

CLIMATE ANALYSIS

WOODEN WINDOW VS WOODEN/ALUMINUM WINDOW

Calculation and comparison of the climate impact on
aluminum cladding compared to repainting wooden windows

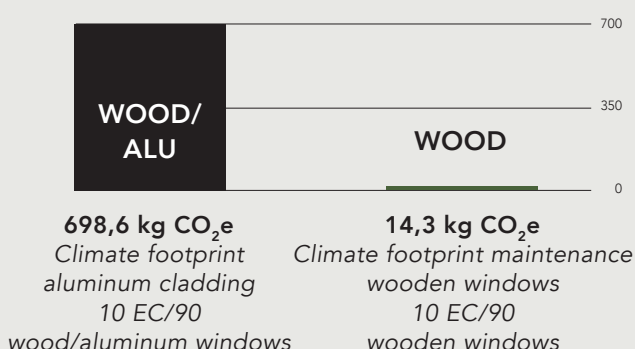


BACKGROUND

This report is a literature study and LCA screening performed by Eco Now, the study is third-party reviewed. The customer is Ekstrands, who wanted a compilation and comparison of the climate footprint between a wooden window and a wooden/aluminium window from a life cycle perspective. The study does not take into account the total climate impact of the product, but only the difference between aluminum cladding and the maintenance of a wooden window during a life cycle. The study focuses on the difference in climate impact expressed in carbon dioxide equivalents. Ekstrands does not take a position for or against any type of window, Ekstrands has a wide range of both wooden windows and aluminum clad windows in the range. The study is purely informative to highlight the CO₂ aspect when choosing of different window types.

SUMMARY

The goal of this study was to clarify about a wooden window without aluminum cladding has a lower climate footprint than wooden windows clad in aluminum from a life-cycle perspective. The aluminum cladding means that the window is "maintenance-free" and does not need repainting, while wooden windows from Ekstrand without aluminum need to be repainted every 10 years at the earliest. The result has been divided into different scenarios depending on the proportion of recycled aluminum included, as well as a summary that also includes variations depending on the number of windows that are repainted. The conclusion shows that regardless of the scenario, there is an overwhelming advantage to the wooden window. EC/90 wood has a footprint of 1.34 kg CO₂e per window for all its repainting during the estimated lifetime + approx. 225 grams of CO₂e per brush used (as a rule one brush per repainting, 4 brushes over a life cycle of 50 years), while the aluminum cladding for Ekstrand EC/90 wood/alu has a total footprint (including powder coating) of 69.86 kg CO₂e. The conclusion is that a wooden window without aluminum cladding is almost 50 times better in this respect (14.3 kg and 698.6 kg, respectively, calculated on 10 windows over a life cycle of 50 years). The reason is simply that aluminum has a higher climate footprint than paint, and that relatively little paint is needed to repaint a window. The study is not an LCA and cannot reflect an exact footprint, but gives a well-claimed indication.



IMPLEMENTATION

This study is based on windows in Ekstrand's own production of wooden windows EC/90 and windows EC/90 wood/aluminium. However, we have included some different scenarios depending on where the aluminum is manufactured and to what extent recycled aluminum has been used. The reason for this is that the climate impact of metals differs depending on where in the world it is manufactured and what percentage of recycled material is included. The aluminum Ekstrands uses is produced in Poland, of which 2% is recycled material according to the manufacturer. The basis of the windows' structure is the same, so only the parameters that differ are what this study focuses on. The study thus does not show the window's total climate footprint, only the differences between aluminum vs repainting. The study is divided into

a section describing the wooden window's climate footprint regarding repainting, a section on the aluminum window's climate footprint and a summary. The dimension of the window in the calculation is 1280x1430 mm according to EN14351-1.

The lifespan of a window has been set at 50 years (see also delimitation & uncertainty below) and the maintenance intervals for painting wooden windows at 10 years. The study has focused on producing an average climate footprint calculated per window, but the summary also states a scenario where 10 windows are repainted. A medium-sized villa has about 20 windows, a smaller terraced house has from 10 windows and up. We have chosen to compare the smallest example.

DEMARCATIION & UNCERTAINTY

No EPD or LCA for the exact color used or on the exact aluminum cladding Ekstrands uses has not been available. An exact calculation is therefore not possible, but by calculating each component's material consumption and the general climate footprint from these materials and comparing with data from EPD and LCA of equivalent products, we get a well-founded opinion. This is called secondary data, primary data is used when it is available and then refers to the exact climate footprint of products or components. Glossary at the end.

The aluminum cladding has some screws and plastic fittings that attach the fittings, these are not included but are considered to be of negligible importance from a comparative perspective between the two different types of windows. Variations regarding freight between the two different windows have also not been included, partly due to insufficient facts, partly because they have not been deemed to be significant from a comparative perspective.

Here it may be appropriate to clarify that in a life cycle analysis, shipping is usually always an essential item to count on, but this study only focuses on comparing the climate footprint between the two types of windows. An aluminum window weighs more than a wooden window and, of course, at some point in the process, a delivery of the aluminum is made for the actual production, while the wooden window has a delivery of the paint for each

repainting, as well as the brush that reasonably needs to be purchased for each occasion. The difference in the climate footprint of these deliveries between the windows has thus not been judged to entail any significant variable.

The assumption of lifespan per repainting (10 years) is based on Ekstrand's own data. Lifespan may vary depending on location and exposure. Coastal areas, for example, usually result in higher wear and tear.

The lifetime assumption of windows varies between different manufacturers and sources. Theoretically, windows can last a very long time, some sources for aluminum clad windows indicate a lifespan of over 70 years¹.

In reality, however, a window has components such as fittings that usually have a significantly shorter lifespan. According to Ekstrand, customers usually change windows if the fittings give up, which is why Ekstrand believes 30 years is a more realistic picture. In this regard, the insurance industry is a good source to compare producers' estimates with, and Länsförsäkringar² has 50 years as an average for windows. ICA reinforcements, which are the source above, indicate around 70 years. The real estate newspaper, in turn, states 40 years³. In this study, we have chosen to start from 50 years. If we instead count on 30 years, the calculation will be even more in favor of the wooden window.

¹ <https://www.icaforsakring.se/tips-rad/hus-och-hem/sa-lang-livslangd-har-de-olika-delarna-i-ditt-hus/?dref>

² <https://mb.cision.com/Main/152/2844777/1065552.pdf>

³ <https://fastighetstidningen.se/ratt-fonster/>



CLIMATE IMPACT REPAINTING OF WOODEN WINDOW EC/90

THE CONDITIONS OF THE WOODEN WINDOW

The wooden window without protective aluminum needs to be repainted at regular intervals. An assumption based on Ekstrand's own data estimates that figure to be every 10 years, but it can be both longer and slightly shorter depending on exposure (Ekstrand's is the only Scandinavian manufacturer that provides up to a 10-year unconditional guarantee on the color film). The customer usually repaints the windows himself on site, but orders the color from Ekstrands. Transport of paint from Ekstrands to the customer has not been included. It gives us a scenario where 4 repaintings are done by the customer during the window's lifespan of 50 years. The visible surface of the EC/90 wooden window is 0.517 m^2 , but the liner/sneak hides some of the surface so the surface that is actually painted if has been calculated by Ekstrand to be 0.477 m^2 .

HOW MUCH PAINT IS USED?

The color product used in Ekstrand's windows is called Aqua top. Data on color consumption for this exact color in hand-ironing quality is missing, but according to Ekstrand, there are two equivalent products, one of which states $3\text{-}6 \text{ m}^2 / \text{liter}$. Ekstrand has a similar paint product where hand ironing quality is stated at $6\text{-}8 \text{ m}^2 / \text{liter}$ of paint. We have started from an average value of these data, which then shows that one liter of paint then covers 5.5 m^2 .



WASTE

It is rare that a customer only has one window to paint, if that were the case, you would probably have to count on a whole 1 liter can of paint per window. The color can theoretically last until it's time for the next repainting, but that would still mean a big waste as one paint application is enough for much more than just two windows. However, this study does not aim to calculate what the climate footprint is for repainting just one window, as it is a scenario that as a rule never occurs. But in a comparison between two different types of windows, it is easiest to enter the calculations based on a common unit and this is set to climate footprint per window - which is therefore not the same as calculating the climate footprint to repaint only one window.

When we thus calculate a waste factor, this constitutes an estimated average per repainting. Hand painting has a relatively high waste factor as you also need to take into account that the volume of the paint can rarely be adapted exactly to the need.

In this study, we have assumed 15% spillage, which, rounded off, means that one liter of paint is enough to repaint $4,675 \text{ m}^2$ of surface.



4,675 m²
with 1 liter paint



0,477 m²
painted surface /
window



0,102 L
used paint / window

CLIMATE FOOTPRINT PAINT

According to Ecoinvent⁴, the general climate footprint for water-based paint is 2.43-3.3 kg CO₂e / liter of paint. In the LCA and EPD on similar colors we have included for comparison, the unit used varies, some count m² of painted surface, others in kg weight or volume in liters. Recalculated, the climate footprint then varies between 1.83-6.56 kg CO₂ / liter of paint (figure 1). Imprints of around 6 kg are, however, highly unusual, which is

why we have chosen to start from the top range from Ecoinvent for this study. That is, 3.3 kg CO₂e per liter of paint.

The climate footprint per 1 application of color of EC/90 wood is thus 0.336 kg CO₂e (3.3 / (4.675/0.477)). During a lifetime of 50 years, 4 repaintings are needed, which gives a total impression color of: 1.34 kg CO₂.

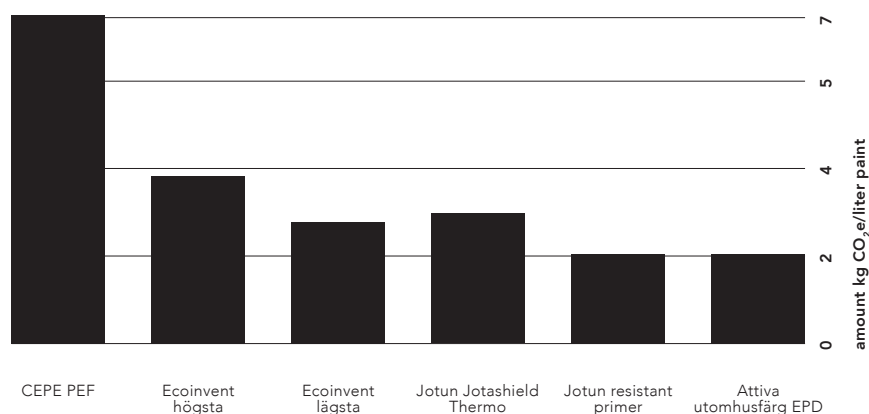


Figure 1
COMPARISON
DATA OF CLIMATE
FOOTPRINT
FROM COLOR

BRUSH

We also assume that 1 paintbrush is used per repainting. A brush weighs about 100 grams and primarily consists of a wooden or plastic handle. No EPDs for paint brushes have been found, but in order not to exclude this element, we have calculated the average climate footprint for plastic, which is between 1.8 - 2.7 kg CO₂e⁵. The average is 2.25 kg CO₂e, which means that 1 brush according to this method of calculation gets a climate footprint of 225 grams of CO₂e. 4 repaintings thus means that the brushes get a complete reprint 900 grams of CO₂e. This gets slightly confusing when paint is counted per window and with 4 repaints, while brushes are only counted per repaint (you can't use one brush per window). We therefore have to use the formula 1.34 per window + 0.9 (for the brushes). This formula works for so long 1 brush per repaint is enough.

⁴ Databas för produkters klimatavtryck. Se ordförklaringslista och källförteckning i slutet.

⁵ LCA av två plastförpackningar, Recycling.se

CLIMATE FOOTPRINT 1 LAYER OF PAINT



0,336 kg CO₂e
climate footprint paint



0,225 kg CO₂e
climate footprint 1 brush

The climate footprint per 1 layer paint thus becomes **0,336 kg CO₂e**.

Calculation formula kg CO₂e for 1 application
EC/90 wood:

3,3 kg CO₂e/l paint
÷ 9,8 window/l paint (4,675m²/l ÷ 0,477m²/window)
= 0,336 kg CO₂e

WOODEN WINDOWS



CLIMATE FOOTPRINT ESTIMATED LIFETIME OF 50 YEARS



**50 YEARS
LIFETIME**



4 REPAINTS



1,34 kg CO₂e
*Climate footprint paint
per window*



0,9 kg CO₂e
*Climate footprint brush
4 repaints*

During a lifetime of 50 years, 4 repaintings are needed
which gives a total impression of color: **1,34 kg CO₂e / window.**
Calculation formula kg CO₂e for 4 repaints EC/90 wood: 1,34 / window + 0,9.
4 repaints on 10 windows: 13,4 + 0,9 =14,3 kg.

CLIMATE FOOTPRINT ALUMINUM WINDOWS

Aluminum has large variations in climate footprint depending on the proportion of recycled material and where in the world the aluminum is manufactured. See figure 2. The energy consumption for virgin aluminum is much higher than for recycled, which is why where in the world the virgin part of aluminum is manufactured is of great importance for the climate footprint. As an average, recycled aluminum has a climate impact of 1 kg of CO₂ e per kg of material⁶, but usually only a small percentage of recycled aluminum is included.

The variation in climate footprint from virgin manufacturing of aluminum differs all the more. Ekstrand's aluminum cladding is manufactured in Poland and Polish aluminum has a stated climate footprint of 16 kg CO₂ e per kg aluminum.¹ However, the global average value is 11.5 kg CO₂ e per kilogram aluminum⁷ which is the value we have for our other scenarios.



HOW MUCH ALUMINIUM?

The weight of the aluminum cladding of the Ekstrand opening window is 4.37 kg. As explained above, it matters a great deal what proportion of recycled aluminum is included and in which country the aluminum is produced. Here we have considered three different scenarios.

Scenario 1 is based on 2% recycled aluminum which is made in Poland as this reflects Ekstrand's own EC/90 wood/alu. This means that scenario one only contains 87.4 grams of recycled aluminium.

Scenario 2 assumes 40% recycled aluminium. This scenario is just a calculation example of how material

the composition could look like in the future. Since scenario two is not attributed to a specific producer or country, we are based here on the global average of 11.5 kg CO₂ e, per kg aluminium. This includes 1.75 kg of recycled aluminum in one window (40% of 4.37 kg).

Scenario 3 we finally count on 75% recycled aluminum which is the highest guaranteed amount of recycled aluminum in production we have encountered. Here we have an exact reference value from the supplier Norska Hydro, which states the total climate footprint of their aluminum at 4 kg CO₂ e, per kilogram of product⁸ (so the climate footprint of recycled and virgin aluminum in total).

⁶ Metaller och deras betydelse för produkters klimatavtryck 2018 /073

⁷ Aluminium insider Mars 2021

⁸ Hydro.com

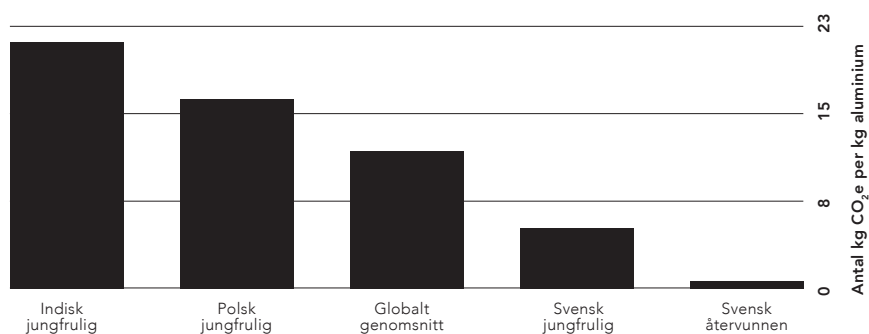


Figure 2

JÄMFÖRELSE

DATA OF CLIMATE FOOTPRINT
FOR ALUMINIUM

ALUMINIUM PRODUCED IN POLEN



16 KG CO₂e/kg aluminium

GLOBAL AVERAGE



11,5 KG CO₂e/kg aluminium

SWEDISH RECYCLED ALUMINIUM



1 KG CO₂e/kg aluminium

COMPILATION CLIMATE IMPACT

ALUMINUM CLADDING EC/90

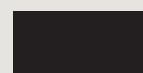
(RAW ALUMINUM EXCL. POWDER COATING)



SCENARIO 1
68,60 kg CO₂e
per window



SCENARIO 2
31,90 kg CO₂e
per window



SCENARIO 3
17,48 kg CO₂e
per window

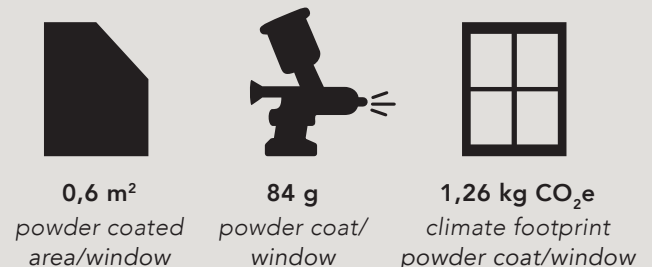
POWDER COATING OF ALUMINUM WINDOWS

Finally, the aluminum cladding is also painted, this is powder coated and should not need to be repainted. As reference data for the climate footprint from powder coating, we have used an EPD⁹ of a similar product - Interpon D1000. The EPD for this product states a climate footprint of 15 kg CO₂ e per kg paint color. To calculate the paint consumption, we have used an average value¹⁰ which shows that a 100 micron thick

layer via spray gun is between 120-140 grams of paint per square meter of painted surface. According to information, EC/90 alu has a 75 micron thick layer, of which we have assumed the higher value. The estimate can then be considered to include consideration of margin of error and spillage. The spillage factor via powder coating is very low compared to hand application.

HOW LARGE AREA IS PAINTED?

Ekstrand's EC/90 has, according to Ekstrand, a surface of 0.6 m² which is powder coated. It is then possible to use the above data as a calculation basis for 84 grams of powder coating per window, which gives a climate footprint of 1.26 kg CO₂ e.

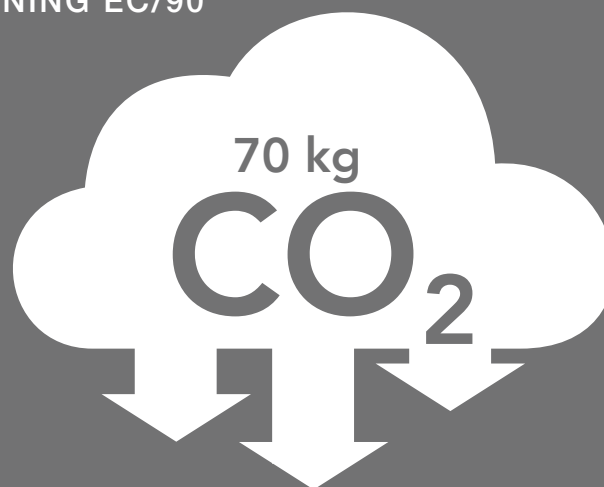


COMPILATION CLIMATE IMPACT ALUMINUM CLADDING WITH POWDER COATING EC/90 PULVERLACKNING EC/90

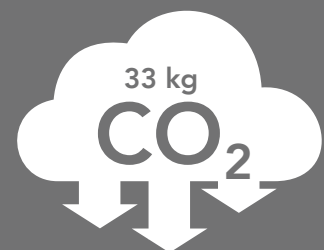
SCENARIO 1
70 kg CO₂e
(69,86 kg CO₂e)

SCENARIO 2
33 kg CO₂e
(33,16 kg CO₂e)

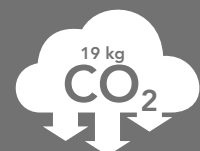
SCENARIO 3
19 kg CO₂e
(18,74 kg CO₂e)



SCENARIO 1
aluminum with
2% recycled material



SCENARIO 2
aluminum with
40% recycled material



SCENARIO 3
aluminium med
75% återvunnet material

HOW MUCH IS A TON OF CARBON DIOXIDE?

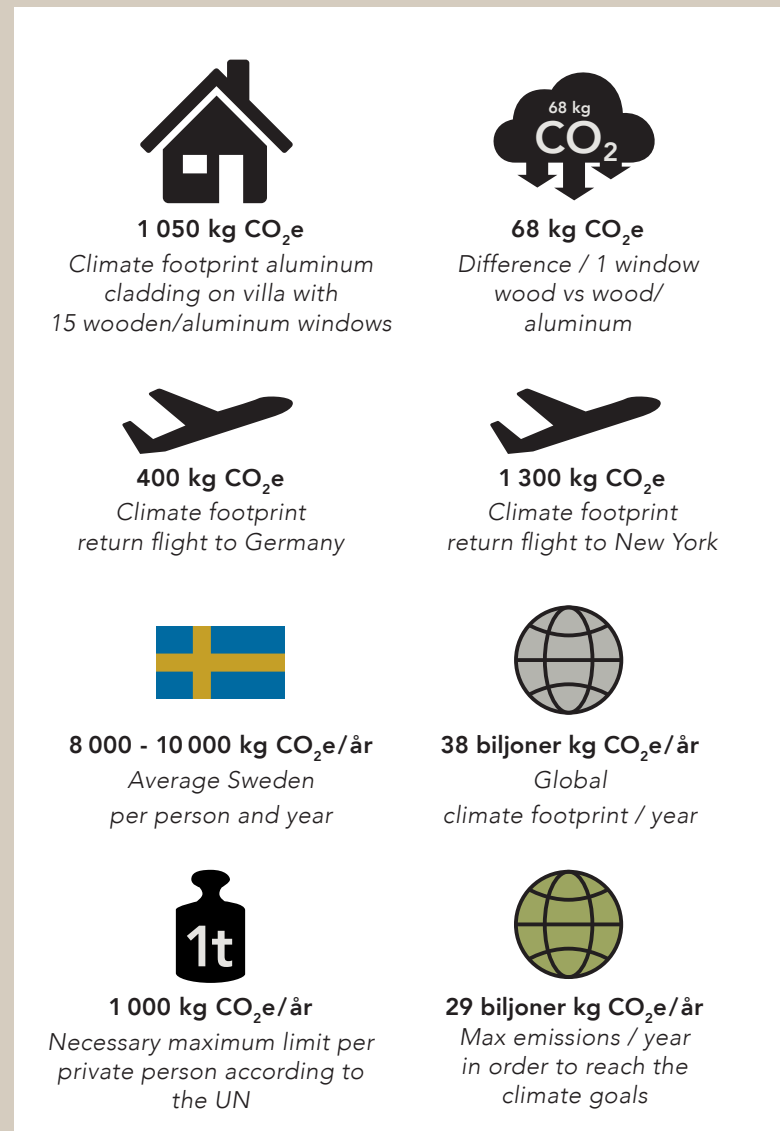
In this context, it may be appropriate to try to give a picture of what a ton of carbon dioxide means. The difference between 1 pc EC/90 Wood and 1 pc EC/90 Wood/alu according to scenario one, approx. 68 kg CO₂e - is it a lot or a little?"

To get a perspective on the matter, it will be easier if we start from how many units are manufactured. About one customer orders 15 EC/90 wood/aluminum windows (small villa or large terraced house), it results in a climate footprint of approx. 1050 kg (70x15) just for the aluminum cladding. 1 ton is the number that the UN climate panel has concluded that private individuals, by 2050 at the latest, should try to stick to as total annual consumption - everything included. In Sweden today, we have an average emission factor of between 8-10 tonnes per person and year, depending on how you calculate.

A round-trip flight to Germany is about 400 kg CO₂, while a round-trip flight to New York is about 2 tons of CO₂. In total, we globally release approx. 38 billion tons per year (2019). According to the IPCC, we can release a maximum of 2900 Gigatons of CO₂ this century¹¹ in order to then have a 66% chance of staying during a global warming of a maximum 2 degree increase.

WHAT A SCENARIO IS MOST RELEVANT?

In the report that the Norwegian Agency for Growth Analysis has made, it appears that aluminum, unlike steel, needs a lot of primary aluminum because there is not that much aluminum in society and because aluminum has a long shelf life. The Swan environmental label states that at least 40% of aluminum in profiles or door leaves must be recycled material, after which an exception is made for "external cladding of external wooden components only for weather protection purposes". What is meant here is precisely the aluminum cladding on windows, according to Svanen, this aluminum profile must have 100% virgin aluminium. Ekstrand's own supplier of aluminum profiles has stated that these consist of 2% recycled material. Ekstrands has also contacted other aluminum suppliers



but was unsuccessful obtain information about the percentage of recycled aluminum that is included in their extruded profiles. It is therefore not possible to say with certainty which scenario is most relevant, but there is good reason to believe that the proportion of recycled aluminum on many window profiles consists of a very small proportion of recycled material.

Another aspect of aluminum window profiles in particular is that a majority of these extruded profiles are powder coated. This means that you must first burn off the paint before the aluminum profile can be recycled, extensive flue gas cleaning is required during this recycling. In addition to CO₂, there are many other environmental aspects, but we will take these not taken into account in this analysis.

¹¹ <https://www.airclim.se/hur-mycket-m%C3%A5ste-utsl%C3%A4ppen-minska>



SUMMERY

Ekstrands EC/90 wooden windows have an average climate footprint of 1.34 kg CO₂e per window for its maintenance via repainting over the estimated lifespan of 50 years + 900 grams CO₂e for the brushes. The brushes thus have very little importance for many windows, but a greater importance for single windows. 10 windows thus have a total climate footprint for their repainting of 14.3 kg including brushes (10 x 1.34 + 0.9). See Figure 3.

MATCHES ESTIMATE WITH REALITY?

Should we apply our average data to an actual scenario, we can take the example of 10 windows. With the waste factor we have calculated (15%), this means that one liter of paint is just not enough for 10 windows (9.8), so in reality, in the scenario of just 10 windows, one can would probably be just enough, or you would have to buy 2 cans, where can two is almost completely wasted. Color is difficult to dimension that way.

SO HOW BIG IS THE DIFFERENCE IF WE INSTEAD COUNT PER OPENED CAN OF PAINT?

If one liter of paint is enough, it will be 3.3 kg CO₂e (the climate footprint for paint) x 4 repaintings + 1 brush = 14.1 kg CO₂e (13.2 kg + 0.9 kg), thus a marginal difference

compared to our average value which was 14, 3 kg of CO₂. But if 10 windows mean that 1 can is just not enough and we have to buy 2 cans per repainting instead, the footprint will instead be 27 kg CO₂e (27.3 kg).

Compared to EC/90 wood/alu, the aluminum cladding still has a much higher climate footprint, but it illustrates well that it is difficult to set a formula that works in all scenarios to reflect an exact footprint. 10 pieces of aluminum cladding with 2% recycled aluminum gives, for example, a footprint of 698.6 kg. So about 48 times as big an impression as a can of paint enough and 25 times as big an impression if we have to use 2 paint cans.

It is clear that regardless of the scenario, the wooden window has a much lower climate footprint than wood/aluminum (figure 4) but also that it entails a large saving in climate footprint if you use recycled aluminium. Here it is important to point out that although there are producers who offer a high proportion of recycled aluminium, the supply is limited.

Today, in 2021, recycled aluminium makes up about 30% of global production¹² and the industry expects to reach 50% by 2050.¹³

Figure 3

REPAINTING WOODEN WINDOWS CLIMATE FOOTPRINT 50 YEARS

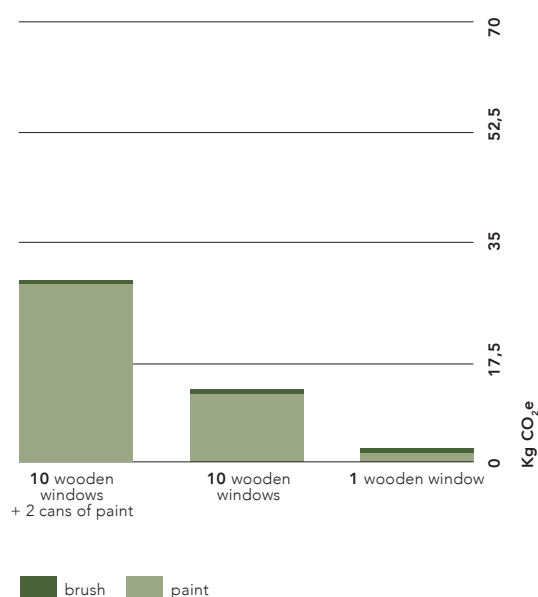
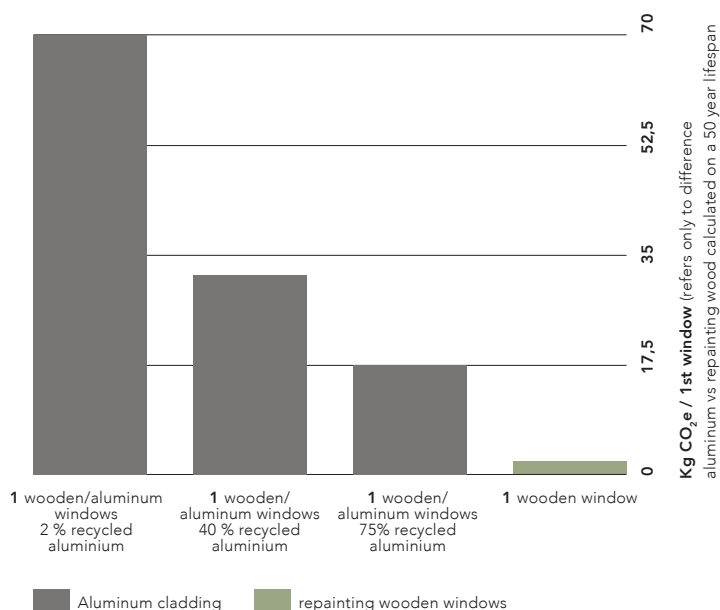


Figure 4

ALUMINUM CLADDING VS REPAINTING WOOD CLIMATE FOOTPRINT 50 YEARS PER 1 WINDOW



12 https://www.world-aluminium.org/media/filer_public/2013/01/15/f0000181.pdf

13 <https://www.metalbulletin.com/Article/3990886/Recycled-aluminium-could-meet-50-of-demand-by-2050-IAI-says.html>

GLOSSARY LIST

CO₂e

Abbreviation for carbon dioxide equivalents. Can also be abbreviated CO₂ eq. There are several different gases that contribute to global warming. Carbon dioxide is only one of these gases. CO₂ e means that you have summed up all these climate gases in a common footprint = CO₂

IPCC

The United Nations Climate Panel, IPCC, is an intergovernmental organization established in 1988 by two UN agencies, the World Meteorological Organization and the UN Environment Programme.

EPD

EPD stands for Environmental Product Declaration and is a verified and registered document with transparent and comparable information about a product's climate and environmental impact drawn up according to a certain standard.

LCA /LCA SCREENING

Life cycle analysis or life-cycle assessment is a method for achieving an overall picture of how big the total environmental impact is during a product's life cycle from raw material extraction, via manufacturing processes and use to waste management, including all transport and all energy consumption in between. LCA screening is a simplified LCA report, often a preliminary study and overview of the climate impact of various components.

ECOINVENT

Ecoinvent is a database for studies and analyzes based on LCA from ISO 14040 and 14044.

SOURCE LIST

LIFE CYCLE ANALYSIS OF TWO PLASTIC PACKAGES

<https://www.diva-portal.org/smash/get/diva2:1230012/FULLTEXT01.pdf>

METALS AND THEIR IMPORTANCE FOR PRODUCTS' CLIMATE FOOTPRINT

<https://www.tillvaxtanalys.se/download/18.62dd45451715a00666f1c3c1/1586366166371/Metaller%20och%20deras%20betydelse%20för%20pro-duktors%20klimatavtryck.pdf>

ALUMINIUM INSIDER MARCH 2021

<https://aluminiuminsider.com/leaders-emerge-in-the-aluminium-industrys-race-to-zero-carbon/>

THE RECYCLING INDUSTRIES

<https://www.recycling.se/klimat/>

VSEVSPA

<https://vsevspa.ru/sv/pokraska/norms-of-consumption-of-powder-paint-are-calculated-by-the-formulas-requirements-for-powder-paints/>

EPD INTERNATIONAL

<https://www.environdec.com/home>

ECOINVENT

<https://www.ecoinvent.org/>

LCA PAINT

<https://www.diva-portal.org/smash/get/diva2:1551014/FULLTEXT01.pdf>

HYDRO. CLIMATE SWITCH HYDRO'S ALUMINIUM

<https://www.hydro.com/en/about-hydro/stories-by-hydro/meet-your-sustainability-goals-with-low-carbon-aluminium>

ekstrands.com



Södra Portgatan 19
283 50 Ösby
Tfn 0479-100 40
info@ekstrands.com