epddanmark

ECO PLATFORM EPD VERIFIED

| | |
|---|---|
| Owner: | Linolie & Pigment A/S |
| No.: | MD-23216-EN |
| Issued: | 16-04-2024 |
| Revision: | 02-04-2025 |
| Valid to: | 16-04-2029 |

3rd PARTY **VERIFIED**

# EPD

VERIFIED ENVIRONMENTAL PRODUCT DECLARATION | **ISO 14025 & EN 15804**


Funded by the European Union

**Owner of declaration**
Linolie & Pigment A/S
ØSBYGADE 46 6100 HADERSLEV
DANMARK
VAT no.: 41189932

**Programme**
EPD Danmark
www.epddanmark.dk

☐ Industry EPD
☒ Product EPD

☒ Product specific
☐ Average
☐ Worst Case

**Declared product(s)**
1 liter Retrolak® in the color: 91/Phnom Penh (Color is showcased on the frontpage)

Number of declared datasets/product variations: 1

**Production site**
ØSBYGADE 46 6100 HADERSLEV DANMARK

**Use of Guarantees of Origin**
☒ No certificates used
☐ Electricity covered by GoO
☐ Biogas covered by GoO

**Declared/ functional unit**
1 liter (Core environmental indicator results for 1 kilogram can be found under *Additional information*)

**Year of production site data (A3)**
2022

**EPD version**
[Revision no. 2], [02-04-2025]: Changes from the previous version include improved data quality and modeling for specific pigments and product packaging, along with a more precise approach to C3 modeling. Additionally, the REACH statement has been corrected, confirming the absence of substances of concern.

**Issued:** 16-04-2024
**Valid to:** 16-04-2029

**Basis of calculation**
This EPD is developed and verified in accordance with the European standard EN 15804+A2.

**Comparability**
EPDs of construction products may not be comparable if they do not comply with the requirements in EN 15804. EPD data may not be comparable if the datasets used are not developed in accordance with EN 15804 and if the background systems are not based on the same database.

**Validity**
This EPD has been verified in accordance with ISO 14025 and is valid for 5 years from the date of issue.

**Use**
The intended use of an EPD is to communicate scientifically based environmental information for construction products, for the purpose of assessing the environmental performance of buildings.

**EPD type**
☒Cradle-to-gate with modules C1-C4 and D
☐Cradle-to-gate with options, modules C1-C4 and D
☐Cradle-to-grave and module D
☐Cradle-to-gate
☐Cradle-to-gate with options

CEN standard EN 15804 serves as the core PCR

Independent verification of the declaration and data, according to EN ISO 14025

☐ internal ☒ external

Third party verifier:

*Guangli Du*
*Aalborg University, BUILD*

*Martha Katrine Sørensen*
*EPD Danmark*

| Life cycle stages and modules (ND = not declared) | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Product | | | Construction process | | Use | | | | | | | End of life | | | | Beyond the system boundary |
| Raw material supply | Transport | Manufacturing | Transport | Installation process | Use | Maintenance | Repair | Replacement | Refurbishment | Operational energy use | Operational water use | De-construction demolition | Transport | Waste processing | Disposal | Re-use, recovery and recycling potential |
| A1 | A2 | A3 | A4 | A5 | B1 | B2 | B3 | B4 | B5 | B6 | B7 | C1 | C2 | C3 | C4 | D |
| X | X | X | ND | ND | ND | ND | ND | MD | ND | ND | ND | X | X | X | X | X |

# Product information

### Product description

Retrolak® is a colored and opaque oil alkyd varnish useful for surfaces where a high abrasion resistance is required. It provides a surface coverage of 8-10 square meters per liter of varnish.

| Surface coverage (liter/m2) |
|---|
| 0.10-0.13 |

Recommended number of coats depends on the conditions of the surface, see technical information

The main product components are shown in the table below.

| Material | Weight-% of declared product |
|---|---|
| Varnish and solvents | 77% |
| Pigments | 15% |
| Linseed oil | 6% |
| Drying agent | 2% |

### Product packaging:

The composition of the sales- and transport packaging of the product is shown in the table below.

| Material | Weight-% of packaging |
|---|---|
| Tin bucket | 77% |
| Cardboard | 21% |
| Corn starch | 2% |

### Representativity

This declaration, including data collection and the modelled foreground system including results, represents the production of 1 liter 91/Phnom Penh Retrolak® on the production site located in Haderslev, Denmark.

Pigments have a varying influence on the environmental performance of Retrolak®. To account for these differences, an EPD tool has been developed and verified in conjunction with this EPD. This tool allows the manufacturer to expediently generate pre-verified project EPDs that reflects the selected pigment and has the possibility to generate data based on custom colour mixes. To obtain a project EPD for a specific formulation from the manufacturer's product catalogue or a custom colour mix, please contact the manufacturer.

Product specific data are based on average values collected in the period 2022. Background data are based on datasets from the LCA databases: EcoInvent 3.9.1 allocation, Agri-footprint version 6.3, and the Evah Pigment database. The datasets are less than 10 years old. Generally, the used background datasets are of high quality, and the majority of the datasets are only a couple of years old.

### Hazardous substances

The product does not contain substances listed on the "Candidate List of Substances of Very High Concern for authorisation"

(http://echa.europa.eu/candidate-list-table)

### Product(s) use

Retrolak® is a colored and opaque oil alkyd varnish useful for surfaces where a high abrasion resistance is required.

### Essential characteristics

The product declared within this EPD are not covered by any harmonized technical specification. Further technical information can be obtained by contacting the manufacturer or on the manufacturer's website:

https://linolie.dk/

## Picture of product(s)

# LCA background

### Declared unit

The LCI and LCIA results in this EPD relates to 1 liter 91/Phnom Penh Retrolak®.

| Name | Value | Unit |
|---|---|---|
| Declared unit | 1 | L |
| Density | 1139.6 | kg/m$^3$ |
| Conversion factor to 1 kg | 1.14 | N/A |

### Functional unit

Not defined.

### PCR

This EPD is developed according to the core rules for the product category of construction products in EN 15804 + A2, and product descriptions adheres to the requirements outlined in IBU PCR Part B for coating with organic binders.

### Energy modelling principles

Foreground system:

No use of certified green energy is applied in this study. A residual energy mix from Denmark is used to model the electricity used in the production.

Consumption of gas for heating is modelled with natural gas.

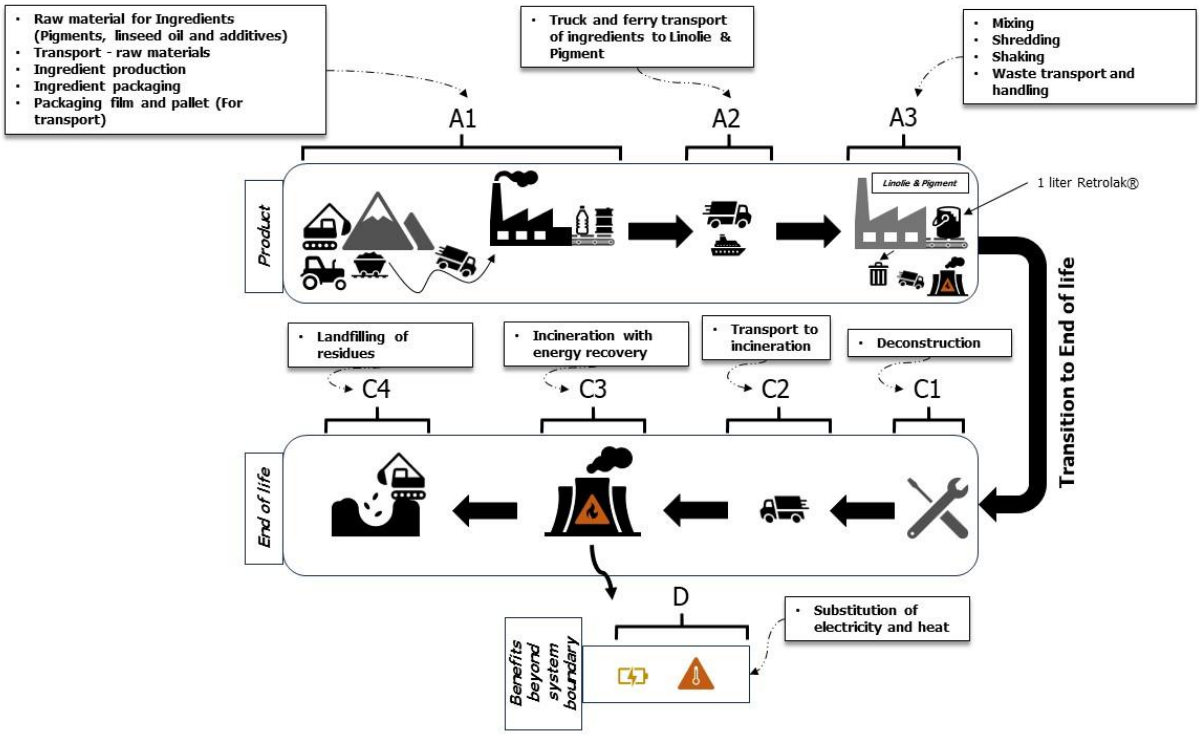
Information about the energy mix in the foreground system:

| Energy mix | EF | Unit |
|---|---|---|
| [Residual grid mix, DK, ref. year 2022] | 0.64 | kg $CO_2$e/kWh |
| [Natural gas, EU, ref. year 2022] | 0.081 | kg $CO_2$e/MJ |

Background system:

Upstream processes are modelled using European average energy mixes and certain country residual mixes. Downstream processes are modelled using European and national average energy mixes.

### Flowdiagram



### System boundaries

This EPD is based on a cradle-to-gate LCA, in which 100 weight-% has been accounted for.

The general rules for the exclusion of inputs and outputs follows the requirements in EN 15804, 6.3.5, where the total of neglected input flows per module shall be a maximum of 5 % of energy usage and mass and 1 % of energy usage and mass for unit processes.

**Product stage (A1-A3) includes**:

A1 – Extraction and processing of raw materials

A2 – Transport to the production site

A3 – Manufacturing processes

The product stage comprises the acquisition of all raw materials, products and energy, transport to the production site, packaging and waste processing up to the ”end-of-waste” state or final disposal.

In **A1**, the extraction of raw materials used in the ingredients for the Retrolak® is covered, along with their transportation to the respective production sites. This module also includes the production of the ingredients, as well as the required packaging for both ingredients and transportation, including pallets.

**A2** addresses the transportation requirements for each ingredient, with most being transported by truck from various European countries to the production facility.

**A3** encompasses the manufacturing of Retrolak®, involving the mixing of ingredients in a production bucket and processing the mixture through steps such as mixing, shredding, and pouring the finished product into a metal bucket for product packaging. It also includes transportation packaging for outbound delivery to customers. Utility consumption, including electricity, gas for heating, water use, and waste generation for the production year 2022, is allocated and partitioned to the declared products using economic allocation and subdivision based on average and specific recipe masses, water content, and viscosity of the mixtures. Lastly, A3 includes waste processing related to the production bucket, ingredient and transport packaging from A1, pallet usage, and any remaining waste deducted from the utility data, all of which are allocated to the declared unit. The waste is modeled up to the "end-of-waste" state or final disposal.

**End of life (C1-C4):**

The End of life stage of Retrolak® is primarily determined by the material to which it is applied. Since the paint remains bonded to the surface, the waste management process follows the disposal or recycling pathway of the underlying material. In most cases, this material is expected to undergo energy recovery through incineration.

During deconstruction and removal in **C1** it is assumed that the surface material will be dismantled manually, without requiring specialized tools. Consequently, these activities are not considered to contribute to the environmental impacts of the product’s life cycle. If specialized tools are required, the presence of Retrolak® will not affect the deconstruction method or the associated energy consumption. Consequently, any environmental impacts are attributed solely to the surface material.

In **C2**, transportation from the deconstruction site to the waste treatment or recycling facility is estimated at 30 km, based on standard distances to such facilities.

In **C3**, the painted surface material is incinerated with energy recovery, while **C4** accounts for the landfill disposal of incineration residues.

**Re-use, recovery and recycling potential (D):**

Module D models the benefits tied to the energy recovery of the linseed product in C3 through incineration in a municipal solid waste incinerator (MSWI).

Electricity and thermal energy generated from the incineration is assumed to substitute electricity in an average Danish electricity mix and district heating from natural gas.

# LCA results

| ENVIRONMENTAL IMPACTS PER 1 LITER | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Indicator** | **Unit** | **A1** | **A2** | **A3** | **C1** | **C2** | **C3** | **C4** | **D** |
| GWP-total | kg $CO_2$ eq. | 4.84E+00 | 2.18E-01 | 2.64E+00 | 0.00E+00 | 6.32E-03 | 1.20E+00 | 2.35E-03 | -3.94E-01 |
| GWP-fossil | kg $CO_2$ eq. | 3.84E+00 | 2.18E-01 | 2.66E+00 | 0.00E+00 | 6.32E-03 | 1.01E+00 | 2.35E-03 | -3.94E-01 |
| GWP-biogenic | kg $CO_2$ eq. | -2.03E-01 | 0.00E+00 | -2.38E-02 | 0.00E+00 | 0.00E+00 | 1.93E-01 | 0.00E+00 | 8.01E-05 |
| GWP-luluc | kg $CO_2$ eq. | 1.21E+00 | 1.07E-04 | 2.34E-03 | 0.00E+00 | 3.12E-06 | 6.48E-05 | 1.63E-06 | -4.61E-05 |
| ODP | kg CFC 11 eq. | 3.00E-07 | 4.74E-09 | 5.26E-08 | 0.00E+00 | 1.38E-10 | 1.04E-08 | 6.77E-11 | -1.15E-08 |
| AP | mol $H^+$ eq. | 5.40E-02 | 4.76E-04 | 1.16E-02 | 0.00E+00 | 1.38E-05 | 5.53E-04 | 1.51E-05 | -8.70E-04 |
| EP-freshwater | kg P eq. | 1.38E-03 | 1.55E-05 | 9.13E-04 | 0.00E+00 | 4.49E-07 | 2.40E-05 | 9.92E-06 | -8.99E-05 |
| EP-marine | kg N eq. | 8.20E-03 | 1.20E-04 | 2.02E-03 | 0.00E+00 | 3.48E-06 | 1.85E-04 | 5.39E-06 | -2.02E-04 |
| EP-terrestrial | mol N eq. | 4.70E-02 | 1.22E-03 | 2.11E-02 | 0.00E+00 | 3.54E-05 | 1.88E-03 | 5.74E-05 | -2.08E-03 |
| POCP | kg NMVOC eq. | 1.92E-02 | 7.38E-04 | 7.25E-03 | 0.00E+00 | 2.14E-05 | 5.96E-04 | 2.12E-05 | -7.66E-04 |
| ADPm[1] | kg Sb eq. | 1.65E-04 | 7.11E-07 | 6.78E-05 | 0.00E+00 | 2.06E-08 | 4.62E-07 | 4.84E-09 | -3.33E-07 |
| ADPf[1] | MJ | 7.14E+01 | 3.09E+00 | 3.25E+01 | 0.00E+00 | 8.97E-02 | 1.21E+00 | 5.72E-02 | -6.05E+00 |
| WDP[1] | $m^3$ | 8.48E+00 | 1.27E-02 | 4.86E-01 | 0.00E+00 | 3.70E-04 | 2.06E-01 | 2.34E-03 | -3.00E-02 |
| Caption | GWP-total = Globale Warming Potential - total; GWP-fossil = Global Warming Potential - fossil fuels; GWP-biogenic = Global Warming Potential - biogenic; GWP-luluc = Global Warming Potential - land use and land use change; ODP = Ozone Depletion; AP = Acidifcation; | | | | | | | | |
| | EP-freshwater = Eutrophication – aquatic freshwater; EP-marine = Eutrophication – aquatic marine; EP-terrestrial = Eutrophication – terrestrial; POCP = Photochemical zone formation; ADPm = Abiotic Depletion Potential – minerals and metals; ADPf = Abiotic Depletion Potential – fossil fuels; WDP = water use | | | | | | | | |
| Disclaimer | [1] The results of this environmental indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator. | | | | | | | | |

*The imbalance in the GWP-biogenic results is due to a biogenic carbon uptake of 3.44E-02 kg $CO_2$ eq. per. liter 91/Phnom Penh Retrolak® in the packaging material in A3 that are released in the omitted module A5, thus offsetting the carbon balance in the declared modules.

| ADDITIONAL ENVIRONMENTAL IMPACTS PER 1 LITER PRODUCT | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Indicator** | **Unit** | **A1** | **A2** | **A3** | **C1** | **C2** | **C3** | **C4** | **D** |
| PM | [Disease incidence] | 3.23E-07 | 1.62E-08 | 1.10E-07 | 0.00E+00 | 4.71E-10 | 5.96E-09 | 2.89E-10 | -3.45E-09 |
| IRP[2] | [kBq U235 eq.] | 5.91E-01 | 4.18E-03 | 2.79E-01 | 0.00E+00 | 1.21E-04 | 6.34E-03 | 6.10E-05 | -5.43E-02 |
| ETP-fw[1] | [CTUe] | 3.80E+02 | 3.06E+00 | 2.47E+01 | 0.00E+00 | 8.87E-02 | 4.68E+01 | 7.38E-02 | -1.07E+00 |
| HTP-c[1] | [CTUh] | 6.74E-09 | 1.98E-10 | 1.40E-08 | 0.00E+00 | 5.76E-12 | 1.53E-10 | 9.17E-11 | -1.18E-10 |
| HTP-nc[1] | [CTUh] | 1.89E-07 | 4.39E-09 | 1.30E-07 | 0.00E+00 | 1.27E-10 | 4.32E-09 | 3.19E-09 | -3.46E-09 |
| SQP[1] | - | 1.01E+02 | 1.87E+00 | 1.33E+01 | 0.00E+00 | 5.42E-02 | 8.00E-01 | 1.81E-01 | -6.75E-01 |
| Caption | PM = Particulate Matter emissions; IRP = Ionizing radiation – human health; ETP-fw = Eco toxicity – freshwater; HTP-c = Human toxicity – cancer effects; HTP-nc = Human toxicity – non cancer effects; SQP = Soil Quality | | | | | | | | |
| Disclaimers | [1] The results of this environmental indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator. | | | | | | | | |

| RESOURCE USE PER 1 LITER PRODUCT | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Parameter** | **Unit** | **A1** | **A2** | **A3** | **C1** | **C2** | **C3** | **C4** | **D** |
| PERE | [MJ] | 3.47E+01 | 4.86E-02 | 4.65E+00 | 0.00E+00 | 1.41E-03 | 9.20E-02 | 6.87E-04 | -1.62E-01 |
| PERM | [MJ] | 2.76E+00 | 0.00E+00 | 4.46E-01 | 0.00E+00 | 0.00E+00 | -2.72E+00 | 0.00E+00 | 0.00E+00 |
| PERT | [MJ] | 3.75E+01 | 4.86E-02 | 5.10E+00 | 0.00E+00 | 1.41E-03 | -2.63E+00 | 6.87E-04 | -1.62E-01 |
| PENRE | [MJ] | 7.23E+01 | 3.09E+00 | 3.25E+01 | 0.00E+00 | 8.97E-02 | 1.21E+00 | 5.72E-02 | -6.05E+00 |
| PENRM | [MJ] | 2.20E+01 | 0.00E+00 | -4.14E+00 | 0.00E+00 | 0.00E+00 | -1.78E+01 | 0.00E+00 | 0.00E+00 |
| PENRT | [MJ] | 9.43E+01 | 3.09E+00 | 2.84E+01 | 0.00E+00 | 8.97E-02 | -1.66E+01 | 5.72E-02 | -6.05E+00 |
| SM | [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 |
| RSF | [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 |
| NRSF | [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 |
| FW | [$m^3$] | 8.41E+00 | 1.27E-02 | 5.45E-01 | 0.00E+00 | 3.68E-04 | 2.17E-01 | 2.33E-03 | -2.54E-02 |
| Caption | PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PERT = Total use of renewable primary energy resources; PENRE = Use of non renewable primary energy excluding non renewable primary energy resources used as raw materials; PENRM = Use of non renewable primary energy resources used as raw materials; PENRT = Total use of non renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non renewable secondary fuels; FW = Net use of fresh water | | | | | | | | |

| WASTE CATEGORIES AND OUTPUT FLOWS PER 1 LITER PRODUCT | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Parameter** | **Unit** | **A1** | **A2** | **A3** | **C1** | **C2** | **C3** | **C4** | **D** |
| HWD | [kg] | 4.24E-03 | 5.77E-05 | 3.29E-02 | 0.00E+00 | 1.68E-06 | 8.04E-01 | 5.54E-07 | -4.25E-05 |
| NHWD | [kg] | 2.57E+00 | 1.54E-01 | 1.52E+00 | 0.00E+00 | 4.46E-03 | 2.23E-01 | 1.84E-01 | -9.37E-03 |
| RWD | [kg] | 1.73E-04 | 1.02E-06 | 6.89E-05 | 0.00E+00 | 2.95E-08 | 1.62E-06 | 1.47E-08 | -1.37E-05 |
| | | | | | | | | | |
| CRU | [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 |
| MFR | [kg] | 0.00E+00 | 0.00E+00 | 1.35E-03 | 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 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EE | [MJ] | 0.00E+00 | 0.00E+00 | 1.07E+01 | 0.00E+00 | 0.00E+00 | 4.16E+00 | 0.00E+00 | 0.00E+00 |
| Caption | HWD = Hazardous waste disposed; NHWD = Non hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EE = Exported energy | | | | | | | | |

| BIOGENIC CARBON CONTENT PER 1 LITER PRODUCT | | |
|---|---|---|
| **Parameter** | **Unit** | **At the factory gate** |
| Biogenic carbon content in product | [kg C] | 0.05 |
| Biogenic carbon content in accompanying packaging | [kg C] | 0.01 |
| Note | 1 kg biogenic carbon is equivalent to 44/12 kg of $CO_2$ | |

# Additional information

## LCA interpretation

The EPD quantifies the environmental impacts associated with 1 liter 91/Phnom Penh Retrolak®. In addition, the core environmental impact indicator results associated with 1 kg of the same product are quantified, see section: *Core environmental impact indicators result – per. 1 kilogram*.

The table below summarizes the most contributing module in each core environmental impact category.

| MOST CONTRIBUTING MODULE – CORE ENVIROMENTAL IMPACT CATEGORIES | |
|---|---|
| **Indicator** | **Module** |
| GWP-total | A1 (Raw material supply) |
| GWP-fossil | A1 (Raw material supply) |
| *GWP-biogenic | N/A |
| GWP-luluc | A1 (Raw material supply) |
| ODP | A1 (Raw material supply) |
| AP | A1 (Raw material supply) |
| EP-freshwater | A1 (Raw material supply) |
| EP-marine | A1 (Raw material supply) |
| EP-terrestrial | A1 (Raw material supply) |
| POCP | A1 (Raw material supply) |
| ADPm[1] | A1 (Raw material supply) |
| ADPf[1] | A1 (Raw material supply) |
| WDP[1] | A1 (Raw material supply) |

*The GWP-biogenic indicator is reported as "N/A" due to the treatment of biogenic $CO_2$ in the LCIA, as outlined in EN ISO 14067:2018 (6.5.2). Biogenic $CO_2$ removals (excluding biomass from native forests) are characterized as −1 kg $CO_2$ eq/kg $CO_2$ upon entering the product system, while emissions and transfers of biogenic $CO_2$ to subsequent systems are characterized as +1 kg $CO_2$ eq/kg $CO_2$. This results in a net zero biogenic carbon balance for the product system, where $CO_2$ is primarily absorbed during raw material production (e.g., linseed cultivation in A1) and released during incineration in A3 and C3. The biogenic carbon neutrality means no single module dominates the GWP-biogenic contribution.

A contribution analysis of GWP-total identifies module A1 (Raw material supply) as the dominant source of impact across the Product stage and End of life modules with estimated emissions amounting to 4.84 kg $CO_2$ eq., equivalent to 54% of the total emissions (excluding Module D).

Within the Product Stage, detailed analysis of module A1 indicates that the primary contributor to this module are emissions associated with the production of Varnish and solvents accounting for 3.78 kg $CO_2$ eq. This represents 78% of the emissions within module A1 and 42% of the total emissions across all modules (excluding Module D). These results highlight the critical influence of raw material production in driving the global warming potential (GWP) of the product's life cycle.

The table below outlines the contribution of each material group.

| A1 – PRODUCTION OF INGREDIENTS | | | | |
|---|---|---|---|---|
| **Material** | **GWP-total (kg $CO_2$ eq.)** | **GWP-total (kg $CO_2$ eq.) - in scientific notation** | **% of module** | **% of all modules excl. Module D** |
| Varnish and solvents | 3.78 | 3.78E+00 | 78.13% | 42.44% |
| Pigments | 0.12 | 1.23E-01 | 2.54% | 1.38% |
| Linseed oil | 0.01 | 6.52E-03 | 0.13% | 0.07% |
| Drying agent | 0.61 | 6.09E-01 | 12.58% | 6.83% |

The emission profile of the packaging materials is summarized in the table below, detailing the total contribution of the materials used to store and transport each ingredient to the manufacturing facility in Haderslev, Denmark.

| A1 – PACKAGING | | | | |
|---|---|---|---|---|
| **Material** | **GWP-total (kg $CO_2$ eq.)** | **GWP-total (kg $CO_2$ eq.) - in scientific notation** | **% of module** | **% of all modules excl. Module D** |
| Product packaging - ingredients | 0.33 | 3.27E-01 | 6.76% | 3.67% |
| Transport packaging - ingredients | 0.00 | 2.44E-03 | 0.05% | 0.03% |
| *Pallet - ingredients | -0.01 | -9.33E-03 | -0.19% | -0.10% |

*The negative GWP-total impact of the pallets is attributed to the biogenic $CO_2$ uptake of the pine wood used in their production. This absorbed $CO_2$ is, however, subsequently released in module A3 during the incineration process as part of waste handling.

In A2, the dominant contributor are emissions associated with the transport of Varnish and solvents that accounts for 0.17 kg $CO_2$ eq. and represents 80% of the emissions associated with the transportation of ingredients to the manufacturing location in Haderslev, Denmark. Overall, the transportation activities in module A2 contributes 2% of the total $CO_2$ eq. emissions across all modules (excluding Module D)

| A2 TRANSPORT | | | | |
|---|---|---|---|---|
| **Material** | **GWP-total (kg $CO_2$ eq.)** | **GWP-total (kg $CO_2$ eq.) - in scientific notation** | **% of module** | **% of all modules excl. Module D** |
| Varnish and solvents | 0.17 | 1.75E-01 | 80.19% | 1.96% |
| Pigments | 0.03 | 2.89E-02 | 13.27% | 0.32% |
| Linseed oil | 0.01 | 1.07E-02 | 4.93% | 0.12% |
| Drying agent | 0.00 | 3.50E-03 | 1.61% | 0.04% |

In module A3, Product packaging is the largest contributor to emissions associated with the manufacturing stage. Product packaging accounts for 45% of the emissions in the module and 13% of the total product emissions. Electricity consumption during manufacturing contributes 22% of the module's emissions and 7% of the total emissions. The use of gas for internal heating at the production site adds 5% to the total emissions, while the handling of waste from manufacturing as well as packaging materials from A1 (including ingredient product packaging materials, transport packaging and pallets) accounts for 4% of the total emissions.

The GWP-total results for A3 are presented in the table below.

| A3 - MANUFACTURING | | | | |
|---|---|---|---|---|
| **Inventory** | **GWP-total (kg $CO_2$ eq.)** | **GWP-total (kg $CO_2$ eq.) - in scientific notation** | **% of module** | **% of all modules excl. Module D** |
| Electricity | 0.58 | 5.82E-01 | 22.03% | 6.53% |
| Gas | 0.46 | 4.64E-01 | 17.56% | 5.20% |
| Water | 0.00 | 1.03E-06 | 0.00% | 0.00% |
| Production bucket | 0.02 | 1.72E-02 | 0.65% | 0.19% |
| Product packaging | 1.18 | 1.18E+00 | 44.68% | 13.25% |
| Transport packaging | 0.03 | 3.21E-02 | 1.21% | 0.36% |
| Waste handling | 0.37 | 3.66E-01 | 13.86% | 4.11% |

The C modules represent the End of Life stage of the product, with module C3 being the primary contributor to emissions. In this stage, the product is incinerated with energy recovery, resulting in emissions of 1.2 kg $CO_2$ eq., which accounts for 13% of the total product emissions. The GWP-total in this module is influenced by the release of biogenic $CO_2$, which was originally absorbed primarily by linseed oil during the raw material production stage (module A1). This reflects the dynamic role of biogenic carbon in the product's life cycle, where the emissions in C3 effectively balance the biogenic carbon uptake recorded earlier. These findings emphasize the importance of considering both carbon uptake and release when interpreting life cycle emissions, particularly in products with substantial biogenic carbon content. Additionally, the waste management pathway of the C modules is determined by the handling processes applied to the underlying material to which the product adheres. This underscores the significant influence of the material's characteristics and regional variations in waste management infrastructure on end-of-life emissions. It is furthermore crucial to evaluate other impact categories, such as resource depletion, acidification, and eutrophication, to ensure a holistic assessment and avoid burden shifting, where reductions in one impact category may unintentionally increase impacts in another.

The GWP-total results for the C modules are summarized in the table below.

| C Modules | | | | |
|---|---|---|---|---|
| **Module** | **GWP-total (kg $CO_2$ eq.)** | **GWP-total (kg $CO_2$ eq.) - in scientific notation** | **% of module** | **% of all modules excl. Module D** |
| *C1 - De-construction demolition | 0.00 | 0.00E+00 | 0.00% | 0.00% |
| C2 - Transport | 0.01 | 6.32E-03 | 0.52% | 0.07% |
| C3 - Waste processing | 1.20 | 1.20E+00 | 99.28% | 13.49% |
| C4 - Disposal | 0.00 | 2.35E-03 | 0.19% | 0.03% |

*The deconstruction/removal of the declared product in C1 are assumed to be done manually, without specialized tools, and are therefore not covered by any processes contributing to the environmental impact of the life cycle.

## Technical information on scenarios

**End of life (C1-C4)**

| Processes | Value | Unit |
|---|---|---|
| Collected separately | 1.14 | kg |
| Collected with mixed waste | 0.00 | kg |
| For reuse | 0.00 | kg |
| For recycling | 0.00 | kg |
| For energy recovery | 1.14 | kg |
| For final disposal | 0.18 | kg |

**Re-use, recovery and recycling potential (D)**

| Processes | Value | Unit |
|---|---|---|
| Amount | 1.14 | kg/DU |
| LHV | 10.51 | MJ/kg |
| EET | 2.86 | MJ/DU |
| EEE | 1.30 | MJ/DU |
| Loss | 7.82 | MJ/DU |

### Core environmental impact indicators result – per. 1 kilogram.

The table below provides the additional information of the core environmental impact indicator results associated with 1 kg 91/Phnom Penh Retrolak®

| ENVIRONMENTAL IMPACTS PER 1 kg | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Indicator** | **Unit** | **A1** | **A2** | **A3** | **C1** | **C2** | **C3** | **C4** | **D** |
| GWP-total | kg $CO_2$ eq. | 4.25E+00 | 1.91E-01 | 2.32E+00 | 0.00E+00 | 5.55E-03 | 1.06E+00 | 2.06E-03 | -3.45E-01 |
| GWP-fossil | kg $CO_2$ eq. | 3.37E+00 | 1.91E-01 | 2.34E+00 | 0.00E+00 | 5.54E-03 | 8.87E-01 | 2.06E-03 | -3.45E-01 |
| GWP-biogenic | kg $CO_2$ eq. | -1.78E-01 | 0.00E+00 | -2.09E-02 | 0.00E+00 | 0.00E+00 | 1.69E-01 | 0.00E+00 | 7.03E-05 |
| GWP-luluc | kg $CO_2$ eq. | 1.06E+00 | 9.43E-05 | 2.05E-03 | 0.00E+00 | 2.74E-06 | 5.69E-05 | 1.43E-06 | -4.05E-05 |
| ODP | kg CFC 11 eq. | 2.64E-07 | 4.16E-09 | 4.62E-08 | 0.00E+00 | 1.21E-10 | 9.16E-09 | 5.94E-11 | -1.01E-08 |
| AP | mol $H^+$ eq. | 4.74E-02 | 4.17E-04 | 1.02E-02 | 0.00E+00 | 1.21E-05 | 4.86E-04 | 1.33E-05 | -7.63E-04 |
| EP-freshwater | kg P eq. | 1.21E-03 | 1.36E-05 | 8.02E-04 | 0.00E+00 | 3.94E-07 | 2.11E-05 | 8.70E-06 | -7.89E-05 |
| EP-marine | kg N eq. | 7.19E-03 | 1.05E-04 | 1.77E-03 | 0.00E+00 | 3.06E-06 | 1.63E-04 | 4.73E-06 | -1.77E-04 |
| EP-terrestrial | mol N eq. | 4.13E-02 | 1.07E-03 | 1.85E-02 | 0.00E+00 | 3.11E-05 | 1.65E-03 | 5.04E-05 | -1.82E-03 |
| POCP | kg NMVOC eq. | 1.68E-02 | 6.48E-04 | 6.36E-03 | 0.00E+00 | 1.88E-05 | 5.23E-04 | 1.86E-05 | -6.72E-04 |
| ADPm[1] | kg Sb eq. | 1.45E-04 | 6.24E-07 | 5.95E-05 | 0.00E+00 | 1.81E-08 | 4.05E-07 | 4.24E-09 | -2.92E-07 |
| ADPf[1] | MJ | 6.27E+01 | 2.71E+00 | 2.85E+01 | 0.00E+00 | 7.87E-02 | 1.06E+00 | 5.02E-02 | -5.31E+00 |
| WDP[1] | $m^3$ | 7.44E+00 | 1.12E-02 | 4.27E-01 | 0.00E+00 | 3.25E-04 | 1.81E-01 | 2.05E-03 | -2.63E-02 |
| Caption | GWP-total = Globale Warming Potential - total; GWP-fossil = Global Warming Potential - fossil fuels; GWP-biogenic = Global Warming Potential - biogenic; GWP-luluc = Global Warming Potential - land use and land use change; ODP = Ozone Depletion; AP = Acidifcation; | | | | | | | | |
| | EP-freshwater = Eutrophication – aquatic freshwater; EP-marine = Eutrophication – aquatic marine; EP-terrestrial = Eutrophication – terrestrial; POCP = Photochemical zone formation; ADPm = Abiotic Depletion Potential – minerals and metals; ADPf = Abiotic Depletion Potential – fossil fuels; WDP = water use | | | | | | | | |
| Disclaimer | [1] The results of this environmental indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator. | | | | | | | | |

*The imbalance in the GWP-biogenic results is due to a biogenic carbon uptake of 2.06E-02 kg $CO_2$ eq. per. kg. 91/Phnom Penh Retrolak® in the packaging material in A3 that are released in the omitted module A5, thus offsetting the carbon balance in the declared modules.

### Indoor air

*The EPD does not give information on release of dangerous substances to indoor air because the horizontal standards on the relevant measurements are not available. Read more in EN15804+A1 chapter 7.4.1.*

### Soil and water

*The EPD does not give information on release of dangerous substances to soil and water because the horizontal standards on the relevant measurements are not available. Read more in EN15804+A1 chapter 7.4.2.*

# References

| | |
|---|---|
| **Publisher** | epddanmark<br>www.epddanmark.dk<br>Template version 2024.2 |
| **Programme operator** | Danish Technological Institute<br>Gregersensvej<br>DK-2630 Taastrup<br>www.teknologisk.dk |
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| **LCA software /background data** | *SimaPro 9.5.0.0 / Ecoinvent v.3.9.1 Database, Agri-footprint version 6.3 Database, Evah Pigment 2019 Database*<br>*EN 15804 reference package 3.1* |
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**General programme instructions**
Version 2.0
www.epddanmark.dk

**EN 15804**
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**ISO 14025**
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**ISO 14040**
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**ISO 14044**
DS/EN ISO 14044:2008 – " Environmental management – Life cycle assessment – Requirements and guidelines"