LCA Background Report

Offshore Platform
Jacket and Topside

Report prepared by EcoReview

Reporting carried out in accordance with I.S. EN 15804+A2; ISO14040:2006; ISO14044:2006; ISO14025:2006. LCA calculation and reporting are in accordance with the “Determination method for the environmental performance of buildings 1.0 Juli 2020”.

Date: 08/10/2021

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1. Introduction

1.1. Background

This LCA assessment has been commissioned by the consortium Iemants - Fabricom, to be carried out for the construction of 3 offshore platforms. Each platform consists out of a steel jacket and steel topside. The Jacket and Topside each consists out of multiple components. The offshore platforms are part of a tender termed: “Hollandse Kust Noord, West Alpha and Beta Platforms”.

Iemants - Fabricom is in the commercial process for the TenneT project “Hollandse Kust Noord & West”. To submit a valid tender, Iemants - Fabricom has to calculate and submit an ECI score, based mainly on the steel structure and the corrosion protection of the structure. To calculate this score, an LCA needs to be executed. Iemants - Fabricom has selected EcoReview for the calculation hereof. In this document we elaborate on the methodology being used to calculate the ECI-score of the definitive design.

This LCA assessment is authored by Ruben van Gaalen of EcoReview B.V.. The report is dated 08/10/2021 and complies with the requirements of ISO 14040 [1], ISO 14044 [2], ISO 14025 [3], I.S. EN 15804:2012+A2:2019[4], and the “Determination method for the environmental performance of buildings 1.0 Juli 2020” [9]. The report is to be verified by a suitably qualified independent verifier experienced in Life Cycle Assessment (LCA). EcoChain version 3.2.7 has been used in the preparation of this report [5]. This report remains valid up to five years after initial publication. The results of the product assessments and resulting 'Environmental Product Declarations' in this report are comparable to others where these also comply to the norms and standards used in this report.

This LCA presents the specific detailed results relating to the “Jacket” and “Topside” of a steel offshore platform.

A report has been submitted on 11/11/2019 containing the information available at the moment of Tender registration. This report is a continuation as more accurate information is known since the final design has been made.

1.2. Goal and target group of the LCA study

The purpose of product environmental profiles is to provide quantitative environmental information on products and resources for market information, environmental optimization and as part of a company's corporate responsibility program. An LCA assessment delivers an increased understanding of the sources of pollution, priority setting for sustainable business practices and aids the commercialization of sustainable products. This LCA study has been carried out in order to:

Provide insight in the environmental impact of the materials used for the execution of a work that is part of a tender and complies to internationally harmonized standards. The Tenderer determines an ECI value for the construction of 3 platforms and the related LCA for specific life cycle phases of the work. With this method it is permitted to build the project-specific LCA from separate (smaller) parts.

In addition, this assessment allows the comparison of the environmental performance against other products with similar functions. This comparison is valid where the product assessments are carried out to the same norms and standards.

The outcomes of this study will be used for business-to-business communication. The intended audience of this study consists of internal stakeholders such as marketers, product innovators, purchasers and process managers, and external stakeholders such as clients with an interest in environmental profiling, such as governments and environmental NGOs.

1.3. Peer review statement

Peer reviewer's statement to be inserted here.

2. Scope

The following sections describe the general scope of this assessment. This includes, but is not limited to, the identification of the specific product systems assessed, the product function(s), product reference unit, the system boundaries, allocation procedures, and cut-off criteria of the study.

2.1. Reference unit

The reference unit for an EPD is presented either as a **functional unit** or as a **declared unit**. A functional unit is a product unit that fulfils a specific function, e.g. a window, concrete beam, staircase, etc. A declared unit is a product unit that can fulfil multiple functions, e.g. a cubic metre of concrete or a square metre of wall panelling. The declared unit is used when the precise function of the product, or scenarios at the building level, is not stated or is uncertain.

In this assessment, a **functional unit** is used. The functional unit is defined as the production, construction and installation of 1 platform. The service life of the product is taken as 30 years, as prescribed by the document ONL- TTB-04318-MA--- ITT-C5.1 Returnable_ Schedule_ Requirements_ ECI_ Calculation. Lifespan of 30 years shall be taken into account for construction, maintenance and replacement for the object's lifetime (even if it deviates from life-span requirements set elsewhere). The lifespan has no consequence for the modelling as the scope is limited to the production, construction and installation of 1 platform. Maintenance is out of scope. The 30 years life span starts at issuing of the Taking-Over Certificate.

The platforms are mainly consisting of different types of steel, corrosion protection anodes, and corrosion protection paint. The platforms are manufactured according to standards.

2.2. Product Description

This LCA is carried out for three (almost) identical platforms. The scope of this LCA is tailored to one platform: "**Hollandse Kust (Noord)**" abbreviated as HKN for the ease of reading. This platform is representative for the production and construction of the other two platforms and is the first to be constructed after tendering. This report speaks about the construction of 1 platform for the ease of reading, as the construction process does not deviate between the platforms. Only the total weight of the first platform deviates slightly.

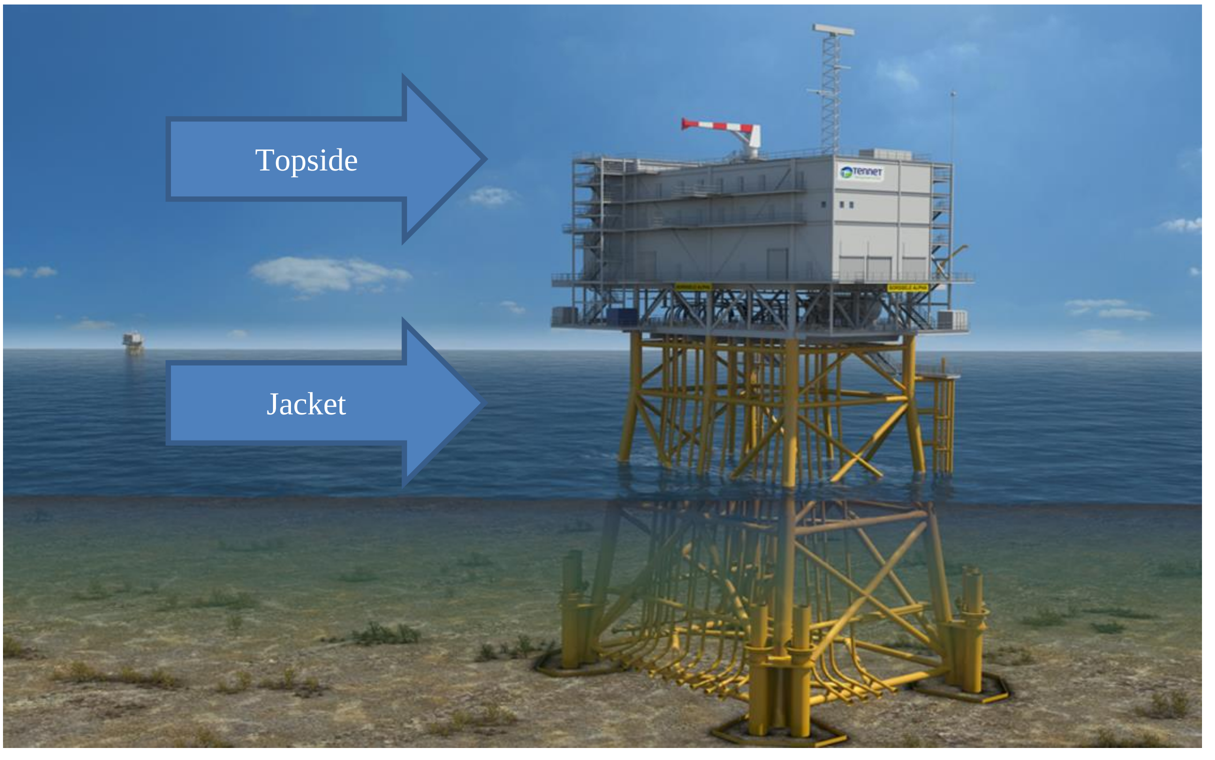
The constituent raw materials of a platform comprise: steel, anodes, paint. The platform is used as a supporting structure for large electrical transformers, which alter the voltage of the energy from wind mills in the North Sea. The electrical cables from the windmills are grouped together and arrive at the platform. Through J-tubes, these cables rise up and the electricity is altered in the transformer. The output of the transformer is electricity that is more suitable for traveling large distances. Through different J-tubes, these cables travel to land. The platforms are therefore also termed "power plug connections" in which offshore windmills, can "plug-in" their cables and transport their power to land in an efficient way. A platform consists of a Jacket, which is the supporting structure under and above sea level, which supports a topside. The topside houses all the equipment for processing and transforming the electric energy. For this LCA, the topside is only the "hull" in which all the equipment will be housed and does not yet contain the actual transformers and electrical equipment that it will be outfitted with in a later phase.

2.3. Process description

The process description of a platform is complex, and processes are carried out on multiple locations. The following paragraphs go over the process description from a high-level to a detailed level.

Jacket and Topside
A platform consists in its most basic form out of 2 separate parts: a "Jacket" and a "Topside". **Error! Reference source not found.** provides an overview.

Figure 1: Model of a platform



Jacket
A jacket consists primarily out of 9 components, as described in the Tender documents. Table 1 provides an overview.

Table 1: Components of a Jacket

Primary steel - Legs and Bracings
Primary steel - Piles
Secondary steel - Mud mats
Secondary steel - J Tube
Secondary steel - Cable deck
Secondary steel - Pile clusters
Secondary steel - Platforms and boat Landings
Corrosion protection (anodes)
Corrosion protection (paint systems)

Topside
A topside consists primarily out of 4 components, as described in the Tender documents. Table 2 provides an overview.

Table 2: Components of a Topside

Primary steel
Secondary steel
Tertiary steel
Corrosion protection (paint systems)

Primary steel means that the steel is part of the main supporting construction (Piles, Legs and Bracings). Secondary steel means the steel is part of the secondary supporting construction. Tertiary Steel means that the steel does not have a supporting function. The terms primary and secondary do not relate to de distinction between virgin and recycled materials. Table 3 provides an exemplary overview of how different steel materials are labelled by Smulders. This is by no means a complete inventory but merely used as an example.

Table 3: Overview of exemplary steel materials for primary, secondary and teriary steel

Primary steel	Secondary Steel	Tertiary Steel
Main Lifting Points	Secondary deck beams	Ladders
Nodes in main tubular columns	Walkways	Supports
Nodes in the crane pedestal	Access platforms	Handrailing
Supporting points	Intruder barrier	Cover plates
Chord elements in tubular joints (if applicable)	Antenna tower / meteo mast	Vent buildings
Crane pedestal	Stairs	
Supporting beams in grid lines		
Equipment supporting beam		
Main tubular columns		
Columns		
Bracing members		
Wall panels		
Deck plates		
Stabbing cones		

As the production started for the Topside it was no longer detectable which steel was belonging to Primary, Secondary or Tertiary Steel. Therefore, all steel used for the construction of the Topside are characterized as Steel (Primary + Secondary + Tertiary).

Production locations
The jacket and topside are constructed on multiple locations in Belgium, The Netherlands and Germany. On a high-level, raw steel is purchased and arrives at various production locations, including subcontractors, and is then pre-assembled into different sub-components. These sub-components are then transported to other production locations, where the sub-components are processed into larger (sub)components. This process repeats until there are only 2 assembled and painted components left: a jacket and a platform. These are then transported to the sea where they are installed.

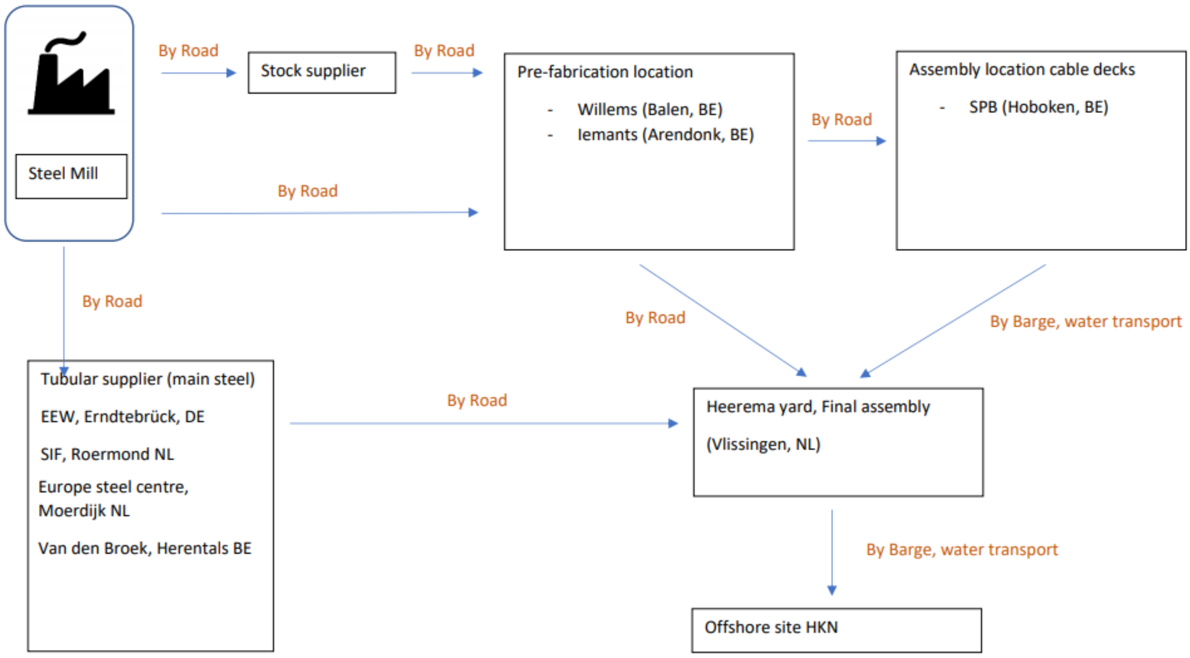
The locations and the different routes that each sub-component travels before being part of a jacket or topside has been modelled in the EcoChain tool. Table 4 displays the various production locations.

Table 4: Production locations of the consortium Iemants - Fabricom

Location name	City	Country	Subcontractor
Iemants Arendonk	Arendonk	Belgium	
Willems Balen	Balen	Belgium	
SPB Hoboken	Hoboken	Belgium	
Yard Tes	Tessenderlo	Belgium	
Van Den Broeck	Herentals	Belgium	X
EEW	Erndtebrück	Germany	X
Europe Steel Centre	Moerdijk	The Netherlands	X
SIF	Roermond	The Netherlands	X
Engie Fabricom	Hoboken	Belgium	
Heerema Yard	Vlissingen	The Netherlands	

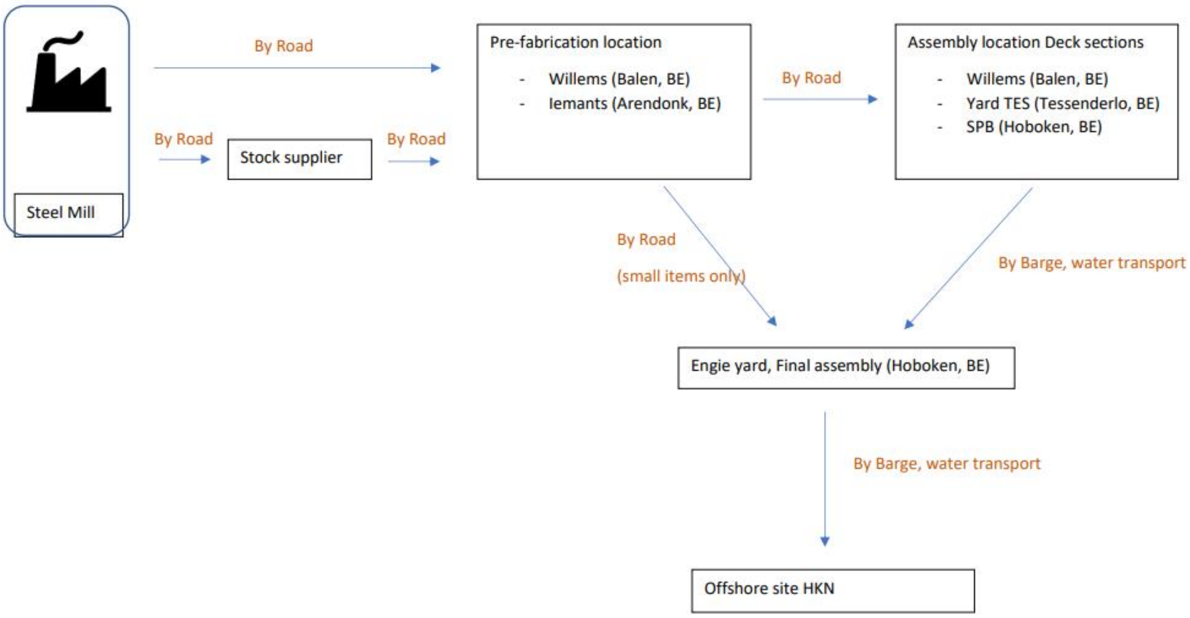
Route of jacket over production locations
Steel for the jacket is purchased by Iemants - Fabricom in Arendonk and Balen, and by subcontractors mentioned above in Table 4 and follows a production route displayed by **Error! Reference source not found.**. Final assembly is in Vlissingen, before being placed on a barge for transport to the final installation location at sea.

Figure 2: Production route Jacket



Route of topside over production locations
Steel for the topside is purchased in Arendonk and Balen and follows a production route displayed by **Error! Reference source not found.**. Final assembly is in Hoboken at the Engie Fabricom production yard, before being placed on a barge for transport to the final installation location at sea.

Figure 3: Production route Topside



The following processes take place in the various locations:

Table 5: Processes taking place per production location

Processes	Aren-donk	Balen	SPB Hoboken	Tessen-derlo	EEW	Europe Steel Centre	SIF	Van Den Broeck	Hoboken Fabricom	Vlissingen
Overhead	X	X	X	X	X	X	X	X	X	X
Machining	X	X	X	X	X	X	X	X		
Pre-assembly	X	X	X	X	X	X	X	X		
Welding	X	X	X	X	X	X	X	X	X	X
Blasting		X	X	X						
Painting		X	X	X						
Internal transport	X	X	X	X	X	X	X	X	X	X
Final assembly									X	X

Brief process description

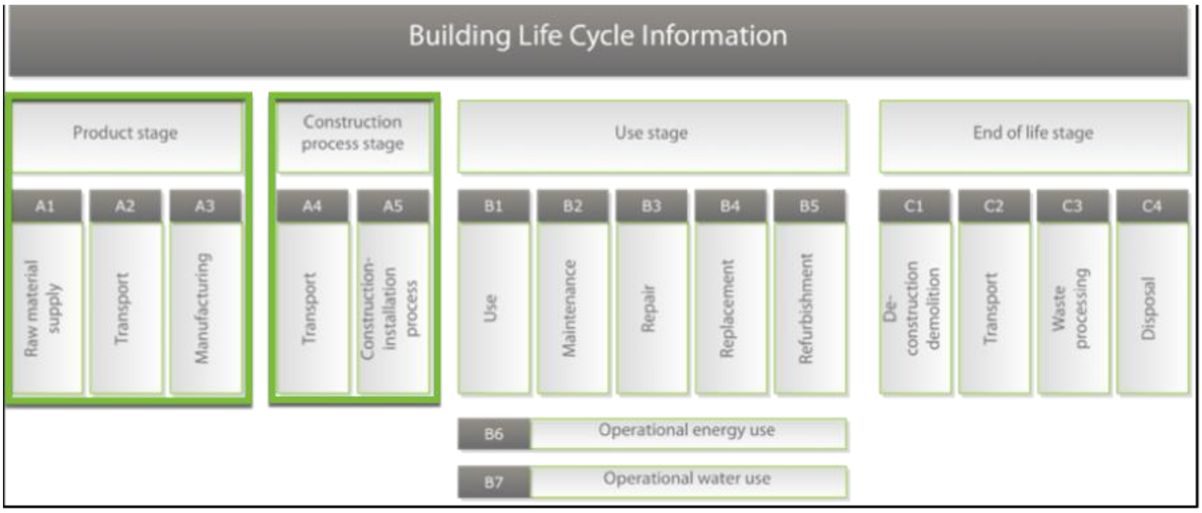
1. Steel materials arrive at Arendonk, Balen and all subcontractors (for the Jacket).
2. Here all steel materials are processed into sub-components for both the Jacket and the Topside.
3. For the Topside these sub-components travel to Tessenderlo and SPB Hoboken and from there they are further processed into larger sub-components. The sub-components of the Jacket produced in Arendonk and Balen are shipped to SPB Hoboken.
4. The larger sub-components are put together to final assemblies. The platform in Hoboken and the jacket in Vlissingen, where it also received all the sub-components from the subcontractors.

2.4. System boundaries and cut-off criteria

All relevant inputs and outputs such as emissions, energy and materials, have been considered in this LCA. In accordance with I.S. EN 15804 and with the "Determination method for the environmental performance of buildings 1.0 Juli 2020". The total neglected input flows per module do not exceed 5% of energy usage and mass and the unit process cut-off of 1%. The EcoChain tool incorporates the EcoInvent background database. Thus, the Ecoinvent boundary approach is relevant.

The system boundary defines the stages of the life of the construction product included in the study. This LCA covers the Product Stage (modules A1 to A3) and the Construction process stage (modules A4 to A5) as illustrated in **Error! Reference source not found.**, below.

Figure 4: Building life cycle stages, from I.S. EN 15804



3. Life Cycle Inventory Analysis

The life cycle inventory comprises of data gathering and calculation procedures to quantify all relevant environmental impacts of the product system. In the analysis, all potential emissions with impacts to air, water and soil are considered, and reported upon where they occur or are relevant.

3.1. Data collection procedures

All suppliers of raw materials for the production of the platform were requested to provide environmentally-relevant product information for this assessment. Almost all suppliers have delivered relevant data such as EPDs, safety data sheets, certification and energy documentation. For suppliers that have not delivered sufficient information, alternative sources such as public references, industry statistics and literature references have been used. Based on this information, representative references from the EcoInvent database have been selected for the various materials and resources used.

3.1.1. Suppliers

Product information has been obtained from the following manufacturers, listed in the table below whose materials are supplied to the consortium Iemants - Fabricom:

Table 6: Material suppliers

Producer	Material	Country	City
Tata Steel UK Limited - Hartlepool	Steel	United Kingdom	Hartlepool
ArcelorMittal Tubular Products Lexy	Steel	France	Lexy
Vallourec Deutschland GmbH - WerkRath-Stopfen	Steel	Germany	Dusseldorf
Mannesmann Line Pipe gmbh	Steel	Germany	Hamm
Tata Steel UK Limited - Corby Works	Steel	United Kingdom	Corby
Marcegaglia Kluczbork	Steel	Poland	Kluczbork
FZC 11 Oktomvri A.D.	Steel	Macedonia	Kumanovo
AG der Dillinger Hüttenwerke	Steel	Germany	Dillingen
Dillinger France	Steel	France	Dunkirk
Voestalpine Grobblech GmbH	Steel	Austria	Linz
British Steel limited - Saltburn Teesside	Steel	United Kingdom	Teeside
Özkan Demir Çelik Sanayi A.S.	Steel	Turkey	Aliaga
Ilsenburger Grobblech GmbH	Steel	Germany	Harz
ArcelorMittal España S.A.	Steel	Spain	Aviles
ArcelorMittal Italia S.p.A - Taranto Works	Steel	Italy	Taranto
Tata Steel (NL)	Steel	The Netherlands	Zwijndrecht
British Steel limited - Redcar Teesside	Steel	United Kingdom	Teeside
ArcelorMittal Belval & Differdange	Steel	Luxembourg	Differdange
Liberty Ostrava a.s.	Steel	Czechia	Ostrava
Peiner Träger GmbH	Steel	Germany	Peine
AFV Accialerie Beltrame S.p.A	Steel	Italy	Vicenza
Celsa Steel UK	Steel	United Kingdom	Cardiff
Megasa - Megasider Zaragoza s.A.U.	Steel	Spain	Zaragoza
Vallourec Deutschland GmbH - Werk Mülheim	Steel	Germany	Mulheim
Tata Steel Nederland Tubes bv - Zwijndrecht	Steel	The Netherlands	Zwijndrecht

Laminés Marchands Européens S.A.	Steel	France	Trith Saint Léger
Arvedi Tubi Acciaio S.p.A.	Steel	Italy	Cremona
Railing / stairs Metal Holland	Steel	Bosnia and Herzegovina	Samac
Válcovny trub Chomutov a.s.	Steel	Czech	Chomutov
Vallourec Deutschland GmbH - Werk Rath-Pilger	Steel	Germany	Dusseldorf
Tenaris - Dalmine S.p.A.	Steel	Italy	Dalmine
Alchemia S.A. - Walcownia Rur Andrzej	Steel	Poland	Chorzow
Voestalpine Krems GmbH	Steel	Austria	Linz
Herregods-Franssen nv - EUPEN	Steel	Belgium	Eupen
Doc 1 Europe Steel Center	Steel	The Netherlands	Moerdijk
Metec	Corrosion protection anodes	United Kingdom	Shields
AkzoNobel	Corrosion protection paint	Sweden	Angered

3.1.2. Data sources

The data on products, by-products and waste in this report were obtained from the energy, resources and materials supplied by Iemants - Fabricom as those being used at the production sites. Primary production data from the year 2020 has been used.

3.2. Inventory and allocation

In this section the quantity, quality and allocation of various materials, energy streams and emissions by processes and products are outlined. The system boundaries that have been adopted are in accordance with the modular approach of I.S. EN 15804, as noted above in section 2.4.

3.2.1. Materials (Module A1)

All relevant resources and materials in production module A1 have been included in this study. The compositions of the platform are split over the jacket and topside for more clarity.

Steel
All steel suppliers mentioned in above Table 6 have provided an EPD for their steel, except for 7 suppliers which are marked yellow.
Since all of the provided EPD's are foreign they do not list the ECI score. The ECI score however is normally calculated with the use of the weighting factors for the environmental impact categories, published in the SBK Bepalingsmethode, here displayed in **Error! Reference source not found.**. The result per environmental impact category is calculated by multiplying the impact scores with the corresponding weighting factors. The sum of the 11 environmental impact categories multiplied with the corresponding weighting factors is the ECI score. The ECI calculations for the producer specific EPDs, have been done in Microsoft excel and have consequentially been uploaded into the EcoChain software.

Figure 5: Weighing factors for environmental impact categories, according to the Bepalingsmethode

Milieueffectcategorie	Equivalent eenheid	Weegfactor [€ / kg equivalent]
Uitputting abiotische grondstoffen (exclusief fossiele energiedragers) – ADP	Sb eq	€ 0,16
Uitputting fossiele energiedragers – ADP	Sb eq[8]	€ 0,16
Klimaatsverandering – GWP 100 j.	CO_2 eq	€ 0,05
Aantasting ozonlaag – ODP	CFK-11 eq	€ 30
Fotochemische oxidantvorming – POCP	C_2H_4 eq	€ 2
Verzuring – AP	SO_2 eq	€ 4
Vermesting – EP	PO_4 eq	€ 9
Humane toxiciteit – HTP	1,4-DCB eq	€ 0,09
Zoetwater aquatische ecotoxiciteit – FAETP	1,4-DCB eq	€ 0,03
Mariene aquatische ecotoxiciteit - MAETP	1,4-DCB eq	€ 0,0001
Terrestrische ecotoxiciteit – TETP	1,4-DCB eq	€ 0,06

Grondstoffen
Emissies
1-puntsscore

Besides not stating the ECI Score, did the foreign EPDs not include the toxicities, which are required to calculate the ECI. The suppliers of the EPDs have been contacted and requested to provide the calculations of the toxicities. At this moment no information has been received yet. Therefore, the toxicities have been used of a generic worst-case steel alloy modelled in EcoChain according to the S355G8+N (EN-10225) 97.3 % steel, unalloyed//[RER] steel production, converter, unalloyed | 1,65% manganese//[RER] manganese production | 0.5% nickel, 99.5%//[GLO] market for nickel, 99.5% | 0.3% copper, blister-copper//[RER] copper production, blister-copper | 0.25% chromium//[RER] chromium production | hot rolling, steel//[RER] hot rolling, steel). The specifications of all EPD's are detailed in appendix A.

Compositions of Jacket

As mentioned in Table 1, the Jacket consist out of 7 steel components, protection anodes and protection paint. The total weight of steel used in 1 jacket is: 2480 Ton. The jacket weight is the same for all three platforms. Below in

an overview of the locations where each sub-component is produced with the split in kilograms. Where "paint" is mentioned the components are first assembled in Arendonk and Balen and later painted in Tessenderlo and Hoboken.

Components of Jacket	Legs and Bracing	Piles	Mud Mats	J tube	Cable Deck	Pile Clusters	Platforms and boat landings
Tessenderlo							Paint
Arendonk					327390		
Balen							67380
Hoboken					Paint		
EEW, Erndtebrück	874980			60500			
SIF, Roermond		750000					
Europe steel Centre, Moerdijk			36720			168640	
Van Den Broeck, Herentals				194700			

Table 7: Overview of produced sub-components for Jacket per location in kg

Compositions of Topside

The total weight of 1 topside (HKN) is: 1679 Ton. The weight of the topside is not the same for all platforms. The following table provide an overview, with the weight split out over the locations.

Table 8: Overview of produced sub-components for Topside per location in kg

Components of Steel	Steel (Primary + Secondary + Tertiary)
Arendonk	60000
Tessenderlo	1090039
Balen	331856
SPB Hoboken	187244

Direct delivery of steel without EPD	10000

Overview of EPD used per location
For an overview of steel suppliers and the corresponding EPD per production location as mentioned in **Error! Reference source not found.** and Table 8, two excel files are attached to this report as mentioned in Appendix C.

Suppliers without EPD
For the 7 suppliers that were unable to provide an EPD a worst-case steel alloy is selected in EcoChain which is modelled as mentioned above under the name S355G8+N.

Paint
For the painting process, paint is required. There are 2 types of paint used for the production of the Jacket as well as the Topside, for which an EPD is provided. Also here the toxicities were missing on the EPD. As a worst-case scenario the toxicities have been derived from an epoxy resin. The specifications of all EPD's are detailed in appendix A. In below Table 9 the type of paint and total usage per paint in kg, and the location of application for Jacket are mentioned.

Table 9: Type of paint used per location for Jacket in kg

	Interthane 990	Including 50% overspray	Interzone 954GF	Including 50% overspray
Tessenderlo	77	154	153	306
SPB Hoboken	372	744	744	1488
Vlissingen	1441	2882	2883	5766

In below Table 10 the same is shown for the Topside.

Table 10: Type of paint used per location for Topside in kg

	Interthane 990	Including 56% overspray	Interzone 954GF	Including 56% overspray
Tessenderlo	2513	5667	5026	11335
Balen	765	1725	1530	3451
SPB Hoboken	432	974	863	1946

The loss in overspray is considered in above mentioned usages of paint. For example; for the Topside an overspray of 56% was measured, which is included in above usages.

Paint loss is paint that does not stick to the surface, and thus stays in the air. The air is extracted and goes through a pre-filter (which takes out the solids) and after that either goes through an active carbon filter or an afterburner (to take out the solvents). Since active carbon is regenerated by burning off the solvents, the solvents are turned into CO_2 in both cases. Paint loss is thus modelled and taken into account, but the regeneration of carbon or afterburner is left out of scope as this effect is deemed marginal and can therefore be omitted.

Blasting is always part of the painting process as this is a necessary step to clean the surface before painting. Blasting however does not require materials (sand and/or steel for blasting is re-used and left out of scope). Only the energy use for blasting is in scope and is part of the usages and emissions of the production plant and allocated over the process blasting by weight.

Anodes
No EPD was available for the Anodes used in the Jacket and Topside, although a manufacturing record book has been provided with the compositions mentioned. Below in Table 11 the amount of anodes and total weight are shown.

Table 11: Corrosion protection (anodes)

Item	Amount	Weight per anode (ton)	Total weight (ton)
Anodes	120	0,35	42

The composition of the Anode according to the manufacturing record book is shown in below Table 12. The steel used, tubes and plates, in the anodes are type S355J2. This record has been modelled as shown in below table.

Table 12: Composition of anodes with references used

Emission source	Total kg used	Reference	Database
Steel S355J2	12766	Steel S355J2 (o.b.v 98,3% steel, unalloyed//[RER] steel production, converter, unalloyed | 1,7% manganese//[RER] manganese production | 0.6 % copper, blister-copper//[RER] copper production, blister-copper | hot rolling, steel//[RER] hot rolling, steel)	Steel supplier account - custom
Aluminium	27864	aluminium production, primary, ingot | aluminium, primary, ingot | IAI Area, Russia & RER w/o EU27 & EFTA	Ecoinvent v3.5 Cut-off
Zinc	1370	market for zinc | zinc | Global	Ecoinvent v3,5 Cut-off
Metal Working	42000	metal working, average for metal product manufacturing | metal working, average for metal product manufacturing | Europe	Ecoinvent v3.5 Cut-off

For the zinc component in the aluminium an average is calculated based upon the test results mentioned in the manufacturing book of 4,69%. All other components in the aluminium are measured to be less than 0,1% and therefore not taking into account. Components mentioned in the manufacturing record book are listed in below table.

Table 13: List of other components in Aluminium (less than 0,1%)

Other components in Aluminium (less than 0,1%)
Indium (In)
Silicon (Si)
Iron (Fe)
Copper (Cu)
Cadmium (Cd)

3.2.2. Transport (Module A2)

Transport from suppliers to production sites

All relevant transport to the Iemants - Fabricom production sites have been included in this study. The Ecoinvent records for transport are according to I.S. EN 15804.

The materials are transported to all Smulders locations and all subcontractors mentioned in Table 4. Transport distances are calculated from the point of origin of the material to the production plant where the materials first arrive. In Ecochain these materials are purchased based on the EPD. Most EPD's handed over for this study are EPD's representing a branche or company with multiple locations. Therefore, for calculating the distances per EPD to each Smulders or subcontractor production location an average distance is calculated by ratio of materials bought per location corresponding to that EPD. The calculated average distances per production location are available in Appendix C.

Transport mode is selected as:

Table 14: Transport reference

Emission source	Reference	Database
Truck	transport, freight, lorry >32 metric ton, EURO5 | transport, freight, lorry >32 metric ton, EURO5 | Europe	Ecoinvent v3.5 Cut-off

Transport between production sites
All relevant transport in between the Iemants - Fabricom production sites and its subcontractors have been included in this study and can be seen in the transport section of each Ecochain subaccount. The Ecoinvent records for transport are according to I.S. EN 15804.

The following section, along with above displayed **Error! Reference source not found.** and **Error! Reference source not found.**, provides an overview of where the components and subcomponents are built and how they move internally in between different production locations.

For the Topside most components start their fabrication and production at the plants in Arendonk and Balen, and visit multiple other processing locations, before arriving at the final assembly location in Hoboken at Engie Fabricom.

For the Jacket the steel components as mentioned in Table 1 start their fabrication at various production locations of Smulders as well as subcontractor before arriving in Vlissingen for final assembly. The J tube is partially constructed at subcontractors Van Den Broeck and EEW, Erndtebrück, before transported to Vlissingen. At Tessenderlo paint is applied on the Platforms and Boat landings previously assembled at Arendonk before arriving at Vlissingen. Also at SPB Hoboken the previously assembled Cable Deck at Balen is painted before arriving at Vlissingen. All other painting operations are completed in Vlissingen during final assembly. Also, the Anodes are delivered directly in Vlissingen. In below Table 15 and Table 16 the flow of components between production locations is depicted.

There is significant transport between the 10 production locations. This has been taken into account.
- Transport between Arendonk, Balen, Tessenderlo and SPB Hoboken is per truck.
- Transport from Balen, Tessenderlo and SPB Hoboken to Engie Fabricom is per barge.
- Transport from Arendonk, Balen, all subcontractors to Vlissingen is per truck.
- Transport from SPB Hoboken to Vlissingen is per barge.

Exact transportation distances have been provided by Iemants Fabricom, including alternative routes which heavy weight trucks have to take.

Jacket

Table 15: Transport between production locations for Jacket

Component	Steel purchasing and sequential processing locations	Distances from (km)
Primary Steel - Legs and Bracings	100% prefab EEW, Erndtebrück → Vlissingen	Truck: 396
Primary Steel - Piles	100% prefab Sif, Roermond→ Vlissingen	Truck: 204
Secondary steel - Mud mats	100% prefab Europe Steel Centre → Vlissingen	Truck: 90,3
Secondary steel - J Tube	100% prefab EEW, Erndtebrück/Van Den Broeck → Vlissingen	EEW Truck: 396 Van Den Broeck Truck: 105
Secondary steel - Cable deck	100% prefab in Balen → SPB Hoboken → Vlissingen	Balen Truck: 67 SPB Hoboken Barge: 88

Secondary steel - Pile clusters	100% prefab in Europe Steel Centre → Vlissingen	Truck: 90,3
Secondary Steel - Platforms and boat Landings	100% prefab in Arendonk → Tessenderlo → Vlissingen	Arendonk Truck: 38,5 Tessenderlo Truck: 131
Anodes	100% Vlissingen	Truck: 804
Paint	100% Vlissingen	Truck: 1243

Topside

Table 16: Transport between production locations for Topside

Component	Steel purchasing and sequential processing locations	Distances from (km)
Primary, Secondary and Tertiary steel	34% prefab Arendonk → 20% Balen → Engie Fabricom	Arendonk Truck: 30 Balen Barge: 72
	→ 60% Tessenderlo → Engie	Arendonk Truck: 38,5 Tessenderlo Barge: 69
	→ 10% SPB Hoboken → Engie	Arendonk Truck: 61 SPB Hoboken Barge: 0,1
	→ 10% Engie Fabricom	Truck: 61
	66% prefab Balen → 60% Tessenderlo → Engie	Balen Truck: 12,5 Tessenderlo Barge: 69
	→ 10% SPB Hoboken → Engie	Balen Truck: 67 SPB Hoboken Barge: 0,1
	→ 30% Engie Fabricom	Barge: 72

Transport modes are selected as displayed in Table 17.

Table 17 Transport modes between production locations

Emission source	Reference	Database
Truck	transport, freight, lorry >32 metric ton, EURO5 | transport, freight, lorry >32 metric ton, EURO5 | Europe	Ecoinvent v3.5 Cut-off
Barge	transport, freight, inland waterways, barge | transport, freight, inland waterways, barge | Europe	Ecoinvent v3.5 Cut-off

3.2.3. Production (Module A3)

As shown in previous paragraphs the production of the Topside and Jacket occur in different production locations. For all Iemants – Fabricom production sites the usages and emissions have been shared. For the subcontractors who were part of the production of the Jacket, these usages have not been shared. Therefore, averages have been calculated for each Jacket production site at Arendonk and Balen based on their output per kg produced. These were then multiplied by ratio of the production weight per production location of each subcontractor. Worst-case scenarios were realised by selecting a grey electricity mix for the subcontractors, where the Iemants – Fabricom production locations make use of solar energy.

The usage and emissions figures are based on the production of 2021 and in order to distribute these usages and emissions correctly over the production, the production figures of 2021 of each component per production location have also been modelled in EcoChain by adding the weight to each unit.
The emissions are then allocated on the products on a mass basis. This has been done for all locations.
The usages of each production location have been provided by the client and are displayed in the excel file belonging to Appendix C.

Based on the usages and emissions the following background profiles from the Nationale Milieudatabase and Ecoinvent database have been selected.

Table 18: References for emission sources, materials and products

Emission source	Reference	Database
Electricity mix low voltage Belgium	market for electricity, low voltage | electricity, low voltage | Belgium	Ecoinvent v3.5 Cut-off
Electricity (average), solar electricity (PV, rooftop or facade)	market for electricity, solar PV, rooftop, low voltage | electricity, solar PV, rooftop, low voltage | Cutoff, U - RoW	Ecoinvent v 3.5 Cut-off (adapted by Ecochain)
Natural gas MJ (average Europe)	heat production, natural gas, at industrial furnace >100kW | heat, district or industrial, natural gas | Europe without Switzerland	Ecoinvent v 3.5 Cut-off
Propane (gaseous, liter)	propaan, gebruik (zwak proces, met beperkte verbrandingsemissies)	Nationale Milieudatabase v 3.1 (obv Ecoinvent 3.5)
Diesel	0095-pro&Diesel, gasolie, gebruik, liter (o.b.v. 35,8 MJ Diesel, burned in building machine {GLO}| processing | Cut-off, U)	Nationale Milieudatabase v 3.1 (obv Ecoinvent 3.5)
Petrol	0109-pro&benzine, gebruik, per liter (o.b.v. 15,3 km Bezine, gebruik, per km (o.b.v. Transport, passenger car, medium size, petrol, EURO 4 | Alloc Rec, U; AANGEPAST)	Nationale Milieudatabase v 3.1 (obv Ecoinvent 3.5)
Heavy fuel oil	heat production, heavy fuel oil, at industrial furnace 1MW | heat, district or industrial, other than natural gas | Rest-of-World	Ecoinvent v3.5 Cut-off
Ethyne (000074-86-2)	CHEMICAL_SUBSTANCES_EMISSIONS_TO_AIR_ETHYNE_000074_86_2_KG	SBK Bepalingsmethode v 3.1 (december 2019)
Carbon dioxide (000124-38-9)	CHEMICAL_SUBSTANCES_EMISSIONS_TO_AIR_CARBON_DIOXIDE_000124_38_9_KG	SBK Bepalingsmethode v 3.1 (december 2019)
Butane (000106-97-8)	CHEMICAL_SUBSTANCES_EMISSIONS_TO_AIR_BUTANE_000106_97_8_KG	SBK Bepalingsmethode v 3.1 (december 2019)

Assumptions – Processes and allocation

The usages and emissions are allocated over processes. The processes that have been identified are displayed in Table 19. This table also provides an example of how the electricity usage has been allocated over the various processes.

Table 19: Processes and allocation of energy sources

	Alocation of electricity for Arendonk en subcontractors	Alocation of electricity for Balen en Tessenderlo	Alocation of electricity for SPB Hoboken	Alocation of electricity/diesel for Engie Hoboken	Alocation of electricity/diesel for Vlissingen
Overhead	12,5 %	5 %	5 %		
Machining	25 %	15 %	0 %		
Pre-assembly	10 %	5 %	5 %		
Welding	40 %	25 %	25 %		
Blasting	0 %	25 %	25 %		
Painting	0 %	20 %	20 %		
Transport	12,5 %	5 %	20 %		
Assembly				100%	100%
Total	100%	100%	100%	100%	100%

The allocation of energy over the processes has been determined by the Client. The Client is in the process of acquiring more detailed information on the allocation of energy over the various processes, the exact use of electricity will therefore be monitored during realisation.

All other emission sources are allocated over each process as shown in below table.

Table 20: Allocation of emission sources other than energy

Emission source	Allocation
Natural gas MJ (average Europe)	Overhead
Propane (gaseous, liter)	Overhead
Diesel	Overhead and Internal transport
Petrol	Overhead
Heavy fuel oil	Overhead
Ethyne (000074-86-2)	Welding
Propylene oxide (000075-56-9)	Welding
Carbon dioxide (000124-38-9)	Welding
Butane (000106-97-8)	Internal Transport
Propane (000074-98-6)	Welding

The exact distribution of usages and emissions can be found in the EcoChain tool per production location.

The processes are furthermore allocated to the products, by production weight. It is assumed that each product goes through each step of the production process in equal amounts. This means that the allocation of energy consumption over processes does not make much difference for the current study.

Because the final processing takes place in Vlissingen and Engie Fabricom, the A3 figures for the processing only represent the assembly. The A2 represents the transport to Vlissingen from the previous sub-assembly locations and from the anodes and paint suppliers. The processing of the sub-assembly location and the previous transport streams are therefore calculated in A1.

3.2.4. Transportation (A4) and installation (A5)

The ECI calculations for modules A4 and A5 are calculated based on Marine Gas Oil (MGO) consumption figures of previous installations of similar platforms by the selected transport and installation company (T&I company). Marine gasoil (MGO) describes marine fuels that consist exclusively of distillates. Distillates are all those components of crude oil that evaporate in fractional distillation and are then condensed from the gas phase into liquid fractions. Marine gasoil usually consists of a blend of various distillates. Marine gasoil is similar to diesel fuel[1]. The diesel consumption figures per campaign are provided in **Error! Reference source not found.**. This conjunction is based on tons of fuel for the complete operation. Because the Jacket has to be installed before the Topside can be placed, the installation of the platform requires two campaigns. In the first campaign the jacket is installed and in the second the Topside is placed on the previously installed jacket.

The overspray considered in Table 9 and Table 10 is excluded for the transport in A4 as it's lost during the painting process. Only the paint effectively attached to both Jacket and Topside are mentioned below.

Table 21: Total weight for transport and installation

Weight in ton	Total weight of steel Components	Total weight of paint excluding overspray	Total weight of anodes	Total Weight
Jacket	2480	6	42	2528
Topside	1679	11	-	1690
Total				4218

From the figures in Table 22 we have calculated the total amount of diesel consumed, these are then divided by the total weight of the Topsides and the Jackets in order to calculate the diesel consumption per ton steel. For A5 the combined consumption based on the consumption of previous installations of Heerema is divided by the total weight of the platform. The A4 calculations have been done separately for the Jacket and the Topside, as the Jacket is transported from Vlissingen and the Topside is transported from Engie Hoboken. The A4 calculation has been based on diesel usage and not on EcoInvent transport processes, because the transport is "exceptional" and no EcoInvent data on "Barges" or "Ships" resembles the specific situation under which this transport is carried out. As the diesel use is accurately predicted by the T&I contractor, this is the most realistic and pessimistic way of modelling A4.

	Total tons of diesel	Ton diesel per ton weight
A5 Total	760	0,180
A4 Jacket	115	0,045
A4 Topside	160	0,095

In order to calculate the diesel consumption allocated to both the installation and transport of the Jacket and the Topside the amount of diesel required per ton of total weight is multiplied by the weight of the respective components. This results in the diesel consumption in kg which can be used in the calculations in EcoChain.

	A5	A4
Jacket	455.496	115.000
Topside	304.504	160.000

In EcoChain in the Vlissingen account the transportation and installation of the Jacket is modelled in a separate scenario. In the Engie Fabricom account the transportation and installation of the Topside

[1] https://www.marquard-bahls.com/en/news-info/glossary/detail/term/marine-gasoil-mgo.html

is modelled. This is the case because these are the final production locations before the components are transported to the sea location.

Table 22: Fuel consumption provided by T&I contractor

	MGO consumption (ton)						
	Thialf	Support Tug	BBC Vessel	Guard Vessel	Barge Tow to site	Barge Tow to Port	Total MGO (ton)
Jacket	300	80	130	40	65	50	665
Topside	150	40		20	85	75	370
Total A4/A5	760				275		

Thialf, Support Tug, BBC Vessel and Guard Vessel are used for installation (A5). Barge Tow to site and Barge Tow to port are transportation in A4.

4. Data validation

4.1. Data quality

Data flows have been modelled, as realistically as possible. Data quality assessment is based on the principle that the primary data used for materials and processes occurring at the production site is selected in the first instance. Where this is not available, other reference data is selected from appropriate sources.

4.1.1. Data representation

Data used in this LCA is assessed with respect to age, geographical and technical relevance. In this LCA the data relating to the production of the platforms and the background processes for environmental impacts are assumed to be recent, that is less than 2 years.

The processes used in the production of the platform are geographically representative, insofar as the production location of the consortium Iemants - Fabricom lies within the region for which the relevant Ecoinvent environmental records have been selected.

The Ecoinvent data is European generic, rather than specific or national data. As such it is representative for the materials used in the platform, as these materials all arise from European manufacturers. Producer specific EPD's have been used for specific steel references.

The dataset is representative for the production processes used in 2020 and 2021.

4.1.2. Completeness of environmental impacts and economic flows

All identified environmental effects have been translated into the appropriate environmental impact categories. Direct emissions from the inventory have been characterized according to the characterization factors of CML, baseline version [6]. The EcoChain tool calculates with characterised values for Ecoinvent background data. Besides the CML characterisation factors there are no complementary characterisation values.

4.1.3. Consistency and reproducibility

The process descriptions and quantities in this study are reproducible in accordance to the reference standards that have been used. The references of all sources, both primary and public sources and literature, have been documented in the references (Section 7). In addition, to facilitate the reproducibility of this LCA, a full set of data records has been generated which can be accessed via the EcoChain tool. This data portfolio contains a summary of all the data used in this LCA, and correspondingly, in Client's EcoChain account.

5. Life Cycle Impact Assessment

In Figure 5 the calculation method and all weighing factors for each environmental impact categories for calculating the ECI score is depicted. In below table the ECI score per component per module is depicted.

Table 23: ECI results for Topside and Jacket A1-A5

Component	A1	A2	A3	A4	A5	A1-A3	A1-A5
Topside Steel	€ 475.252,86	€ 732,49	€ 9.463,89	€ 69.497,15	€ 132.263,49	€ 485.449,24	€ 687.209,88
Topside - Corrosion Protection (Paint)	€ 13.162,52	€ 4,86	€ 62,73	€ 460,65	€ 876,69	€ 13.230,11	€ 14.567,46
Topside Total	€ 488.415,38	€ 737,35	€ 9.526,62	€ 69.957,80	€ 133.140,19	€ 498.679,35	€ 701.777,34
Jacket - Primary Steel - Legs and Bracing	€ 230.036,98	€ 2.431,11	€ 9.925,34	€ 17.403,58	€ 68.932,69	€ 242.393,43	€ 328.729,70
Jacket - Primary Steel - Piles	€ 197.999,85	€ 2.083,86	€ 8.507,63	€ 14.917,69	€ 59.086,51	€ 208.591,34	€ 282.595,54
Jacket - Secondary Steel - Mud Mats	€ 15.681,70	€ 102,03	€ 416,53	€ 730,37	€ 2.892,88	€ 16.200,26	€ 19.823,51
Jacket - Secondary Steel - J Tube	€ 86.261,25	€ 709,07	€ 2.894,86	€ 5.075,99	€ 20.105,17	€ 89.865,18	€ 115.046,34
Jacket - Secondary Steel - Cable Deck	€ 88.067,35	€ 909,64	€ 3.713,75	€ 6.511,87	€ 25.792,45	€ 92.690,75	€ 124.995,06
Jacket - Secondary Steel - Pile Clusters	€ 70.834,43	€ 468,56	€ 1.912,97	€ 3.354,29	€ 13.285,80	€ 73.215,96	€ 89.856,05
Jacket - Secondary Steel - Platforms and boat landings	€ 22.207,17	€ 187,21	€ 764,33	€ 1.340,21	€ 5.308,33	€ 23.158,71	€ 29.807,25
Jacket - Corrosion protection (paint)	€ 4.786,77	€ 15,75	€ 64,32	€ 112,78	€ 446,69	€ 4.866,84	€ 5.426,30
Jacket - Corrosion protection (anodes)	€ 160.265,29	€ 116,70	€ 476,43	€ 835,39	€ 3.308,84	€ 160.858,42	€ 165.002,65
Jacket Total	€ 876.140,79	€ 7.023,93	€ 27.254,36	€ 50.282,17	€ 199.159,37	€ 910.419,07	€ 1.159.860,61
Platform Total	€ 1.364.556,17	€ 7.761,28	€ 36.780,98	€ 120.239,97	€ 332.299,56	€ 1.409.098,43	€ 1.861.637,95

6. Interpretation

6.1. Comparison of ECI-score with Tender registration

To give an overview of the difference in results mentioned in above chapter 5 compared to the moment of Tender registration, in below table the ECI-score at Tender registration are shown.

Table 24: ECI-score at tender registration

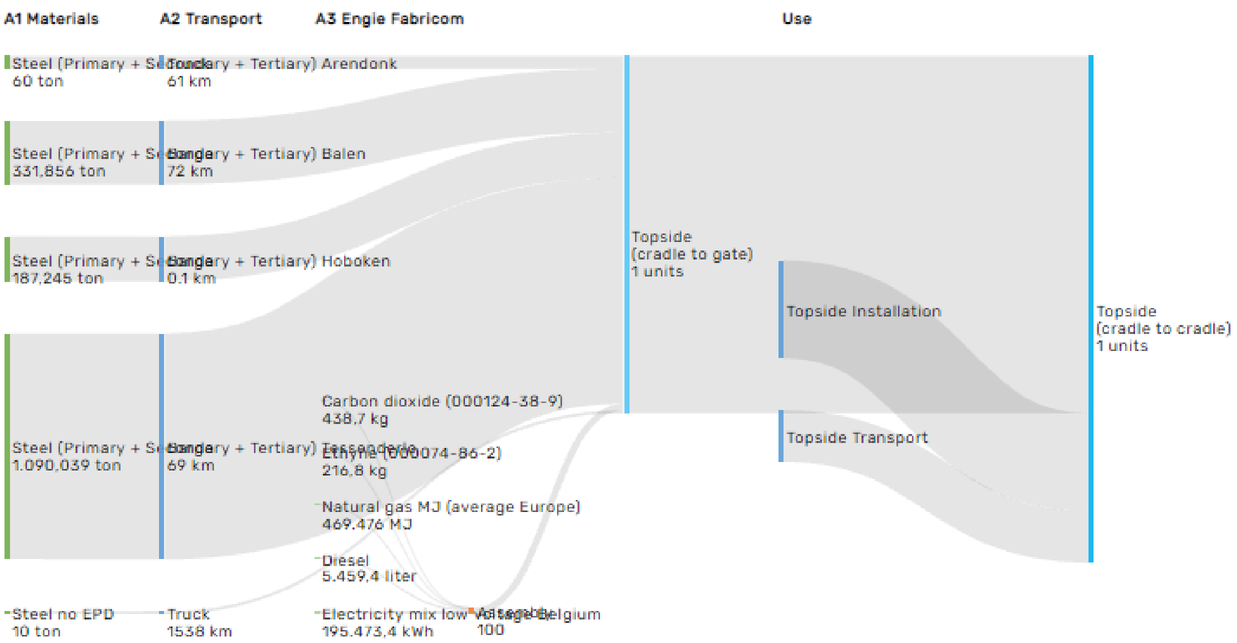
	Topside	Jacket
A1	€ 486.339	€ 1.100.558
A2	€ 207	€ 4.045
A3	€ 4.423	€ 18.929
A4	€ 39.795	€ 42.563
A5	€ 184.883	€ 283.245

The lower scores in A1 are due for a large part because of a lower weight total for both Jacket and Topside compared to moment of registration, 2551 and 1737 tons respectively. Included in the A1 at Vlissingen and Engie Fabricom are the processing done at all production locations. These are now based on actual figures. For the Corrosion protection anodes a profile has been modelled based on the manufacturing book which contains the component steel, whereas at moment of Tender registration a worst-case scenario was modelled without steel and more of aluminium, which has a higher impact on environment.

6.2. Hotspot analysis

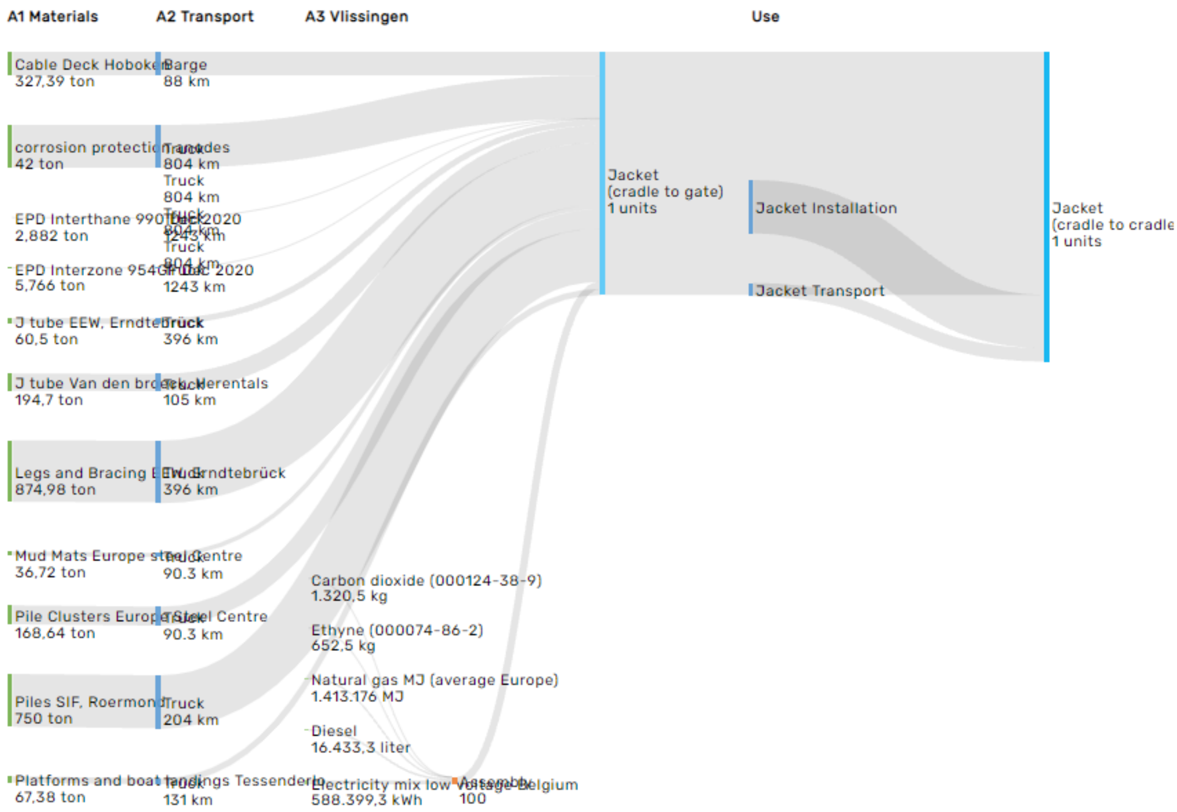
The main impact of the Topside occurs in A1-A3 with € 498.679,35 at 71%. The transport to installation site (A4) accounts for 10% with an ECI score of € 69.957,80 and the installation (A5) has an ECI score of € 133.140,19 at 19%.

Figure 6: Flow chart of Topside at Engie Fabricom



As shown in below figure, the main impact of the Jacket also occurs in A1-A3 for 79% with an ECI score of € 910.419,07. The transport to installation site (A4) accounts for 4% with an ECI score of € 50.282,17 and the installation (A5) has an ECI score of € 199.159,37 at 17%.

Figure 7: Flow chart of Jacket at Vlissingen



As shown in Table 23 and above Figure 7, the contribution of the Anodes to the total ECI score for the Jacket is significant with 14%. This is primarily due to the high amount of aluminium (66%) used in the Anodes.

6.2.1. Contribution per production location and subcontractor

Because the components for the Topside and Jacket are built in different locations, it has also been modelled in different EcoChain accounts. The processing and the transport of the Topside is minimal in Engie Fabricom and the same can be said for the Jacket in Vlissingen. This is the case because only final assembly takes place here. Most of the processing is done at other production sites of Iemants-Fabricom and at the subcontractors. In below figures the contribution per location to the ECI-scores are presented.

As can be seen in Appendix C.2, most of the prefabrication of the Topside is done at Willems Balen and Yard Tes, the contribution of the ECI-scores for these locations to the ECI of the Topside are therefore also the highest.

Figure 8: Contribution to ECI-score for Iemants Arendonk

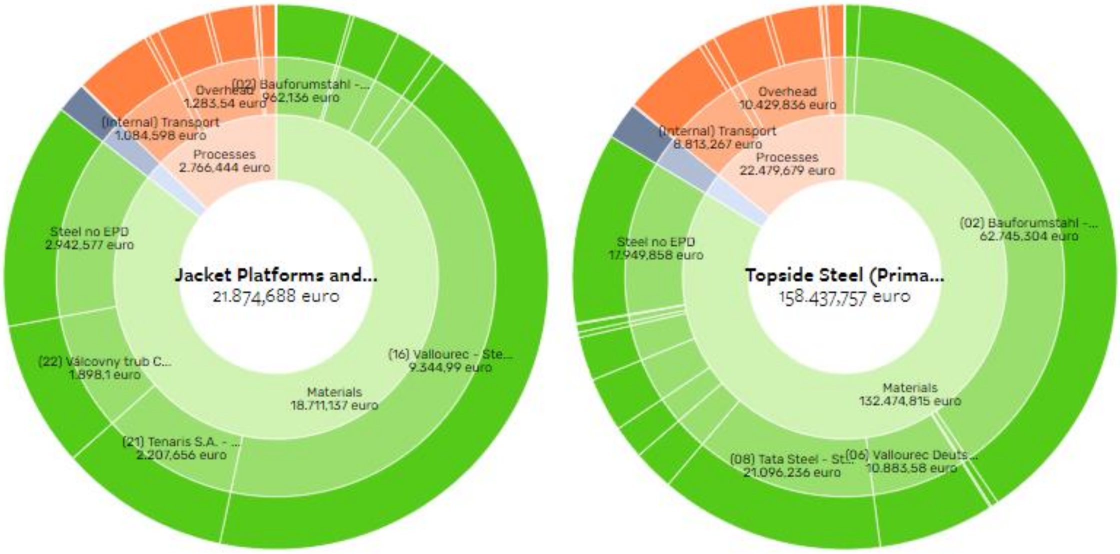


Figure 9: Contribution to ECI-score for Willems Balen

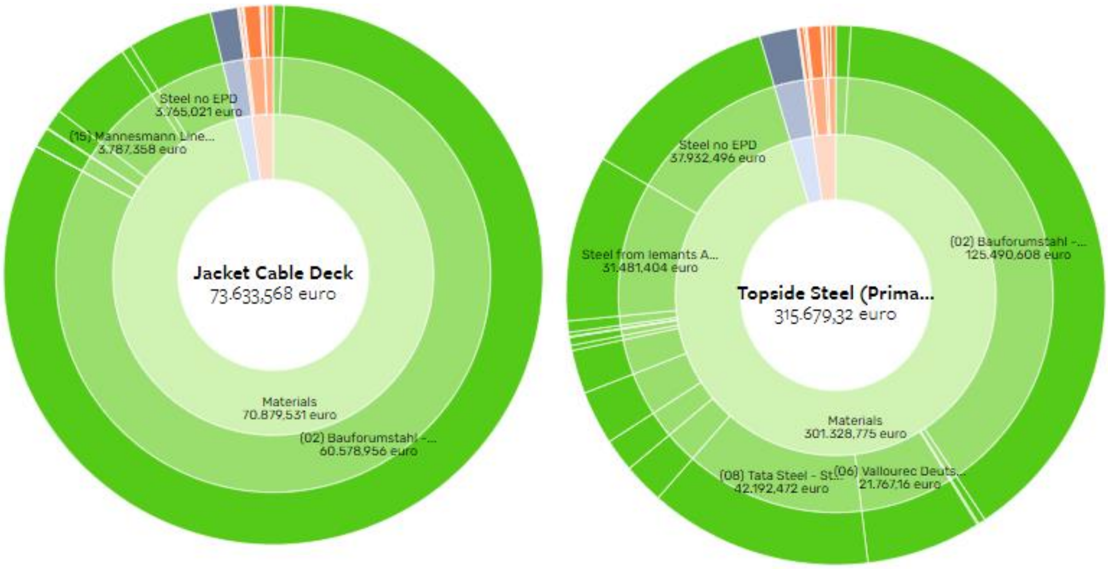


Figure 10: Contribution to ECI-score for Yard Tes

Figure 11: Contribution to ECI-score for SPB Hoboken

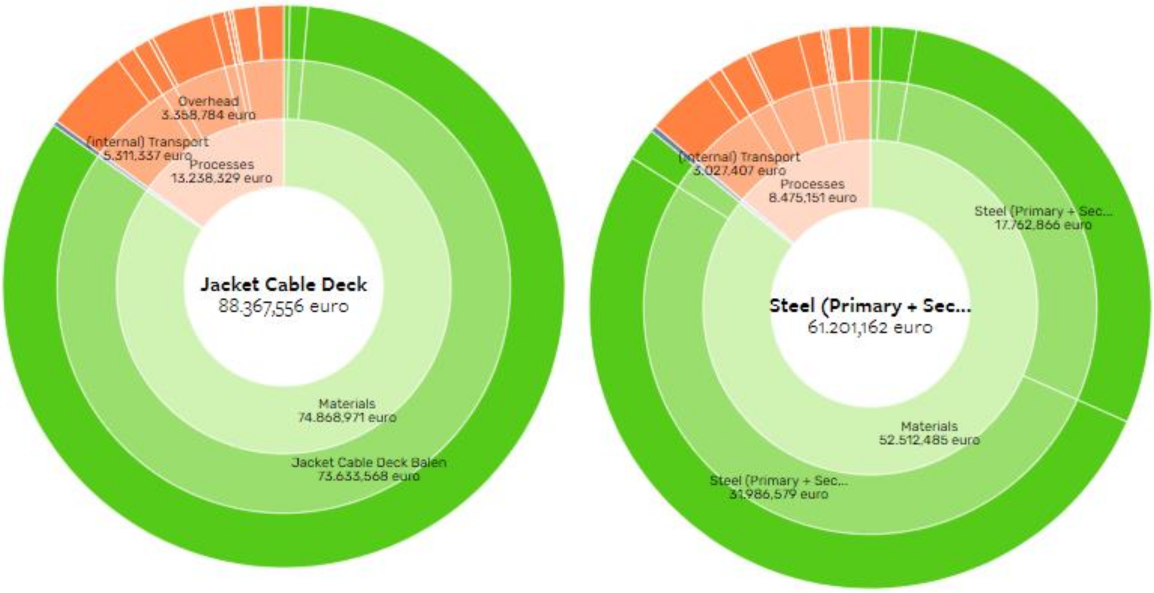


Figure 12: Contribution to ECI-score for EEW

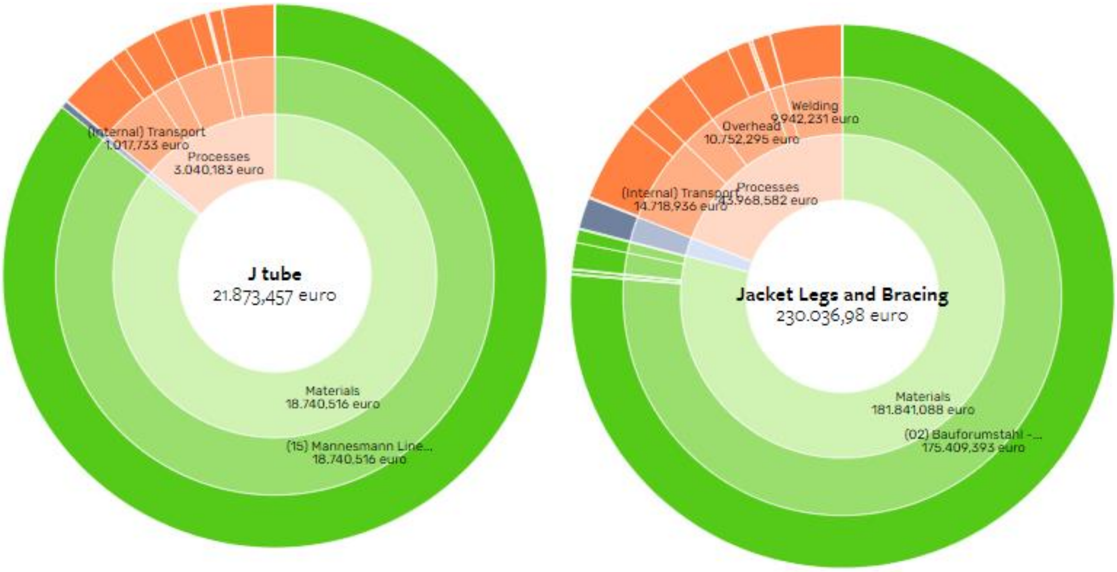


Figure 13: Contribution to ECI-score for Europe Steel Centre

Figure 14: Contribution to ECI-score for Van Den Broeck

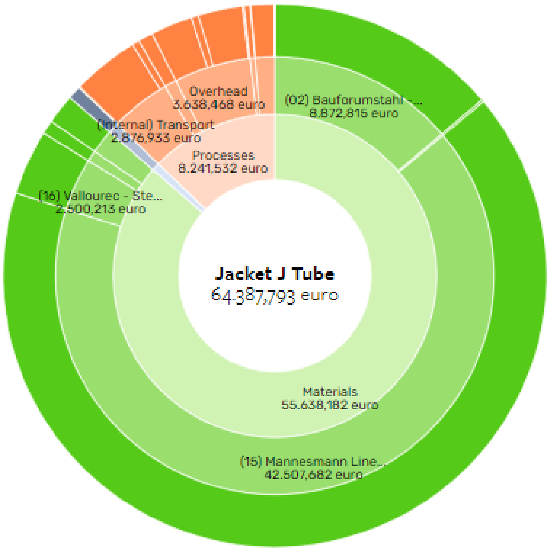
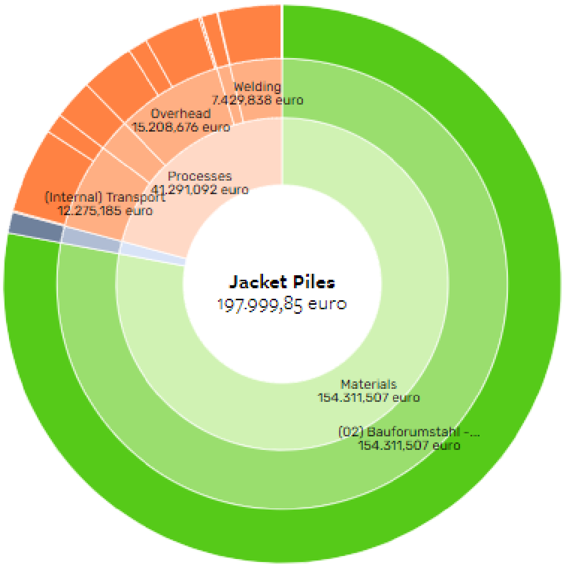


Figure 15: Contribution to ECI-score for SIF



6.2. Sensitivity analysis

As shown in above figures of the Hotspot analysis the most important element in this LCA is the use of steel. All steel EPD's used did not include the toxicities necessary to calculate the ECI. Therefore, the toxicities of a worst-case steel profile (S355G8+N) have been used as surrogates. The EPD's modelled in Appendix A all made use of the same toxicities, derived from this modelled steel profile. In the sensitivity analysis we are comparing the results of these calculation with calculations in which the toxicities have been omitted altogether, to check the ratio in which the toxicities accounted for the ECI. This is a check that the toxicities would have led to a worst-case ECI for all the EPD's used, a comparison has been set up. Table 25 displays this comparison. It can be seen that the toxicities of the original reference: S355G8+N (EN-10225) increase the ECI by 159%. The same toxicities increase the ECI of all other EPD's by far more than 159% and thus are a worst-case selection of toxicities for these EPD's to calculate the ECI.

Table 25: Comparison of the impact of toxicities on the foreign EPD's

EPD's used	ECI without toxicities	ECI with toxicities from the S355G8+N (EN-10225) profile	Ratio
S355G8+N (EN-10225)	€ 233	€ 370	159%
1	€ 42	€ 179	426%
2	€ 69	€ 206	299%
3	€ 38	€ 175	461%
4	€ 47	€ 184	391%
6	€ 145	€ 282	194%
8	€ 156	€ 293	188%
10	€ 76	€ 213	280%
11	€ 125	€ 262	210%
12	€ 156	€ 293	188%
13	€ 53	€ 190	358%
14	€ 157	€ 294	187%
15	€ 173	€ 310	179%
16	€ 137	€ 274	200%
19	€ 47	€ 184	391%
21	€ 97	€ 234	241%
22	€ 149	€ 286	192%

Since steel accounts for the majority of the ECI impact caused in this project, the selection of the correct background data for steel production is important. In the ECI calculations the EPD's of the selected producers have been used. In the sensitivity analysis we are comparing the results of these calculation with calculations in which the compiled Ecoinvent records described in the following table have been used.

Table 26 Compiled EcoInvent records

Alloy	Description
S355J2 (EN-10025-2)	97.7% steel, unalloyed//[RER] steel production, converter, unalloyed | 1,7% manganese//[RER] manganese production | 0.6% copper, blister-copper//[RER] copper production, blister-copper | hot rolling, steel//[RER] hot rolling, steel)
S355G8+N (EN-10225)	97.3 % steel, unalloyed//[RER] steel production, converter, unalloyed | 1,65% manganese//[RER] manganese production | 0.5% nickel, 99.5%//[GLO] market for nickel, 99.5% | 0.3% copper, blister-copper//[RER] copper production, blister-copper | 0.25% chromium//[RER] chromium production | hot rolling, steel//[RER] hot rolling, steel)

The S355J2 has been used for the production of the components for the Topside. The 355G8+N is more structural and is used in the production of the Jacket. The EcoChain accounts of all the of the production location have been copied (in year 2015) and modified with the EcoInvent records in order to make the comparison and to assess the sensitivity of the background data. This analysis only focusses on the A1-A3 production of the platform and not the A4-A5 transport and installation as this is not impacted by changes in steel background data.

In below figures 16 and 17 the results are shown for the locations Willems Balen and Iemants Arendonk, where components for both Jacket and Arendonk are produced, the modelling per steel type is done per weight ratio as shown in excel files of Appendix C.

Figure 16: Sensitivity analysis results for Iemants Arendonk

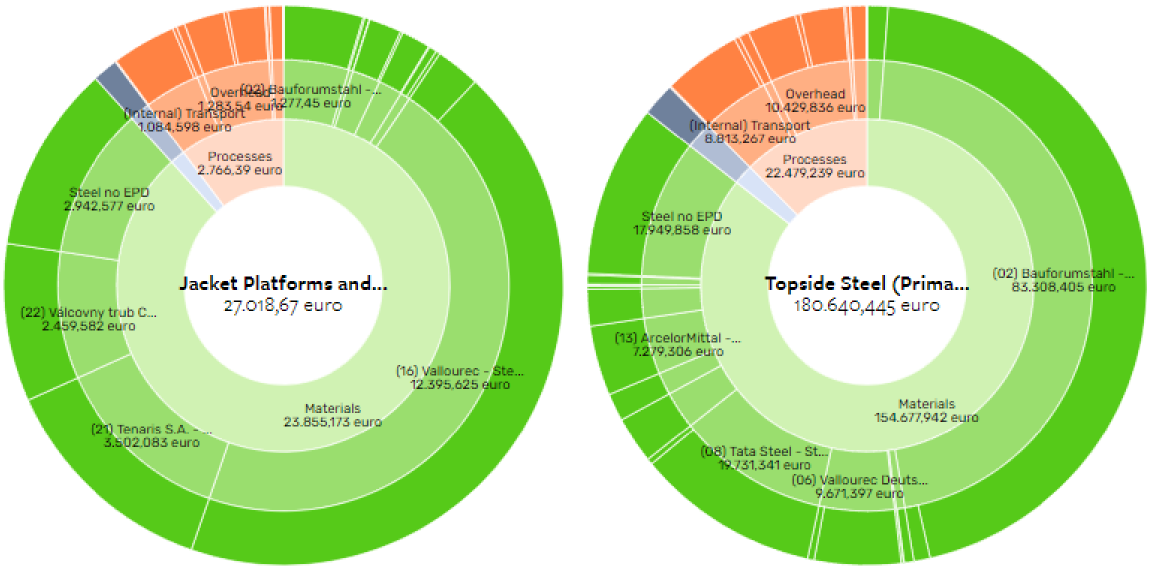
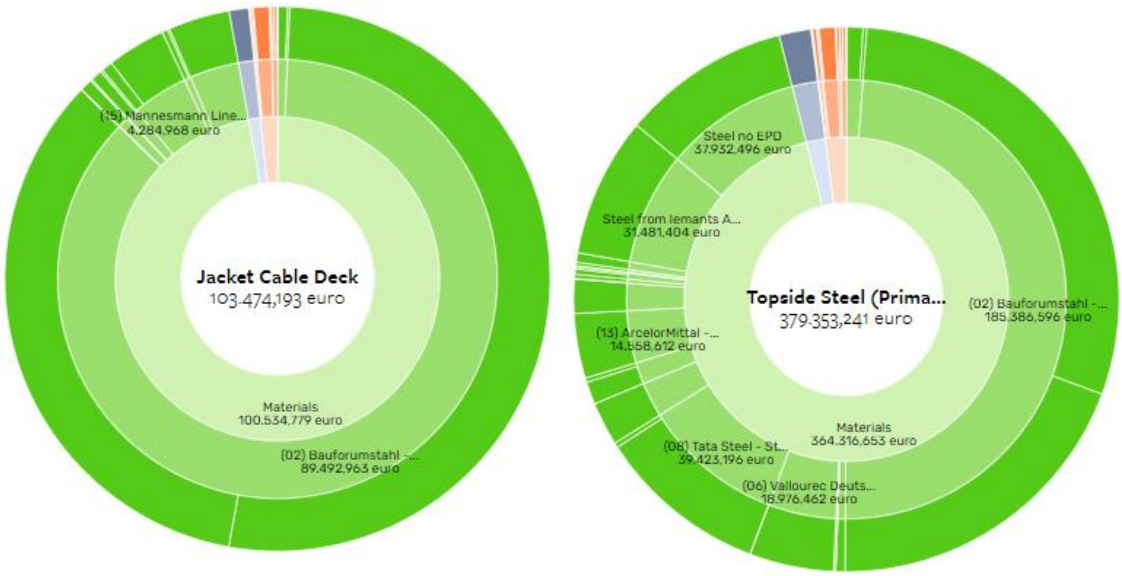


Figure 17: Sensitivity analysis results for Willems Balen



When comparing above results with the results presented in Figure 8 and Figure 9, an increase of 23% is measured on the ECI score for the Jacket components produced at Iemants Arendonk. Whereas for the Topside components produced at Iemants Arendonk an increase of 14% is accounted when worst-case scenario steel profiles S355J2 and S355G8+N are selected.
For the production of the Jacket components at Willems Balen an increase in ECI-score of 40% and 20% for the Topside components would be realized.
The EPD's provided by the suppliers for modelling have a positive outcome on the final ECI-score.

7. References

[1] ISO 14040: Environmental management - Life cycle assessment – Principles and Framework', International Organization for Standardization, ISO14040:2006.

[2] ISO 14044: Environmental management - Life cycle assessment - Requirements and guidelines', International Organization for Standardization, ISO14044:2006.

[3] ISO 14025: Environmental labels and declarations -- Type III environmental declarations -- Principles and procedures', International Organization for Standardization, ISO14025:2006.

[4] I.S. EN 15804: Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products', I.S. EN 15804:2012+A1:2013.

[5] EcoChain, 2017, web: http://app.ecochain.com.

[6] CML - Department of Industrial Ecology, CML-IA Characterisation Factors, Dated August 2016, Leiden University, Leiden, Netherlands Available at: https://www.universiteitleiden.nl/en/research/research-output/science/cml-ia-characterisation-factors

[7] Ministerie van Verkeer en Waterstaat, 8 maart 2004, Toxiciteit heeft z'n prijs, Schaduwprijzen voor (eco-)toxiciteit en uitputting van abiotische grondstoffen binnen DuboCalc.

[8] I.S. EN 16757:2017 Sustainability of Construction Works - Environmental Product Declarations - Product Category Rules for Concrete and Concrete Elements.

[9] Determination method for the environmental performance of buildings 1.0 Juli 2020

8. Appendix A

The ECI scores for the specific EPD's have been calculated in MS Excel.
Below the extracted information from these EPD's are displayed as tables. The tables indicate:

- The name of the EPD owner
- The name of the material for which the EPD has been set up.
- A description of the material
- The minimum tensile strength of the steel

A second table that displays the 7 environmental impact categories from the EPD + the 4 toxicities derived from the steel profile: S355G8+N (EN-10225) (97.3 % steel, unalloyed//[RER] steel production, converter, unalloyed | 1,65% manganese//[RER] manganese production | 0.5% nickel, 99.5%//[GLO] market for nickel, 99.5% | 0.3% copper, blister-copper//[RER] copper production, blister-copper | 0.25% chromium//[RER] chromium production | hot rolling, steel//[RER] hot rolling, steel)

- The calculated ECI score

ArcelorMittal Tubular Products Europe

Structural Hollow Sections

(01) ArcelorMittal - Structural Hollow Section (1 ton)

24-26, boulevard d'Avranches, L1160 Luxembourg

non alloy fine grain steel

Impact	Impact	eq	Weighting factor (euro)	eq, Kg	eq, Kg x weighing factor
Uitputting abiotische grondstoffen	ADP	Sb	0,16	0,00	€0
Uitputting fossiele energiedragers	ADP	Sb	0,16	10,77	€2
Klimaatsverandering	GWP	CO2	0,05	227,00	€11
Ozonlaag	ODP	CFK	30	0,00	€0
Smog	POCP	C2H4	2	0,71	€1
verzuring	AP	SO2	4	5,91	€24
vermesting	EP	PO4	9	0,46	€4
Humaan T	HTTP	DCB	0,09	1437,9524	€129
Zoetwater T	FAETP	DCB	0,03	20,3363	€1
mariene T	MAETP	DCB	0,0001	67642,659	€7
Terrestrische T	TETP	DCB	0,06	4,3089	€0
ECI totaal					€179

Bauforumstahl e,V,

Structural steel (sections and plates)

(02) Bauforumstahl - structural steel (sections and plates) 1 (ton)

Sohnstraße 65, D-40237 Düsseldorf, Germany

non or low-alloy steel

S235 to S960

Impact	Impact	eq	Weighting factor (euro) euro	eq, Kg kg	eq, Kg x weighing factor ECI
Uitputting a grondstoffen	ADP	Sb	0,16	0,00	0,0
Uitputting fossiele energiedragers	ADP	Sb	0,16	4,9062	0,8
Klimaatsverandering	GWP	CO2	0,05	1130,00	56,5
Ozonlaag	ODP	CFK	30	0,00	0,0
Smog	POCP	C2H4	2	0,40	0,8
verzuring	AP	SO2	4	2,16	8,6
vermesting	EP	PO4	9	0,22	2,0
Humaan T	HTTP	DCB	0,09	1437,9524	129,4
Zoetwater T	FAETP	DCB	0,03	20,3363	0,6
mariene T	MAETP	DCB	0,0001	67642,659	6,8
Terrestrische T	TETP	DCB	0,06	4,3089	0,3
ECI totaal					205,7

AFV Beltrame Group

Merchant Bars and hot rolled structural profiles

(03) AFV Beltrame Group - Merchant bars (1 ton)

VIALE DELLA SCIENZA 81, 36100, VICENZA – ITALY

<2% alloy elements, <2% other elements, >96% Iron

Not known

Impact	Impact	eq	Weighting factor (euro) euro	eq, Kg kg	eq, Kg x weighing factor ECI
Uitputting a grondstoffen	ADP	Sb	0,16	0,00	0,0
Uitputting fossiele energiedragers	ADP	Sb	0,16	3,985085	0,6
Klimaatsverandering	GWP	CO2	0,05	551,00	27,6
Ozonlaag	ODP	CFK	30	0,00	0,0
Smog	POCP	C2H4	2	0,14	0,3
verzuring	AP	SO2	4	1,93	7,7
vermesting	EP	PO4	9	0,24	2,2
Humaan T	HTTP	DCB	0,09	1437,9524	129,4
Zoetwater T	FAETP	DCB	0,03	20,3363	0,6
mariene T	MAETP	DCB	0,0001	67642,659	6,8
Terrestrische T	TETP	DCB	0,06	4,3089	0,3
ECI totaal					175,4

Celsa Barcelona & Celsa Huta Ostrowiec

Structural steel sections

(04) Celsa Barcelona & Celsa Huta Ostrowiec - Structural steel section (1 ton)					
Hot rolled in various shapes (I, H, L, U, flats, etc)					
low allow steel	Scrap metal in electric arc furnace				
S235 to S960					
Impact	Impact	eq	Weighting factor (euro)	eq, Kg	eq, Kg x weighing factor
			euro	kg	ECI
Uitputting a grondstoffen	ADP	Sb	0,16	0,00	0,0
Uitputting fossiele energiedragers	ADP	Sb	0,16	3,63636	0,6
Klimaatsverandering	GWP	CO2	0,05	632,00	31,6
Ozonlaag	ODP	CFK	30	0,00	0,0
Smog	POCP	C2H4	2	0,22	0,4
verzuring	AP	SO2	4	3,08	12,3
vermesting	EP	PO4	9	0,19	1,7
Humaan T	HTTP	DCB	0,09	1437,9524	129,4
Zoetwater T	FAETP	DCB	0,03	20,3363	0,6
mariene T	MAETP	DCB	0,0001	67642,659	6,8
Terrestrische T	TETP	DCB	0,06	4,3089	0,3
ECI totaal					183,7

voestalpine Grobblech GmbH					
voestalpine heavy plates, ALDUR, ALFORM, DUROSTAT, TOUGHCORE					
(06) voestalpine Grobblech GmbH - voestalpine heavy plates, ALDUR, ALFORM, DUROSTAT, TOUGHCORE (1 ton)					
Steel plates, but can be rolled and welded					
75% crude steel, 25% scrap steel +alloy		voestalpine-Strasse 3, 4020 Linz, Austria			
270 N/mm2 Tensile strength					
Impact	Impact	eq	Weighting factor (euro)	eq, Kg	eq, Kg x weighing factor
			euro	kg	ECI
Uitputting a grondstoffen	ADP	Sb	0,16	0,01	0,0
Uitputting fossiele energiedragers	ADP	Sb	0,16	9,33136563	1,5
Klimaatsverandering	GWP	CO2	0,05	2130,00	106,5
Ozonlaag	ODP	CFK	30	0,00	0,0
Smog	POCP	C2H4	2	0,75	1,5
verzuring	AP	SO2	4	7,26	29,0
vermesting	EP	PO4	9	0,68	6,2
Humaan T	HTTP	DCB	0,09	1437,9524	129,4
Zoetwater T	FAETP	DCB	0,03	20,3363	0,6
mariene T	MAETP	DCB	0,0001	67642,659	6,8

Terrestrische T	TETP	DCB	0,06	4,3089	0,3
ECI totaal					281,7

Tata Steel UK

Structural hollow sections

(08) Tata Steel - Structural hollow sections (1 ton)

Various locations; Structural hollow sections; Corby, Hartlepool, Maastricht, Zwijndrecht | Hot rolled coil; Port Talbot Ijmuiden,

Cold formed and hot finished; 470 to 630N/mm2 tensile strength

Impact	Impact	eq	Weighting factor (euro)	eq, Kg	eq, Kg x weighing factor
			euro	kg	ECI
Uitputting a grondstoffen	ADP	Sb	0,16	0,00	0,0
Uitputting fossiele energiedragers	ADP	Sb	0,16	12,0731	1,9
Klimaatsverandering	GWP	CO2	0,05	2500,00	125,0
Ozonlaag	ODP	CFK	30	0,00	0,0
Smog	POCP	C2H4	2	0,87	1,7
verzuring	AP	SO2	4	5,59	22,4
vermesting	EP	PO4	9	0,54	4,8
Humaan T	HTTP	DCB	0,09	1437,9524	129,4
Zoetwater T	FAETP	DCB	0,03	20,3363	0,6
mariene T	MAETP	DCB	0,0001	67642,659	6,8
Terrestrische T	TETP	DCB	0,06	4,3089	0,3
ECI totaal					292,9

Liberty Ostrava a. s.

Structural steel sections and merchant bars

(10) Liberty Ostrava a. s. - Structural steel sections and merchant bars (1 ton)

Vratimovska 689/117, 719 00 Ostrava - Kuncice, CZ Republic

Beams, Steel bars and special profiles

Impact	Impact	eq	Weighting factor (euro)	eq, Kg	eq, Kg x weighing factor
			euro	kg	ECI
Uitputting a grondstoffen	ADP	Sb	0,16	0,01	0,0
Uitputting fossiele energiedragers	ADP	Sb	0,16	5,9644	1,0
Klimaatsverandering	GWP	CO2	0,05	677,00	33,9
Ozonlaag	ODP	CFK	30	0,00	0,0
Smog	POCP	C2H4	2	0,53	1,1
verzuring	AP	SO2	4	5,22	20,9
vermesting	EP	PO4	9	2,11	19,0
Humaan T	HTTP	DCB	0,09	1437,9524	129,4

Zoetwater T	FAETP	DCB	0,03	20,3363	0,6
mariene T	MAETP	DCB	0,0001	67642,659	6,8
Terrestrische T	TETP	DCB	0,06	4,3089	0,3
ECI totaal					212,8

Alchemia S.A. Oddzia Walcowania Rur Batory

Seamless steel pipes and tubes

(11) Alchemia S.A. Oddzia Walcowania Rur Batory - Seamless steel pipes and tubes (1 ton)

Dyrekcyjna 6, 41-506 Chorzów, Poland

Impact	Impact	eq	Weighting factor (euro)	eq, Kg	eq, Kg x weighing factor
			euro	kg	ECI
Uitputting a grondstoffen	ADP	Sb	0,16	2,96	0,5
Uitputting fossiele energiedragers	ADP	Sb	0,16	9,62	1,5
Klimaatsverandering	GWP	CO2	0,05	2100,00	105,0
Ozonlaag	ODP	CFK	30	0,00	0,0
Smog	POCP	C2H4	2	0,16	0,3
verzuring	AP	SO2	4	3,41	13,6
vermesting	EP	PO4	9	0,43	3,9
Humaan T	HTTP	DCB	0,09	1437,9524	129,4
Zoetwater T	FAETP	DCB	0,03	20,3363	0,6
mariene T	MAETP	DCB	0,0001	67642,659	6,8
Terrestrische T	TETP	DCB	0,06	4,3089	0,3
ECI totaal					261,9

British steel

Steel Rails and Sections (including semi-finished long products)

(12) British Steel - Steel Sections, rails and rolled billet (1 ton)

UK (semi finished products, sections, rails & rolled billets) and France (rails)

75% crude steel, 25% scrap steel +alloy

Impact	Impact	eq	Weighting factor (euro)	eq, Kg	eq, Kg x weighing factor
			euro	kg	ECI
Uitputting a grondstoffen	ADP	Sb	0,16	0,00	0,0
Uitputting fossiele energiedragers	ADP	Sb	0,16	11,7845	1,9
Klimaatsverandering	GWP	CO2	0,05	2450,00	122,5
Ozonlaag	ODP	CFK	30	0,00	0,0
Smog	POCP	C2H4	2	1,54	3,1
verzuring	AP	SO2	4	6,05	24,2
vermesting	EP	PO4	9	0,47	4,2

Humaan T	HTTP	DCB	0,09	1437,9524	129,4
Zoetwater T	FAETP	DCB	0,03	20,3363	0,6
mariene T	MAETP	DCB	0,0001	67642,659	6,8
Terrestrische T	TETP	DCB	0,06	4,3089	0,3
ECI totaal					292,9

ArcelorMittal Europe – Long Products

Structural steel sections and merchant bars

(13) ArcelorMittal - Structural steel sections and merchant bars (1 ton)

66, rue de Luxembourg, L-4221 Esch-sur-Alzette, Luxembourg

Impact	Impact	eq	Weighting factor (euro)	eq, Kg	eq, Kg x weighing factor
			euro	kg	ECI
Uitputting a grondstoffen	ADP	Sb	0,16	0,00	0,0
Uitputting fossiele energiedragers	ADP	Sb	0,16	3,94901	0,6
Klimaatsverandering	GWP	CO2	0,05	842,00	42,1
Ozonlaag	ODP	CFK	30	0,00	0,0
Smog	POCP	C2H4	2	0,24	0,5
verzuring	AP	SO2	4	1,98	7,9
vermesting	EP	PO4	9	0,19	1,7
Humaan T	HTTP	DCB	0,09	1437,9524	129,4
Zoetwater T	FAETP	DCB	0,03	20,3363	0,6
mariene T	MAETP	DCB	0,0001	67642,659	6,8
Terrestrische T	TETP	DCB	0,06	4,3089	0,3
ECI totaal					189,9

ArcelorMittal Europe

Heavy Steel Plates

(14) ArcelorMittal Europe - Heavy Steel Plates (1 ton)

24-26, boulevard d'Avranches, L1160 Luxembourg

Impact	Impact	eq	Weighting factor (euro)	eq, Kg	eq, Kg x weighing factor
			euro	kg	ECI
Uitputting a grondstoffen	ADP	Sb	0,16	0,00	0,0
Uitputting fossiele energiedragers	ADP	Sb	0,16	11,3035	1,8
Klimaatsverandering	GWP	CO2	0,05	2600,00	130,0
Ozonlaag	ODP	CFK	30	0,00	0,0
Smog	POCP	C2H4	2	0,89	1,8
verzuring	AP	SO2	4	4,76	19,0
vermesting	EP	PO4	9	0,46	4,1

Humaan T	HTTP	DCB	0,09	1437,9524	129,4
Zoetwater T	FAETP	DCB	0,03	20,3363	0,6
mariene T	MAETP	DCB	0,0001	67642,659	6,8
Terrestrische T	TETP	DCB	0,06	4,3089	0,3
ECI totaal					293,8

Mannesmann Line Pipe GmbH

MSH (structural and hollow) sections

(15) Mannesmann Line Pipe GmbH - Structural hollow Sections (1 ton)

In der Steinwiese 31, 57074 Siegen, Germany

Steel grades: S235JRH – S460NLH; S235JRH – S460MLH

360 - 730 N/mm2 minimum tensile strength

Impact	Impact	eq	Weighting factor (euro)	eq, Kg	eq, Kg x weighing factor
			euro	kg	ECI
Uitputting a grondstoffen	ADP	Sb	0,16	0,00	0,0
Uitputting fossiele energiedragers	ADP	Sb	0,16	13,6123	2,2
Klimaatsverandering	GWP	CO2	0,05	2540,00	127,0
Ozonlaag	ODP	CFK	30	0,00	0,0
Smog	POCP	C2H4	2	1,21	2,4
verzuring	AP	SO2	4	8,60	34,4
vermesting	EP	PO4	9	0,75	6,7
Humaan T	HTTP	DCB	0,09	1437,9524	129,4
Zoetwater T	FAETP	DCB	0,03	20,3363	0,6
mariene T	MAETP	DCB	0,0001	67642,659	6,8
Terrestrische T	TETP	DCB	0,06	4,3089	0,3
ECI totaal					309,8

Vallourec Tubular Solutions Worldwide

Steel Tube

(16) Vallourec - Steel tube (1 ton)

27, Avenue du Général Leclerc, 92100 Boulogne-Billancourt, France

2% alloy, 44% steel scrap, 54% Pig Iron

Impact	Impact	eq	Weighting factor (euro)	eq, Kg	eq, Kg x weighing factor
			euro	kg	ECI
Uitputting a grondstoffen	ADP	Sb	0,16	0,00	0,0
Uitputting fossiele energiedragers	ADP	Sb	0,16	13,640679	2,2
Klimaatsverandering	GWP	CO2	0,05	1632,00	81,6
Ozonlaag	ODP	CFK	30	0,00	0,0
Smog	POCP	C2H4	2	2,64	5,3

verzuring	AP	SO2	4	6,33	25,3
vermesting	EP	PO4	9	2,50	22,5
Humaan T	HTTP	DCB	0,09	1437,9524	129,4
Zoetwater T	FAETP	DCB	0,03	20,3363	0,6
mariene T	MAETP	DCB	0,0001	67642,659	6,8
Terrestrische T	TETP	DCB	0,06	4,3089	0,3
ECI totaal					274,0

Asociación Sostenibilidad Siderúrgica

Branche specific EPD

Steel structures, bars and profiles

Organisations; Megasider Zaragoza, S.A.U.
Grupo Megasa
La Cartuja Baja, Zaragoza (España)

(19.1) Asociación Sostenibilidad Siderúrgica - Steel structures, bars and profiles (1 ton)

Impact	Impact	eq	Weighting factor (euro)	eq, Kg	eq, Kg x weighing factor
			euro	kg	ECI
Uitputting a grondstoffen	ADP	Sb	0,16	0,01	0,0
Uitputting fossiele energiedragers	ADP	Sb	0,16	4,36725393	0,7
Klimaatsverandering	GWP	CO2	0,05	567,26	28,4
Ozonlaag	ODP	CFK	30	0,00	0,0
Smog	POCP	C2H4	2	0,15	0,3
verzuring	AP	SO2	4	3,08	12,3
vermesting	EP	PO4	9	0,55	4,9
Humaan T	HTTP	DCB	0,09	1437,9524	129,4
Zoetwater T	FAETP	DCB	0,03	20,3363	0,6
mariene T	MAETP	DCB	0,0001	67642,659	6,8
Terrestrische T	TETP	DCB	0,06	4,3089	0,3
ECI totaal					183,7

Tenaris S.A.

Offshore and onshore seamless structural solutions

(21) Tenaris S.A. - Offshore and onshore seamless steel structural solutions (1 ton)

29 AVENUE DE LA PORTE-NEUVE, L2227 - LUXEMBOURG

2% alloy Elements, 2% other, 96% Iron

Impact	Impact	eq	Weighting factor (euro)	eq, Kg	eq, Kg x weighing factor
			euro	kg	ECI
Uitputting a grondstoffen	ADP	Sb	0,16	0,04	0,0
Uitputting fossiele energiedragers	ADP	Sb	0,16	11,189022	1,8
Klimaatsverandering	GWP	CO2	0,05	1510,50	75,5
Ozonlaag	ODP	CFK	30	0,00	0,0

Smog	POCP	C2H4	2	0,29	0,6
verzuring	AP	SO2	4	3,72	14,9
vermesting	EP	PO4	9	0,43	3,9
Humaan T	HTTP	DCB	0,09	1437,9524	129,4
Zoetwater T	FAETP	DCB	0,03	20,3363	0,6
mariene T	MAETP	DCB	0,0001	67642,659	6,8
Terrestrische T	TETP	DCB	0,06	4,3089	0,3
ECI totaal					233,7

Válcovny trub Chomutov, a.s.

Seamless Steel Tubes

(22) Válcovny trub Chomutov, a.s. - Seamless Steel Tubes (1 ton)

Tovární 629, 430 01 Chomutov, Czech Republic

Steel grades: S 235 JRH S 275 J0H a J2H S 355 J0H, J2H a K2H S 275 NH a NLH S 355 NH a NLH S 420 NH a NLH S 460 NH a NLH

Impact	Impact	eq	Weighting factor (euro)	eq, Kg	eq, Kg x weighing factor
			euro	kg	ECI
Uitputting a grondstoffen	ADP	Sb	0,16	0,01	0,0
Uitputting fossiele energiedragers	ADP	Sb	0,16	11,8326	1,9
Klimaatsverandering	GWP	CO2	0,05	2150,00	107,5
Ozonlaag	ODP	CFK	30	0,00	0,0
Smog	POCP	C2H4	2	0,58	1,2
verzuring	AP	SO2	4	6,42	25,7
vermesting	EP	PO4	9	1,43	12,9
Humaan T	HTTP	DCB	0,09	1437,9524	129,4
Zoetwater T	FAETP	DCB	0,03	20,3363	0,6
mariene T	MAETP	DCB	0,0001	67642,659	6,8
Terrestrische T	TETP	DCB	0,06	4,3089	0,3
ECI totaal					286,2

AkzoNobel

International Interzone 954GF (Part A & Part B)

(02) AkzoNobel - International Interzone 954GF (1 m2)

Stoneygate Lane, NE10 0JY, Felling, Gateshead, UK

A high solid, low VOC epoxy barrier coat reinforced with chemically resistant high aspect ratio lamellar glass flake for enhanced durability.

Density (kg/l) = 1.600; Coverage (kg/m²) = 0.917; Number of Layers = 1; Total product used (kg/m²) = 0.917

Impact	Impact	eq	Weighting factor (euro) euro	eq. Kg kg	eq. Kg x weighing factor ECI
Uitputting a grondstoffen	ADP	Sb	0,16	0,00005	0,00
Uitputting fossiele energiedragers	ADP	Sb	0,16	0,03295	0,01
Klimaatsverandering	GWP	CO2	0,05	4,28000	0,21
Ozonlaag	ODP	CFK	30	0,00001	0,00
Smog	POCP	C2H4	2	0,00412	0,01
verzuring	AP	SO2	4	0,05870	0,23
vermesting	EP	PO4	9	0,00610	0,05
Humaan T	HTTP	DCB	0,09	0,54213	0,05
Zoetwater T	FAETP	DCB	0,03	0,03967	0,00
mariene T	MAETP	DCB	0,0001	0,00842	0,00
Terrestrische T	TETP	DCB	0,06	0,00031	0,00
ECI totaal					0,57

AkzoNobel

International Interthane 990 (Part A & Part B)

(03) AkzoNobel - International Interthane 990 (1 m2)

Stoneygate Lane, NE10 0JY, Felling,
Gateshead, UK

A two component, high gloss, polyurethane finish, Interthane 990 provides excellent durability and flexible application

Density (kg/l) = 1.200; Coverage (kg/m²) = 0.159; Number of Layers = 1; Total product used (kg/m²) = 0.159

Impact	Impact	eq	Weighting factor (euro) euro	eq. Kg kg	eq. Kg x weighing factor ECI
Uitputting a grondstoffen	ADP	Sb	0,16	0,0000	0,00
Uitputting fossiele energiedragers	ADP	Sb	0,16	0,0073	0,00
Klimaatsverandering	GWP	CO2	0,05	0,6510	0,03
Ozonlaag	ODP	CFK	30	0,0000	0,00
Smog	POCP	C2H4	2	0,0005	0,00
verzuring	AP	SO2	4	0,0051	0,02
vermesting	EP	PO4	9	0,0013	0,01
Humaan T	HTTP	DCB	0,09	0,0063	0,00
Zoetwater T	FAETP	DCB	0,03	0,0013	0,00
mariene T	MAETP	DCB	0,0001	0,0000	0,00
Terrestrische T	TETP	DCB	0,06	0,0000	0,00
ECI totaal					0,07

9. Appendix B

To calculate the ECI, The EcoChain software has been used as the ECI calculation tool. The EcoChain software is able to model a complete production plant and all of the products that are being produced.

EcoChain, established in the Netherlands in 2011, is an independent online environmental management tool. It combines Big Data Analytics, LCA, Activity-Based Footprinting, and Activity-Based Costing to measure sustainability performance at all levels in the supply chain.

The key features of EcoChain are:

- Compliant to: ISO 14001; ISO 50001; ISO 14040/44; ISO 14064/67; ISO 14021/25; PAS2050; Product & Organizational Environmental Footprint compliance (PEF / OEF); Global Reporting Initiative; Carbon Disclosure Project; CO2 Performance Ladder (Dutch); Energy Efficiency Directive.
- Operates on its own stand-alone platform, fully independent of any other supporting systems.
- GDPR compliant since Jan 2018.
- Data encryption in transit and at rest (in database); 2-factor authentication.
- Application is stress-tested at regular intervals and monitored continuously.
- Generic application, suitable for any industry.
- In-built audit platform for external validation by independent auditors (EY, SGS, Ricardo).
- Powerful and dynamic dashboards provide deep insights into environmental impacts and facilitates clear sustainability reporting (see further detail in Appendix 4).
- In-built one-click LCA report generators using bespoke templates (Appendix 4).
- EcoChain outputs can articulate the sustainability achievements of Lean Manufacturing.
- Enables easy Environmental Profit and Loss Accounting (EP&L), and provides complete breakdowns to process level, product level and material level.
- EcoChain is a collaborative tool. It can be connected up and down the supply chain, so that suppliers can be linked to manufacturers through a single application.

10. Appendix C

A dossier is attached to the document and presented to the verifier with the following documents;

1. Jacket Staal EPD's gebruikt per component per locatie
2. Topside Staal EPD's gebruikt per component per locatie
3. Average transport distances per EPD per production location
4. Emissions and usages per production location
5. Composition of Anodes

11. Appendix D: Cover letter of approval by verifier