

Improvement measures analysis

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Improvement measures analysis

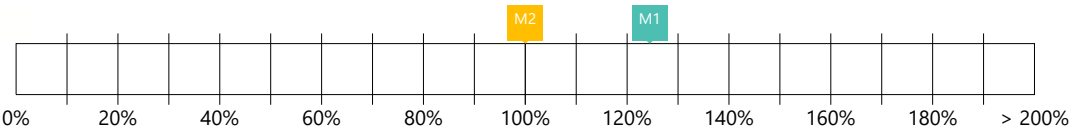
1. RESULTS SUMMARY

1.1. Energy analysis

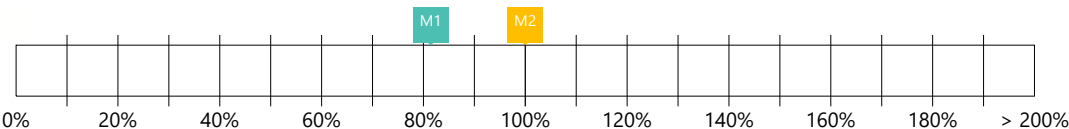
Net floor area (m ²)	Heating demand (kWh/m ² ·Year)		Cooling demand (kWh/m ² ·Year)		Final energy consumption (kWh/m ² ·Year)		Non-renewable primary energy consumption (kWh/m ² ·Year)		Emissions (kg CO ₂ /m ² ·Year)	
SR: Reference project (Reference situation)										
441.10	13.83	100.00%	28.75	100.00%	43.59	100.00%	73.75	100.00%	13.24	100.00%
M1: Solar control glazing										
441.10	17.21	124.44%	23.41	81.43%	45.17	103.62%	74.16	100.56%	13.49	101.89%
M2: PV panels										
441.10	13.83	100.00%	28.75	100.00%	43.59	100.00%	17.74	24.05%	3.76	28.40%

Improvement measures analysis

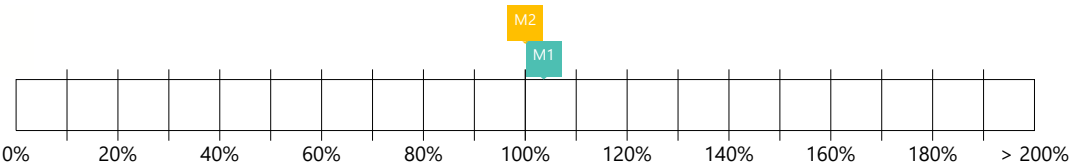
Heating demand



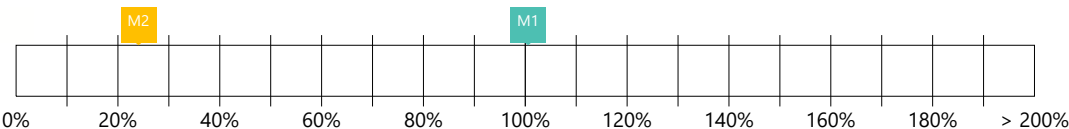
Cooling demand



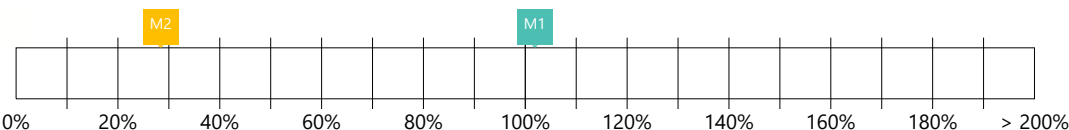
Final energy consumption



Non-renewable primary energy consumption



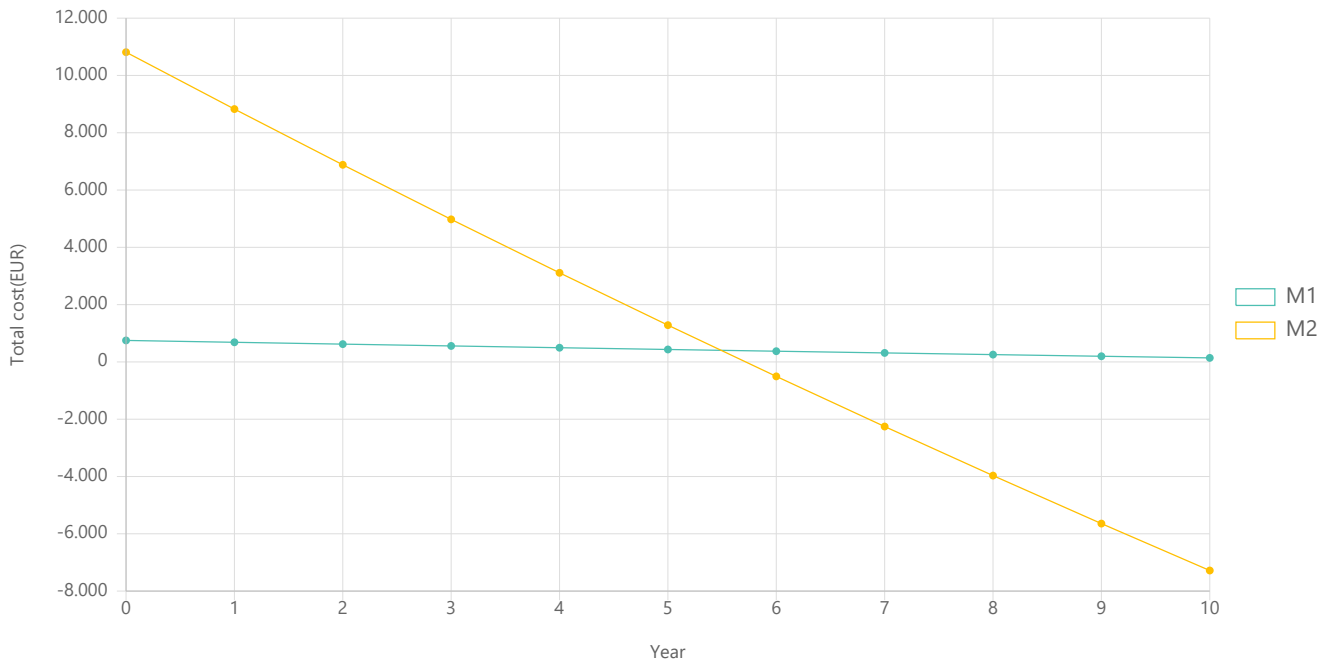
Emissions



Improvement measures analysis

1.2. Economic analysis

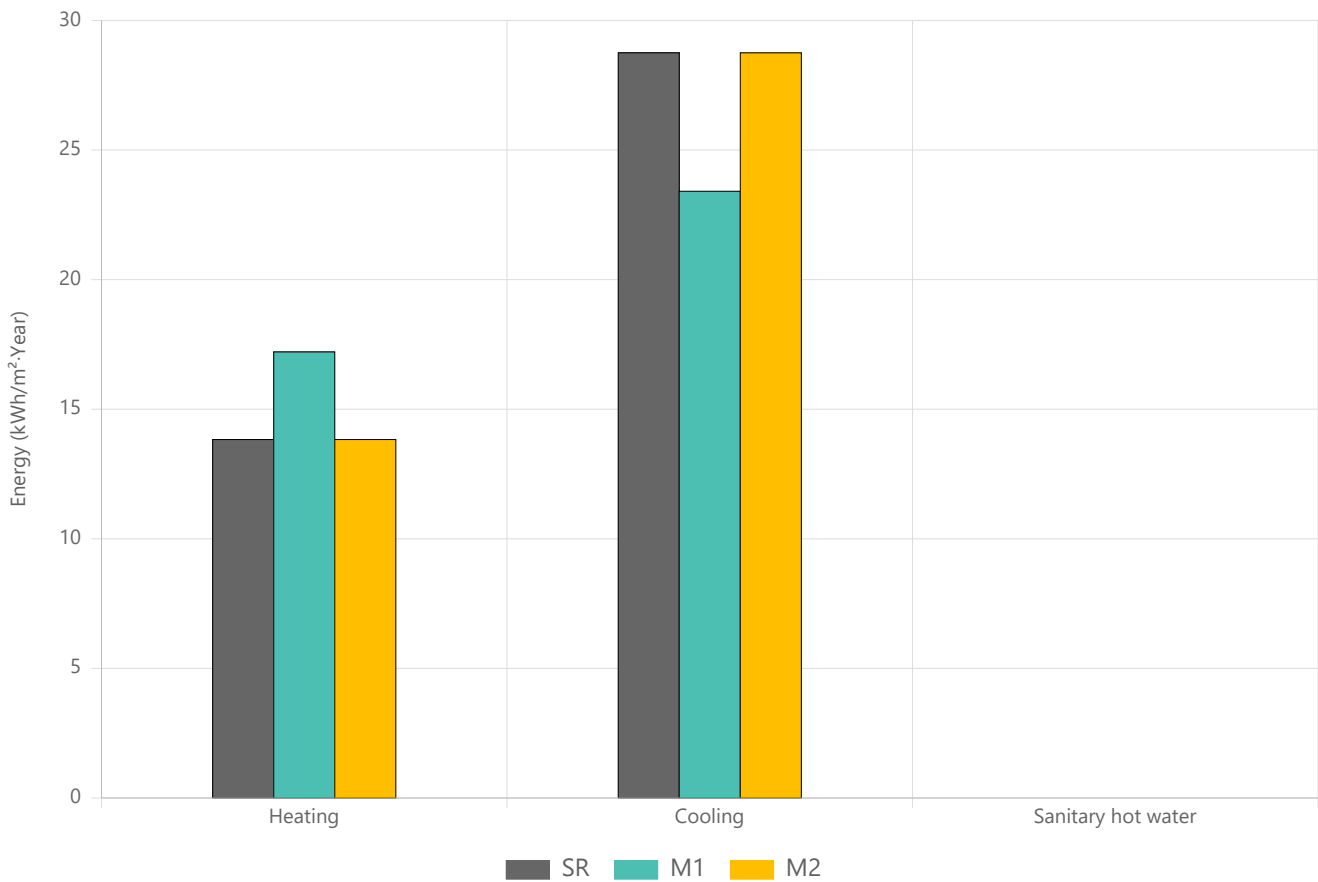
Net floor area (m²)	Net cost of the investment (EUR)	Energy cost (EUR/Year)	Net savings (EUR/Year)		Payback (Year)	NCV (Year)
SR: Reference project (Reference situation)						
441.10	-	2893.81	-	-	-	-
M1: Solar control glazing						
441.10	750.00	2827.87	65.94	2.28%	11.37	12.46
M2: PV panels						
441.10	10812.00	427.78	2026.04	70.01%	5.34	5.70



Improvement measures analysis

2. ENERGY ANALYSIS

2.1. Energy demand of the building.

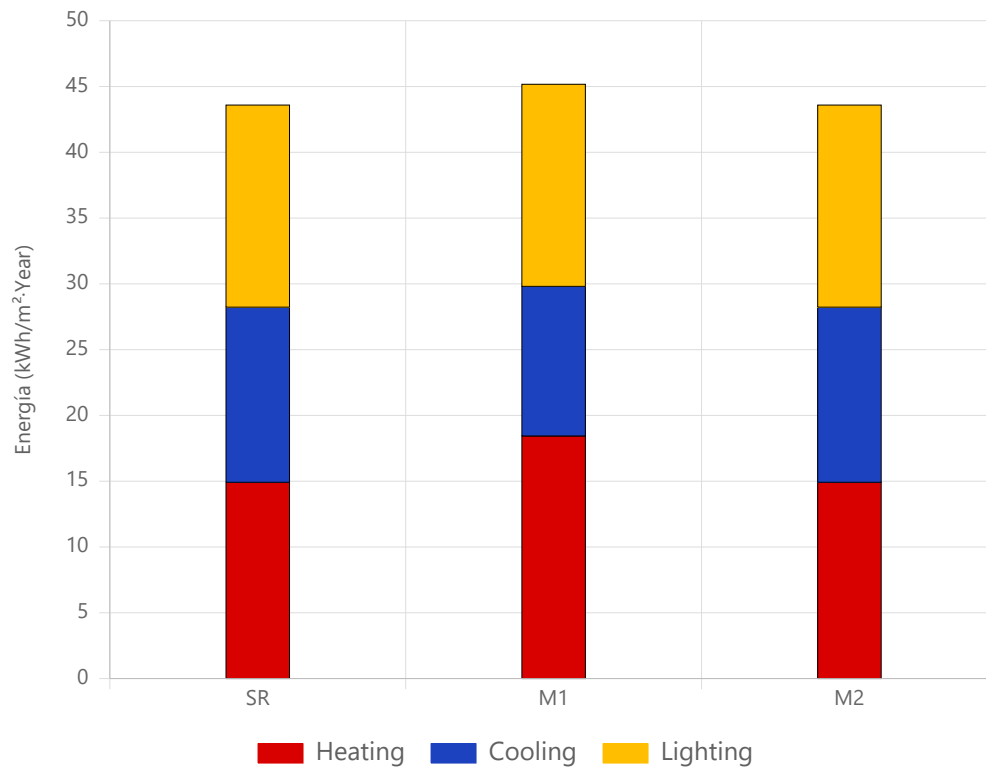


Net floor area (m²)	Heating demand (kWh/m²·Year)	Savings	Cooling demand (kWh/m²·Year)	Savings	DHW demand (kWh/m²·Year)	Savings
SR: Reference project (Reference situation)						
441.10	13.83	-	28.75	-	0.00	-
M1: Solar control glazing						
441.10	17.21	-24.44%	23.41	18.57%	0.00	0.00%
M2: PV panels						
441.10	13.83	0.00%	28.75	0.00%	0.00	0.00%

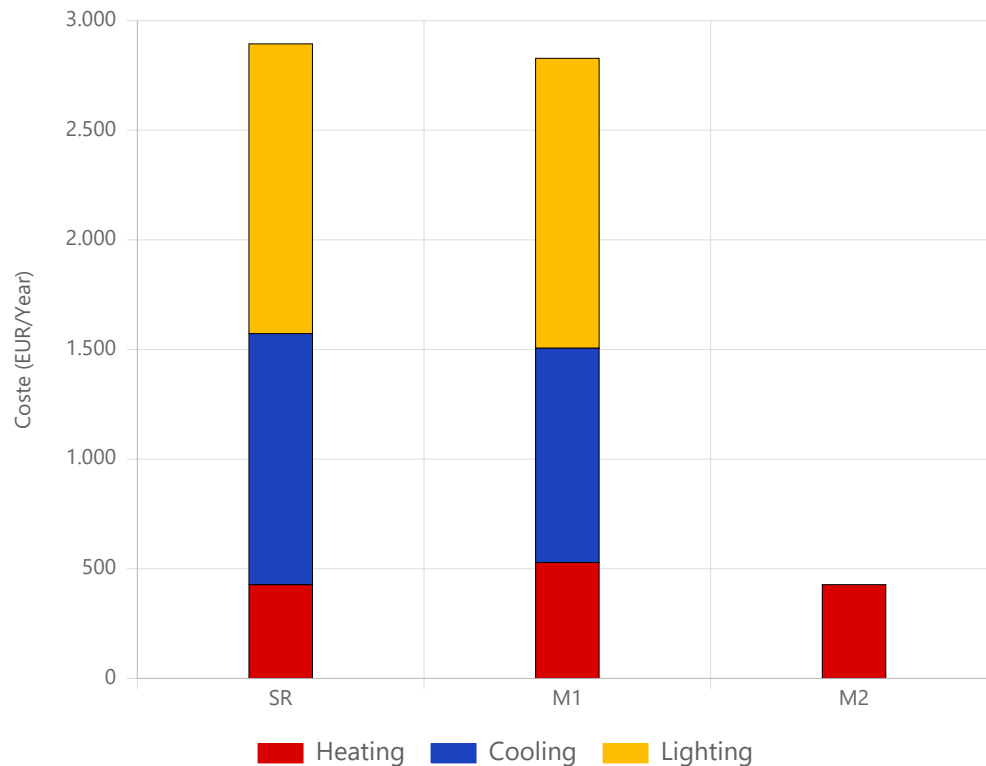
Improvement measures analysis

2.2. Final energy consumption and energy cost

2.2.1. Final energy consumption broken down by technical service

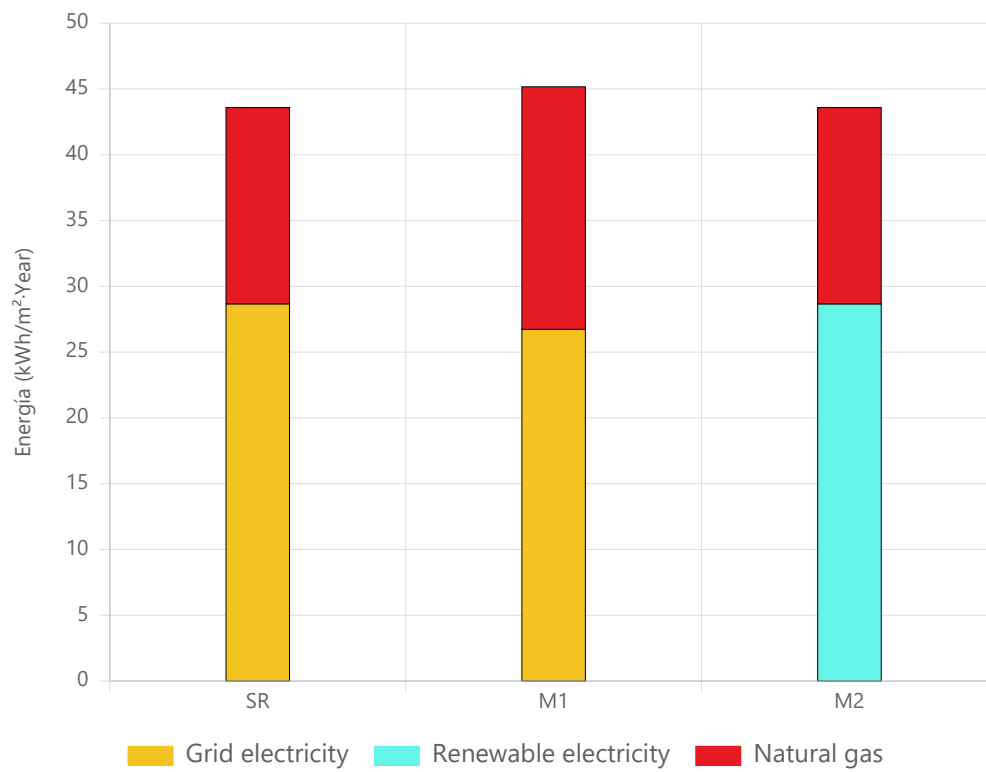


2.2.2. Energy cost broken down by technical service



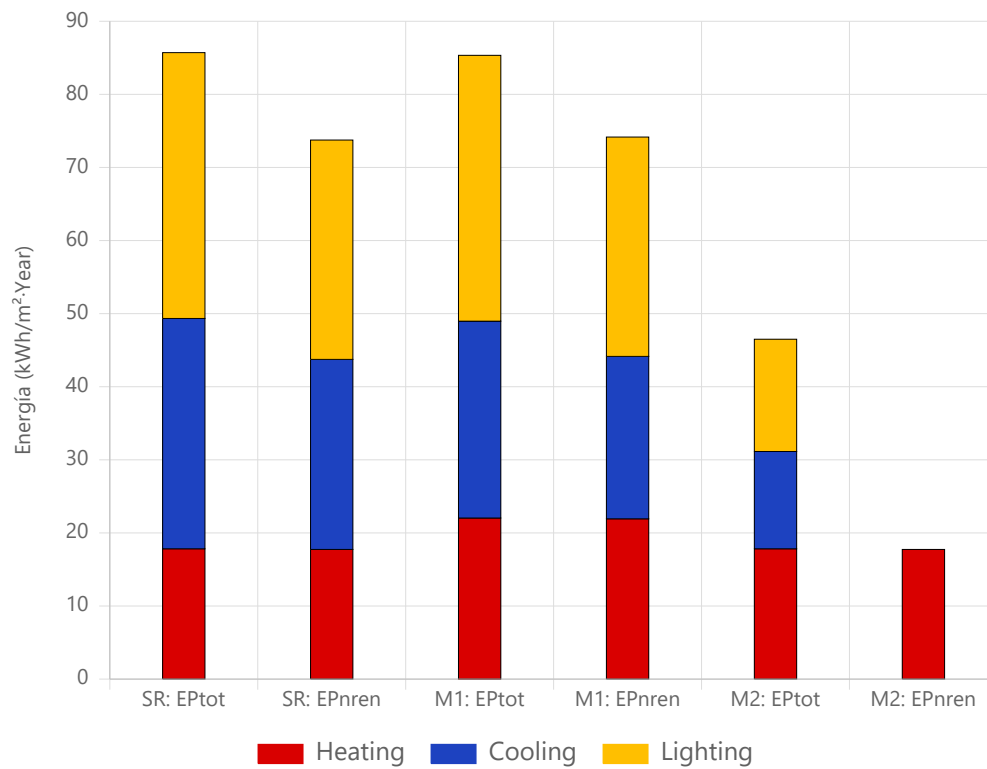
Improvement measures analysis

2.2.3. Final energy consumption broken down by energy vector



Improvement measures analysis

2.3. Primary energy consumption



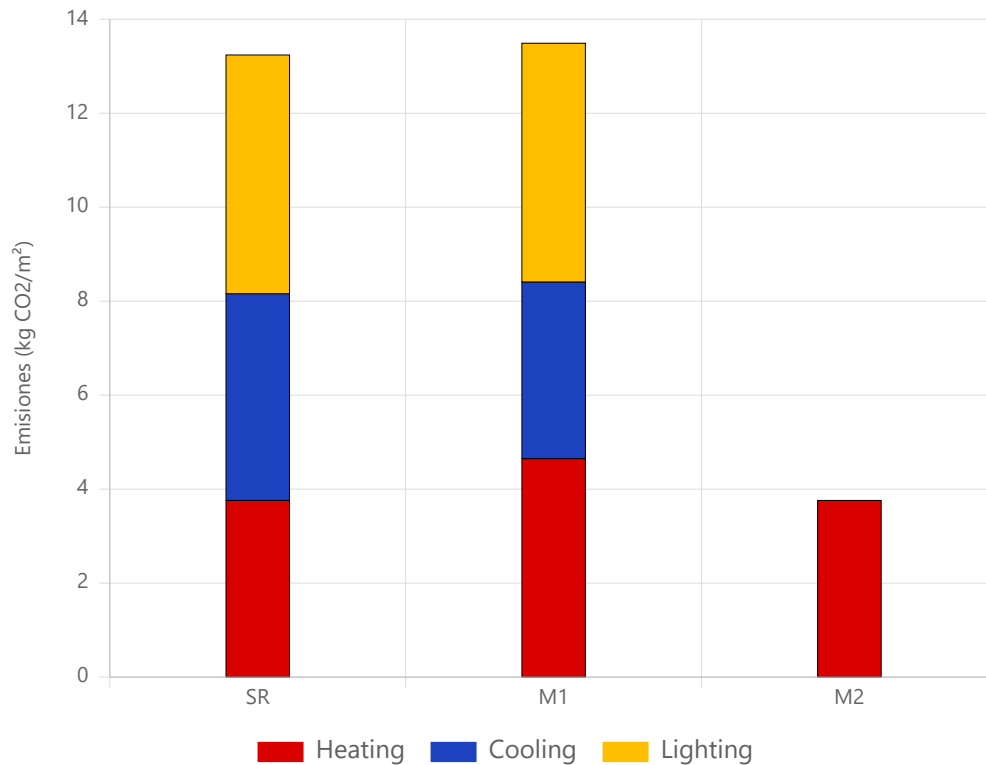
donde:

EP_{tot}: Consumo de energía primaria total

EP_{nren}: Consumo de energía primaria de origen no renovable

Improvement measures analysis

2.4. Emissions



2.5. Numerical results of the design alternatives

2.5.1. SR: Reference project (Reference situation)

New construction project of an office building.

		Final energy	Energy cost	Primary energy	Non-renewable primary energy	Emissions
Net floor area: 441.10 m²		(kWh/m²·Year)	(EUR/Year)	(kWh/m²·Year)	(kWh/m²·Year)	(kg CO2/m² ·Year)
Heating	Natural gas	14.92	427.78	17.83	17.74	3.76
	Total	14.92	427.78	17.83	17.74	3.76
Cooling	Grid electricity	13.31	1144.85	31.51	26.00	4.40
	Total	13.31	1144.85	31.51	26.00	4.40
Lighting	Grid electricity	15.36	1321.18	36.37	30.01	5.08
	Total	15.36	1321.18	36.37	30.01	5.08
TOTAL		43.59	2893.81	85.71	73.75	13.24

2.5.2. M1: Solar control glazing

Solar control properties are added to glazings facing south and east, with the purpose of reducing the cooling demand of the building. Solar factor of 0.3 is considered in those glazings, instead of solar factor of 0.7 specified in the project.

Improvement measures analysis

Net floor area: 441.10 m ²											
Final energy				Energy cost		Primary energy		Non-renewable primary energy		Emissions	
		(kWh/m ² ·Year)	Savings	(EUR/Year)	Savings	(kWh/m ² ·Year)	Savings	(kWh/m ² ·Year)	Savings	(kg CO2/m ² ·Year)	Savings
Heating	Natural gas	18.44	-23.59%	528.70	-23.59%	22.04	-23.61%	21.93	-23.62%	4.65	-23.67%
	Total	18.44	-23.59%	528.70	-23.59%	22.04	-23.61%	21.93	-23.62%	4.65	-23.67%
Cooling	Grid electricity	11.37	14.58%	977.98	14.58%	26.93	14.54%	22.22	14.54%	3.76	14.55%
	Total	11.37	14.58%	977.98	14.58%	26.93	14.54%	22.22	14.54%	3.76	14.55%
Lighting	Grid electricity	15.36	0.00%	1321.18	0.00%	36.37	0.00%	30.01	0.00%	5.08	0.00%
	Total	15.36	0.00%	1321.18	0.00%	36.37	0.00%	30.01	0.00%	5.08	0.00%
TOTAL		45.17	-3.62%	2827.87	2.28%	85.34	0.43%	74.16	-0.56%	13.49	-1.89%

2.5.3. M2: PV panels

Installation of photovoltaic (PV) panels on the building's roof, covering an area of □□60 m². Annual production is estimated at 19300 kWh.

Net floor area: 441.10 m ²											
Final energy			Energy cost		Primary energy			Non-renewable primary energy		Emissions	
		(kWh/m ² ·Year)	Savings	(EUR/Year)	Savings	(kWh/m ² ·Year)	Savings	(kWh/m ² ·Year)	Savings	(kg CO2/m ² ·Year)	Savings
Heating	Natural gas	14.92	0.00%	427.78	0.00%	17.83	0.00%	17.74	0.00%	3.76	0.00%
	Total	14.92	0.00%	427.78	0.00%	17.83	0.00%	17.74	0.00%	3.76	0.00%
Cooling	Renewable electricity	13.31	-	0.00	-	13.31	-	0.00	-	0.00	-
	Total	13.31	0.00%	0.00	-	13.31	57.76%	0.00	-	0.00	-
Lighting	Renewable electricity	15.36	-	0.00	-	15.36	-	0.00	-	0.00	-
	Total	15.36	0.00%	0.00	-	15.36	57.77%	0.00	-	0.00	-
TOTAL		43.59	0.00%	427.78	85.22%	46.50	45.75%	17.74	75.95%	3.76	71.60%

Improvement measures analysis

3. COST AND BENEFIT ANALYSIS

3.1. Expenses and grants

3.1.1. Solar control glazing

3.1.1.1. Investment costs

Description	Amount (EUR/Year)
Estimate	750.00

3.1.2. PV panels

3.1.2.1. Investment costs

Description	Un	Quantity	Price (EUR/Un)	Amount (EUR)
Execution budget				
Materials		1.00	9300.00	9300.00
Labor		1.00	1300.00	1300.00
Total budget				10600.00
Associated expenses				
Associated costs	%	2.00	-	212.00
Total associated costs				212.00
TOTAL INVESTMENT COST				10812.00

3.1.2.2. Maintenance cost

Description	Amount (EUR/Year)
Annual maintenance	440.00
Total	440.00

3.2. Static analysis of investment recovery

The investment recovery period, indicated in years, is obtained by dividing the net cost of the investment by the annual net savings generated by the improvement measure.

$$\text{Payback} = \frac{\Delta \text{Net cost of investment}}{\text{Net saving per year}}$$

If an investment cost has been assigned to the baseline scenario, the cost difference between the improvement measure and the baseline scenario will be considered.

The net cost of the investment corresponds to the sum of the cost of the improvement measures, minus the grants and financial aid that can be obtained.

$$\text{Net cost of investment} = \text{Cost of investment} - \text{Aids and subsidies}$$

The net annual savings correspond to the energy savings generated by the improvement measure, from which the annual maintenance cost must be subtracted.

$$\text{Annual net saving} = \text{Annual saving} - \Delta \text{Annual maintenance cost}$$

Improvement measures analysis

Net investment cost			Annual net savings			Investment recovery period	
Investment (EUR)	Grants (EUR)	Net cost (EUR)	Energy cost (EUR/Year)	Savings (EUR)	Maintenance (EUR/Year)	Net savings (EUR/Year)	(Year)
SR: Reference project (Reference situation)							
-	-	-	2893.81	-	-	-	-
M1: Solar control glazing							
750.00	0.00	750.00	2827.87	65.94	0.00	65.94	11.37
M2: PV panels							
10812.00	0.00	10812.00	427.78	2466.04	440.00	2026.04	5.34

Improvement measures analysis

3.3. Dynamic analysis of the investment recovery: NCV

The Net Present Value (NPV) has been used as a dynamic evaluation criteria of the investment, with the aim to establish the recovery period of the investment in a more realistic way.

This criteria is based on the determination of the future benefits based on the variation of the types of interest with time and the cash flow generated by the project. The result is shown as the difference between the future benefits and the net cost of the investment.

$$NCV = \text{Up-to-date Future Savings} - \Delta \text{Net cost of investment}$$

The future updated savings have been established by taking into account the increment of the energy expenses and the discount fee, by updating the cash flows of the investment.

All the profit generated due to the improvement of the energy efficiency of the building has been considered as positive flow. All the cost due to maintenance of the improvement measures entered in the project, is taken as negative flow.

The discount fee defined in the project corresponds to the difference between the nominal interest type and the inflation.

$$\text{Upcoming Future Savings} = \text{Up-to-date Energy Savings} - \text{Up-to-date maintenance costs}$$

The updated energy savings are established using the following expression:

$$\text{Up-to-date Energy Savings} = \sum_{i=1}^n \left[(1 + \Delta P_{\text{energy}}) / (1 + T_{\text{discount}}) \right]^n \times \text{Annual energy savings}$$

ΔP_{Energy} : Annual increase of the energy cost

T_{discount} : Discount fee (Nominal interest type - foreseen inflation)

The updated maintenance cost is established using the following expression:

$$\text{Up-to-date maintenance costs} = \sum_{i=1}^n \left[(1 + T_{\text{inflation}}) / (1 + T_{\text{interest}}) \right]^n \times \Delta \text{Annual maintenance costs}$$

$T_{\text{inflation}}$: Foreseen inflation

$T_{\text{interests}}$: Nominal interest type

The dynamic calculation (NCV) establishes the net cost of the investments as the sum of the cost of the improvement measures minus the amount of the grants and reductions related with these improvement measures.

$$\text{Net cost of investment} = \text{Cost of investment} - \text{Aids and subsidies}$$

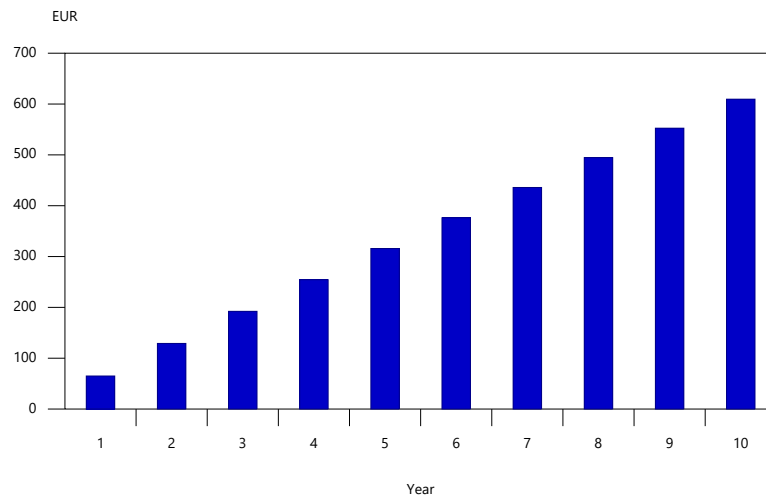
Annual energy cost increase	3.00%
Discount fee	4.50%
Foreseen inflation	1.20%
Nominal interest type	0.00%

Improvement measures analysis

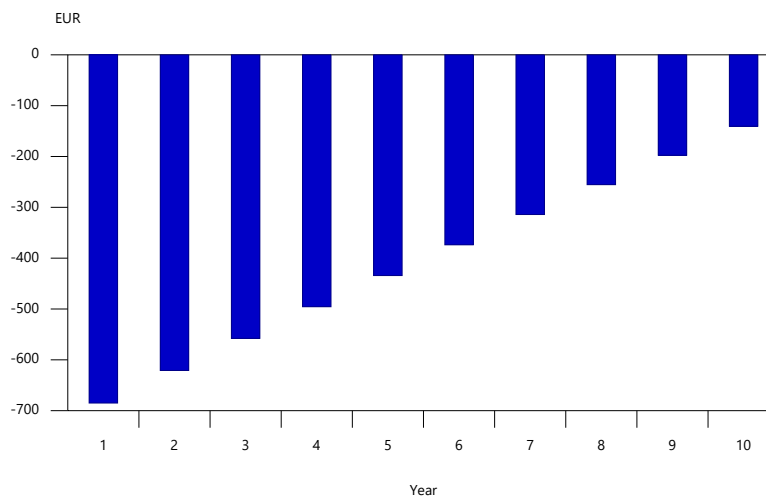
3.3.1. Solar control glazing

Period (Year)	Energy savings		Maintenance cost		NCV Total savings (EUR)
	Partial	Accumulated	Partial	Accumulated	
-	-	-	-	-	-750.00
1	65.00	65.00	0.00	0.00	-685.00
2	64.06	129.06	0.00	0.00	-620.94
3	63.15	192.21	0.00	0.00	-557.79
4	62.24	254.45	0.00	0.00	-495.55
5	61.35	315.79	0.00	0.00	-434.21
6	60.46	376.26	0.00	0.00	-373.74
7	59.60	435.85	0.00	0.00	-314.15
8	58.74	494.60	0.00	0.00	-255.40
9	57.90	552.49	0.00	0.00	-197.51
10	57.07	609.56	0.00	0.00	-140.44

Future savings



NCV

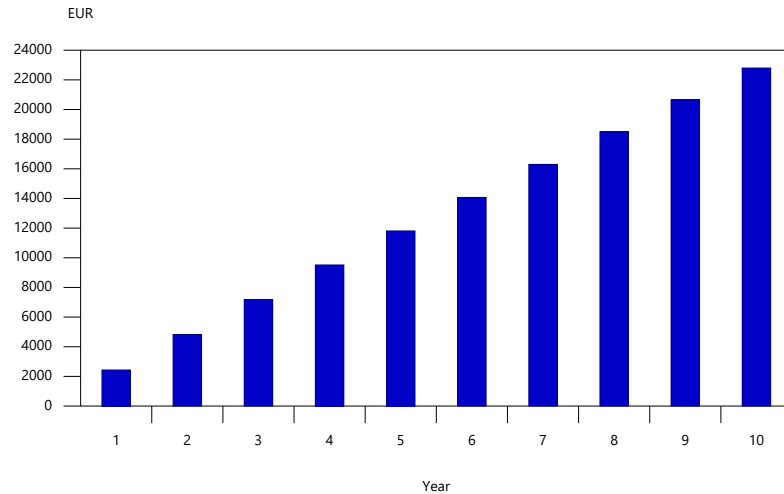


Improvement measures analysis

3.3.2. PV panels

Period (Year)	Energy savings		Maintenance cost		NCV Total savings (EUR)
	Partial	Accumulated	Partial	Accumulated	
-	-	-	-	-	-10812.00
1	2430.64	2430.64	445.28	445.28	-8826.64
2	2395.75	4826.39	450.62	895.90	-6881.52
3	2361.36	7187.75	456.03	1351.93	-4976.19
4	2327.46	9515.21	461.50	1813.44	-3110.23
5	2294.06	11809.27	467.04	2280.48	-1283.21
6	2261.13	14070.39	472.65	2753.12	505.27
7	2228.67	16299.06	478.32	3231.44	2255.62
8	2196.68	18495.75	484.06	3715.50	3968.25
9	2165.15	20660.89	489.87	4205.37	5643.53
10	2134.07	22794.96	495.74	4701.11	7281.85

Future savings



NCV

