES
Bedroom 13	P1E13	YES
Bedroom 14	P1E14	YES

Fig. 5.8. Rooms of the house equipped with HVAC systems (Source: M.R.de Adana's private archive)

The proposed HVAC system is composed of two multisplit heat pumps for the cooling/heating demand and a boiler for the domestic hot water (DHW) demand. Fig. 5.9 shows the proposed HVAC system.

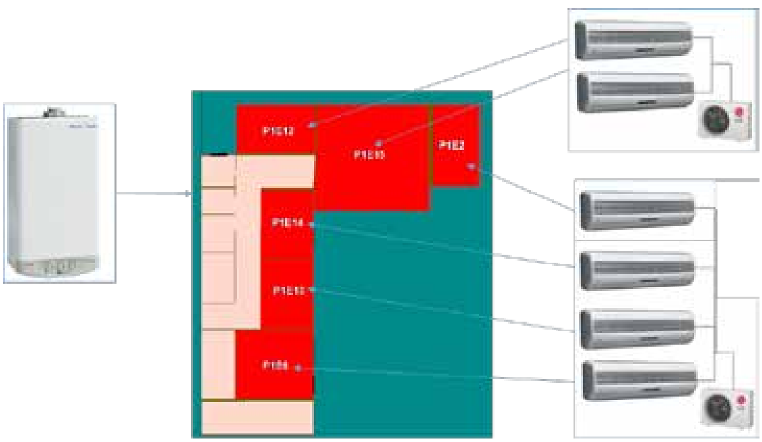


Fig. 5.9. HVAC systems in the residential house (Source: M.R.de Adana's private archive)

70% of the calculated DWH demand is covered by a solar thermal system. The DHW demand is 90 litres per day. The natural gas boiler has a thermal power of 15 kW and an efficiency of 90%.

The four bedrooms are equipped with a multisplit HVAC heat pump system with the characteristics shown in Fig. 5.10.

Indoor units		[illegible]	[illegible]	[illegible]	[illegible]
Nominal cooling capacity	kW	1	1	1	1
Nominal sensible cooling capacity	kW	0.6	0.6	0.6	0.6
Nominal heating capacity	kW	1.1	1.1	1.1	1.1
Airflow rate	m³/h	300	300	300	300

Outdoor unit		[illegible]
Nominal cooling capacity	kW	4
Nominal cooling consumption	kW	1.5
Nominal heating capacity	kW	4.5
Nominal heating consumption	kW	1.17

Fig. 5.10. Characteristics of the multisplit HVAC heat pump system for the bedrooms (Source: M.R.de Adana's private archive)

The living room and kitchen are equipped with another multisplit HVAC heat pump system with the characteristics shown in Fig. 5.11.

Indoor units		[illegible]	[illegible]
Nominal cooling capacity	kW	2.5	1
Nominal sensible cooling capacity	kW	1.6	0.6
Nominal heating capacity	kW	2.75	1.1
Airflow rate	m³/h	750	300

Outdoor unit		[illegible]
Nominal cooling capacity	kW	4
Nominal cooling consumption	kW	1.5
Nominal heating capacity	kW	4.5
Nominal heating consumption	kW	1.17

Fig. 5.11. Characteristics of the multisplit HVAC heat pump system for the living room and the kitchen (Source: M.R.de Adana's private archive)

The HVAC system is composed of two multisplit heat pumps for the cooling/heating demand and a boiler for the domestic hot water (DHW) demand. Fig. 5.11 shows the proposed HVAC system.

The residential house and HVAC systems are defined in the Spanish software HULC to calculate the energy efficiency and obtain a certificate of energy efficiency. An example of the certificate of energy efficiency is shown in Fig. 5.12.

CERTIFICATE OF ENERGY EFFICIENCY OF THE BUILDING

BUILDING DATA:

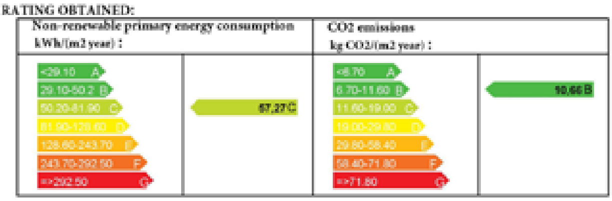
Name of the building	Residential house		
Address	Avda Brillante 70		
City	Córdoba	**Postal code**	14009
Province	Córdoba	**Autonomous community**	Andalucía
Climatic area	B4	**Year of construction**	2015
Regulation	Certification of the energy efficiency of buildings		
Registry number of the building	00126789		

Type of building or part of building to be certified	
☒ New construction building	☐ Existing building
☒ Households	☐ Non residential building
☒ Single family home	☐ Whole building
☐ Block house	☐ Part of the building
☐ Whole building	
☐ Part of the building	

Data of the expert issuing the certificate:

Name and surname	John Smith	**NIF/NIE**	0426789
Company	HVAC and Buildings	**CIF**	ES-Q4267891 1B
Address	Tendillas Street		
City	Córdoba	**Postal code**	14002
Province	Córdoba	**Autonomous community**	Andalucia
E-mail	j.smith@gmail.com	**Phone**	
Qualification	Engineer		
Recognized energy rating procedure used and version:	HULC V1.7		

ENERGY RATING OBTAINED:



The undersigned technician declares responsibly that he has made the energy certification of the building or of the part that is certified in accordance with the procedure established by current regulations and that the data contained in this document and its annexes are true:

Date 00/00/0000

Signature of the certifying technician:

Appendix I. *Description of the energetic characteristics of the building.*
Appendix II. *Energy rating of the building.*
Appendix III. *Recommendations for the improvement of energy efficiency.*
Appendix IV. *Tests, verifications and inspections carried out by the certifying technician.*

Register of the Competent Territorial Organ:

Fig. 5.12. An example of Spanish certificate of energy efficiency for a residential house (Source: M.R.de Adana's private archive)

5.4.2. Improving energy efficiency

Different actions can be considered to improve the energy efficiency of the residential house. A schematic overview of some of these actions is shown in Fig. 5.13.

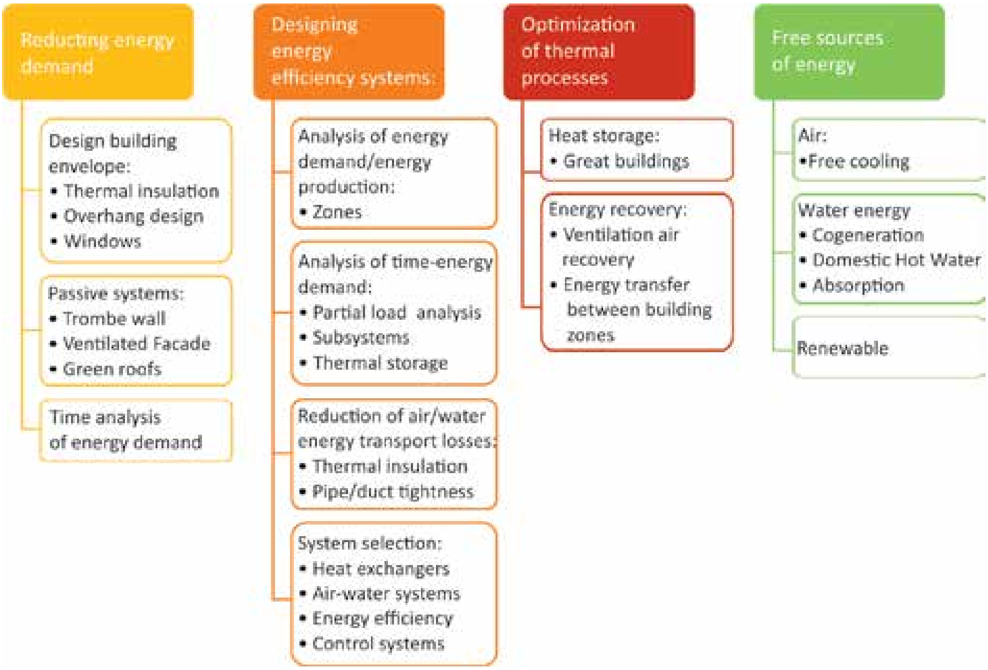


Fig. 5.13. Examples of actions to improve the energy efficiency in buildings (Source: own elaboration)

5.4.3. A certificate for a house in Poland

The same house located in Bialystok, Poland was analysed. Due to Polish climatic conditions, all rooms in the house are heated. A two-pipe water system was chosen with panel radiators and PeX pipes located on the floor (Fig. 5.14).

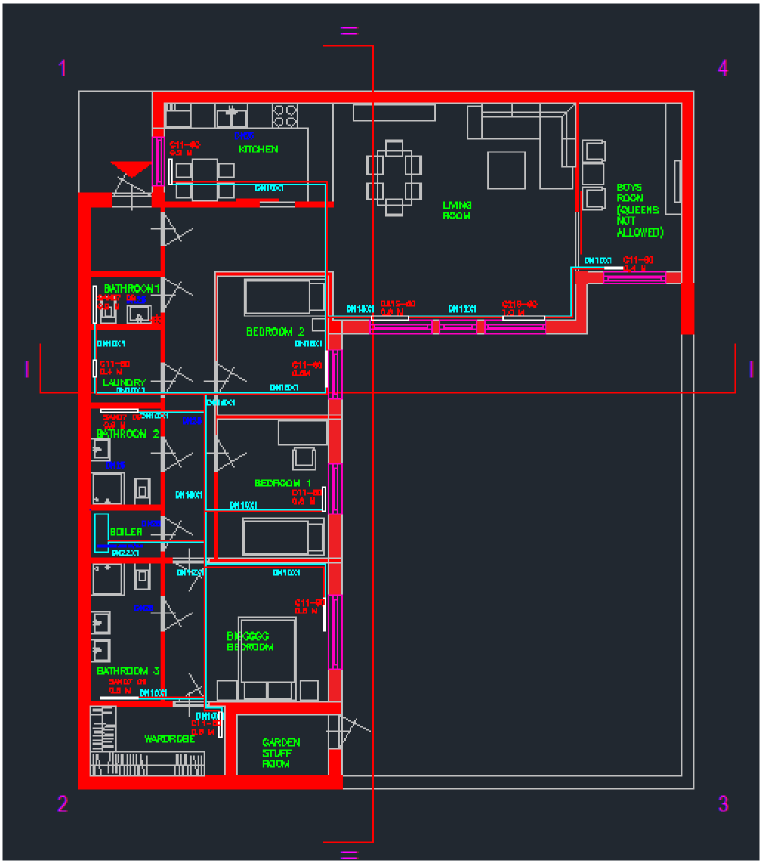


Fig. 5.14. The plan of the residential building with the heating system (Source: a teamwork of VIPSKILLS students)

All calculations including U values of walls, roof and floors, heat losses and energy consumption were conducted using Audytor OZC Sankom software that allows to prepare energy certificates according to Polish methodology. Data about the type of the building, its habitants, energy sources and the HVAC and DHW systems efficiency was introduced and final document was obtained which is presented in Fig. 5.15. The following assumptions for calculations were made:

- T-pipe heating system with PEX-Al-PEX pipes in floors and panel radiators,
- 4 habitants,
- a ground heat pump as an energy source for heating and hot water,
- air conditioning in the living room and the kitchen (multisplits).

Energy Efficiency Certificate No…				
Technical specifications of the building				
Intended use of the building				single family house
Number of storeys				1
Useable floor area				110.00 m^2
Useable floor area with adjustable temperature				110.00 m^2
Regular operating temperatures**		Winter	: 20.0	°C
Occupancy of the useable floor area		100.0		0.0%
Total volume				321.2 m^2
Compactness ratio of the building**				0.84
Number of users/ /inhabitants				4
Type of building structure		Traditional		
Building *envelope*		House has only 1 floor. All U values are lower than maximum values according to Polish law.		
Heating system		We choose tee pipe system. Our energy source is heat pump. We have 2 pipes system.		
Ventilation system		natural ventilation		
Air-conditioning system				
Domestic hot water preparation system				
Computational energy demand				
Annual final energy demand per unit**				
Energy carrier	Heating and ventilation	Hot water	Auxiliary devices	Total
Electrical energy – mixed energy *generation / production*	36.1	7.1	4.5	48.1
Division of energy demand				
Annual useable energy demand per unit**				
	Heating and ventilation	Hot water	Auxiliary devices	Total
Value**	120.0	17.8	4.5	143.7
Share [%]	83.5	12.4	3.1	100.0
Annual final energy demand per unit				
	Heating and ventilation	Hot water	Auxiliary devices	Total
Value**	36.1	7.1	4.5	48.1
Share [%]	75.1	14.7	9.3	100.0
Annual primary energy demand per unit**				
Value**	Heating and ventilation	Hot water	Auxiliary devices	Total
Share [%]	108.4	21.2	13.5	144.3
	75.1	14.7	9.3	100.0
Total annual demand for non-renewable primary energy per unit**				
1) including air-conditioning				144.3

Fig. 5.15. An example of Polish certificate of energy efficiency for a residential house (Source: own elaboration)

References

EN 15217:2007 *Energy performance of buildings. Methods for expressing energy performance and for energy certification of buildings* (and its national attachments to Lithuanian standard LST EN 15217:2007). Lithuanian Standards Board

EN 15603:2008 *Energy performance of buildings. Overall energy use and definition of energy rating* (and its national attachments to Lithuanian standard LST EN 15603:2008). Lithuanian Standards Board

EN ISO 13790:2008 *Energy performance of buildings. Calculation of energy use for space heating and cooling* (and its national attachments to Lithuanian standard LST EN ISO 13790:2008). Lithuanian Standards Board

EN 15316-1:2007 Heating systems in buildings. Method for calculation of system energy requirements and system efficiencies – Part 1: Lithuanian Standards Board

EN ISO 6946:2007 Building components and building elements. Thermal resistance and thermal transmittance. Calculation method (and its national attachments to Lithuanian standard LST EN ISO 6946:2008). Lithuanian Standards Board

EN ISO13370:2007 Thermal performance of buildings. Heat transfer via the ground. Calculation methods (and its national attachments to Lithuanian standard LST EN ISO 13370:2008). Lithuanian Standards Board

REG-1, 2016 Lietuvos Respublikos statybos įstatymas Nr. I-1240, pakeistas 2016 Nr. XII-2573 (Republic of Lithuania Law on Construction No. I-1240 amended and supplemented 2016 No. XII-2573). LRS, TAR, 2016-07-13, Nr. 20300

REG-2, 2011 Lietuvos Respublikos atsinaujinančių išteklių energetikos įstatymas Nr. XI-1375, pakeistas 2018 Nr. XIII-1078. (Republic of Lithuania Law on Renewable Energy, Order No. XI-1375, 2011 amended and supplemented 2018 No. XIII-1078). LRS, TAR, 2018-04-24, Nr. 6508

REG-3, 2013. Royal Decree 235 (2013) *Basic procedure for the certification of the energy efficiency of buildings.* Ministry of the Presidency, Government of Spain., April 5, BOE, 89, 27548-27562

REG-4, 2006. Royal Decree 314 (2006) *Technical Building Code (CTE).* Ministry of Housing. Government of Spain, March 17 BOE, 74 (2006), 11816-11831

REG-5, 2003. DOUE, 1 (2003) *European Parliament and Council. Directive 2002/91/ EC of the European Parliament and of the Council of 16 December on the energy performance of buildings*, 65-71

REG-6, 2010. DOUE, 153 (2010) *European Parliament and Council. Directive 2010/31/EU of the European Parliament and of the Council of 19 May on the energy performance of buildings*, 13-35

REG-7, 2009. Order VIV/984 (2009) Ministry of Development, Government of Spain. *Update to the Basic Document DB-HE on Energy Saving of the Technical Building Code*. 99, Ministry of Public Works, Government of Spain, 36395-36450

REG-8: Ministry of Development, Government of Spain. Update to the Basic Document DB-HE on Energy Saving of the Technical Building Code, Order FOM / 1635/2013. 219, Ministry of Public Works, Government of Spain (2013), 67137-67209

REG-9, 2015. Ministry of Development, Government of Spain. *Certification of the energy efficiency of buildings.* Ministry of Development, Government of Spain. Madrid, 2015

REG-10, 2008. Ministerstwo Infrastruktury (2008). *Rozporządzenie Ministra Infrastruktury z dnia 6 listopada 2008 r. w sprawie metodologii obliczania charakterystyki energetycznej budynku i lokalu mieszkalnego lub części budynku stanowiącej samodzielną całość techniczno* – użytkową oraz sposobu sporządzania i wzorów świadectw ich charakterystyki energetycznej. Dz.U.2008, Nr 201 poz.1240

REG-11, 2015. Ministerstwo Infrastruktury i Rozwoju (2015) *Rozporządzenie Ministra Infrastruktury i Rozwoju z dnia 27 lutego 2015 r. w sprawie metodologii wyznaczania charakterystyki energetycznej budynku lub części budynku oraz świadectw charakterystyki energetycznej.* Dz.U. 2015 poz. 376

REG-12, 2015. Ministerstwo Infrastruktury i Rozwoju (2015) *Rozporządzenie Ministra Infrastruktury i Budownictwa w sprawie warunków technicznych jakim powinny odpowiadać budynki i ich usytuowanie.* Załącznik do obwieszczenia Ministra Infrastruktury i Rozwoju z dnia 17 lipca 2015 r. poz. 1422

STR1, 2011 – Statybos techninis reglamentas STR 1.02.09:2011 Teisės atlikti pastatų energinio naudingumo sertifikavimą įgijimo tvarkos aprašas, patvirtintas Lietuvos Respublikos aplinkos ministro 2011 m. gruodžio 14 d. įsakymu Nr. D1-972 (Lithuanian Building Technical Regulation STR 1.02.09:2011 Procedure for the Acquisition of Energy Performance Certificates for Buildings, approved by the Minister of the Environment of the Republic of Lithuania on December 14, 2011 Order No. D1-972)

STR2, 2016 – Statybos techninis reglamentas STR 2.01.02:2016 Pastatų energinio naudingumo projektavimas ir sertifikavimas, patvirtintas Lietuvos Respublikos aplinkos ministro 2016 m. lapkričio 11 d. Nr. D1-754 (Lithuanian Building Technical Regulation STR 2.01.02:2016 Energy Performance of Buildings – Design and Certification, approved by the Minister of the Environment of the Republic of Lithuania on November 11, 2016 Order No. D1-754)

STR3, 2016 – Statybos techninis reglamentas STR 1.01.02:2016 Normatyviniai statybos techniniai dokumentai, patvirtintas Lietuvos Respublikos aplinkos ministro 2016 m. spalio 10 d. įsakymu Nr.D1-669 (Lithuanian Building Technical Regulation STR1.01.02:2016 Normative Technical Documents for Construction approved by the Minister of Environment of the Republic of Lithuania on October 10, 2016 Order No. D1-669)

STR4, 2017 – Statybos techninis reglamentas STR 1.01.03:2017 Statinių klasifikavimas, patvirtintas Lietuvos Respublikos aplinkos ministro 2016 m. spalio 27 d. įsakymu Nr. D1-713 (Lithuanian Building Technical Regulation STR 1.01.03:2017 Classification of Buildings, approved by the Minister of Environment of the Republic of Lithuania on October 27, 2016. Order No. D1-713)

STR5, 2017 – STR1.04.04:2017 Design of the Building, Project Expertise, approved by the Minister of Environment of the Republic of Lithuania on November 7, 2016 Order No. D1-738

WEB-1 https://ec.europa.eu/energy/en/topics/energy-efficiency/buildings

WEB-2 Lithuanian Standards Board. http://www.lsd.lt/