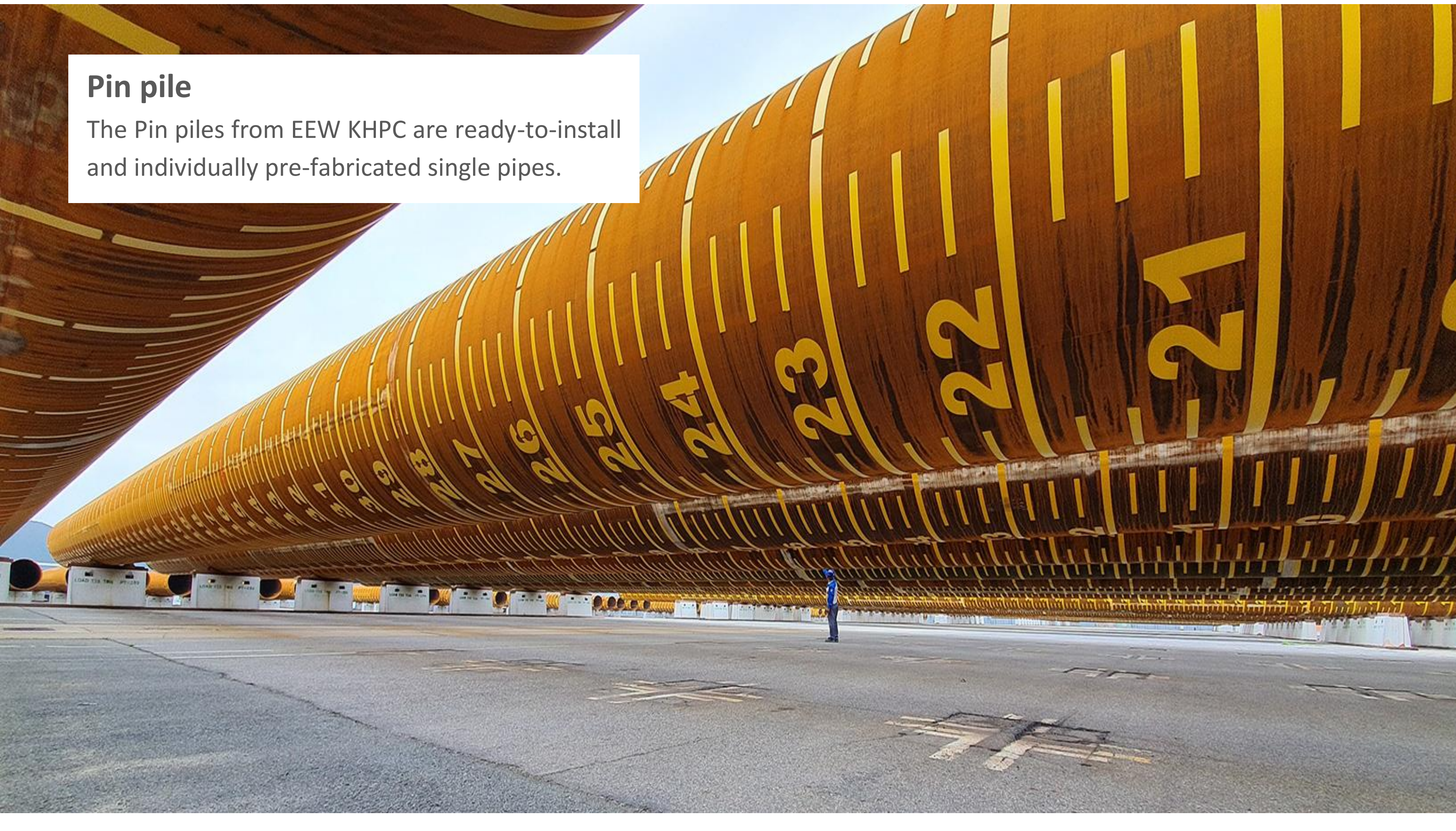
Environmental Product Declaration

as per ISO 14025 and EN 15804

Owner of the declaration:	EEW KHPC
Publisher:	Kiwa-Ecobility Experts
Programme operator:	Kiwa-Ecobility Experts
Registration number:	EPD-Kiwa-EE-000403-EN
Issue date:	19.06.2024
Valid to:	19.06.2029

Pin pile

The Pin piles from EEW KHPC are ready-to-install and individually pre-fabricated single pipes.



1. General information

EEW KHPC	Pin pile
Programme operator Kiwa GmbH, Ecobility Experts Wattstraße 11-13 Haus 1, 3. OG, TH 1 13355 Berlin Germany	**Owner of the declaration** EEW KHPC 71-9, Hangman 7-ro, Gwangyang-Si Jeollanam-do, 57772 South Korea
Registration number EPD-Kiwa-EE-000403-EN	**Declared product / declared unit** 1 metric ton Pin pile
This declaration is based on the Product Category Rules Kiwa-EE: PCR B – construction steel products (Edition 2020-03-13 (draft)) **Issue date** 19.06.2024 **Valid to** 19.06.2029	**Scope** Pin pile is a ready-to-install and individually pre-fabricated single pipe used in offshore wind or offshore oil & gas platforms. It is produced and distributed by EEW KHPC, located in Gwangyang, South Korea. The EPD refers to the specific Product. EPD type: Cradle to gate, modules A1-A5, C1-C4, and module D. Kiwa-Ecobility Experts assumes no liability for manufacturer's information, LCA data and evidence.
Raoul Mancke (Head of programme operations, Kiwa-Ecobility Experts)	**Verification** The European standard EN 15804+A2:2019 serves as the core PCR. Independent verification of the declaration and data, according to EN ISO 14025:2010. ☐internal ☒external
Martin Koehrer (Verification body, Kiwa-Ecobility Experts)	Anne Kees Jeeninga (Third party verifier)

2. Product

2.1 Product description

The Pin pile from EEW are ready-to-install and individually pre-fabricated single pipes.

2.2 Application

Pin pile is used in offshore wind or offshore oil & gas platforms.

2.3 Reference Service Life (RSL)

The service life of the construction will limit the lifetime pin piles which is 30 years.

2.4 Technical data

The technical data is listed in the table below. The values for the unit weight depend on the product type and its corresponding tensile strength. For this reason, only the value ranges for pin pile are given here.

Characteristic	Value/Tolerance	Unit
Diameter range	1219 - 7000	mm
Length range	1500 – 90000	mm
Wall thickness range	30 – 150	mm
Weight Range	1630 – 600000	kg
Tensile strength	448 – 720	MPa
Yield strength	320 – 483	MPa

2.5 Substances of very high concern

The Product does not contain substances from the "Candidate list of substances of very high concern for authorisation" (SVHC).

2.6 Base materials / Ancillary materials

EEW Pin piles are manufactured from Heavy plate.

Raw material	value	unit
Heavy plate: VL D36, E36 EN10025-4 S355ML~S460ML	99.1	%
Welding rod	0.9	%

There is no biogenic carbon in the products.

2.7 Manufacturing

The manufacturing is located at EEW KHPC CO.,LTD, 71-9, Hangman 7-ro Gwangyang-Si Jeollanam-do 57772, South Korea. The production of pin piles comprises the following process steps and is shown in the following figure:

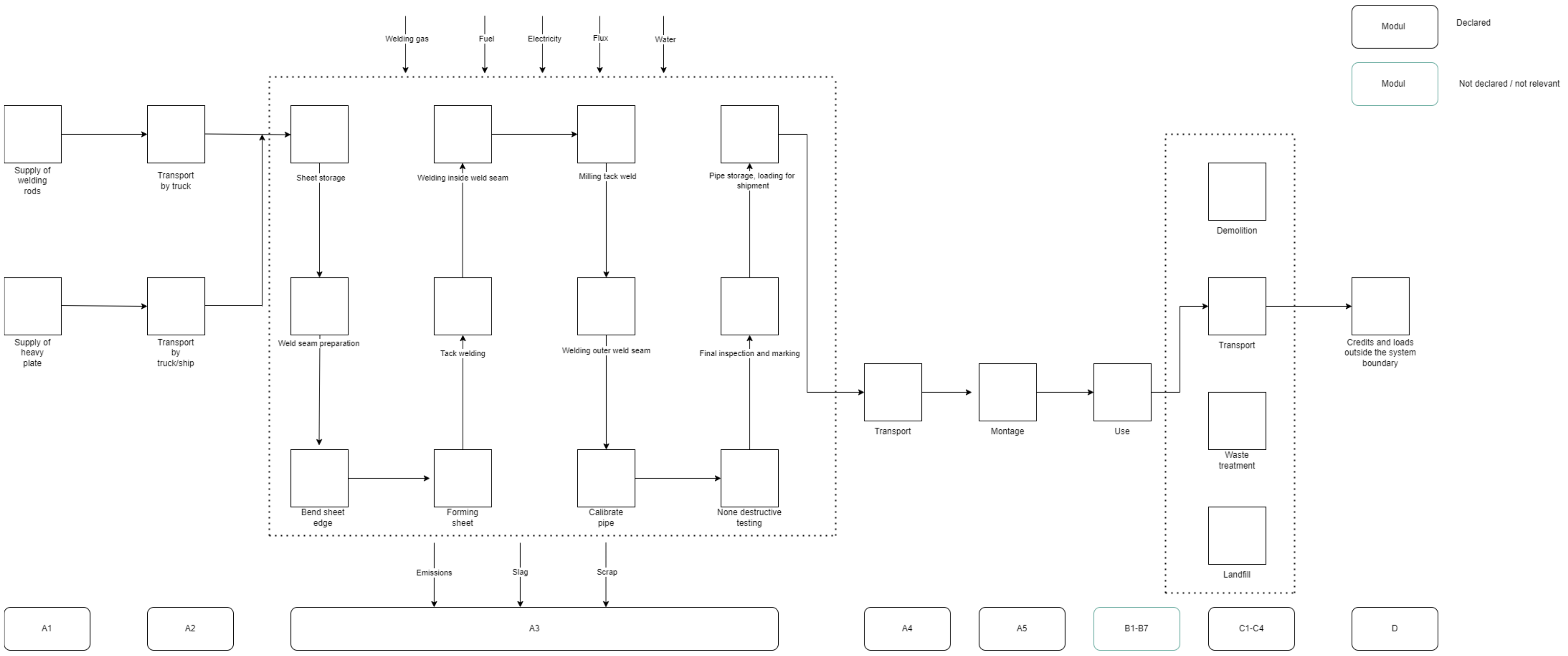
1. Incoming goods - unload sheet metal, incoming goods inspection; Sheet storage
2. Weld seam preparation - milling or burning sheet edge
3. Bend sheet edge: pre-bending of the prepared sheets
4. Forming sheet: Final bending of the bent sheets to form a raw tube preform
5. Tack welding: Closing the open ends of the tube blank with a tack weld
6. Welding inside weld seam: UP Internal welding of the pipe
7. Milling tack weld: Milling of the outer tacking seam
8. Welding outer weld seam: UP external welding of the pipe

9. Calibrate pipe: Calibration of the finished welded tube
10. None destructive testing
11. Final inspection and marking
12. Pipe storage; Loading for shipment

There is no packaging used for this product. Only load securing - square timbers, wooden wedges, rubber mats, and tension belts are used.

2.8 Other Information

For further information on Pin pile, please visit the official EEW KHPC webpage under the following link: (eewkhpc.co.kr)



Process Flow Chart of The Production of EEW KHPC Pine Pile

3. LCA: Calculation rules

3.1 Declared unit

In accordance with PCR B, one metric ton pin pile is chosen as the declared unit.

3.2 Conversion factors

Product	Unit	Value
Declared Unit	metric ton pin pile	1
Conversion factor to 1 kg	-	0.001

3.3 Scope of declaration and system boundaries

The Environmental Product Declaration is a complete life cycle with a functional unit. It considers all potential environmental impacts of the product from the cradle to the factory gate with options. In addition to the production stage A1-A3, the A4 (transport to customer), A5 (installation), and the end-of-life stage (C1-C4 & D) are considered.

The manufacturing phase includes the production or extraction of the source materials, the transport to the respective production plant, and the production of the pin pile. All inputs (raw materials, pre-cursors, energy, and auxiliary materials), as well as the by-products and waste, are considered for all life cycle phases.

The year 2022 represents the time reference for raw materials and electricity consumption. By defining the scenarios (transport from the production site and end-of-life scenarios) according to specifications of the Dutch Environmental Database (NMD), the Netherlands is the relevant geographical reference for this EPD. Due to manufacturing in Gwangyang (Module A1-A3), the exact geographical reference area is Korea. Environmental effects such as the greenhouse effect can occur with a substantial spatial and temporal offset.

All benefits and loads beyond the system boundary (Module D) resulting from reusable products, re-cyclable materials and/or useful energy carriers leaving the product system are considered in this LCA.

The table below outlines the system boundaries and declares which modules are included and ex-cluded in this LCA:

Description of the system boundary																
Product stage			Construction process stage		Use stage							End of life stage				Benefits and loads beyond the system boundaries
Raw material supply	Transport	Manufacturing	Transport from manu-facturer to place of use	Construction/ installation process	Use	Maintenance	Repair	Replacement	Refurbishmen	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	X	ND	ND	ND	ND	ND	ND	ND	X	X	X	X	X
X=Module declared | ND= Module not declared																

The waste materials and quantities produced are included in the respective modules.

3.4 Geographical reference area

Pin piles are marketed worldwide. After the final inspection, the pipes are ready to be shipped. No average transport distances could be determined, as the logistics are sometimes organized by the customer and sometimes by EEW. A frequent shipment is transported by truck to Gwangyang port and distributed world-wildly.

3.5 Cut-off Criteria

All flows that influence is higher than 1% on the total mass, energy, or environmental impact are included in the LCA. All process-specific data could be determined and modelled by generic data (Ecoinvent 3.6).

3.6 Allocation

Pin piles account for 93% of total KHPC output by mass. As a result, all supplier contributions, energy usage, and additional materials were allocated proportionally according to the mass ratio.
During the production of pin pile, no co-products are generated.

3.7 Data collection and reference time period

For all processes, primary data was collected and provided by EEW_KHPC. The primary data refers to the year 2022.
Secondary data were taken from the Ecoinvent 3.6 database, released in 2019. The database is regularly checked and thus complies with the requirements of ISO 14040/44 (background data not older than 10 years). The background data meets the requirements of EN 15804.
The quantities of raw materials, consumables and supplies used as well as the energy consump-tion have been recorded and averaged over the entire year of operation.
ReTHiNK EPD web application from the company NIBE was used to model the life cycle for the production and disposal of the declared product systems. To ensure that the results are comparable, consistent background data from the international database Ecoinvent was used in the LCA (e.g., data records on energy, transport, auxiliary materials, and supplies). Almost all consistent data sets contained in the Ecoinvent database are documented and can be viewed online.
The general rule that specific data from certain production processes or average data derived from certain processes must have priority when calculating an EPD or LCA was observed. Data for processes over which the manufacturer has no influence were assigned to generic data.

3.8 Estimates and assumptions

Transport distances for all raw materials (raw materials, operating materials, packaging) could be recorded. A payload factor of 50% was used for all truck transports (suppliers, disposal transports, and internal transports), which corresponds to a full delivery and empty return trip. A data set for a non-specific truck was used.
The energy and material consumptions are average values and refer to the year 2022. The EEW_KHPC site also processes other steel products. Measured in terms of output, pin piles account for 93 percent of mass production.
The total amount of waste products generated, including slag, dust, and scrap, was reported at 8.5 kg per ton of product. The proportions of these three waste products are used as a reference value for calculating the raw material production waste amount.

$$p_{production\ waste\ amount}\ (\%) = \frac{m_{waste,raw\ material}}{m_{raw\ material}}$$

As a result, in the following report, overall 0.84%, of the raw material is considered waste during production.
Pin piles are marketed worldwide. No average transport distances could be determined, as the logistics are organized by the customer.

For transportation to the construction site (A4), transportation by lorry (truck) from production location to Gwangyang Port was assumed. Since the EEW_KHPC plant is located at Gwangyang Port, a distance of 1 km was considered.
EEW is not responsible for installing the pile, so an fictive installation scenario (A5) was assumed based on literature. This scenario includes the use of a self-propelled jack-up barge, 600 tons, with two engines consuming 310 liters/hr (while in operation) for a full day (24 hr), along with one generator consuming 88 liters/hr (while on standby) for 12 hours.
No CO2 certificates were considered

3.9 Comparability

In principle, a comparison or assessment of the environmental impacts of different products is only possible if they have been prepared in accordance with EN 15804. For the evaluation of the comparability, the following aspects have to be considered in particular: PCR used, functional or declared unit, geographical reference, the definition of the system boundary, declared modules, data selection (primary or secondary data, background database, data quality), scenarios used for use and disposal phases, and the life cycle inventory (data collection, calculation methods, allocations, validity period). PCRs and general program instructions of different EPDs programs may differ. Comparability needs to be evaluated. For further guidance, see EN 15804+A2 (5.3 Comparability of EPD for construction products) and ISO 14025 (6.7.2 Requirements for comparability).

4. LCA: Scenarios and additional technical information

The distance to the construction site (A4) was calculated according to the NMD (Nationale Milieu Database (Dutch National Environmental Database)) method. Accordingly, the distance between the production site in EEW_KHPC and Gwangyang port was considered (1 km) by truck.
It is assumed that no activities for maintenance, repair, transport and replacement, refurbishment, or other material and energy flows take place during the RSL. Modules B1 to B7 are therefore assumed to be zero.
Due to a high life expectancy and the fact that EEW is not responsible for this, there is no company data available on the material recovery of installed pin piles. However, since there is a high potential for recycling and reusing steel pipe, this solution remains an attractive possibility. So, it is assumed that removal will be performed in the same manner as installation, a self-propelled jack-up barge, 600 ton, 2x engines 310 liters/hr (steaming) for one day (24 hr) with 1x generator 88 liters/hr (standby) for 12 hr, with the addition of an oxy-fuel cutting operation are stated for module C1 (demolition).

For the calculation of end-of-life, the standard waste scenario for steel, permanent (100yr) sheet piles placed in soil/marine water was followed based on the "national milieu databank" (NMD ID 90). This defines the waste scenario as 63.2% recycling and 36.8% to be left.

Note: The transport distances of the waste are based on the standard waste scenarios of the NMD Determination Method (SBK 2019): incineration 150 km/ recycling 50 km/landfill 100 km; vehicle: truck, unspecific. For energy recovery, it is assumed that only fossil raw materials are substituted, considering the calorific values of the raw materials of the declared product and energy and thermal efficiencies of 18% and 32%. According to EN 15804, loads are credited in A3 or C3 to C4, and benefits are credited in module D.

For all road transports, the environmental profile of a non-specific truck transport was used (conservative assumption): The vehicle operates with diesel and provides a fleet average that includes different lorry classes and EURO classes. This environmental profile contains data for transport, which is calculated for an average load factor, including empty return trips (Ecoinvent 3.6).

5. LCA: Results

5.1 Results of the LCA – Environmental Impact

The following tables show the results of the impact assessment indicators, resource use, waste, and other output streams. The results presented here refer to the declared specific product.

Disclaimer on ADP-e, ADP-f, WDP, ETP-fw, HTP-c, HTP-nc, SQP: The results of these environmental impact indicators must be used with caution, as the uncertainties in these results are high or as there is limited experience with the indicator.

Disclaimer on IR: This impact category mainly addresses the potential effect of low-dose ionizing radiation on human health in the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents and occupational exposures, nor does it consider radioactive waste disposal in underground facilities. Potential ionizing radiation from soil, radon, and some building materials are also not measured by this indicator.

Results of the LCA – Environmental impact: 1 ton Pin pile (EN 15804+A2)											
Parameter	**Unit**	**A1**	**A2**	**A3**	**A4**	**A5**	**C1**	**C2**	**C3**	**C4**	**D**	**Total A1-A3**
Core environmental impact indicators												
ADP-mm	kg Sb-eqv.	7.13E-02	3.68E-04	1.61E-03	3.39E-06	1.34E-04	1.37E-04	1.07E-04	0.00E+00	1.74E-05	-5.42E-04	7.33E-02
ADP-f	MJ	4.44E+04	2.19E+02	3.70E+03	2.02E+00	1.20E+03	1.21E+03	6.38E+01	0.00E+00	5.30E+01	-5.60E+03	4.83E+04
AP	mol H+ eqv.	2.16E+01	8.43E-02	6.88E-01	7.76E-04	9.11E-01	9.16E-01	2.45E-02	0.00E+00	1.80E-02	-3.09E+00	2.24E+01
EP-fw	kg PO4 eqv.	2.52E-01	1.47E-04	8.19E-03	1.35E-06	3.17E-04	3.72E-04	4.26E-05	0.00E+00	2.12E-05	-2.83E-02	2.60E-01
EP-m	kg N eqv.	4.34E+00	2.97E-02	1.35E-01	2.73E-04	4.02E-01	4.03E-01	8.64E-03	0.00E+00	6.19E-03	-5.74E-01	4.50E+00
EP-t	mol N eqv.	4.81E+01	3.28E-01	1.51E+00	3.01E-03	4.41E+00	4.42E+00	9.52E-02	0.00E+00	6.84E-02	-6.70E+00	5.00E+01
GWP-b	kg CO2 eqv.	-2.49E+00	6.71E-03	4.33E-01	6.18E-05	2.42E-02	2.58E-02	1.95E-03	0.00E+00	3.74E-03	8.35E+00	-2.05E+00
GWP-f	kg CO2 eqv.	4.24E+03	1.45E+01	1.29E+02	1.34E-01	8.71E+01	8.82E+01	4.23E+00	0.00E+00	1.90E+00	-8.02E+02	4.38E+03
GWP-luluc	kg CO2 eqv.	2.29E+00	5.33E-03	9.24E-02	4.90E-05	6.86E-03	8.61E-03	1.55E-03	0.00E+00	5.29E-04	5.91E-01	2.39E+00
GWP-total	kg CO2 eqv.	4.24E+03	1.45E+01	1.29E+02	1.34E-01	8.71E+01	8.82E+01	4.23E+00	0.00E+00	1.90E+00	-7.93E+02	4.38E+03
ODP	kg CFC 11 eqv.	2.19E-04	3.21E-06	3.36E-05	2.95E-08	1.88E-05	1.88E-05	9.33E-07	0.00E+00	7.81E-07	-1.96E-05	2.55E-04
POCP	kg NMVOC eqv.	2.07E+01	9.35E-02	4.60E-01	8.61E-04	1.21E+00	1.22E+00	2.72E-02	0.00E+00	1.98E-02	-4.56E+00	2.12E+01
WDP	m3 world eqv.	1.03E+03	7.84E-01	2.80E+01	7.22E-03	1.61E+00	2.64E+00	2.28E-01	0.00E+00	2.38E+00	-1.53E+02	1.06E+03
Additional environmental impact indicators												
ETP-fw	CTUe	1.99E+05	1.96E+02	3.61E+03	1.80E+00	7.22E+02	7.44E+02	5.68E+01	0.00E+00	3.44E+01	-2.69E+04	2.03E+05
HTP-c	CTUh	3.51E-05	6.34E-09	3.33E-07	5.84E-11	2.52E-08	2.55E-08	1.84E-09	0.00E+00	7.96E-10	-1.04E-07	3.54E-05
HTP-nc	CTUh	2.69E-04	2.14E-07	7.66E-06	1.97E-09	6.20E-07	6.31E-07	6.22E-08	0.00E+00	2.44E-08	1.58E-04	2.77E-04
IRP	kBq U235 eqv.	8.61E+01	9.19E-01	1.83E+01	8.45E-03	5.14E+00	5.18E+00	2.67E-01	0.00E+00	2.17E-01	1.37E+01	1.05E+02
PM	disease incidence	3.78E-04	1.31E-06	5.28E-06	1.20E-08	2.41E-05	2.42E-05	3.80E-07	0.00E+00	3.50E-07	-4.65E-05	3.85E-04
SQP	-	1.50E+04	1.90E+02	4.94E+02	1.75E+00	1.53E+02	1.55E+02	5.53E+01	0.00E+00	1.11E+02	-1.24E+03	1.57E+04

ADP-mm= Abiotic depletion potential for non-fossil resources | **ADP-f**=Abiotic depletion for fossil resources potential | **AP**= Acidification potential, Accumulated Exceedance | **EP-fw** = Eutrophication potential, fraction of nutrients reaching freshwater end compartment | **EP-m**= Eutrophication potential, fraction of nutrients reaching marine end compartment| **EP-T**= Eutrophication potential, Accumulated Exceedance | **GWP-b**=Global Warming Potential biogenic | **GWP-f**=Global Warming Potential fossil fuels | **GWP-luluc**=Global Warming Potential land use and land use change |**GWP-total**=Global Warming Potential total| **ODP**=Depletion potential of the stratospheric ozone layer |**POCP**=Formation potential of tropospheric ozone | **WDP**=Water (user) deprivation potential, deprivation- weighted water consumption | **ETP-fw**=Potential Comparative Toxic Unit for ecosystems | **HTP-c**=Potential Toxic Unit for Humans toxicity, cancer | **HTP-nc**= Potential Toxic Unit for humans, non-cancer | **IRP**=Potential Human exposure efficiency relative to U235, human health | **PM**=Potential incidence of disease due to Particulate Matter emissions | **SQP**=Potential soil quality index

Results of the LCA – Environmental impact: 1 ton Pin pile (EN 15804+A2)												
Parameter	**Unit**	**A1**	**A2**	**A3**	**A4**	**A5**	**C1**	**C2**	**C3**	**C4**	**D**	**Total A1-A3**
PERE	MJ	4.19E+03	2.74E+00	8.00E+01	2.53E-02	6.48E+00	7.80E+00	7.98E-01	0.00E+00	4.28E-01	1.63E+02	4.27E+03
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	4.19E+03	2.74E+00	8.00E+01	2.53E-02	6.48E+00	7.80E+00	7.98E-01	0.00E+00	4.28E-01	1.63E+02	4.27E+03
PENRE	MJ	4.70E+04	2.33E+02	2.56E+03	2.14E+00	1.27E+03	1.28E+03	6.77E+01	0.00E+00	5.63E+01	-5.81E+03	4.98E+04
PENRM	MJ	0.00E+00	0.00E+00	1.37E+03	0.00E+00	0.00E+00	4.76E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.37E+03
PENRT	MJ	4.70E+04	2.33E+02	3.92E+03	2.14E+00	1.27E+03	1.29E+03	6.77E+01	0.00E+00	5.63E+01	-5.81E+03	5.12E+04
SM	Kg	1.09E+02	0.00E+00	1.09E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E+02
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	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	0.00E+00	0.00E+00	0.00E+00
FW	M3	3.06E+01	2.67E-02	9.05E-01	2.46E-04	6.17E-02	8.82E-02	7.77E-03	0.00E+00	5.65E-02	-2.90E+00	3.16E+01
HWD	Kg	2.66E-01	5.56E-04	5.15E-03	5.11E-06	3.26E-03	3.27E-03	1.62E-04	0.00E+00	7.92E-05	-9.63E-02	2.72E-01
NHWD	Kg	1.73E+03	1.39E+01	2.09E+01	1.28E-01	1.42E+00	1.49E+00	4.04E+00	0.00E+00	3.60E+02	-7.85E+01	1.76E+03
RWD	Kg	8.51E-02	1.44E-03	2.03E-02	1.32E-05	8.32E-03	8.35E-03	4.19E-04	0.00E+00	3.48E-04	4.73E-03	1.07E-01
CRU	Kg	0.00E+00	0.00E+00	4.69E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.69E-01
MFR	Kg	0.00E+00	0.00E+00	1.58E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.32E+02	0.00E+00	0.00E+00	1.58E+01
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	0.00E+00	0.00E+00	0.00E+00
EE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EET	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

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**=Use of fresh water | **HWD**=Hazardous waste disposed | **NHWD**=Non-hazardous waste disposed | **RWD**=Radioactive waste disposed | **CRU**=Components for reuse | **MFR**=Materials for recycling | **MER**=Materials for energy recovery | **EE**=Exported energy | **EET**= Exported Energy Thermic | **EEE**= Exported Energy Electric

LCA results- information on biogenic carbon content:1 ton Pine pile/ (EN15804+A2)		
Parameters	**Unit**	**Value**
Biogenic carbon content in the product	Kg C	0
Biogenic carbon content in the associated packaging	Kg C	0
Note: 1 kg of biogenic carbon corresponds to 44/12 kg of CO2		

5.2 Calculation of the MKI value (Dutch: Milieukostenindicator, English: Environmental Cost Indicator, ECI)

The results are aggregated to a single-point score using the shadow price method, which is presented in the SBK Determination Method (2009) and NMD Environmental Performance Assessment Method for Construction (2022). The ECI is a suitable valuation method, especially in the Dutch construction sector. In the Netherlands, it is a prerequisite for public tenders. The indicator aims to show the shadow price for the environmental impacts of a product or project. The following weighting is used for aggregation:

Weighting factors (for the environmental impact categories) (NMD 2022)

Impact	Equivalent Unit	Weighting [€/ Equivalent Unit]
Depletion of abiotic raw materials (excluding fossil energy carriers) - ADP	kg Sb eq.	0.16
Depletion of fossil energy carriers - ADP	kg Sb eq.	0.16
Global warming - GWP 100 years	kg CO_2 Eq	0.05
Ozone layer depletion - ODP	kg CFC-11 Eq	30
Photochemical oxidant-formation - POCP	kg C_2H_4 eq	2
Acidification - AP	kg SO_2 Eq	4
Eutrophication - EP	kg PO_4^{3-} Eq	9
Human toxicity - HTP	1,4-DCB eq	0.09
Freshwater aquatic ecotoxicity - FAETP	1,4-DCB eq	0.03
Marine aquatic ecotoxicity - MAETP	1,4-DCB eq	0.0001
Terrestrial ecotoxicity - TETP	1,4-DCB eq	0.06

Due to its weighting, the impact category GWP has the greatest influence on the indicator score. The application of single-point scores is an additional assessment tool for eco-balance results. However, it must be pointed out that weightings are always based on value maintenance and not on a scientific basis (EN 14040). The ECI results are shown in the following tables.

Results - MKI value (1-point evaluation) per 1 ton pin pile

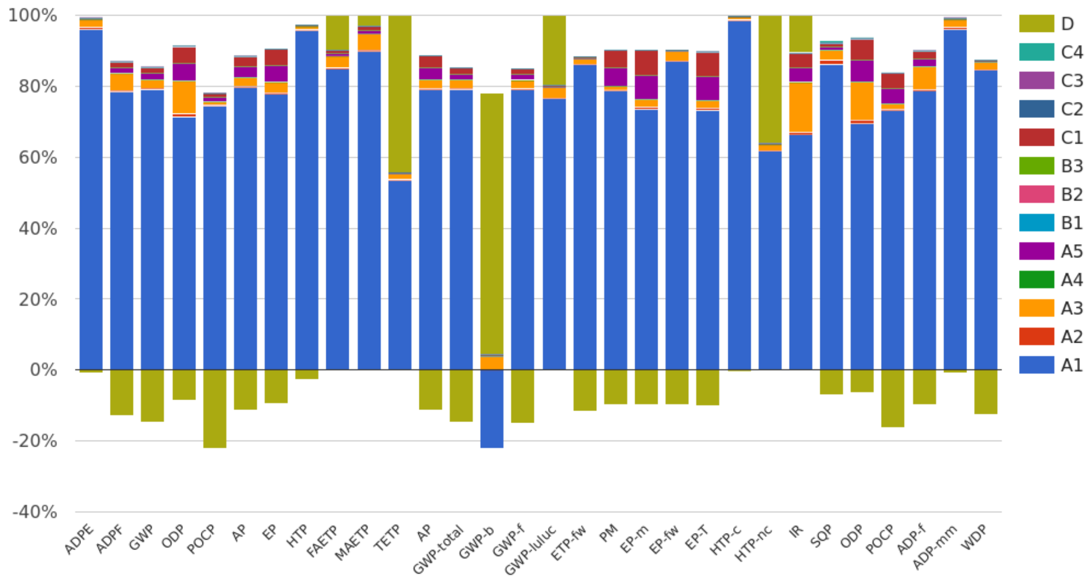
Module EN15804	ECI NL (€)per module	Share in total (%)
A1 Raw Materials Supply	1787.50	102.4
A2 Transport	1.74	0.1
A3 Manufacturing	25.54	1.5
A4 Transport from the gate to the site	0.02	0.0
A5 Construction - Installation process	11.54	0.7
C1 Demolition	11.65	0.7
C2 Transport	0.50	0.0
C3 Waste processing	0.00	0.0
C4 Final disposal	0.26	0.0
D Benefits and loads beyond the product system boundary	-93.3	-5.3
ECI NL per functional unit	**1745.46**	

Note: Users of weighting factors should be aware that there is less consensus on weighting and weighting factors than, for example, on characterization factors and that the method is also subject to uncertainties (NMD 2022).

6. LCA: Interpretation

The following figure shows the impact categories for 1 ton of the pin pile.
Pin piles account for 93% of total KHPC output by mass and all supplier contributions, energy usage, and additional materials were allocated proportionally according to the 93% mass ratio Subsequently, all input values (raw and ancillary materials , energy) were calculated considering 1 ton of product (Pin pile) as the reference point.

As shown in the Figure, A1 (raw material supply) shows the most significant influence on environmental core indicators. This is primarily due to the use of heavy plate, which notably impacts the environmental life cycle of the product. In general, pin piles have the potential for recycling. As a result, D has a credit outside of the production system based on the waste scenario. Transports (A2, A4, C2) have rather a minor impact within all core indicators.



Pin pile - Impact of the individual modules on the environmental core indicators (NMD set 1+2)

7. References

Ecoinvent Datenbank Version 3.6 (2019)

EN 15804:2012+A2:2019 Sustainability of construction works — Environmental Product Declarations — Core rules for the product category of construction products

ISO 14040:2006, Environmental management - Life cycle assessment - Principles and framework

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

ISO 14025:2006: Environmental labels and declarations — Type III environmental declarations — Principles and procedures EN 13249

PCR A: Kiwa-Ecobility Experts, Berlin, 2022: PCR A – General Program Category Rules for Construction Prod-ucts from the EPD programme of Kiwa-Ecobility Experts; Version 2.1

PCR B: PCR B - Requirements on the Environmental Product Declarations for construction steel products (Edi-tion 2020-03-13 (draft)

R<THiNK 2023; Online-EPD-Tool by NIBE B.V.

SimaPro Software,Industry data LCA library; website: https://simapro.com/databases/industry-data-lca-library

CML-IA April 2013 – Charakterisierungsfaktoren entwickelt durch Institut of Environmental Sciences (CML): Uni-versität Leiden, Niederlande - http://www.cml.leiden.edu/software/data-cmlia.html

European Commission Joint Research Centre Institute for Prospective Technological Studies (JCR 2014): End-of-waste criteria for waste plastic for conversion, Seville, 2014, doi:10.2791/13033

Stichting Bouwkwaliteit (SBK 2019): Assessment Method - Environmental Performance Construction and Civil Engineering Works (GWW), Rijswijk, Version "3.0 January 2019" incl. amendments July 2019, Jan 2020

Stichting Bouwkwaliteit: verification protocol - inclusion data in the Dutch environmental database, Rijswijk, Final Version 3.0, January 2019

NMD STICHTING NATIONAL ENVIRONMENTAL DATABASE: Environmental Performance Assessment Method for Construction; 1.1 (March 2022); Rijswijk

Protocol EPD-online - 25011.16.03.015 - Protocol EPD online - NMD, version 1.2, November 2016, NIBE

self propelled jack-up barge, https://www.damentrading.com/-/media/Trading/For-Sale/Jack-up-barge/07613-Used-self-propelled-jack-up-barge/Downloads/07613_self_propelled_barge_damen_trading_01.pdf. adopted on 12.09.2022.

Livaniou, S., Iordanis, S., Anaxagorou, P., Mocanu, B., Sykes, R., Goormachtigh, J., ... & Antrobus, M. (2015). Lo-gistic Efficiencies And Naval architecture for Wind Installations with Novel Developments. Tech. Rep. 614020, Leanwind.

Topham, Eva, David McMillan, Stuart Bradley, and Edward Hart. "Recycling offshore wind farms at decom-mis-sioning stage." Energy policy 129 (2019): 698-709.

Molina, F.S., 2021. An LCA Review of Current Status and Future Trends of the Offshore Wind Industry. Uni-ver-sity of California, Davis.

Gokhale, A.U., 2020. Assessment of recycling potential and circularity in decommissioning of offshore wind farms.)

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