Energy, CO_2 and cost savings by using highly energy efficient plastic spacer bars in comparison to aluminium and stainless steel spacer bars in different climates in France

A study by the Passive House Institute on behalf of SWISSPACER, Kreuzlingen, Switzerland

Report

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Contents

1 Introduction

Saving energy in order to reduce CO_2 emissions which are harmful to the climate and to relieve the burden on renewable energy sources is one of the most important tasks of our time.

Energy savings have many benefits for the energy efficiency of buildings. They regularly go hand in hand with lower life cycle costs. This is particularly clear with spacer bars in thermal insulation glazing: only a few cents more have to be invested per linear metre for highly efficient spacer bars. A lot of this – compared with conventional aluminium spacer bars – can be saved in energy costs over the period of use. Another significant benefit is that the temperatures at the edge of the glass are significantly increased with the highly efficient spacer bars. The area, in which use free from mildew and condensation is possible, is expanded considerably in this way.

This study was carried out by the Passive House Institute Dr. Wolfgang Feist. It discusses the potential savings by using highly energy-efficient plastic spacer bars in comparison to aluminium and stainless steel spacer bars using a building model in three different climates in France. The study works with the example of the SWISSPACER ULTIMATE spacer bar. A lot of the manufacturers of warm edge spacer bars have similar products.

2 Approach

2.1 Overview of the individual steps in the method

- Firstly, the thermal values of an aluminium, a stainless steel and a plastic spacer bar were calculated in connection with different reference frames and glazing.

- Using these values, the energy balance of a normal building in France with double glazing was calculated in a second step with the passive house project planning package (PHPP, Version 9.4). Based on this, the savings in energy, energy costs and CO_2 in different climates were determined.

- In step 3, these results were applied to the linear metres at the edge of the glass and extrapolated to a high-rise building with double glazing in step 4.

- Step 2 was repeated for triple glazing and a passive house: The energy balance, as well as savings in energy, energy costs and CO_2 in three climates was also determined for these.

2.2 The spacer bar frame combinations and their glass edge thermal bridge loss coefficients

As reference frames, this study uses the variants for cool-temperate, warm-temperate and warm climate from the ‘wood-aluminium’ range of the Passive House Institute’s spacer bar certification (see Table 1).

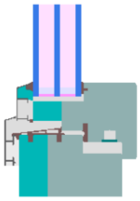
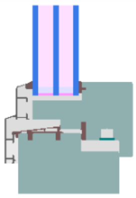
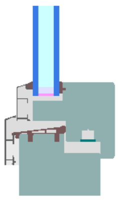
Frame	Value	Aluminium spacer bar	Stainless steel spacer bar	Plastic spacer bar
	**Cool-temperate climate.** $U_f = 0.75$ W/(m²K), $b_f = 12$ cm Used for the passive house at the Nancy site			
	Ψ_g [W/(mK)]	0.109	0.053	0.028
	$f_{Rsi=0.25\ m^2K/W}$ [-]	0.47	0.64	0.71
	Warm-temperate climate. $U_f = 0.97$ W/(m²K), $b_f = 12$ cm Used for the reference building with triple glazing at all sites and for the passive house in La Rochelle and Nice.			
	Ψ_g [W/(mK)]	0.107	0.051	0.028
	$f_{Rsi=0.25\ m^2K/W}$ [-]	0.44	0.61	0.68
	**Warm climate.** $U_f = 1.19$ W/(m²K), $b_f = 12$ cm Used for the reference building with double glazing in all locations			
	Ψ_g [W/(mK)]	0.093	0.056	0.034
	$f_{Rsi=0.25\ m^2K/W}$ [-]	0.37	0.49	0.56

Table 1: Thermal values of the underlying spacer bar / frame combinations

All variants were calculated with polysulfide (0.40 W/(mK)) as a secondary seal with a height of 3 mm (Box 1). The aluminium spacer bar was modelled with a height of 6.5 mm and a wall width of 0.5 mm, 160 W/(mK), filled with silica gel as a drying agent (0.13 W/(mK)). A thermal conductivity of Box 2 with 0.61 W/(mK) and a height of 7 mm was estimated for the stainless steel spacer bars. The thermal conductivity of Box 2 of the plastic spacer bar was assumed at 0.14 W/(mK) at a height of 6.5 mm. All calculations were performed with Flixo 7 pro. The results are presented in Table 1. The hygiene requirements for windows in passive houses are only achieved in cool-temperate climates with the plastic spacer bar, and also with the stainless steel spacer bars in the warm-temperate and warm-temperate climate.

2.3 The building model used and its locations

For the study, the following French sites were selected: Nancy in the cool-temperate climate, La Rochelle in the warm-temperate temperature and Nice in the warm climate. Table 2 on the next page shows the hot degree hours of the locations.

The building model

The study works with a building model which was modelled with the passive house project planning package (PHPP). Drawings were made available by the customer for this building. The model is equipped with a gas fired boiler, which supplies the heat and hot water. A heat pump also supplies the cooling system at the location in Nice. The passive house and both double and triple-glazed variants are variants of the same building model.

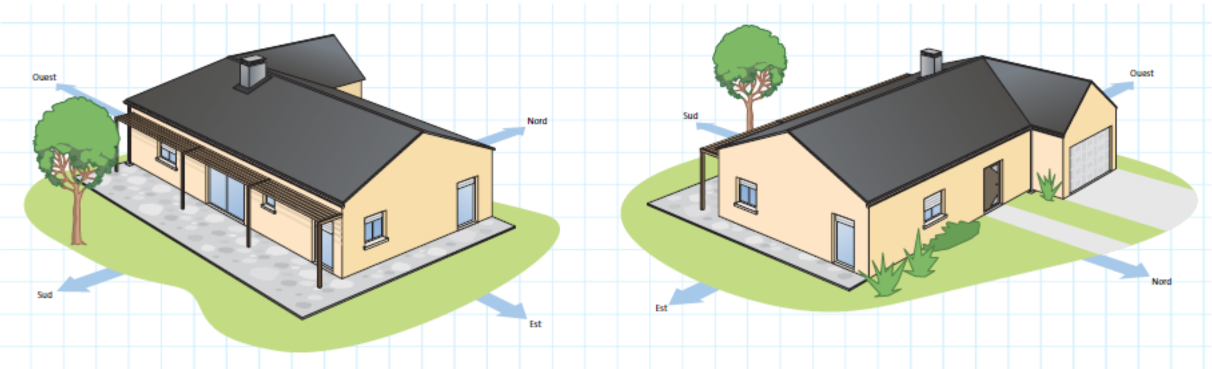


Figure 1: The single-storey building model with 100 m² of living space.

Features of individual building variants and locations

The starting point is the building which does not exceed an annual heating requirement of 50 kWh/(m²a) with double glazing and aluminium spacers at all locations. To achieve this, when using the wood-aluminium window frame for the warm climate, the heat transmission coefficient for the walls, roof and floors were adapted specifically for the climate, see table 2. The building is ventilated using an exhaust system. As a characteristic value for the air tightness of the building, a value of n50 = 0.6 1/h was specified by the customer.
The heating requirement deteriorates accordingly when using the stainless steel or aluminium spacer.
With regard to the hygiene criterion – that is to say, the limitation of the risk of mould due to low temperatures – aluminium spacer bars cannot be recommended in any of the climates. The stainless steel spacer bar is not recommended for Nancy.

Value	Unit	Nancy	La Rochelle	Nice
Heating degree hours	kK/a	71	48	34
U-value outer wall	$W//(m^2K)$	0.15	0.40	0.45
U-value roof	$W//(m^2K)$	0.15	0.30	0.40
U-value basement ceiling	$W//(m^2K)$	0.24	0.50	0.60
U-value window frame	$W//(m^2K)$	1.18	1.19	1.19
U-value glass	$W//(m^2K)$	1.20	1.20	1.20
q-value glass	-	62%	62%	62%

Table 2: Climatic characteristics and component qualities of the reference building with double thermal insulation glazing

The calculations were repeated for the building with triple thermal insulation glazing (g=0.62, U_g= 0.64 W/(m²K)) and lower window frames. During the calculations, the heat requirement was, in turn, calibrated at 50 kWh/(m²a). The characteristic values can be found in Table 3.

Value	Unit	Nancy	La Rochelle	Nice
Heating degree hours	kK/a	71	48	34
U-value outer wall	$W//(m^2K)$	0.18	0.45	0.71
U-value roof	$W//(m^2K)$	0.18	0.31	0.50
U-value basement ceiling	$W//(m^2K)$	0.30	0.60	1.00
U-value window frame	$W//(m^2K)$	0.97	0.97	0.97
U-value glass	$W//(m^2K)$	0.64	0.64	0.64
q-value glass	-	62%	62%	62%

Table 3: Climatic characteristics and component qualities of the reference building with double thermal insulation glazing

The maximum permissible annual heating requirement for a passive house is 15 kWh/(m²a), less than one-third of the 50 kWh for the reference version. The single-storey reference building has a highly unfavourable cubature for the highly energy-efficient and cost-effective building, since the heated volume, or the heated usable floor space has a relatively large heat transferring enveloping surface. The building envelope components used must be of a correspondingly high level of quality.
Therefore, the plastic spacer bar was used as an output variant to achieve the required 15 kWh/m^2 annual heating requirement. Stainless steel and aluminium spacer bars then increase the heating requirement beyond the passive house level.
For the locations in Nancy and La Rochelle, an air conditioning unit with heat recovery (heat provision 93%, electrical efficiency 0.24 Wh/m³) was chosen. The ventilation system at the location in Nice is enough to fulfil the passive house standard. However, that is only in conjunction with the triple-glazed window frames for the warm-temperate climate, see table 1. The same frame was also used for the passive house in La Rochelle, for Nancy the heat-insulated window frame was chosen for the cold-temperate climate. Table 4 also lists the U-values of the opaque components.

Value	Unit	Nancy	La Rochelle	Nice
U-value outer wall	W//(m^{2}K)	0.12	0.24	0.30
U-value roof	W//(m^{2}K)	0.10	0.20	0.24
U-value basement ceiling	W//(m^{2}K)	0.19	0.32	0.50
U-value window frame	W//(m^{2}K)	0.75	0.97	0.97
U-value glass	W//(m^{2}K)	0.64	0.64	0.64
q-value glass	-	62%	62%	62%

Table 4: Component qualities in the passive house variant.

The interior temperature was set at 20°C at all locations and in all variants in the winter, and a maximum of 24°C in the summer.

2.4 How was the cash value of the energy savings calculated?

In order to calculate the financial savings of the lower energy consumption, the study assumes the following boundary conditions: Term of use: 40 years Inflation-adjusted interest rate: 2%. Heat price € 0.1/kWh. It is assumed that the power required for the top cooling in summer at the location in Nice is completely covered by a PV system using a heat pump (annual coefficient of performance 2) . The electricity cost price was assumed to be € 0.1, so in combination with the annual coefficient of performance of the heat pump, the useful cooling price is € 0.05/kWh.

The cash values were determined with the following equations.

$$K_e = k_j \cdot B_B$$

$$k_j = Q_{Energie} \cdot k_{Energie}$$

$$B_B = \frac{1-(1+p_{real})^{t_B-1}}{p_{real}}$$

K_e: Cash value of the energy costs [€]
k_j: Annual energy costs [€]
B_B: Cash value factor for period studied [-]
$Q_{Energie}$: Amount of energy [kWh]
$k_{Energie}$: Energy costs [€/kWh]
p_{real}: Inflation-adjusted interest rate
t_B: Period studied [a]

2.5 How were the CO_2 savings calculated?

In order to determine the CO_2 savings, the energy requirements for heating (energy source: gas) and cooling (energy source: solar power) were multiplied by the CO_2eq emissions factor. It contains not only the CO_2 produced per kWh of end energy, but also the climatic impact of other harmful gases standardised to the effect of CO_2.

The CO_2eq emission factor for gas in this study was set at 4.94 to 0.25 kgCO_2eq/ kWh$_{end}$ in accordance with GEMIS, the electricity generated by the PV system for cooling was set at 0.13 kgCO_2eq/ kWh$_{End}$.

2.6 Converting the results into linear metres of the glass edge

In order to convert the results into linear metres of the glass edge, the savings for the whole reference building were divided by the linear metres of glass edge in the building. This is 66.2 metres.

2.7 Converting the results for the "high-rise building with double glazing"

The values determined were converted into the “high-rise with double glazing” building model. To do this, the results per linear metre of glass edge in the reference building were multiplied by the linear metres of glass edge in the high-rise building. Per storey, this is 99.4 metres, a total of 1093.4 metres for 11 storeys. Figure 2 shows views and a floor plan of the high-rise building.

Figure 2: East and south view and floor plan of the 'high-rise passive house standard' building model

3 Results

Chapter 3 presents selected results of the study: the focus is on the figures concerning savings in energy, costs and CO_2 emissions from using highly energy-efficient plastic spacer bars in comparison to aluminium and stainless steel spacer bars in three different climates. The percentage energy savings always refer to the overall heating requirement of the respective building.
Here you will find key results and comments on the savings

- In the reference building (Chapter 3.1)
- In the reference building per linear metre of glass edge (Chapter 3.2)
- In the multi-storey residential building using the example of a high-rise building with double glazing (Chapter 3.3)
- In the reference building with triple thermal glazing (Chapter 3.5)
- In the passive house (Chapter 3.6)

At the end of the study, there is a table with the results.

3.1 Results for the reference building model with double thermal glazing

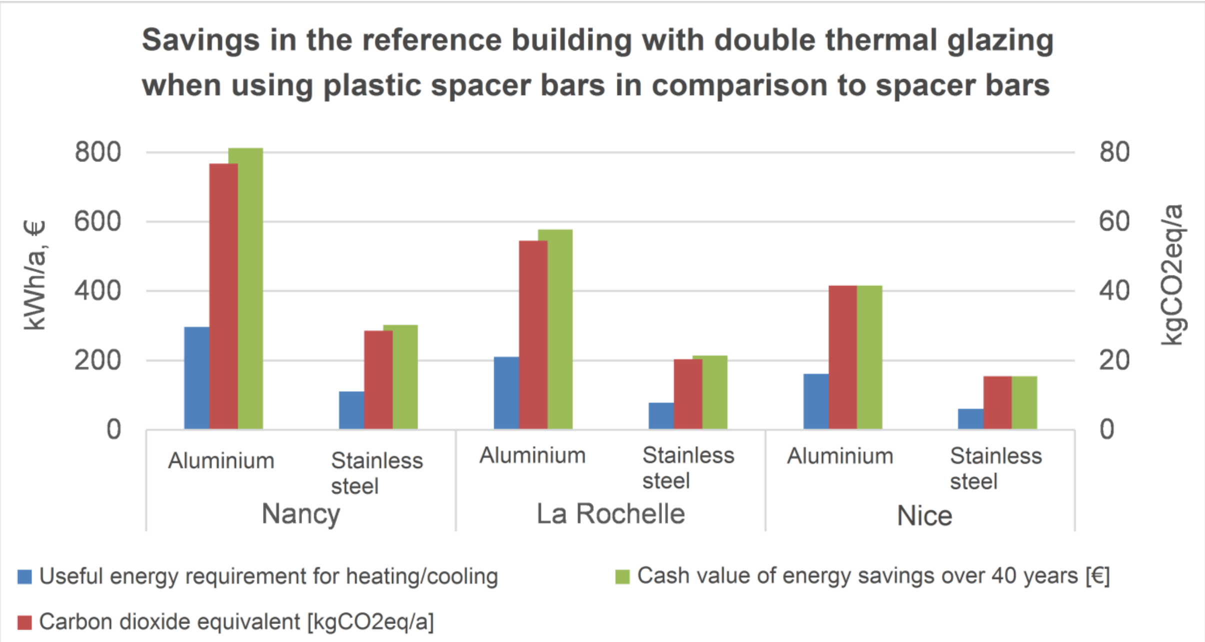


Figure 3: Energy, cost and CO_2 savings in the reference building model with double thermal glazing

Results for the reference building with double thermal glazing in Nancy

The annual heating requirement in the reference building at the location in Nancy with the aluminium spacer bar was calibrated to 50.4 kWh/(m²a). It is reduced

- by using the stainless steel spacer bar by 1.9 kWh/(m²a) to 48.6 kWh/(m²a)
- by using the plastic spacer bar again by 1.1 kWh/(m²a) to 47.5 kWh/(m²a)

Therefore, **the energy savings** amount to

- 5.9% with the plastic spacer bar instead of an aluminium spacer bar
  2.3% with the plastic spacer bar instead of a stainless steel spacer bar

The carbon dioxide savings are as follows:
in comparison to the aluminium spacer bar

- 48 kg CO_2eq/a with the stainless steel spacer bar
- 77 kg CO_2eq/a with the plastic spacer bar.
  That corresponds to driving approximately 645 kilometres with a Golf VI 1.6 TDI

in comparison to the stainless steel spacer bar

- 29 kg CO_2eq/a with the plastic spacer bar.

The financial savings due to the lower heating requirement over the assumed use cycle of the spacer bars of 40 years amount to:
in comparison to the aluminium spacer bar

- approx. € 510 with the stainless steel spacer bar
- approx. € 813 with the plastic spacer bar

in comparison to the stainless steel spacer bar

- approx. € 302 with the plastic spacer bar

Results for the reference building with double thermal glazing in La Rochelle

It is warmer in La Rochelle than in Nancy. That can be seen well using the degree day: It is 71 kKh/a in Nancy and 48 kKh/a in La Rochelle. Also lower are the potential savings from using highly energy-efficient components, such as plastic spacer bars.

The annual heating requirement in the reference building at the location in La Rochelle with the aluminium spacer bar was calibrated to 49.8 kWh/(m²a). It is reduced

- by using the stainless steel spacer bar by 1.3 kWh/(m²a) to 48.5 kWh/(m²a)
- by using the plastic spacer bar again by 0.8 kWh/(m²a) to 47.7 kWh/(m²a)

Therefore, **the energy savings** amount to

- 4.2% with the plastic spacer bar instead of an aluminium spacer bar
  1.6% with the plastic spacer bar instead of a stainless steel spacer bar

The carbon dioxide savings are as follows:
in comparison to the aluminium spacer bar

- 34 kg CO_2eq/a with the stainless steel spacer bar
- 55 kg CO_2eq/a with the plastic spacer bar.
  That corresponds to driving approximately 495 kilometres with a Golf VI 1.6 TDI

in comparison to the stainless steel spacer bar

- 20 kg CO_2eq/a with the plastic spacer bar.

The financial savings due to the lower heating requirement over the assumed use cycle of

the spacer bars of 40 years amount to:
in comparison to the aluminium spacer bar

- approx. € 362 with the stainless steel spacer bar
- approx. € 577 with the plastic spacer bar

in comparison to the stainless steel spacer bar

- approx. € 215 with the plastic spacer bar

Results for the reference building with double thermal glazing in La Rochelle

In the warm climate of Nice, in addition to the 49.6 kWh/(m²a) annual heating requirement (with aluminium spacer bars), there is also a useful cooling requirement of 6.5 kWh/(m²a) at 24°C maximum internal temperature. The dehumidifying requirement is not considered here, as it is separate from the thermal qualities of the building structure. The calculations were repeated with an internal temperature of 20° C. In this case, the annual useful cooling requirement with aluminium spacer bars is increased significantly to 33.3 kWh/(m²a).

The combined annual heating and useful cooling requirement at a maximum temperature of 24° C in summer is as follows:

- 54.5 kWh/(m²a) with the plastic spacer bar
- 55.1 kWh/(m²a) with the stainless steel spacer bar
- 56.1 kWh/(m²a) with the aluminium spacer bar

The energy savings are lower in comparison to the pure heating climates. They are

- 2.9% with the plastic spacer bar instead of the aluminium spacer bar
- 1.1% with the plastic spacer bar instead of the stainless steel spacer bar

The carbon dioxide savings are as follows:
in comparison to the aluminium spacer bar

- 26 kg CO_2eq/a with the stainless steel spacer bar
- 42 kg CO_2eq/a with the plastic spacer bar.
  That corresponds to driving approximately 350 (370) kilometres in a Golf VI 1.6 TDI

in comparison to the stainless steel spacer bar

- 16 kg CO_2eq/a with the plastic spacer bar.

The combined annual heating and useful cooling requirement at a maximum temperature of 20°C in the summer is as follows:

- 81.1 kWh/(m²a) with the plastic spacer bar
- 81.8 kWh/(m²a) with the stainless steel spacer bar
- 81.9 kWh/(m²a) with the aluminium spacer bar

The energy savings are lower in comparison to the pure heating climates. They are

- 2.3% with the plastic spacer bar instead of the aluminium spacer bar

- 0.9% with the plastic spacer bar instead of the stainless steel spacer bar

The carbon dioxide savings are as follows:
in comparison to the aluminium spacer bar

- 27.3 kg CO_2eq/a with the stainless steel spacer bar
- 43.6 kg CO_2eq/a with the plastic spacer bar.
  That corresponds to driving approximately 350 (370) kilometres in a Golf VI 1.6 TDI

in comparison to the stainless steel spacer bar

- 16.2 kg CO_2eq/a with the plastic spacer bar.

The financial savings due to the lower useful energy requirement
over the assumed use cycle of the spacer bars of 40 years are as follows in comparison to the aluminium spacer bar

- approx. € 262 with the stainless steel spacer bar
- approx. € 416 with the plastic spacer bar

in comparison to the stainless steel spacer bar

- approx. € 155 with the plastic spacer bar

3.2 Results per linear metre of glass edge in the reference building with double glazing

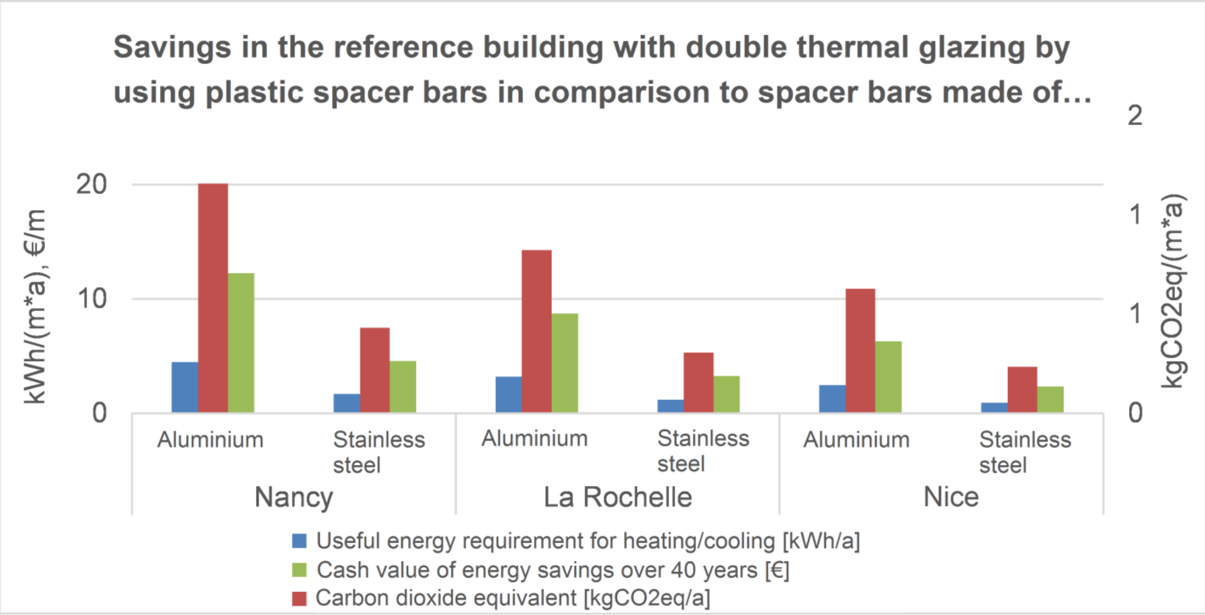


Figure 4: Savings in the reference building model with double thermal glazing per linear meter of glass edge

Results per linear metre of glass edge in the reference building with double thermal glazing in Nancy

The savings per linear metre in comparison to the aluminium spacer bar are as follows:

for the stainless steel spacer bar

- 2.82 kWh/(m*a) energy for heating
- 0.73 kg CO_2eq/(m*a) carbon dioxide
- 7.7 €/m energy costs over 40 years of use

for the plastic spacer bar

- 4.48 kWh/(m*a) energy for heating
- 1.16 kg CO_2eq/(m*a) carbon dioxide
- 12.3 €/m energy costs over 40 years of use

The savings per linear metre in comparison to the stainless steel spacer bar are as follows:

with the plastic spacer bar

- 1.67 kWh/(m*a) energy for heating
- 0.43 kg CO_2eq/(m*a) carbon dioxide
- 4.6 €/m energy costs over 40 years of use

Results per linear metre of glass edge in the reference building with double thermal glazing in La Rochelle

In the warmer La Rochelle, the savings are lower.

The savings per linear metre in comparison to the aluminium spacer bar are as follows:

with the stainless steel spacer bar

- 2.0 kWh/(m*a) energy for heating
- 0.52 kg CO_2eq/(m*a) carbon dioxide
- 5.5 €/m energy costs over 40 years of use

with the plastic spacer bar

- 3.2 kWh/(m*a) energy for heating
- 0.82 kg CO_2eq/(m*a) carbon dioxide
- 8.7 €/m energy costs over 40 years of use

The savings per linear metre in comparison to the stainless steel spacer bar are as follows:

with the plastic spacer bar

- 1.2 kWh/(m*a) energy for heating
- 0.31 CO_2eq/(m*a) carbon dioxide
- 3.2 €/m energy costs over 40 years of use

Results per linear metre of glass edge in the reference building with double thermal glazing in Nice

In the cool climate in Nice, the savings are even smaller.

The savings per linear metre in comparison to the aluminium spacer bar are as follows:

with the stainless steel spacer bar

- 1.53 kWh/(m*a) energy for heating+cooling
- 0.39 kg CO_2eq/(m*a) carbon dioxide
- 4.0 €/m energy costs over 40 years of use

with the plastic spacer bar

- 2.44 kWh/(m*a) energy for heating+cooling
- 0.63 kg CO_2eq/(m*a) carbon dioxide
- 6.3 €/m energy costs over 40 years of use

The savings per linear metre in comparison to the stainless steel spacer bar are as follows:

with the plastic spacer bar

- 0.91 kWh/(m*a) energy for heating+cooling
- 0.23 CO_2eq/(m*a) carbon dioxide
- 2.3 €/m energy costs over 40 years of use

3.3 Results for the high-rise building model

In order to determine the values for the multi-storey residential building, the study researches the influence of the spacer bars on the heating energy requirement of a high-rise building with double thermal glazing. To do this, the results per metre of glass edge in the reference building with thermal glazing (Chapter 3.2) were multiplied by the glass edge lengths of the high-rise building. This is 99.4 metres per storey and 1,093.4 metres for 11 storeys. Figure 5 shows selected results.

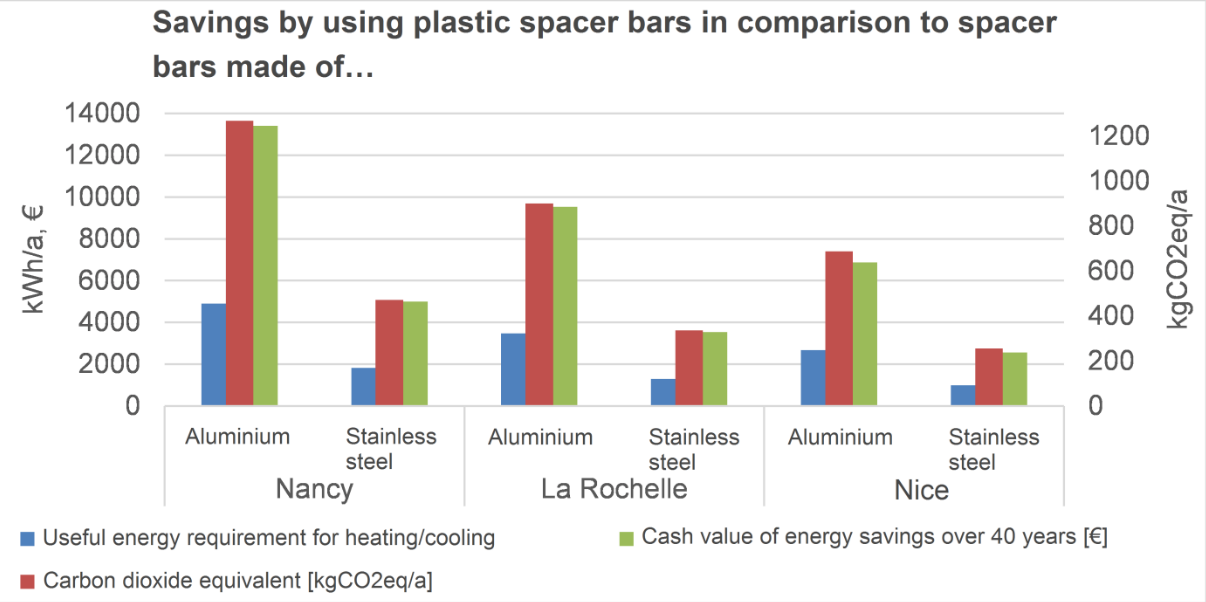


Figure 5: Visualising selected results for the building type "high-rise building with double thermal glazing"

Results for the high-rise building with double thermal glazing in Nancy

The savings in comparison to the aluminium spacer bar are as follows:
with the stainless steel spacer bar

- 3.1 MWh/a energy for heating
- approx. 0.8 tonnes CO_2eq/a carbon dioxide equivalent
- approx. €8,400 energy costs over 40 years of use

with the plastic spacer bar

- 4.9 MWh/a energy for heating
- approx. 1.3 tonnes CO_2eq/a carbon dioxide equivalent
- approx. €13,400 energy costs over 40 years of use

The savings in comparison to the stainless steel spacer bar are as follows:
with the plastic spacer bar

- 1.8 MWh/a energy for heating
- 0.5 tonnes CO_2eq/a carbon dioxide equivalent
- approx. €5,000 energy costs over 40 years of use

Results for the high-rise building with double thermal glazing in La Rochelle

In the milder climate in La Rochelle, the savings are lower.

The savings in comparison to the aluminium spacer bar are as follows:
for the stainless steel spacer bar

- 2.2 MWh/a energy for heating
- 0.6 tonnes CO_2eq/a carbon dioxide equivalent
- €6,000 energy costs over 40 years of use

for the plastic spacer bar

- 3.5 MWh/a energy for heating
- approx. 0.9 tonnes CO_2eq/a carbon dioxide equivalent
- approx. €10,000 energy costs over 40 years of use

The savings in comparison to the stainless steel spacer bar are as follows:
with the plastic spacer bar

- 1.3 MWh/a energy for heating
- approx. 0.3 tonnes CO_2eq/a carbon dioxide equivalent
- approx. €4,000 energy costs over 40 years of use

Results for the high-rise building with double thermal glazing in Nancy

In the climate in Nice, the savings are even slightly lower.

The savings in comparison to the aluminium spacer bar are as follows:
with the stainless steel spacer bar

- 1.7 MWh/a useful cold energy
- 0.43 tonnes CO_2eq/a carbon dioxide equivalent
- €4,300 energy costs over 40 years of use

with the plastic spacer bar

- 2.7 MWh/a useful cold energy
- approx. 0.69 tonnes CO_2eq/a carbon dioxide equivalent
- approx. €6,900 energy costs over 40 years of use

The savings in comparison to the stainless steel spacer bar are as follows:
with the plastic spacer bar

- 1.0 MWh/a useful cold energy
- approx. 0.26 tonnes CO_2eq/a carbon dioxide equivalent
- approx. €2,600 energy costs over 40 years of use

3.4 Results for the reference building with triple thermal glazing

With the improved windows and the triple thermal glazing, the quality of the remaining components can be reduced, see Chapter 2.3.
The differences in the thermal bridge loss coefficients at the edge of the glass for aluminium and plastic spacer bars are more evident in the triple glazing than in the double glazing. This is also the reason for higher absolute potential savings for the useful energy requirements for different types of spacer bars.

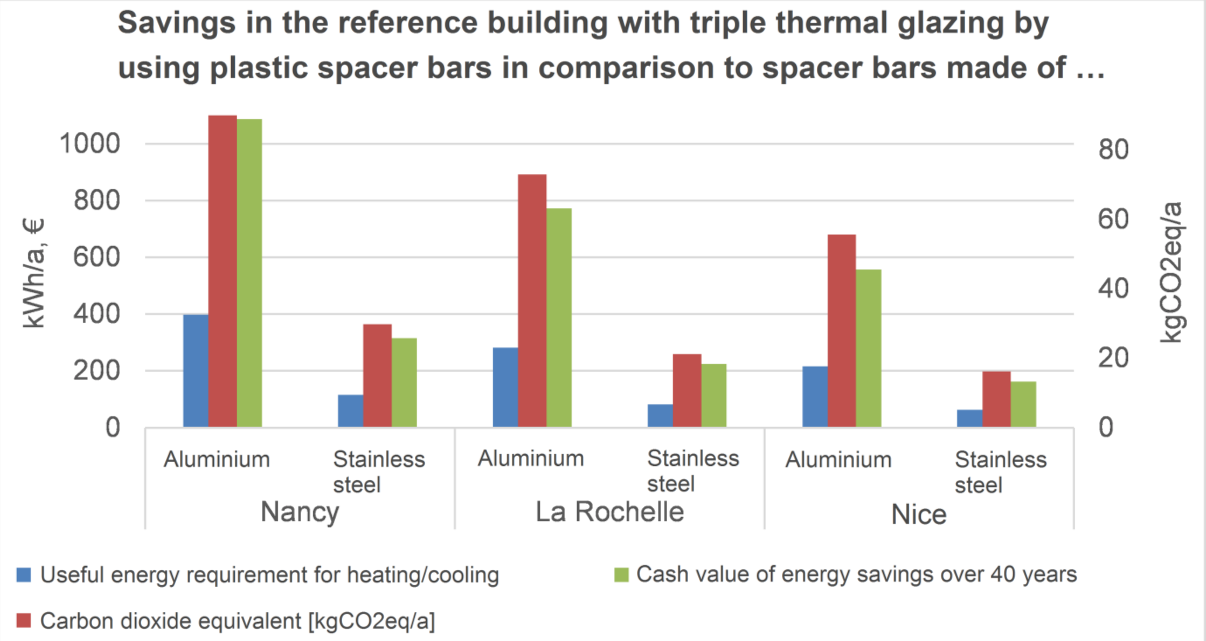


Figure 6: Savings in the triple glazed reference building model

The annual heating requirement (in Nancy and La Rochelle)
and annual heating and useful cooling requirement (in Nice)
with the plastic spacer bars in the triple glazed reference building are as follows:

- approx. 46.2 kWh/(m²a) in Nancy
- approx. 47.0 kWh/(m²a) in La Rochelle
- approx. 47.9 + 6.5 = 54.4 kWh/(m²a) in Nice

The savings in comparison to the aluminium spacer bar are as follows:
with the plastic spacer bar in Nancy

- 7.9% of the whole building's heating energy
- 103 kg CO_2eq/a carbon dioxide
  That corresponds to driving approximately 864 kilometres in a Golf VI 1.6 TDI
- € 1090 energy costs over 40 years of use
- approx. € 16.4 per metre of glass edge

with the plastic spacer bar in La Rochelle

- 5.7 % of the whole building's heating energy

- 73 kg CO_2eq/a carbon dioxide
  That corresponds to driving approximately 613 kilometres in a Golf VI 1.6 TDI
- € 772 energy costs over 40 years of use
- approx. € 12 per metre of glass edge

with the plastic spacer bar in Nice

- 3.8% of the useful energy for heating and cooling
- 56 kg CO_2eq/a carbon dioxide
  That corresponds to driving approximately 468 kilometres in a Golf VI 1.6 TDI
- € 560 energy costs over 40 years of use
- approx. € 8.4 per metre of glass edge

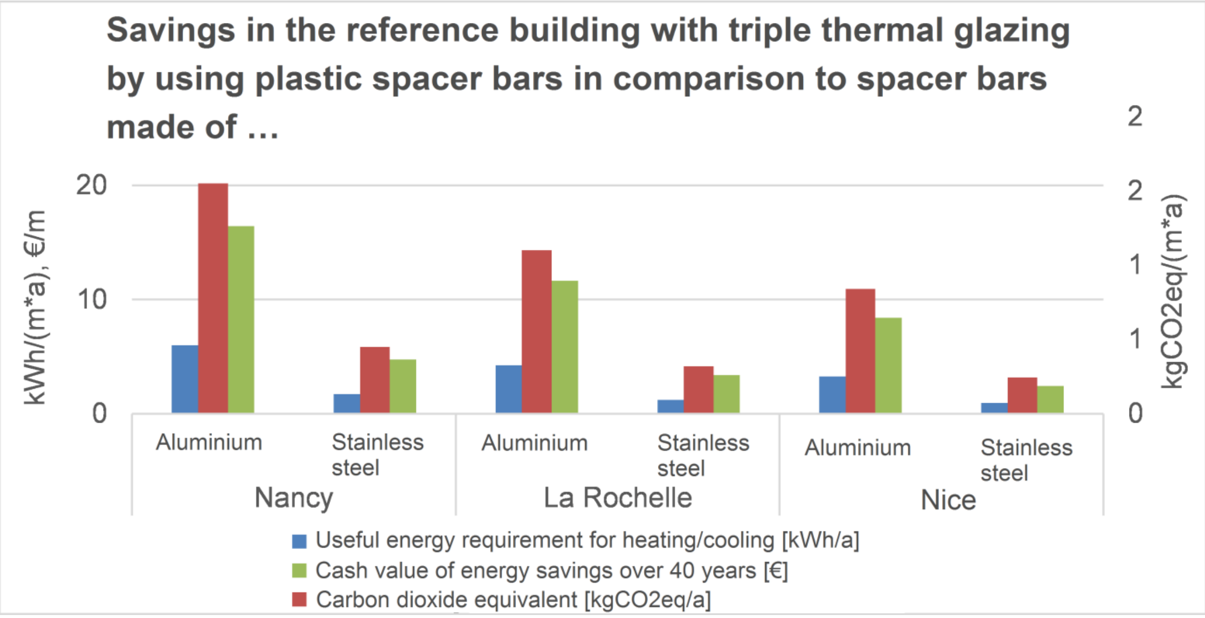


Figure 7: Savings per linear metre of glass edge in the triple glazed reference building model

3.5 Results for the passive house

The significantly reduced annual heating requirement in the passive house in particular means improving the spacer bars results in significantly higher relative savings. In Nancy, that is just under 18% for the plastic spacer bar in comparison to the aluminium spacer bar.

The annual heating requirement (in Nancy and La Rochelle)
and annual heating and useful cooling requirement (in Nice) are as follows:
with the plastic spacer bar in the passive house:

- approx. 15.1 kWh/(m²a), with the aluminium spacer bar: 18.3 kWh/(m²a) in Nancy
- approx. 15.0 kWh/(m²a), with the aluminium spacer bar: 17.3 kWh/(m²a) in La Rochelle
- approx. 14.8 + 4.9 = 19.7 kWh/(m²a), with the aluminium spacer bar: 16.7 + 4.9 = 21.6 kWh/(m²a) in Nice

The savings in comparison to the aluminium spacer bar are as follows:
with the plastic spacer bar in Nancy

- 17.7 % of the whole building's heating energy
- 83 kg CO_2eq/a carbon dioxide
  That corresponds to driving approximately 700 kilometres in a Golf VI 1.6 TDI
- € 890 energy costs over 40 years of use
- approx. € 13 per metre of glass edge

with the plastic spacer bar in La Rochelle

- 13.3 % of the whole building's heating energy
- 60 kg CO_2eq/a carbon dioxide
  That corresponds to driving approximately 500 kilometres in a Golf VI 1.6 TDI
- € 630 energy costs over 40 years of use
- approx. € 10 per metre of glass edge (due to the significantly lower electricity price)

with the plastic spacer bar in Nice

- 8.8 % of the useful energy for heating and cooling
- 50 kg CO_2eq/a carbon dioxide
  That corresponds to driving approximately 420 kilometres in a Golf VI 1.6 TDI
- € 455 energy costs over 40 years of use
- approx. € 7 per metre of glass edge

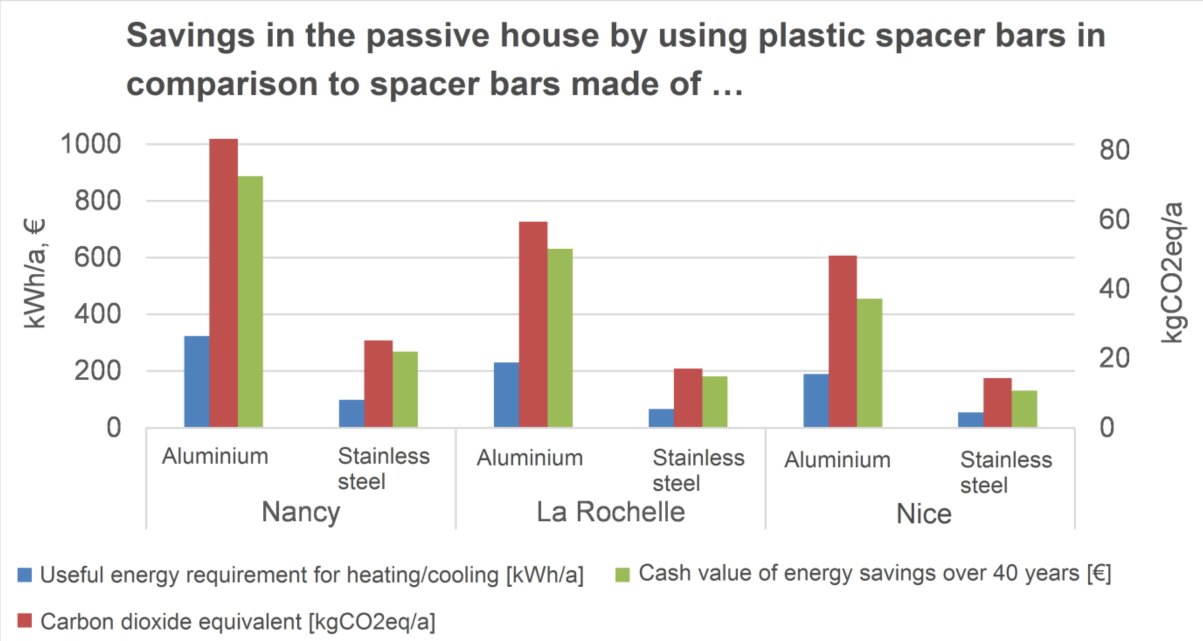


Figure 8: Savings in the passive house

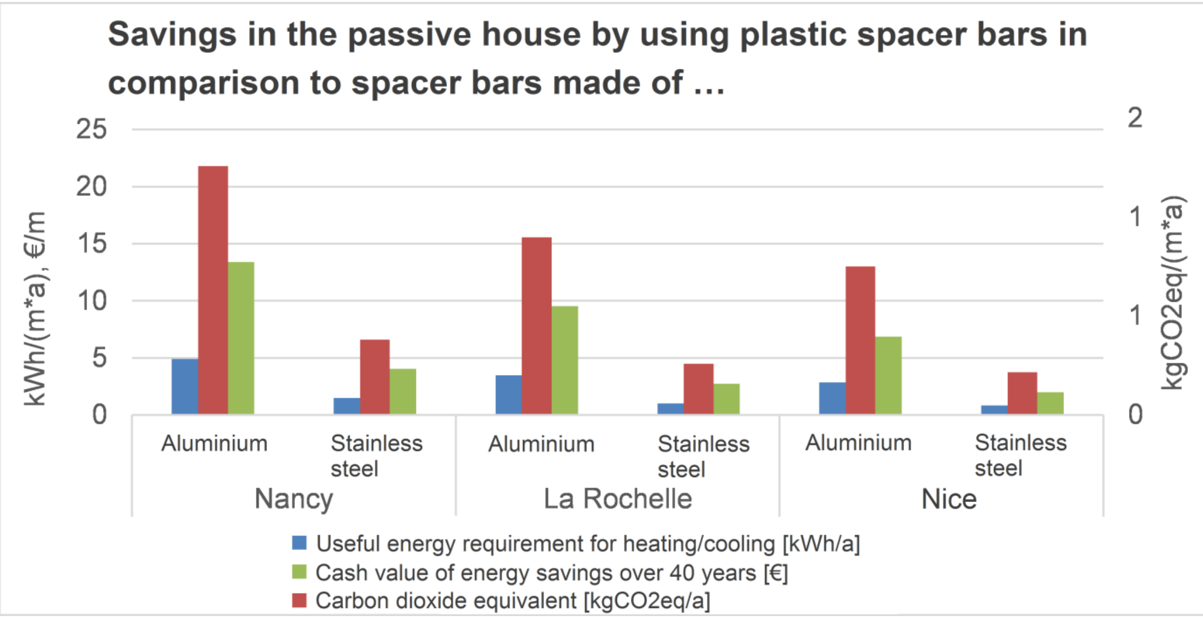


Figure 9: Savings per linear metre of glass edge in the passive house

4 Summary

The study by the Passive House Institute shows: using highly energy-efficient plastic spacer bars in windows with insulated glass has many benefits. The energy – and therefore the CO_2 – and cost savings are considerable. Moreover, the hygiene situation at the edge of the glass is significantly improved, meaning that the risk of condensation or mould at the edge of the glass is significantly reduced. This applies in particular in comparison to aluminium, but also compared with stainless steel spacer bars. The colder or hotter a climate is – or, more specifically: the more the outside climate differs from the desired inside climate – the higher the potential energy and CO_2 savings.

With a view to protecting the climate, energy saving measures are also significant to the topic of “highly energy-efficient spacer bars”. For example, the CO_2eq emissions of 100 kg CO_2eq prevented in the triple glazed reference building with the plastic spacer bar in comparison with the aluminium spacer bar corresponds to driving approx. 850 km in a Golf VI 1.6 TDI per year.

The absolute savings determined here can be transferred in good approximation to other energy standards if the same glass and frame combinations are selected. If, as assumed in the case of the reference variants with lower thermal component qualities, the potential savings compared to the passive house fall, the basic message remains: Regardless of the selected glass, frame, building or climate, the use of highly energy-efficient spacer bars is highly recommended.

5 Tables

(SWS U = the highly efficient plastic “Swisspacer Ultimate” spacer bar)

Results for the reference building with double thermal glazing

Annual heat and cooling requirement [kWh/(m²a)]			
	SWS U	Stainless steel	Aluminium
Heating energy Nancy	47.5	48.6	50.4
Heating energy La Rochelle	47.7	48.5	49.8
Heating energy Nice	48.0	48.6	49.6
Useful cooling Nice	6.5	6.5	6.5

Savings in terms of the heat and cooling requirement									
	Building: [%]			**Building: [kWh/(m²a)**			**Linear metres: [kWh/(m²a)]**		
	Stainless steel vs aluminium	**SWS U vs stainless steel**	**SWS U vs aluminium**	**Stainless steel vs aluminium**	**SWS U vs stainless steel**	**SWS U vs aluminium**	**Stainless steel vs aluminium**	**SWS U vs stainless steel**	**SWS U vs aluminium**
Nancy	3.7%	2.3%	5.9%	1.9%	1.1	3.0	2.8%	1.7	4.5
La Rochelle	2.7%	1.6%	4.2%	1.3%	0.8	2.1	2.0%	1.2	3.2
Nice	1.8%	1.1%	2.9%	1.0%	0.6	1.6	1.5%	0.9	2.4

Savings in terms CO2 equivalent									
	Building: [kg CO2-eq/a]			**Building: [kilometres of driving/a)**			**Linear metres: [kWh/(m²a)]**		
	Stainless steel vs aluminium	**SWS U vs stainless steel**	**SWS U vs aluminium**	**Stainless steel vs aluminium**	**SWS U vs stainless steel**	**SWS U vs aluminium**	**Stainless steel vs aluminium**	**SWS U vs stainless steel**	**SWS U vs aluminium**
Nancy	48.2	28.6	76.8	405.2	240.2	645.3	0.73	0.43	1.16
La Rochelle	34.2	20.3	54.6	287.8	170.8	458.6	0.52	0.31	0.82
Nice	26.1	15.5	41.7	219.7	130.3	350.0	0.39	0.23	0.63

Monetary savings (cash value)						
	Building: [€ in 40 years]			**Per linear metre: [€ in 40 years]**		
	Stainless steel vs aluminium	**SWS U vs stainless steel**	**SWS U vs aluminium**	**Stainless steel vs aluminium**	**SWS U vs stainless steel**	**SWS U vs aluminium**
Nancy	510.1	302	813	7.7	4.6	12.3
La Rochelle	362.2	215	577	5.5	3.2	8.7
Nice	261.5	155	416	3.9	2.3	6.3

Results for the triple-glazed reference building

Annual heat and cooling requirement [kWh/(m²a)]			
	SWS U	Stainless steel	Aluminium
Heating energy Nancy	46.2	47.3	50.2
Heating energy La Rochelle	47.0	47.8	49.8
Heating energy Nice	47.9	48.5	50.0
Useful cooling Nice	6.5	6.5	6.6
Nice combined	54.4	55.0	56.6

Savings in terms of the heat and cooling requirement						
	Building: [%]		**Building: [kWh/(m²a)**		**Linear metres: [kWh/(m²a)]**	
	SWS U vs stainless steel	**SWS U vs aluminium**	**SWS U vs stainless steel**	**SWS U vs aluminium**	**SWS U vs stainless steel**	**SWS U vs aluminium**
Nancy	2.4%	7.9%	1.2	4.0	1.7	6.0
La Rochelle	1.7%	5.7%	0.8	2.8	1.2	4.3
Nice	1.1%	3.8%	0.6	2.2	1.0	3.3

Savings in terms CO2 equivalent						
	Building: [kg CO2-eq/a]		**Building: [kilometres of driving/a)**		**Linear metres: [kWh/(m²a)]**	
	SWS U vs stainless steel	**SWS U vs aluminium**	**SWS U vs stainless steel**	**SWS U vs aluminium**	**SWS U vs stainless steel**	**SWS U vs aluminium**
Nancy	29.8	102.8	250.7	863.7	0.5	1.6
La Rochelle	21.2	73.0	178.2	613.4	0.3	1.1
Nice	16.2	55.7	136.1	468.1	0.2	0.8

Monetary savings				
	Building: [€ in 40 years]		**Per linear metre: [€ in 40 years]**	
	SWS U vs stainless steel	**SWS U vs aluminium**	**SWS U vs stainless steel**	**SWS U vs aluminium**
Nancy	316	1,088	4.8	16.4
La Rochelle	224	772	3.4	11.7
Nice	162	557	2.4	8.4

Results for the passive house

Annual heat and cooling requirement [kWh/(m^{2}a)]			
	SWS U	Stainless steel	Aluminium
Heating energy Nancy	15.1	16.1	18.3
Heating energy La Rochelle	15.0	15.6	17.3
Heating energy Nice	14.8	15.4	16.7
Useful cooling Nice	4.9	4.9	4.9
Nice combined	19.7	20.2	21.6

Savings in terms of the heat and cooling requirement						
	Building: [%]		**Building: [kWh/(m^{2}a)**		**Linear metres: [kWh/(m^{2}a)]**	
	SWS U vs stainless steel	**SWS U vs aluminium**	**SWS U vs stainless steel**	**SWS U vs aluminium**	**SWS U vs stainless steel**	**SWS U vs aluminium**
Nancy	6.1%	17.7%	1.0	3.2	1.5	4.9
La Rochelle	4.2%	13.3%	0.7	2.3	1.0	3.5
Nice	2.7%	8.8%	0.5	1.9	0.8	2.9

Savings in terms CO2 equivalent						
	Building: [kg CO2-eq/a]		**Building: [kilometres of driving/a]**		**Linear metres: [kWh/(m^{2}a)]**	
	SWS U vs stainless steel	**SWS U vs aluminium**	**SWS U vs stainless steel**	**SWS U vs aluminium**	**SWS U vs stainless steel**	**SWS U vs aluminium**
Nancy	25.3	88.3	212.2	700.4	0.4	1.3
La Rochelle	17.1	59.5	143.9	499.8	0.3	0.9
Nice	14.3	49.7	120.5	417.7	0.2	0.8

Monetary savings (cash value)				
	Building: [€ in 40 years]		**Per linear metre: [€ in 40 years]**	
	SWS U vs stainless steel	**SWS U vs aluminium**	**SWS U vs stainless steel**	**SWS U vs aluminium**
Nancy	269	887	4.1	13.4
La Rochelle	182	631	2.7	9.5
Nice	131	455	2.0	6.9