Life Cycle Analysis

June 2023

Complete life cycle analysis of the Eker Bicycles bamboo bike frames including comparison to aluminium frames.

1.9 kg CO_2e

Contents

This report

This report is a summary of a life cycle assessment in which the environmental impacts caused by the production of the Eker bicycle frames were assessed and evaluated. The results were then compared to similar impacts caused by a conventional aluminium frame of similar dimensions. The purpose of this was to investigate any environmental benefits from manufacturing bicycle frames using bamboo as the main material.

The study was conducted in accordance with **ISO 14040** and **ISO 14044** with the majority of data being manufacturer specific and sourced directly from the production line. The scope of the LCA was cradle to gate with options, including customer transport and end-of-life scenarios. The declared unit is 1 bicycle frame.

Disclaimers

Conducting life cycle analyses to estimate the environmental impacts of products is a well-established method. However, such studies are based on assumptions and often rely on generic data in order to create scenarios of the processes included in a product's life cycle.

As the purpose of the conventional aluminium frame and the Eker bicycles frames are the same, the use phase of their life cycles were excluded. Any maintenance of a bicycle frame was also assumed to be negligible.

Generic data was gathered from Ecoinvent 3.8 (2021) and can be considered of good quality.

About Eker Bicycles

The Swedish bicycle manufacturer Eker Bicycles AB was founded in 2020 and produces high performance bicycles with frames handmade from sustainably sourced materials. The frames are made in Uganda, with sustainably grown bamboo as the main material. The bikes are then assembled in Sweden. The frames, which are made by natural composite materials, are created to leave a minimal climate footprint.

Eker promotes good working conditions for its employees in Uganda. As part of the remuneration program the employees benefit from the company's policies for health care, pension, bonus, etc. for themselves and their close family members. The aim is to contribute to better societies while reducing the environmental footprint of the bicycle industry, one bike at a time.

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Introduction

The purpose of this study was to examine the environmental impacts of the Eker Bicycles Frames manufactured by Eker Bicycles AB on a life-cycle basis in accordance with ISO 14040 and ISO 14044. All human activities affect the environment from which we ultimately receive the food, water and materials necessary for our survival and development. Therefore, the choices made by consumers in their professional and every-day lives play an important role in reaching the 17 goals of the UN 2030 Agenda for Sustainable Development.

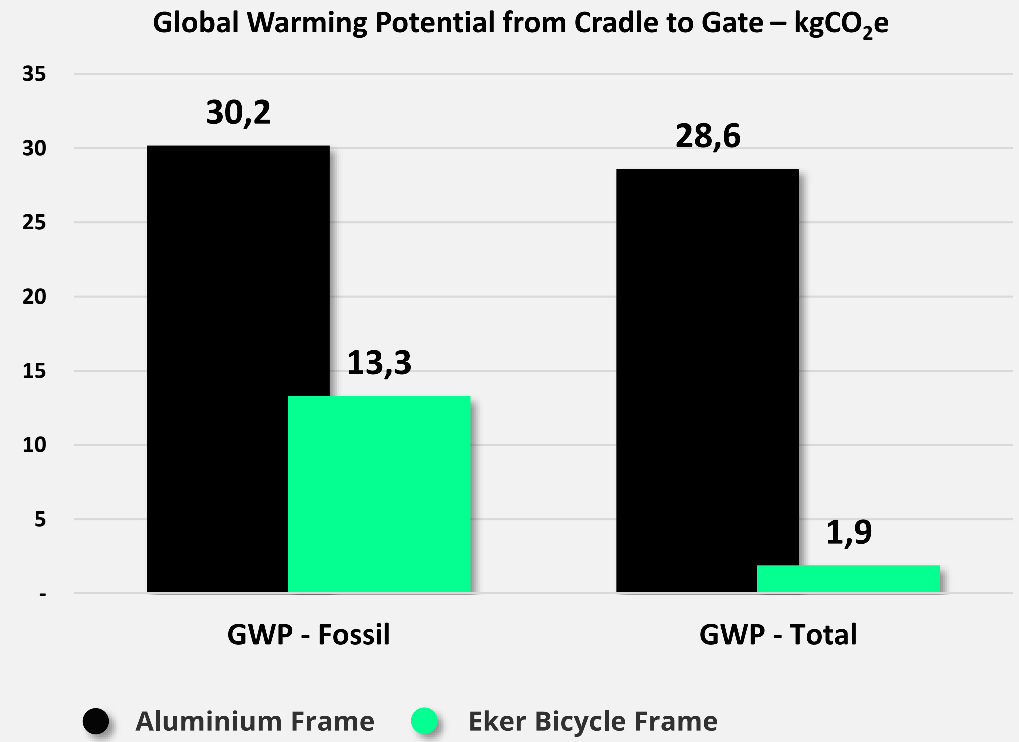
Life cycle analysis is a reliable tool to help consumers make informed choices from a sustainability perspective when purchasing various products or services. It is also creating another dimension of competition between manufacturers, where not only price and product quality are considered, but environmental performance as well. This may lead to increased innovation and market niches in which more sustainable products are created. In time, this could reduce the impact that human activities have on the environment.

The Swedish bike manufacturer Eker Bicycles AB have found their niche by manufacturing bicycles with an alternative frame material - bamboo. Even though bamboo frames have been made since the late 1800's, aluminium, steel and carbon-fiber are more established frame materials on most markets. By utilizing strong and lightweight bamboo in combination with aluminium fittings, an epoxy resin and natural fibers, the hand-made bamboo frames offer a viable alternative to conventional materials in terms of technical performance. The purpose of this LCA was to investigate the environmental performance of the Eker bicycle frames in comparison to aluminium frames.

Summary

This LCA has examined the environmental impacts of the Eker bicycle frames (without additional components like brakes, drivetrain, etc.) and compared these with a conventional aluminium frame of similar dimensions using representative, generic data on material and energy use. Results show a 93 % reduction in net greenhouse gas emissions compared to the aluminium alternative from cradle to gate. This is partly due to the reduced amount of aluminium but also because of stored carbon dioxide in the natural materials (bamboo and bark fibers) of the frame and in soil.

In terms of global warming potential measured in fossil CO_2 equivalents, the most contributing component in the Eker Bicycle frames are the aluminium fittings in the corners of the frame. These components emit 64 % of total emissions. The second most contributing material in terms of emissions is the epoxy resin (27 %) which is used to secure the components of the frame to each other. The production and transport of bamboo and wooden fibers produce approximately 9 % of total emissions. The total greenhouse gas emissions deriving from fossil fuels from cradle to gate are approximately 13,3 kgCO_2e. However, if the absorbed CO_2 by the plant-based materials are included, the net emissions become as low as 1,9 kgCO_2e. See pages 8-10 for more detailed results.



Terms and definitions

LCA
An evaluation of the compiled inputs, outputs, processes and associated environmental impacts of a product system throughout its life cycle.

Life cycle
The interlinked stages within a product system, all the way from raw material acquisition to final treatment, such as landfill or recycling. The number of stages included in an LCA may vary.

Module
A life cycle can be divided into several modules – A1-A5, B1-B7, C1-C4 and D. These represent different stages of a product system's life cycle.

Cradle-to-gate
An LCA that only includes modules A1-A3, meaning that only raw material acquisition, transport to the manufacturing facility and manufacturing of the product is included in the analysis.

Cradle-to-grave
An LCA that assesses the entire life cycle of a product system from module A1 to C4, as well as D, which accounts for benefits and loads outside of the product system.

End-of-life
The end of a product system's life cycle which commonly includes collection and treatment of various wastes, as well as reuse, recycling, incineration or landfill of said wastes.

Dataset
In the context of LCA, a dataset is a set of data containing information about a product system's life cycle.

Cut-off criteria
Specification of materials and energy flows excluded from an LCA based on environmental significance and impact.

Declared unit
The reference unit for which the results of an LCA are valid. For instance, one kilogram or meter of product. Or one bicycle frame.

GHG
Greenhouse gases. The most commonly analysed GHG are carbon dioxide, methane, nitrous oxide and freons or CFCs. These can also be reported together as carbon dioxide equivalents (CO_2e).

GWP
Global warming potential is an impact category measured in CO_2e, and is an indicator of the global warming potential of a product or service.

Impact category
LCA results are commonly assigned to various impact categories representing certain environmental aspects of concern, such as GWP, water use, eutrophication or human toxicity.

About the frames

The Eker bicycle frames are made of select pieces of sustainably sourced bamboo grown in Uganda. The frames are made by hand, all the way from harvesting the tubes and fiber cloth to preparing and joining these with aluminium fittings into unique frames which are built to withstand long riding in all types of conditions. The bamboo in these frames is strong and lightweight with high ability to resist wear and tear. It is treated and combined with aluminium fittings designed and manufactured in Sweden. The combination creates bicycles that dampen and reduce vibrations, while maintaining a stiff ride ensuring that the power and force of the cyclist ends up on the track.

The fiber cloth used to join the tubes and aluminium fittings is made from Mutuba (ficus natalensis) bark, which is harvested by hand without harming the tree itself. This provides a versatile and environmentally friendly option to other fibers. The bark can be harvested annually for up to 40 years.

An epoxy resin partially made from renewable ingredients is used to secure the various components of the frame and serves as frame protection.

Manufacturing

The aluminium fittings are manufactured in Sweden before they are flown to the main facility in Kampala, Uganda, by plane. The bamboo and Mutumba bark fibers are harvested locally by hand in Uganda, and the epoxy is transported to the facility from South Africa.

The bamboo is treated with an organophosphate compound for preservation purposes before being cut into appropriate dimensions and assembled with aluminium fittings into a frame. This is done by wrapping the pieces together using thin strips of fiber cloth which were previously soaked in epoxy resin to create a secure fit.

After curing, the frame is polished and checked for inconsistencies or quality issues before being packed into recycled cardboard boxes and shipped to Sweden, where the rest of the bike will be assembled. The assembly of the bike is however not included in the scope of this study.

What is a Life Cycle Analysis?

Life cycle analysis (LCA) is a well-established method of determining the environmental impact of a product or service. Since the practice of LCA started in the 1960s with energy analyses, the method has been standardized with improved frameworks and methodology. By looking at materials, energy and processes used to manufacture a product, the potential environmental impacts of a product throughout its life cycle can be assessed.

An LCA is often conducted in four phases. The first phase defines the goal and scope of the study and the methods used. The scope can be divided into different stages or “modules” of a product’s life cycle (as shown in the figure to the right). This is followed by an examination of inputs, outputs and processes included in each stage. The third phase is to perform the actual impact assessment by pairing each input, output and process with their individual impact on the environment (such as climate change, toxicity, resource depletion, etc.). This is often done by using environmental databases such as Ecoinvent, but other reliable information such as peer-reviewed scientific research can also be used to assess impacts from a particular material or process.

Finally, an interpretation of the results is performed which should eventually lead to conclusions and recommendations about the product from an environmental perspective. The modules included in this particular LCA are described on this page. The use phase (B1-B7) as well as module A5 and C1 have been excluded from this LCA as they are not considered relevant in the life cycle of the Eker bicycle frames.

Product Life Cycle

A1

Material production

Everything begins with the extraction and processing of raw materials used for the product, but also for packaging or ancillary materials used for manufacturing but not as part of the product itself. This is often where the largest impact occurs.

A2

Transport of materials

Transport of materials from suppliers to the manufacturer. Impacts are measured by looking at the transported mass, how far it is transported, and how.

A3

Manufacturing

Energy consumption, waste generation and other aspects tied to manufacturing of the product. This only includes manufacturing of the product itself, and not of the materials included in it.

A5 B1-B7 C1

Excluded modules

For reasons of relevancy, impacts from installation (A5), the use phase (B) and de-construction (C1) were excluded from this LCA.

A4

Transport to customer

The environmental impact caused by transport to the customer is measured by looking at the transported mass, how far it is transported, and how.

C2 C3 C4 D

End-of-life

At the end of life, materials are transported (C2) to facilities where they are processed for reuse, recycling, incineration with energy recovery (C3), or simply disposed on a landfill (C4). That depends on the material and the country in which they are processed. The loads, such as incineration, and benefits (avoided primary production) from such processes are modelled in module D.

Method

The first step of this study was to determine its goal and scope. The LCA covers the life cycle modules A1-A4, C2-C4, and D. This means that raw material extraction and processing, transport to the manufacturer, manufacturing, customer transport, as well as end-of-life have been included. The actual use of the bike has not been included, the reason being that maintenance of a bicycle frame is quite limited, and does not differ in a significant way between the compared frame materials.

The data for the analysis of the Eker bicycle frames was gathered directly from Eker Bicycles AB. This was done by sending a questionnaire in which relevant information, such as energy and materials used, could be filled in. Further information was gathered through direct contact with Eker Bicycles as the project advanced. Additional generic data for the bamboo and aluminium frame was gathered from Ecoinvent 3.8 and peer-reviewed articles online.

The data was examined and its quality ensured before it was used to create models of both frames in One Click LCA – a third-party verified online LCA tool. The tool was used to assign environmental impact indicators to each input of energy, materials or processes included in the various life cycle modules. These are then compiled into an overall result which can be seen on pages 11 to 12.

Finally, these results were interpreted so that a comparison between bamboo and aluminium frames could be performed. Furthermore, hotspots in the supply chain and production of the Eker bicycles frames were identified so that any environmental impacts can be reduced in future development of the product.

Cut-off criteria

All inputs and outputs of the product life cycle for which data is available are included in the analysis. The total excluded input and output flows do not exceed 5% of mass or energy flow. The study only covers the “first life” of the materials included in the product, and not the use of these as recycled or reused materials further down the line.

Assumptions

Bicycle components such as brakes, drivetrain, etc. are excluded.

Impacts considered from transportation include exhausts resulting from transportation of raw materials and ancillary materials from supplier to Eker Bicycles’ facilities as well as the environmental impacts of the production of used fuel. Manufacturing, maintenance and disposal of vehicles as well as road and tire wear during this transportation are also included. The transportation distances and transport modes were provided by Eker Bicycles.

The aluminium frame was assumed to be manufactured in China, as that is the most common place of production for bicycles in the world.

Since most customers reside in Europe according to Eker Bicycles, the distance for delivery transport was set to Kampala-Amsterdam. The frames are transported to Europe by plane. The aluminium frame was assumed to be shipped from China to Amsterdam by container ship, with a general transport distance of 20 000 km. It was assumed that the cardboard packaging of both frame alternatives goes directly to municipal incineration with energy recovery after having fulfilled its purpose.

It is assumed that 100 % of the frame is brought to a waste treatment facility from which recyclable materials such as aluminium are sent directly to recycling facilities. Any sorting processes are assumed to have very little losses, which are therefore not considered in the assessment. It is assumed that bamboo and fiber cloth go with other wooden waste to incineration with energy recovery.

The carbon content of bamboo and fiber cloth was assumed to 50 %. The epoxy is assumed to be 21% based on renewable materials.

Standards and impact categories

This study was conducted in line with ISO 14040:2006, which describes the principles and framework for LCA. It was also conducted in line with ISO 14044:2006, which specifies requirements and provides guidelines for LCA.

The impact categories which describe the environmental impacts of the frames include the use of natural resources, end-of-life output flows, but most importantly, core environmental impact indicators as defined in EN15804+A2. This standard is used when creating environmental product declarations (EPD) and includes impact indicators such as GWP, ozone depletion, acidification, eutrophication and other important indicators.

Results – Cradle to grave

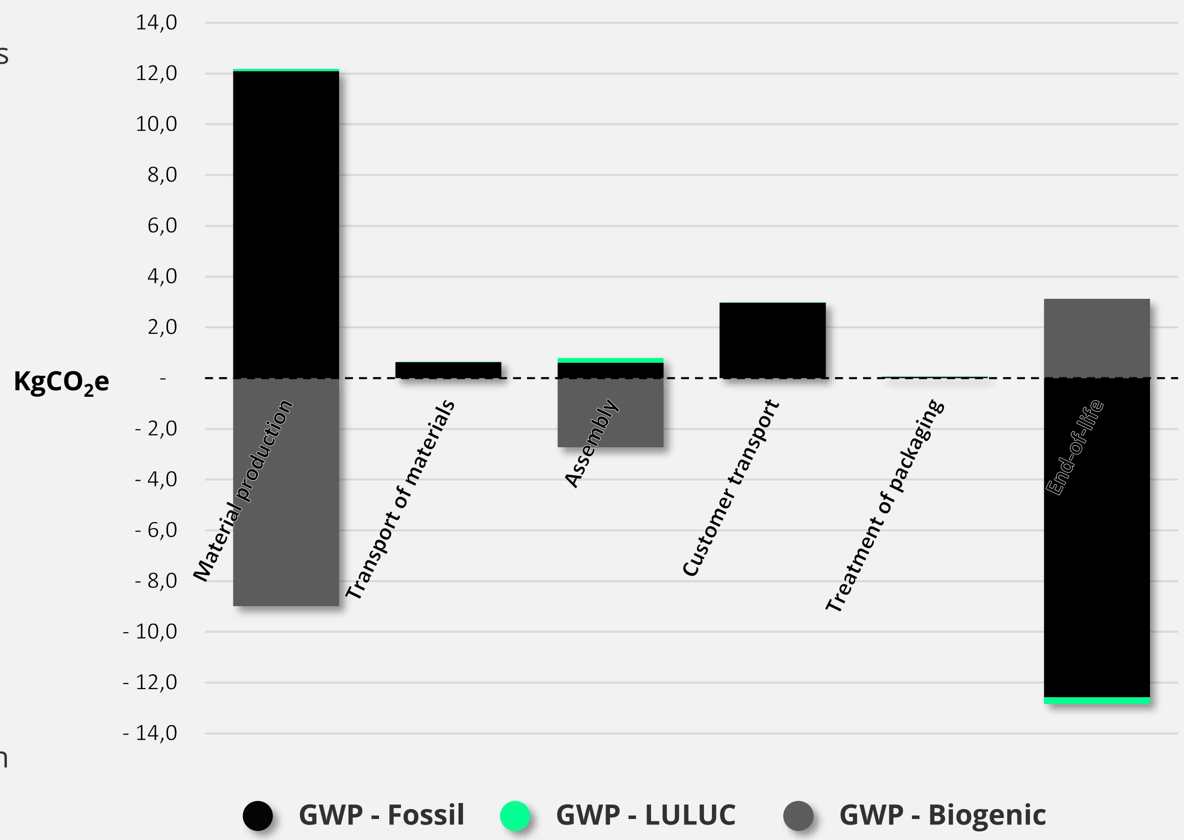
This page covers the greenhouse gas emissions generated during the entire life cycle of an Eker bicycle frame. Other impact categories are covered in the appendices on pages 11 and 12. The highest emissions are found during material production and at the end-of-life, where the bamboo is incinerated, and aluminium parts are recycled. Notice that a large amount of CO_2 is absorbed during production of bamboo and bark fibers. This CO_2 is stored in soil and in the frame until incineration at the end-of-life.

Different types of emissions

The results of an LCA can be interpreted in a variety of ways depending on which impact indicators and which life cycle stages are included. Because global warming is such a pressing matter, the main results of this LCA are expressed in global warming potential (GWP) measured in carbon dioxide equivalents (CO_2e). Depending on their origin, emissions are further divided into the four categories fossil, biogenic, LULUC (land use and land use change) and total GWP.

As shown in the diagram to the right, most emissions occur during material production. However, due to the use of bamboo and bark fibers, a large amount of CO_2 is absorbed during this phase. Customer transport is the second-largest contributor to fossil CO_2e, while fossil emissions from other life cycle phases are quite limited.

During the end-of-life phase, the CO_2 which was absorbed in the natural materials during production is released again through incineration of the frame. The heat and power from incineration processes are however harnessed. This, and recycling of aluminium parts, leads to avoided energy use from primary production, and is shown in the diagram as negative GWP – Fossil.



Results – Frame production

The production of one Eker bicycle frame produces approximately 13,3 kg of CO_2e deriving from fossil fuels. However, when accounting for the carbon dioxide stored in the natural materials and soil, the net emissions are 1,9 kg of CO_2e. The figure to the right shows global warming potential from fossil resources only, divided by materials included in the frame.

The diagram to the right presents the emissions of fossil CO_2e caused by the extraction, transport and processing of materials included in an Eker bicycle frame. Approximately 64 % of these emissions are caused by the aluminium fittings, and 27 % by the epoxy resin. The production and transport of the main material bamboo only accounts for about 9 %. Emissions caused by the fibre cloth are neglectable.

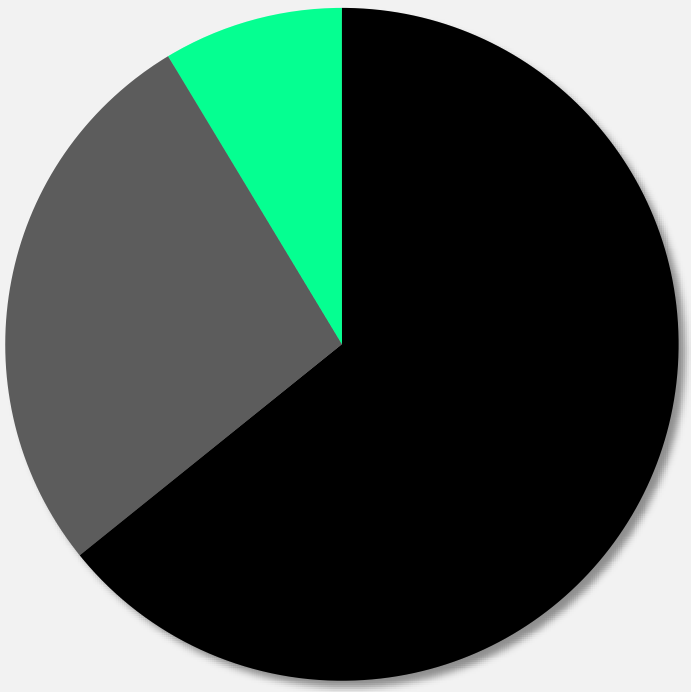
In terms of mass, the aluminium parts only account for 14 % of the frame's total 2,8 kg. But because aluminium is very energy intensive to manufacture, it makes a large contribution to the frame's total carbon footprint compared to the other materials. This impact can be reduced by increasing the share of recycled aluminium in these parts or reducing the amount of aluminium used for each part.

When considering the carbon stored in the bamboo and fibre cloth, as well as carbon stored in soil as these plants grow, the total global warming potential is significantly reduced. The use of these materials leads to approximately 9,1 kg of stored carbon dioxide. By adding these "negative emissions" to the emissions of greenhouse gases from fossil fuels and land use change, the total global warming potential can be calculated as seen below.

$$GWP_{Fossil} + GWP_{LULUC} + GWP_{Biogenic} = GWP_{Total}$$

$$\mathbf{13{,}3} + \mathbf{0{,}3} - \mathbf{11{,}7} = \mathbf{1{,}9}\ kgCO_2e$$

Global Warming Potential – Fossil CO_2e



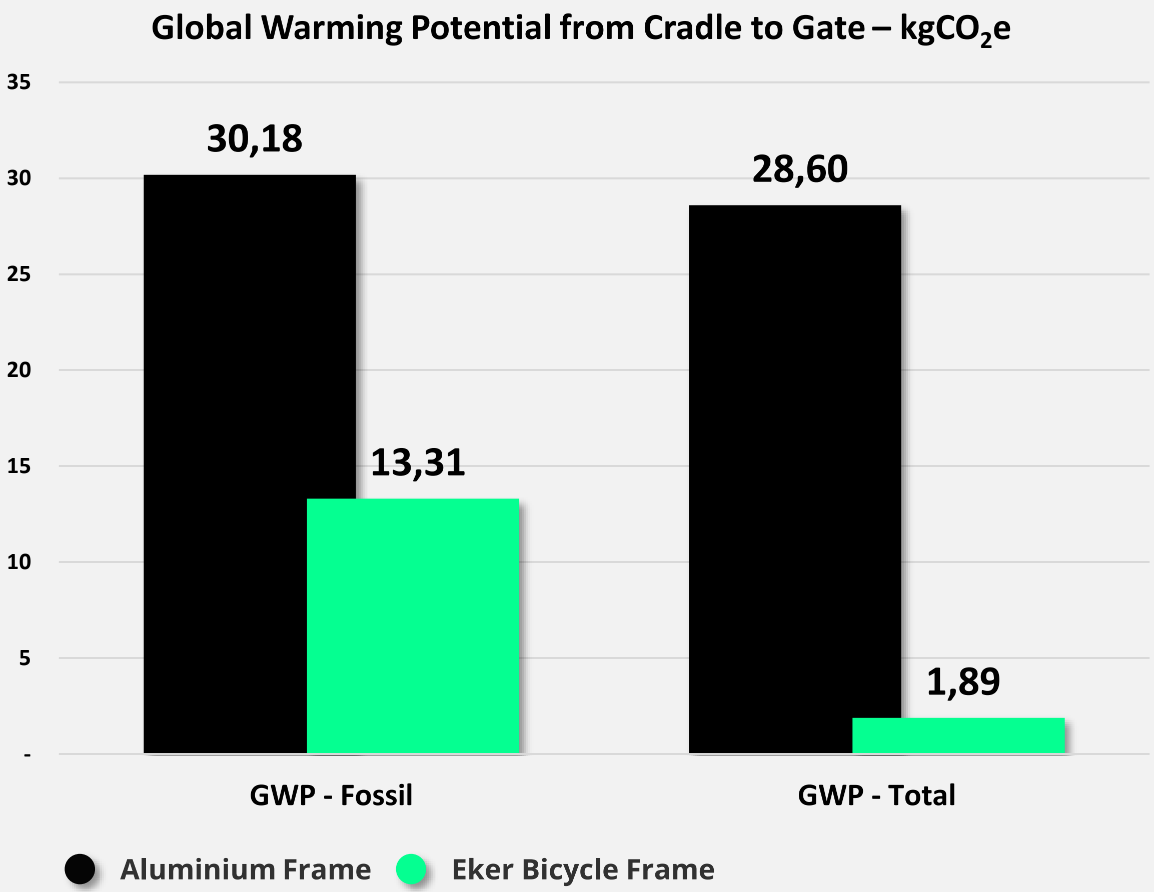
GWP-Fossil from materials only: 13,04 $kgCO_2e$

- **Aluminium:** 64 % **/** 8,38 $kgCO_2e$
- **Epoxy resin:** 27 % **/** 3,54 $kgCO_2e$
- **Bamboo:** 9 % **/** 1,13 $kgCO_2e$
- **Fibre cloth:** 0,002 % **/** 0,0003 $kgCO_2e$

Comparison

The results from this LCA have been compared to a generic model of an aluminium bicycle frame of similar dimensions. As most of the world's bicycles (35 %) are manufactured in China, this was chosen as a reference location for manufacturing. The aluminium frame was modelled using a mixture of generic data from the Ecoinvent 3.8 database and results from another, peer-reviewed life cycle assessment performed in 2016.

The comparison shows a 56 % reduction in global warming potential by fossil sources (GWP - Fossil) from cradle to gate when choosing an Eker Bicycle frame instead of the aluminium alternative. For GWP – Total, the reduction is 93 %. This reduction is partly caused by the lower use of aluminium components, but also by the bamboo's ability to store carbon in soil and the frame itself.



EKER BICYCLE FRAME

\+ Renewable main material
\+ Sustainably sourced main material
\+ Carbon stored in frame
\+ 56 % lower carbon footprint

\- Difficult to recycle main material
\- Slightly heavier frame

ALUMINIUM FRAME

\+ Recyclable main material
\+ Slightly lighter frame
\+ Standardized production

\- Non-renewable material
\- High energy use during production
\- Considerably higher carbon footprint

Conclusions

With this LCA, we have investigated the environmental impacts of the Eker bicycle frames from a life cycle perspective and compared these to a conventional aluminium frame. Whether you only consider the *production* of the frame or its entire life cycle, the Eker bicycle frame causes considerably lower greenhouse gas emissions than a conventional aluminium frame. This is because large amounts of energy is used to manufacture aluminium, and because a relatively large amount of CO_2 is stored in bamboo and the soil in which it was grown.

However, there is room for improvement in both of these frames. With an increased share of recycled aluminium in the conventional frame, emissions could be significantly reduced. This is of course also true for the aluminium parts of the Eker bicycle frame. Recycled aluminium has a much lower carbon footprint than virgin material, and is actually quite a common commodity due to well-established recycling systems around the world.

It is important to consider the fact that the CO_2 stored in the soil and frame will be released again eventually once the material is incinerated at the end of its life cycle. As with all products, it is therefore important to properly maintain and protect your frame to extend its life for as much as possible. Once the bike is no longer used, selling or giving it to another owner instead of throwing it away will also extend its life time and thereby store the CO_2 within the frame for even longer.

This study did not include any of the additional components that are part of a complete bicycle. This is because an Eker bicycle frame is used with similar components as a conventional frame would, so including these would not have contributed to the comparison. However, these components should also be properly maintained to avoid excessive replacements, which cost money and lead to additional greenhouse gases being released into the atmosphere.

The Eker bicycle frames provide an excellent example of how innovation and alternative materials or processes can accelerate our work against climate change, without compromising product quality or performance. It is important that the materials we use most, such as steel, concrete or plastics, become subject to a similar approach so that emissions can be reduced on a global scale.

APPENDIX 1. Core Environmental Impact Indicators

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	C2	C3	C4	D
GWP – total*	kg CO_2e	3,18E+00	6,34E-01	-1,93E+00	1,89E+00	2,96E+00	5,27E-02	1,31E-02	3,24E+00	0,00E+00	-1,30E+01
GWP – fossil	kg CO_2e	1,21E+01	6,34E-01	6,04E-01	1,33E+01	2,97E+00	5,27E-02	1,31E-02	1,15E-01	0,00E+00	-1,27E+01
GWP – biogenic	kg CO_2e	-8,99E+00	1,86E-04	-2,72E+00	-1,17E+01	4,51E-04	0,00E+00	7,26E-07	3,12E+00	0,00E+00	0,00E+00
GWP – LULUC	kg CO_2e	9,00E-02	1,56E-04	1,84E-01	2,74E-01	2,07E-04	4,52E-05	4,85E-06	5,64E-04	0,00E+00	-2,68E-01
Ozone depletion pot.	kg $CFC_{-11}e$	1,05E-06	1,44E-07	6,56E-08	1,26E-06	6,71E-07	3,52E-09	3,02E-09	1,61E-08	0,00E+00	-1,23E-06
Acidification potential	mol H^+e	7,30E-02	2,96E-03	3,82E-03	7,98E-02	1,57E-02	2,55E-04	5,56E-05	6,83E-04	0,00E+00	-7,50E-02
EP-freshwater	kg Pe	5,10E-04	3,58E-06	1,52E-05	5,28E-04	5,62E-06	1,47E-06	1,08E-07	3,29E-06	0,00E+00	-7,00E-04
EP-marine	kg Ne	1,11E-02	9,77E-04	7,52E-04	1,28E-02	5,78E-03	6,79E-05	1,65E-05	2,12E-04	0,00E+00	-8,75E-03
EP-terrestrial	mol Ne	1,19E-01	1,07E-02	7,30E-03	1,38E-01	6,34E-02	6,61E-04	1,82E-04	2,29E-03	0,00E+00	-9,63E-02
POCP ("smog")	kg NMVOCe	3,97E-02	3,09E-03	2,11E-03	4,49E-02	1,64E-02	2,17E-04	5,83E-05	6,49E-04	0,00E+00	-3,53E-02
ADP-minerals & metals	kg Sbe	1,51E-04	1,04E-06	1,35E-05	1,66E-04	1,13E-06	7,24E-07	3,08E-08	6,18E-07	0,00E+00	2,68E-04
ADP-fossil resources	MJ	1,68E+02	9,17E+00	5,62E+00	1,83E+02	4,08E+01	4,82E-01	1,97E-01	1,59E+00	0,00E+00	-1,97E+02
Water use	m^3e depr.	9,39E+00	3,13E-02	8,19E+00	1,76E+01	6,86E-02	8,92E-03	8,83E-04	1,82E-02	0,00E+00	-2,22E+01

*GWP = Global Warming Potential is measured in greenhouse gas emissions, which are further divided into fossil, biogenic and LULUC, where Total is the sum of these three; EP = Eutrophication potential; POCP = Photochemical ozone formation; ADP = Abiotic depletion potential.

APPENDIX 2. Use of Natural Resources

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	C2	C3	C4	D
Renew. PER* as energy	MJ	2,57E+01	7,89E-02	2,66E+01	5,24E+01	1,70E-01	3,66E-02	2,22E-03	8,95E-02	0,00E+00	-7,46E+01
Renew. PER as material	MJ	5,30E+01	0,00E+00	0,00E+00	5,30E+01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Total use of renew. PER	MJ	7,87E+01	7,89E-02	2,66E+01	1,05E+02	1,70E-01	3,66E-02	2,22E-03	8,95E-02	0,00E+00	-7,46E+01
Non-re. PER as energy	MJ	1,59E+02	9,17E+00	5,62E+00	1,74E+02	4,08E+01	4,82E-01	1,97E-01	1,59E+00	0,00E+00	-1,97E+02
Non-re. PER as material	MJ	8,72E+00	0,00E+00	0,00E+00	8,72E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Total use of non-re. PER	MJ	1,68E+02	9,17E+00	5,62E+00	1,83E+02	4,08E+01	4,82E-01	1,97E-01	1,59E+00	0,00E+00	-1,97E+02
Secondary materials	kg	9,98E-02	1,77E-03	3,95E-03	1,06E-01	1,84E-03	1,07E-03	5,48E-05	9,31E-04	0,00E+00	1,60E+00
Renew. secondary fuels	MJ	2,17E-03	1,87E-05	6,53E-05	2,25E-03	2,94E-05	4,66E-06	5,53E-07	1,99E-05	0,00E+00	-3,44E-04
Non-ren. secondary fuels	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Use of net fresh water	m^3	2,13E-01	8,88E-04	1,91E-01	4,05E-01	1,81E-03	2,26E-04	2,56E-05	3,74E-04	0,00E+00	-4,92E-01

*Primary Energy Resources.

APPENDIX 3. End of Life – Output Flows

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	C2	C3	C4	D
Components for re-use	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Materials for recycling	kg	0,00E+00	0,00E+00	1,20E+00	1,20E+00	0,00E+00	0,00E+00	0,00E+00	4,00E-01	0,00E+00	0,00E+00
Materials for energy rec	kg	0,00E+00	0,00E+00	1,50E+00	1,50E+00	0,00E+00	2,00E+00	0,00E+00	2,40E+00	0,00E+00	0,00E+00
Exported energy	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

Materials can have different ends of life depending on their ability to be reused, recycled or incinerated.