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The Norwegian EPD Foundation

# ENVIRONMENTAL PRODUCT DECLARATION

in accordance with ISO 14025

| | |
|---|---|
| Owner of the declaration: | Hexagon Ragasco AS |
| Program operator: | The Norwegian EPD Foundation |
| Publisher: | The Norwegian EPD Foundation |
| Declaration number: | NEPD-2950-1647-EN |
| Issue date: | 07.07.2021 |
| Valid to: | 07.07.2026 |

## Composite LPG cylinder

Hexagon Ragasco AS

www.epd-norge.no

## General information

**Product**

Hexagon Ragasco composite LPG cylinder, 24,5L

**Owner of the declaration**

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**Manufacturer**

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e-mail: info@hexagonragasco.com

**Declaration number**

NEPD-2950-1647-EN

**Place of production:**

Raufoss, Norway

**This declaration is based on Product Category Rules:**

NPCR 023:2019 Packaging products and services (07/2019)

**Management system:**

ISO 9001:2015, ISO 14001:2015 ISO 50001:2018

**Statements**

The owner of the declaration shall be liable for the underlying information and evidence.
EPD Norway shall not be liable with respect to manufacturer, life cycle assessment data and evidences.

**Organisation no:**

878612752

**Issue date**

07.07.2021

**Valid to**

07.07.2026

**Declared unit:**

1 Composite LPG cylinder with a capacity of 24,5 L

**Year of study:**

2019

**Declared unit with option:**

1 Composite LPG cylinder with a capacity of 24,5 L, cradle-to-gate A1-A3, A4

**Comparability:**

EPDs from different programme operators might not be directly comparable

**Functional unit:**

**The EPD has been worked out by:**

Alexander Borg

Alexander Borg

asplan viak

**Verification:**

Independent verification of the declaration and data, according to ISO14025:2010

☐ internal ☑ external

Third party verifier:

Christofer Skaar

SINTEF

Christofer Skaar, PhD
(Independent verifier approved by EPD Norway)

Approved

Håkon Hauan
Managing Director of EPD-Norway

## Product description

Hexagon Ragasco is the largest global manufacturer of composite LPG (Liquified Petroleum Gas, i.e., propane/butane mixes) cylinders.

The company has over the last 21 years developed and operated a fully automated manufacturing plant in Raufoss, Norway, with an annual production capacity of 2 million cylinders. Since the year 2000, the company has sold over 19 million cylinders in over 85 countries. The cylinders are fully compatible with Bio-LPG, also called renewable LPG.

The Hexagon Ragasco cylinders are designed in compliance with international T4 composite cylinder standards like EN 12245, EN 14427, ISO 11119-3, DOT-SP 12706 and TC SU 5931. The products have unique benefits which give environmental advantages in all phases of the products lifetime:

- **Lightweight:** reduced product weight by approx. 50% compared to traditional steel cylinders, resulting in reduced raw material consumption, reduced carbon emissions during transportation and reduced material for end-of-life handling.
- **Rust-free materials:** prolonged lifetime in high humidity climates, eliminates the need for refurbishment as required for steel cylinders and which generates toxic residues such as paints and chemicals.
- **Durability:** durable cylinders with proven lifetime of 20 years (and counting). The first cylinders produced in the year 2000 are still in the value chain in Norway and Finland.

In addition, the products have enhanced safety as they do not explode if exposed to a fire.

Hexagon Ragasco offers a spare parts concept to customers to ensure the longest possible lifetime of the products in their value chain.
Based on the use of Norwegian hydroelectric power and Lean Manufacturing principles,
Hexagon Ragasco manufactures in compliance with international industry-, environmental- and energy standards such as ISO 9001, ISO 14001 and ISO 50001.

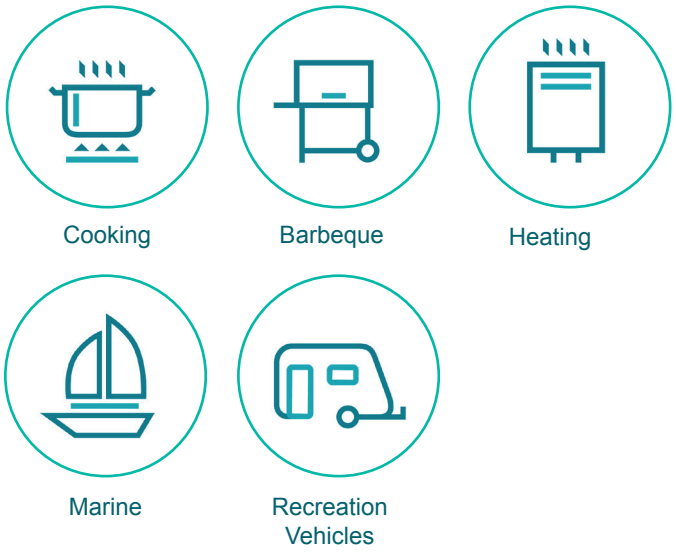
Since 2000 the company has re-used its own liner waste directly in production. Hexagon Ragasco continuously invests in more environmentally friendly processes in production, such as incineration facility, energy recovery systems, water cleaning systems, grinders for thermoplastics, etc. The company also investigates new circular solutions for end-of-life of the composite cylinders through several funded R&D projects with strategic partners. Focus is put on product- and technology innovations covering the whole value chain to secure a sustainable business for customers and stakeholders, including lifetime prediction and real-life ageing in several climatic regions in the world.

Hexagon Ragasco performed their first Life Cycle Assessment (LCA) in 2015, while this EPD is now based on updated 2019 production figures.

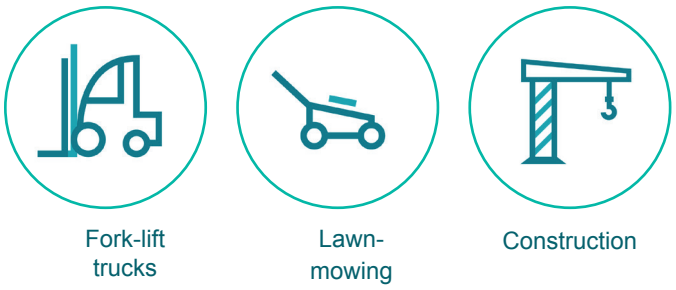
Hexagon Ragasco will use LCA as a strategic tool for future technological development and sourcing, and it will also give the company the possibility to further improve the product's environmental carbon footprint in the value chain, including the use phase, end-of-life phase and into new circular products.

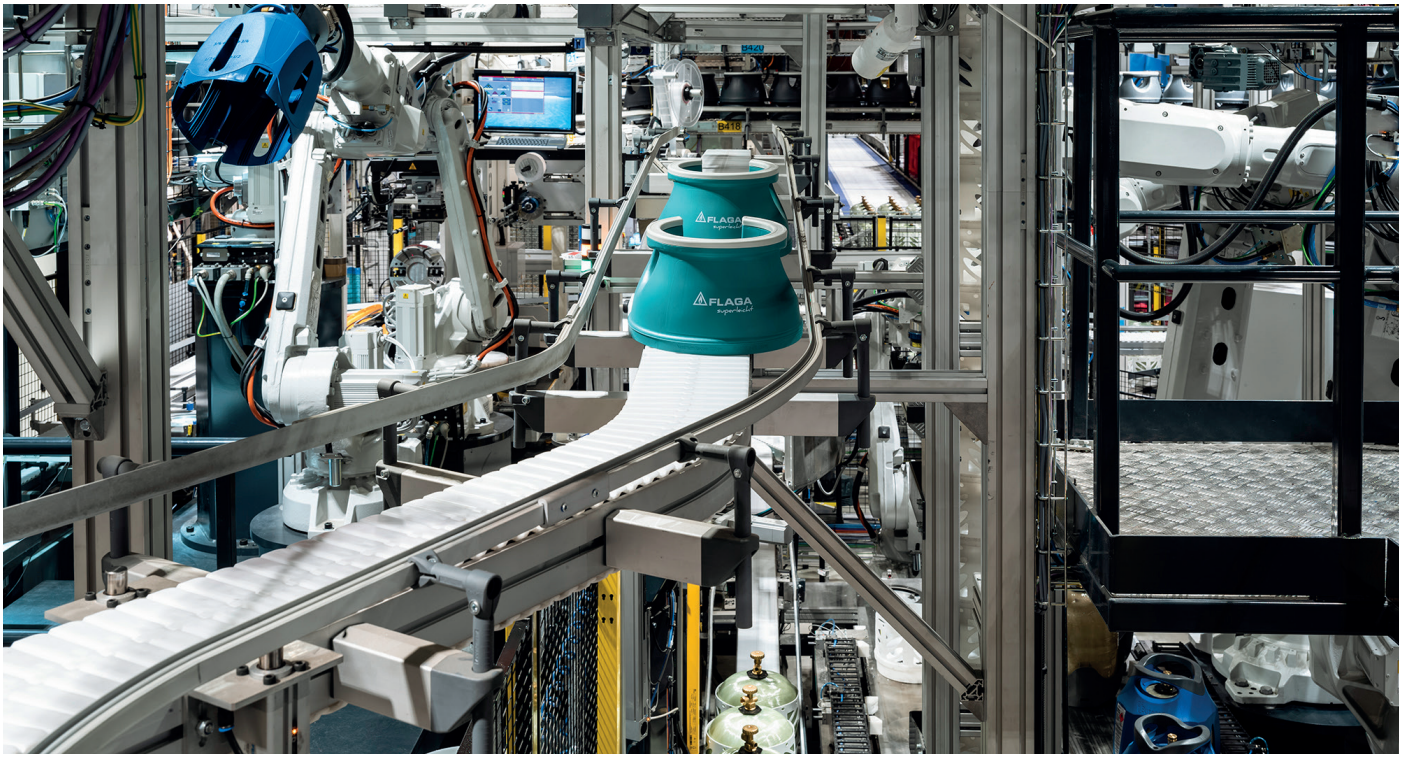
LPG is a transition fuel for cleaner cooking, replacing wood, charcoal, kerosene, and other highly polluting energy sources in large parts of the world. The use of LPG eliminates the soot and particles released through combustion and thereby improves the air quality and the health of millions of people around the world. As an example, since 2016, Hexagon Ragasco has sold 1 million cylinders to Bangladesh which has potentially helped avoid emissions of approx. 137,000 metric tons of $CO_2$ equivalents by replacing dirty and dangerous fuels.

**Hexagon Ragasco composite cylinders are in use across a wide range of domestic and leisure applications:**

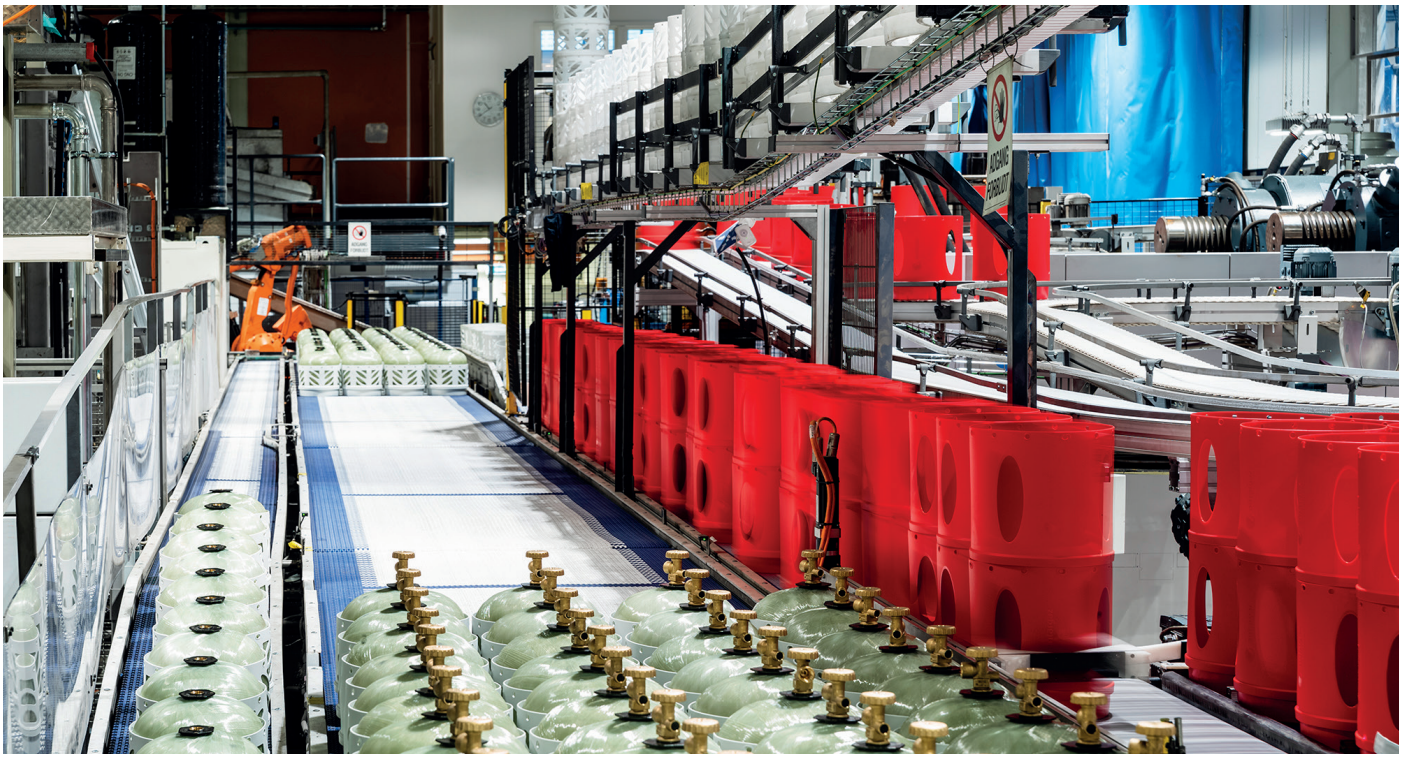



**As well as industrial applications:**






Hexagon Ragasco manufacturing facility in Raufoss, Norway



Hexagon Ragasco cylinders are widely used to power forklift trucks

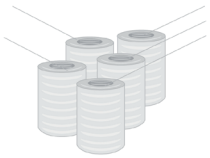
Cooking with Hexagon Ragasco cylinders in Bangladesh

**Product specification**
All manufacturing processes are done in-house and are fully automated, starting with the raw materials through to the completed cylinders on pallet ready for shipment.

# Manufacturing process
# Hexagon Ragasco composite cylinders

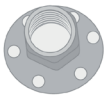
## Components

Thermoplastics



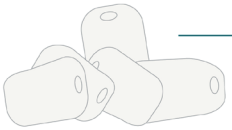
Glass fiber

Chemicals



Brass insert

Valves

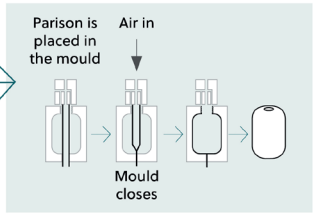


Grinded liner scrap

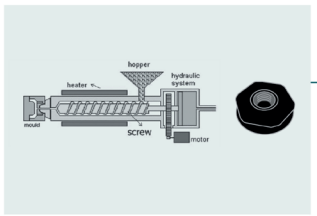
## Transport to our plant


Raufoss, Norway

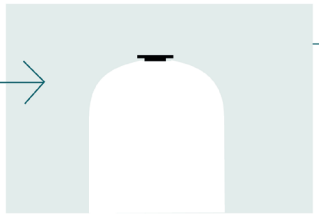
## Production



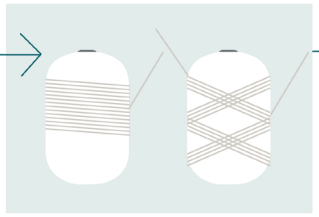

Blow moulding of liner



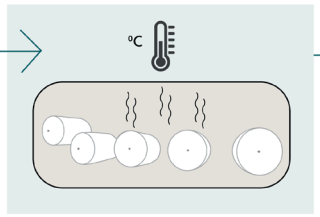

Injection moulding of boss



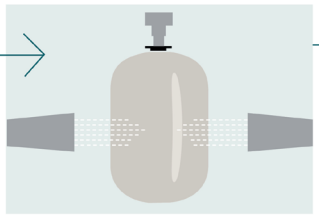
Welding of boss to liner



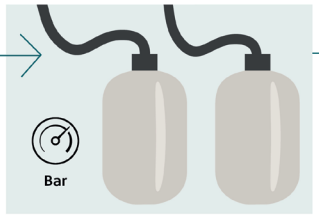
Filament winding



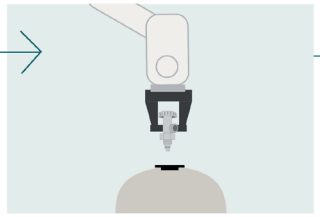

Curing of pressure vessel



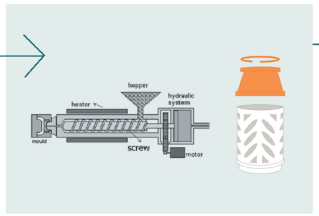
Surface treatment



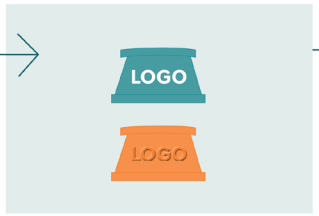

Pressure test



Assembly of valve




Injection moulding of casing




Branding

Assembly of parts

Palletizing

## Transport to port

## Technical Specifications

| |  |  |  |  |  |  |
|---|---|---|---|---|---|---|
| SPECIFICATIONS[1] | 12,5 L | 18,2 L | 24,5 L | 26,2 L | 27,4 L | 33,5 L |
| Propane Capacity (kg) | 5 | 7,5 | 10 | 10,7 | 11,2 | 14 |
| Butane Capacity (kg) | 6 | 8,5 | 12 | 12,8 | 13,4 | 16,5 |
| Empty weight[2] (kg) | 3,4 | 4,1 | 5 | 5,1 | 5,3 | 6,3 |
| Water content (L) | 12,5 | 18,2 | 24,5 | 26,2 | 27,4 | 33,5 |
| Height (mm) | 384 | 468 | 571 | 595 | 622 | 715 |
| Diameter (mm) | 305 | 305 | 305 | 305 | 305 | 305 |

[1.] All values are nominal. [2.] Without a valve
Hexagon Ragasco cylinders can be delivered with a wide variety of different valves for different uses with vapor or liquid outtake.

| Materials | Kg | % |
|---|---|---|
| Vessel excl. Brass | 3,63 | 62,9 |
| Casing parts | 1,62 | 28,1 |
| Valve System Brass | 0,52 | 9,0 |
| Sum | 5,77 | 100 |
| Diposable pallet | 0,27 | |
| Packaging film | 0,03 | |
| Sum with packaging | 6,06 | |

**Technical data:**
Propane capacity: 10 kg
Butane capacity: 12 kg
Water content: 24,5 l
Height: 571 mm
Diameter: 305 mm

**Technical standards:**
The LPG Cylinders are produced to the following technical standards:
ISO 11119-3, EN 12245, EN 14427

**Market:**
Cradle-to-gate scenarios are valid for global market. Transport to customer is modelled for the Norwegian market.

**Reference service life:**
Not applicable

**Calculation for different sizes**
The GWP for A1-A3 can be calculated with the given conversion factors for the following cylinder sizes. The calculation is done by multiplying GWP for A1-A3 with the conversion factor given below:

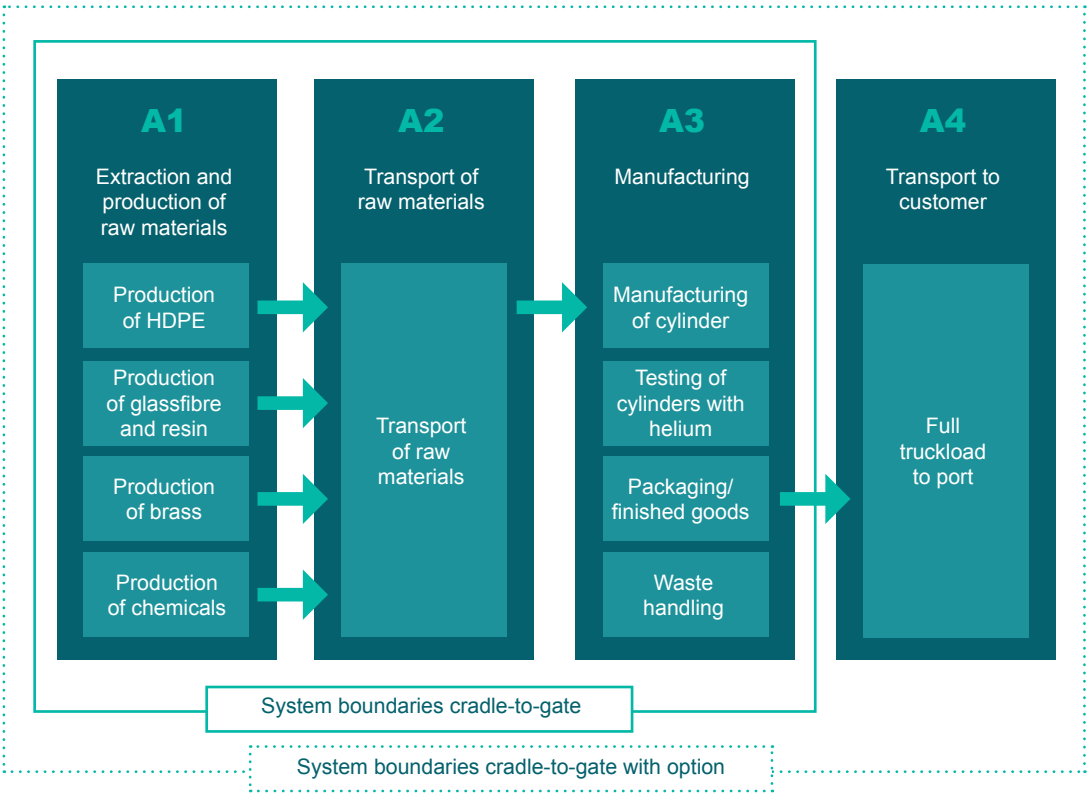
12,5 l cylinder: 0,682
18,2 l cylinder: 0,725
20,6 l cylinder: 0,900
26,2 l cylinder: 1,046
33,5 l cylinder: 1,283

## LCA: Calculation rules

**Declaration unit:**
1 Composite LPG cylinder with a capacity of 24,5 L

**System boundary:**
A1-A3, A4

Figure 1: System boundary




**Data Quality:**
Data for production and transport is site specific for Raufoss and based on specific data for the year 2019. Generic data is from ecoinvent v3.6. All generic data is <10 years old. Chacterization factors are according to EN 15804:2012+A1 2013

**Allocation:**
The allocation is made in accordance with the provisions of ISO 14025. Incoming energy and waste production in-house is allocated equally among all products through mass allocation. Transportation of the material is allocated to this analysis.

**Cut-off criteria:**
All major raw materials and all the essential energy is included. The production process for raw materials and energy flows that are included with very small amounts (<1%) are not included. This cut-off rule does not apply for hazardous materials and substances.

## LCA: Scenarios and additional technical information

The following information describe the scenarios in the different modules of the EPD**.** The transportation distance represents transport of the cylinder to port in Oslo, which is the most likely scenario for the Norwegian market. The amount of cylinders in one truck is limited by volume, and therefore the capacity utilization by mass is relatively low. The volume capacity utilization factor is 100%.

| Type | Capacity utilization by mass (incl. return) % | Type of vehicle | Distance km | Fuel consumption | Unit |
|---|---|---|---|---|---|
| Truck | 16,60 % | 32 t Euro 6 | 120 | 0,062 | l/tkm |

## LCA: Results

The LCA results show environmental impact and resource consumption calculated according to EN 15804 + A1 2013. The results are presented per unit 24,5l Hexagon Ragasco cylinder delivered to port in Oslo.

### SYSTEM BOUNDARIES (X=included, MND=module not declared, MNR=module not relevant)

| Product stage | | | Assem-bly stage | | Use stage | | | | | | | End of life stage | | | | Beyond the system boundaries |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Raw materials | Transport | Manufacturing | Transport | Assembly | Use | Maintenance | Repair | Replacement | Refurbishment | Operational energy use | Operational water use | De-construction demolition | Transport | Water processing | Disposal | Reuse-Recovery-Recycling-potential |
| A1 | A2 | A3 | A4 | A5 | B1 | B2 | B3 | B4 | B5 | B6 | B7 | C1 | C2 | C3 | C4 | D |
| x | x | x | x | MND | MND | MND | MND | MND | MND | MND | MND | MND | MND | MND | MND | MND |

### ENVIRONMENTAL IMPACT

| Parameter | Unit | A1 | A2 | A3 | A1-A3 | A4 |
|---|---|---|---|---|---|---|
| GWP | kg $CO_2$ -eqv | 1,42E+01 | 1,12E+00 | 6,39E-01 | 1,60E+01 | 1,38E-01 |
| ODP | kg CFC11-eqv | 7,59E-07 | 1,95E-07 | 4,10E-08 | 9,94E-07 | 1,63E-10 |
| POCP | kg $C_2H_4$ -eqv | 9,67E-03 | 4,86E-04 | 2,11E-04 | 1,04E-02 | 4,04E-06 |
| AP | kg $SO_2$ -eqv | 7,55E-02 | 1,78E-02 | 2,49E-03 | 9,58E-02 | 3,92E-05 |
| EP | kg $PO_4^{3-}$-eqv | 4,07E-02 | 2,20E-03 | 9,87E-04 | 4,39E-02 | 1,30E-05 |
| ADPM | kg Sb-eqv | 6,41E-04 | 1,32E-05 | 1,15E-05 | 6,66E-04 | 5,96E-07 |
| ADPE | MJ | 3,15E+02 | 1,59E+01 | 1,78E+01 | 3,48E+02 | 2,55E-02 |

GWP Global warming potential
ODP Depletion potential of the stratospheric ozone layer
POCP Formation potential of tropospheric photochemical oxidants
AP Acidification potential of land and water
EP Eutrophication potential
ADPM Abiotic depletion potential for non fossil resources
ADPE Abiotic depletion potential for fossil resource

## RESOURCE USE

| Parameter | Unit | A1 | A2 | A3 | A1-A3 | A4 |
|---|---|---|---|---|---|---|
| RPEE | MJ | 1,65E+01 | 1,52E-01 | 3,41E+01 | 5,08E+01 | 4,02E-03 |
| RPEM | MJ | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 |
| TPE | MJ | 1,65E+01 | 1,52E-01 | 3,41E+01 | 5,08E+01 | 4,02E-03 |
| NRPE | MJ | 1,99E+02 | 1,59E+01 | 1,01E+01 | 2,25E+02 | 2,55E-02 |
| NRPM | MJ | 1,15E+02 | 0,00E+00 | 7,63E+00 | 1,23E+02 | 0,00E+00 |
| TRPE | MJ | 3,15E+02 | 1,59E+01 | 1,78E+01 | 3,48E+02 | 2,55E-02 |
| SM | kg | 3,09E-01 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 |
| RSF | MJ | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 |
| NRSF | MJ | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 |
| W | $m^3$ | 1,45E-01 | 1,31E-03 | 2,47E-01 | 3,92E-01 | 1,97E-05 |

RPEE Renewable primary energy resources used as energy carrier
RPEM Renewable primary energy resources used as raw materials
TPE Total use of renewable primary energy resources
NRPE Non renewable primary energy resources used as energy carrier
NRPM Non renewable primary energy resources used as materials
TRPE Total use of non renewable primary energy resources
SM Use of secondary materials
RSF Use of renewable secondary fuels
NRSF Use of non renewable secondary fuels
W Use of net fresh water

## END OF LIFE - WASTE

| Parameter | Unit | A1 | A2 | A3 | A1-A3 | A4 |
|---|---|---|---|---|---|---|
| HW | kg | 2,13E-02 | 7,67E-04 | 1,46E-02 | 3,67E-02 | 3,23E-06 |
| NHW | kg | 1,44E+00 | 7,09E-01 | 2,27E-01 | 2,38E+00 | 1,2E-04 |
| RW | kg | 2,94E-04 | 1,09E-04 | 3,08E-05 | 4,41E-04 | 1,43E-07 |

HW Hazardous waste disposed
NHW Non hazardous waste disposed
RW Radioactive waste disposed

## END OF LIFE - OUTPUT FLOW

| Parameter | Unit | A1 | A2 | A3 | A1-A3 | A4 |
|---|---|---|---|---|---|---|
| CR | kg | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 |
| MR | kg | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 |
| MER | kg | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 |
| EEE | MJ | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 |
| ETE | MJ | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 | 0,00E+00 |

CR Components for reuse; MR Materials for recycling
MER Materials for energy recovery
EEE Exported electric energy
ETE Exported thermal energy

Reading example: 9,0 E-03 = $9,0*10^{-3}$ = 0,009

## Additional Norwegian requirements

**Greenhouse gas emission from the use of electricity in the manufacturing phase.**
National production mix from import, medium voltage (production of transmission lines, in addition to direct emissions and losses in grid) of applied electricity for the manufacturing prosess (A3).

| Data source | Amount | Unit |
|---|---|---|
| Ecoinvent v3.6 | 20,3 | g $CO_2$-eqv/kWh |

**Dangerous substances**

- ☑ The product contains no substances given by the REACH Candidate list or the Norwegian priority list
- ☐ The product contains substances given by the REACH Candidate list or the Norwegian priority list that are less than 0,1 % by weight.
- ☐ The product contain dangerous substances, more then 0,1% by weight, given by the REACH Candidate List or the Norwegian Priority list, see table.
- ☐ The product contains no substances given by the REACH Candidate list or the Norwegian priority list. The product is classified as hazardous waste (Avfallsforskiften, Annex III), see table.

Some products used in the manufacturing may contain substances on the REACH candidate list, but during the curing process these materials change properties and are no longer considered harmful substances. This is confirmed by the material supplier and documentation is available upon request.

**Indoor environment**

No tests have been carried out on the product concerning indoor climate

## Bibliography


| | |
|---|---|
| ISO 14025:2010 | *Environmental labels and declarations - Type III environmental declarations - Principles and procedures* |
| ISO 14044:2006 | *Environmental management - Life cycle assessment - Requirements and guidelines* |
| EN 15804:2012+A1:2013 | *Sustainability of construction works - Environmental product declaration - Core rules for the product category of construction products* |
| ISO 21930:2007 | *Sustainability in building construction - Environmental declaration of building products* |
| LCI Report | *Life Cycle Assesment report of Composite LPG cylinders, 2021, Alexander Borg* |
| NPCR 023:2019 | *Packaging products and services. Reg 05.07.2019, Norwegian EPD foundation* |
| ISO 9001:2015 | *Quality management systems - Requirements* |
| ISO 14001:2015 | *Environmental management systems - Requirements with guidance for use* |
| ISO 50001:2018 | *Energy management systems - Requirements with guidance for use* |
| ISO 11119-3:2020 | *Gas cylinders - Design, construction and testing of refillable composite gas cylinders and tubes* |
| CEN - EN 12245:2009 | *Transportable gas cylinders - Fully wrapped composite cylinders* |
| DIN - EN 14427:2014 | *LPG equipment and accessories - Transportable refillable fully wrapped composite cylinders for LPG - Design and construction* |



| | | | |
|---|---|---|---|
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