REPEAT Materials

Life Cycle Assessment

02/2022
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REPEAT®

PREFACE

Recent studies from the European Commission show that **80% of the product's environmental impacts are determined at the design phase**. However, the linear pattern of "take-make-use-dispose" does not provide producers with sufficient incentives to make their products more circular.

The company **REPEAT Materials** was founded to contribute to a **more circular economy**.

How? To start with, to quantify our impacts to address our sustainability and environmental protection. At REPEAT Materials we firmly believe that you cannot manage what you do not measure. **This report outlines the Life Cycle Assessment (LCA) of our products and competing products.**

This methodology represents the most reliable and fact-based tool available to help companies, institutions, and governments to systematically incorporate sustainability into their decision-making process.

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INTRODUCTION

Problem Statement - FACTS

There is only one planet Earth, yet by 2050, the world will be consuming as if there were three. The European Commission determine some **alarming facts** related to building materials:

Global consumption of materials such as biomass, fossil fuels, metals, and minerals is expected to double in the next forty years, while annual waste generation is projected to increase by 70% by 2050.

The built environment requires vast amounts of resources and **accounts for** about **50% of all extracted material.**

Greenhouse gas emissions from material extraction, manufacturing of **construction products**, construction, and renovation of buildings **are estimated at 5-12% of total national GHG emissions.**

Half of the total greenhouse gas emissions and more than 90% of biodiversity loss and water stress come from resource extraction and processing.

The construction sector is responsible for over 35% of the EU's total waste generation.

Greater material efficiency at the design phase of products could save 80% of emissions.

Source: European Commission. (2020). Circular Economy Action Plan: For a cleaner and more competitive Europe..

INTRODUCTION
REPEAT MATERIALS

For the construction industry that needs sustainable building materials, REPEAT Materials provides high performance, low cost, low environmental impact structural panels, because we combine traditional engineering with innovative state-of-the-art circular manufacturing processes.

REPEAT Materials panels give new life to post-consumer PET waste and can be recycled into new panels at the end of their lifetime. The benefits:

- **Lessening the pressure resource extraction**-> REPEAT Materials panels are 75% from recycled PET drinking bottles, post-consumer or in-house waste

- **Increase the availability of sustainable building materials** -> Sustainable yet high performance: Strong, impact-resistant, lightweight, waterproof, easy to work with (safe and simple to cut), and stiff (self-supporting walls) So different from innovative but useless (bio-based)) alternatives.

- **Reduce transportation** -> REPEAT Materials has a local production, which means shorten supply lines, so fewer trucks, and less CO2.

OBJECTIVES

REPEAT Materials is the first one to bring a building material panel on the market consisting entirely of at least 75% recycled PET plastic. The literature reveals that there is a research gap in the environmental performance of PET building material panels.

The present research seeks to address this gap in the literature by performing an analysis of the environmental performance of rPET building material panels and competing products which perform the same function.

The intended application and the reason for carrying out this study are to answer the following question:

- **Which steps in the life cycle stand for the major contribution to the product's total impact?**

- **How is the environmental performance of the REPEAT Materials panels compering with competing products which perform the same function?**

The result is to be used for internal purposes as input to product development and in external communication to inform customers or consumers.

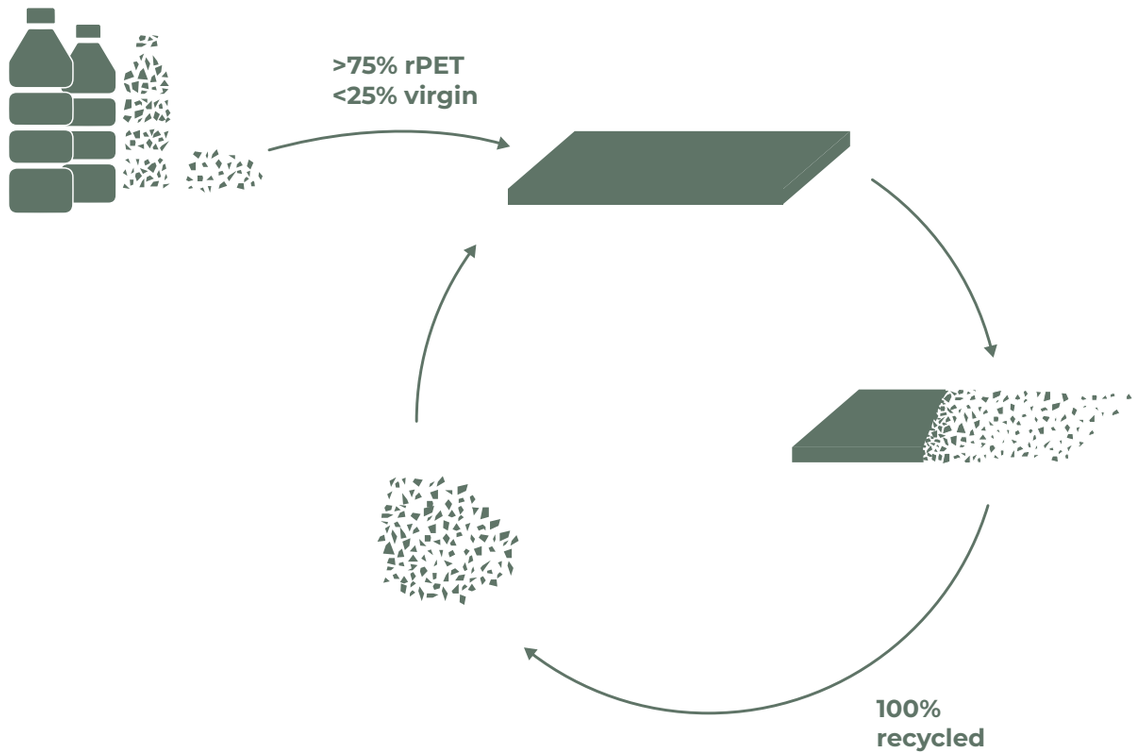

Figure 1. Life cycle of the production of REPEAT Materials panels

METHOD: LCA

What is a life cycle assessment (LCA)?

Life cycle assessment (LCA) is the factual **analysis of a product's entire life cycle in terms of sustainability**. Every part of a product's life cycle – extraction of materials from the environment, the production of the product, the use phase, and what happens to the product after it is no longer used – can have an impact on the environment in many ways. With LCA, you can evaluate the environmental impacts of your product or service from the very first to the very last.

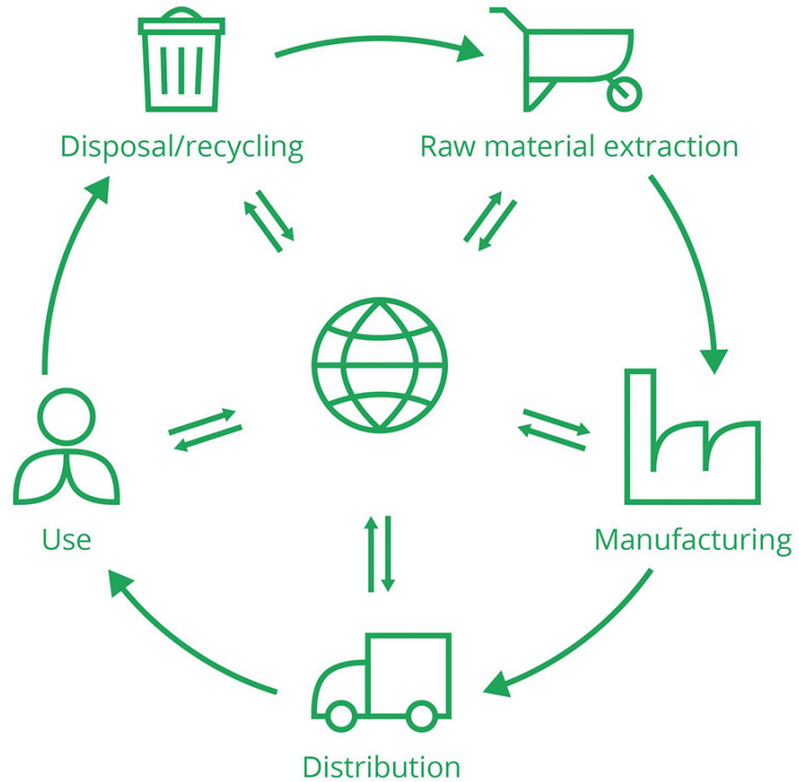

Figure 2: Overview all life cycle stages

Four steps of life cycle assessment

LCA is a standardized methodology, which gives it its reliability and transparency. The standards are provided by the International Organisation for Standardisation (ISO) in ISO 14040 and 14044, and describe the four main phases of an LCA:

1. Goal and scope definition
2. Life Cycle Inventory (LCI)
3. Impact assessment
4. Interpretation

1. The goal & scope definition step ensures that your LCA is performed consistently.

2. In the Life Cycle Inventory (LCI) step you look at all the environmental inputs and outputs associated with the product in every life cycle (see figure 2 above).

3. In the impact assessment step, all of these data are then translated into potential human health and environmental impacts and expressed as such factors as global warming potential (based on greenhouse gases emissions), water quality impacts, human health impacts, or many others.

4. During the last fourth step, the interpretation phase, you check that your conclusions are well-substantiated.

METHOD

Building up durability: Cradle-to-gate approach

System boundaries are the boundaries for which processes in the product's life cycle that is included in the LCA. This LCA takes a **Cradle-to-Gate** approach, considering all the production processes involved from raw materials extraction (i.e. the cradle) to the point where the final product is made available to the market (i.e. the gate). This includes: The product phase (extraction of raw material) and the production phase (production of the panel products).

The **functional unit** provides a reference to which the inputs and outputs of the different products can be related. This means that all the environmental impacts of the different products are related to the same reference unit. This enables the comparison of the different panel products. The functional unit considered in this study: **1 unit of 1,2 by 2.5 m panel**

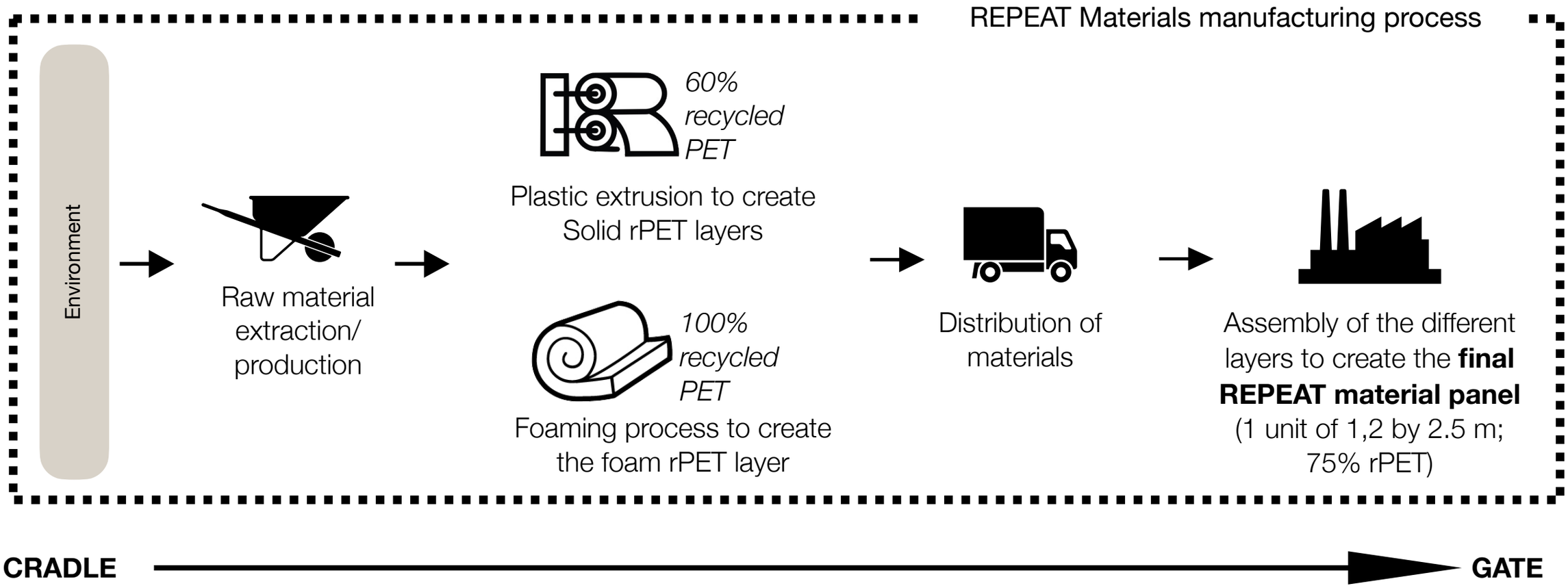

Figure 3. Cradle-to-gate boundaries of REPEAT materials panels life-cycle.

METHOD

Impact assessment

The impact assessment was performed using the software OpenLCA. The ReCiPe method with a hierarchical approach was used. This method is based on the most common policy principles with regards to time-frame and other issues. It gives the impacts in a 100-year timeframe. The impact categories considered in this LCA:

Climate change (global warming potential) addresses adverse effects upon ecosystem health, human health, and material welfare, related to emissions of greenhouse gases to the air. Results are given in kg CO2 eq. in a 100-year timeframe.

Fossil resource scarcity addresses adverse effects upon human welfare, human health, and ecosystem health, related to the extraction of fossil fuels due to inputs in the system. Results are given in kg oil eq. in a 100-year timeframe.

Water consumption addresses the impact on freshwater eco-systems, related to the extraction of water due to inputs in the system. Results are given in m3 water in a 100-year timeframe.

Also, note that the LCA results should be interpreted with caution considering uncertainty limitations due to the complexity to compare different complex products.

RESULTS

REPEAT Materials Rigid Layer

Each of the manufacturing steps described in the system boundaries contributes to a different extent to the total environmental impact of our panels. Such impact originates from the manufacturing process and the production of the materials.

In the table below, the contribution of the main manufacturing stages is indicated as a percentage over the total REPEAT materials production's impact. Such contribution is in turn split (doughnut charts) into the share attributable to the process itself.

RIGID PANELS	2 solid rPET layers (Top and Bottom)	1 Foam rPET layer (Middle)	Assemble of the different layers	Transport of raw materials	Total 100%
Climate Change *GWP100*	90%	4%	4%	2%	4,26 kg CO2 eq.
Fossil resource scarcity	88%	3%	2%	7%	1,91 kg oil eq.
Water consumption	92%	3%	4%	1%	0,08 m3

Materials contribution
Process contribution

Figure 4. Cradle-to-gate impact contribution.

RESULTS
2022 CRADLE-TO-GATE TARGETS

REPEAT Materials aims to work on the cradle-to-gate portion of our life cycle to reduce its environmental impact while keeping the bar straight on the product's functionality.

The LCA results show that the two solid layers contribute the most to the total environmental impact. This is due to the input of 40% of Virgin PET in the solid layers. The rigid layers are from 60% recycled PET in comparison with the foam layer from 100% recycled PET. In the future, we want to improve the sustainability of our solid layers.

The target of REPEAT materials is to produce a solid layer of 90+ % recycled PET by 2023.

Solid layer	*60% rPET, 40% Virgin PET*
Foam layer	*100% rPET*
Solid layer	*60% rPET, 40% Virgin PET*

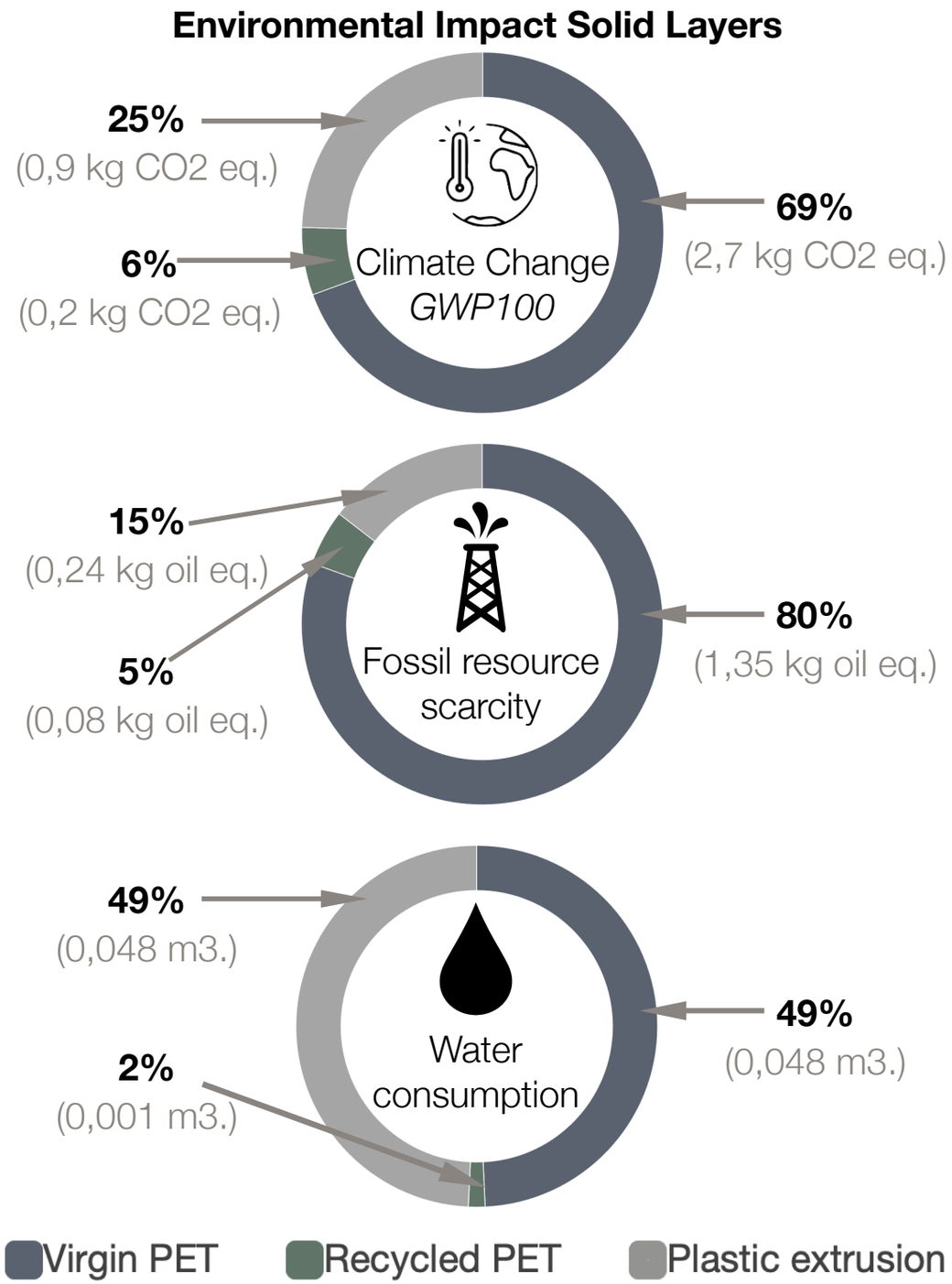

Figure 5. Cradle-to-gate impact contribution solid layers

RESULTS
Tech specifications

A similar cradle-to-gate methodology was applied in the life cycle assessment of the main building materials present on the market. See below the technical data from each panel with the dimension with the length of 2,5 m and width of 1,2 m.

REPEAT Materials Rigid 15

15 mm – solid rPET/ rPET foam / solid rPET – 24 kg/panel

Trespa HPL*

**HPL = High Pressure Laminate*

Bio-based FRP**

22 mm – bio-composite/ rPET foam / bio-composite – 6.1 kg/panel

***FRP = Fiber Reinforced Polymers*

Dibond

3 mm – aluminium / polyethylene plastic / aluminium – 16.5 kg/panel

RESULTS

Comparison Environmental Impact Different Building Materials

The results show that **REPEAT Materials carbon footprint is significantly reduced (87%) compared to the competing products** which performs the same function available on the market.In the figure 5 below, the results for the Climate Change (GWP100) category are given for 1 unit of 2,5 by 1,20 m panel of each building material panel. The GWP100 means the Global Warming Potential in kg CO2 equivalent in the timeframe of the next 100 years. One kilogram of CO2 equivalent is equivalent to the greenhouse effect of 1 kilogram of CO2.

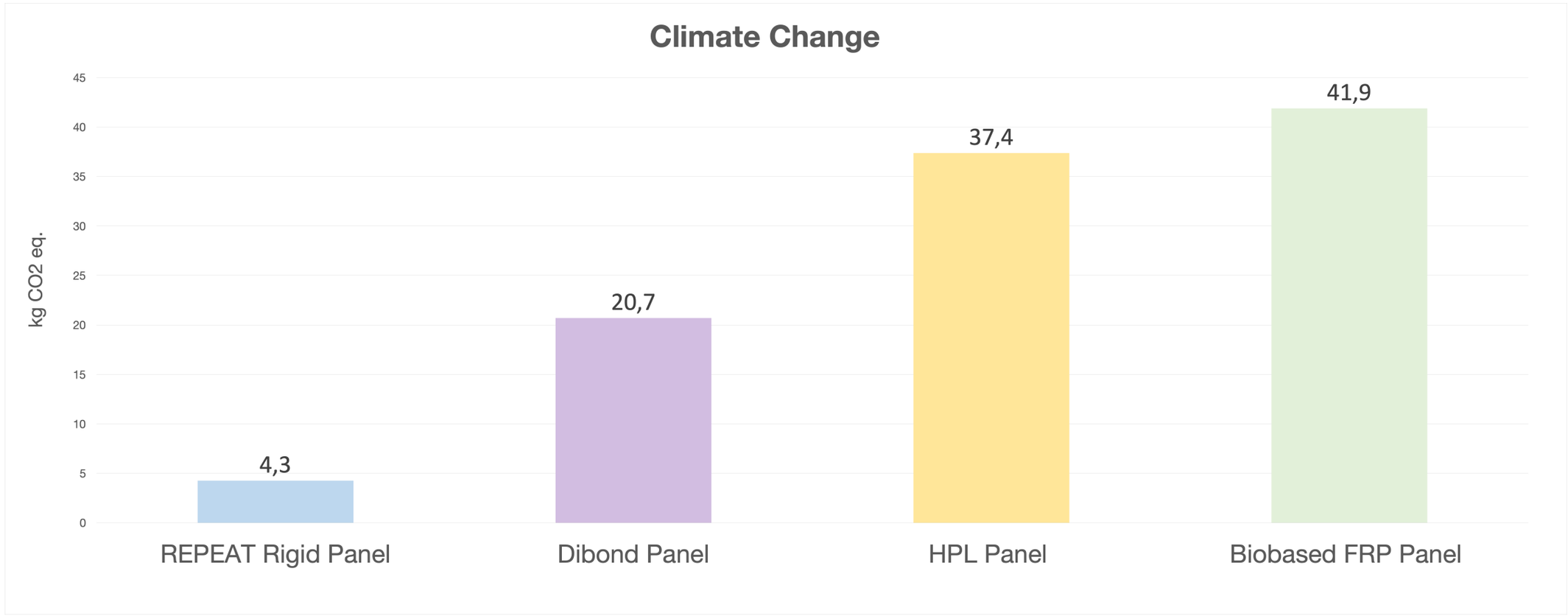

Figure 6. Comparison of environmental impact of various building material panels.

Source: REPEAT Rigid panel: Own data; High Pressure Laminate Panel (HPL) Panel: EPD Trespa; Bio-based Fiber Reinforced Polymers (FRP) Panel: Flax fiber Epoxy composites

CONCLUSIONS

The European Commission determine some alarming facts related to building materials, with as highlight that greater material efficiency at the design phase of products could save 80% of emissions. However, the linear pattern of “take-make-use-dispose” does not provide producers with sufficient incentives to make their products more circular.

REPEAT Materials mission is to contribute to a more circular economy because we aim to create a more sustainable future. And the best way to predict the future is to design it: Sustainable yet high performance. We do this by offering competitive, circular alternatives to traditional building materials. This report quantifies our impacts to address our sustainability and environmental protection because at REPEAT Materials we firmly believe that you cannot manage what you do not measure.

REPEAT Materials panel is the absolute best in its class in terms of global warming potential - its carbon footprint is significantly reduced (87%) compared to the main competitive panels. Based on these results, one may conclude that REPEAT materials contributes to a more sustainable future and supports the guidelines of circular economy, in which being environmentally and socially responsible goes hand in hand with running a profitable business.

REPEAT materials will continue to work on the cradle-to-gate portion of our life cycle to reduce its environmental impact while keeping the bar straight on the product’s functionality. We will keep improving our LCA model, by putting continuous efforts to increase the accuracy of data collection of our production process.