Erasmus+ Project ID: 2023-1-ES01-KA220-HED-000156652

This Erasmus+ Project has been funded with support from the European Commission. This publication reflects the views only of the authors, and the European Commission and Erasmus+ National Agencies cannot be held responsible for any use which may be made of the information contained therein

Lithuanian Case Study

Part II: Analysis of improvement measures

3.9. Case Results II. Energy Consumption and Energy rating of the alternatives to improve the building.

- **Case 2: Improvement 1: 25 cm isolation layer in facades + low emissive triple-glazed windows with argon gas (U= 0.8** W/m²·K)

Energy consumption of the building's technical services

BUILDING (S_u = 2363.76 m²)

Technical Services	EF		EP_{tot}		EP_{nren}	
	(kWh/year)	(kWh/m²·year)	(kWh/year)	(kWh/m²·year)	(kWh/year)	(kWh/m²·year)
Heating	200814.53	84.96	287076.39	121.45	154795.61	65.49
Cooling	255.00	0.11	605.12	0.26	498.75	0.21
DHW	163407.07	69.13	212428.82	89.87	99268.50	42.00
	364476.60	154.19	500110.34	211.57	254562.86	107.69

where:

S_u: Living area included in the thermal envelope, m².
EF: Final energy consumed by the technical service at the point of consumption.
EP_{tot}: Total primary energy consumption.
EP_{nren}: Primary energy consumption of non-renewable origin.

Final energy consumption of the building. Monthly results.

		Jan (kWh)	Feb (kWh)	Mar (kWh)	Apr (kWh)	May (kWh)	Jun (kWh)	Jul (kWh)	Aug (kWh)	Sep (kWh)	Oct (kWh)	Nov (kWh)	Dec (kWh)	Year (kWh/year)	Year (kWh/m²·year)
BUILDING (S_u = 2363.76 m²)															
Energy demand	**Heating**	**30802.2**	**30389.4**	**23188.1**	**7188.8**	**892.3**	**--**	**--**	**--**	**--**	**14109.0**	**23932.2**	**30858.1**	**161360.1**	**68.3**
	Cooling	**--**	**--**	**--**	**--**	**--**	**67.0**	**224.7**	**387.9**	**--**	**--**	**--**	**--**	**679.6**	**0.3**
	DHW	**13878.4**	**12535.3**	**13878.4**	**13430.7**	**13878.4**	**13430.7**	**13878.4**	**13878.4**	**13430.7**	**13878.4**	**13430.7**	**13878.4**	**163407.2**	**69.1**
	TOTAL	**44680.6**	**42924.7**	**37066.5**	**20619.5**	**14770.7**	**13497.8**	**14103.1**	**14266.3**	**13430.7**	**27987.4**	**37362.9**	**44736.5**	**325446.8**	**137.7**
Network 1 (Red 1)	**Heating**	33534.1	33179.9	25740.5	8572.9	1367.9	--	--	--	--	14721.0	25809.1	33527.9	176453.3	74.6
	Cooling	--	--	--	--	--	--	--	--	--	--	--	--	--	
	DHW	13878.4	12535.3	13878.4	13430.7	13878.4	13430.7	13878.4	13878.4	13430.7	13878.4	13430.7	13878.4	163407.2	69.1
Electricity	**Heating**	4364.2	4313.9	3605.2	1567.7	385.7	--	--	--	--	2302.3	3473.6	4348.5	24361.2	10.3
	Cooling	--	--	--	--	--	--	--	--	--	--	--	--	--	
	DHW	--	--	--	--	--	--	--	--	--	--	--	--	--	
	Ventilation	--	--	--	--	--	--	--	--	--	--	--	--	--	
	Humidity control	--	--	--	--	--	--	--	--	--	--	--	--	--	
	Lighting	--	--	--	--	--	--	--	--	--	--	--	--	--	
Electricity	**Heating**	--	--	--	--	--	--	--	--	--	--	--	--	--	

		Jan (kWh)	Feb (kWh)	Mar (kWh)	Apr (kWh)	May (kWh)	Jun (kWh)	Jul (kWh)	Aug (kWh)	Sep (kWh)	Oct (kWh)	Nov (kWh)	Dec (kWh)	Year (kWh/year)	Year (kWh/m²·year)
(Substitution System)	Cooling	--	--	--	--	--	18.5	85.5	151.0	--	--	--	--	255.0	0.1
	DHW	--	--	--	--	--	--	--	--	--	--	--	--	--	
	$C_{ef,total}$	51776.7	50029.2	43224.1	23571.3	15632.0	13449.2	13963.9	14029.4	13430.7	30901.7	42713.4	51754.8	364476.6	154.2

where:

S_u: *Living area included in the thermal envelope, m².*

$C_{ef,total}$: *Energy consumption at the point of consumption (final energy), kWh/m²·year.*

Energy rating of the building: Improvement 1.

Climatic zone (eq.)	E1	**Use**	Private residential

ENERGY RATING OF THE BUILDING IN EMISSIONS

1.

GLOBAL INDICATOR	PARTIAL INDICATORS			
	HEATING		**DHW**	
< 10,4 A 10,4-16,1 B 16,1-24,0 C 24,0-35,7 D 35,7-82,9 E 82,9-97,0 F ≥ 97,0 G **23,58 C**	Heating emissions [$kgCO_2/m^2$·year]	**A**	DHW emissions [$kgCO_2/m^2$·year]	**C**
	13.86		**9.68**	
	COOLING		**LIGHTING**	
Global emissions[$kgCO_2/m^2$·year][1]	Cooling emissions [$kgCO_2/m^2$·year]	**A**	Lighting emissions [$kgCO_2/m^2$·year]	**-**
	0.00		**-**	

2.

The overall rating of the building is expressed in terms of carbon dioxide released into the atmosphere as a result of its energy consumption.

	$kgCO_2/m^2$·year	**$kgCO_2$·year**
CO2 emissions from electricity consumption	3.45	8147.96
CO2 emissions from other fuels	20.13	47580.45

ENERGY RATING OF THE BUILDING IN NON-RENEWABLE PRIMARY ENERGY CONSUMPTION

3.

Non-renewable primary energy refers to the energy consumed by the building from non-renewable sources that has not undergone any conversion or transformation process.

4.

GLOBAL INDICATOR	PARTIAL INDICATORS			
	HEATING		**DHW**	
< 46,9 A 46,9-72,1 B 72,1-107,5 C 107,5-160,1 D 160,1-358,8 E 358,8-419,8 F ≥ 419,8 G **107,69 D**	Primary energy heating [kWh/m²·year]	**A**	DHW Primary energy [kWh/m²·year]	**E**
	65.49		**42**	
	COOLING		**LIGHTING**	
Global consumption of non-renewable primary energy[kWh/m²·year][1]	Primary energy cooling [kWh/m²·year]	**A**	Primary energy lighting [kWh/m²·year]	**-**
	0.21		**-**	

PARTIAL RATING OF HEATING AND COOLING ENERGY DEMAND

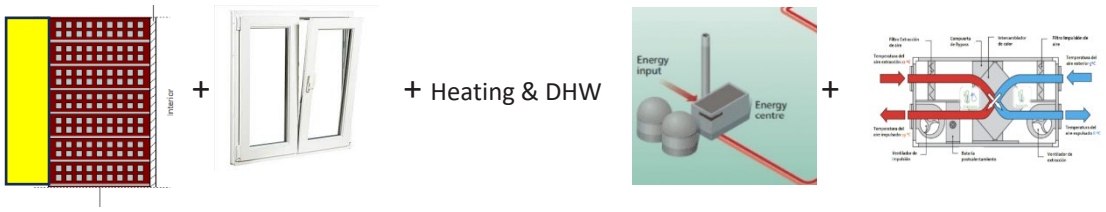
The energy demand for heating and cooling is the energy needed to maintain the building's internal comfort conditions.

5.

HEATING DEMAND	COOLING DEMAND
< 15,7 A 15,7-36,3 B 36,3-65,5 C 65,5-109,6 D 109,6-189,5 E 189,5-206,5 F ≥ 206,5 G **68,26 D**	**Non-Qualifying**
6. Heating demand[kWh/m²·year]	Cooling demand[kWh/m²·year]

1 The global indicator is the result of the sum of the partial indicators plus the value of the indicator for auxiliary consumption, if any (only tertiary buildings, ventilation, pumping, etc...). Self-consumed electricity is only deducted from the global indicator, not from the partial values.

- **case 3: Improvement 2: 25 cm isolation layer in facades + low emissive triple-glazed windows with argon gas U= 0.8 + Mechanical ventilation system with heat recovery**



Energy Consumption of the building: Improvement 2.

Energy consumption of the building's technical services

BUILDING (S_u = 2363.76 m²)

Technical Services	EF		EP_{tot}		EP_{nren}	
	(kWh/year)	(kWh/m²·year)	(kWh/year)	(kWh/m²·year)	(kWh/year)	(kWh/m²·year)
Heating	119584.90	50.59	170980.28	72.33	92224.49	39.02
Cooling	433.93	0.18	1028.24	0.44	848.59	0.36
DHW	163407.09	69.13	212428.82	89.87	99268.50	42.00
Ventilation	10956.42	4.64	25944.64	10.98	21408.58	9.06
	294382.35	124.54	410381.98	173.61	213750.17	90.43

where:

S_u: Living area included in the thermal envelope, m².
EF: Final energy consumed by the technical service at the point of consumption.
EP_{tot}: Total primary energy consumption.
EP_{nren}: Primary energy consumption of non-renewable origin.

Final energy consumption of the building. Monthly results.

		Jan (kWh)	Feb (kWh)	Mar (kWh)	Apr (kWh)	May (kWh)	Jun (kWh)	Jul (kWh)	Aug (kWh)	Sep (kWh)	Oct (kWh)	Nov (kWh)	Dec (kWh)	Year (kWh/year)	Year (kWh/m²·year)
BUILDING (S_u = 2363.76 m²)															
Energy demand	**Heating**	**24288.4**	**24134.4**	**17534.5**	**3449.2**	**125.8**	**--**	**--**	**--**	**--**	**9397.8**	**18295.8**	**24482.1**	**121707.9**	**51.5**
	Cooling	**--**	**--**	**--**	**--**	**--**	**55.3**	**444.8**	**631.7**	**--**	**--**	**--**	**--**	**1131.8**	**0.5**
	DHW	**13878.4**	**12535.3**	**13878.4**	**13430.7**	**13878.4**	**13430.7**	**13878.4**	**13878.4**	**13430.7**	**13878.4**	**13430.7**	**13878.4**	**163407.2**	**69.1**
	TOTAL	**38166.8**	**36669.7**	**31412.9**	**16879.9**	**14004.2**	**13486.0**	**14323.2**	**14510.1**	**13430.7**	**23276.2**	**31726.5**	**38360.5**	**286246.8**	**121.1**
Network 1 (Red 1)	**Heating**	21224.8	21106.8	15060.6	2564.8	41.7	--	--	--	--	7743.8	15879.6	21412.8	105034.9	44.4
	Cooling	--	--	--	--	--	--	--	--	--	--	--	--	--	
	DHW	13878.4	12535.3	13878.4	13430.7	13878.4	13430.7	13878.4	13878.4	13430.7	13878.4	13430.7	13878.4	163407.2	69.1
Electricity	**Heating**	2780.9	2777.0	2186.8	572.3	37.8	--	--	--	--	1250.5	2137.8	2790.4	14533.5	6.1
	Cooling	--	--	--	--	--	--	--	--	--	--	--	--	--	
	DHW	--	--	--	--	--	--	--	--	--	--	--	--	--	
	Ventilation	1036.0	935.8	1036.0	1002.6	1036.0	697.2	720.4	720.4	697.2	1036.0	1002.6	1036.0	10956.4 4.6	
	Humidity control	--	--	--	--	--	--	--	--	--	--	--	--	--	
	Lighting	--	--	--	--	--	--	--	--	--	--	--	--	--	
Electricity (Substitution System)	**Heating**	--	--	--	--	--	--	--	--	--	--	--	--	--	
	Cooling	--	--	--	--	--	21.3	170.0	242.7	--	--	--	--	433.9	0.2
	DHW	--	--	--	--	--	--	--	--	--	--	--	--	--	
	$C_{ef,total}$	**38920.2**	**37362.5**	**32161.8**	**17570.4**	**14994.0**	**14149.2**	**14768.8**	**14841.6**	**14127.9**	**23917.6**	**32450.7**	**39117.7**	**294382.3**	**124.5**

where:

S_u: Living area included in the thermal envelope, m².
$C_{ef,total}$: Energy consumption at the point of consumption (final energy), kWh/m²·year.

Energy rating of the building: Building with improvement 2.

Climatic zone (eq.)	E1	Use	Private residential

ENERGY RATING OF THE BUILDING IN EMISSIONS

1.

GLOBAL INDICATOR	PARTIAL INDICATORS			
< 10,4 A 10,4-16,1 B 16,1-24,0 C 24,0-35,7 D 35,7-82,9 E 82,9-97,0 F ≥ 97,0 G 19,53 C	HEATING		DHW	
	Heating emissions [kgCO₂/m²·year]	A	DHW emissions [kgCO₂/m²·year]	C
	8.26		9.68	
	COOLING		LIGHTING	
Global emissions[kgCO₂/m²·year][1]	Cooling emissions [kgCO₂/m²·year]	A	Lighting emissions [kgCO₂/m²·year]	-
	0.00		-	

2.

The overall rating of the building is expressed in terms of carbon dioxide released into the atmosphere as a result of its energy consumption.

	kgCO₂/m²·year	kgCO₂·year
CO2 emissions from electricity consumption	3.63	8580.79
CO2 emissions from other fuels	15.90	37586.01

ENERGY RATING OF THE BUILDING IN NON-RENEWABLE PRIMARY ENERGY CONSUMPTION

3.

Non-renewable primary energy refers to the energy consumed by the building from non-renewable sources that has not undergone any conversion or transformation process.

4.

GLOBAL INDICATOR	PARTIAL INDICATORS			
< 46,9 A 46,9-72,1 B 72,1-107,5 C 107,5-160,1 D 160,1-358,8 E 358,8-419,8 F ≥ 419,8 G 90,43 C	HEATING		DHW	
	Primary energy heating [kWh/m²·year]	A	DHW Primary energy [kWh/m²·year]	E
	39.02		42	
	COOLING		LIGHTING	
Global consumption of non-renewable primary energy[kWh/m²·year][1]	Primary energy cooling [kWh/m²·year]	A	Primary energy lighting [kWh/m²·year]	-
	0.36		-	

PARTIAL RATING OF HEATING AND COOLING ENERGY DEMAND

The energy demand for heating and cooling is the energy needed to maintain the building's internal comfort conditions.

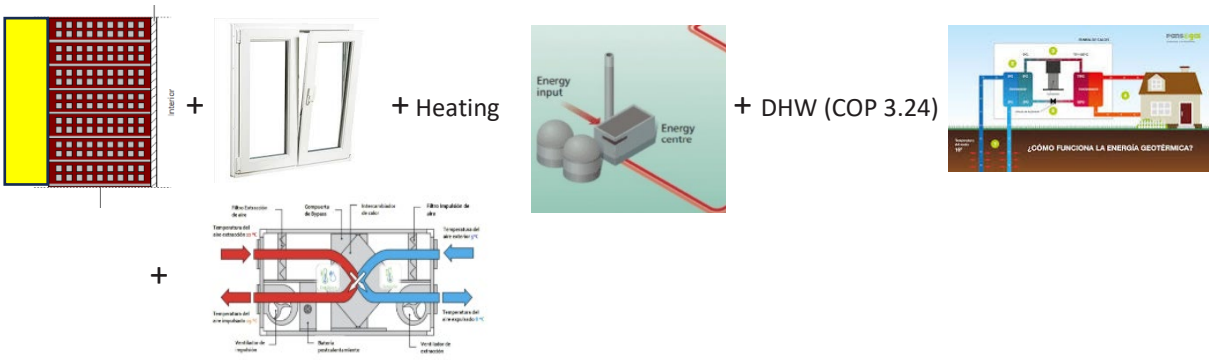
5.

HEATING DEMAND	COOLING DEMAND
< 15,7 A 15,7-36,3 B 36,3-65,5 C 65,5-109,6 D 109,6-189,5 E 189,5-206,5 F ≥ 206,5 G 51,49 C	**Non-Qualifying**
Heating demand[kWh/m²·year]	Cooling demand[kWh/m²·year]

6.

1 The global indicator is the result of the sum of the partial indicators plus the value of the indicator for auxiliary consumption, if any (only tertiary buildings, ventilation, pumping, etc...). Self-consumed electricity is only deducted from the global indicator, not from the partial values.

- **Case 4: Improvement 3: DHW with ground heat pump (COP 3.24) + 25 cm isolation layer in facades + low emissive triple-glazed windows with argon gas U= 0.8 + Mechanical ventilation system with heat recovery.**



Energy Consumption of the building: Improvement 3.

Energy consumption of the building's technical services

BUILDING (S_u = 2363.76 m²)

Technical Services	EF		EP_{tot}		EP_{nren}	
	(kWh/year)	(kWh/m²·year)	(kWh/year)	(kWh/m²·year)	(kWh/year)	(kWh/m²·year)
Heating	119614.32	50.60	171037.01	72.36	92267.04	39.03
Cooling	434.13	0.18	1028.24	0.44	848.59	0.36
DHW	114707.05	48.53	170904.64	72.30	80270.95	33.96
Ventilation	10956.42	4.64	25944.64	10.98	21408.58	9.06
	245711.93	103.95	368914.52	156.07	194795.17	82.41

where:

S_u: Living area included in the thermal envelope, m².
EF: Final energy consumed by the technical service at the point of consumption.
EP_{tot}: Total primary energy consumption.
EP_{nren}: Primary energy consumption of non-renewable origin.

Final energy consumption of the building. Monthly results.

		Jan (kWh)	Feb (kWh)	Mar (kWh)	Apr (kWh)	May (kWh)	Jun (kWh)	Jul (kWh)	Aug (kWh)	Sep (kWh)	Oct (kWh)	Nov (kWh)	Dec (kWh)	Year (kWh/year)	Year (kWh/m²·year)
BUILDING (S_u = 2363.76 m²)															
Energy demand	**Heating**	**24283.8**	**24129.9**	**17530.4**	**3447.0**	**125.6**	**--**	**--**	**--**	**--**	**9395.1**	**18292.1**	**24477.7**	**121681.5**	**51.5**
	Cooling	**--**	**--**	**--**	**--**	**--**	**55.4**	**445.0**	**631.9**	**--**	**--**	**--**	**--**	**1132.3**	**0.5**
	DHW	**9742.2**	**8799.4**	**9742.2**	**9428.0**	**9742.2**	**9428.0**	**9742.2**	**9742.2**	**9428.0**	**9742.2**	**9428.0**	**9742.2**	**114707.0**	**48.5**
	TOTAL	**34026.0**	**32929.3**	**27272.7**	**12874.9**	**9867.8**	**9483.4**	**10187.3**	**10374.2**	**9428.0**	**19137.3**	**27720.0**	**34220.0**	**237520.8**	**100.5**
Network 1 (Red 1)	**Heating**	21267.3	21100.7	15054.9	2561.9	41.6	--	--	--	--	7740.1	15874.4	21406.9	105047.8	44.4
	Cooling	--	--	--	--	--	--	--	--	--	--	--	--	--	
	DHW	--	--	--	--	--	--	--	--	--	--	--	--	--	
Electricity	**Heating**	2788.8	2778.9	2188.5	573.2	37.8	--	--	--	--	1251.5	2139.3	2792.1	14550.1	6.2
	Cooling	--	--	--	--	--	--	--	--	--	--	--	--	--	
	DHW	3489.0	3151.4	3489.0	3376.5	3489.0	3376.5	3489.0	3489.0	3376.5	3489.0	3376.5	3489.0	41080.5	17.4
	Ventilation	1036.0	935.8	1036.0	1002.6	1036.0	697.2	720.4	720.4	697.2	1036.0	1002.6	1036.0	10956.4	4.6
	Humidity control	--	--	--	--	--	--	--	--	--	--	--	--	--	
	Lighting	--	--	--	--	--	--	--	--	--	--	--	--	--	
Electricity (Substitution System)	**Heating**	--	--	--	--	--	--	--	--	--	--	--	--	--	
	Cooling	--	--	--	--	--	21.3	170.1	242.8	--	--	--	--	434.1	0.2
	DHW	--	--	--	--	--	--	--	--	--	--	--	--	--	
Environment		--	--	--	--	--	--	--	--	--	--	--	--	--	
		--	--	--	--	--	--	--	--	--	--	--	--	--	
		6253.2	5648.1	6253.2	6051.5	6253.2	6051.5	6253.2	6253.2	6051.5	6253.2	6051.5	6253.2	73626.5	31.1
	$C_{ef,total}$	**34834.4**	**33622.4**	**28021.7**	**13565.6**	**10857.6**	**10146.5**	**10632.8**	**10705.5**	**10125.2**	**19778.8**	**28444.3**	**34977.2**	**245711.8**	**103.9**

where:

S_u: Living area included in the thermal envelope, m².
$C_{ef,total}$: Energy consumption at the point of consumption (final energy), kWh/m²·year.

Energy rating of the building: Building with improvement 3.

Climatic zone (eq.)	E1	Use	Private residential

ENERGY RATING OF THE BUILDING IN EMISSIONS

1.

GLOBAL INDICATOR	PARTIAL INDICATORS			
< 10,4 A 10,4-16,1 B 16,1-24,0 C 24,0-35,7 D 35,7-82,9 E 82,9-97,0 F ≥ 97,0 G 15,61 B	HEATING		DHW	
	Heating emissions [$kgCO_2/m^2$·year]	A	DHW emissions [$kgCO_2/m^2$·year]	C
	8.26		**5.75**	
	COOLING		LIGHTING	
Global emissions[$kgCO_2/m^2$·year][1]	Cooling emissions [$kgCO_2/m^2$·year]	A	Lighting emissions [$kgCO_2/m^2$·year]	-
2.	**0.00**		-	

The overall rating of the building is expressed in terms of carbon dioxide released into the atmosphere as a result of its energy consumption.

	$kgCO_2/m^2$·year	$kgCO_2$·year
CO2 emissions from electricity consumption	9.39	22184.00
CO2 emissions from other fuels	6.22	14710.82

ENERGY RATING OF THE BUILDING IN NON-RENEWABLE PRIMARY ENERGY CONSUMPTION

3.

Non-renewable primary energy refers to the energy consumed by the building from non-renewable sources that has not undergone any conversion or transformation process.

4.

GLOBAL INDICATOR	PARTIAL INDICATORS			
< 46,9 A 46,9-72,1 B 72,1-107,5 C 107,5-160,1 D 160,1-358,8 E 358,8-419,8 F ≥ 419,8 G 82,41 C	HEATING		DHW	
	Primary energy heating [kWh/m^2·year]	A	DHW Primary energy [kWh/m^2·year]	E
	39.03		**33.96**	
	COOLING		LIGHTING	
Global consumption of non-renewable primary energy[kWh/m^2·year][1]	Primary energy cooling [kWh/m^2·year]	A	Primary energy lighting [kWh/m^2·year]	-
	0.36		-	

PARTIAL RATING OF HEATING AND COOLING ENERGY DEMAND

The energy demand for heating and cooling is the energy needed to maintain the building's internal comfort conditions.

5.

HEATING DEMAND	COOLING DEMAND
< 15,7 A 15,7-36,3 B 36,3-65,5 C 65,5-109,6 D 109,6-189,5 E 189,5-206,5 F ≥ 206,5 G 51,48 C	**Non-Qualifying**
6. Heating demand[kWh/m^2·year]	Cooling demand[kWh/m^2·year]

1 The global indicator is the result of the sum of the partial indicators plus the value of the indicator for auxiliary consumption, if any (only tertiary buildings, ventilation, pumping, etc...). Self-consumed electricity is only deducted from the global indicator, not from the partial values.

- **Case 5: Improvement 4: Photovoltaic panels (150 panels of 480 W- 3 m2 unit) ➔ (71250 kWh year) + DHW with geothermal heat pump+ 25 cm isolation layer in facades + low emissive triple-glazed windows with argon gas U= 0.8 + Mechanical ventilation system with heat recovery.**

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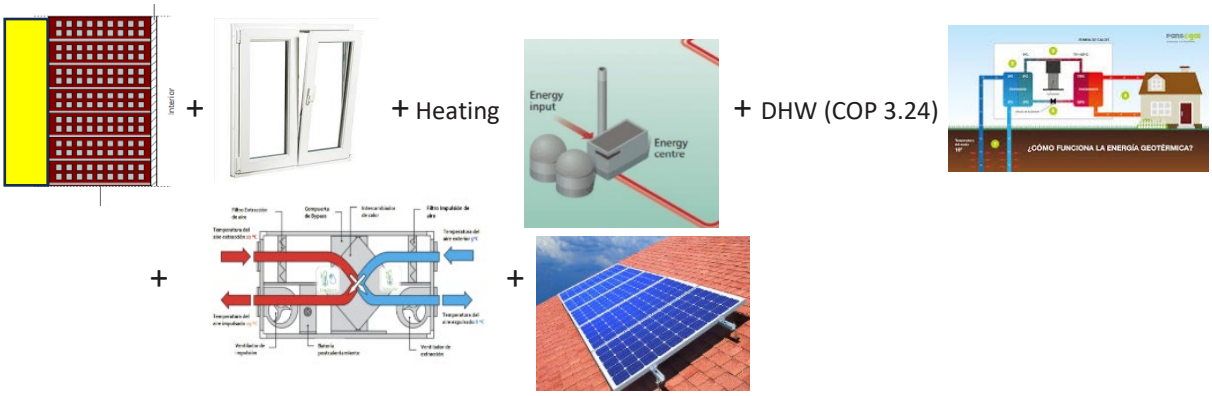

Energy Consumption of the building: Improvement 4.

Energy consumption of the building's technical services

BUILDING (S_u = 2363.76 m²)

Technical Services	EF		EP_{tot}		EP_{nren}	
	(kWh/year)	(kWh/m²·year)	(kWh/year)	(kWh/m²·year)	(kWh/year)	(kWh/m²·year)
Heating	119958.96	50.75	157892.13	66.80	73054.39	30.91
Cooling	431.18	0.18	619.31	0.26	267.10	0.11
DHW	114707.05	48.53	132517.16	56.06	25438.79	10.76
Ventilation	10956.42	4.64	15704.83	6.64	6783.99	2.87
	246053.61	104.09	306733.43	129.77	105544.29	44.65

where:

S_u: Living area included in the thermal envelope, m².
EF: Final energy consumed by the technical service at the point of consumption.
EP_{tot}: Total primary energy consumption.
EP_{nren}: Primary energy consumption of non-renewable origin.

Final energy consumption of the building. Monthly results.

		Jan (kWh)	Feb (kWh)	Mar (kWh)	Apr (kWh)	May (kWh)	Jun (kWh)	Jul (kWh)	Aug (kWh)	Sep (kWh)	Oct (kWh)	Nov (kWh)	Dec (kWh)	Year (kWh/year)	(kWh/m²·year)
BUILDING (S_u = 2363.76 m²)															
Energy demand	**Heating**	**24351.2**	**24196.6**	**17591.8**	**3481.9**	**129.0**	**--**	**--**	**--**	**--**	**9437.9**	**18348.5**	**24543.5**	**122080.3**	**51.6**
	Cooling	**--**	**--**	**--**	**--**	**--**	**54.3**	**441.6**	**628.4**	**--**	**--**	**--**	**--**	**1124.3**	**0.5**
	DHW	**9742.2**	**8799.4**	**9742.2**	**9428.0**	**9742.2**	**9428.0**	**9742.2**	**9742.2**	**9428.0**	**9742.2**	**9428.0**	**9742.2**	**114707.0**	**48.5**
	TOTAL	**34093.4**	**32996.1**	**27334.0**	**12909.9**	**9871.2**	**9482.2**	**10183.9**	**10370.6**	**9428.0**	**19180.1**	**27776.4**	**34285.7**	**237911.5**	**100.6**
Network 1 (Red 1)	**Heating**	21279.0	21160.5	15109.8	2591.7	43.4	--	--	--	--	7777.7	15924.7	21466.0	105352.8	44.6
	Cooling	--	--	--	--	--	--	--	--	--	--	--	--	--	
	DHW	--	--	--	--	--	--	--	--	--	--	--	--	--	
Electricity	**Heating**	2790.0	2786.0	2195.1	577.9	39.6	--	--	--	--	1256.3	2145.5	2799.4	14589.8	6.2
	Cooling	--	--	--	--	--	--	--	--	--	--	--	--	--	
	DHW	3489.0	3151.4	3489.0	3376.5	3489.0	3376.5	3489.0	3489.0	3376.5	3489.0	3376.5	3489.0	41080.5	17.4
	Ventilation	1036.0	935.8	1036.0	1002.6	1036.0	697.2	720.4	720.4	697.2	1036.0	1002.6	1036.0	10956.4	4.6
	Humidity control	--	--	--	--	--	--	--	--	--	--	--	--	--	
	Lighting	--	--	--	--	--	--	--	--	--	--	--	--	--	
Electricity (Substitution System)	**Heating**	--	--	--	--	--	--	--	--	--	--	--	--	--	
	Cooling	--	--	--	--	--	20.9	168.8	241.5	--	--	--	--	431.2	0.2
	DHW	--	--	--	--	--	--	--	--	--	--	--	--	--	
Environment		--	--	--	--	--	--	--	--	--	--	--	--	--	
		--	--	--	--	--	--	--	--	--	--	--	--	--	
		6253.2	5648.1	6253.2	6051.5	6253.2	6051.5	6253.2	6253.2	6051.5	6253.2	6051.5	6253.2	73626.5	31.1
	$C_{ef,total}$	**34847.3**	**33689.2**	**28083.2**	**13600.1**	**10861.3**	**10146.0**	**10631.5**	**10704.2**	**10125.2**	**19821.1**	**28500.7**	**35043.7**	**246053.5**	**104.1**

where:

S_u: Living area included in the thermal envelope, m².
$C_{ef,total}$: Energy consumption at the point of consumption (final energy), kWh/m²·year.

Energy rating of the building: Building with improvement 4.

Climatic zone (eq.)	E1	**Use**	Private residential

ENERGY RATING OF THE BUILDING IN EMISSIONS

1.

GLOBAL INDICATOR	**PARTIAL INDICATORS**			
< 10,4 A 10,4-16,1 B 16,1-24,0 C 24,0-35,7 D 35,7-82,9 E 82,9-97,0 F ≥ 97,0 G **9,22 A**	**HEATING**		**DHW**	
	Heating emissions [$kgCO_2/m^2$·year]	**A**	DHW emissions [$kgCO_2/m^2$·year]	**C**
	6.89		**1.82**	
	COOLING		**LIGHTING**	
Global emissions[$kgCO_2/m^2$·year][1]	Cooling emissions [$kgCO_2/m^2$·year]	**A**	Lighting emissions [$kgCO_2/m^2$·year]	**-**
	0.00		**-**	

2.

The overall rating of the building is expressed in terms of carbon dioxide released into the atmosphere as a result of its energy consumption.

	$kgCO_2/m^2$·year	**$kgCO_2$·year**
CO2 emissions from electricity consumption	2.98	7034.16
CO2 emissions from other fuels	6.24	14753.51

ENERGY RATING OF THE BUILDING IN NON-RENEWABLE PRIMARY ENERGY CONSUMPTION

3.

Non-renewable primary energy refers to the energy consumed by the building from non-renewable sources that has not undergone any conversion or transformation process.

4.

GLOBAL INDICATOR	**PARTIAL INDICATORS**			
< 46,9 A 46,9-72,1 B 72,1-107,5 C 107,5-160,1 D 160,1-358,8 E 358,8-419,8 F ≥ 419,8 G **44,65 A**	**HEATING**		**DHW**	
	Primary energy heating [kWh/m^2·year]	**A**	DHW Primary energy [kWh/m^2·year]	**E**
	30.91		**10.76**	
	COOLING		**LIGHTING**	
Global consumption of non-renewable primary energy[kWh/m^2·year][1]	Primary energy cooling [kWh/m^2·year]	**A**	Primary energy lighting [kWh/m^2·year]	**-**
	0.11		**-**	

PARTIAL RATING OF HEATING AND COOLING ENERGY DEMAND

The energy demand for heating and cooling is the energy needed to maintain the building's internal comfort conditions.

5.

HEATING DEMAND	**COOLING DEMAND**
< 15,7 A 15,7-36,3 B 36,3-65,5 C 65,5-109,6 D 109,6-189,5 E 189,5-206,5 F ≥ 206,5 G **51,65 C**	**Non-Qualifying**
6. Heating demand[kWh/m^2·year]	Cooling demand[kWh/m^2·year]

1 The global indicator is the result of the sum of the partial indicators plus the value of the indicator for auxiliary consumption, if any (only tertiary buildings, ventilation, pumping, etc...). Self-consumed electricity is only deducted from the global indicator, not from the partial values.

3.10. Analysis of Results. Emissions, Energy Consumption and Energy rating of the cases

Comparison of results

Final energy consumption (kWh/m2·year)

Technical Services	Case 1 Initial situation	Case 2 Imp 1	Case 3 Imp 1+Imp 2	Case 4 Imp 1+Imp 2+ Imp 3	Case 5 Imp 1+Imp 2+ Imp 3+ Imp 4
Heating	123.86	84.96	50.59	50.60	50.75
Cooling	0.01	0.11	0.18	0.18	0.18
DHW	69.13	69.13	69.13	48.53	48.53
Ventilation	--	--	4.64	4.64	4.64
	193.00	154.19	124.54	103.95	104.09

Legend

BIS - Building initial situation

Imp 1- Improvement 1: Improved thermal envelope + triple glassed windows

Imp 2- Improvement 2: Mechanical ventilation with heat recovery

Imp 3- Improvement 3: Ground heat pump for DHW

Imp 4 - Improvement 4: Photovoltaic panels

Total primary energy consumption (kWh/m2·year)

Technical Services	Case 1 Initial situation	Case 2 Imp 1	Case 3 Imp 1+Imp 2	Case 4 Imp 1+Imp 2+ Imp 3	Case 5 Imp 1+Imp 2+ Imp 3+ Imp 4
Heating	177.17	121.45	72.33	72.36	66.80
Cooling	0.03	0.26	0.44	0.44	0.26
DHW	89.87	89.87	89.87	72.30	56.06
Ventilation			10.98	10.98	6.64
	267.07	211.57	173.61	156.07	129.77

Primary energy consumption of non-renewable origin (kWh/m2·year)

Technical Services	Case 1 Initial situation	Case 2 Imp 1	Case 3 Imp 1+Imp 2	Case 4 Imp 1+Imp 2+ Imp 3	Case 5 Imp 1+Imp 2+ Imp 3+ Imp 4
Heating	95.61	65.49	39.02	39.03	30.91
Cooling	0.02	0.21	0.36	0.36	0.11
DHW	42.00	42.00	42.00	33.96	10.76
Ventilation			9.06	9.06	2.87
	137.63	107.69	90.43	82.41	44.65
Energy rating	**D**	**D**	**C**	**C**	**A**

Building Emissions (kgCO2/m2·year)

Technical Services	Case 1 Initial situation	Case 2 Imp 1	Case 3 Imp 1+Imp 2	Case 4 Imp 1+Imp 2+ Imp 3	Case 5 Imp 1+Imp 2+ Imp 3+ Imp 4
CO2 from electricity	5.01	3.45	3.63	9.39	2.98
CO2 from other fuels	24.90	20.13	15.90	6.22	6.24
	29.91	23.58	19.53	15.61	9,22
Energy rating	**D**	**C**	**C**	**B**	**A**

Legend

BIS - Building initial situation

Imp 1- Improvement 1: Improved thermal envelope + triple glassed windows

Imp 2- Improvement 2: Mechanical ventilation with heat recovery

Imp 3- Improvement 3: Ground heat pump for DHW

Imp 4 - Improvement 4: Photovoltaic panels