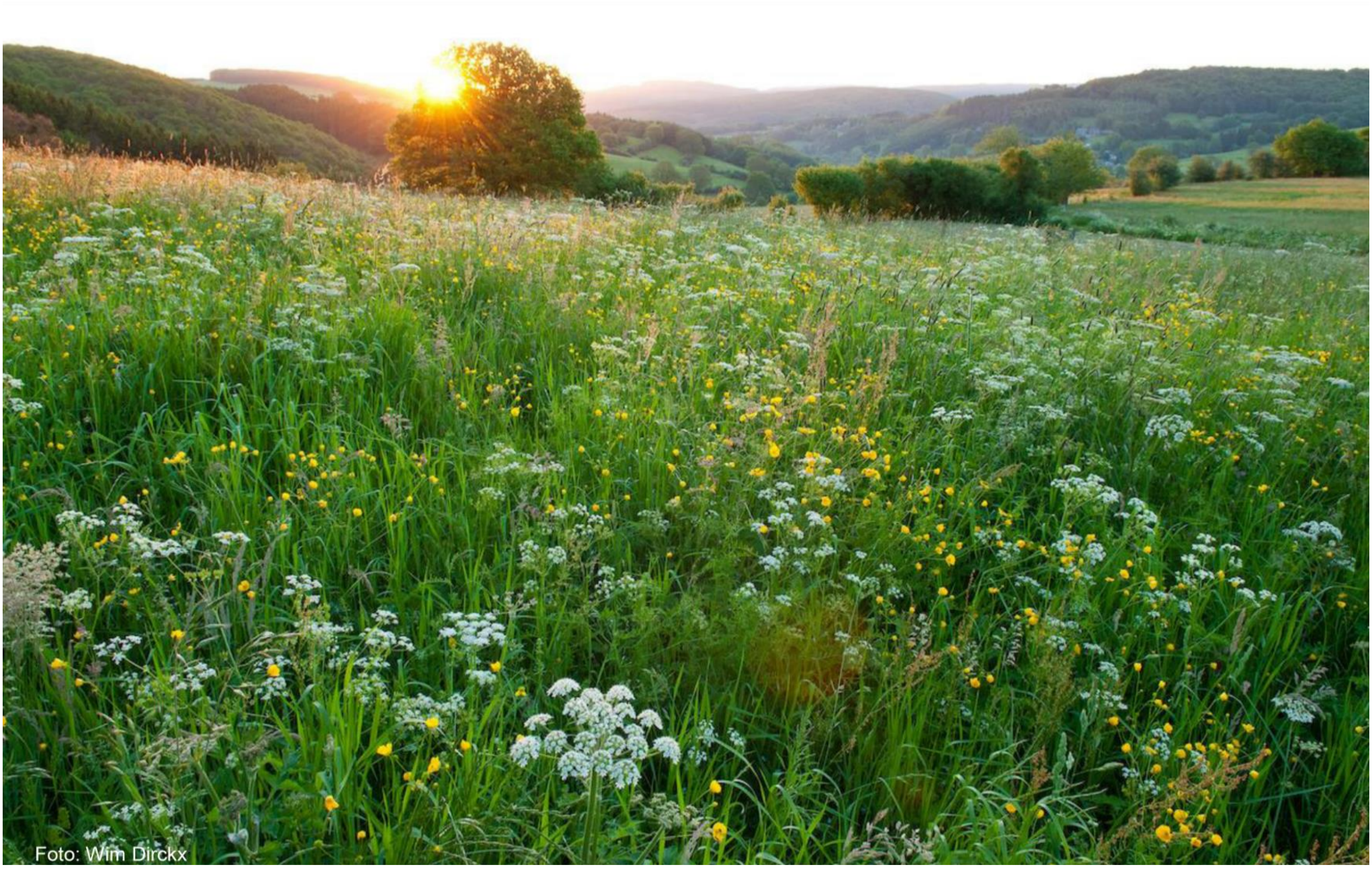
Rapport GrasGoed

Natuurlijk Groen als Grondstof

LCA summary report

Grass fiber insulation versus Stone wool insulation



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Report

LCA summary report

Grass fiber insulation versus Stone wool insulation

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This project runs from August 2016 to March 2020.

THIS PROJECT WAS MADE POSSIBLE BY:

Het Europese Fonds voor Regionale Ontwikkeling
Het Vlaams Gewest
De provincie Antwerpen
De provincie Noord-Brabant

DISCLAIMER

The Life Cycle Assessment described in this report is performed according to ISO 14040 and ISO 14044 standards and aims to comply with LCA definitions. This (summary) report contains information from multiple sources which are accurate and reliable to the best of our knowledge. However, both technical and methodological aspects will change over time due to new technical developments and insights. Because of this we strongly advise NOT to use the outcomes of this study after 1st of April 2023.

The outcomes of this study are intended for (ecological) optimization purposes for the products/services of NewFoss and partners only. For liability, we refer to article 9 of the general terms of delivery of Avans (see: https://www.avans.nl/binaries/content/assets/nextweb/over-avans/organisatie/inkoop_leveringsvoorwaarden.pdf).

Content

1. Introduction

1.1 Cause & background

The LCA is made in scope of the EU Interreg Vlaanderen-Nederland project: GrasGoed – Natuurlijk groen als grondstof. The aim of GrasGoed is to utilize grass clippings from nature reserves which are not applied yet as an innovative raw material. NewFoss developed a process to refine grass and take out the fibers. These fibers are further processed into insulation materials by Gramitherm.

Although the utilization of residual streams is considered sustainable, this has not been quantified for the specific process from NewFoss. The current study aimed to quantify the environmental impacts of thermal insulation materials from fibers extracted in a possible new NewFoss facility in Tongeren (BE). From there, fibers are delivered to Gramitherm in Namen (BE). Here the fibers are further processed into panels for thermal insulation of buildings. The request of NewFoss to the Centre of Expertise Biobased Economy at Avans Hogeschool was to compare the environmental impacts of this biobased product to the impacts of its conventional alternative: stone wool insulation.

1.2 Goal

This study aims to quantify the environmental impacts of grass fiber insulation, more specifically the panels produced by Gramitherm using grass fibers from NewFoss. These impacts will be compared to the impacts of stone wool insulation. For both materials an LCA was performed. The purpose of these LCA's is to show the differences in environmental impact.

1.3 Product system & Boundaries

Figure 1 presents the product system for the grass insulation scenario. Here can be seen which processes are taken into account to calculate the environmental impacts of the product. As can be seen the cultivation of grass is not taken into account. This is because the mowed grass is considered a residual stream which has no application yet. The fresh grass is entering the NewFoss facility, experiencing many passages like washing, cutting and pressing giving out grass fibers, residual products and water. The water is then partly reused and the other part is going to a water treatment facility, while the residual products from the grass are sent to a digestor to create thermal and electrical energy. The fibers are dried and sent to Gramitherm. Some additives are added to the fibers which are then pressed forming the insulation material.

In both scenarios the USE PHASE is not included in the computations. As end of life we assumed, for both scenarios, that the insulation material will be incinerated. From the incineration process, credits for both heat and electricity are obtained.

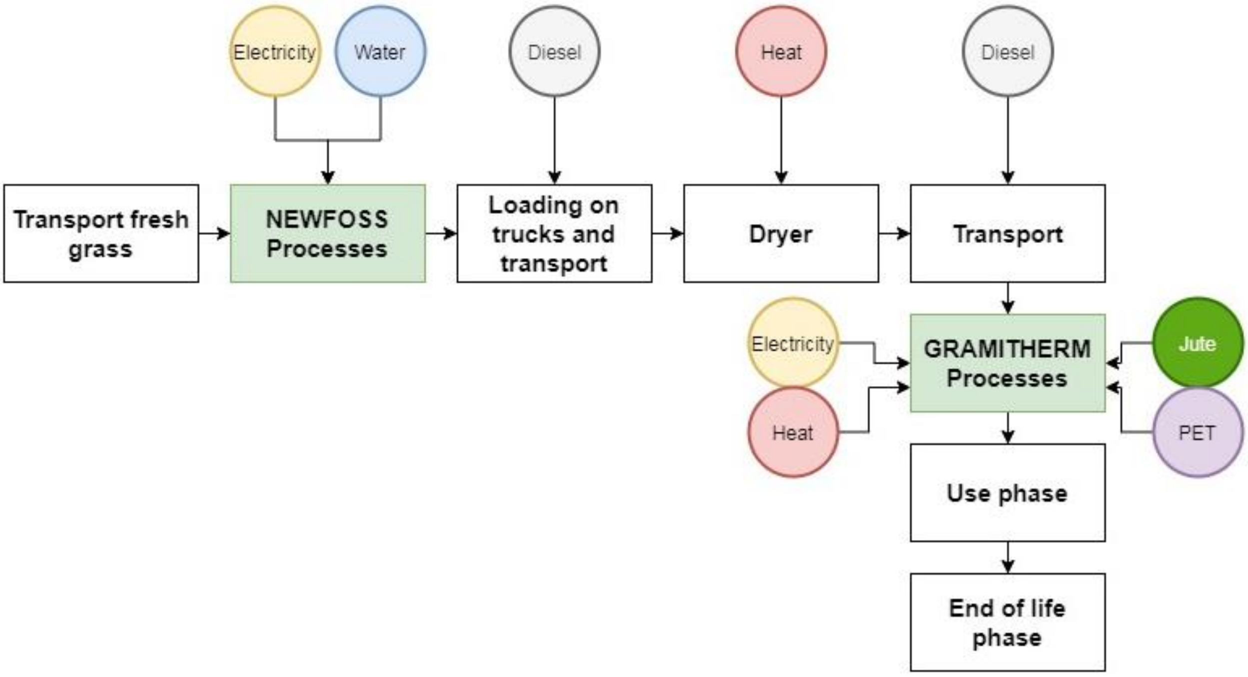

Figure 1: Product system of the grass fiber insulation material (the use phase is NOT included in the computations, see text)

Figure 2 is illustrating the production process of stone wool insulation materials, which start with the transport of recycled stone wool, cokes and basalt to the facility where the insulation materials are made. At first, the input products go into a dome oven where the temperature goes up to 1500°C, obtaining lava. When the lava is not hot anymore, fibers, binders and water repellent oil will be added to the lava and next everything is hardened in an oven. Fibers will be connected and plates and roles will be made from the stone wool; the other products of this process will be recycled.

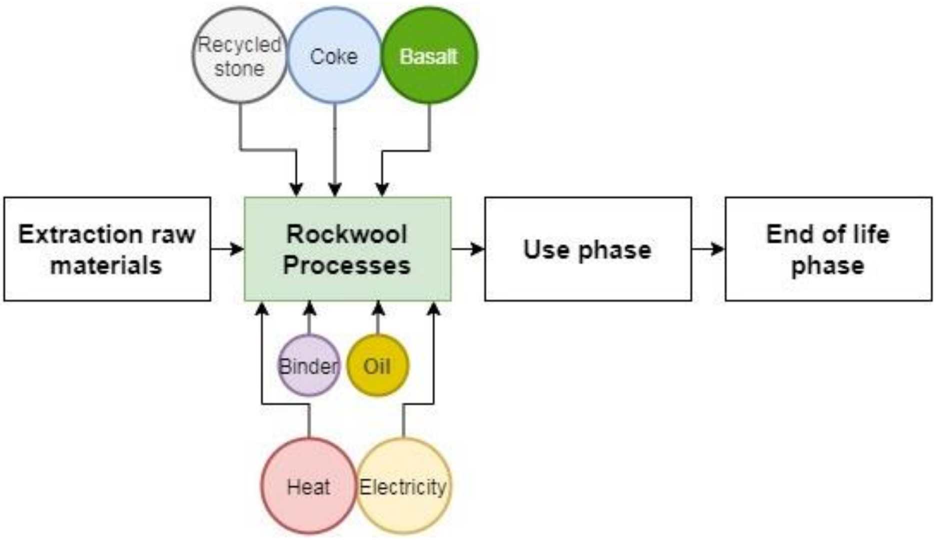

Figure 2: Product system of the stone wool insulation material (the use phase is NOT included in the computations, see text)

2. Methods & data

2.1 Methods

The LCA has been modelled by using the LCA software GaBi. Below the most important methods and choices from this study are described.

Functional unit and reference flow

The functional unit of this study is one insulation panel of 1200mm x 600mm with a λ-value of 0.037 W/mK. Due to differences in density and insulation value, to compensate for this, the compared weight of the actual materials (the reference flows) are different. In this study, 2.33 kg of grass insulation is compared to 1.89 kg of stone wool insulation.

By-products and allocation

The life cycle of the products results in several products that are not directly of interest for the modelled process, but that are valuable and that can replace other products on the market. Examples are heat and electricity that are produced from residual streams of the fiber production. In this study, the substitution approach was chosen to deal with these by products. This means that it has been assumed that the by-products will replace their conventional product and therefore the impacts related to the conventional product are subtracted from the impacts of our main product. This method is called crediting.

LCIA methods

When calculating the results of an LCA, it is possible to use many different impact assessment methods. Each method gives as a results indicators of environmental impacts. Environmental impacts can be expressed in different stages of the cause-effect chain; it can either be expressed as midpoints or endpoints. Endpoints are representing the environmental effects at the end of this chain while midpoints are expressed as environmental impacts earlier along the cause-effect chain. Endpoint environmental indicators are derived from midpoint environmental indicators.

The Life Cycle Impact Analysis in this research will be calculated according to the ReCiPe 2016 method (1). This method will transform the results of the Life Cycle Inventory (LCI) into 19 midpoints. Midpoints can be more difficult to interpret because they consider a large number of impacts, but it is more detailed. These midpoints can be calculated into three endpoints, which are:

- Damage to human health – expressed in DALY:
  DALY stands for Disability Adjusted Life Years and is a measure of overall disease burden, expressed as the cumulative number of years lost due to illness, disability or early death. It can be seen as the gap between an ideal health situation, where individuals live longer, free of disease and disability, and the loss of quality and quantity of life years. It is a quantified pre-mature mortality involved by being exposed to certain emissions.

- Damage to ecosystems – expressed in species × year:
  The unit for ecosystem quality is the local species loss integrated over time and can be seen as the entity of damage done to the ecosystem due to environmental emissions.

- Damage to resource availability - $:
  The use of fossil or mineral resources is expressed in dollar to represent the damage made to resource availability. It also includes the additional costs for future fossil or mineral resource extraction.

Perspective

Three different perspectives exist (hierarchist, individualist and egalitarian), each representing different perceptions of the world with regards to time preference, uncertainty and local preference. The hierarchist perspective is the one chosen for this comparative LCA since it is the most balanced perspective regarding to present and future impacts and regarding benefits and risks.

Normalization

The endpoint environmental impacts are normalized using ReCiPe 2006. Normalization is a principle in which you compare a certain impact to the impact which in caused by an average, in this case European, person on yearly basis.

Checks

A sensitivity analysis and a completeness check were performed.

2.2 Data & Assumptions

Data

The grass insulation scenario has been modelled based on information gathered from our contacts at NewFoss. Personal communications with Edwin Hamoen, Technology Manager for NewFoss, were fundamental for gathering the information required for performing the LCA. Furthermore information was gathered from an earlier bachelor thesis describing the process of Gramitherm (2). Also representative datasets from the GaBi database have been used for electricity production, transport and water treatment. Other processes, such as fiber extraction, had to be developed based on the obtained information.

For stone wool insulation production, a process from the GaBi database has been used.

Assumptions

In each LCA, assumptions were made in order to model reality. The most important assumptions are listed below:

- The natural grass feedstock for the grass insulation production is coming without any burden. This is because nothing will change by making use of this grass since it is available without any other purpose to apply it.
- The grass input is 6250 kg/h (assumed dry matter content: 30%).
- It was assumed that the NewFoss process has its own water treatment plant, digester and cogeneration.
- Assumed was that the digester produces 4320 Nm^3/day of biogas with a 65% methane content. The electricity produced from cogeneration is enough for self-support of the plant that produces the grass insulation panel. For the surplus electricity of 1.1MJ that is produced, crediting was performed.
- It was assumed that $50m^3$ of water is coming out of the NewFoss process every hour of which $20m^3$ is being recycled in the process. The other $30m^3$ cannot be reused and goes to a general water treatment facility.
- Jute is used as an additive for the grass fiber insulation, 20% should be applied (466 grams per insulation panel of 2.33 kg). Since jute is not available in the GaBi database, it was excluded from the assessment.
- PET is used as an additive for the grass fiber insulation, 8% should be applied (186 grams per insulation panel of 2.33 kg).
- Diammonium phosphate is used as additive, 1.5% per panel.
- The truck payload is 17.3 ton.
- The average transport distance of grass fibers from the location it is clipped to NewFoss was set at 50 km.
- The dryer is assumed to be in Tongeren, a transport distance of 2 km was set.
- The transport to the Gramitherm factory in Namen was set at 70 km.

3. Results

The comparative results presented as ReCiPe endpoint environmental impact categories are shown in table 1. Endpoints are deduced from the more elaborate midpoints (Appendix 1). Although midpoint indicators give more elaborate information, they are also more difficult to interpret. This is why endpoints are presented here to give an overview of the results.
Checks on sensitivity of outcomes towards (assumed) data were performed. The outcome was that there are no immediate reasons to doubt the outcome of the performed LCA.
Taking into account that all outcomes are related to the functional unit (one insulation panel of 1200mm x 600mm with a λ-value of 0.037 W/(mK), 2.33 kg of grass insulation is compared to 1.89 kg of stone wool insulation

Table 1: Comparative assessment at endpoints area of protection, per functional unit

Endpoint environmental impact	**Grass fibers**	**Stone wool**	**Factor**
Damage to human health (DALY)	-1.74E-06	6.96 E-06	4.99
Damage to ecosystems (species × year)	-2.05E-09	1.12 E-08	6.44
Damage to resource availability ($)	7.60E-02	1.03 E-01	1.36

Damage to human health
From table 1, it appears that the damage to human health for producing insulation material from stone wool is almost 5 times as high as valorising grass fibers into grass insulation panels. The credits for the surplus in energy and heat production results in reduced impacts on human health for the grass insulation panels. Crediting this energy means that the surplus of energy will be put back into the grid, therefore, less energy needs to be produced in the conventional way. This is why we see negative values in the table. Negative values means in practice positive impacts, representing the prevention of a certain impact. So with this scenario, emissions are prevented from being emitted, so a certain amount of damage to human health is prevented to occur. The damage to human health related to the stone wool production is mainly caused by the production process itself. Since the data that was used for the stone wool insulation production is a pre-made GaBi process, it is not possible to provide specific information about which part of the product system has the most impact for this scenario.

Damage to ecosystem
Regarding damage to ecosystems, the difference in impact is a factor bigger than 6 in favour of the grass insulation. Also for this environmental impact the credits for the surplus in energy and heat production is important for the reduced impact on damage to ecosystems for grass insulation. Next to that, making freshwater available again also contributes a lot to reducing the damaging impact on ecosystems. The damage to ecosystems related to the stone wool production is again mainly caused by the production process itself.

Damage to resource availability
The score on this environmental indicator differs less, a factor of 1.36 in favour of the grass insulation. For the grass fiber scenario, it can be concluded that the use of PET contributes the most to this environmental indicator.

The results from table 1 were normalized in order to give an indication about the order of magnitude of the outcomes. Normalization is kind of a translation step in which the outcomes of table 1 are set as a percentage in relation to the average damage caused by one European person per year. The value is still related to the functional unit and used reference flow.

Table 2 shows for example that for the category damage to resource availability, one panel of grass fiber equals 0.0247% of the impact that one average European person would have throughout a year. For stone wool, one panel equals 0.0336% of the same impact. Same thing could be concluded for the negative impacts, so for example in the damage to human health category, the production of one panel of grass fiber insulation material saves 0.0086% of the impact that one average European person would have throughout a year, while one panel of stone wool produces 0.0336% of the same impact. Table 2 is showing the normalized results.

Table 2: Normalized endpoints

Endpoint environmental impact	**Grass fibers**	**Stone wool**
Damage to human health	-0.0086%	0.0344%
Damage to ecosystems	-0.0011%	0.0062%
Damage to resource availability	0.0247%	0.0336%

In table 3, the results from table 2 are presented in a different way. The highest impact from table 2 was converted to a value of 100. The other impacts were multiplied with the same conversion factor (relative scaling). This way the relative effects between the six environmental endpoint impact values are given on a scale from 0 to 100. The results shown in table 3 are also the results used for the infographic (Appendix 2) which is created from the LCA (in Dutch).

Table 3: Results in a scale from 0 to 100

Endpoint environmental impact	**Grass fibers**	**Stone wool**
Damage to human health	-25.1	100.0
Damage to ecosystems	-3.3	17.9
Damage to resource availability	71.7	97.6

4. Conclusions

The purpose of this study was to assess the environmental impacts of grass fiber insulation panels and compare them with the environmental impacts of stone wool insulation panels. This comparison was conducted by means of an LCA. All conclusions are only valid for the specific scenario modelled in this study.

The results are showing a better environmental performance for what concerns the grass fiber scenario. This is true for all the endpoint environmental impact categories, damage to human health, damage to ecosystems and also for damage to resource availability.

It should be mentioned again that the use of jute was not taken into account in this assessment, however, it is not said that this would have a negative influence on the outcomes. It can be stated that the damage to resource availability regarding the grass fiber insulation panels is caused mainly from the use of PET as additive. If this additive is replaced by a more environmental friendly alternative, which is available in the form of PLA, or if it is reduced in required amount per panel, the environmental impact would decrease even more.

References

1. National Institute for Public Health and the Environment (RIVM). *LCIA: the ReCiPe model.* [Online] National Institute for Public Health and the Environment (RIVM). [Citaat van: 16 March 2020.] www.rivm.nl/en/life-cycle-assessment-lca/recipe.

2. De Giacomi, Claudio. *Graswärmedämmung Gramitherm Ökologische Begutachtung und Transferkonzept (confidential).* sl : ZÜRCHER HOCHSCHULE FÜR ANGEWANDTE WISSENSCHAFTEN DEPARTEMENT LIFE SCIENCES UND FACILITY MANAGEMENT INSTITUT UNR, 2014.

Appendix 1: Midpoint environmental impacts

Table 4: Comparative results per midpoint environmental impact category

Midpoint environmental impact categories	Comparative results		
	Grass fiber	**Stone wool**	**Factor**
Climate change, excl biogenic carbon [kg CO_2 eq.]	-3.62E-01	2.69E+00	8.4
Climate change, incl biogenic carbon [kg CO_2 eq.]	2.93E+00	2.71E+00	1.1
Fine Particulate Matter Formation [kg PM2.5 eq.]	-1.75E-03	2.95E-03	2.7
Fossil depletion [kg oil eq.]	-1.18E-01	5.60E-01	5.7
Freshwater Consumption [m^3]	-3.29E-04	9.40E-03	29.6
Freshwater ecotoxicity [kg 1,4 DB eq.]	8.51E-04	1.39E-04	6.1
Freshwater Eutrophication [kg P eq.]	4.97E-05	4.11E-06	12.1
Human toxicity, cancer [kg 1,4-DB eq.]	4.20E-03	6.39E-03	1.5
Human toxicity, non-cancer [kg 1,4-DB eq.]	7.79E-02	2.50E-01	3.2
Ionizing Radiation [Bq C-60 eq. to air]	-2.06E-03	9.78E-03	5.7
Land use [Annual crop eq.·y]	1.26E-02	1.58E-02	1.3
Marine ecotoxicity [kg 1,4-DB eq.]	1.40E-03	2.41E-03	1.7
Marine Eutrophication [kg N eq.]	9.80E-05	5.44E-05	1.8
Metal depletion [kg Cu eq.]	3.70E-02	2.34E-02	1.6
Photochem. Ozone Form, Ecosystems [kg NO_x eq.]	8.26E-04	4.88E-03	5.9
Photochem. Ozone Form, Hum. Health [kg NO_x eq.]	7.46E-04	4.69E-03	6.3
Stratospheric Ozone Depletion [kg CFC-11 eq.]	3.56E-07	5.83E-07	1.6
Terrestrial Acidification [kg SO_2 eq.]	-5.48E-03	1.29E-02	3.4
Terrestrial ecotoxicity [kg 1,4-DB eq.]	9.30E-01	1.19E+01	12.8

Appendix 2: Infographic

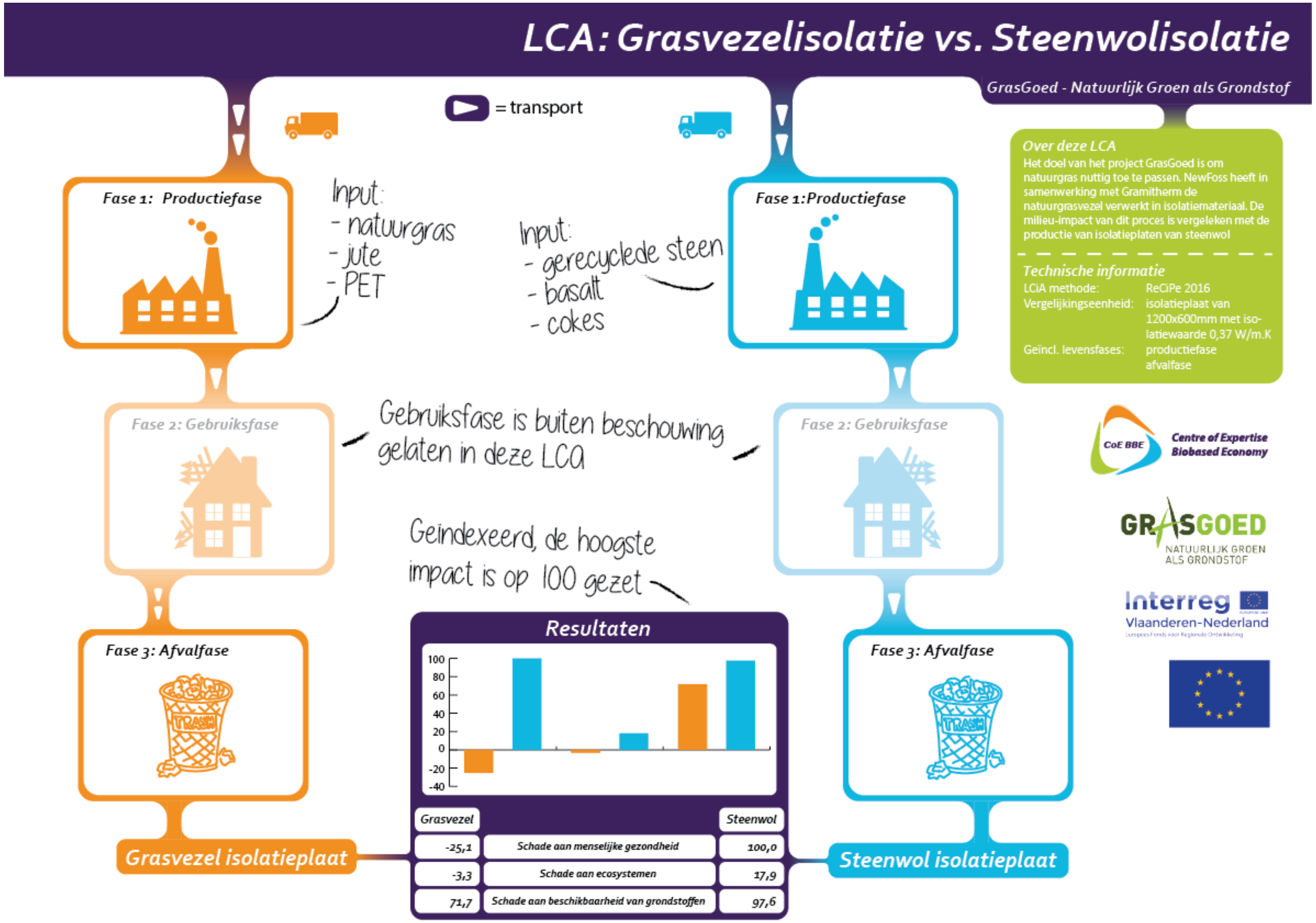

Figure 3: Infographic