Carbon footprint of Duplicor composites

Executive summary

CE Delft

Committed to the Environment

Carbon footprint of Duplicor composites

Executive summary

Delft, CE Delft, April 2021

Publication code: 21.200359.051

This summary is prepared by: Maarten Bruinsma and Martijn Broeren, CE Delft

Overview

- Duplicor® is a series of novel, partly biobased composites developed by Holland Composites, that can be used in construction and furniture.

- CE Delft analysed the cradle-to-grave carbon footprint of three Duplicor® products for building facades, furniture and flooring.

- The carbon footprint is 45 kg CO_2-eq. for 1 m^2 of Duplicor® facade, 11 kg CO_2.-eq. for 1 m^2 of Duplicor® furniture, and 39 kg CO_2-eq. for 1 m^2 of Duplicor® floor.
  When compared to alternative facades, the carbon footprint of the Duplicor® facade is 2 to 6 times lower.

- The largest contributions to the carbon footprint come from the production of materials (including the Duplicor® *prepreg*) that are used in the Duplicor® products.

- This executive summary provides a high-level overview of the goal, method and results of the analysis. A detailed background report containing full data and modelling details is available at Holland Composites.

1 Introduction to Duplicor®

Duplicor® is a range of novel, partly biobased composites developed by Holland Composites, that can be used for instance in construction and furniture. They are developed around Prepreg (pre-impregnated fibres) made from biobased resin and glass fibre.

This analysis determines the carbon footprint of three Duplicor® products.
The characteristics of these products are provided in Table 1.

Table 1 - Duplicor® product characteristics

	Duplicor® facade panel	Duplicor® furniture	Duplicor® floor element
Weight (kg per m^2)	22.84	4.32	38.36
Thickness (mm)	170	18	300
Composition	Oriented strand board Recycled PET foam Duplicor® resin (biobased) Glass fibre	Recycled PET foam Paper honeycomb Duplicor® resin (biobased) Glass fibre	Oriented strand board Knauf Naturoll glasswool Duplicor® resin (biobased) Glass fibre

Duplicor product description by Holland Composites

Duplicor® facade panel
In today's architecture, facades are an integral part of the street scene. Current facade frames are often made of aluminium or (lightweight) concrete, which is not always possible for timber frames. Duplicor® facade frames can be 75% lighter than aluminium variants at practically the same cost. Complete facade panels can also be realised with Duplicor®.

Duplicor® furniture
Duplicor® gives the freedom of design without boundaries. Paper honeycomb or even flax or jute fibres can be used in combination with the Duplicor® resin to produce 100% biobased furniture. The Duplicor® furniture in this study is made with paper honeycomb.

Duplicor® floor element
Structural floor elements or roof structures can be produced with Duplicor® as well. By combining oriented strand board with fiberglass reinforced Duplicor® resin, the biobased elements can compete with conventional floor & roof structures with the benefit of being environmentally friendlier.

2 Carbon footprint analysis

This study has two goals:
1. Determine carbon footprint of the three Duplicor® products in Table 1, using life cycle assessment (LCA).
2. Comparison of carbon footprint of facade to similar alternatives.

The carbon footprint, expressed in CO_2-equivalents (eq.), refers to the contribution to global climate change due to the emission of greenhouse gases[1]. All results are expressed per 1 m^2.

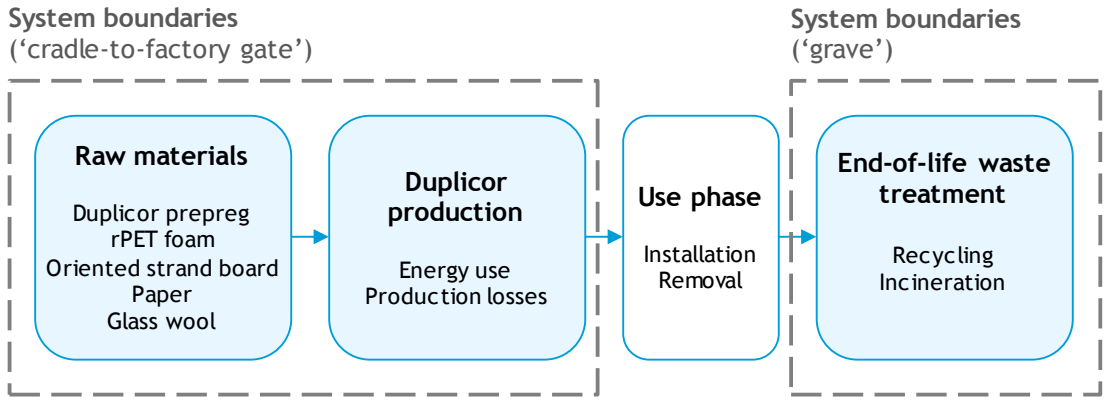
[1] Other environmental impacts, such as toxicity, acidification or particulate matter emissions, can be included in a future expansion of this analysis.

The analysis highlights which materials or parts of the life cycle contribute most the carbon footprint of the Duplicor® products. This enables future optimisations and makes it possible to compare the Duplicor® products to similar alternatives.

Scope

The study scope is cradle-to-grave, meaning all steps from raw material extraction/ cultivation, up to Duplicor® production and end-of-life. This is illustrated in Figure 1.

Figure 1 - System boundaries of the carbon footprint analysis



The system boundaries include all life-cycle phases which are the same for every application. This means the use phase of the products is not included, which covers the installation and removal of the Duplicor® products. The use phase is highly dependent on the way the products are used, which means its carbon footprint is variable.

The fabrication, transport and waste treatment are based on the current situation in the Netherlands.

Data and modelling

The analysis is conducted in line with the *Bepalingsmethode* (Nationale Milieudatabase, 2020). This LCA standard is commonly used in the construction sector in the Netherlands and is based on the European EN15804 norm.

The manufacturing of the Duplicor® products and Prepreg composite is based on data supplied by Holland Composites. This includes the composition of all Duplicor® products and Prepreg variants, energy use, losses during manufacturing and transport of materials.

The production of the materials used in the Duplicor® products is based on background data from literature sources, including Environmental Product Declarations from suppliers, TNO (2014; 2020), Ecoinvent (v3.5, cut-off) and the Nationale Milieudatabase NMD (v3.2). The carbon footprint of electricity use is based on the most up-to-date data of the electricity mix in the Netherlands (CE Delft, 2020).

The waste treatment (end-of-life) of all materials is modelled using predefined waste treatment scenario's from the Bepalingsmethode.

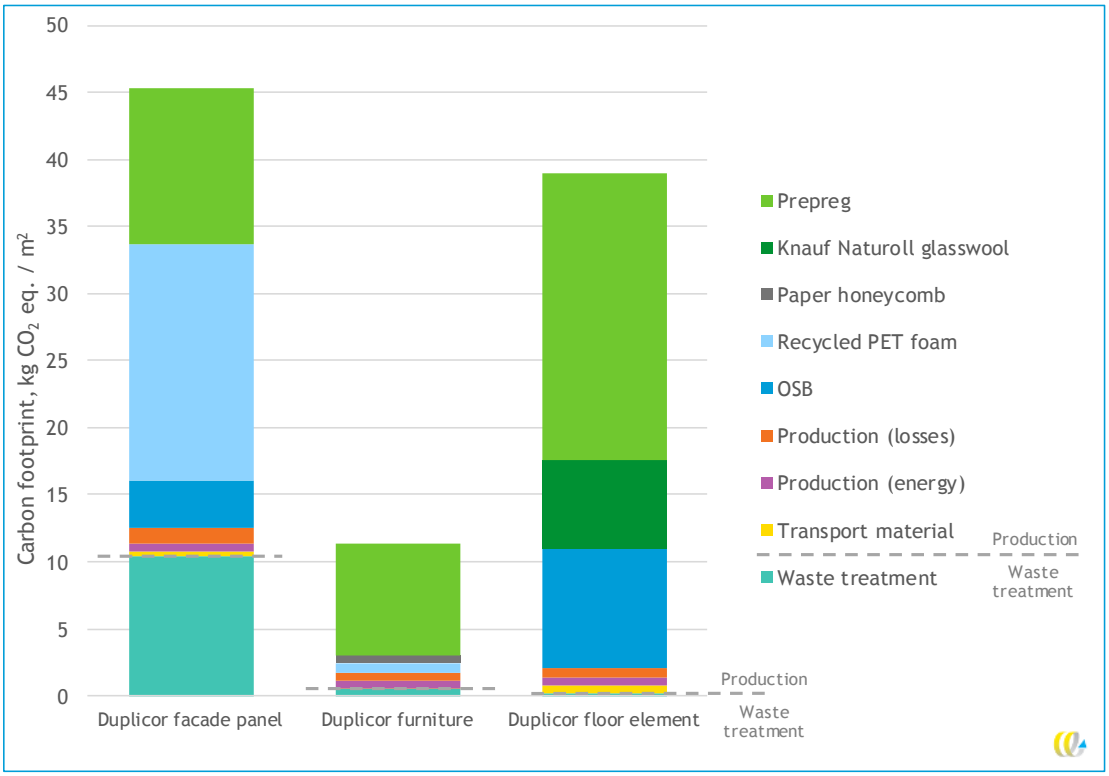
More details on the data and assumptions are available in the background report.

3 Results and interpretation

3.1 Duplicor® carbon footprint breakdown

Figure 2 shows a detailed breakdown of the carbon footprint for 1 m^2 of Duplicor® product.

Figure 2 - Breakdown of the carbon footprint of Duplicor® products (kg CO_2-eq./m^2)



The carbon footprints are estimated at:

- Duplicor® facade panel: 45.32 kg CO_2-eq./m^2
- Duplicor® furniture: 11.35 kg CO_2-eq./m^2
- Duplicor® floor element: 38.97 kg CO_2-eq./m^2

As shown in Figure 2, the carbon footprint for all Duplicor® products mainly comes from the production of their constituent materials. The contribution of the production phase is relatively small for all Duplicor® products. The same is true for the contribution of the waste treatment phase for the Duplicor® furniture and Duplicor® floor element.

The carbon footprint of waste treatment at end-of-life is based on predefined waste treatment scenarios from the Bepalingsmethode, which has a higher uncertainty than the carbon footprint of the materials, production and transport. As such, the carbon footprint of the waste treatment is separated from the remaining carbon footprint of the Duplicor® products in Figure 2 with a dotted line.

The waste treatment of the Duplicor® facade panel, however, is relatively high in comparison to the other studied products. This is due to the fact that this product contains much more recycled PET foam. The reason this results in a higher contribution of the waste

treatment phase, is that 10% of this recycled PET foam is assumed to be lost during the waste treatment of the Duplicor® products. In line with the Bepalingsmethode, this 10% loss of material is calculated as a burden in the waste treatment phase. Even so, the total life-cycle impact (production + waste) of the recycled PET foam is still lower than of virgin PET foam.

A more detailed table with the breakdown of the carbon footprint of all Duplicor® products can be found in Appendix A.

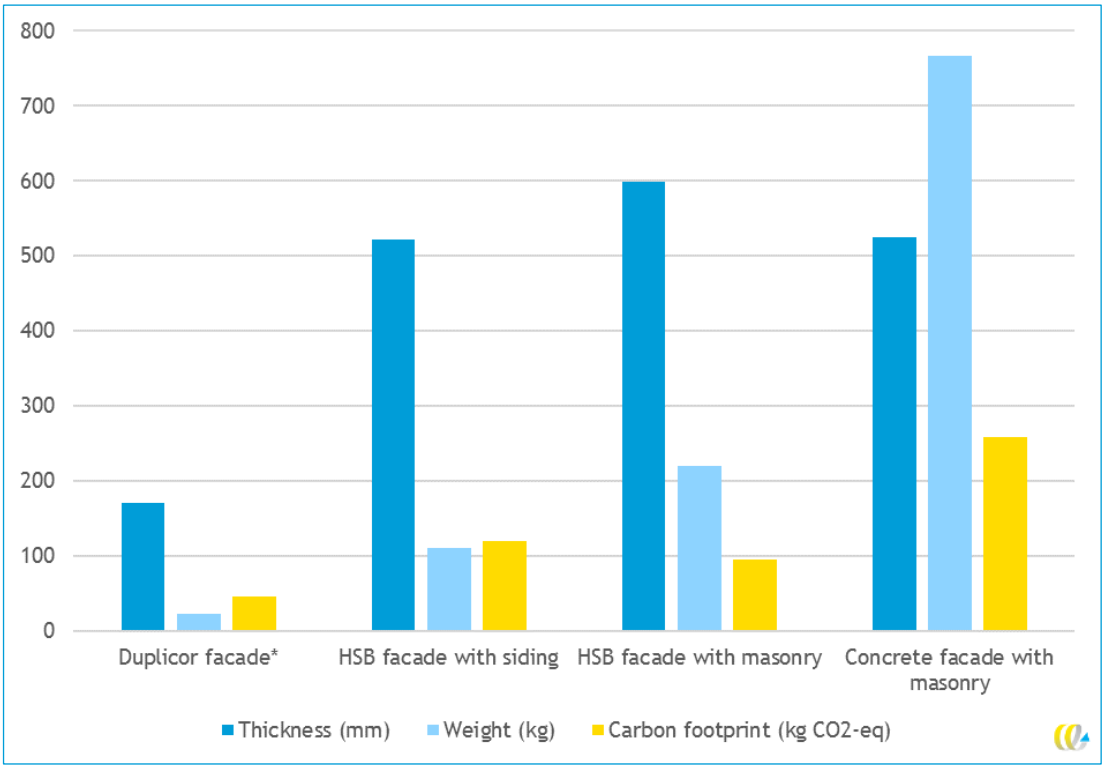
3.2 Comparison of Duplicor® facade to other facade panels

In order to illustrate how Duplicor® products perform in comparison with conventional alternatives on the market, a comparison is made. The Duplicor® facade panel is compared to three conventional facade panels, as described by Holland Composites:

- **Typical isolated HSB facade with siding:** This type of facades consist of glass wool isolated timber frames, with a gypsum board finish and a solid surface facade finish (modelled as 75% rock wool, 25% polyester resin).
- **Typical isolated HSB facade with masonry:** Like the HSB facade with siding, this type consists of a glass wool isolated timber frame, but is finished with bricks instead of siding.
- **Typical concrete facade with masonry:** This facade is made out of concrete (90% concrete, 10% rebar) and contains PIR HR insulation foam. The outside finishing is done with a brickwork layer.

The four facade panels are compared on thickness, weight and carbon footprint in Figure 3 (thickness (mm), weight (kg) and carbon footprint (kg CO_2-eq./m^2) are all shown on the vertical axis). The Duplicor facade panel performs better in all comparisons. Its thickness is 3 to 4 times lower, the weight about 5 to 30 times lower and the carbon footprint 2 to 6 times lower.

Figure 3 - Carbon footprint, thickness and weight comparison of Duplicor® facade panel and alternative facade panels



* The carbon footprint of the Duplicor® facade panel also includes transport and product manufacturing, while the carbon footprint of the other facade panels only includes the carbon footprint of the materials (production and waste treatment).

4 References

Armacell, 2018. *Life Cycle Assessment PET foams,* Thimister-Clermont: Armacell Benelux S.A..

Armacell, 2021. *Collection Guideline PET and Duplicor 2021,* s.l.: s.n.

CE Delft, 2020. *Emissiekentallen elektriciteit,* Delft: CE Delft.

Medite Smartply, 2019. *Environmental Product Declaration SMARTPLY oriented stand boards (OSB),* Dublin: SMARTPLY EUROPE DAC.

Nationale Milieudatabase, 2020. *Bepalingsmethode Milieuprestatie Bouwwerken versie 1.0 (juli 2020),* s.l.: NMD.

TNO, 2014. *Updated results resin analysis (TFC),* Utrecht: TNO.

TNO, 2020. *Resin,* Utrecht: TNO.

A Carbon footprint breakdown for Duplicor® products

This appendix presents a breakdown of the carbon footprint of the three Duplicor® products in Table 2, Table 3 and Table 4. The carbon footprint of the production phase and of the waste treatment phase (the life-cycle phases) is shown separately. These carbon footprints are also presented in Figure 2.

A breakdown of the performance of the Duplicor facade element in comparison to the three alternative facade elements is shown in Table 5 (as presented in Figure 3).

Table 2 - Carbon footprint of Duplicor® facade, per material and phase (kg CO_2-eq.)

Material	Production (kg CO_2-eq.)	Waste treatment* (kg CO_2-eq.)	Total (kg CO_2-eq.)
OSB	3.57	-0.19	3.38
PET foam	17.63	10.38	28.01
Prepreg	11.65	0.27	11.92
Transport material	0.35	n.a.	0.35
Energy	0.57	n.a.	0.57
Production waste	1.09	n.a.	1.09
Total	**34.85**	**10.46**	**45.32**

* Waste treatment is only applicable to materials, not to production processes or transport.

Table 3 - Carbon footprint of Duplicor® furniture, per material and phase (kg CO_2-eq.)

Material	Production (kg CO_2-eq.)	Waste treatment* (kg CO_2-eq.)	Total (kg CO_2-eq.)
PET foam	0.71	0.42	1.13
Paper honeycomb	0.58	-0.01	0.58
Prepreg	8.29	0.17	8.46
Transport material	0.01	n.a.	0.01
Energy	0.57	n.a.	0.57
Production waste	0.60	n.a.	0.60
Total	**10.77**	**0.58**	**11.35**

* Waste treatment is only applicable to materials, not to production processes or transport.

Table 4 - Carbon footprint of Duplicor® floor, per material and phase (kg CO_2-eq.)

Material	Production (kg CO_2-eq.)	Waste treatment* (kg CO_2-eq.)	Total (kg CO_2-eq.)
OSB	8.92	-0.49	8.44
Knauf Naturoll	6.62	0.17	6.79
Prepreg	21.40	0.49	21.89
Transport material	0.61	n.a.	0.61
Energy	0.57	n.a.	0.57
Production waste	0.67	n.a.	0.67
Total	**38.80**	**0.17**	**38.97**

* Waste treatment is only applicable to materials, not to production processes or transport.

Table 5 - Performance of Duplicor® facade element, compared to three typical facade elements

Subject	Duplicor facade*	HSB facade with siding	HSB facade with masonry	Concrete facade with masonry
Thickness (mm)	170	311	389	395
Weight (kg)	23	97	233	455
Carbon footprint (kg CO_2 eq.)	45	201	186	170