Environmental Product Declaration

In accordance with ISO14025:2006 and EN15804:2012+A2:2019

Green Plow Anchor

Owner of the declaration:
Momek Løvold AS

Product name:
Green Plow anchor

Declared unit:
1 kg of Green Plow Anchor manufactured by Løvold Momek

Product category /PCR:
NPCR PART A: Construction products and services v2. issued 24.03.2021: NPCR 031 Part B for sea-based aquaculture infrastructure and components v.1 issued 2023-04-26.

Program holder and publisher:
The Norwegian EPD foundation

Declaration number:
NEPD-5531-4839-EN

Registration number:
NEPD-5531-4839-EN

Issue date: 12.12.2023

Valid to: 12.12.2028

ver-110324

The Norwegian
EPD Foundation

General information

Product:
Plow Anchor

Program operator:
The Norwegian EPD Foundation
Post Box 5250 Majorstuen, 0303 Oslo, Norway
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Declaration number:
NEPD-5531-4839-EN

This declaration is based on Product Category Rules:
NPCR PART A: Construction products and services v2. issued 24.03.2021
NPCR 031 Part B for sea-based aquaculture infrastructure and components v.1 issued 2023-04-26.

Statement of liability:
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.

Declared unit:
1 kg of Green Plow Anchor manufactured by Løvold Momek

Functional unit:
1 kg of Plow Anchor manufactured by Løvold Momek e and delivered at the sea-farm, including waste treatment at end-of-life.

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

internal ☐ external ■

Gaylord Booto
Independent verifier approved by EPD Norway

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Management system:
14001:2015: 9001:2015

Organisation no:
926 593 447

Issue date:
12.12.2023

Valid to:
12.12.2028

Year of study:
2023

Comparability:
EPD of construction products may not be able to compare if they do not comply with EN 15804 and are seen in a building context.

The EPD has been worked out by:
Pavel Stránský

Approved

Manager of EPD Norway

Product

Product description:

The Plow Anchor, made of S355J2 steel, is constructed using a 25mm base plate, 30mm shank plate, and 75mm wear plate. Designed for aquaculture mooring, the anchor is available in weights from 1000-4500 kg, with the specified model at 1400 kg, supporting a load of 56 tonnes (Tolerances according to NS-EN ISO13920 -DH)

The anchor is corrosion-resistant, ensures effective seabed penetration, and offers stable positioning. It meets the NYTEK NS 9415:2021 standard.

Intended Application: Used for mooring in aquaculture systems, the anchor is compatible with various mooring setups and allows for efficient deployment.

Product specification:

Produced in Norway with SSAB steel

Materials	Value	%
S355J2 steel	1400 kg	99.997
Green acrylic paint	4.7 kg	0.003

Technical data:

Main Data	Description	Value	Notes
	Width	2.4m	
	Height	2.0m	
	Length	2.8m	
	Weight	1.4t	
	Break Load	168 tons	
	Material Quality Bearing Construction Port	NS EN 10025 - S355J2	

Market:

Aquaculture

Additional technical information

Load Angle (+ Skew Load if applicable)	Value (Tons)	Load Case Description
0 degrees	145	Parallel to the base plate
30 degrees	168	30 degrees up from the base plate
50 degrees	168	50 degrees up from the base plate
60 degrees	168	60 degrees up from the base plate
0 degrees + 10% skew load	61	Parallel to the base plate
30 degrees + 10% skew load	168	30 degrees up from the base plate
50 degrees + 10% skew load	168	50 degrees up from the base plate
60 degrees + 10% skew load	140	60 degrees up from the base plate

The analyzes show that all the load cases fall within the requirement for 15% plastic strain according to NS-EN ISO13920:1996, therefore the anchor is considered to satisfy the requirements for safety (Myhre, 2022).

Reference service life, product

The product is expected to last for 20 years.

Reference service life, building or construction works

There is no standard service life for sea-based aquaculture farm. Each components have different service life and are repaired/replaced according to the regulations in NS9415-2021.

LCA: Calculation rules

Declared unit:

1 kg of Green Plow Anchor manufactured by Løvold Momek

Cut-off criteria:

The EPD follows criteria from NPRC part A, B and EN 15804:2012+A2:2019+AC:2021 chapter 6.3.6

Allocation:

Given the complexity of operations at Momek Løvold AS, which includes multiple production lines and a range of equipment, the plant's total electricity and heat consumption is allocated based on production area. This method is chosen due to the lack of detailed consumption data per equipment or line. For instance, the welding robot, a significant element in production, has a maximum power consumption of 4.5 kW (Panasonic Connect Co., Ltd, 2021). However, due to operational diversities and the absence of specific consumption sensors, a generalized allocation method is deemed most practical.

The electricity consumption for metalworking processes is estimated similarly, based on the typical energy requirements of the equipment and the proportion of production area they occupy. This approach, while not capturing equipment-specific details, provides a reasonable estimation of energy consumption, aligning with the EPD's goal of presenting a reliable environmental impact assessment.

Data quality:

The analysis uses primary data where available however some data inputs, like road transport, are sourced from generic databases, adding a layer of uncertainty. The use of generic databases for certain data inputs, such as road transport. Generic databases may introduce a layer of uncertainty into the analysis. The database used is Allocation, cut-off by classification, ecoinvent database version 3.8 (2021). Data for production metrics are directly sourced from the manufacturing site, reflecting average values for the year 2022.

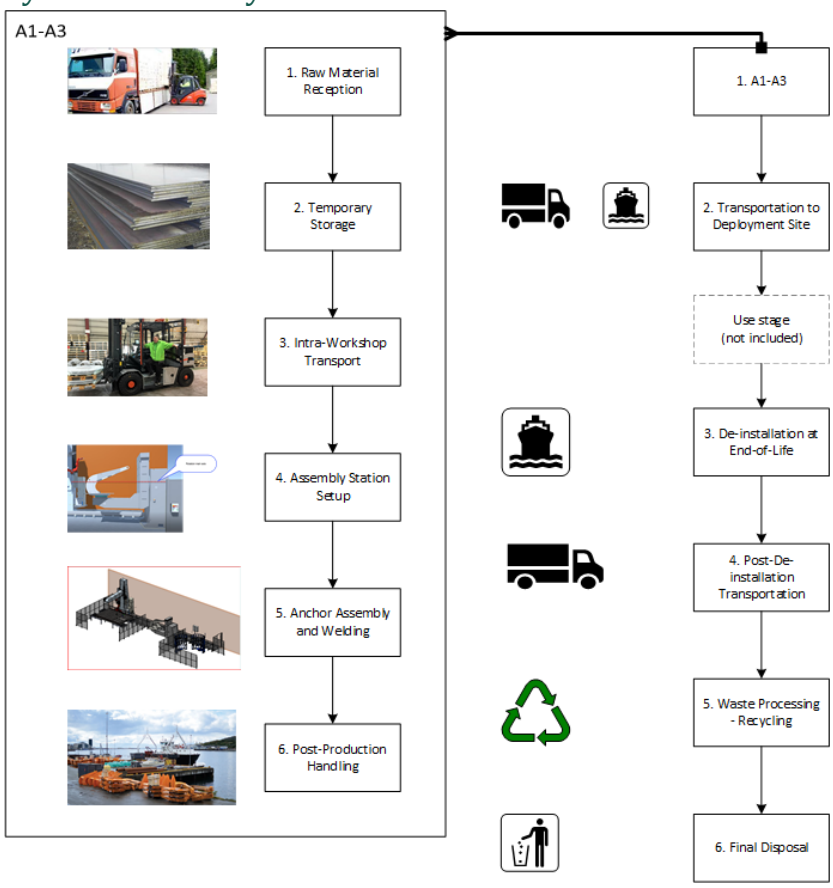
System boundaries (X=included, MND=module not declared, MNR=module not relevant)

Product stage			Assembly stage		Use stage							End of life stage				Benefits & loads beyond system boundary
Raw materials	Transport	Manufacturing	Transport	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste 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	X	X	X	X	X

The EPD is therefore cradle-to-gate with modules A4; C1-C4 and module D

System boundary:



A1-A3

1. **Raw Material Reception**: This initial stage involves the delivery and unloading of steel, sourced from SSAB, at the manufacturing site.
2. **Temporary Storage**: Post-delivery, the steel plates are stored in a temporary holding area.
3. **Intra-Workshop Transport**: This involves the transportation of steel plates from the temporary storage to the assembly station within the workshop.
4. **Assembly Station Setup**: In this phase, steel plates for two anchors are transported to the assembly jig inside the workshop.
5. **Anchor Assembly and Welding**: Utilizing advanced technology, the anchors are assembled and welded, predominantly by robotic arms and manipulators.

   Post-Production Handling: This final stage in the production phase involves moving the completed anchors to the storage area or directly prepping them for shipping.

A4-C4

1. **Transportation to Deployment Site**: This includes road freight (default 300 km to the producer's dock) and sea freight (additional 1 Nautical Mile to the aquaculture location).

2. **De-installation at End-of-Life**: The removal of the Green Anchor from the aquaculture site is executed using a work boat.
3. **Post-De-installation Transportation**: Mirroring module A4, the Green Anchor is transported from the coastal area to the processing or disposal site, assumed to be 300 km by truck.
4. **Waste Processing - Recycling**: In line with NPCR Part B, 90% of the anchor material is recycled.
5. **Final Disposal**: The remaining 10% of the anchor, which is not recycled, is directed to landfill.

Overall System Boundary

The system boundary for the Green Anchor spans from the point of raw material reception to the final disposal of the product. It encompasses production, transportation to the deployment site, operational use, de-installation processes, and end-of-life management including recycling and disposal. This holistic approach ensures a comprehensive understanding of the product's environmental impact throughout its lifecycle.

LCA: Scenarios and additional technical information

Transport from production place to assembly/user (A4)

Transport from production place to assembly/user (A4)	Capacity utilisation (incl. return) %	Distance (km)	Fuel/Energy consumption	Unit	Value
Truck	50%	300	0.0472	Kg diesel/tkm	0.014
Boat	-	1.8	6	l/h	0.0109

This distance is estimated based on information from the manufacturer and its relevance to the intended market. In the absence of specific data, a default distance of 300 km is used for Norwegian conditions. Work Boat Operations: Utilizing cranes, these operations involve various engine regimes, including idling and moving. The boats are primarily tasked with dismantling components and transporting them to the sea. The primary environmental consideration in these operations is the consumption and combustion of marine fuels. Standard work boats, measuring 14x7.5 meters, are typically operated for 4,200 hours annually. This operation time includes 1,400 hours of sailing or towing and 2,800 hours of on-site operations, with an estimated fuel consumption of 20 liters per hour from propulsion machinery. Additionally, generator fuel consumption averages about 6 liters per hour during both sailing and on-site operations. The generic ecoinvent process "diesel, burned in fishing vessel | Cutoff, U" is applied.

End of Life (C1, C3, C4)

	Unit	Value
Hazardous waste disposed	kg	0
Collected as mixed construction waste	kg	0
Reuse	kg	0
Recycling	kg	0.9
Energy recovery	kg	0
To landfill	kg	0.1

For waste treatment (C3) and landfilling (C4), the processes and default rates are defined in Table 3, which is based on NPCR031 Part B The scenarios assume complete collection of materials at the end-of-life phase. Alternatives to Table 3 can be utilized if properly documented. For example, the Norwegian aquaculture industry can refer to these studies or their latest updates for representative scenarios and statistics for life cycle modules C3 and C4 for major material categories.

In the context of mooring, connectors, and joints, the generic scenarios are:

C3: Waste Treatment: Central sorting of metals, with metals directed towards recycling. Default recycling rates for steel and other relevant metals are 90%.

C4: Landfilling: Landfilling of metals and ashes from incineration, with default landfilling rates for steel and other relevant metals set at 10%.

Transport to waste processing (C2)

Transport from production place to assembly/user (C2)	Capacity utilisation (incl. return) %	Distance (km)	Fuel/Energy consumption	Unit	Value
Truck	50%	300	0.0472	Kg diesel/tkm	0.014
Boat	-	1.8	6	l/h	0.0109

The C2 scenario involves transporting components from the sorting/storing facility near the dock to the waste treatment or recycling facility. This distance is estimated based on information from the manufacturer and its relevance to the intended market. In the absence of specific data, a default distance of 300 km is used for Norwegian conditions.

Benefits and loads beyond the system boundaries (D)

Benefits and loads beyond the system boundaries (D)	Unit	Value
Substitution of primary steel with net scrap	kg	0.95

LCA: Results

Functional unit:

1 kg of Plow Anchor manufactured by Løvold Momek and delivered at the standard sea-farm, including standard waste treatment at end-of-life.

The functional unit for this assessment is 1 kg of Green Plow Anchor produced by Løvold Momek. The anchors typically weigh 1,400 kg and have a maximum permitted load of 56 tonnes. This unit aligns with the specifications of NPCR 031 Part B, focusing on cradle-to-gate analyses incorporating modules A1-A3, A4, C1-C4, and D

Core environmental impact indicators

Indicator	Unit	A1-A3	A4	C1	C2	C3	C4	D
GWP - total	kg CO2 eq	3.00E+00	9.83E-02	3.42E-02	6.41E-02	7.53E-03	5.28E-04	-1.09E+00
GWP - fossil	kg CO2 eq	2.99E+00	9.82E-02	3.42E-02	6.40E-02	7.51E-03	5.27E-04	-1.10E+00
GWP - biogenic	kg CO2 eq	-2.50E-03	6.75E-05	9.22E-06	5.83E-05	1.07E-05	5.22E-07	9.68E-03
GWP - luluc	kg CO2 eq	5.58E-03	3.21E-05	1.85E-06	3.03E-05	6.15E-06	4.97E-07	1.43E-04
ODP	kg CFC11 eq	2.73E-08	2.20E-08	7.57E-09	1.44E-08	2.51E-09	2.13E-10	-3.73E-08
AP	molc H+ eq	9.30E-03	1.39E-03	1.21E-03	1.81E-04	6.14E-05	4.95E-06	-3.31E-03
EP- freshwater	kg P eq	2.47E-04	5.17E-06	3.46E-07	4.83E-06	8.36E-07	4.82E-08	-4.80E-04
EP -marine	kg N eq	1.43E-04	3.27E-04	2.91E-04	3.54E-05	2.16E-05	1.72E-06	-8.60E-04
EP - terrestrial	molc N eq	1.35E-03	3.58E-03	3.19E-03	3.85E-04	2.36E-04	1.88E-05	-9.35E-03
POCP	kg NMVOC eq	5.45E-04	9.77E-04	8.29E-04	1.48E-04	6.81E-05	5.48E-06	-6.08E-03
ADP-M&M[2]	kg Sb-Eq	2.29E-05	2.99E-07	5.87E-09	2.93E-07	2.09E-08	1.20E-09	2.35E-06
ADP-fossil[2]	MJ	3.02E+01	1.43E+00	4.69E-01	9.58E-01	1.75E-01	1.47E-02	-8.71E+00
WDP[2]	m³	4.18E-02	3.40E-03	2.23E-04	3.18E-03	6.03E-03	6.62E-04	-8.39E-02

GWP-total: *Global Warming Potential;* ***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:*** *Depletion potential of the stratospheric ozone layer;* ***AP:*** *Acidification potential, Accumulated Exceedance;* ***EP-freshwater:*** *Eutrophication potential, fraction of nutrients reaching freshwater end compartment; See "additional Norwegian requirements" for indicator given as PO4 eq.* ***EP-marine:*** *Eutrophication potential, fraction of nutrients reaching freshwater end compartment;* ***EP-terrestrial:*** *Eutrophication potential, Accumulated Exceedance;* ***POCP****: Formation potential of tropospheric ozone;* ***ADP-M&M****: Abiotic depletion potential for non-fossil resources (minerals and metals);* ***ADP-fossil:*** *Abiotic depletion potential for fossil resources;* ***WDP:*** *Water deprivation potential, deprivation weighted water counsumption*

Reading example: 9,0 E-03 = 9,0*10-3 = 0,009

Additional environmental impact indicators

Indicator	Unit	A1-A3	A4	C1	C2	C3	C4	D
PM	Disease incidence	2.06E-08	1.34E-08	9.06E-09	4.37E-09	1.20E-09	9.97E-11	-5.82E-08
IRP[1]	kBq U235 eq.	1.56E-02	7.19E-03	2.09E-03	5.09E-03	8.61E-04	6.53E-05	8.26E-02
ETP-fw[2]	CTUe	2.51E+00	1.03E+00	2.40E-01	7.80E-01	1.20E-01	1.00E-02	-3.42E+01
HTP-c[2]	CTUh	7.72E-10	4.71E-11	1.88E-11	2.83E-11	3.91E-12	2.36E-13	1.57E-08
HTP-nc[2]	CTUh	2.57E-09	9.29E-10	1.71E-10	7.58E-10	9.48E-11	6.15E-12	-2.03E-08
SQP[2]	Dimensionless	2.12E+00	6.24E-01	5.76E-02	5.67E-01	3.12E-01	3.09E-02	-1.15E+00

PM: *Particulate matter emissions;* ***IRP:*** *Ionising radiation, human health;* ***ETP-fw:*** *Ecotoxicity (freshwater);* ***ETP-c:*** *Human toxicity, cancer effects;* ***HTP-nc:*** *Human toxicity, non-cancer effects;* ***SQP:*** *Land use related impacts / soil quality*

[1] This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator.

[2] The results of this environmental impact 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

No primary energy resources are used in the manufacturing process, only electricity and district heating.

Parameter	Unit	A1-A3	A4	C1	C2	C3	C4	D
RPEE	MJ	0	0	0	0	0	0	0
RPEM	MJ	0	0	0	0	0	0	0
TPE	MJ	0	0	0	0	0	0	0
NRPE	MJ	0	0	0	0	0	0	0
NRPM	MJ	0	0	0	0	0	0	0
TRPE	MJ	0	0	0	0	0	0	0
SM	kg	0	0	0	0	0	0	0
RSF	MJ	0	0	0	0	0	0	0
NRSF	MJ	0	0	0	0	0	0	0
W	m^3	3.18E-3	0	0	0	0	0	0

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*** *Nonrenewable primary energy resources used as energy carrier;* ***NRPM*** *Nonrenewable 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-A3	A4	C1	C2	C3	C4	D
HW	kg	0.0006	0	0	0	0	0	
NHW	kg	0.136	0	0	0	0.9	0.1	0.95
RW	kg	0.0005	0	0	0	0	0	

HW *Hazardous waste disposed;* ***NHW*** *Non-hazardous waste disposed;* ***RW*** *Radioactive waste disposed.*

End of life – output flow

Parameter	Unit	A1-A3	A4	C1	C2	C3	C4	D
CR	kg	0	0	0	0	0	0	0
MR	kg	0.05	0	0	0	0.9	0	0.95
MER	kg	0	0	0	0	0	0	0
EEE	MJ	0	0	0	0	0	0	0
ETE	MJ	0	0	0	0	0	0	0

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

Information describing the biogenic carbon content at the factory gate

Biogenic carbon content	Unit	Value
Biogenic carbon content in product	kg C	0
Biogenic carbon content in the accompanying packaging	kg C	0

The product is almost exclusively made from steel. The origins of carbon contained in steel are not assessed.

Additional requirements

Location based electricity mix from the use of electricity in manufacturing

National production mix from import, low voltage (production of transmission lines, in addition to direct emissions and losses in grid) of applied electricity for the manufacturing prosess (foreground/core) per functional unit.

National electricity grid	Data source	Foreground / core [kWh]	GWP_{total} [kg CO2 - eq/kWh]	SUM [kg CO2 - eq]
Electricity, low voltage {NO}| market for | Cut-off, U	Ecoinvent 3.8	0.011	0.0263	0.0002893

Additional environmental impact indicators required for construction products

In order to increase the transparency of biogenic carbon contribution to climate impact, the indicator GWP-IOBC is required as it declares climate impacts calculated according to the principle of instantanious oxidation. GWP-IOBC is also reffered to as GWP-GHG in context to Swedish public procurement legislation.

Parameter	Unit	A1-A3	A4	C1	C2	C3	C4	D
GWP-IOBC	kg	3.00E+00	9.82E-02	3.42E-02	6.40E-02	7.52E-03	5.27E-04	-1.10E+00

GWP-IOBC *Global warming potential calculated according to the principle of instantaneous oxidation.*

Hazardous substances

The declaration is based upon reference to threshold values and/or test results and/or material safety data sheets provided to EPD verifiers. Documentation available upon request to EPD owner.

- **The product contains no substances given by the REACH Candidate list.**

Indoor environment

The product meets the requirements for low emissions.

Carbon footprint

While a carbon footprint analysis has not been conducted for the product separately, the results section does include an evaluation of Global Warming Potential (GWP) with such an analysis. The GWP total results presented in this EPD document represents the carbon footprint of the product studied.

Bibliography

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ISO 14044:2006	Environmental management - Life cycle assessment - Requirements and guidelines
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