Chain analysis ‘Green Fibre project’

Renewi Nederland b.v.

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1 Introduction

For the audit of 2024, Renewi wants to analyse the 'Green Fibre project' in the context of the CO_2 Performance Ladder. Renewi expects that the GHG (Greenhouse Gas) generated by this new way of processing is less compared to the current way, over the whole chain taken.

This document describes the chain analysis of the process of this project. The report has been produced by Spaak Circular Solutions BV (hereafter: Spaak) on behalf of Renewi.

1.1 What is a chain analysis?

A chain analysis (NL: ketenanalyse) provides information about the CO_2 emissions of a certain product or service for the entire chain. This includes the life cycle of a product from the extraction of raw materials to the impact of the product's end of life, including options of recycling.

1.2 Activities Renewi Netherlands Holding b.v.

Renewi strives to be the leading waste-to-product company by contributing to a sustainable society for their key stakeholders: customers, employees, local communities and their shareholders. Renewi focuses on obtaining value from waste instead of incinerating or landfilling waste. Of the 60 million tonnes of waste processed annually in the Netherlands, 90% is recycled or used for energy recovery[1]. Renewi believes that this unique approach to waste-to-product is in line with social and regulatory developments. This approach also offers the most capital-efficient solution for effective recycling and waste management.

1.3 Goal of the research

The main objective for carrying out this chain analysis is to identify CO_2 reduction opportunities, define reduction targets and monitor progress. Based on the insight into Scope 3 emissions and this chain analysis, a reduction target is formulated. Within the CO_2 management system, that has been introduced, active efforts are made to reduce Scope 3 emissions.

Providing information to partners within Renewi's chain and sector – who are part of a similar chain of activities – is explicitly part of this chain analysis. Based on the results, Renewi will take steps to involve these partners in achieving the reduction targets.

1.4 Scope 3 emissions and selection of chain analysis

Renewi's business activities are part of a chain of activities. For example, raw materials, which are collected or acquired, first have to be produced – these are the 'upstream' emissions. Second, transportation, use and processing of delivered products or services use energy and emit GHGs – these are the 'downstream' emissions.
Renewi has chosen to do the chain analyses within the Product-Market Combination of 'Commercial Waste – Company'[2]. The project analysed in this document is a

1 www.afvalcirculair.nl; www.ned.nl

2 The underlying calculations can be found in Appendix 4.A.1. Scope 3 analyse – PMC – Renewi Netherlands Holding b.v. 2017

process in which Renewi specialises and which focuses on the circular economy.

This report describes the chain analysis of the ‘Green Fibre project’. The analysis compares two chains concerning the processing of waste streams of the tomato production. The two chains will be explained in the next chapter.

2 Identification of the chain

2.1 Background Green Fibre project

The Netherlands produces 910.000 tonnes of tomates per year[3]. 14 kg of tomato produces 1 kg of waste[4], leading to 65.000 tonnes of tomato waste per year. Running full capacity, Renewi can process 60.000 tonnes of tomato waste per year.

Renewi partners together with two partners to process this waste stream of the tomato production in a more sustainable, circulair way. By making products from this waste stream that fit the building industry they connect two sectors, making the output of one, the input of the other.

The Green Fibre project processes 9.000 tonnes of tomato waste currently, being 14% of the total tomato waste in the Netherlands. In 2025, Renewi is planning to process 45.000 tonnes of tomato waste, 69% of this waste stream.

2.2 Current chain

Currently, Renewi collects the tomato waste from the tomato producers and transports it to the location of Renewi in Hoek van Holland. The tomato waste consists of organic waste, plastic and iron. Plastic and iron clips are bieng used to stablize the plants when full with heavy tomatos. The organic material is composted at the plant of Renewi. The plastics and iron (with a little organic waste left) is landfilled. See Figure 1 for a schematic overview.

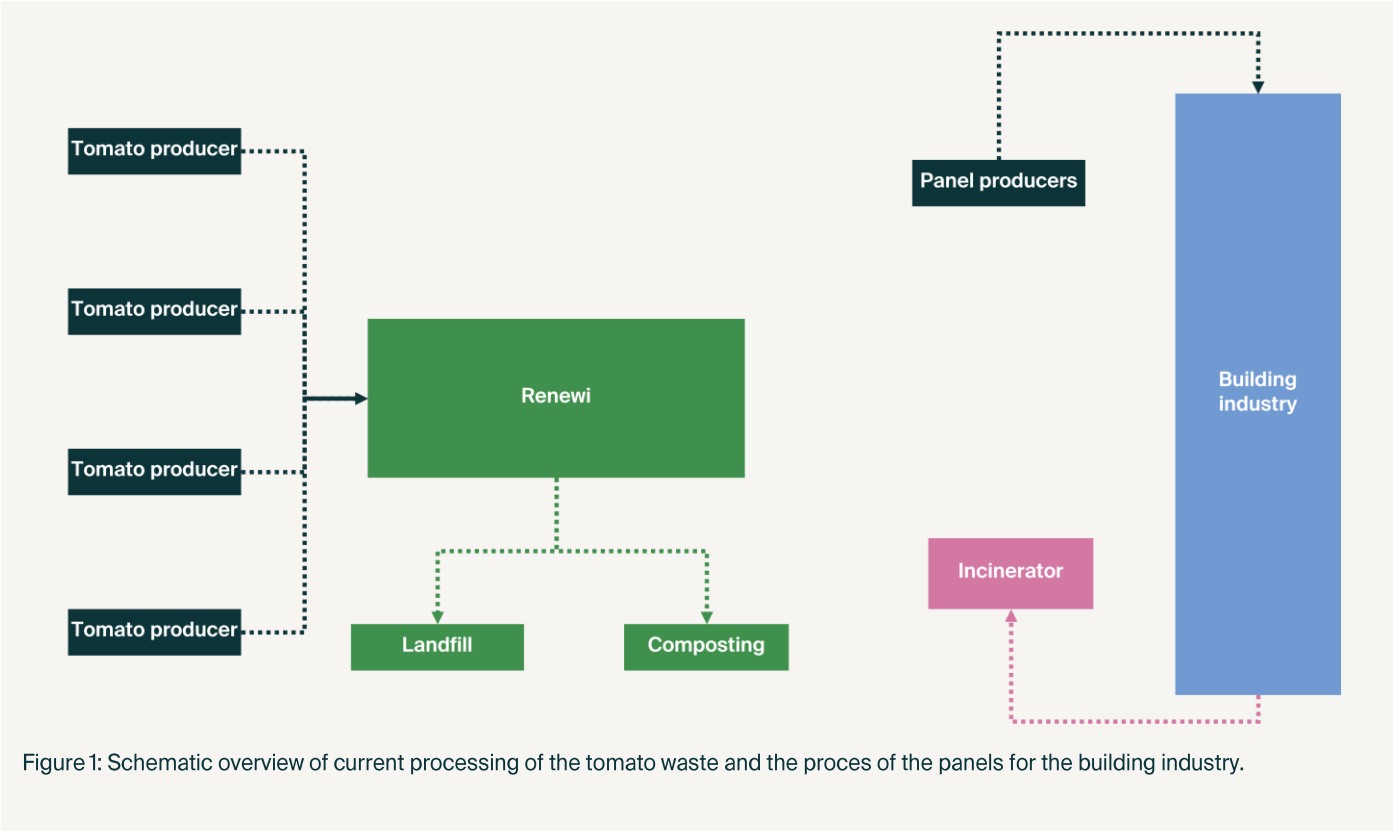

Figure 1: Schematic overview of current processing of the tomato waste and the proces of the panels for the building industry.

3 https://www.nieuweoogst.nl/nieuws/2021/11/10/nederland-zet-11-miljard-kilo-tomaten-af-in-2020

4 Natuurverdubbelaars_factsheet-reststromen.pdf

On the building industry side, panels are produced, installed and used. When a building is demolished or renovated the panels are incinerated with other waste streams (see Figure 1).

2.3 Chain of the Green Fibre project

The Green Fibre project connects the two industries mentioned in the previous section. The waste of the tomato producers is not entirely composted anymore, but part of it is used as an input for the production of panels for the building industry. Figure 2 shows a schematic overview of this chain, with all processes carried out by Renewi in green, the panel producers in yellow and the building industry in blue.

Renewi treats the waste, afterwhich they transport the fibres to the panel producers in Rotterdam and Venlo (see green arrows in Figure 2). The panel producers make panels out of it to be used in the interior design or as construction panels (see yellow arrows from panel producers to building industry in Figure 2).

After the products are used and a building is demolished or renovated, the panels go directly back to the panel producers to be used again in their production cycle (see yellow arrows from building industry to panel producers in Figure 2), or the waste is transported to Renewi, where it will be treated as demolition waste (see blue arrow in Figure 2). This depends on the ownership of the panels after using it in buildings and the way a building is demolished.

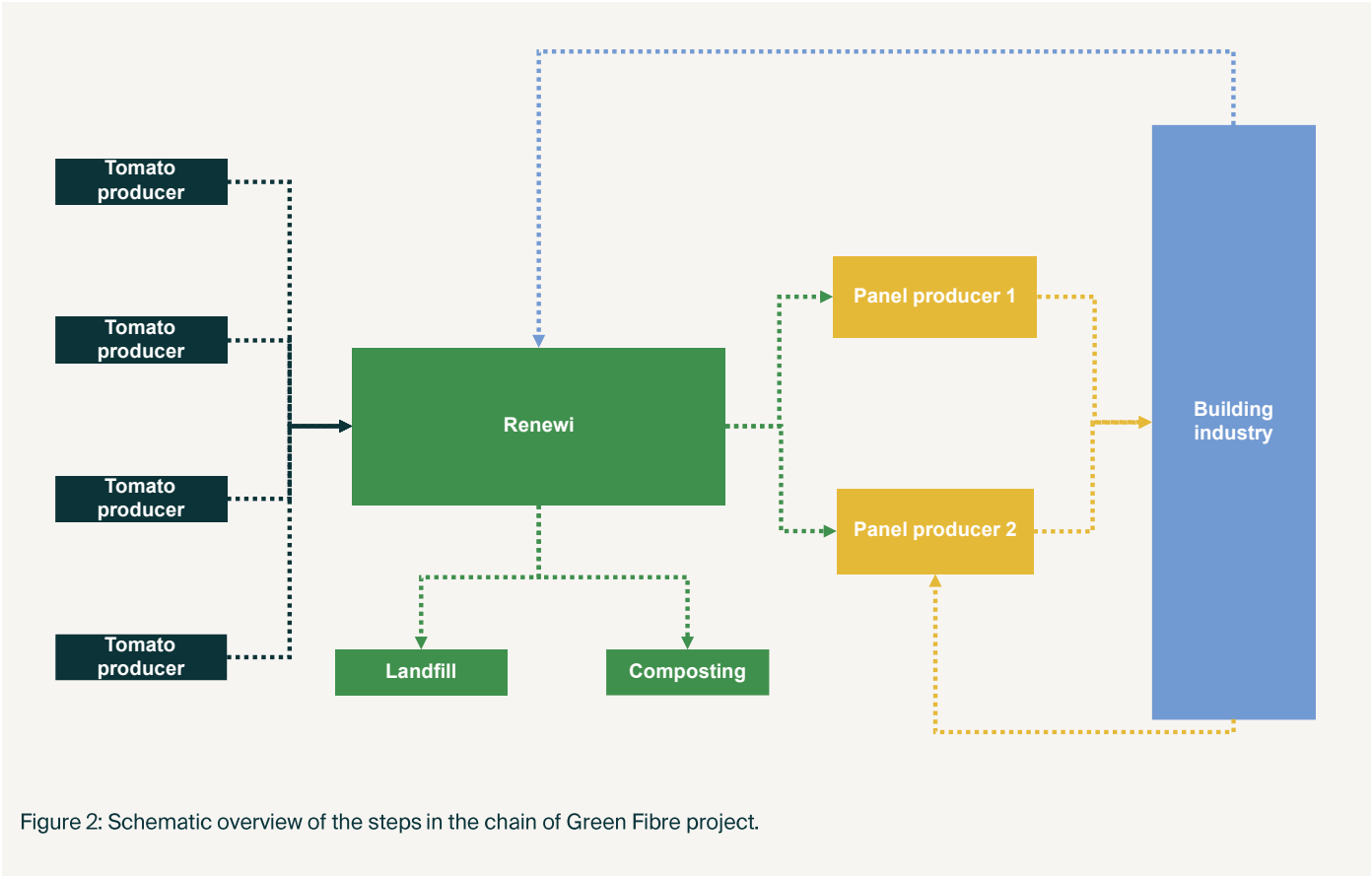

Figure 2: Schematic overview of the steps in the chain of Green Fibre project.

3 Environmental impact analysis

The total CO_2 footprint of the process of Green Fibre project is analyzed in comparison with the current tomato waste management process in The Netherlands.

3.1 Methodology

The methodology used, is related to that of a lifecycle assessment (LCA) defined by the ISO standards but is adapted to meet the needs of Renewi. The impact analysis goes through the following steps:

1. Defining the scope of the analysis;
2. Defining the steps of the processes that will be compared into the Input-Tech-Output model;
3. Making an inventory of all material and energy flows and their quantity within the processes;
4. Calculating the emissions that are impacting the environment in CO_2 equivalents;
5. Interpreting the results and defining reduction possibilities for Renewi and the chain they are acting in.

3.2 Scope

The scope includes all direct emissions from Renewi's processes as well as indirect emissions from purchased electricity. The substitution of recycled material for virgin material production is also included in the calculations.

Not within the scope are:

- Transport of tomato waste from the tomato producers to Renewi's facilities, as this will remain the same compared to the current situation.
- Production of machinery.
- Emissions from the processes of the panel producers.

To calculate the avoided emissions, MDF is used as a substitute fibre. This is because the project is still in development and it has not yet been decided which materials will be replaced.

3.3 Input-Tech-Output model

The Input-Tech-Output model builds the basis for the impact assessment. Inputs include all the (raw) materials needed for the processes within the scope of the project. The Tech part of the model covers the necessary technology to keep the processes running, such as electricity, fuel, and transport. Finally, Output considers material flows that get out of the process. See Figure 3 for all the inputs and outputs of the project.

3.4 Processing steps at Renewi in the Green Fibre project

In the current process, the tomato waste is separated at Renewi in Hoek van Holland. Almost 90% of this waste is used for composting, while the rest (plastics) goes to landfill. This separation is done with a sieve. Renewi's new process adds a processing step after this sieve. Instead of 90% going to composting, 15% is processed in a pilot plant to make fibres to produce panels. The remaining 75% is still composted. Renewi's aim is to reduce this to 0%. In this way, all tomato waste will be used as input for the construction industry.

After the sieve, the organic waste is immersed in a washing process to separate the remaining plastics and remove them for landfill. In the future, the water

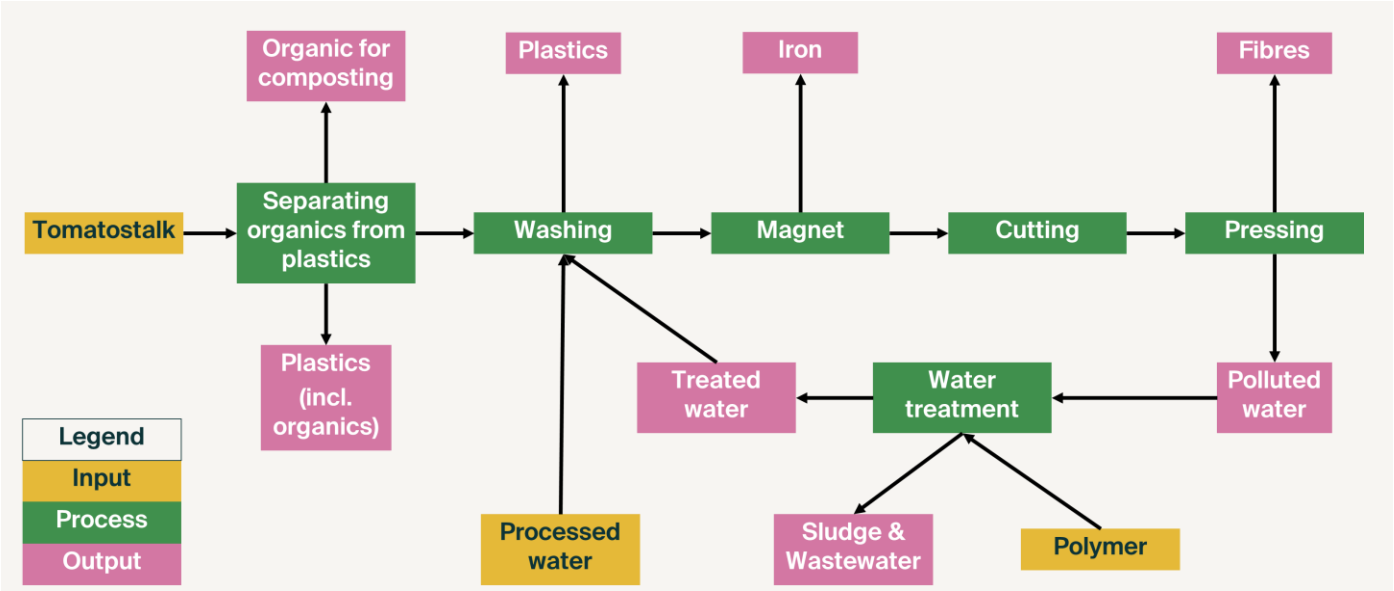

Figure 3: Schematic overview of the process at Renewi.

used is processed water from other processes at Renewi Hoek van Holland. A magnet then removes the iron for recycling. Finally, the organic waste is shredded into small fibres and pressed to extract the water (see Figure 3). The pressed fibre output is transported to the panel producers.

The water pressed out of the organic material is processed in a decanter, where polymers are added for sedimentation. This separates the sludge from the water. Some water is discarted with the sludge. The treated water is reused in the washing process to separate the plastics (see Figure 3). The sludge is composted.

4 Quantification of emissions

This chapter illustrates the total CO_2 footprint of the process of the Green Fibre project.

4.1 Emissions

The CO_2 emissions are compared between the current processing of tomato waste and two scenarios with different processing capacity, named pilot and future scenarios. The pilot and future scenarios differ in the production capacity of the plant. The following terms are taken into account:

1. The total carbon footprint is the CO_2 emissions emitted by the processing steps. Considering composting, landfilling, recyling and the Green Fibre project process.
2. The avoided emissions are the CO_2 emissions avoided by substituting MDF panels by panels made out of tomato stalk. Since there are panels produced from this waste stream, less MDF has to be produced and therefore emissions are avoided.
3. The net emissions is the sum of the former two.

Table 1 shows the CO_2 emissions for the three different scenarios.

Table 1: Summary scenario emissions, avoided and net emissions.

	Current (ton CO_2 eq)	Pilot (ton CO_2 eq)	Future (ton CO_2 eq)
Total emissions	9.145	8.601	5.869
Avoided emissions	-	-5.250	-27.001
Net emissions	**9.145**	**-3.351**	**-21.132**

The following sections detail the results obtained for each scenario.

4.1.1 Scenario: Current

The annual emissions of the current scenario are 9.145 tonnes of CO_2-eq. This is equivalent to 0,15 ton CO_2-eq per tonne of tomato waste (60 kton/year). In this scenario, 9.060 ton CO_2-eq are emitted due to landfilling and composting of waste, while 85 ton CO_2-eq are emitted due to electricity consumption and transport to landfill, as detailed in Table 2.

Table 2: Total emissions by scenario.

	Process	Current (ton CO_2 eq)	Pilot (ton CO_2 eq)	Future (ton CO_2 eq)
Input	Freshwater	-	0,4	0,7
	Polymer	-	11	35
Tech	Electricity	17	75	173
	Transport	68	118	328
Output	Compost	4.830	4.167	1.101
	Landfill	4.230	4.230	4.231
Total		**9.145**	**8.601**	**5.869**

4.1.2 Scenario: Pilot

The pilot scenario has an average processing capacity of 5 tonnes of tomato waste per hour (2-8 ton/h). In this scenario, 8.601 ton CO_2-eq are emitted in the production process, including materials, transport and electricity, as detailed in Table 2.

Recycling of iron and the replacement of MDF avoid 5.250 ton CO_2-eq (see Table 3). Therefore, the net emissions for the pilot scenario are 3.351 ton CO_2-eq, which is equivalent to 0,06 ton CO_2-eq per ton of tomato waste (see Table 1).

To calculate the emissions of MDF, an environmental product declaration (EDP) was used to calculate the

emission factor[5]. In that report MDF a standard 18mm panel has an emission of 7,81 kg CO_2-eq/m^2 with a density of 13 kg of fibres/m^2, therefore an emission factor of 0,6 kg CO_2-eq/kg fibre is used here.

Table 3: Avoided emissions in pilot and future scenarios.

	Process	Pilot (ton CO_2 eq)	Future (ton CO_2 eq)
Output	Fibre	-5.250	-27.000
	Recycled iron	-0,3	-1,0
Total		**-5.250**	**-27.001**

4.1.3 Scenario: Future

The future scenario has an average processing capacity of 20 tonnes of tomato waste per hour. In this scenario, 5.869 ton CO_2-eq are emitted in the production process, including materials, transport and electricity, as detailed in Table 2.

Recycling of iron and the replacement of MDF avoid 27.001 ton CO_2-eq (see Table 3). Therefore, the net emissions for the future scenario are -21.132 ton CO_2-eq, which corresponds to -0,35 ton CO_2-eq per tonne of tomato waste (see Table 1).

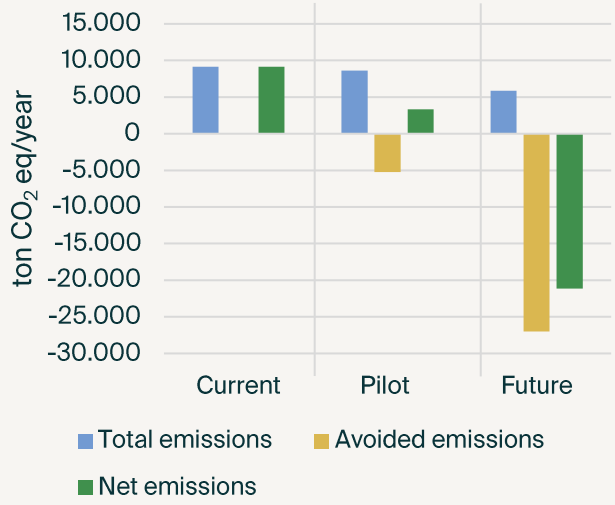

Figure 4: Emitted and avoided emissions by scenario

4.2 Positive impacts

Although the pilot and future scenarios require more energy and material transport, the substitution of virgin materials has an even greater positive impact on the environment, as shown in Figure 4.

The iron recycling process generates material flows that can be reused in other industries, while the fibres mainly substitute the production of MDF. These two material flows substitute virgin materials and thus avoid emissions, as shown in Table 3.

5 https://epd-australasia.com/wp-content/uploads/2018/04/EDP-4-MDF-Dec-2020-1.pdf

5 Reduction possibilities

Based on the emissions calculated, reduction possibilities have emerged within the process of the Green Fibre project, but also within the influence field of the whole chain, where Renewi is a main player.

5.1 Reduction possibilities within the process

Renewi is reducing its carbon footprint by implementing projects such as this one. However, there are several possibilities to further reduce emissions, some of which are explained below.

Firstly, the two processes that have the biggest impact on the carbon footprint are composting and landfilling. All waste not processed by the Green Fibre project is composted at Renewi's facilities. In the future scenario, this amount is drastically reduced, but some remains unprocessed. When production increases to 23 ton/h in the future scenario, it is possible to process all the tomato waste, reducing emissions from composting by 52%. It is not fully reduced because the sludge from water treatment is also composted.

Plastics separated from organic waste go to landfill, which accounts for more than 50% in the future scenario. To reduce this impact, tomato producers could use biodegradable clips, which could either be part of the fibres or composted. This would eliminate the source of plastic use in the value chain. While this transition is taking place at the producers side, the option of separating the plastic for recycling or incineration for energy production could be explored.

Renewi is investigating the possibility of using treated water from other processes at Hoek van Holland as input water for the Green Fibre project. This will avoid the use of almost 500 m^3 in the future scenario. Biodegradable polymer alternatives are available for sedimentation processes that have a lower environmental impact. Unlike metal-based polymers, biodegradable polymers degrade in the sludge.

The use of electric trucks, electric mechanical equipment and renewable energies is also a good strategy for reducing the carbon footprint. Renewi is already making progress in electric mobilisation and most of its processes already use renewable energy. However, there is no electrical infrastructure for plastics separation, so an electrical generator is used.

5.2 Reduction possibilities up- and downstream of the process

One possible option to reduce the emissions generated by the transport of materials is to relocate the panel producers facility at the Renewi site. By doing this, half or all of the fibres produced will be converted into panels without the need to transport them to Rotterdam or Venlo.

Panel manufacturers use these fibres to make panels, using binders to make them stronger. Most of the time this binder is synthetic, they could explore bio-based binders to reduce direct impact emissions and make the fibres easier to reuse after building renovation or demolition.

5.3 Reduction possibilities within chain

The panel producers could explore a business model in which they own the panels. In this way, they are responsible of the discarded panels after a renovation

or demolition of a building and create a monostream after it's life cycle. This way, the end of life of the panels can be better managed according to their conditions, either for reuse, recycling or incineration.

The other actors in the value chain (tomato producers, panel producers) could include the use of renewable energies and electric transport for their operations. Thus a reduction of the carbon footprint in the whole value chain can be achieved.

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