Envision Energy Co., Ltd

ENVIRONMENTAL PRODUCT DECLARATION

PRODUCT NAME

Wind turbine EN171-6.0/6.25/6.5

Wind turbine EN182-6.25

Plants

No.3, Shenzhuang Road, Shenggang Street, Jiangyin City, Wuxi, Jiangsu, China

No.1 Beisi Road, Yulong Industrial Park, Wudan Town, Wengniute Banner, Chifeng City, Inner Mongolia Autonomous Region，China

in accordance with ISO 14025

Program Operator	EPDItaly
Publisher	EPDItaly

Declaration Number	Envision-Wind-EPD001_rev01
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Valid to	27/08/2030

www.epditaly.it

1. GENERAL INFORMATION

EPD Owner:	Envision Energy Co., Ltd Address: No.3, Shenzhuang Road, Shenggang Street, Jiangyin City, Wuxi, Jiangsu, 214400, China
Product Name:	EN171-6.0/6.25/6.5 EN182-6.25
Production site:	1. Jiangyin site: No.3, Shenzhuang Road, Shenggang Street, Jiangyin City, Wuxi, Jiangsu, 214400, China 2. Chifeng Site: No.1Beisi Road , Yulong Industrial Park, Wudan Town, Wengniute Banner, Chifeng City, Inner Mongolia Autonomous Region， China
Product technical description of application:	Wind turbines are widely used for electricity generation on onshore wind farms.
Program Operator:	EPDITALY (www.epditaly.it) Add: via Gaetano De Castillia n° 10 - 20124 Milano, Italy
CPC Code:	171 "Electrical energy"
Company Contact:	Name: Danying Chen Email: Danying.Chen@envision-energy.com
External Audit:	This declaration has been developed referring to EPDItaly, following the General Program Instruction; further information and the document itself are available at: www.epditaly.it. Independent verification of the declaration and data, according to EN ISO 14025:2010. ☐ INTERNAL ☒ EXTERNAL Third party verifier: ICMQ SpA - Via Gaetano De Castillia, 10 - 20124 – Milano/Italy
LCA Consultant:	This life cycle assessment was conducted in accordance with ISO 14044 and the reference PCR by Shanghai Univers Co., Ltd.
LCA report	LCA report of Envision Energy wind turbines for Environmental Product Declaration (EPD), Rev1, date: 28/06/2025.
Reference PCR and version number:	ELECTRICITY PRODUCED BY WIND TURBINES EPDItaly 013 – rev. 1.1, issue date: 16-03-2020; validity: 15-03-2026;
Other reference documents:	Regulations of the EPDItaly Program rev. 6.0.
Comparability:	EPDs relating to the same category of products but belonging to different programmes may not be comparable. Full conformance with a PCR allows EPD comparability only when all stages of a life cycle have been considered. However, variations and deviations are possible. Example of variations: Different LCA software and background LCI datasets may lead to differences results for upstream or downstream of the life cycle stages declared.
Liability:	The owner of the declaration will be responsible for the information and supporting evidence. EPDItaly disclaims any liability regarding the manufacturer's information data.

Reference document:	This declaration is based on the EPDItaly regulation, available on the website www.epditaly.com

2. INTRODUCTIONS

2.1 About the company

Envision Energy is a world-leading green-tech company committed to becoming a net zero technology partner for global enterprises, governments, and institutions. Encompassing three major business sectors - Smart Wind Turbines, Energy Storage, and Green Hydrogen Solutions, Envision Energy constructs comprehensive solutions for energy transition.

Envision Energy operates in countries and regions including China, Germany, France, the UK, Spain, Denmark, the UAE, India, Vietnam, Indonesia, Australia, the US, Japan, Mexico, Argentina, and Chile. It has set up over 20 operational headquarters and R&D centers globally, along with more than 50 manufacturing bases.

With its contributions to global green energy transition, Envision Energy is listed as a “Green Giant” in 2024 “TIME 100 Most Influential Companies” list. Recognized as an “Energy Innovator”, the company is also included in Fortune’s 2024 “Change the World” list for its major innovations in net zero industrial parks and full-stack green hydrogen technology, marking its second appearance after 2021. Envision Energy earned a spot on Forbes China’s “Best Employers” list in both 2022 and 2024. The company also received several accolades for its sustainability performance, including the Ecovadis Gold Medal in 2024 and the CDP “A List” in 2024.

As a pioneer in net zero transition, Envision Energy achieved global operational carbon neutrality in 2022 and will leverage technology to accelerate progress toward its 2040 net zero goal.

2.2 About products

Envision is the first in the industry to develop smart wind turbines that combine advanced control systems, data analysis, active performance control, and reliability prediction capabilities. Through this ‘digital twin’, wind turbines understand real-time status down to the component level, and a deep understanding of environmental conditions. This ‘software defined’ approach extends from design through deployment, resulting in a turbine with increased effectiveness and longer service life.

Figure 1. Wind turbine picture

Wind turbine EN 171-6.0/6.25/6.5 and EN 182-6.25 feature horizontal axis, three blades, upwind rotor, variable-speed variable-pitch regulation, high speed drive train, and DFIG converter. The general details of the wind turbine can be seen in the Table 1 below.

Table 1. General details of Wind turbine EN 171-6.0/6.25/6.5 and EN 182-6.25

Basic information	
Item	**Parameters**
Basic data on wind turbine	EN-171/6.0, EN-171/6.25, EN-171/6.5 EN-182/6.25
Rated power	6000 kW (EN-171/6.0) 6250 kW (EN-171/6.25) 6500 kW (EN-171/6.5) 6250 kW (EN-182/6.25)
Design service life	25 years
Blade	
Manufacture / Blade model	Envision 83.9m (EN-171/6.0, EN-171/6.25, EN-171/6.5) Envision 89 m (EN-182/6.25)
Swept area	22965 m^2 (EN-171/6.0, EN-171/6.25, EN-171/6.5) 25759 m^2 (EN-182/6.25)
Pitch system	Direct current pitch motor drive

Generator	
Generator Type	Doubly Fed Induction Generator
Rated power	6250 kW (EN-171/6.0) 6500 kW (EN-171/6.25) 6750 kW (EN-171/6.5) 6500 kW (EN-182/6.25)
Rated voltage	1140 V
Converter	
Converter type	Doubly Fed Frequency Conversion System
Rated output voltage	1140 V
Drive system	
Gear grade	Multistage transmission
Brake system	
Main brake system	Pitch brake
2nd brake system	Hydraulic brake
Yaw System	
Type	Yaw motor drive
Tower	
Type	Steel conical tower
Hub height	100.6 m (EN-171/6.0, EN-171/6.25, EN-171/6.5) 105.56 m (EN-182/6.25)

2.3 Materials compositions

Table 2 shows the main materials compositions of EN 171-6.0/6.25/6.5 and EN 182-6.5.

Table 2. Material compositions of EN 171-6.0/6.25/6.5 and EN 182-6.5

Material	EN-171/-6.0(%)	EN-171/6.25(%)	EN-171/6.5(%)	EN-182/6.25(%)
Aluminium	0.60%	0.60%	0.60%	0.60%
Cable	0.10%	0.10%	0.10%	0.10%
Copper	0.50%	0.60%	0.60%	0.60%
Elecrtonic parts	0.10%	0.10%	0.10%	0.10%
Epoxy resin	0.00%	0.00%	0.00%	0.00%
Glass fiber	7.10%	7.20%	7.10%	7.40%
lubricating	0.20%	0.20%	0.20%	0.20%
Polymer	5.40%	5.40%	5.40%	5.90%
Steel&Iron	85.70%	85.50%	85.60%	84.90%
Wood	0.30%	0.30%	0.30%	0.30%
Total	100.00%	100.00%	100.00%	100.00%

2.4 Description of the production process

All the components used in this project are custom - processed. All the products share similar manufacturing processes in Envision Energy company. Figure 1 describes the main production processes in Envision Assembly Factory.

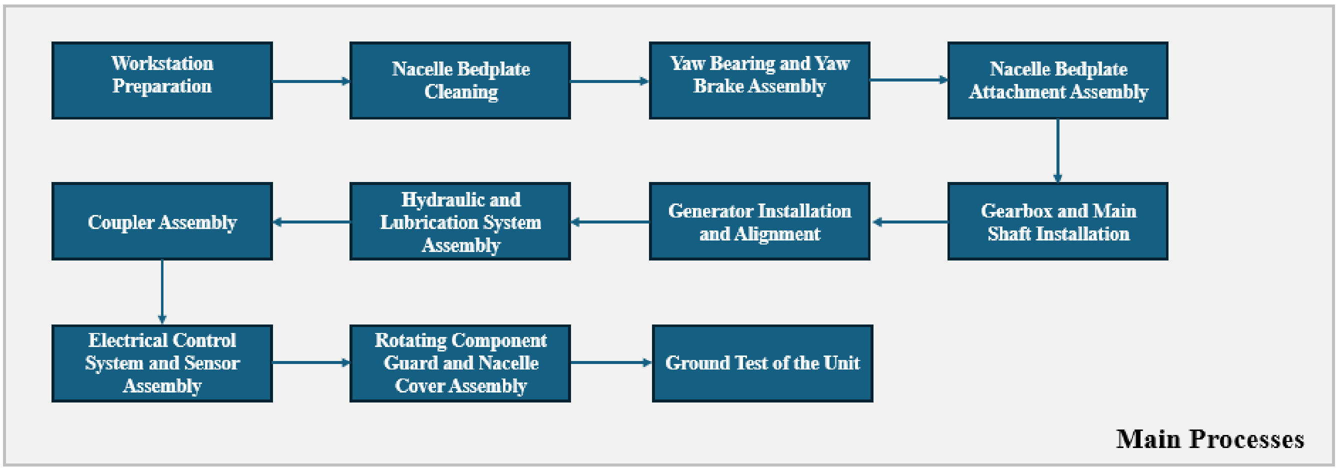

Figure 1. Manufacturing processes flow diagram of wind turbine.

(1) Workstation Preparation
Prepare the operation in advance at the machine head, nacelle and each sub - assembly workstation.

(2) Nacelle Bedplate Cleaning
Clean residual oil stains from the nacelle bedplate and interior using cloth and cleaning agent.

(3) Yaw Bearing and Yaw Brake Assembly
Install the yaw bearing and yaw brake below the nacelle bedplate.

(4) Nacelle Bedplate Attachment Assembly
Install sensors, cables and other attachments onto the nacelle bedplate.

(5) Gearbox and Main Shaft Installation
Install the gearbox and main shaft using a crane and hydraulic wrench.

(6) Generator Installation and Alignment
Connect the generator to the bedplate and ensure that the generator and the gearbox are on the same axis.

(7) Hydraulic and Lubrication System Assembly
Install hydraulic/lubrication systems and fill oil per generator.

(8) Coupler Assembly
Install a coupler to connect the gearbox and the generator, which also serves as a vibration - damping function.

(9) Electrical Control System and Sensor Assembly
Install electrical control cabinets and sensors in designated positions.

(10) Rotating Component Guard and Nacelle Cover Assembly
Attach guards to rotating parts, then hoist the transmission unit into the fiberglass nacelle cover.

(11) Ground Test of the Unit
Verify shaft rotation, transmission performance, and electrical system functionality with test equipment.

3. SCOPE AND TYPE OF EPD

3.1 Type of EPD

This EPD is a product-specific EPD.
The declaration covers 4 products which are produced in 2 factories respectively:

1) EN-171/6.0 – Jiangyin factory
2) EN-171/6.25 – Jiangyin factory
3) EN-171/6.5 – Jiangyin factory
4) EN-182/6.25 – Chifeng factory

3.2 System boundary

The system boundary of this study on wind turbines encompasses the entire life cycle of the product, from cradle to grave, including the manufacturing, distribution, installation, use, and end-of-life stage. All the life cycle stages are divided based on the segmentation as defined in the PCR, namely upstream module, core module (core infrastructure and core process), and downstream module. A flow chart is depicted in Figure 33 to illustrate the considered life cycle stages and system boundary.

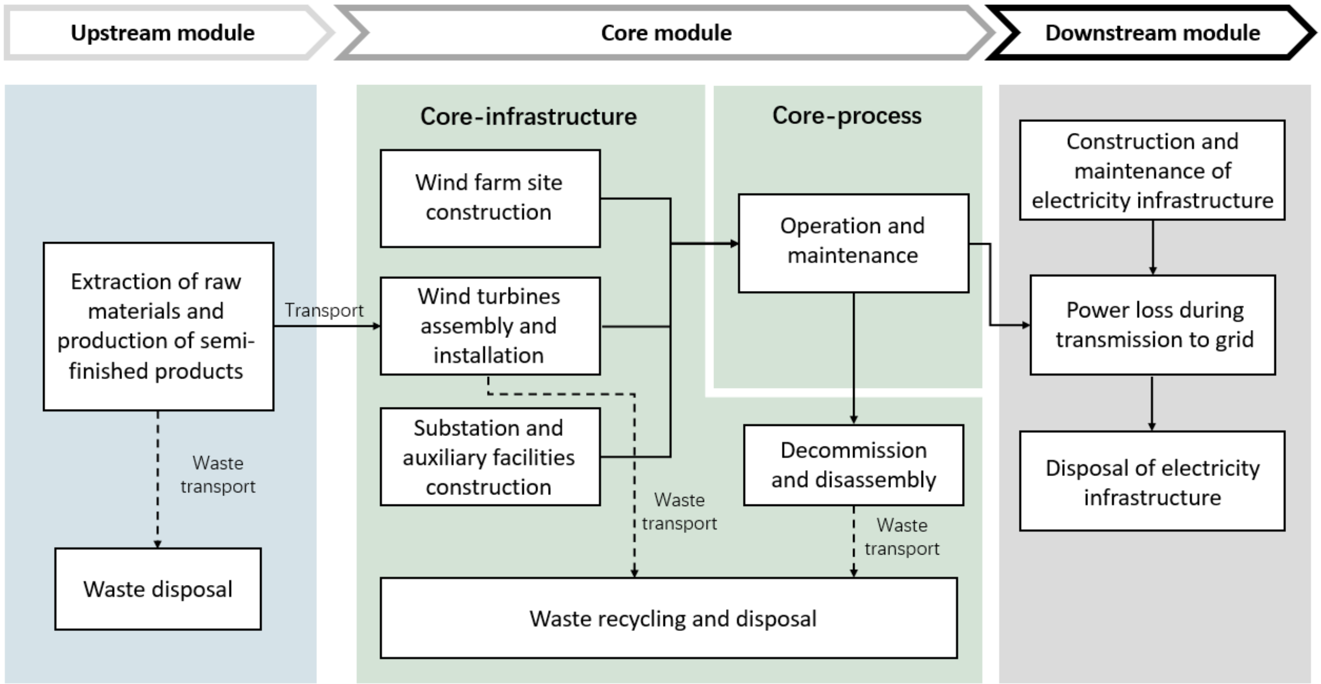

Figure 3 Overview of system boundaries

(1) Geographical scope
The production and assembling of wind turbines take place in China. In this study, wind turbines of EN-171/6.0/6.25/6.5 were assembled in Jiangyin factory. EN 182-6.25 was assembled in Chifeng factory.
After the assembling, wind turbines are sold globally. To model the electricity generation by the wind farm using the declared wind turbine models, a specific wind farm has been selected which located in Spain.

(2) Time scope
All manufacturing data has been collected by Envision Energy based on the production inventory of the past year from Jan.2024-Dec.2024. For upstream materials, data of manufacturing has been modeled according to current industry practices.

(3) Technology scope
This study focuses on the studied Envision wind turbines, covering their production, transportation of components to the installation site, the erection of wind turbines and the setup of the wind farm. It also examines site operations and maintenance, as well as the dismantling and scrapping of wind plant components at the end of their lifespan. All these processes are modeled according to the state-of-the-art technologies applied by Envision Energy. Technical boundary to nature is defined as materials and energy flows from nature to the technosphere and emissions released from the technosphere to nature are all included in.

3.3 Functional unit and Reference Service Life (RSL)

The functional unit defined in this study is:

1 kWh of electricity generated as output from the wind farm located at Spain，

and operating under specific wind condition (IEC S-S),
and thereafter distributed to a 220KV electrical grid, with a reference service life of 20 years.

The assessed wind farm design is a special wind site (IEC wind class S) with the wind conditions at the site being appropriate for class I-A. The average wind speed at hub height is 7.9 m/s. Site-specific parameters for losses and uncertainties are considered using a net annual energy production (AEP) calculation.

The designed standard lifetime is 25 years. In principle, the lifetime of those turbines can be extended by 10 or even 15 years to a total lifetime of 30 or even up to 35 years, according to the method of lifetime extensions and the related advisory opinions by our assessment partner.

However, as specified by the PCR, the baseline assumption for the wind farm lifetime is 20 years. In LCAs on onshore wind turbines, the lifetime is often defined with 20 years as base case. To check the sensitivity to the results, a scenario with 25 years, also with 30 years and 35 years lifetime is calculated.

The resulting average nominal wind power density per turbine in the wind farm is 301.9 W/m² (based on 6.5 MW as average nominal power per turbine in the wind farm and a rotor sweep of 22965 m²).

The total energy produced by the plant during the reference service life needs to be calculated. The total energy produced by the plant will therefore be equal to

$$Etot[kWh] = Eyear * RSL$$

Based on the data of EN171-6.5, annual net energy production per turbine is 21785 MWh per year.. Based on the same formula, EN 171-6.0/6.25 and EN 182-6.25 with annual net energy production is 20941 MWh,21319 MWh,22817MWh respectively. The transmission loss is assumed of 2.1 %. The actual amount of produced and delivered energy to the electricity grid is 21328 MWh per year for one turbine. For a realistic lifetime of 25 years, the average total energy produced per turbine is 533.189 GWh (544.626 GWh without transmission loss).

3.4 Database and LCA software used

The software OpenLCA 2.2.0 was used for LCA modelling. The database that was used in this study were the following: Ecoinvent3.9.1. The impact assessment method used was the EN15804+A2.

4. Life cycle stages

4.1 Upstream

All activities related to the extraction of raw materials, production of semi-finished products and transportation from suppliers to the company manufacturing/assembling the wind turbine should be included in this stage.
Raw materials used for the wind turbine are derived from a bill of materials (BOM) sourced from Envision Energy, which specifies the composition and weight of each Level 2 component that covers the whole wind turbine. For each level 2 components, they are purchased from suppliers thus the production information of semi-finished products is provided by the representative suppliers of recent manufacturing situations

4.2 Core-infrastructure

Wind turbine assemblies take place in Envision factories. Electricity is the only energy source involved in the manufacturing processes. To be noticed that Envision factories use 100% renewable energy. Envision uses standard process flows for the assembly of wind turbine mainframes. So, the assembly data for four types of wind turbines are collected site-specific data with physical allocation.

The core infrastructure phase encompasses all steps related to the construction and decommissioning of the wind farm, from cradle to grave. This includes all stages, starting from the extraction of raw materials needed to build the wind turbines (WTGs) and the wind farm, right up to the dismantling of the wind farm. Additionally, it involves the proper management of generated waste and recycled components, along with their corresponding EoL treatments.

4.3 Core-process

Based on the Envision internal annual maintenance statistic information, the annual inventory list has been used to model one wind turbine been maintained for 20 years as RSL. Total main material, energy consumption and material transport have been included in this part.

4.4 Downstream

Two aspects of environmental impacts are mainly represented in the downstream stage. The first one is the impact related to the dissipation of electricity before feeding into the grid, this part was assumed to be 2.1% of dissipation rate. The second impact is related to the environmental impacts associated with the construction, maintenance and disposal of electricity infrastructure. Ecoinvent3.9.1 dataset was used to represent this part calculation, and the length was assumed to be 16 km.

5. LCA RESULTS

The LCA results show the environmental impacts and resource input, and output flows calculated according to ISO 14025.

5.1 Environmental impacts

The life cycle impact assessment (LCIA) results reveal the environmental performance of the four Envision wind turbine models, EN171-6.0, EN171-6.25, EN171-6.5, and EN182-6.25 across multiple impact categories. The analysis covers the entire life cycle from raw material extraction to end-of-life treatment, and the results, see Table 3, are normalized per 1 kWh of electricity generated.

Table 3 Environmental impacts of EN171-6.0/6.25/6.5 and EN182-6.25

EN-171/6.0							
Impact indicator	**Unit**	**Upstream stage**	Core Infrastructure	Core Process	**Core stage**	**Downstream stage**	**Total**
Global Warming Potential total (GWP-total)	kg CO2 eq.	3.68E-03	2.03E-03	7.92E-05	2.10E-03	1.56E-04	5.94E-03
Global Warming Potential fossil fuels (GWP-fossil)	kg CO2 eq.	3.68E-03	2.01E-03	7.98E-05	2.09E-03	1.55E-04	5.93E-03
Global Warming Potential biogenic (GWP-biogenic)	kg CO2 eq.	-3.39E-06	1.07E-05	-1.00E-06	9.66E-06	2.69E-07	6.54E-06
Global Warming Potential land use and land use change(GWP-luluc)	kg CO2 eq.	3.64E-06	1.05E-06	4.27E-07	1.48E-06	1.71E-07	5.29E-06
Depletion potential of the stratospheric ozone layer (ODP)	kg CFC-11 eq.	7.48E-09	3.07E-11	8.15E-11	1.12E-10	1.69E-10	7.76E-09
Acidification potential,Accumulated Exceedance (AP)	mol H+ eq.	2.16E-05	1.67E-05	4.06E-07	1.71E-05	1.68E-06	4.04E-05
Eutrophication potential, fraction of nutrients reaching freshwater end compartment (EP-freshwater)	kg P eq.	1.73E-06	5.75E-07	1.80E-08	5.93E-07	1.13E-07	2.43E-06

Eutrophication potential, fraction of nutrients reaching marine end compartment (EP-marine)	kg N eq.	3.97E-06	4.10E-06	8.53E-08	4.19E-06	2.32E-07	8.39E-06
Eutrophication potential, Accumulated Exceedance (EP-terrestrial)	mol N eq.	4.19E-05	4.50E-05	7.87E-07	4.58E-05	2.60E-06	9.03E-05
Formation potential of tropospheric ozone (POCP)	kg NMVOC eq.	1.73E-05	1.40E-05	7.70E-07	1.48E-05	9.61E-07	3.30E-05
Consumption of abiotic resources - minerals and materials potential (ADP-minerals & metals)	kg Sb eq.	3.84E-08	1.68E-08	3.91E-10	1.72E-08	4.01E-09	5.96E-08
Consumption of abiotic resources - fossil resources potential (ADP-fossil)	MJ	4.30E-02	2.13E-02	2.14E-03	2.35E-02	1.79E-03	6.82E-02
Water deprivation potential, deprivation-weighted water consumption (WDP)	m3 World eq.	1.24E-03	2.80E-04	3.31E-05	3.13E-04	4.86E-05	1.60E-03
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw material (PENRE)	MJ	4.30E-02	2.13E-02	2.14E-03	2.35E-02	1.79E-03	6.82E-02
Use of renewable primary energy excluding renewable primary energy resources used as raw material (PERE)	MJ	3.94E-03	9.00E-04	9.54E-05	9.96E-04	1.67E-04	5.11E-03
Use of non-renewable primary energy resources used as raw material (PENRM)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of renewable primary energy resources used as raw material (PERM)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PENRT)	MJ	4.30E-02	2.13E-02	2.14E-03	2.35E-02	1.79E-03	6.82E-02
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PERT)	MJ	3.94E-03	9.00E-04	9.54E-05	9.96E-04	1.67E-04	5.11E-03
Net use of fresh water (FW)	m3	2.09E-05	1.03E-05	7.43E-07	1.10E-05	1.13E-06	3.31E-05
Use of secondary raw materials (Ms)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Use of renewable secondary fuels (RSF)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of non-renewable secondary fuels (NRSF)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
hazardous landfill waste(HWD)	kg	2.63E-07	1.44E-07	2.69E-08	1.71E-07	1.16E-08	4.46E-07
Non-hazardous waste disposed (NHWD)	kg	9.43E-06	3.73E-06	2.46E-07	3.97E-06	3.19E-07	1.37E-05
Radioactive waste disposed (RWD)	kg	3.90E-08	8.59E-09	9.13E-10	9.51E-09	1.39E-09	4.99E-08
Materials for energy recovery (MER)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling (MFR)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Componentsfor reuse (CRU)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported thermal energy (ETE)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported electricity energy (EEE)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

EN-171/6.25							
Impact indicator	**Unit**	**Upstream stage**	Core Infrastructure	Core Process	**Core stage**	**Downstream stage**	**Total**
Global Warming Potential total (GWP-total)	kg CO2 eq.	3.50E-03	1.99E-03	7.78E-05	2.07E-03	1.51E-04	5.72E-03
Global Warming Potential fossil fuels (GWP-fossil)	kg CO2 eq.	3.50E-03	1.98E-03	7.84E-05	2.06E-03	1.50E-04	5.71E-03
Global Warming Potential biogenic (GWP-biogenic)	kg CO2 eq.	-3.70E-06	1.05E-05	-9.84E-07	9.49E-06	2.57E-07	6.05E-06
Global Warming Potential land use and land use change (GWP-luluc)	kg CO2 eq.	3.39E-06	1.04E-06	4.19E-07	1.46E-06	1.65E-07	5.01E-06
Depletion potential of the stratospheric ozone layer (ODP)	kg CFC-11 eq.	7.32E-09	3.02E-11	8.00E-11	1.10E-10	1.65E-10	7.59E-09
Acidification potential,Accumulated Exceedance (AP)	mol H+ eq.	2.06E-05	1.64E-05	3.99E-07	1.68E-05	1.63E-06	3.91E-05
Eutrophication potential, fraction of nutrients reaching freshwater end compartment (EP-freshwater)	kg P eq.	1.59E-06	5.65E-07	1.77E-08	5.82E-07	1.09E-07	2.28E-06
Eutrophication potential, fraction of nutrients reaching marine end compartment (EP-marine)	kg N eq.	3.74E-06	4.04E-06	8.38E-08	4.13E-06	2.25E-07	8.09E-06
Eutrophication potential, Accumulated	mol N eq.	3.95E-05	4.44E-05	7.73E-07	4.51E-05	2.52E-06	8.71E-05

Exceedance (EP-terrestrial)							
Formation potential of tropospheric ozone (POCP)	kg NMVOC eq.	1.63E-05	1.38E-05	7.57E-07	1.45E-05	9.31E-07	3.18E-05
Consumption of abiotic resources - minerals and materials potential (ADP-minerals & metals)	kg Sb eq.	3.07E-08	1.65E-08	3.84E-10	1.69E-08	3.79E-09	5.14E-08
Consumption of abiotic resources - fossil resources potential (ADP-fossil)	MJ	4.07E-02	2.10E-02	2.10E-03	2.31E-02	1.73E-03	6.55E-02
Water deprivation potential, deprivation-weighted water consumption (WDP)	m3 World eq.	1.18E-03	2.75E-04	3.25E-05	3.07E-04	4.70E-05	1.53E-03
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw material (PENRE)	MJ	4.07E-02	2.10E-02	2.11E-03	2.31E-02	1.73E-03	6.55E-02
Use of renewable primary energy excluding renewable primary energy resources used as raw material (PERE)	MJ	3.70E-03	8.84E-04	9.37E-05	9.78E-04	1.60E-04	4.84E-03
Use of non-renewable primary energy resources used as raw material (PENRM)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of renewable primary energy resources used as raw material (PERM)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PENRT)	MJ	4.07E-02	2.10E-02	2.11E-03	2.31E-02	1.73E-03	6.55E-02
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PERT)	MJ	3.70E-03	8.84E-04	9.37E-05	9.78E-04	1.60E-04	4.84E-03
Net use of fresh water (FW)	m3	1.98E-05	1.01E-05	7.30E-07	1.08E-05	1.10E-06	3.18E-05
Use of secondary raw materials (Ms)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of renewable secondary fuels (RSF)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of non-renewable secondary fuels (NRSF)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
hazardous landfill waste(HWD)	kg	2.52E-07	1.42E-07	2.64E-08	1.68E-07	1.12E-08	4.31E-07
Non-hazardous waste disposed (NHWD)	kg	8.88E-06	3.66E-06	2.42E-07	3.90E-06	3.05E-07	1.31E-05
Radioactive waste disposed (RWD)	kg	3.55E-08	8.44E-09	8.97E-10	9.34E-09	1.31E-09	4.62E-08
Materials for energy recovery (MER)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling (MFR)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Componentsfor reuse (CRU)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported thermal energy (ETE)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported electricity energy (EEE)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

EN-171/6.5							
Impact indicator	**Unit**	**Upstream stage**	Core Infrastructure	Core Process	**Core stage**	**Downstream stage**	**Total**
Global Warming Potential total (GWP-total)	kg CO2 eq.	3.53E-03	1.95E-03	7.62E-05	2.02E-03	1.48E-04	5.70E-03
Global Warming Potential fossil fuels (GWP-fossil)	kg CO2 eq.	3.53E-03	1.94E-03	7.68E-05	2.01E-03	1.48E-04	5.69E-03
Global Warming Potential biogenic (GWP-biogenic)	kg CO2 eq.	-4.00E-06	1.02E-05	-1.02E-06	9.23E-06	2.54E-07	5.48E-06
Global Warming Potential land use and land use change(GWP-luluc)	kg CO2 eq.	3.36E-06	1.01E-06	4.68E-07	1.48E-06	1.61E-07	5.00E-06
Depletion potential of the stratospheric ozone layer (ODP)	kg CFC-11 eq.	7.18E-09	2.95E-11	5.50E-11	8.45E-11	1.62E-10	7.43E-09
Acidification potential, Accumulated Exceedance (AP)	mol H+ eq.	2.02E-05	1.60E-05	3.91E-07	1.64E-05	1.59E-06	3.82E-05
Eutrophication potential, fraction of nutrients reaching freshwater end compartment (EP-freshwater)	kg P eq.	1.54E-06	5.52E-07	1.74E-08	5.70E-07	1.06E-07	2.21E-06
Eutrophication potential, fraction of nutrients reaching marine end compartment (EP-marine)	kg N eq.	3.75E-06	3.94E-06	8.23E-08	4.03E-06	2.20E-07	8.00E-06
Eutrophication potential, Accumulated Exceedance (EP-terrestrial)	mol N eq.	3.96E-05	4.33E-05	7.58E-07	4.40E-05	2.46E-06	8.61E-05
Formation potential of tropospheric ozone (POCP)	kg NMVOC eq.	1.62E-05	1.35E-05	7.45E-07	1.42E-05	9.11E-07	3.13E-05
Consumption of abiotic resources - minerals and materials potential (ADP-minerals & metals)	kg Sb eq.	2.81E-08	1.62E-08	3.76E-10	1.65E-08	3.67E-09	4.84E-08
Consumption of abiotic resources - fossil	MJ	4.09E-02	2.05E-02	2.06E-03	2.26E-02	1.70E-03	6.52E-02

resources potential (ADP-fossil)							
Water deprivation potential, deprivation-weighted water consumption (WDP)	m3 World eq.	1.16E-03	2.69E-04	3.21E-05	3.01E-04	4.60E-05	1.50E-03
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw material (PENRE)	MJ	4.09E-02	2.05E-02	2.06E-03	2.26E-02	1.70E-03	6.52E-02
Use of renewable primary energy excluding renewable primary energy resources used as raw material (PERE)	MJ	3.42E-03	8.65E-04	9.29E-05	9.58E-04	1.57E-04	4.53E-03
Use of non-renewable primary energy resources used as raw material (PENRM)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of renewable primary energy resources used as raw material (PERM)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PENRT)	MJ	4.09E-02	2.05E-02	2.06E-03	2.26E-02	1.70E-03	6.52E-02
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PERT)	MJ	3.42E-03	8.65E-04	9.29E-05	9.58E-04	1.57E-04	4.53E-03
Net use of fresh water (FW)	m3	1.94E-05	9.89E-06	7.20E-07	1.06E-05	1.07E-06	3.11E-05
Use of secondary raw materials (Ms)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of renewable secondary fuels (RSF)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of non-renewable secondary fuels (NRSF)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
hazardous landfill waste(HWD)	kg	2.42E-07	1.39E-07	2.58E-08	1.65E-07	1.10E-08	4.18E-07
Non-hazardous waste disposed (NHWD)	kg	8.68E-06	3.58E-06	2.37E-07	3.82E-06	2.99E-07	1.28E-05
Radioactive waste disposed (RWD)	kg	3.59E-08	8.26E-09	8.81E-10	9.14E-09	1.29E-09	4.63E-08
Materials for energy recovery (MER)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling (MFR)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Components for reuse (CRU)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported thermal energy (ETE)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported electricity energy (EEE)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

EN-182/6.25							
Impact indicator	**Unit**	**Upstream stage**	Core Infrastructure	Core Process	**Core stage**	**Downstream stage**	**Total**
Global Warming Potential total (GWP-total)	kg CO2 eq.	3.42E-03	1.88E-03	7.28E-05	1.95E-03	1.44E-04	5.51E-03
Global Warming Potential fossil fuels (GWP-fossil)	kg CO2 eq.	3.42E-03	1.87E-03	7.33E-05	1.94E-03	1.44E-04	5.50E-03
Global Warming Potential biogenic (GWP-biogenic)	kg CO2 eq.	-2.83E-06	9.80E-06	-9.73E-07	8.82E-06	2.53E-07	6.25E-06
Global Warming Potential land use and land use change (GWP-luluc)	kg CO2 eq.	3.64E-06	9.75E-07	4.46E-07	1.42E-06	1.64E-07	5.23E-06
Depletion potential of the stratospheric ozone layer (ODP)	kg CFC-11 eq.	7.03E-09	2.89E-11	5.25E-11	8.14E-11	1.59E-10	7.27E-09
Acidification potential，Accumulated Exceedance (AP)	mol H+ eq.	1.99E-05	1.54E-05	3.73E-07	1.58E-05	1.54E-06	3.73E-05
Eutrophication potential, fraction of nutrients reaching freshwater end compartment (EP-freshwater)	kg P eq.	1.52E-06	5.30E-07	1.66E-08	5.47E-07	1.03E-07	2.17E-06
Eutrophication potential, fraction of nutrients reaching marine end compartment (EP-marine)	kg N eq.	3.63E-06	3.79E-06	7.86E-08	3.87E-06	2.14E-07	7.71E-06
Eutrophication potential, Accumulated Exceedance (EP-terrestrial)	mol N eq.	3.83E-05	4.16E-05	7.24E-07	4.23E-05	2.39E-06	8.30E-05
Formation potential of tropospheric ozone (POCP)	kg NMVOC eq.	1.58E-05	1.29E-05	7.12E-07	1.36E-05	8.84E-07	3.04E-05
Consumption of abiotic resources - minerals and materials potential (ADP-minerals & metals)	kg Sb eq.	2.93E-08	1.54E-08	3.59E-10	1.58E-08	3.56E-09	4.86E-08

Consumption of abiotic resources - fossil resources potential (ADP-fossil)	MJ	4.00E-02	1.97E-02	1.97E-03	2.17E-02	1.66E-03	6.34E-02
Water deprivation potential, deprivation-weighted water consumption (WDP)	m3 World eq.	1.14E-03	2.59E-04	3.06E-05	2.89E-04	4.48E-05	1.47E-03
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw material (PENRE)	MJ	4.00E-02	1.97E-02	1.97E-03	2.17E-02	1.66E-03	6.34E-02
Use of renewable primary energy excluding renewable primary energy resources used as raw material (PERE)	MJ	3.59E-03	8.31E-04	8.87E-05	9.20E-04	1.52E-04	4.66E-03
Use of non-renewable primary energy resources used as raw material (PENRM)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of renewable primary energy resources used as raw material (PERM)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PENRT)	MJ	4.00E-02	1.97E-02	1.97E-03	2.17E-02	1.66E-03	6.34E-02
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PERT)	MJ	3.59E-03	8.31E-04	8.87E-05	9.20E-04	1.52E-04	4.66E-03
Net use of fresh water (FW)	m3	1.93E-05	9.49E-06	6.88E-07	1.02E-05	1.04E-06	3.06E-05
Use of secondary raw materials (Ms)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of renewable secondary fuels (RSF)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of non-renewable secondary fuels (NRSF)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
hazardous landfill waste (HWD)	kg	2.44E-07	1.33E-07	2.47E-08	1.58E-07	1.07E-08	4.13E-07

Non-hazardous waste disposed (NHWD)	kg	8.54E-06	3.43E-06	2.26E-07	3.66E-06	2.90E-07	1.25E-05
Radioactive waste disposed (RWD)	kg	3.46E-08	7.94E-09	8.41E-10	8.78E-09	1.25E-09	4.46E-08
Materials for energy recovery (MER)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling (MFR)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Componentsfor reuse (CRU)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported thermal energy (ETE)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported electricity energy (EEE)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

5.2 Additional environmental impacts- Results for lifetime extension of 25, 30, and 35 years

Below lists the results for lifetime extension of 25, 30, and 35 years.
To be noticed that this part of calculation is based on the declared data which refers to the sum of Upstream, Core, and Downstream phases. The results below are calculated based on the above GWP-total divided by electricity generation for 25,30 and 35 years.
These scenarios represent the most significant assumptions made in the LCA study. Table 4 presents the GWP-total values of the four wind turbine models under 25-year, 30-year and 35-years lifetimes.

Table 4 GWP-total values (kg CO_2-eq/FU) of the four wind turbines under 25-year, 30-year and 35-year lifetimes

Lifetime	EN171-6.0	EN171-6.25	EN171-6.5	EN182-6.25
25 years	4.75E-03	4.57E-03	4.56E-03	4.41E-03
30 years	3.96E-03	3.81E-03	3.80E-03	3.67E-03
35 years	3.39E-03	3.27E-03	3.26E-03	3.15E-03

6. Calculation rules

6.1 Allocations

Multi-input allocation
Input of Electricity used in the wind turbine assembly factory has been allocated to per unit of wind turbine production.
Materials and energy used for the construction and deconstruction of wind farm, electricity infrastructure allocated to each unit of wind turbines.

Multi-output allocation
There are no by-products produced from production stage, so no multi-output product is applied in this study.
The solid waste output was measured by the factory of total amount generated during the reference period, thus the allocation applied to each unit of wind turbine.

End-of-life allocation
For the end-of-life stage of retired wind turbines, the polluter pays principle (PPP) is followed in this report. It means the disassembling of the wind turbines, and the transportation of wastes to treatment sites are considered. While the benefits and loads from waste treatment are allocated to the next life cycle of substituted products, but not to primary producers. Hence no burden or benefit will be allocated to the primary producer of the wind turbines.

6.2 Assumptions and limitations

This section outlines the key assumptions used in the LCA that affect environmental performance.

Table 5 Key assumptions

Categories	Items	Assumptions
Upstream-Supplier	Transport distance of some components (e.g. Intelligent sensing, Cable)	The transport distance of major components (e.g. Hub & Cover, Nacelle Cover, etc.) is foreground data, and the transport distance data of some components (e.g. Intelligent sensing, Cable, etc.) are assumed due to the difficulty of collecting them, and assumptions are used, which are uniformly assumed to be 1000km.
Core-infrastructure	Wind farm construction	Data related to materials, energy consumption and emissions for wind farm construction are derived from similar onshore wind farm construction, combined with empirical estimates.
Core-process	Round trip during maintenance phase	During the maintenance phase, the travelling distance of the maintenance personnel is assumed that 20 L gasoline is used for a round trip of 200km per inspection.
Core-infrastructure	Deconstruction	Based on the data of wind farm construction, for the recyclable materials obtained from wind farm dismantling, the transportation of recyclable materials is considered, and the transportation distance is assumed to be 300 km. The transportation distance of recyclable materials dismantled from wind turbines is also assumed to be 300 km.
Downstream-Electricity infrastructure	Transmission distance from wind farm to grid	The transmission distance from the wind farm to the grid is assumed to be 16km.
Downstream-Electricity dissipation	Dissipation	Based on empirical data for EN171/EN182-6.X turbines, the local grid transmission loss is 2.1%.

6.3 Cut-off rules

In this study, the cut-off criteria have been controlled by 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.
EPDs related to electricity generated by wind turbines can be cut off in the following life cycle stages:
• Upstream - production and disposal of intermediate product packaging.
• Core - material and energy flows within the system controlled by the EPD holder, provided that their contribution does not exceed 2% (respectively, of the wind turbine's unit weight and the energy needed to produce and assemble it).
• Core - inspection operations in the case of plants which are easily accessible. This means plants, typically stand-alone but not exclusively, that are within 10km of control personnel.

6.4 Data quality

Primary data (such as materials or energy flows that enter and leave the production system) is from manufacturing facilities in a reference period from Jan. 2024 to Dec. 2024. Generic data related to the life cycle impacts of the material or energy flows that enter and leave the production system is sourced from Ecoinvent 3.9.1 database.

7. Reference

(1) Regulations of the EPDItaly programme, Revision 6.0, issue date: 30/10/2023

(2) PCR EPDItaly013, Title: ELECTRICITY PRODUCED BY WIND TURBINES, Revision 1.1, issue date: 16-03-2020; validity: 15-03-2025.

(3) LCA report of Envision Energy wind turbines for Environmental Product Declaration (EPD), Rev1, 20/06/2025.

(4) 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 version3.9.1 was used.

(5) Software:OpenLCA 2.2.0 (https://www.openlca.org/)

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

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

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

(9) Yang Jingyan 1, Ruan Ziwen 1, Yang Xiu 2, Li Chaojun 1, Bian Shaoqing 1,Lu Xi 1, 3, 4, 5*, He Kebin 1, 3, 4, 5, (2024), International Comparative Study on Dynamic Change of Onshore Wind Power Carbon Footprint, Strategic Study of CAE, ISSN 1009-1742,CN 11-4421/G3

8. History Section

This EPD has been published on August 27th 2025, and revised on July 15th 2026 to correct editorial errors.