# Environmental Product Declaration

In accordance with ISO EN 14025:2010 and PCR 2021:03 V1.1 for

## Green $CO_2$

| | |
|---|---|
| Programme: | The International EPD® System, www.environdec.com |
| Programme operator: | EPD International AB |
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An EPD should provide current information and may be updated if conditions change.
The stated validity is therefore subject to the continued registration and publication at www.environdec.com.

# Program operator and EPD information

| | |
|---|---|
| **EPD program operator:** | The International EPD® System<br>EPD International AB<br>Box 210 60<br>SE-100 31 Stockholm<br>Sweden<br>www.environdec.com<br>info@environdec.com |

| **PCR, LCA and third-party verification data** |
|---|
| **Product category rules (PCR)** |
| PCR: Basic chemicals. 2021:03, Version 1.1. Product category classification: UN CPC Group 342 Basic inorganic chemicals. 3421 Hydrogen, Nitrogen, Oxygen, Carbon Dioxide and Rare gases |
| PCR review was conducted by: International EPD® System Technical Committee - Lars-Gunnar Lindfors. Contact: info@environdec.com |
| **Life Cycle Assessment (LCA)** |
| LCA preparation: *Tecnalia – Centro de Investigación y Desarrollo Tecnológico* |
| **Third party verification** |
| Independent verification of the declaration, according to EN ISO 14025:2010:<br><br>☒ External verification<br><br>Third party verifier: Elisabet Amat, GREENIZE. eamat@greenize.es<br><br>Accredited or approved by: The International EPD® System |
| Procedure for follow-up of data during EPD validity involves third party verifier:<br><br>☐ Yes ☒ No |

The EPD owner has the sole ownership, liability, and responsibility for the EPD. EPDs within the same product category but from different programs may not be comparable.For further information about comparability, see ISO 14025

The geographical scope is Spain and the reference year of the data used in the EPD is 2022.

# Company information

EPD Owner: Carburos Metálicos.

Contact data: expertos@carburos.com

Description of the organisation: Carburos Metálicos is a leading company in the industrial and medical gases sector that produces, distributes and sells gases for multiple sectors: metallurgy, glass, water, food, medicinal, energy, petrochemical, laboratories, freezing, refrigeration, enology, leisure and beverages. The company provides a wide range of products, solutions and services to its customers, as well as materials and equipment intended for the applications of these gases.

Founded in 1897, Carburos Metálicos has been serving the industry for 125 years and has always maintained a strong link with society. Currently, it is a leader in the industrial and medical gases sector in Spain and a benchmark in the chemical sector in matters of safety, innovation and sustainability.

Carburos Metálicos has a team of more than 700 professionals in Spain, a daily production capacity of more than 1,200 tons of liquefied gas (mtpd), 12 production plants, 14 packaging plants, 2 laboratories of high purity gases and an R+D center located in Bellaterra (Barcelona) that serve more than 100,000 customers. Since 1995, the company belongs to the American group Air Products (NYSE:APD).

The group recorded sales of $10.3 billion in 2021 from its activities in more than 50 countries and currently has a market capitalization of around $65 billion. More than 20,000 employees from diverse, passionate, committed and talented backgrounds are guided by Air Products' ultimate goal of creating innovative solutions that benefit the environment, improve sustainability and address the challenges facing customers, communities and the world.

Plant certifications: Carburos metálicos owns the following product and management systems certifications: Ecovadis 2021 (gold), ISO 9001, ISO 14001, ISO 45001, ISO 13485, ISO 22000, ISO 50001 e ISO 26000. Garray facilities owns the following product and management systems certifications: ISO 9001, FSSC 22000.

Name and location of the production site: The production of carbon dioxide takes place in a separation, purification and liquefaction plant coupled to the Bioelectric electricity production plant of Garray, located in Ctra. Tardesillas – El Royo, km. 4.5. 42162 – Garray, Soria, Spain.

# Product description

Trade name: Green $CO_2$.

Product identification: $CO_2$, CAS 124-38-9.

Product description: This study covers a single product, $CO_2$ obtained from the waste exhaust gases of a biomass-fueled power cycle to generate electricity located in Garray, Soria, Spain. The power plant belongs to the company ENSO, while Carburos Metálicos manages the plant that recovers the residual gases that leave the biomass boiler, being able to convert these gases into **liquefied green $CO_2$ after a purification and separation process**, as it is a current generated from the combustion of biomass of forest and agricultural waste.

Carbon dioxide has numerous industrial applications, so it is not possible to define a single usage scenario. Among some of its industrial applications are raising agent for carbonated beverages, precursor in the chemical and fuel industry, preservative product and generator of inert atmospheres in the agri-food industry, food in algae industry, precursor in fire-fighting systems, etc.

The product is marketed liquefied in steel tanks that serve for transport from the generation plant to its point of use.

*Table 1: Physic-chemical characteristics of the product.*

| Physic-chemical characteristics | |
|---|---|
| **Name** | Carbon dioxide |
| **Alternative names** | Carbonic acid gas, Carbon anhydrous, R-744, dry ice. |
| **Chemical formula** | $CO_2$ |
| **Molecular weight** | 44.011 g/mol |
| **CAS Number** | 124-38-9 |
| **REACH (1907/2006 18th December 2006)** | Included |
| **State** | Liquid |
| **Colour** | Colourless |
| **Smell** | **None at low concentrations and acid at high concentrations** |
| **Fusion point** | -56.6ºC at 5,2 atm. |
| **Hazardous (Regulation 1272/2008)** | **Hazardous by inhalation in concentrations above 5,000 ppm** |
| **Danger in transport (ADR, RID, IMDG, IATA)** | Dangerous from 1,000 litres. |
| **Flammability** | Non-flammable |
| **Explosiveness** | Non-explosive |
| **Density (g/ml)** | 1.032 (liquid at -20ºC and 20 bar) |
| **Humidity** | 0.00 |
| **Solubility** | 1.45 g/l at 1 bar and 25ºC |

UN CPC Code: 342 Basic inorganic chemicals under the UN CPC Classification System v.2.1. Sub-heading: 3421, Hydrogen, Nitrogen, Oxygen, Carbon dioxide and rare gases; Inorganic oxygen compounds of nonmetals.

Geographical scope: Spain.

# LCA calculation information (LCA)

Declared unit: the LCA study has been carried out for a declared unit instead of the functional unit, this being 1 kg of green $CO_2$ delivered to the customer in liquid state.

Temporal representativeness: The data used have been obtained for the months between May and September 2022.

Data base(s) and LCA software: The data used to model the process and obtain the Life Cycle Inventory are specific and have been obtained in the previous period. These data are representative of the different processes implemented in the production center to obtain the final product. The data has been measured directly under the company's own premises.

The European life cycle inventory database Ecoinvent 3.6 has been used and Simapro 9.3 was used for impact modelling. The selected assessment methods are those corresponding to EN 15804:2012+A2:2019.

System boundaries: This study covers the activities of separation, purification, compression and liquefaction and storage in the facilities of Garray (Soria, Spain), transport to customer and end of life of the tank used to transport the product.

The production period for the analysis was from 1 May 2022 to 30 September 2022. It should be noted that this facility is experimental and that, therefore, the data collection period so far has been five months, that is, from the start-up period up to the time of EPD development. In that period, adjustments have been made to the plant and, therefore, the data shows a remarkable variability between months. At the time this EPD is made, the average information of these five months has been used. In the case of subsequent modifications to the plant, or when there is at least one year of operating data, this EPD may be subject to an update.

The scope of the LCA study covers the modules "upstream (cradle to gate)", "core (gate to gate)" and "downstream (gate to grave)", consistent with application PCR requirements.

With regard to the upstream module, the processes covered in the study contemplate the generation of the exhaust gas stream in the the boiler of the power cycle (including the associated transport of biomass, but not to its growth and collection as it is considered a waste), the generation of electricity and steam used in the $CO_2$ separation plant, generated in the power cycle coupled (considering all consumables and waste generated in the power plant), the manufacture and treatment of waste generated in the production of auxiliary materials used in the plant and the manufacture of the storage tank for transport of $CO_2$ to the customer.

In the core module, the transport of auxiliary materials to the capture and separation plant has been considered, including the waste generated by these, the emissions and discharges generated by the consumption of the auxiliaries and the consumption of electricity, water and steam.

In the downstream module, transport to customer and end-of-life of the transport tank have been considered, but the use phase and the end of life of the product are excluded, since it is a product usable for such a wide range of applications that it is not possible to identify a specific use phase. Personnel-related impacts, such as transportation to and from work, are not accounted for in the LCI, as are infrastructure.

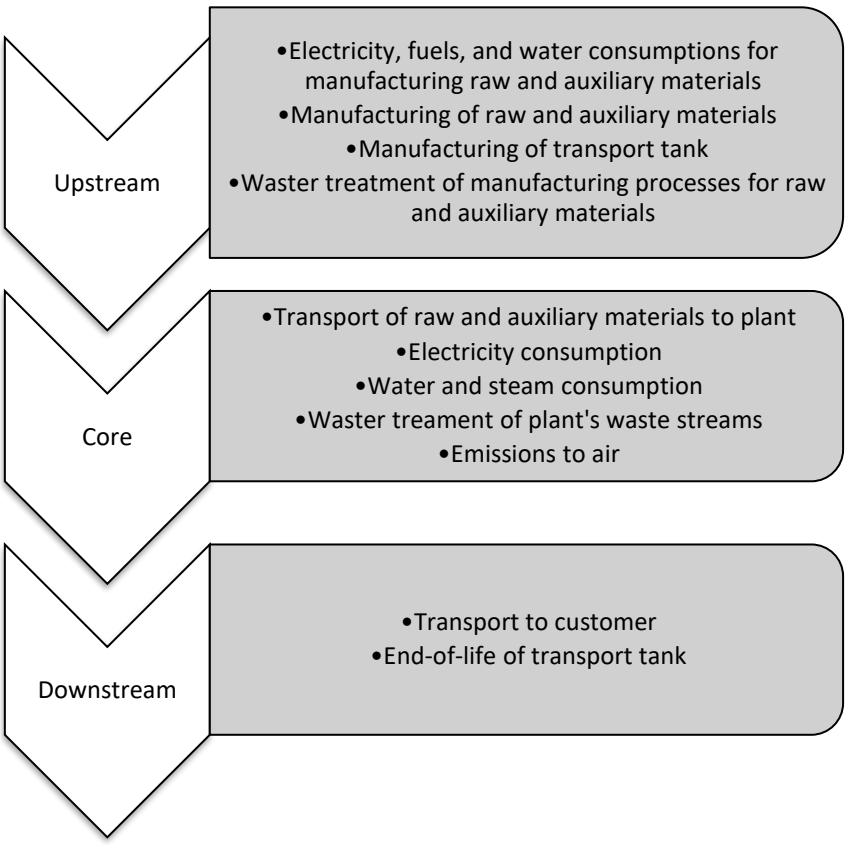


*Figure 1: System boundaries.*

Carburos Metáicos carbon capture plant and power cycle facility:

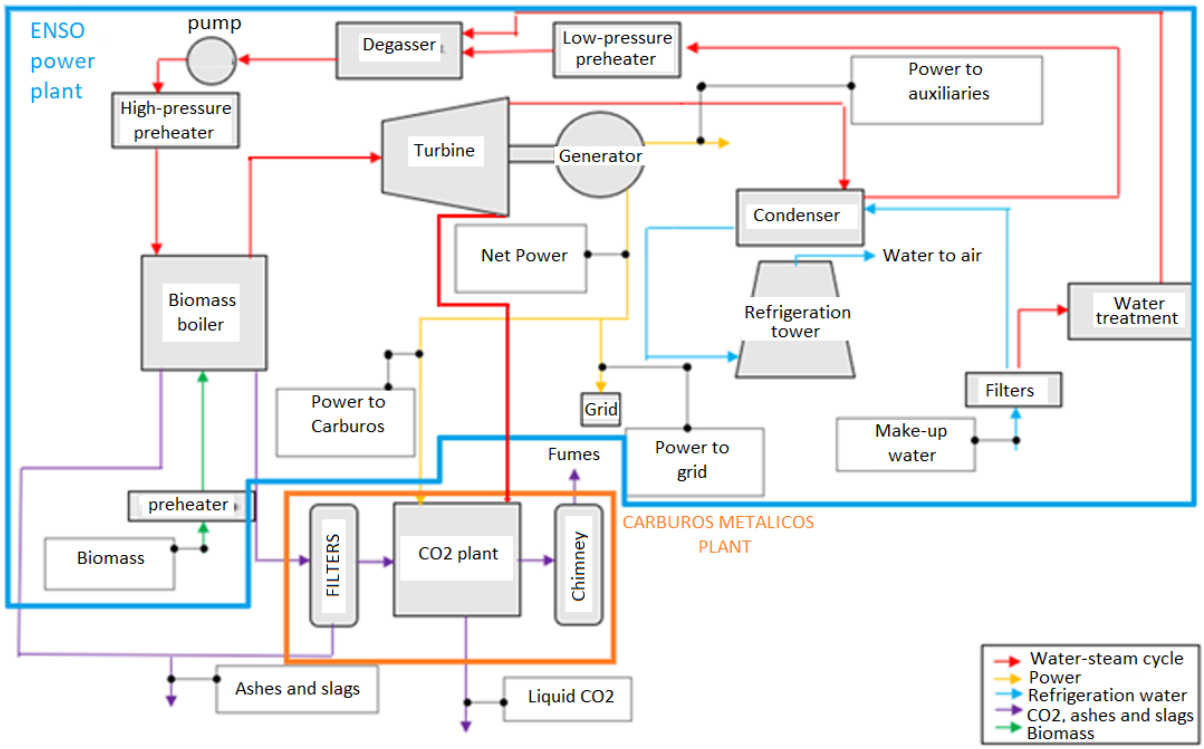


*Figure 2: Diagram of the production process covered by the LCA study.*

*Figure 3: Power plant and gas separation system (Carburos Metálicos)*

The compressed $CO_2$ could be transported by pipeline to its point of consumption, but in this case the $CO_2$ is liquefied and stored in 250-tonne $CO_2$ tanks and then other tanks or bottles can be filled with stored $CO_2$.

Liquefaction is a complex process that uses various compressions and expansions to produce high pressures and very low temperatures. To summarize, the process consists of cooling $CO_2$ to a temperature below its critical temperature so that liquid carbon dioxide can be formed at an appropriate pressure, also below the crucial pressure. After moving to a liquid state, $CO_2$ is ready to be stored in storage tanks at 17.5 bar.

Power from the power cycle, deionized water, steam extracted from the last turbine stage of the power plant, activated carbon, NaOH and amines, as well as exhaust gases from the power cycle's boiler are inputs in the system under study. On the other hand, the waste generated (amines, activated carbon and filters), unused air emissions ($CO_2$, CO, NOx, $SO_2$ and $H_2O$) and liquefied green $CO_2$ are outputs from the system.

Excluded lifecycle stages: The use phase has been excluded from the downstream module, because it is not possible to identify a single use or a scenario of specific uses. For the same reason, the end-of-life of the product is also excluded.

Data quality: The calculation is based on established international standards for the development of environmental product declarations, such as ISO 14025 for the preparation of the environmental declaration of the product, ISO 14040 and ISO 14044 for the preparation of the life cycle assessment and product category rules (PCR): Basic chemicals 2021:03, Version 1.1.

The data related to the supply of raw materials, transport to the treatment plants, production and distribution (upstream, core and downstream) are based on the specific consumptions of the production center located in Garray, Soria, Spain for the year 2022. Data quality analysis reflects good geographical representativeness and very good technological and temporal representativeness.

Allocation procedure:

- For the evaluation of the impacts of electricity and steam, an allocation has been made where all impacts have been attributed to electricity and steam, assuming that the power plant owner does not obtain any benefit (and as such is a residue) from the exhaust gas stream of his boiler.
- In the plant of Carburos Metálicos there are no co-products, so there is no allocation.
- The waste management data correspond to all the waste generated in the facilities of the production plant.
- Distribution and scenario were created for the declared (mass) unit.

Assumptions: LCA has followed the polluter-pays principle and the modularity principle (environmental loads are assigned to the stage where the impact occurs). In the preparation of this EPD, the following must be considered:

- It does not include manufacturing equipment, capital goods, spare parts and / or maintenance, whose useful life is equal to or greater than 3 years.
- The environmental impact corresponding to the general management, offices and central services is not included.
- The impact caused by people (common activities, travelling, etc.) is not considered.
- The consumption of natural gas for sanitary hot water in showers and staff heating is not included.
- The environmental impact of external transport has been calculated using the trucks from the Ecoinvent 3.6 database: Euro VI with a capacity of 3.5-7.5 tonnes for auxiliary and waste transport and 16-32 tonnes for product transport.
- For the impact associated with the acquisition of auxiliary materials, the location of the suppliers has been considered, which are located at between 250 and 450 km from the production plant. For the waste management of the plant, the real location of the manager located 162 km from the production plant has been used.
- A scenario has been defined to get the distance to the average customer. For the calculation of this average distance, the data of sales of this product managed by Carburos Metálicos have been used, as well as a theoretical scenario with an expected distance of 400 km for the product sold to the customer that has been transported by said client, obtaining an average distance to customer of 604 km.
- The fuel in the biomass boiler comes from forest wastes (between 5 km and 333 km) and an average distance to the plant of 150 km has been considered. In particular, forest wastes are composed of chips, vines, roll, pruning residues, branches, bales, chipped bark and long bark, all materials that are not considered energy crops so their impact has been considered zero, being wastes from other production processes.
- It has been considered that the plastic and metal drums where the auxiliaries are distributed are made of 50% plastic and 50% metal. It has been considered that 80 % of these drums are recycled while 20% are considered under landfill treatment. For residual activated carbon and contaminated filters, an incineration treatment for hazardous waste has been considered. In the case of residual amines, a chemical treatment for these is considered.

Cut-off rules: the downstream phase has been excluded from the downstream stage because it is not possible to identify a single use or a scenario of specific uses, as well as, for the same reason, the end-of-life of the product. Data for elementary flows to and from the product system contributing to a minimum of 99% of the declared environmental impact have been included.

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# Content declaration

## Product composition

| Description | [weight, kg] | % | Post-consumer or post-industrial material, weight, % raw material | Renewable material, weight, % raw material |
|---|---|---|---|---|
| $CO_2$ | 1 | 100 | 100 | 100 |

**Declaration of hazardous substances:** Declared products contain less than 0.1% or no hazardous substances from the "Candidate of Substances of Very High Concern" list. All material products declared here comply with REACH Regulation (EC) No 1907/2006 on the Registration, Evaluation, Authorisation and Restriction of Chemicals.

## Packaging

This product does not use packaging. Tanks or bottles can be used for transport. In particular, it has been considered to be transported in a liquid state in a 22-tons capacity steel tank. Likewise, the recycling of this tank has been considered as a conservative scenario, similar to what would be done in the treatment of packaging for another product.

## Recycled material content

It has been considered that all the raw material is post-consumption, since it comes from the combustion of biomass obtained from pruning remains. For the same reason, the raw material has been considered to be 100% renewable.

## Biogenic carbon

Due to the nature of its components, it is considered that the product ($CO_2$) has a 100% biogenic origin as it comes from biomass from forest residues and pomace.

| Biogenic carbon content | Unit | Amount |
|---|---|---|
| Biogenic carbon in the product | kg C | 2,72E-01 |
| Biogenic carbon in the packaging | kg C | 0,00E+00 |

It should be highlighted that 1 kg of biogenic coal is equivalent to 44/12 kg $CO_2$.

# Environmental performance

## Environmental impact potential

| Environmental indicator | | UNIT | Upstream | Core | Downstream | TOTAL |
|---|---|---|---|---|---|---|
| Global Warming Potential (GWP) | Fossil | kg $CO_2$ eq. | 9,93E-03 | 2,31E-02 | 8,14E-02 | 1,14E-01 |
| | Biogenic | kg $CO_2$ eq. | 2,38E-05 | 1,45E-04 | 4,38E-06 | 1,73E-04 |
| | Land use and land transformation | kg $CO_2$ eq. | 9,63E-06 | 1,74E-06 | 6,18E-07 | 1,20E-05 |
| | TOTAL | kg $CO_2$ eq. | 9,97E-03 | 2,32E-02 | 8,14E-02 | 1,15E-01 |
| Ozone Depletion Potential (ODP) | | kg CFC 11 eq. | 2,79E-09 | 3,32E-09 | 1,49E-08 | 2,10E-08 |
| Acidification potential (AP) | | mol $SO_2$ eq. | 3,07E-05 | 4,19E-05 | 1,34E-04 | 2,07E-04 |
| Eutrophication potential (EP) | Freshwater | kg P eq. | 3,93E-07 | 1,02E-06 | 4,46E-08 | 1,45E-06 |
| | Marine | kg N eq. | 3,33E-05 | 6,58E-04 | 2,68E-05 | 7,18E-04 |
| | Terrestrial | mol N eq. | 8,36E-05 | 1,52E-03 | 2,98E-04 | 1,90E-03 |
| Formation Potential of Tropospheric Ozone (POCP) | | kg NMVOC eq. | 2,21E-05 | 5,08E-05 | 1,05E-04 | 1,78E-04 |
| Abiotic Depletion Potential (ADP) | Mineral and metals | kg Sb eq. | 1,02E-09 | 1,10E-09 | 3,46E-09 | 5,57E-09 |
| | Fossil resources* | MJ, n.c.p. | 2,03E-01 | 2,30E-01 | 1,16E+00 | 1,59E+00 |
| Water Scarcity Potential (WDP) | | $m^3$ eq. | 7,92E-03 | 4,06E-02 | -1,64E-04 | 4,83E-02 |

* Disclaimer: The results of this environmental impact indicator shall be used with care as the uncertainties of these results are high or as there is limited experience with the indicator

## Resources use

| PARAMETER | | UNIT | Upstream | Core | Downstream | TOTAL |
|---|---|---|---|---|---|---|
| Primary Energy Resources - Renewable | Use as energy carrier | MJ, n.c.p. | 1,16E-02 | 2,09E-03 | 1,70E-03 | 1,54E-02 |
| | Use as raw material | MJ, n.c.p | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 |
| | TOTAL | MJ, n.c.p | 1,16E-02 | 2,09E-03 | 1,70E-03 | 1,54E-02 |
| Primary Energy Resources – Non-renewable | Use as energy carrier | MJ, n.c.p | 2,45E-01 | 2,45E-01 | 1,23E+00 | 1,72E+00 |
| | Use as raw material | MJ, n.c.p | 6,09E-04 | 0,00E+00 | 0,00E+00 | 6,09E-04 |
| | TOTAL | MJ, n.c.p | 2,45E-01 | 2,45E-01 | 1,23E+00 | 1,72E+00 |
| Secondary Material | | kg | 1,05E+00 | 0,00E+00 | 0,00E+00 | 1,05E+00 |
| Renewable Secondary Fuels | | MJ, n.c.p | 0,00E+00 | 8,17E+02 | 0,00E+00 | 8,17E+02 |
| Non-renewable Secondary Fuels | | MJ, n.c.p | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 |
| Net use of freshwater | | $m^3$ | 0,00E+00 | 8,40E-04 | 0,00E+00 | 8,40E-04 |

## Waste production and outputs flows

### Waste production

| PARAMETER | UNIT | Upstream | Core | Downstream | TOTAL |
|---|---|---|---|---|---|
| Hazardous waste disposed | Kg | 8,06E-08 | 7,19E-07 | 3,06E-06 | 3,86E-06 |
| Non-hazardous waste disposed | kg | 2,61E-04 | 1,23E-02 | 4,83E-05 | 1,26E-02 |
| Radioactive waste disposed | kg | 5,37E-07 | 1,60E-06 | 8,38E-06 | 1,05E-05 |

### Outputs flows

| PARAMETER> | UNIT | Upstream | Core | Downstream | TOTAL |
|---|---|---|---|---|---|
| Components for re-use | kg | 0,00E+00 | 1,24E-08 | 0,00E+00 | 1,24E-08 |
| Materials for recycling | kg | 0,00E+00 | 0,00E+00 | 6,50E-04 | 6,50E-04 |
| Materials for energy recovery | kg | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 |
| Exported energy, Power | MJ | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 |
| Exported energy, Thermal | MJ | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 |

# Additional information

The impacts associated with the different modules are represented below for all the impact categories analyzed.

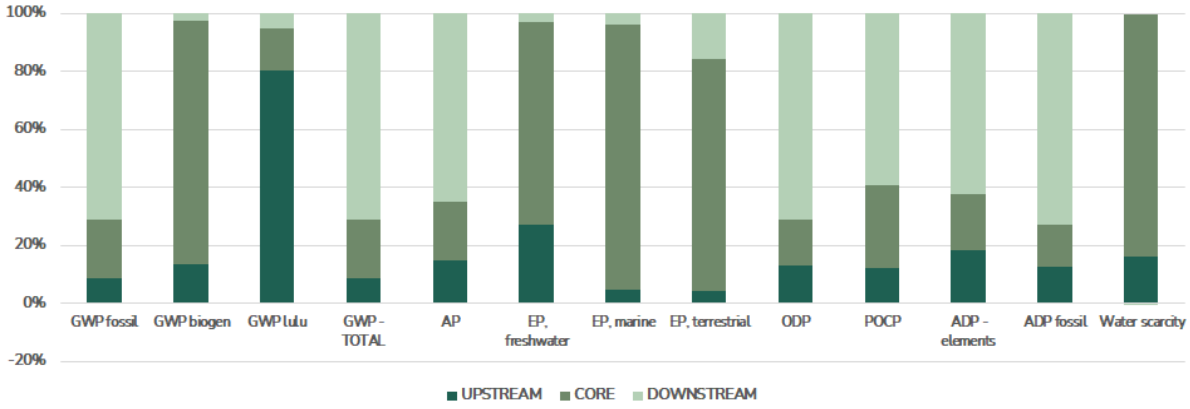


*Figure 4: Environmental impact indicators by stage for 1 kg green $CO_2$.*

Figure 4 determines that:

- The downstream module is the main responsible in almost all impact categories except for eutrophication and water scarcity where the core phase is mainly responsible.
- In the change of land uses, the upstream module has a relevant impact, due to the generation of electricity to produce the amines and hydroxide and the production of cotton to produce the filters.

**Contribution of declared modules to resource use indicators**

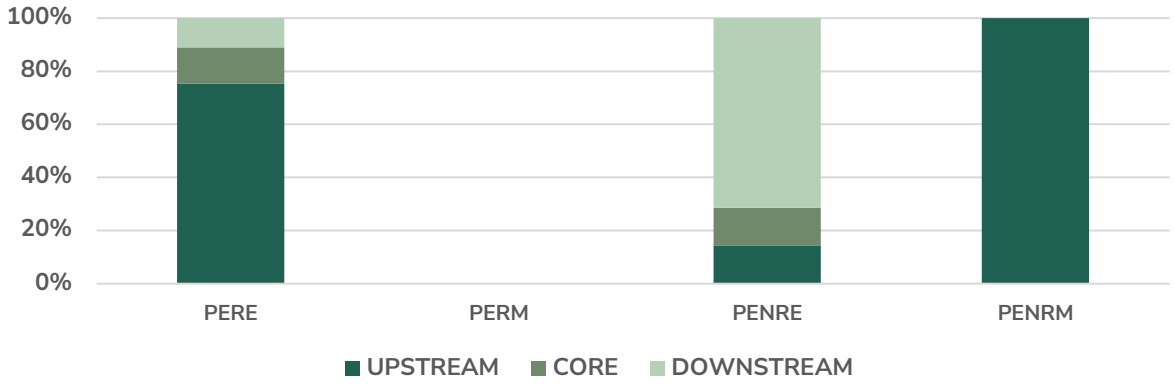


*Figure 5: Contribution of modules to energy resource use indicators.*

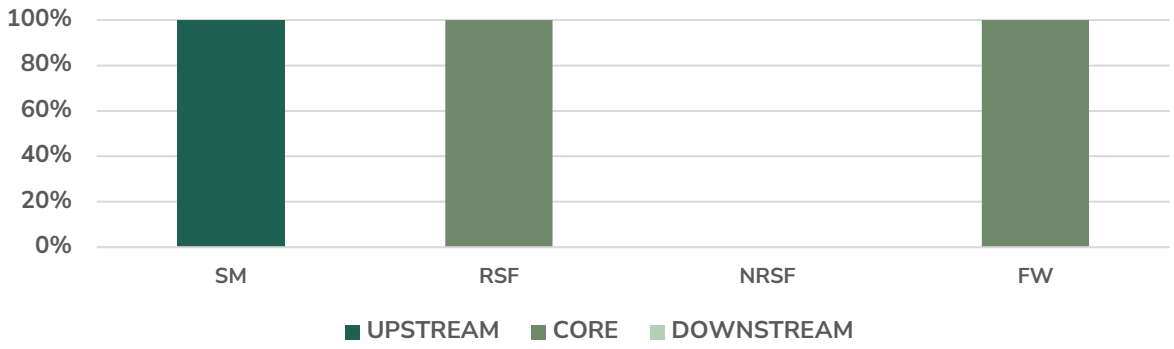


*Figure 6: Contribution of modules to indicators of use of non-energy resources.*

From figures 5 and 6 it can be extracted that:

- In terms of the renewable primary energy resource, approximately 75% of the impact is associated with the upstream module, followed by the downstream module and the power plant. When the impacts are analyzed, this is due to thermal and electrical energy coming from biogenic sources (wood chips), hydroelectric and wind energy to produce sodium hydroxide and amines, followed by the impacts associated with electricity to produce diesel for transport.
- No energy resource is introduced into the life cycle in the form of renewable matter (PERM), but non-renewable (such as activated carbon) and this is reflected in the upstream stage (PERNM).
- The results of the indicators of use of non-renewable primary energy resources (PENRE), show that the greatest source of impact is the consumption of fuels due to transport.
- As far as secondary material is concerned, 100% of the impacts refer to the gases coming from the power cycle plant, and this is reflected in the upstream module.
- As far as secondary fuels are considered, 100% of thermal and electrical energy comes from renewable sources and this is reflected in the central module.
- On the other hand, the indicator of freshwater use (FW) is primarily associated with consumption during the separation stage in the core module.

**Contribution of declared modules to waste indicators**

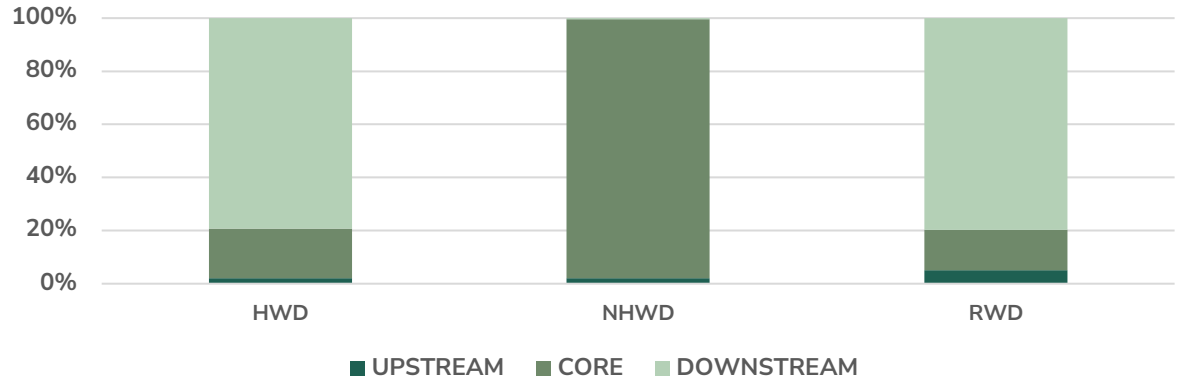


*Figure 7: Contribution of modules to waste stream indicators.*

Figure 7 determines that:

- The hazardous waste indicator (HWD) is mainly evident in the downstream module, due to the transport of finished product by road.
- The NHWD indicator (non-hazardous waste), is determined from the mixture of ordinary waste produced in the central module, for electricity production (96%), which is managed in a local landfill and inert waste that is also deposited in landfill, mostly due to slag generated in the electricity production plant.
- The RWD indicator (radioactive waste), presents results that originate in the energy consumption for transport, however, the magnitudes obtained are a much lower amount than the other indicators for all the cases studied.

**Contribution of declared modules to output flow indicators**

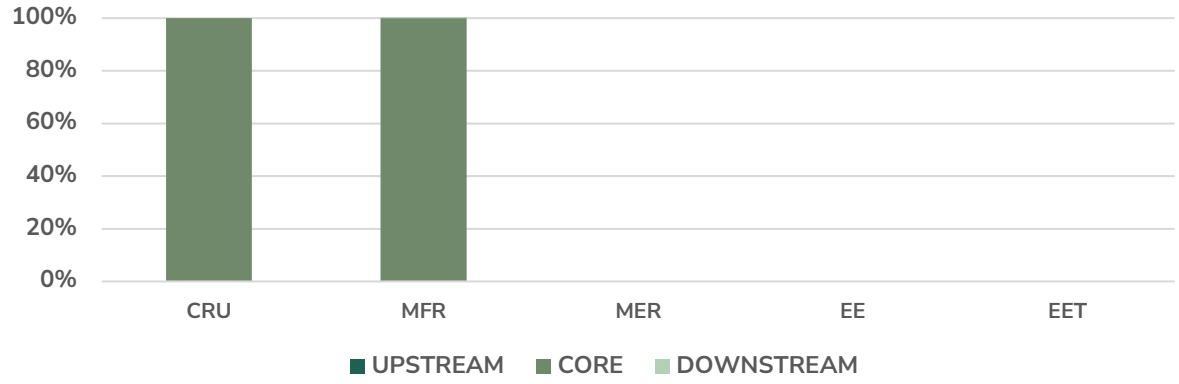


*Figure 8: Contribution of the evaluated modules to the output flow indicators.*

From Figure 8 it can be extracted that:

- The Material for Reuse (CRU) indicators have the impact associated with the reuse of the steel tank for transporting $CO_2$ again. In the case of exported energy, it does not have contributions in the data inventory at any stage. Waste sent for recycling (MFR) is reported, including non-hazardous waste associated with the end-of-life of the steel tank after 20 years but much less than that associated with the recycling of the drums where soda and amines are transported to the plant.
- There is no energy recovery from waste so there is no material for energy recovery or exported energy.

## Differences from previous versions

*This version of the DAP is the first version.*

## References


- *General Programme Instructions of the International EPD® System. Version 4.0.*
- *BASIC CHEMICALS PRODUCT CATEGORY CLASSIFICATION: UN CPC 341, 342, 343, 345 (EXCEPT SUBCLASS 3451). PCR 202121:0303. V . 1.11.1 valid until 2025-05-03*
- *EN 15804:2012+A2:2019. Sustainability of construction works. Environmental product declarations. Core rules for the product category of construction products.*
- *ISO 14025:2006. Environmental labels and declarations — Type III environmental declarations — Principles and procedures.*
- *ISO 14040:2006 – "Environmental management – Life cycle assessment – Principles and framework".*
- *ISO 14044:2006 – "Environmental management – Life cycle assessment – Requirements and guidelines".*
- *Ecoinvent 3.6 Cut-Off, allocation cut-off. 2020.*
- *Factores de emisión. Registro de huella de carbono, compensación y proyectos de absorción de dióxido de carbono. Ministerio para la Transición Ecológica y el Reto Demográfico. Versión 17, abril 2021.*

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