Electricity from a European offshore wind power plant using SG 15-236 wind turbines

Environmental Product Declaration according to ISO 14025

PCR 2007:08 - Electricity, steam, and hot water generation & distribution - Version 5.0.1

An EPD should provide current information, and may be updated if conditions change. The stated validity is therefore subject to the continued registration and publication at www.environdec.com

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Contents

Acronyms and abbreviations

AEP	Annual Energy Production
BoM	Bill of Materials
B2B	Business to Business
B2C	Business to Consumer
EPD	Environmental Product Declaration
GPI	General Programme Instructions
HSE	Health, Safety & Environment
IUCN	International Union for Conservation of Nature
PCR	Product Category Rules
CPC	Central Product Classification
IEC	International Electro technical Commission
ISO	International Organization for Standardization
LCA	Life Cycle Assessment
LCI	Life Cycle Inventory
LCIA	Life Cycle Impact Assessment
LCoE	Levelized Cost of Energy
MW	Megawatt
WTG	Wind Turbine Generator

1. Introduction

1.1. Functional unit

This document represents the certified Environmental Product Declaration (EPD), of the electricity generated through an offshore wind power plant of SG 15-236 wind turbine generators, located in an European scenario and operating under high wind conditions (IEC I wind class).

Siemens Gamesa is dedicated to both the design and the manufacturing of its wind turbines as well as to the installation commissioning and maintenance of the final product at the wind power plant. Therefore, the company is fully aware of the entire life cycle of their products.

The functional unit, to which all outcomes are referred to is:

Functional unit

1 kWh net of electricity generated through an offshore wind power plant of Siemens Gamesa SG 15-236 wind turbine generators, in an European location and operating under high wind conditions (IEC I), and thereafter distributed via 320 kV export cable to an European electrical grid

A total reference flow of 137,399,724 MWh has been used to refer all the inputs and outputs of the system to 1 single kWh. This reference flow represents the whole net electricity generation expected for 80 SG 15-236 wind turbine generators (WTGs) and related wind power plant infrastructure under high wind conditions during its service life, which has been set to 25 years.

Siemens Gamesa is able to supply different kind of towers, seeking a right placement of the rotor at the height which optimizes the energy harvested. The baseline scenario includes towers with a hub height of 136 m.

The growth in electricity generated from renewable energy sources during the period 2013 to 2023 largely reflects an expansion in two renewable energy sources across the EU, namely wind power and solar power[1], with the foreseeable depletion of the non-renewable traditional energy resources. Furthermore, it is a guarantee of competitiveness, because in most countries it is responsible for the lowering price of the energy.

Although having common features with other renewable energy sources -avoids CO_2 emissions, it is an inexhaustible resource and reduces the energy vulnerability of countries– its industrial character and maturity, with a developed technological learning curve, allows achieving very competitive market prices.

Wind energy will be the leading technology in transforming the global electricity supply structure towards a truly sustainable energy future based on indigenous, non-polluting and competitive renewable technologies.

[1] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Renewable_energy_statistics

1.2. Environmental Declaration and the EPD system

An environmental product declaration is defined in ISO 14025 as the quantification of environmental data for a product with categories and parameters specified in the ISO 14040 standard series but not excluding additional environmental information.

The International EPD® System has as main goal, the ambition to help and support organizations to communicate the environmental performance of their products (goods and services) in a credible and understandable manner.

Therefore, it offers a complete program for any organization interested in developing and communicating EPDs according to ISO 14025, also supporting other EPD programs (i.e., national, sectoral, etc.) in seeking cooperation and harmonization and helping organizations to broaden the use of environmental claims on the international market.

Environmental Product Declarations add a new dimension to the market, offering information on the environmental performance of products and services. The use of EPDs, leads to several benefits for organizations that develop declarations of their own products as well as for those who make use of the information contained in these Environmental Product Declarations.

This EPD has been made in accordance with the standards of the International EPD Consortium. The International EPD® System is a system for international use of type III Environmental Declarations, according to ISO 14025. The International EPD® System and its applications are described in the General Program Instructions (GPI).

The documents on which this EPD is based are, in order of relevance:

- Product Category Rules 2007:08. Electricity, steam, and hot water generation & distribution. Version 5.0.1
- EN 15804:2012+A2:2019/AC:2021- Sustainability of construction works Environmental product declarations Core rules for the product category of construction products.
- General Programme Instructions for Environmental Product Declarations, Ver. 4.0;
- ISO 14025:2010 - Type III environmental declarations;
- ISO 14040:2006 and ISO 14044:2006 on Life Cycle Assessment (LCA).

This EPD contains an LCA-based environmental behavior statement. It also contains additional environmental information, in accordance with the corresponding PCR 2007:08 - Electricity, steam, and hot water generation & distribution - Version 5.0.1:

- Information on the biodiversity protection;
- Information on land use and land cover classification in Europe;
- Information on environmental risks;
- Information on electromagnetic field generation;
- Information on the product noise;
- Information about the visual impact of the wind power plant.

2. The company and the product

2.1. Siemens Gamesa Renewable Energy

Siemens Gamesa is a leading supplier of wind power solutions to customers all over the globe. A key player and innovative pioneer in the renewable energy sector, we have installed products and technology in more than 90 countries, with a total capacity base of over 145GW installed globally and 25,000 employees.

Siemens Gamesa´s end-to-end value chain expertise encompasses onshore and offshore wind turbine design, manufacturing, installation as well as cutting-edge service solutions.

Onshore

Siemens Gamesa Onshore offers an extensive range of wind turbine technologies to cover all wind classes and site conditions around the world. Continuous innovation, a dedication to technological excellence and solutions adapted to customer needs are the pillars of our portfolio, setting the foundation for Siemens Gamesa as a benchmark technologist. This is backed by validated and recognized products, as well as by more than 35 years of experience and over 120 GW installed across the globe.

Offshore

Siemens Gamesa Offshore is the most experienced player in offshore wind; pioneering the industry when installing the world's first offshore wind power plant, Vindeby in Denmark, in 1991. Since then, we have successfully installed approximately 5,000 offshore wind turbines with a combined capacity of more than 25 GW. These turbines have been installed in US, multiple EU countries, UK, Korea, Japan and Taiwan.

Services

Siemens Gamesa has a proven track record of excellence in operation and maintenance. Leveraging scale and global reach, we offer a flexible service portfolio that can be tailored to our customers' diverse operating models. We also provide advanced diagnostics and digitalization capabilities, as well as customized offshore services.

Siemens Gamesa business management system, is certified according to the following international standards:

- ISO 14001:2015 - Environmental management systems;
- ISO 9001:2015 - Quality management systems;
- ISO 45001:2018 - Occupational health and safety management systems

2.2. Product system description

The baseline system under study is an offshore SG 15-236 European wind power plant, using towers with a hub height of 136 m. Since Siemens Gamesa started the LCA study, it was found interesting to extrapolate the results, as far as possible, to a test case of a European wind power plant and not only to a specific site. The reason pursued, is to make the information extracted from this report useful to a wider audience. To achieve this goal, it has become necessary to create a generic wind power plant model, representing a Siemens Gamesa European average client

2.2.1. The European SG 15-236 wind site

The differences between the environmental impacts caused by the commissioning of various wind power plants rely primarily on two variables, the location and the size of the site. The location of the wind plant is directly related to the environmental impact caused during the distribution stage. The farther the wind power plant is from the production centers, the more logistics needed.

The determination of the geographical location of the average offshore wind power plant, is based on Siemens Gamesa's construction experience, leading to a default distance of 50 km between the final wind power plant location and the shore of the preassembly site, which in this case has been considered to be at Esbjerg (Denmark).

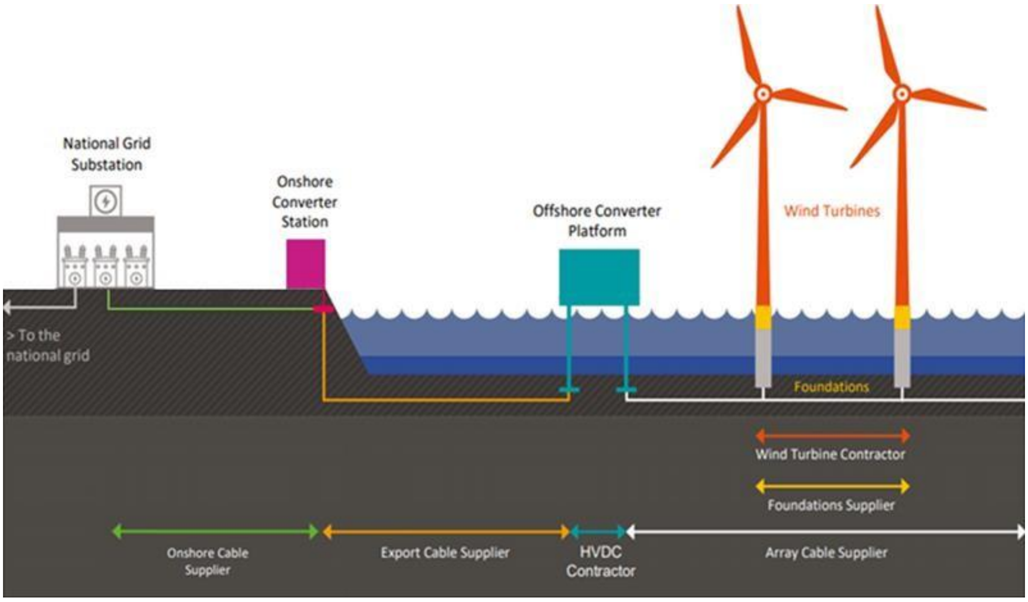

Figure 1.- Considered connections for the European average wind power plant case

Once the energy is generated in the wind power plant, it needs to be delivered to the customers through different electrical networks. This stage is known as the downstream module in the LCA. In this case, the downstream module covers the electricity losses for the onshore wiring system from the onshore substation until an average European customer connected to the grid. Moreover, the downstream module also includes the construction of the onshore electrical lines from the wind power plant shore until 22 km away. This point constitutes the boundary of the analyzed system.

Regarding the size of the wind power plant, the average size of an offshore wind site in Europe has been considered to be 80 turbines. Therefore, the installed power considered for the European average wind power plant is set to 1200 MW. When modelling the infrastructures shared by many wind turbines (i.e., transformer substation, inter-array cabling, connection infrastructure to the electrical network…) this average wind power plant size of 1200 MW installed has been used to reference all the values.

2.2.2. SG 15-236 Wind turbine

The new SG 15-236 is the next step towards producing clean and safe energy. With a 236-meter rotor and up to 15 MW capacity, we offer proven technology to deliver sustainable energy.

Enhancing and upgrading our proven Direct Drive technology has allowed us to raise the output of our 15 MW turbine. This enables the SG 15-236 to offer more than 2% Annual Energy Production compared to the SG 14-236 in similar conditions.

SG 15-236	
IEC class	I, S
Nominal power	15 MW
Rotor diameter	236 m
Blade length	115 m
Swept area	43,500 m^2
Hub height	Site-specific
Power regulation	Pitch-regulated, variable speed

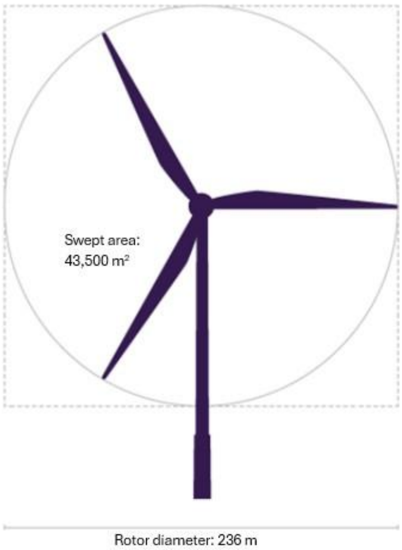

Figure 2.- SG 15-236 WTG Technical specifications

We strive to make a difference, and we are committed to safely maximizing operational performance while minimizing technological risks. Step by step development of proven technology will also for our SG 15-236 ensure low risk and high availability for our customers. From both an environmental and a financial point of view, we're committed to driving the offshore wind industry to levels where clean energy becomes the indisputable global choice for power generation. Our Direct Drive technology, IntegralBlade®, tower concepts, as well as maintenance and safety systems have evolved over generations of offshore wind turbines. Features such as High Wind Ride Through and the Power Boost function enable our turbines to produce even more energy while maintaining an industry-leading availability.

We ensure unmatched reliability through extensive testing in one of the world's largest dedicated wind turbine test centers. With every new generation of our offshore Direct Drive technology, component improvements allow for greater performance while maintaining the proven dependability of the technology. The expected service life of the product is stated in 25 years, not considering Siemens Gamesa's life extension program which can significantly enhance this period of time. For the present LCA, a life cycle model has been created, using towers with a hub height of 136 m.

2.2.3. Electricity transmission and distribution infrastructure

Once the wind is converted into electricity by the SG 15-236 wind turbine, the energy is delivered to each consumer through the electrical transmission and distribution network. This electrical transport stage also entails some environmental impacts that cannot be left out.

The environmental impacts associated with the construction and dismantling of the infrastructure needed to transport all the electricity generated by the WTGs must be considered. The materials used to build these electrical lines depend on the voltage level of the electricity being transported in each step, from the power generation until later consumption.

Furthermore, the electrical losses which occur because of the inevitable heating of electric wires during transport and in the successive voltage transformations that occur until the consumption point, cannot be avoided. All these impacts have also been considered in the system under study.

The WTG generates low voltage electricity. This voltage is increased in the transformer located inside the backend reaching medium voltage level to minimize electricity losses. At the exit of the wind power plant there is another transformer station allowing the delivery of high voltage electricity to the general network.

The distance between the wind power plant transformer station and the connection point to the electrical grid is a variable value dependent on the specific location. According to previous Siemens Gamesa experiences in an European context, this value was assumed to be 22 km average, which is the length of the line modeled for the LCA. The environmental impacts of building and dismantling this electricity transmission line have been taken from the Ecoinvent 3.11 (cut-off) LCI database. Ecoinvent estimates a technical service life for this kind of line of 30-40 years, over the wind power plant technical life cycle.

It should also be noted, that Siemens Gamesa is not a company dedicated to the energy distribution business. Instead, it is dedicated to the manufacture of wind turbine generators, so that the environmental impacts of this stage are inside the wind energy life cycle, but outside of the direct range of the Siemens Gamesa's activities.

3. Environmental performance based on LCA

3.1. Life cycle assessment methodology

As stated in ISO 14025:2010 (Environmental labels and declarations - Type III environmental declarations - Principles and procedures), the environmental impact data outlined in an Environmental Impact Declaration EPD, are part of the results obtained from an analysis following the Life Cycle Assessment methodology.

The LCA methodology, which has been followed when conducting this study is a procedure based on the international standards ISO 14040, ISO 14044 and the Product Category Rules 2007:08 - Electricity, steam, and hot water generation & distribution - Version 5.0.1. The evaluated product category code is CPC 171 standing for electrical energy generation.

With the use of the LCA method we are able to obtain a complete breakdown of the elementary inputs and outputs which compose our product system along its whole life cycle. These inputs and outputs are given in as raw material consumption or as different kind of emissions and are the indicators showing the real interaction of the analyzed product with nature. Besides, the LCA methodology also allows us to obtain global results associated to different environmental impact categories such as global warming potential, acidification potential, eutrophication potential or photochemical ozone formation potential, if we apply different characterization methods.

The LCA only quantifies information on environmental impacts, leaving apart social and economic indicators. In the same way, some environmental impacts associated with the product life cycle as land use, biodiversity protection, electromagnetic fields, noise, visual impact or accidental risks cannot be identified from the LCA perspective. For this reason, these environmental impacts will be individually analyzed in section 4 of this EPD (“Additional environmental impact”).

3.2. System boundaries and data sources

This Environmental Product Declaration reflects the cradle-to-grave life cycle impact of the electricity generated through an offshore wind power plant using SG 15-236 wind turbines, located on an European scenario, operating under high wind conditions (IEC I) and thereafter distributed to an European power transmission grid.

Obviously, the energy life cycle is a complex system in which it is necessary to clearly establish the boundaries between the different phases to avoid mistakes. Following the recommendations of the PCR, the whole life cycle has been divided into three main modules. These are the core module, the up-stream module and the down-stream module. The concepts included in each of these modules are summarized in the following paragraphs.

The following table provides a simplified representation of the matching between the modules seen in the Product Category Rules 2007:08 - Electricity, steam, and hot water generation & distribution - Version 5.01 with UNE-EN 15804:2012+A1:2014 modules.

ELECTRICITY PCR 2007:08	LIFE CYCLE STAGE	LIFE CYCLE ASPECT	EN 15804
CORE INFRASTRUCTURE	RAW MATERIALS	COMPONENT 1	A1
		COMPONENT 2	
		COMPONENT 3	
		COMPONENT 4	
	WTG MANUFACTURING	COMPONENT 1	A3
		COMPONENT 2	
		COMPONENT 3	
		COMPONENT 4	
	LOGISTICS	TRANSPORT BETWEEN GAMESA AND ITS SUPPLIERS	A2
		TRANSPORT TO WIND POWER PLANT	A4
	WIND POWER PLANT CONSTRUCTION	FOUNDATIONS	A5
		TERRAIN ADAPTATION	
		UNDERGROUND TRENCHES	
		INTERNAL WIRING	
		ELECTRICAL SUBSTATION	
		OTHER MACHINERY USE	
		CONSTRUCTION WASTE MANAGEMENT	
	OPERATION & MAINTENANCE	CORRECTIVE MAINTENANCE	B4
UPSTREAM		PREVENTIVE MAINTENANCE	B2
CORE PROCESS		MAINTENANCE WASTE MANAGEMENT	
		MAINTENANCE TRAVEL	
CORE INFRASTRUCTURE	END OF LIFE	END OF LIFE TRANSPORT	C2
		END OF LIFE TREATMENTS	C3-C4
DOWNSTREAM	DOWNSTREAM	ELECTRICAL NETWORK - LOSSES	NA
		ELECTRICAL NETWORK - INFRASTRUCTURE	NA

Table 1.- PCR modules matching

Obviously, the energy life cycle is a complex system in which it is necessary to clearly establish the boundaries between the different phases to avoid mistakes. Following the recommendations of the PCR, the whole life cycle has been divided into three main modules. These are the core module, the up-stream module and the down-stream module. The concepts included in each of these modules are summarized in the following paragraphs.

The previous table provides a simplified representation of the boundaries of the studied system, decomposing the life cycle on different modules, as required by the PCR.

The data used to create the model of the life cycle phases described in the above table, have been obtained directly from Siemens Gamesa Renewable Energy or from its suppliers. This data are fully traceable and is the basis for ensuring that the results of the LCA correspond to the reality of the product.

As baseline, all the data for which Siemens Gamesa has direct access to, have been included in the analysis seeking the best data completeness. However, given the complexity of the system and the multitude of information needed, in order to ease the assessment, the following criteria have been followed when making the life cycle inventory:

- The sum of all material flows that have not been included in the analysis should be less than 1% of the total weight of all material flows.
- The sum of all energy flows that have not been included in the analysis should be less than 1% of the total energy flows.

By the time the study ended, 99.8% of the total material flows of the system had been successfully included. The inflows that have been not included in the model, are related to small parts and pieces that are difficult to be inventoried (e.g., nuts, bolts, washers, small parts…). From previous Siemens Gamesa experiences, it is known that these parts do not have relevant environmental contribution in the results. In addition, all the energy flows incurred in Siemens Gamesa manufacturing plants have also been included in the analysis. Regarding data quality, the environmental impact of the processes where other generic data were used, is below 10% of the overall environmental impact from the whole product system.

From these primary data, when creating the life cycle model of the analyzed system Ecoinvent 3.11 (cut-off) life cycle inventories database has been used. All the data used to create the life cycle model of the electricity generated by an offshore wind power plant using SG 15-236 wind turbines reflect the technology currently used by the manufacturer and are considered representative for the period of validity of this EPD.

In the points of the study where impact allocation was required, physical allocation criteria was used to resolve multifunctionality issues, as recommended by the relevant PCR of the International EPD® System concerning this product category. In the manufacturing stage of the wind turbine, the annual environmental aspects of every production center were divided between the total units of components manufactured during that year in every specific location, to obtain the allocated impacts per wind turbine. In the next sections, the scope of the study and the data sources used are further detailed for every of the different stages that compose the life cycle of the generated and distributed energy.

3.2.1. Upstream

The upstream module considered in the study includes the environmental impacts related to the production of all necessary ancillary substances for the proper operation of the wind power plant during the 35 years of service life.

Since wind power requires no fuel for equipment operation, this module mainly includes the required quantities of hydraulic oil, lubricating oil and greases, as well as the emissions arising from the transport of these substances from the suppliers to the wind power plant. The replacements of lubricating oil, hydraulic oil and grease due to preventive maintenance, were obtained from Siemens Gamesa's statistics on the requirement for these supplies.

3.2.2. Core – Infrastructure

The core infrastructure phase encompasses all the steps related to the construction, and decommissioning of the wind power plant from cradle to grave. This comprehends all the stages from the extraction of the raw materials needed to build the WTGs and the wind power plant, until the dismantling of the wind power plant, including the proper management of the waste generated and the recycled components as well as their corresponding end of life treatments.

This module also refers to the manufacturing processes of the WTG performed by Siemens Gamesa and its suppliers. Besides, the expected corrective maintenance actions for the machinery during its service life (estimated component replacements and repairs) are included. All the environmental impacts arising from the logistics related to the previously mentioned concepts, are part of the core module too.

3.2.2.1. Wind power plant Construction

The main environmental aspects of the construction of a wind power plant are commonly related to the machinery used during the groundwork and WTG assembly, as well as to the material consumption for the foundations.

For this EPD, Siemens Gamesa has calculated the environmental impacts arisen from the construction of a virtual 80 WTG wind power plant, as explained in section 2.2.1.

Figure 3.- Westermost Rough offshore wind power plant

Different items have been considered in the LCA model of the wind power plant construction stage, such as the energy consumed by the vessels when building the foundations or for the WTG assembly, as well as the consumption of construction materials for the foundations and all the inter array wiring network. All the assets and materials needed for the construction of the offshore electrical substation, including the topside and its foundation, have also been included in the analysis.

3.2.2.2. Wind turbine generator manufacturing

Siemens Gamesa is responsible for the manufacturing and assembly of most of the major components of the wind turbine. The company, as manufacturer of the WTGs, has provided primary data on the raw materials, energy flows and generated waste streams during the wind turbines manufacturing and assembly stage, according to their real manufacturing processes. These data are based on the technology currently used by Siemens Gamesa and are considered representative as long as the same manufacturing technologies are used.

Data on the environmental aspects of Siemens Gamesa production processes have been collected during 1 full financial year period (from October 2023 to September 2024, both included). In addition, the material breakdown of the WTGs has been extracted from the BoM of the turbine models actually designed during the year 2025.

In the case of an offshore SG 15-236 wind turbine delivered to an European location, the factories involved in the manufacturing of the machine are the ones collected in the following table. Primary data have been gathered for all these manufacturing plants, which have been individually assessed for the purpose of the study.

Activity	Location	Owner
Backend & hub & generator manufacturing	Cuxhaven - GERMANY	SIEMENS GAMESA
Blades manufacturing	Aalborg - DENMARK	SIEMENS GAMESA
Tower manufacturing	Give - DENMARK	WELCON
Foundation manufacturing	Ferrol - SPAIN	NAVANTIA

Table 2.- Manufacturing plants included in the core infrastructure module

These facilities are responsible for the manufacturing and assembly of the main components of the SG 15-236 WTG, given to a European client. It is important to highlight that direct data on the foundation manufacturing process was not provided by Navantia. Therefore, the specific model of this manufacturing activity is based on estimations. All the electricity consumed in the manufacturing centers and offices owned by Siemens Gamesa during 2024 has a 100% renewable energy Guarantee of Origin certified by the supplier of the electricity.

In the LCA model, this 100% renewable electricity has been modeled using only the share of renewable sources in the 2024 electricity mix for the countries in which the manufacturing centers are established. This is the case for the SGRE blades manufacturing facility at Aalborg (Denmark) and for the SGRE backend, hub and generator manufacturing and nacelle assembly (i.e. assembly of backend, hub and generator) facility at Cuxhaven (Germany).The electricity consumed in the other two manufacturing centers included in the scope that are not directly owned by Siemens Gamesa (NAVANTIA and WELCON), has been modeled using the Spanish and Danish national electricity mixes respectively, for 2024.

Data on components directly purchased from suppliers and the distances traveled by these components to Siemens Gamesa manufacturing plants are real primary data, so that these distances closely match the reality of an European scenario. In addition, data on the distance traveled by the main components of the WTG to the wind power plant, have been included considering the European average wind power plant location explained in section 2.2.1.

3.2.2.3. Reinvestments

All the SG 15-236 wind turbine components are designed to have a service life equal to or greater than the turbine itself. However, sometimes the WTG is exposed to situations that differ from the normal design operation, that can reduce the expected lifetime of a component or even disable it.

Seeking to have a good overview of the environmental impact caused by these unexpected failures and the need for reinvestment of components, the impact of performing corrective maintenance actions on SG 15-236 turbines has been modeled in the LCA which supports this EPD. Data on failure rate statistics have been taken directly from internal studies made by Siemens Gamesa.

3.2.2.4. End of life

Finally, the materials that appear after the decommissioning of the wind power plant and their end-of-life management have been estimated according to previous Siemens Gamesa LCA experiences. For the LCA, the following hypotheses have been assumed.

Sub-system	End of life hypothesis
Foundation materials	97% recyclable 3% left in situ
Tower	99% recyclable 1% incineration/energy recovery
Blades	84% incineration/energy recovery 16% repaired
Backend structures	Fully recyclable
Bedframe	95% recyclable 5% incineration/energy recovery
Transformer	95% recyclable 5% incineration/energy recovery
Canopy	8% recyclable 92% incineration/energy recovery
Yaw system	97% recyclable 3% incineration/energy recovery
Tower top adaptor	95% recyclable 5% incineration/energy recovery
Backend electronic components	96% recyclable 4% incineration/energy recovery
Rest backend	96% recyclable 4% incineration/energy recovery
Blade bearing	Fully recyclable
Hub primary structure	99% recyclable 1% incineration/energy recovery
Hub castings	95% recyclable 5% incineration/energy recovery
Hub electronic components	74% recyclable 26% incineration/energy recovery
Spinner	88% recyclable 12% incineration/energy recovery
Hydraulic system	97% recyclable 3% incineration/energy recovery

Sub-system	End of life hypothesis
Rest hub	95% recyclable 5% incineration/energy recovery
Generator segments, primary structures and rest	Fully recyclable
Magnets	87% recyclable 13% incineration/energy recovery
Main shaft	95% recyclable 5% incineration/energy recovery
Generator electronic components	71% recyclable 29% incineration/energy recovery
Rotor house	99% recyclable 1% incineration/energy recovery
Main bearing	97% recyclable 3% incineration/energy recovery
WTG cables and internal wind power plant wiring	95% recyclable 5% incineration/energy recovery
Cable Protection System (CPS)	Fully incineration/energy recovery
J-TUBES	Fully recyclable
Offshore electrical substation	All metals parts and oils fully recyclable All plastic and fiber parts fully incineration/energy recovery 96% of electronic components, recyclable 4% of electronic components, incineration/energy recovery
Onshore substation	Topside fully recyclable Foundation left in situ

Table 3.- End of life hypotheses

3.2.3. Core – Process

All the environmental impacts associated with the operation of the wind power plant, given its 25 years of life, have been considered in this module. One of the main advantages of the wind energy over other non-renewable sources of energy is its independence on fossil fuels. This environmental benefit is reflected at this stage when we look at the results.

In the core-process module the following concepts have been considered:

- Preventive maintenance required during the lifespan of the wind power plant, including the maintenance travel vessels fuel consumption.
- The proper waste management of the consumables needed during operation and maintenance of the wind power plant, including transportation stage to the authorized entity for later treatment.

Figure 4.- Blade manufacturing in Siemens Gamesa

Finally, the core also contains a vital part of the wind turbine life cycle, which is technical performance. Factors such as the annual energy production, the availability of the machine, the electrical losses during operation or the energy self-consumption of the turbine for its auxiliary systems, have a decisive influence on the environmental impact of the functional unit. These are also primary data directly provided by the manufacturer.

3.2.4. Downstream

Lastly, the downstream stage comprises all the impacts that happen from the moment when the energy is delivered to the electricity network (leaving this way the wind power plant), until the moment when it reaches the final consumer. The downstream module represents mainly two different environmental impacts. The first one is the impact related to the construction and decommissioning of the electrical grid, which is considered within the sub-module "downstream infrastructure". The second impact is related to the electrical losses inherent to the voltage transformations and to the Joule effect when transporting the generated electricity, which are considered in the sub-module "downstream process". Note that these losses depend on the connection voltage of the final consumer.
Siemens Gamesa has experienced difficulties trying to separate the distributed energy losses to every kind of European customer. Accordingly, using the information published by the Council of European Energy Regulators (CEER) in its third report on power losses, an average value of 2.08% for the electrical losses in the transmission network for a European situation has been assumed. This means that 2.08% of every kWh generated is lost in the transmission network between the wind power plant and the declared customer. These losses will depend directly on the length of the evaluated line, so this assumption can be considered a conservative estimate of the losses in a real situation.

The distance between the wind power plant transformer station and the connection point to the electrical grid is a variable value dependent on the specific location. According to previous Siemens Gamesa experiences, this value has been assumed to be 22 km from shore for this study. These underground export cables were modelled for the LCA using primary information gathered by the company.

3.3. Eco-profile

In the following tables, the environmental performance of the SG 15-236 wind turbine from a life cycle perspective is shown, in the separated phases that were described above. The characterization factors for each of these impact categories have been used in accordance with the mandatory core environmental impact categories in EN 15804:2012+A2:2019/AC:2021 standard.

The EPD verifier had access to more comprehensive information on the LCA, which supports this declaration. The functional unit, to which all outcomes are referred to is:

Functional unit

1 kWh net of electricity generated through an offshore wind power plant of Siemens Gamesa SG 15-236 wind turbine generators, in an European location and operating under high wind conditions (IEC I), and thereafter distributed via 320 kV export cable to an European electrical grid

3.3.1. Potential environmental impacts

Potential environmental impacts		Unit	Upstream	Core process	Core Infrastructure	Total generated	Downstream process	Downstream infrastructure	Total distributed
Global warming potential	Fossil	g CO_2 eq	7.08E-03	5.86E-01	6.40E+00	6.99E+00	1.45E-01	4.42E-02	7.18E+00
	Biogenic		3.43E-05	6.32E-05	1.73E-02	1.74E-02	3.62E-04	8.15E-05	1.78E-02
	Land use and transformation		4.95E-03	5.81E-05	1.41E-02	1.91E-02	3.97E-04	9.78E-05	1.96E-02
	TOTAL		1.21E-02	5.87E-01	6.43E+00	7.03E+00	1.46E-01	4.44E-02	7.22E+00
Photochemical ozone formation potential		g NMVOC eq	7.43E-05	7.71E-03	4.18E-02	4.95E-02	1.03E-03	1.81E-04	5.08E-02
Acidification potential		mol H^+ eq	8.05E-08	5.06E-06	5.95E-05	6.47E-05	1.35E-06	2.46E-07	6.63E-05
Eutrophication potential (freshwater)		g P eq	6.57E-07	2.07E-06	4.19E-04	4.22E-04	8.78E-06	1.42E-06	4.32E-04
Eutrophication potential (marine)		g N eq	5.07E-05	2.35E-03	1.80E-02	2.04E-02	4.24E-04	4.02E-05	2.08E-02
Eutrophication potential (terrestrial)		mol N eq	2.11E-07	2.58E-05	1.48E-04	1.74E-04	3.62E-06	4.47E-07	1.78E-04
Ozone layer depletion		g CFC-11eq	4.07E-09	8.41E-09	2.37E-07	2.49E-07	5.19E-09	8.66E-10	2.55E-07
Abiotic depletion potential - Elements		g Sb eq	6.69E-08	2.05E-07	4.64E-04	4.64E-04	9.66E-06	4.13E-07	4.74E-04
Abiotic depletion potential – Fossil fuels		MJ, net calorific value	2.73E-04	2.88E-04	4.34E-02	4.39E-02	9.14E-04	2.70E-04	4.51E-02
Water scarcity potential		m^3 eq	1.14E-05	1.60E-05	2.09E-03	2.11E-03	4.39E-05	1.64E-05	2.17E-03

Table 4.- Potential environmental impacts

3.3.2. Use of resources

Primary energy resources Renewable	Unit	Upstream	Core process	Core Infrastructure	Total generated	Downstream process	Downstream infrastructure	Total distributed
Used as energy carrier	MJ, net calorific value	1.65E-04	4.66E-05	8.10E-03	8.31E-03	1.73E-04	6.04E-05	8.55E-03
Used as raw materials	MJ, net calorific value	3.98E-05	0.00E+00	1.62E-06	4.15E-05	8.62E-07	0.00E+00	4.23E-05
TOTAL	MJ, net calorific value	2.05E-04	4.66E-05	8.10E-03	8.35E-03	1.74E-04	6.04E-05	8.59E-03

Table 5.- Primary energy resources – Renewable

Primary energy resources Non-renewable	Unit	Upstream	Core process	Core Infrastructure	Total generated	Downstream process	Downstream infrastructure	Total distributed
Used as energy carrier	MJ, net calorific value	6.40E-05	2.88E-04	4.33E-02	4.37E-02	9.09E-04	4.44E-05	4.47E-02
Used as raw materials	MJ, net calorific value	2.16E-04	0.00E+00	4.26E-05	2.58E-04	5.37E-06	2.26E-04	4.89E-04
TOTAL	MJ, net calorific value	2.80E-04	2.88E-04	4.34E-02	4.40E-02	9.14E-04	2.70E-04	4.51E-02

Table 6.- Primary energy resources - Non-Renewable

3.3.3. Waste production

Waste production and output flows	Unit	Upstream	Core process	Core Infrastructure	Total generated	Downstream process	Downstream infrastructure	Total distributed
Hazardous waste disposed	Kg	8.26E-10	5.14E-08	4.15E-06	4.20E-06	8.74E-08	2.29E-08	4.31E-06
Non-hazardous waste disposed	Kg	6.30E-07	5.34E-06	8.57E-04	8.63E-04	1.79E-05	1.89E-06	8.83E-04
Radioactive waste disposed	Kg	1.88E-09	7.75E-10	2.84E-07	2.87E-07	5.96E-09	8.28E-10	2.94E-07

Table 7.- Waste production

3.4. Hot spot analysis and conclusions

To find the aspects that are mainly causing these environmental impacts, it is required to look into every phase of the whole life cycle from an integral perspective.

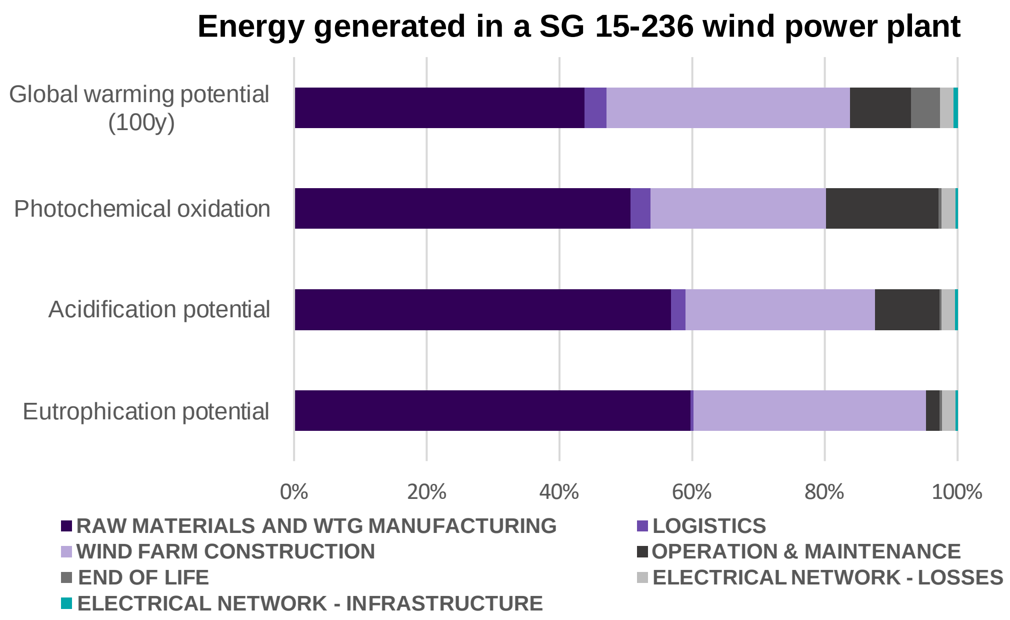

Figure 5.- Environmental hot spots

As shown in the figure above, there are two life cycle stages dominating the life cycle environmental impacts of the distributed energy. The wind power plant construction stage together with the raw material and WTG manufacturing stage, are responsible for approximately 85% of the total environmental impacts for these 4 impact categories. From a life cycle point of view, these two stages are the main hot spots of the energy generated in the SG 15-236 wind power plant, and should be carefully designed in future projects.

Nearly 52.8% (in average for the 4 impact categories) of the environmental impacts of the energy generated and distributed by a SG 15-236 WTG are caused in the raw material acquisition and WTG manufacturing phase. This is a logical consequence, since a wind turbine does not consume any fossil fuel during its operation as the conventional energy sources do, so the main environmental aspect of this technology is related to the manufacturing of its infrastructure. This is mostly caused by the raw materials needed to manufacture all the steel parts of the WTG and the subsequent machining phases. The most critical components in this phase are the tower and the electronic components. Concerning the wind power plant construction, this stage represents 31.7% of the impacts (in average). The most relevant environmental aspects for the construction stage are the materials consumption when building the foundations and the materials used for the inter-array cables.

Finally, the rest of the modules such as use and maintenance, end of life, electrical losses in the network and logistics, have a minor contribution to the life cycle environmental impacts of the generated and distributed energy using SG 15-236 WTGs. More detailed conclusions on the environmental impacts were made in the full LCA report. Please, refer to Siemens Gamesa Renewable Energy for further information.

4. Additional environmental impact

4.1. Biodiversity protection

Siemens Gamesa products and services, use certain natural resources to perform its activities, thereby interacting with, and potentially affecting, ecosystems, landscapes and species. This mainly happens throughout our operations over the product life cycle, for example:

- When we establish new facilities.
- When constructing our wind power plants.

Some impacts to biodiversity can include, for example:

- Potential land use changes by using vehicles and machinery to open up paths and remove vegetation;
- Prolonged human presence which temporarily affects the behavior of species of fauna in a generally reversible way;
- Potential species mortality due to collisions with our customers' wind turbines.

Despite these potential impacts on biodiversity, Siemens Gamesa's wind projects are constructed in a sustainable way allowing a balanced coexistence with the environment, thus conserving and protecting natural assets, i.e., biodiversity and climate. This respect for biodiversity and ecosystems plays a leading role in the company's business strategy. There are different regulatory and voluntary instruments to achieve a positive net balance in relation to biodiversity and the environment, including:

- Company policies and procedures under the integrated management system;
- Full compliance with permits granted by environmental and conservation authorities at each region, which set out requirements to ensure the local environment's protection;
- Setting environmental and control plans and implementing management systems, the majority of which have been certified according to the ISO 14001 standard to prevent and control environmental risks;
- Fulfilling legislation on conducting environmental impact studies, which include analysis and prevention mechanisms that consider different alternatives and lay down corrective measures to avoid, mitigate or offset any possible damage.

As a rule, protected areas and areas of high biodiversity value without protection are avoided during the design stage of new infrastructures. Potential environmental impacts are analyzed through a formal HSE aspects evaluation and by conducting environmental impact assessments beforehand, with measures to correct and minimize the impacts. In case they cannot be completely mitigated, offsetting measures are taken.

The company has activities in some areas where threatened species included in the IUCN Red List and in other national conservation lists live or could be present. This, however, does not mean that they are affected or threatened by such activities. Hence, the identification of species on the IUCN Red List and other species included in national conservation lists which could be affected by Siemens Gamesa's activities is permanently monitored to take the necessary measures to avoid endangering them.

4.2. Land use

As this EPD is not relative to one specific site in Europe, but to an average European Siemens Gamesa location, a specific land use analysis cannot be performed. Alternatively, a description on the land uses across Europe, has been performed.

The data source used for the land use and land cover classes information in Europe, are the maps published by the Copernicus Land Monitoring system. Copernicus, is a European system for monitoring the Earth. Data is collected by different sources, including Earth observation satellites and in-situ sensors. The data is processed and provides reliable and up-to-date information in six thematic areas: land, marine, atmosphere, climate change, emergency management and security.

4.2.1. Description of land cover classes across Europe

The following table shows the land cover classes across the area for which the study is representative. The surface is expressed in hectares. The bigger areas in Europe are occupied by non-irrigated arable lands as well as by coniferous and mixed forests. It is important to highlight that as the analysis is being performed on an offshore wind power plant, only water bodies will be affected when a new wind power plant of this type is built.

Land cover classes	Surface (ha)	%
Urban fabric	21,587,189	4.1%
Other artificial areas	1,606,124	0.3%
Non-irrigated arable land	109,894,155	21.0%
Permanently irrigated arable land	4,695,274	0.9%
Pastures	41,045,873	7.9%
Other agricultural areas	55,442,269	10.6%
Broad-leaved forest	55,083,970	10.5%
Coniferous and mixed forest	104,911,554	20.1%
Other shrub and/or herbaceous areas	76,061,803	14.6%
Beaches, sands and rocks	23,490,231	4.5%
Burnt areas	223,000	0.0%
Wetlands	14,410,030	2.8%
Water bodies	13,962,613	2.7%
TOTAL	522,414,084	100.0%

Table 8.- Land cover classes across Europe

4.2.2. Description of the activities on the occupied areas

The area of land occupied by artificial elements in a 80 offshore wind turbine wind power plant will be approximately of 9,848 m^2, affecting to water bodies. This area will be mainly occupied by the following artificial elements during 25 years and 6 months, including the construction, operation and dismantling periods of the wind power plant:

- Foundations;
- Electrical offshore substation compounds;

4.3. Environmental risks

Although the probability and severity of undesirable events is very low, the most representative environmental risk is an accidental oil spill. This chance is quite reduced if we compare this wind turbine model to an onshore machine, because direct drive offshore turbines do not have gearbox component, thus greatly reducing the oil quantity at the site. Operational controls are implemented at all Siemens Gamesa production facilities and project sites to protect water and soil from spills e.g., through the establishment of prevention and response plans and the use of control measures such as spill trays, loading and unloading areas, proper storage of substances, routine inspections, etc. Should a spill occur, Siemens Gamesa is equipped with detection, reporting and correction methods to reduce the extent of the spill and prevent a recurrence.

A total of 563 spills were recorded in FY24, considering all the Siemens Gamesa production facilities and project sites worldwide. None of these spills required exceptional corrective measures. When using the declared wind power plant as reference, these spills happen less frequent than once in three years.

4.4. Electromagnetic fields

The 2014/35/UE Directive regulates the electromagnetic compatibility of equipment. It aims to ensure the functioning of the internal market by requiring equipment to comply with an adequate level of electromagnetic compatibility. The directive makes a clear distinction between apparatus and fixed installations with regard to documentation of compliance with the protection requirements. The term “fixed installation”, in the view of the European Commission, is a comprehensive term for electrical installations consisting of different types of apparatus and other devices that are combined permanently at an unchangeable location. A formal conformity assessment of such installations is often difficult to perform and, in some cases, even impossible due to their size and complexity. In addition, fixed installations are often subject to constant change through which the formal conformity assessment of their undefined and changeable EMC conditions also appears to be problematic. Wind turbine is transported to its site of installation in separate parts and assembled on-site, erected and put into operation. It is operated exclusively at that location. According to these requirements, a wind turbine is a fixed installation according to the definition of terms in the EMC Directive.

For these reasons, the EMC Directive foregoes a formal conformity assessment and CE marking of fixed installations. However, it stipulates that such installations must be installed according to generally accepted rules of technology, and that the specifications for the intended use of the installed components have been observed. The measures for compliance with the essential requirements of the EMC Directive also has been documented in the technical file. In addition, the basic standard for the design of wind turbines, EN 61400-1, obligates EMC assessment and to the respective measurements. According to the design risk assessment, there are no people exposed to electromagnetic radiation hazards in the wind turbine.

4.5. Noise

The noise produced by a wind turbine is twofold, one mechanic and other aerodynamics. The first comes from the machine components and can easily be reduced by conventional techniques. Aerodynamic noise produced by the air flowing on the blades tends to increase with the speed rotation of the blades and with wind flow turbulent conditions noise may increase. Although the backend mechanical noise exists, it is low compared to aerodynamic noise, and at ground level, the only relevant noise is the aerodynamic one.

The emitted noise values are within the normal values within the wind industry. It is noteworthy that offshore wind power plants are in uninhabited areas and distances greater than 300 m the noise level is greatly reduced and is considered negligible to be lower than the ambient noise threshold in nature, wind, etc.

Nevertheless, for locations with strict noise requirements, low noise operation modes are available. In those versions, the total noise is limited to the required maximum value by reducing the power generated in the most critical wind speed bins.

4.5.1. Noise calculation

There are two international standards establishing noise measurement procedures and noise levels declaration:

- IEC 61400-11 (Ed. 3 2012): Wind turbine generator systems - Acoustic noise measurement techniques. Definition of how to perform noise measurements of a wind turbine;
- IEC 61400-14 (Ed. 2005): Wind turbines - Declaration of apparent sound power level. Definition of how to declare the noise generated by an AEG.

According to the measures carried out for the SG 15-236 wind turbine generator according to IEC 61400-14: 2005 and IEC 61400-11; 3rd Ed.; noise level is lower than 117.5 dB.

4.6. Absolute global warming emissions

In addition to the already declared GWP results under section 3.3, the following chapter contains the absolute global warming emissions for the life cycle of solely 1 SG 15-236 wind turbine, instead of providing the results referenced to the functional unit of 1 kWh of energy distributed, considering an 80 turbine European location.

The downstream stage of the life cycle has been excluded of this new set of results, as that stage is not dependent on the number of turbines. In addition, the common elements of the wind power plant construction stage, which are shared between many turbines, have been scaled down to 1 WTG.

It is important to highlight that the energy performance of the turbine is not influencing these results, as they represent the raw results of commissioning the infrastructure.

Life cycle stage	Group	Absolute GWP [Ton CO_2eq]
RAW MATERIALS AND WTG MANUFACTURING	Backend	1.016
	Generator (inclusive manufacturing)	904
	Hub	335
	Nacelle assembly (inclusive backend + hub manufacturing)	30
	Blades (inclusive manufacturing)	1.041
	Tower (inclusive manufacturing)	2.104
LOGISTICS	Transport between suppliers	345
	Transport to preassembly site	62
WIND POWER PLANT CONSTRUCTION	Wind power plant construction	420
	Foundation	2.733
	Interarray cable	411
	Export cable	498
	CPS (Cable Protection System)	1
	Off-shore substation	391
	On-shore substation	88
OPERATION & MAINTENANCE	Corrective maintenance	115
	Preventive maintenance	21
	Maintenance travel	972
	Maintenance waste treatment	36
END OF LIFE	End of Life transport	31
	End of Life treatments	511
TOTAL		12,066

Table 9.- Absolute global warming emissions per turbine

4.7. Share by materials of the GWP emissions

This last section is meant to provide deeper insight on which materials are the ones responsible of most of the global warming potential emissions during the life cycle of the SG 15-236 wind turbine. In this wind turbine model, materials consumption account to 53.5% of the total life cycle global warming impacts (12,066 Ton CO2eq), being the rest of the impacts caused by other aspects such as transport related emissions, manufacturing facilities related impacts, operation and maintenance efforts or end-of-life treatments.

The following figure contains the global warming potential impacts split by the different materials used when manufacturing the wind turbine. For this calculation, all the groups involving most of the materials consumption have been considered. It should be noted that common elements of the wind power plant such as the inter array cables, the export cables and the offshore substation, have been excluded from the calculation.

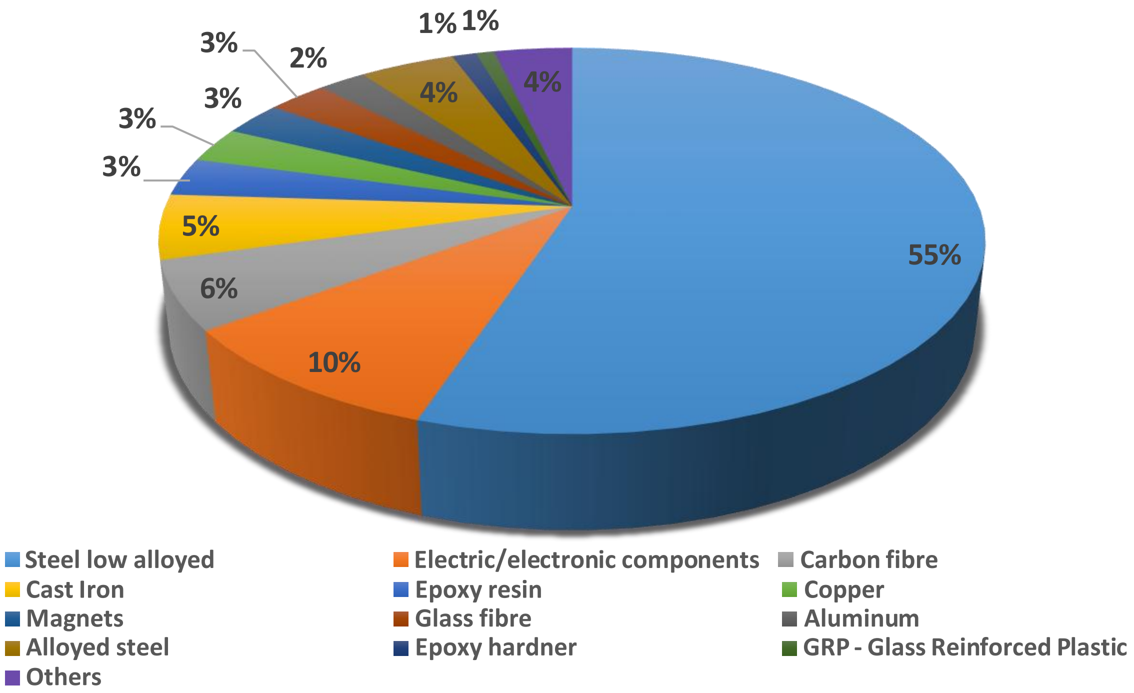

Figure 6.- Share of the GWP emissions by materials

4.8. Visual impact

The landscape impact caused by the presence of wind turbines and power lines is a subjective aspect, which affects differently, depending on the location of the wind power plant. The location of wind power plants is also determined by analyzing the different points from which they are visible to, thereby causing minimal visual impact. Each wind power plant prior to the decision to its location has had an environmental impact assessment that has been approved by the relevant environmental authority.

The addition of any novel structure can drastically alter a landscape or seascape. With regards to wind energy and marine renewable energy devices, some people appreciate their presence as they may attract tourism, while others dislike the new addition as an imposition on the natural environment. However, marine renewable energy devices are typically lower profile, closer to the surface, or submerged underwater, all of which reduce their visibility and perceived visual impacts.

In many cases, as part of the assessment process, interactive maps are used to illustrate the potential effects of the wind turbines. These maps allow viewing the theoretical visibility of the proposed turbines, zooming into an area and viewing photomontages from some particular viewpoints in the surrounding area to see what the wind power plant would look like.

5. Certification body and mandatory statements

5.1. Information from the certification body

The verification process of this environmental product declaration has been carried on by Certinalia S.L.U, accredited certification body by ENAC (the Spanish National Accreditation Body) and the International EPD® System, which verifies that the attached Environmental Product Declaration complies with the applicable reference documents and also certifies that the data presented by the manufacturer are complete and traceable in order to provide supporting evidence of the environmental impacts declared in this EPD document, according to the International EPD® System General Programme Instructions.

The EPD has been made in accordance with the General Programme Instructions for the International EPD® System, published by EPD International AB, and PCR 2007:08 - Electricity, steam, and hot water generation & distribution - Version 5.0.1, valid until 2028-07-02.

This certification is valid until 2031-02-12.

5.2. Mandatory statements

5.2.1. Comparability between EPDs from other Programmes

Note that Environmental Product Declarations (EPD) within the same product category but from different programmes may not be comparable.

5.2.2. Life cycle stages omitted

According to the reference PCR, the phase of electricity use has been omitted, since the use of electricity fulfils various functions in different contexts.

5.2.3. Means of obtaining explanatory materials

The ISO 14025 standard requires that the explanatory material should be available if the EPD will be communicated to end users. This EPD is industrial consumer oriented (B2B) and communication is not intended for B2C (Business-to-consumer).

5.2.4. Responsibility of the verifier and the programme operator

The verifier and the programme operator do not make any claim nor have any responsibility of the legality of the product.

5.2.5. Ownership, liability and responsibility

The EPD owner has the sole ownership, liability and responsibility of the EPD.

5.2.6. EPD validity

An EPD should provide current information, and may be updated if conditions change. The stated validity is therefore subject to the continued registration and publication at www.environdec.com.

5.3. Programme and verification information

Programme and verification information	
EPD Programme	EPD International AB (Programme operator) Box 210 60, SE-100 31 Stockholm, Sweden www.environdec.com support@environdec.com
Registration number	EPD-IES-0028231:001
Publication date	2026-02-12
EPD validity	2031-02-12
Geographical validity of the EPD	This EPD has European validity
Scope of the declaration	Cradle-to-grave
Independent verification of the declaration and data, according to ISO 14025:2006	☒ EPD verification ☐ EPD process certification
Third party verifier	Certinalia, S.L.U. Verifier: Eva Larzabal info@certinalia.com
Third party verifier accredited or approved by	ENAC. Accreditation no.125/C-PR283
Procedure for follow-up of data during EPD validity involves third-party verifier	☒ Yes ☐ No
LCA study developed by	IK Ingenieria
Reference Product Category Rules (PCR)	PCR 2007:08 - Electricity, steam and hot water generation and distribution – UN CPC 171 & 173 – Version 5.0.1
PCR review conducted by	Technical Committee of the International EPD® System. A full list of members is available on www.environdec.com The review panel may be contacted via support@environdec.com PCR review chair: Lars-Gunnar Lindfors
PCR prepared by	Technical Committee of the International EPD® System. PCR Moderator: Lena Landström – Vattenfall AB PCR Moderator: Karin Lundmark – Vattenfall AB lena.landstrom@vattenfall.com

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6. Links and references

Additional information about Siemens Gamesa Renewable Energy:

www.siemensgamesa.com/en-int

Siemens Gamesa Renewable Energy sustainability commitment:

www.siemensgamesa.com/en-int/sustainability

Additional information about the International EPD® System:

www.environdec.com

The International EPD® System is based on a hierarchical approach using the following international standards:

- ISO 9001, Quality management systems;
- ISO 14001, Environmental management systems;
- ISO 14040, LCA - Principles and procedures;
- ISO 14044, LCA - Requirements and guidelines;
- ISO 14025, Type III environmental declarations.

Data base used for the LCA:

Ecoinvent 3.11 Database, published by the Swiss Centre for Life Cycle Inventories

http://www.ecoinvent.org

VERIFICATION STATEMENT CERTIFICATE

CERTIFICADO DE DECLARACIÓN DE VERIFICACIÓN

Certificate No. / *Certificado nº: EPD01616*

CERTINALIA, S.L.U., confirms that independent third-party verification has been conducted of the Environmental Product Declaration (EPD) on behalf of:
CERTINALIA, S.L.U., confirma que se ha realizado verificación de tercera parte independiente de la Declaración Ambiental de Producto (DAP) en nombre de:

SIEMENS GAMESA RENEWABLE ENERGY
Parque Tecnológico de Bizkaia, Ed. 222
48170 ZAMUDIO (Bizkaia) - SPAIN

for the following product(s):
para el siguiente(s) producto(s):

ELECTRICITY FROM AN EUROPEAN OFFSHORE WIND FARM USING SG 15-236 WIND TURBINES.
ELECTRICIDAD GENERADA POR UN PARQUE EÓLICO MARINO EUROPEO CON AEROGENERADORES SG 15-236.

with registration number **EPD-IES-0028231** in the International EPD® System *(www.environdec.com)*
con *número de registro **EPD-IES-0028231** en el Sistema International EPD® (www.environdec.com)*

it´s in conformity with:
es conforme con:

- **ISO 14025:2010 Environmental labels and declarations. Type III environmental declarations.**
- **General Programme Instructions for the International EPD® System v4.**
- **PCR 2007:08 Electricity, steam and hot water generation and distribution v 5.0.**
- **UN CPC 171 Electrical energy.**

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Carlos Nazabal Alsua
Manager

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