Goldwind Science & Technology Co., Ltd.

ENVIRONMENTAL PRODUCT DECLARATION

In compliance with ISO 14025

Product Name: Goldwind GW165-5.2/5.6/6.0

Wind Turbine

Site Plant: Dafeng & Funing, Jiangsu Province, China

Program Operator:	EPDItaly
Publisher:	EPDItaly

Declaration Number	5
Registration Number	EPDITALY 0817

Issue Date	10/02/2025
Valid to	10/02/2030

www.epditaly.it

1. General information

EPD OWNER	
Name of the company	Goldwind Science & Technology Co., Ltd.
Registered office	NO.8 Boxing 1st Road, Economic & Technological Development Zone,Beijing, P. R. China
Contacts for information on the EPD	Yang Liwen yangliwen@goldwind.com

PROGRAM OPERATOR	
EPDItaly	Via Gaetano De Castillia n° 10 - 20124 Milano, Italy

INFORMATION ON THE EPD	
Product name (s)	Goldwind GW165-5.2/5.6/6.0 wind turbine
Site (s)	No.5, Xiang Feng Road, Dafeng Economic & Technology Development Zone, Yanchen, Jiangsu Province, P. R. China No.23, Xiexin Road, Funing Economic & Technology Development Zone, Yanchen, Jiangsu Province, P. R. China
Short description and technical information of the product (s)	wind turbine
Field of application of the product (s)	Wind power generation
Product (s) reference standards (if any)	IEC 61400-1 Wind energy generation systems - Part 1: Design requirements
CPC Code (number) https://unstats.un.org/unsd/classifications/Econ	171 "Electrical energy"

VERIFICATION INFORMATION	
PCR (title, version, date of publication or update)	ELECTRICITY PRODUCED BY WIND TURBINES EPDItaly 013 – rev. 1, issue date: 16-03-2020; validity: 15-03-2025;
EPDItaly Regulation (version, date of publication or update)	Regulation of the EPDItaly Programme – rev. 6, issue date: 30-10-2023
Project Report LCA	
Independent Verification Statement	The PCR review was performed by Ing. Daniele Pace, Arch. Michele Paleari, Ing. Sara Toniolo - info@epditaly.it. Independent verification of the declaration

	and data, carried out according to ISO 14025: 2010. Internal ☑ External Third party verification carried out by: ICMQ S.p.A., via Gaetano De Castillia n ° 10 - 20124 Milan, Italy. Accredited by Accredia.
Comparability Statement	Environmental statements published within the same product category, but from different programs, may not be comparable.
Liability Statement	The EPD Owner releases EPDItaly from any non-compliance with environmental legislation. The holder of the declaration will be responsible for the information and supporting evidence. EPDItaly disclaims any responsibility for the information, data and results provided by the EPD Owner for life cycle assessment.

OTHER INFORMATION	

2. Introduction

2.1 Company Information

Goldwind Science & Technology Co. Ltd. (referred to Goldwind onwards) is the pioneer and witness in the growth and development of wind power industry in China. Today, with operations in strategic global markets, Goldwind is dedicated to leading clean energy development, energy conservation and environmental protection. As of Jun. 2024, Goldwind has more than 123 GW of installed capacity of wind power, with more than 52,000 wind turbines operating worldwide. Goldwind has been operating business in 6 continents and 43 countries and regions in the world, with above10,000 employees globally.

2.2 Scope and Type of EPD

Product name: The GW165-5.2/5.6/6.0 direct-drive permanent-magnet wind turbine
Product description: GW165-5.2/5.6/6.0 direct-drive permanent-magnet wind turbine has a design featuring horizontal axis, three blades, and upwind arrangement of rotor, variable-speed variable-pitch regulation, direct drive, and external rotor. This wind turbine has a 165-meter rotor combined

with a 5.2/5.6/6.0 MW generator; the GW 165-5.2/5.6/6.0 is especially suited to Class IIIB/S wind sites. The general details of the wind turbine can be seen in the Table 1 below.

Table 1. The general details of the wind turbine GW165-5.2/5.6/6.0

General details		
Item	**Unit**	**Parameters**
Basic data of wind turbine		GW 165-5.2/5.6/6.0
Manufacturer/Model		Goldwind Science & Technology Co., Ltd GW 165-5.2/5.6/6.0
Rated power	kW	5,200 (GW 165-5.2) 5,600 (GW 165-5.6) 6,000 (GW 165-6.0)
Class of wind zone		IIIB/S
Design service life	year	≥ 20
Altitude of area where wind turbine is installed	m	0-2,000 (included)
Blades		
Manufacturer/Model		GW81
Material of blade		Glass fibre reinforced resin
Swept area of wind turbine rotor	m2	21,382
Generator		
Manufacturer		Goldwind Science & Technology Co. Ltd
Generator type		Permanent magnet
Rated power	kW	5,500 (GW 165-5.2) 5,900 (GW 165-5.6) 6,300 (GW 165-6.0)
Rated voltage	V	950V
Frequency range of generator	Hz	5.133~8.866 (GW 165-5.2) 5.133~9.613 (GW 165-5.6) 5.133~9.987 (GW 165-6.0)
Protection class		IP54
Tower		
Type		Tapered steel tower (equipped with ladders and fall protection inside).
Anti-corrosion class		Internal: C3; external: C4
Electrical control system		
Type of control unit		PLC
Control type		Distributed control

Main switch cabinet		Beijing Etechwin Electric Co. Ltd
Converter		
Number of phases	phases	3
Converter type		Full power converter
Main materials for the wind turbine production		
Fiberglass, Resin (polyester), Resin (Voltacast 3200), Basa wood		
Stainless steel, Cast iron, Aluminium alloy, Alloy steel (42CrMo4), Q235-A steel, S355/S325 low alloyed steel, Copper, 65WH600 silicon steel sheet, Galvanized steel sheet.		

Geographical scope:

The study reflects production of GW165-5.2/5.6/6.0 in China. The country grid average "CN: Electricity grid mix 1kV-60kV (China electric power yearbook)" of electricity applied for the manufacturing and assembling activities. The data for the production of electricity applied represent the country average, Chinese grid mix, for the reason that the raw materials are produced in China. The data are based on the Gabi database and the mix of energy sources are presented in Figure 1.

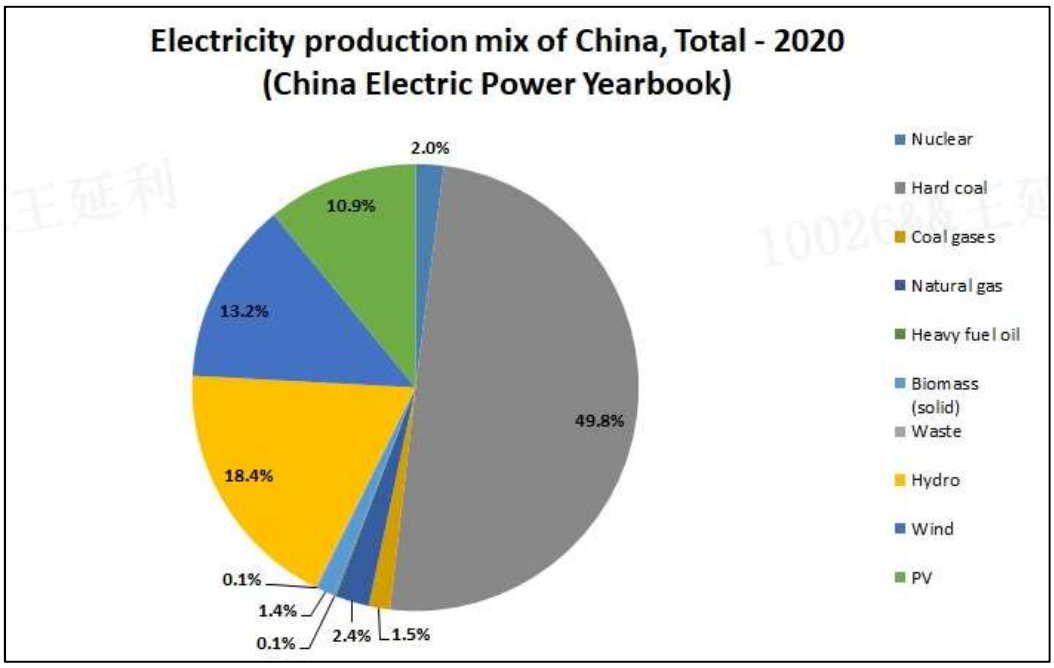

Figure 1 Mix of energy sources for electricity production.

The installation and operation site were chosen as the wind farm located in an exemplary Uzbekistan scenario, while the purpose of this EPD is mainly to give an overall picture of the wind power production, which is the direct business of Goldwind, rather than focus on any particular wind farm location. For the power output, it is based on the theoretical calculation of the selected Uzbekistan wind farm.

The Goldwind GW165-5.2/5.6/6.0 wind turbine has been designed to operate under low to medium wind conditions (IIIB/S) and for this study, medium wind conditions have been selected as the baseline scenario, as Goldwind predicts medium wind sites to be the main world market. The

GW165-5.2/5.6/6.0 was designed wind turbine by Goldwind. The target markets meet North America, South America, Europe, Asia, Africa, and Australia. The Uzbekistan wind farm is an exemplary scenario, which has been analyzed for mean WTG results and hub heights, which optimizes the produced energy.

Time representativeness: The reference years for this study are from Jan. 2023 to Dec. 2024. The data collected in the production process of each wind turbine components was based on the data of factory production in the whole two years from Jan. 2023 to Dec. 2024.

Database(s) and LCA software used: The LCA-systems are modelled in the Gabi LCA software, with Gabi ts data base and professional Ecoinvent database.

Product system description

This study is a cradle-to-grave LCA, assessing the potential environmental impacts associated with electricity generated from a GW165-5.2/5.6/6.0 wind turbine installed in a 500 MW inland wind farm. An overview of the life cycle stages included in the LCA study are presented in the flow chart.

Product flow chart

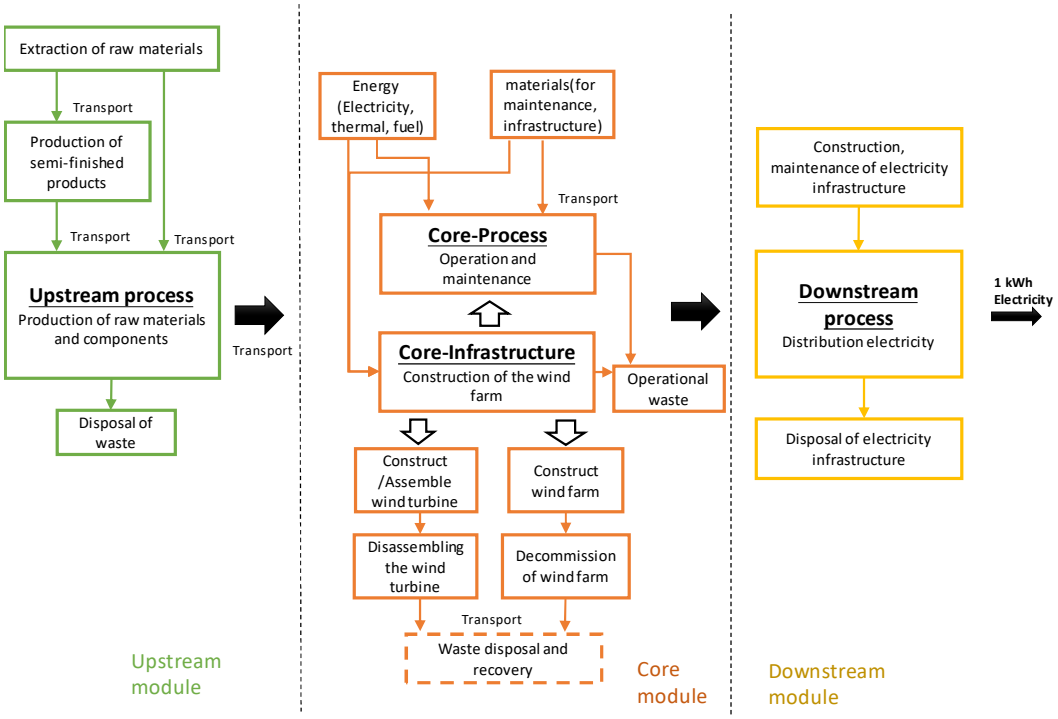

Figure 2. The flow chart of the LCA study

Function Unit:

The functional unit of this LCA study is defined as:

1 kWh of electricity generated through an inland wind farm of GW165-5.2/5.6/6.0 wind turbines, located in an exemplary Uzbekistan scenario and operating under medium wind condition (IIIB/S), and thereafter distributed to a 220 kV Uzbekistan electrical grid.

Total reference flow is 484,800MWh for GW165-5.2, 509,800MWh for GW165-5.6, and 535,970MWh for GW165-6.0**,** they have 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 from one GW165-5.2/5.6/6.0 WTG under medium wind (8.6 m/s) during its reference service life (RSL). In order to ensure that the EPDs based on this PCR can be compared, a constant fixed RSL of 20 years was set.

Cut-off rules:
In this study, the cut-off criteria have been controlled of no more than 1% of materials and energy flows within the system controlled by the EPD holder. It follows the regulation of PCR and EPDItaly system.

3. Environmental performance

In the result table below, it is possible to see the environmental performance of all categories. Each impact category result is presented in Table 2. The results are categorized into "Upstream stage", "Core process", "Core infrastructure", "Downstream stage". The column named "Total environmental impact" is the overall results.

Table 2. Results stated the environmental impacts of declared unit (per kWh).

GW165-5.2						
Impact indicator	**Unit per declared unit**	**Upstream stage**	**Core process**	**Core infrastructure**	**Downstream stage**	**Total environmental impact**
Global Warming Potential total (GWP-total)	kg CO2 eq	3.96E-03	2.30E-05	1.60E-03	6.44E-04	6.23E-03
Global Warming Potential total (GWP-fossil)	kg CO_2 eq	3.98E-03	2.29E-05	1.61E-03	6.45E-04	6.26E-03
Global Warming Potential total (GWP-biogenic)	kg CO_2 eq	-2.55E-05	8.95E-09	-2.35E-05	-2.11E-06	-5.11E-05
Global Warming Potential total (GWP-luluc)	kg CO_2 eq	3.04E-06	2.38E-08	1.34E-05	1.21E-06	1.77E-05
Depletion potential of the stratospheric ozone layer (ODP)	kg CFC-11 eq	2.92E-11	2.81E-12	7.75E-12	3.43E-11	7.41E-11
Acidification potential, Accumulated Exceedance (AP)	mole H+ eq	1.58E-05	5.73E-07	8.46E-06	3.33E-06	2.82E-05
Eutrophication potential, fraction of nutrients reaching freshwater end compartment (EP-freshwater)	kg P eq	1.59E-07	1.46E-08	2.17E-07	1.64E-07	5.54E-07

Eutrophication, marine	kg N eq.	2.90E-06	3.74E-08	3.27E-06	7.99E-07	7.00E-06
Eutrophication, terrestrial	Mole of N eq.	2.89E-05	4.48E-07	3.60E-05	8.66E-06	7.40E-05
Formation potential of tropospheric ozone (POCP)	kg NMVOC eq	9.67E-06	2.25E-07	7.09E-06	2.44E-06	1.94E-05
Abiotic Depletion for non-fossil resources potential (ADP-minerals & metals)	kg Sb eq	1.20E-07	4.85E-09	6.24E-08	2.57E-08	2.13E-07
Abiotic Depletion for non-fossil resources potential (ADP-fossil)	MJ	4.84E-02	6.42E-04	1.86E-02	7.53E-03	7.52E-02
Water deprivation potential, deprivation-weighted water consumption (WDP)	m3	1.12E-03	1.34E-05	2.03E-04	2.12E-04	1.55E-03
Use of renewable primary energy excluding renewable primary energy resources used as raw material (PERE)	MJ	6.55E-03	4.42E-05	1.55E-03	6.22E-04	8.77E-03
Use of renewable primary energy resources used as raw material (PERM)	MJ	0	0	0	0	0
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PERT)	MJ	6.55E-03	4.42E-05	1.55E-03	6.22E-04	8.77E-03
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw material (PENRE)	MJ	4.85E-02	6.43E-04	1.86E-02	7.54E-03	7.53E-02
Use of non-renewable primary energy resource used as raw material (PENRM)	MJ	0	0	0	0	0
Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PENRT)	MJ	4.85E-02	6.43E-04	1.86E-02	7.54E-03	7.53E-02
Use of secondary raw materials (SM)	kg	0	0	0	0	0
Use of renewable secondary fuels (RSF)	MJ	0	0	0	0	0
Use of non-renewable secondary fuels (NRSF)	MJ	0	0	0	0	0

Net use of fresh water (FW)	m3	1.28E-04	3.22E-07	1.54E-05	9.45E-06	1.54E-04
Hazardous landfill waste (HWD)	kg	2.86E-11	8.25E-09	-2.64E-12	3.31E-10	8.61E-09
Non-hazardous waste disposed (NHWD)	kg	2.45E-04	1.05E-07	8.98E-05	1.34E-05	3.48E-04
Radioactive waste disposed (RWD)	kg	3.24E-07	4.24E-09	2.48E-08	1.41E-08	3.67E-07
Components for reuse (CRU)	kg	0	0	0	0	0
Materials for recycling (MFR)	kg	0	0	1.21E-03	4.84E-05	1.26E-03
Material for energy recovery (MER)	kg	0	0	0	0	0
Exported electrical energy (EEE)	MJ	0	0	0	0	0
Exported thermal energy (EET)	MJ	0	0	0	0	0

GW165-5.6

Impact indicator	Unit per declared unit	Upstream stage	Core process	Core infrastructure	Downstream stage	Total environmental impact
Global Warming Potential total (GWP-total)	kg CO_2 eq	3.75E-03	2.19E-05	1.56E-03	6.13E-04	5.95E-03
Global Warming Potential total (GWP-fossil)	kg CO_2 eq	3.77E-03	2.18E-05	1.57E-03	6.14E-04	5.98E-03
Global Warming Potential total (GWP-biogenic)	kg CO_2 eq	-2.49E-05	8.51E-09	-2.27E-05	-2.05E-06	-4.97E-05
Global Warming Potential total (GWP-luluc)	kg CO_2 eq	2.77E-06	2.26E-08	1.30E-05	1.15E-06	1.69E-05
Depletion potential of the stratospheric ozone layer (ODP)	kg CFC-11 eq	2.51E-11	2.67E-12	7.94E-12	3.26E-11	6.83E-11
Acidification potential, Accumulated Exceedance (AP)	mole H+ eq	1.52E-05	5.45E-07	8.28E-06	3.18E-06	2.72E-05
Eutrophication potential, fraction of nutrients reaching freshwater end compartment (EP-freshwater)	kg P eq	1.44E-07	1.38E-08	2.22E-07	1.57E-07	5.36E-07
Eutrophication, marine	kg N eq.	2.74E-06	3.56E-08	3.17E-06	7.62E-07	6.71E-06
Eutrophication, terrestrial	Mole of N eq.	2.75E-05	4.26E-07	3.50E-05	8.26E-06	7.11E-05
Formation potential of tropospheric ozone (POCP)	kg NMVOC eq	9.20E-06	2.14E-07	6.91E-06	2.32E-06	1.86E-05
Abiotic Depletion for non-fossil resources potential (ADP-	kg Sb eq	1.09E-07	4.61E-09	6.39E-08	2.45E-08	2.02E-07

minerals & metals)						
Abiotic Depletion for non-fossil resources potential (ADP-fossil)	MJ	4.55E-02	6.11E-04	1.82E-02	7.16E-03	7.16E-02
Water deprivation potential, deprivation-weighted water consumption (WDP)	m3	8.61E-04	1.27E-05	2.02E-04	1.93E-04	1.27E-03
Use of renewable primary energy excluding renewable primary energy resources used as raw material (PERE)	MJ	5.59E-03	4.20E-05	1.52E-03	5.68E-04	7.73E-03
Use of renewable primary energy resources used as raw material (PERM)	MJ	0	0	0	0	0
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PERT)	MJ	5.59E-03	4.20E-05	1.52E-03	5.68E-04	7.73E-03
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw material (PENRE)	MJ	4.55E-02	6.12E-04	1.82E-02	7.17E-03	7.16E-02
Use of non-renewable primary energy resource used as raw material (PENRM)	MJ	0	0	0	0	0
Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PENRT)	MJ	4.55E-02	6.12E-04	1.82E-02	7.17E-03	7.16E-02
Use of secondary raw materials (SM)	kg	0	0	0	0	0
Use of renewable secondary fuels (RSF)	MJ	0	0	0	0	0
Use of non-renewable secondary fuels (NRSF)	MJ	0	0	0	0	0
Net use of fresh water (FW)	m3	1.17E-04	3.06E-07	1.54E-05	8.82E-06	1.42E-04
Hazardous landfill waste (HWD)	kg	2.72E-11	7.85E-09	-2.47E-12	3.15E-10	8.19E-09
Non-hazardous waste disposed (NHWD)	kg	2.33E-04	9.97E-08	8.76E-05	1.28E-05	3.34E-04

Radioactive waste disposed (RWD)	kg	3.04E-07	4.03E-09	2.41E-08	1.33E-08	3.45E-07
Components for reuse (CRU)	kg	0	0	0	0	0
Materials for recycling (MFR)	kg	0	0	1.15E-03	4.62E-05	1.20E-03
Material for energy recovery (MER)	kg	0	0	0	0	0
Exported electrical energy (EEE)	MJ	0	0	0	0	0
Exported thermal energy (EET)	MJ	0	0	0	0	0

GW165-6.0

Impact indicator	Unit per declared unit	Upstream stage	Core process	Core infrastructure	Downstream stage	Total environmental impact
Global Warming Potential total (GWP-total)	kg CO2 eq	3.57E-03	2.08E-05	1.54E-03	5.85E-04	5.71E-03
Global Warming Potential total (GWP-fossil)	kg CO2 eq	3.59E-03	2.08E-05	1.54E-03	5.86E-04	5.74E-03
Global Warming Potential total (GWP-biogenic)	kg CO2 eq	-2.37E-05	8.10E-09	-2.22E-05	-1.97E-06	-4.79E-05
Global Warming Potential total (GWP-luluc)	kg CO2 eq	2.64E-06	2.15E-08	1.27E-05	1.11E-06	1.64E-05
Depletion potential of the stratospheric ozone layer (ODP)	kg CFC-11 eq	2.39E-11	2.54E-12	8.09E-12	3.10E-11	6.55E-11
Acidification potential, Accumulated Exceedance (AP)	mole H+ eq	1.44E-05	5.19E-07	8.15E-06	3.04E-06	2.61E-05
Eutrophication potential, fraction of nutrients reaching freshwater end compartment (EP-freshwater)	kg P eq	1.37E-07	1.32E-08	2.26E-07	1.50E-07	5.26E-07
Eutrophication, marine	kg N eq.	2.61E-06	3.39E-08	3.11E-06	7.29E-07	6.48E-06
Eutrophication, terrestrial	Mole of N eq.	2.61E-05	4.06E-07	3.42E-05	7.90E-06	6.87E-05
Formation potential of tropospheric ozone (POCP)	kg NMVOC eq	8.75E-06	2.04E-07	6.78E-06	2.22E-06	1.79E-05
Abiotic Depletion for non-fossil resources potential (ADP-minerals & metals)	kg Sb eq	1.04E-07	4.39E-09	6.51E-08	2.35E-08	1.97E-07
Abiotic Depletion for non-fossil resources potential (ADP-fossil)	MJ	4.33E-02	5.81E-04	1.79E-02	6.84E-03	6.87E-02
Water deprivation potential, deprivation-weighted water	m3	8.19E-04	1.21E-05	2.01E-04	1.84E-04	1.22E-03

consumption (WDP)						
Use of renewable primary energy excluding renewable primary energy resources used as raw material (PERE)	MJ	5.32E-03	4.00E-05	1.50E-03	5.42E-04	7.41E-03
Use of renewable primary energy resources used as raw material (PERM)	MJ	0	0	0	0	0
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PERT)	MJ	5.32E-03	4.00E-05	1.50E-03	5.42E-04	7.41E-03
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw material (PENRE)	MJ	4.33E-02	5.82E-04	1.79E-02	6.84E-03	6.87E-02
Use of non-renewable primary energy resource used as raw material (PENRM)	MJ	0	0	0	0	0
Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PENRT)	MJ	4.33E-02	5.82E-04	1.79E-02	6.84E-03	6.87E-02
Use of secondary raw materials (SM)	kg	0	0	0	0	0
Use of renewable secondary fuels (RSF)	MJ	0	0	0	0	0
Use of non-renewable secondary fuels (NRSF)	MJ	0	0	0	0	0
Net use of fresh water (FW)	m3	1.12E-04	2.91E-07	1.53E-05	8.42E-06	1.36E-04
Hazardous landfill waste (HWD)	kg	2.58E-11	7.47E-09	-2.31E-12	3.00E-10	7.79E-09
Non-hazardous waste disposed (NHWD)	kg	2.22E-04	9.49E-08	8.54E-05	1.23E-05	3.20E-04
Radioactive waste disposed (RWD)	kg	2.89E-07	3.83E-09	2.35E-08	1.27E-08	3.29E-07
Components for reuse (CRU)	kg	0	0	0	0	0
Materials for recycling (MFR)	kg	0	0	1.10E-03	4.41E-05	1.15E-03

Material for energy recovery (MER)	kg	0	0	0	0	0
Exported electrical energy (EEE)	MJ	0	0	0	0	0
Exported thermal energy (EET)	MJ	0	0	0	0	0

(1) "Total environmental impact" represented the environmental impacts from the whole life cycle stage of the WTG during the RSL. It was the sum of "Upstream stage", "Core process", "Core infrastructure", "Downstream stage".

(2) The impact category provides a zero result since components reuse has not been applied in Goldwind due to the barriers of recovery value, suitability, and technical possibility.

(3) According to PCR that the recovery process which take place outside the boundaries of the product system, only impacts related to the transportation of the waste to the treatment platform should be taken into account. Thus the exported thermal energy and electricity energy provides a zero result.

(4) This table presented the impacts value which have been scaled to 1 kWh as the declared unit.

(5) Input data from databases, trade organizations etc. do NOT distinguish between resources used as material and energy, even though there is a difference in practice.

As data shown in the above, the upstream has the greatest contribution to the climate change, which is responsible for about 70% of the total CO_2 and other greenhouse gas emissions in terms of global warming potential. The second largest environmental factor is the core infrastructure.
Among all the environmental impacts for downstream stage, the photochemical ozone formation and eutrophication of water have the largest impact. The core process has relatively low environmental impact.

4. references

Regulations of EPDItaly programme, Revision 6, issue date: 30-10-2023.

EPDItaly013, PCR Title: ELECTRICITY PRODUCED BY WIND TURBINES, rev. 1, issue date: 16-03-2020; validity: 15-03-2025.

The EPDItaly system, https://www.epditaly.it

Gabi database. The September 2024 Edition.

Gabi LCA software. The Gabi LCA software and corresponding database are provided by Sphera in Leinfelden-Echterdingen, Germany. Gabi September 2024 Edition was used.

LCA database published by the Ecoinvent association originally known as the Ecoinvent Centre, the Swiss Centre for Life Cycle Inventories. Since June 2013 Ecoinvent is a not-for-profit association founded by institutes of the ETH Domain and the Swiss Federal Offices. The version 3.9.1 was used.

ISO (2006a). ISO 14025:2006, Environmental labels and declarations – Type III environmental declarations – Principles and procedures.

ISO (2006b). ISO 14040:2006, Environmental management – Life cycle assessment – Principles and framework.

ISO (2006c). ISO 14044: 2006, Environmental management – Life cycle assessment – Requirements and guidelines.

Sphera. The provider of the Gabi LCA software and database.

World Steel Association (worldsteel) is an industry association, with members in every major steel-producing country, representing steel producers, national and regional steel industry associations, and steel research institutes.

Technical Specification, GW165-5.2/5.6/6.0 Wind Turbine Technical Specification, Goldwind Science & Technology Co., Ltd.

LCA methodology report – Goldwind GW165-5.2/5.6/6.0 wind turbines product EPD, Revision 1, issue date: 15-01-2025.