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Environmental impact for steel- and wooden doors in a life cycle perspective

A summary of Environmental Product Declarations and additional analysis

Commissioned by Daloc AB

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This report has been reviewed and approved in accordance with IVL's audited and approved management system.

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Introduction

The Daloc group develops, manufactures and markets steel- and wooden doors. The group is comprised of Daloc AB and Daloc Trädörrar AB among others. These two entities have developed and published one Environmental Product Declaration (EPD) each for steel doors and wooden doors respectively in order to communicate the environmental performance of their products. The EPDs are published at the International EPD® system, see:

- Steel door: https://www.environdec.com/Detail/?Epd=14470
- Wooden doors: https://www.environdec.com/Detail/?Epd=14469

In addition to these EPDs, one non-public background report was written which is mandatory when carrying out an EPD according to the International EPD® system. The report is more detailed than the EPDs regarding for instance assumptions, data use and additional information. Based on that report Daloc wishes to share parts of the content including a more elaborate analysis of the results. Thus, the purpose of this report is to be able to broaden the EPD with important issues which can be communicated together with the EPDs to Daloc´s stakeholders. The result will however only focus on climate change effects, caused by climate impacting gases.

Environmental Product Declaration (EPD)

Background

In an Environmental Product Declaration (EPD), the environmental performance of a product or a service is presented for the entire life cycle or part of the life cycle. Life cycle phases are for example extraction and production of raw materials, manufacturing of product, transports and waste management. In the EPD, environmental impacts are analyzed and presented based on resources used, emissions and waste occurring along the life cycle covered.

IVL Swedish Environmental Research Institute has carried out the EPDs where Daloc supported during the project with for example data collection and assumptions made. The method Life Cycle Assessment was used for calculating the environmental performance of the steel- and wooden doors. In addition, the methodology used follows the International EPD® system´s General Program instructions version; ver 3.0 of 11/12/2017 as well as PCR 2012:01 Construction products and construction services; ver. 2.2 of 2017-05-30 (Environdec, 2018a, b). These are in line with the international standards for LCA: EN15804, ISO 14025, ISO 14040 and 14044 (CEN 2013; ISO 2006a, b, c).

The results presented are primarily based on one steel door or one wooden door. There are three types of steel doors and four types of wooden doors included in the assessment. Pictures of these are presented in Figure 1 and Figure 2. A description of the door types are given in Table 1.

Table 1 – The door alternatives included in the assessment

Door type	Alternative	Description
Steel door	Alt. 1 – Steel door from carbon steel	The door leaf is made of mild steel from carbon steel with no glass on it. See Figure 1.
	Alt. 2 – Steel door from stainless steel	The door leaf is made of stainless steel with no glass on it. See Figure 1.
	Alt. 3 – Steel door from carbon steel – glass	The door leaf is made of mild steel from stainless steel with a glass sheet on it. See Figure 1.
Wooden door	Alt. 1 – Wooden door with wood frame	The door leaf and the door frame are made of wooden products. See Figure 2.
	Alt. 2 – Wooden door with wood frame – glass	The door leaf and the door frame are made of wooden products. A glass sheet is attached in the door leaf. See Figure 2.
	Alt 3 – Wooden door with steel frame	The door leaf is made of wooden products and the door frame is made of carbon steel. See Figure 2.
	Alt 4 – Wooden door with steel frame - glass	The door leaf is made of wooden products and the door frame is made of carbon steel. A glass sheet is attached in the door leaf. See Figure 2.

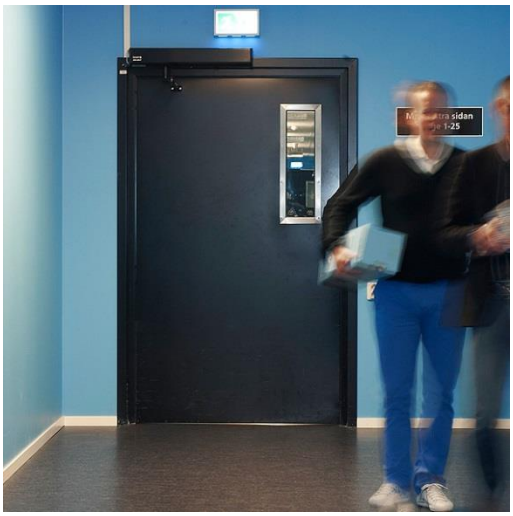

Figure 1 – The steel doors included in the analysis: *Steel door from carbon steel, alterative 1* (top left), *Steel door from stainless steel, alternative 2* (top right), *Steel door from carbon steel – glass, alterative 3* (bottom)

Figure 2 – The wooden doors included in the analysis: *Wooden door with wood frame, alternative 1* (top left), *Wooden door with wood frame – glass, alternative 2* (top right), *Wooden door with steel frame, alternative 3* (bottom left), *Wooden door with steel frame – glass*, alternative 4 (bottom right)

Figure 3 presents an overview of the flowchart for the products. The same figure can be used to illustrate both steel- and wooden doors. The system is connected to the life cycle stages included (A1-A4) in the assessment which is further described below.

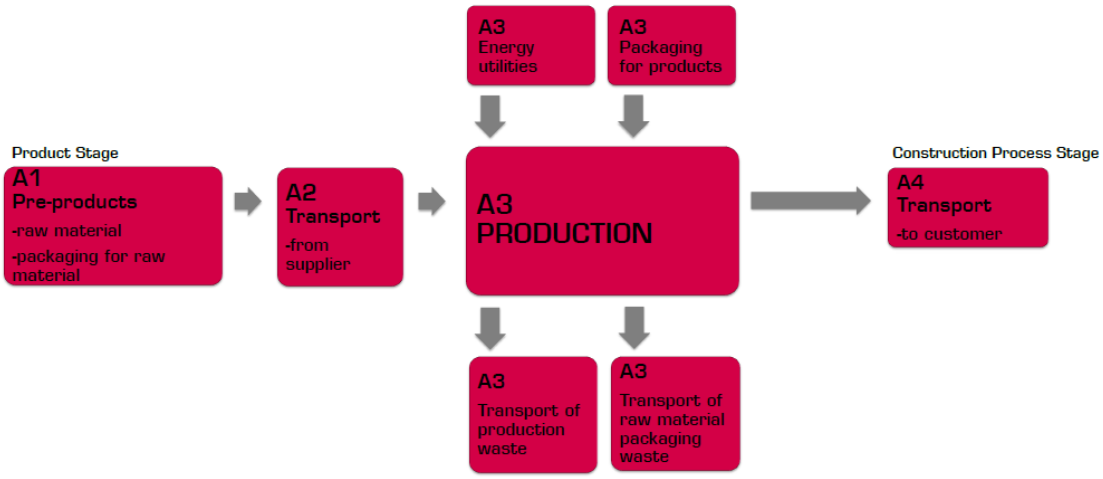

Figure 3 – Overview of the product system.

The EPDs generated are so called cradle-to-gate with options as described in the PCR used (Environdec, 2018b). This means that additional life cycle stages except from the mandatory stages A1-A3 may be included in the EPD. Table 2 shows all life cycle stages available in the PCR used.

Several life cycle stages are declared as optional. It is indicated below if a stage is included or not in the EPDs. An "X" means that the stage is included and "MND" (Module Not Declared) means the opposite, see Table 2 .

Table 2 – Included life cycle stages in the study.

Product stage			Construction process stage		Use stage							End of life stage					Resource recovery stage
Raw material	Transport	Manufacturing	Transport	Construction installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction, demolition	Transport	Waste processing	Disposal		Reuse, recycling or energy recovery potentials
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4		D
X	X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND		MND

The life cycle stages included in the assessment are A1-A4 for all products. This mean extraction and production of raw materials with subsequent transport, door manufacturing and transport to Daloc´s customers. This means that the installation phase at the building is not included, neither is the use phase or the waste management phase included.

Life Cycle Inventory (LCI)

In a Life Cycle Assessment, all data used in the modelling is described in the Life Cycle Inventory (LCI). It includes material- and energy resources, emissions, waste, used and generated along the life cycle. This is to meet the requirement of transparency and providing the reader with all

necessary data used in the calculations. All background data used to generate the results are presented in the EPD background report, while an excerpt of it is presented in the EPDs. Thus, this information is not repeated in this section.

Life Cycle Impact Assessment (LCIA)

In the Life Cycle Impact Assessment (LCIA) the resources, emissions and waste mapped in the Life Cycle Inventory (LCI) are transformed to various result/impact categories. The categories included can be found in the EPDs (for steel doors see https://www.environdec.com/Detail/?Epd=14470 and for wooden doors see https://www.environdec.com/Detail/?Epd=14469).

As described in the introduction of this report, the focus is put on climate impact, (impact category *Global Warming potential*). A full list of the result can be found in the EPDs.

The climate change impact is presented in Figure 4. Consideration has not been given to different product life times and different recycling rates.

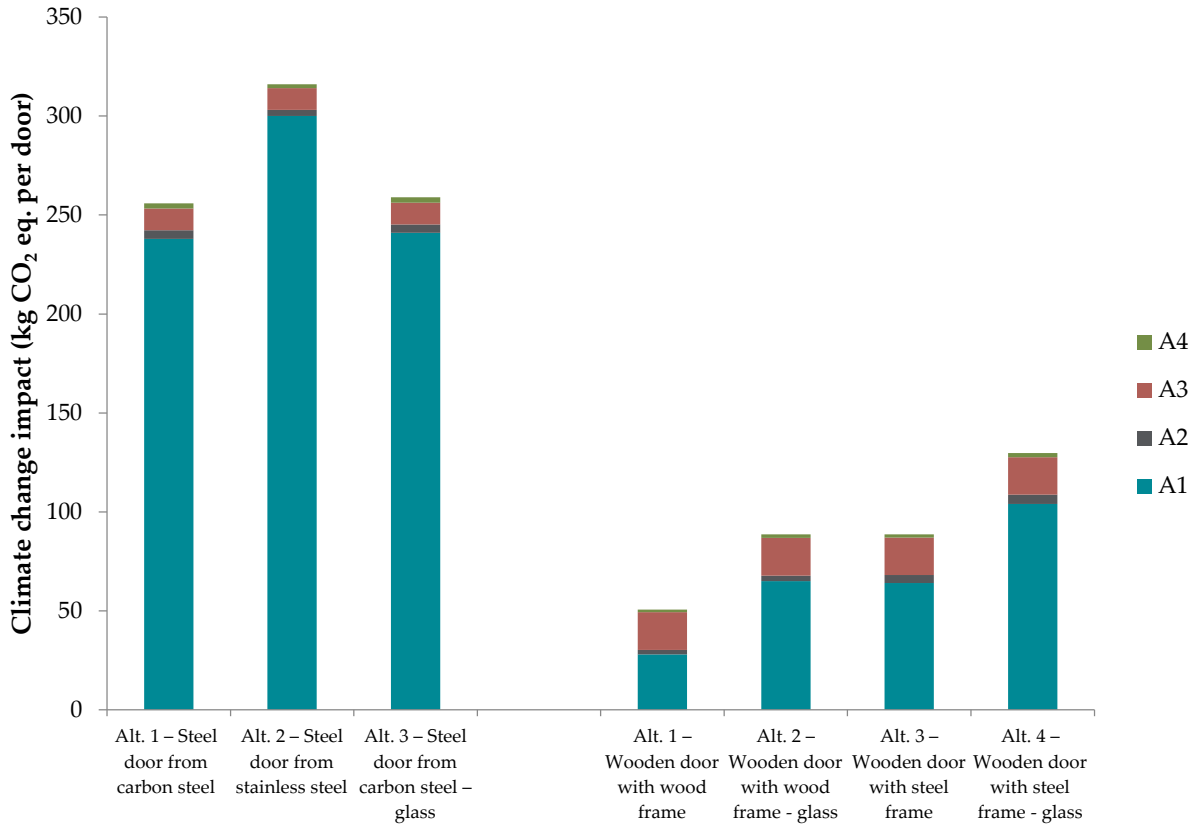

Figure 4 –Climate change for 1 steel door and 1 wooden door delivered to the customer based on the different alternatives. Consideration has not been given to different product life times and different recycling rates.

When studying Figure 4 it can be seen that module A1 (Raw material) is dominating the climate impact. This means that the majority of the impact can be found in the raw material productions. In

order to exemplify this, A1 is subdivided and the raw materials are separately presented, in Figure 5 and Figure 6. The other modules are presented separately or aggregated.

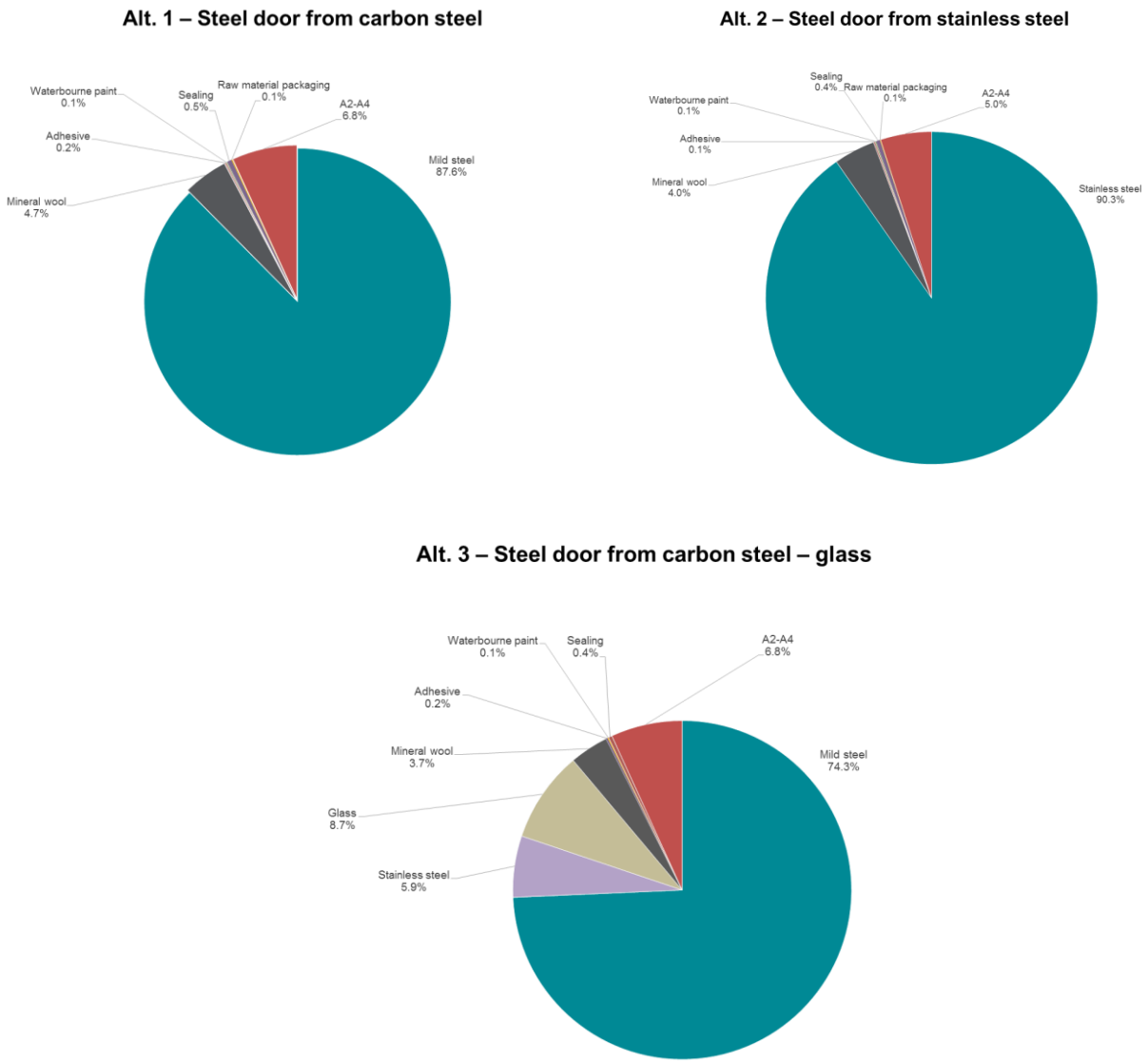

Figure 5 – Climate change impact divided on the different raw material contributors including modules A2 to A4 aggregated for *Steel door from carbon steel* (top left), *Steel door from stainless steel* (top right), *Steel door from carbon steel* (bottom).

The majority of the climate change impact can be derived to the steel production, which is by weight the dominant raw material in the doors. In the third alternative, the impact from the glass gives a significant impact. In general the other modules, A2, A3 and A4 give low impacts to climate change.

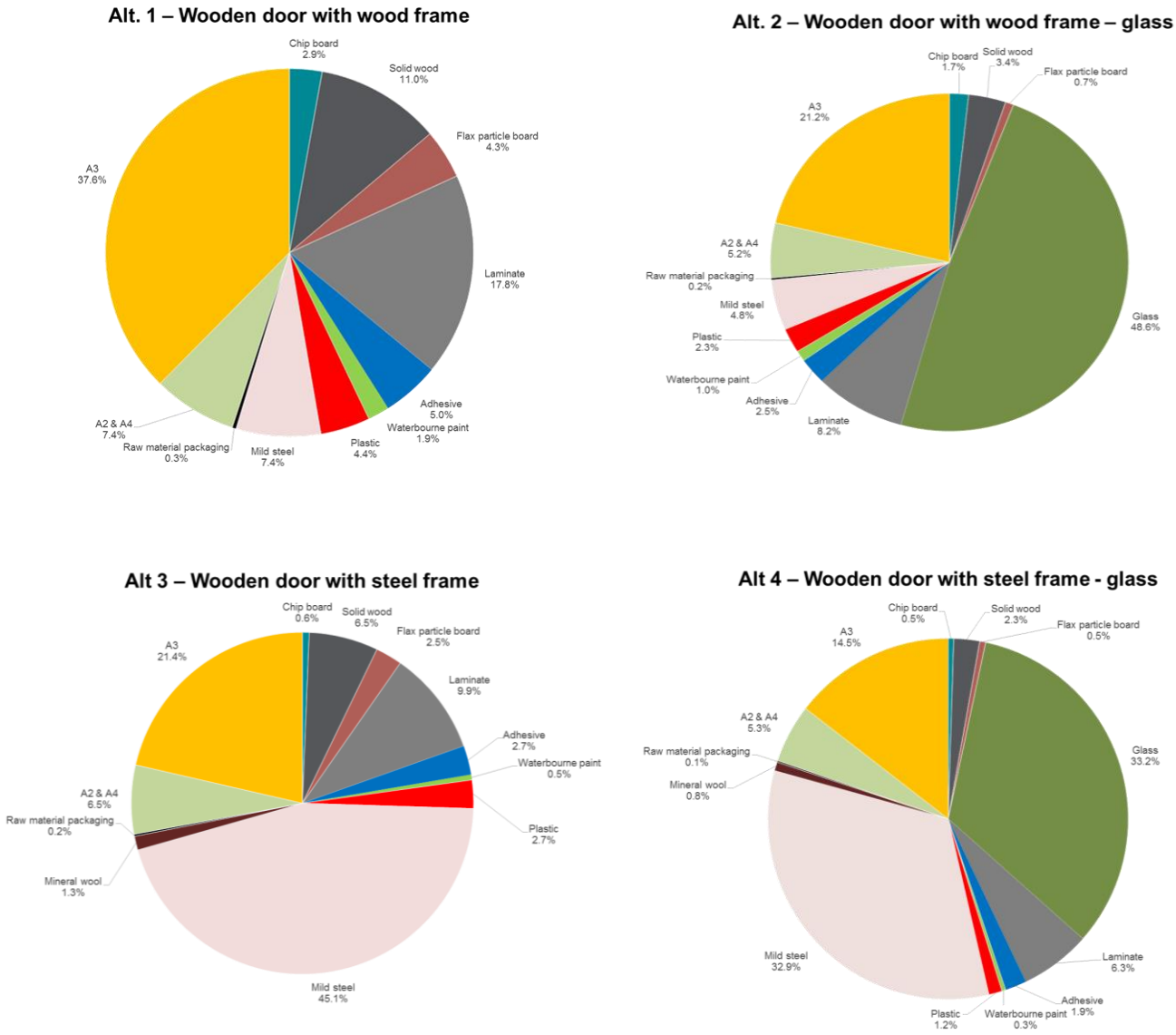

Figure 6 – Climate change impact divided on the different raw material contributors including modules A2 and A4 aggregated and A3 separately for *Wooden door with wood frame* (top left), *Wooden door with wood frame - glass* (top right), *Wooden door with steel frame* (bottom left), *Wooden door with steel frame – glass* (bottom right).

For the wooden doors the climate impact can be derived from several sources. In all alternatives, more than 50% of the impact is related to module A1, raw materials. Steel and glass are major contributors, when included in the products. Also the laminate gives a significant impact. The climate change impact of module A3 is about 15 - 40% of the total impact which is mainly related to the energy production.

Additional analysis of the EPD results

The above sections cover the main content of the published EPDs (notice that the only category covered in above sections is the climate change). To broaden the EPD, two important issues are outlined and discussed in the sections below. This is a complement to the published EPDs and can facilitate the interpretation of the climate impact results from the EPD. The first aspect is to

understand the potential for reducing the climate impact by hypothetically use 100% recycled carbon steel from a recycled product in the steel doors. Currently the recycling rate is 20%. The second aspect is to make a comparison between steel doors and wooden doors based on their lifetimes.

Increased recycling rate for carbon steel in steel doors

Currently the carbon steel used in the steel doors comes partly from steel manufactured in a recycling process and partly from virgin produced steel. The recycled steel content is 20% based on information from Daloc´s steel supplier. Producing steel is an energy intensive process, while producing steel from recycled sources is a less energy intensive process.

Currently, the global demand for steel is growing. Therefore, the steel scrap is only sufficient for a smaller amount of steel production and the rest must be made from iron ore. In the long term, the global demand for steel is expected to meet by remelted steel scrap (Jernkontoret, 2017).

To narrow the assessment, the climate impact is assessed and the steel door *Alternative 1 – Steel door from carbon steel* is examined.

The climate impact in the base case for one door is 256 kg CO_{2e}. As indicated in Figure 5, 87.6% of the impact comes from the carbon steel production. This implies that the climate impact for the steel is 224.2 kg CO_{2e}.

Based on the model calculations the global warming potential for 100% recycled steel is reduced by 55% compared to the original recycling rate.

The difference between the climate impact from virgin and recycled steel is 122.5 kg CO_{2e}. The total impact for the steel door examined is 256 kg CO_{2e}. The hypothetical reduction potential by using steel from 100% recycled sources is about 48% (122.5/256).

Notice that the datasets used in this comparison is based on generic data. This implies that the exact reduction potential is difficult to verify as specific data (for example EPDs on steel) would be necessary for the different steel grades. Whether it is technically possible to use 100% recycled steel in the doors Daloc manufactures is not examined. Also notice that the reduction potential for stainless steel is not examined. This is probably lower due to that average stainless steel consists of a high proportion of recycled material.

Comparison of steel door and wooden door

When comparing different products, it is important to base the comparison on the same functional equivalence meaning that the same function is fulfilled by the products under study. When comparing doors, normally they have different properties affecting for example the performance in terms of durability, fire protection, burglary safety, insulation and life length etc. Based in this, it is difficult to compare a steel door with a wooden door straight away.

Though, assuming the customer accepts the differences in performance and chooses between steel- and wooden doors, the comparison can be fairer. One aspect that can be included in the comparison is the life length of the products. It is estimated by Daloc that the life length of a steel door is twice as the life length of a wooden door, 50 years versus 25 years. To illustrate the comparison by an example, the climate impact is chosen. The impact from the three steel doors and the four wooden doors can be seen in Table 3.

Table 3 – Climate impact for the steel- and wooden doors.

Alternative	Expected life length (years)	Climate impact (kg CO_{2e})	Average Climate impact (kg CO_{2e})
Alt. 1 – Steel door from carbon steel	50	256	276
Alt. 2 – Steel door from stainless steel		315	
Alt. 3 – Steel door from carbon steel – glass		258	
Alt. 1 – Wooden door with wood frame	25	50	89
Alt. 2 – Wooden door with wood frame – glass		89	
Alt 3 – Wooden door with steel frame		88	
Alt 4 – Wooden door with steel frame - glass		130	

Applying the life length of the doors, the impact for the steel door is 5.5 kg CO_{2e} per door and year (i.e. 276 divided by 50). The corresponding impact for the wooden door is 3.6 kg CO_{2e} per door and year (i.e. 89 divided by 25).

If the comparison instead is made between the hypothetical 100% recycled steel and average wooden door (see previous section), the result for the steel door is 2.7[1] kg CO_{2e} per door and year. The result for the wooden door is still 3.6 kg CO_{2e} per door and year.

These comparisons are illustrated in Figure 7.

It should be emphasized that the door installation, use phase and waste management phase are not included in the assessment and the outcome could differ if these phases are included.

[1] 133.5 kg CO_{2e} per door (256-122.5). Divided by 50 years to reach the impact per year.

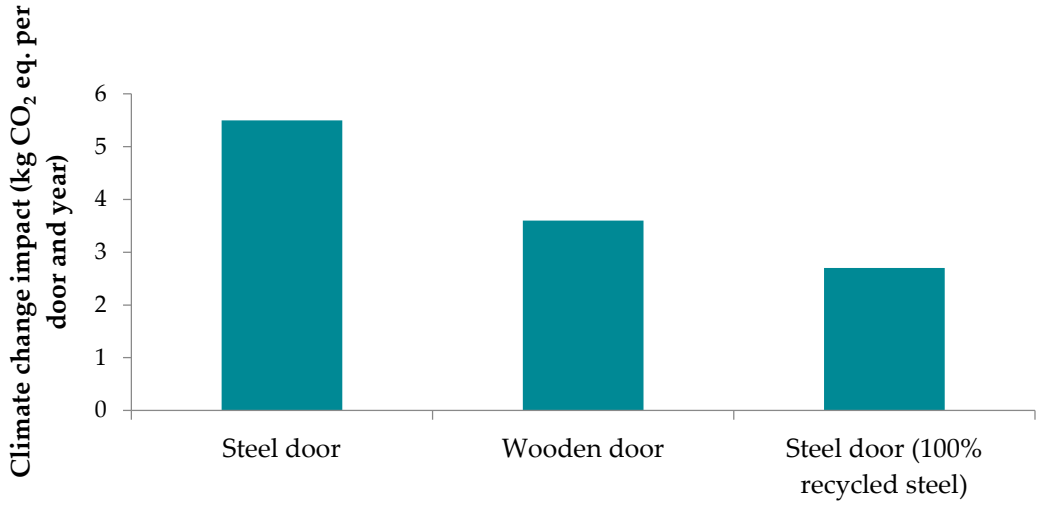

Figure 7 – Comparisons of an average wooden door with an average steel door and a steel door using 100% recycled steel.

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Jernkontoret (2017) Stål formar en bättre framtid.

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