IMPIANTO DI PRODUZIONE DI ENERGIA DA FONTE EOLICA
"Parco Eolico San Pietro" DI POTENZA PARI A 60 MW

REGIONE PUGLIA
PROVINCIA di BRINDISI

PARCO EOLICO E RELATIVE OPERE DI CONNESSIONE NEI COMUNI DI:
Brindisi, San Pietro Vernotico, Cellino San Marco

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LCA e certificazione EDP aerogeneratore Siemens Gamesa 8.0-167

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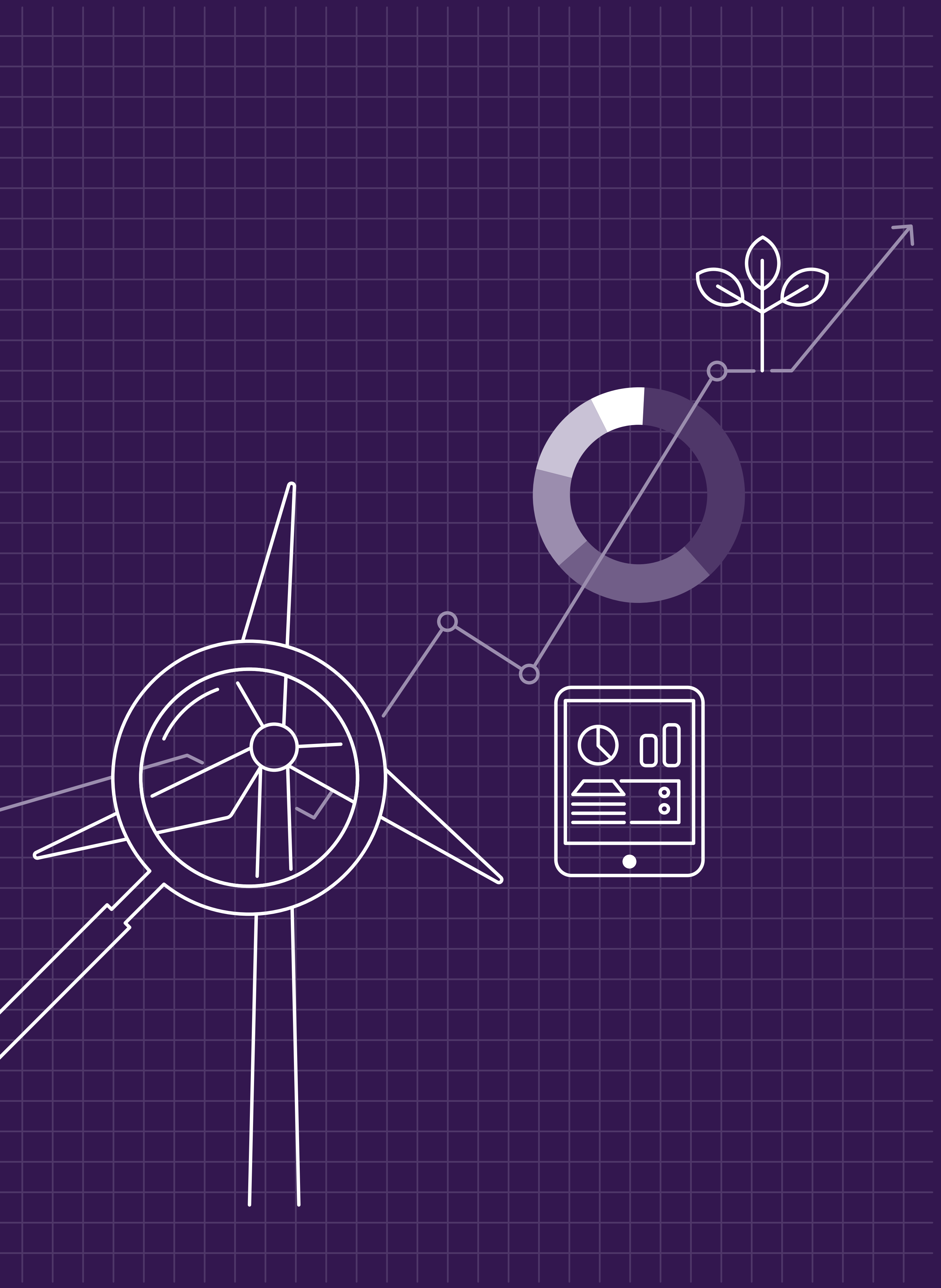
A clean energy solution – from cradle to grave

Environmental Product Declaration
SG 8.0-167 DD

SIEMENS Gamesa
RENEWABLE ENERGY



Assessing the performance of a wind power plant

The environmental impact of wind power
The world today faces the challenge of meeting a growing demand for energy while reducing greenhouse gas emissions. One solution is to increase the contribution of renewable energy systems such as wind, sun, or biomass to the electricity mix. Siemens Gamesa Renewable Energy is pioneering this approach by offering an extensive wind turbine portfolio that includes the SG 8.0-167 DD turbine. Siemens Gamesa Renewable Energy has performed a Life Cycle Assessment (LCA) of an offshore wind power plant employing the SG 8.0-167 DD. The LCA evaluated the inputs, outputs, and potential environmental impacts that occur throughout the wind power plant lifecycle. It encompasses raw material extraction, materials processing, manufacturing, installation, operation and maintenance, and dismantling and end-of-life.

The results are presented in this Environmental Product Declaration (EPD) in order to communicate the impacts of our wind power plant to our stakeholders. All results are verified by internal reviews. The international ISO 14021 standard (environmental labels and declarations–self-declared environmental claims – Type II) is the basis for this EPD. The data presented has been derived from a full-scale LCA in accordance with ISO 14040.

Designed to deliver clean energy

Offshore wind power plant
This EPD is based on a full-scale LCA of an average European offshore wind power plant with 80 SG 8.0-167 DD turbines installed. It includes wind turbine components such as a nacelle, rotor, and tower, as well as the foundation, cables to grid, and substation.

The SG 8.0-167 DD is an upgrade in the Offshore Direct Drive platform. The upgrade allows the SG 8.0-167 DD to deliver up to 20% more energy output than its predecessor, the SWT-7.0-154.

The functional unit for this LCA is defined as 1 kWh of electricity delivered to the grid.

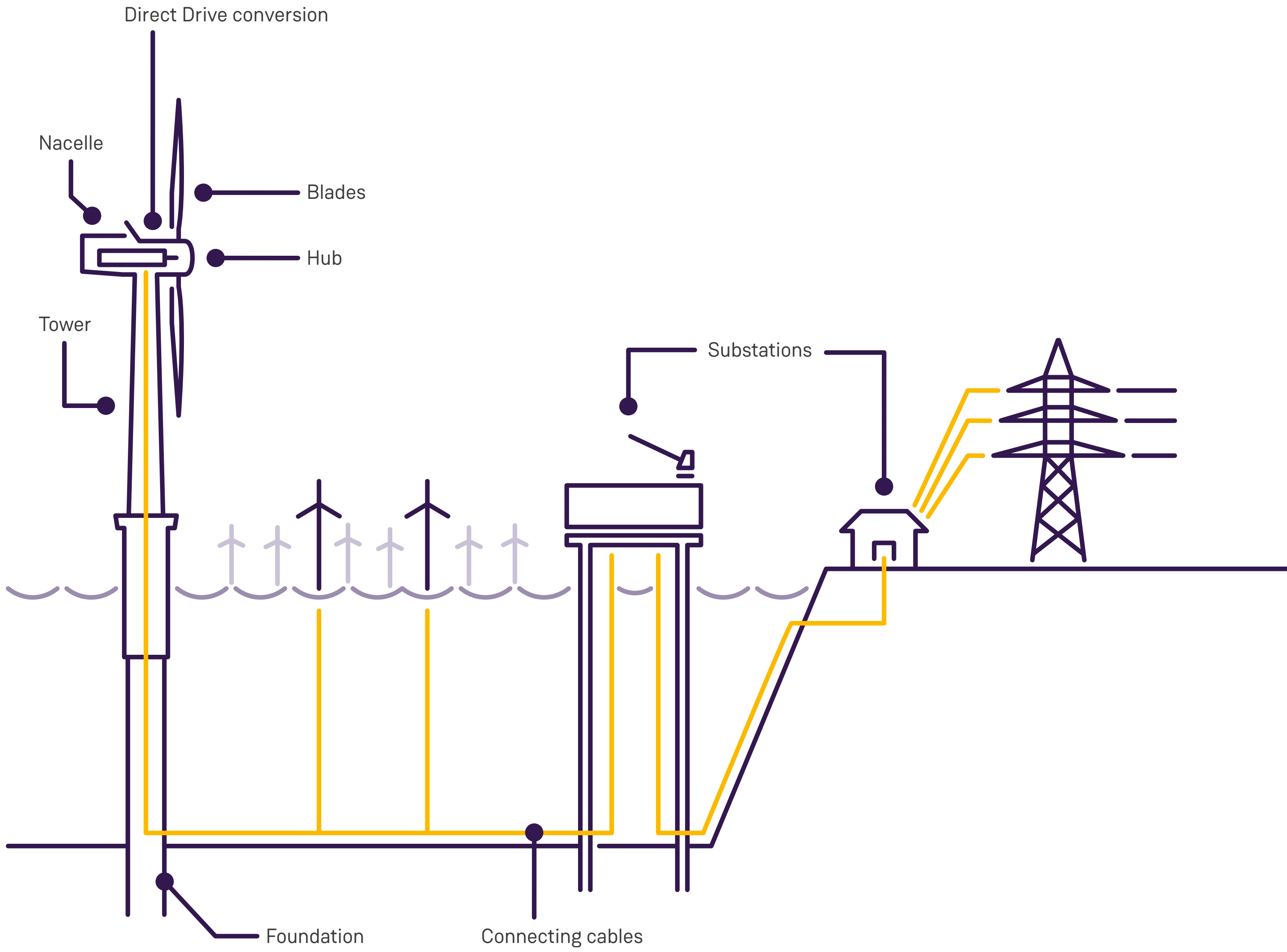
The identified average wind speed is relative to the turbine IEC classification.
Class I: 10 m/s for SG 8.0-167 DD.

Each wind power plant has specific site constraints that influence the choice of turbine, tower height, foundation size, and infrastructure.

Product and system description, including main components

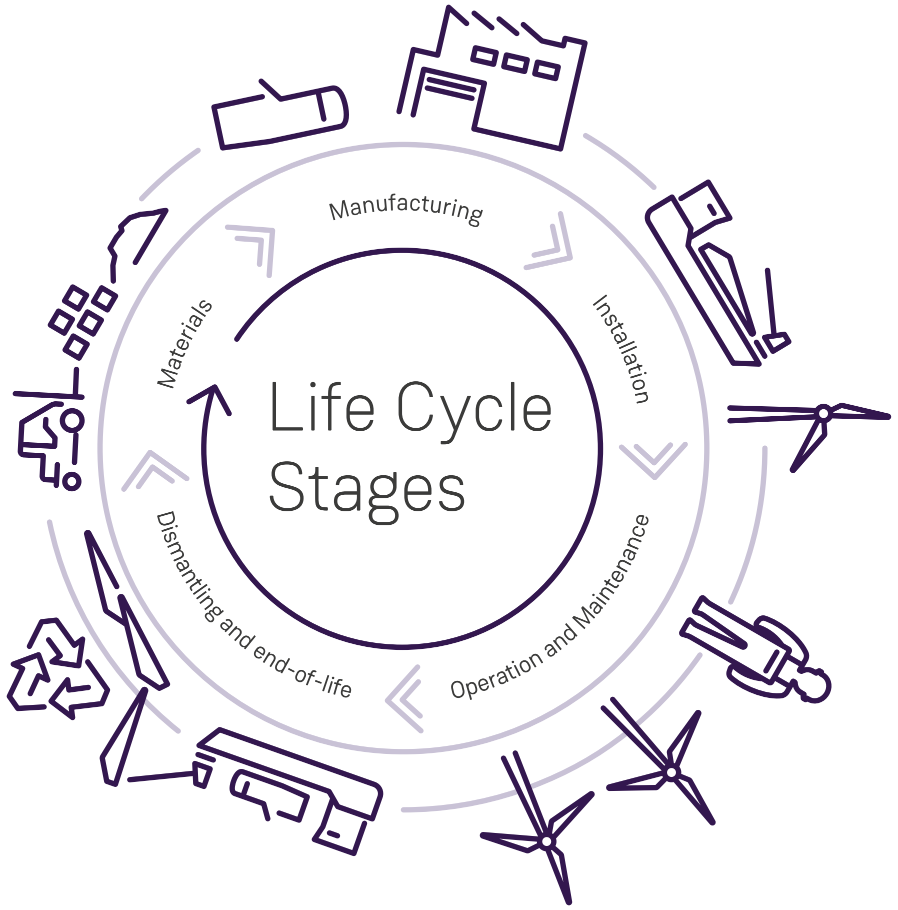
Product and system description	Main characteristics
Turbine	SG 8.0-167 DD
Number of turbines in wind power plant	80
Expected lifetime	25 years
Expected average wind speed	10 m/s
Distance to shore/shore to grid	50 km/22 km
Annual energy production to grid per turbine (wake, availability and electrical losses substracted)	Approx. 34,000 MWh
Estimated energy production of the wind power plant in 25 years	68,035,000 MWh
Nacelle	8.0 MW DD (steel, iron, copper)
Blades	81 m (fiberglass, epoxy)
Tower	92 m (steel)
Foundation	925 t (steel)
Substations	12,700 t (steel, concrete)

System boundaries for an offshore wind power plant



From cradle to grave

Life cycle of a wind power plant
The lifecycle has been divided into five main stages: materials, manufacturing of the main parts, installation, operation and maintenance, dismantling, recycling, and disposal at the end-of-life. Relevant transport activities and energy consumption were included in each life cycle stage.



Materials
We identified the types and quantities of materials and energy that had to be extracted and consumed to produce the turbine components and the elements needed to connect the wind power plant to the grid, i. e. substations and connecting cables.

Manufacturing
We collected data from Siemens Gamesa Renewable Energy's own production sites and from main suppliers. Consumption data for manufacturing as well as waste and subsequent treatment is based primarily on annual manufacturing data from European production sites. Transport of materials to the manufacturing site is included in the data.

Installation
Components, auxiliary resources, and workers are transported to the site during this stage. On-site installation includes preparing the site, erecting the turbines, and connecting the turbines to the grid. These installation activities result in the consumption of resources and production of waste. Associated data has been collected from actual on-site installations.

Operation and Maintenance
The structural design lifetime of an SG 8.0-167 DD turbine is designed to last 25 years. We collected actual site data, including manpower, materials, and energy required for service and maintenance over the turbine's lifetime. Wake, availability, and electrical losses have been included in our assessment to define a realistic estimate of annual energy production delivered to the grid.

Dismantling and end-of-life
At the wind power plant's end-of-life, the components will be disassembled and the materials transported and treated according to different waste handling methods. For the turbine components, we assumed that recycling would apply to all recyclable materials; for example, metals. Recycling leads to the recovery of materials, which subsequently reduces primary material extraction. The rest of the materials are either thermally treated or disposed of in landfills. The end-of-life stage described here represents the current status of waste management options in Northern Europe.

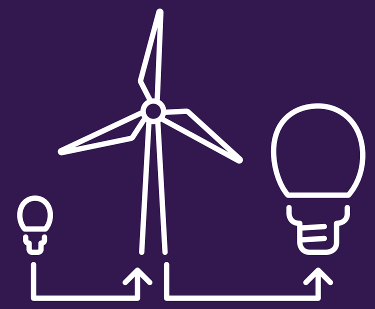
Other environmental impacts
Planning a new wind power plant includes assessing the environmental impact of the installation and operation phases to minimize negative impacts. Often these assessments focus on birds, marine wildlife and visual impacts. How a wind power plant impacts its surroundings varies depending on its location and is not included in our LCA study.

Environmental footprint

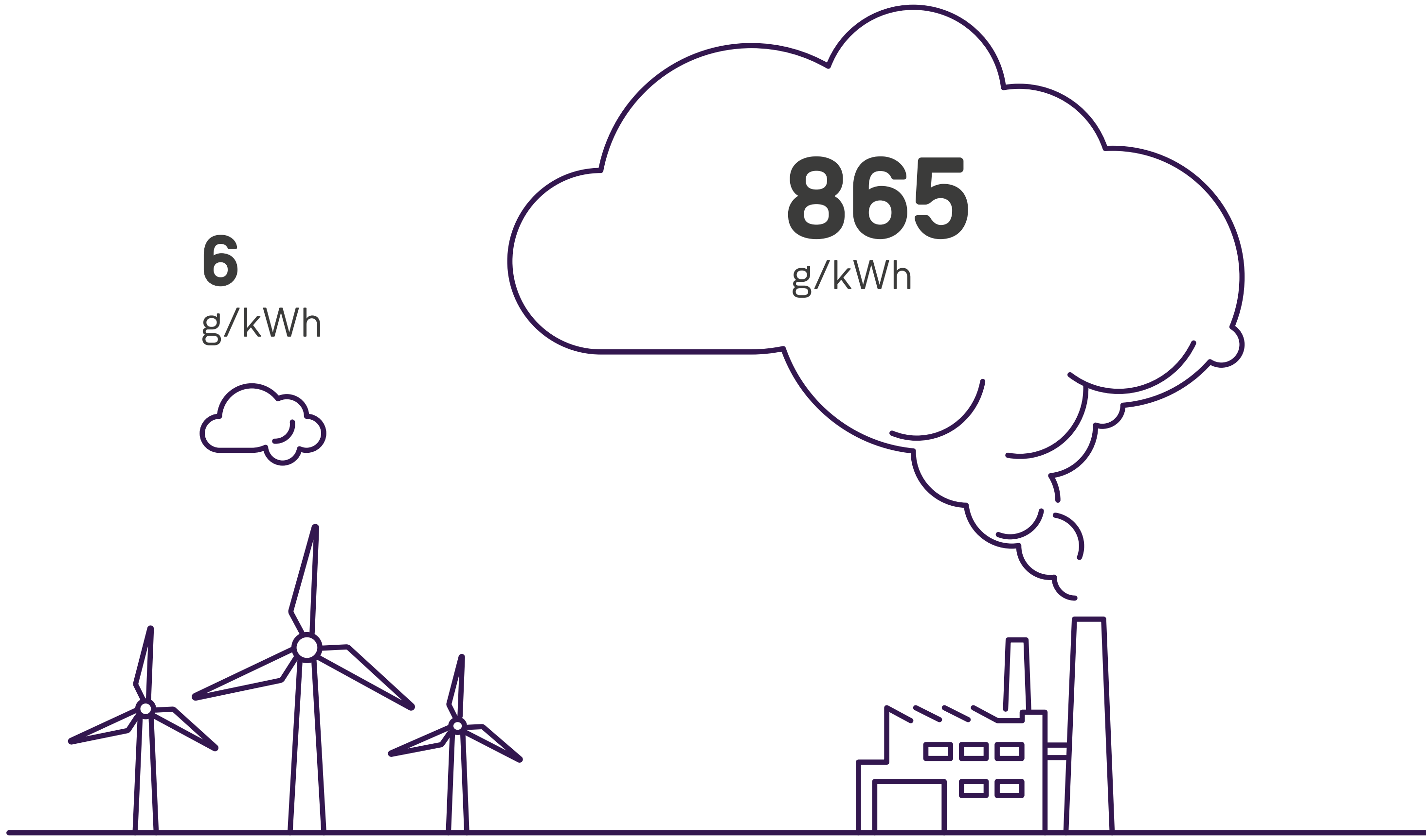
Low greenhouse gas emissions
Greenhouse gases such as CO_2 and methane contribute to global warming. Electricity produced by wind turbines contributes significantly less to global warming than electricity produced by fossil fuels. During its lifetime, the wind power plant emits less than 1% of the CO_2 emitted per kWh by an average power plant using fossil fuels.

7.4 months energy payback time
The energy payback time for the wind power plant in this assessment is less than 7.4 months. That is the length of time the wind power plant has to operate in order to produce as much energy as it will consume during its entire ifecycle.

Global warming is …
… an environmental impact caused by the increased concentration of greenhouse gases in the atmosphere. Each of these gases radiates different amounts of heat, which can be quantified in units of carbon called carbon dioxide-equivalent (CO_2 eq). (IPCC ref)

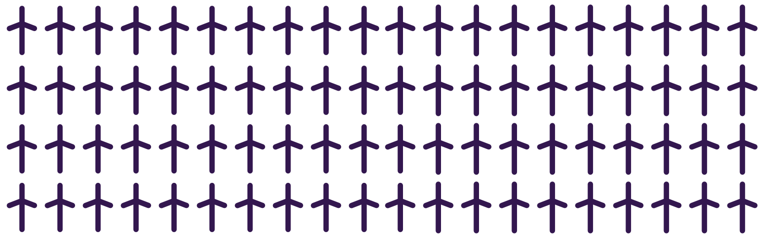


During its entire lifecycle the wind power plant produces 41 times more energy than it consumes.



CO_2 emissions from the wind power plant versus global fossil power production (IEA World Energy Outlook, 2012).

58,400,000 t
of CO_2 savings



80 turbines, 25 years

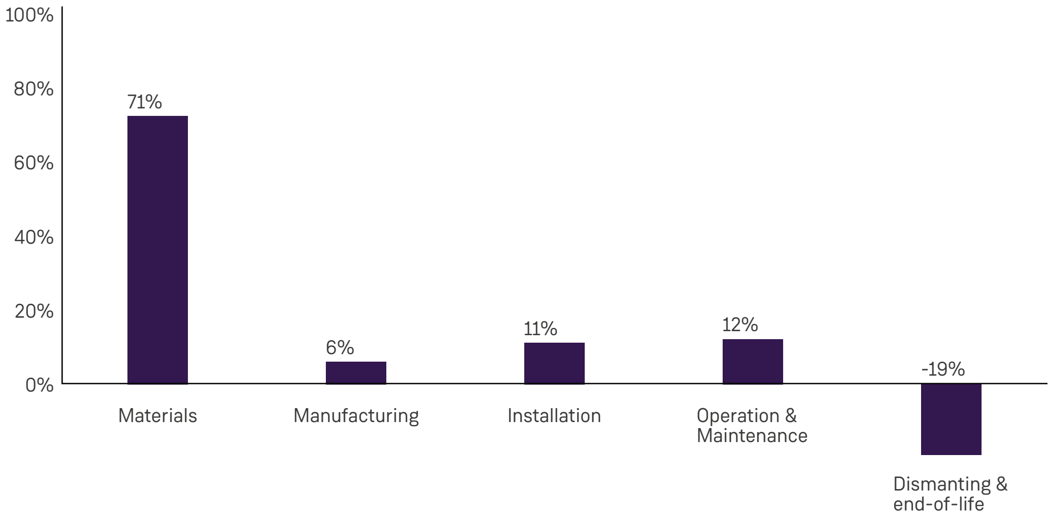
1,667 km²
forest area

During its estimated lifetime the wind power plant produces 68,035,000 MWh and saves 58,400,000 tonnes of CO_2, which is equal to the amount of CO_2 absorbed by a forest with an area of 1,667 km² over 25 years.

Every stage counts

Contributions to global warming
To examine how much each stage of the wind power plant's life cycle contributes to global warming, we assessed their specific CO_2 emissions (figure below).

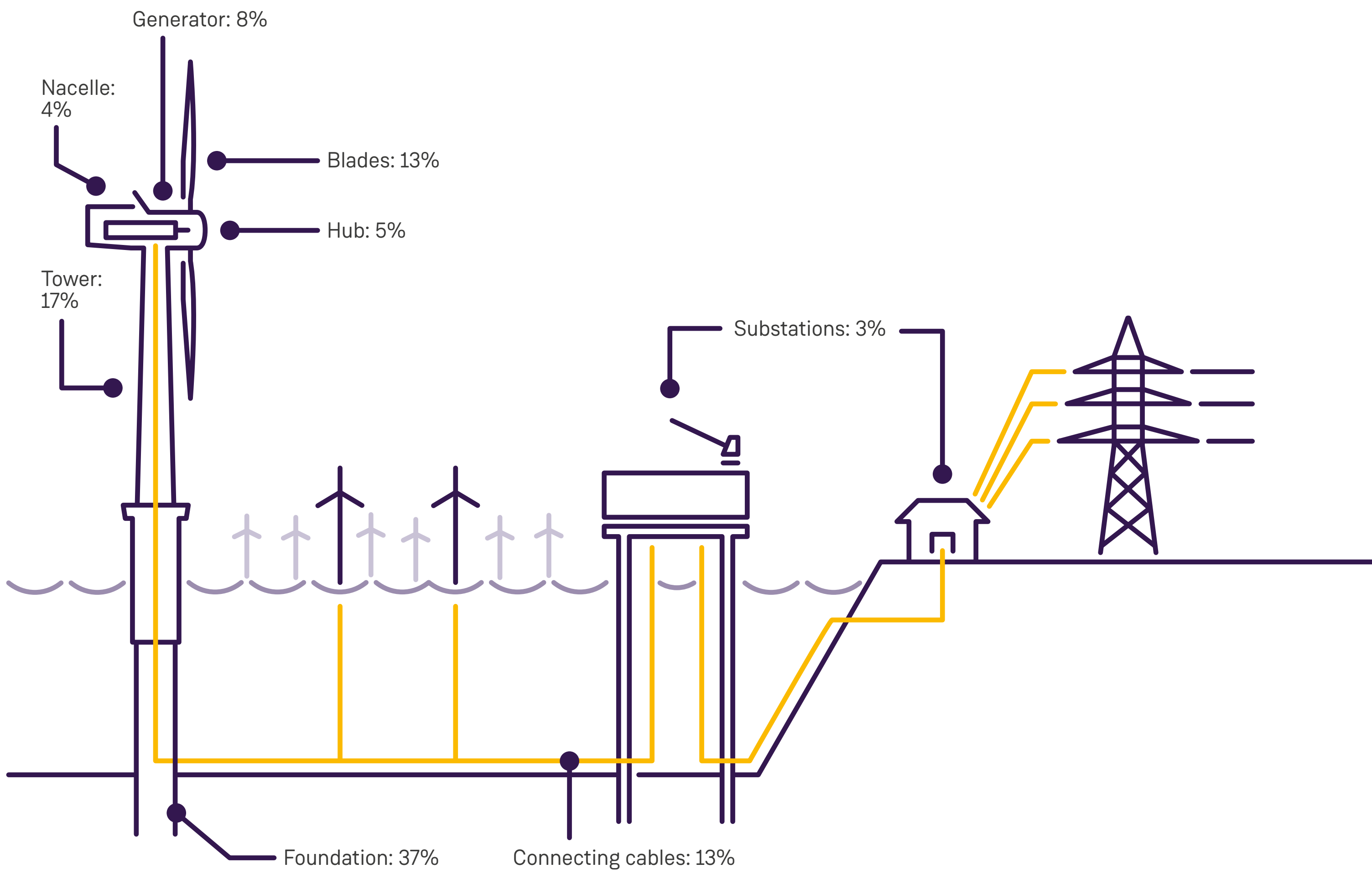
Percentage of global warming contribution from each life cycle stage (g CO_2 eq/kWh)



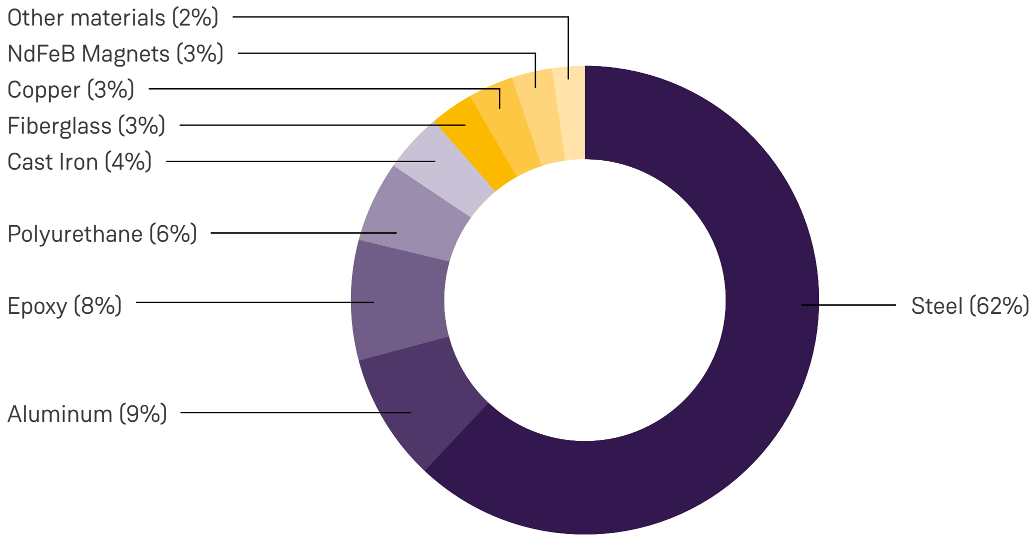
The main contributor to global warming is the materials stage (71%) because of the emissions during material extraction. The emissions related to manufacturing are minimal (6%), while those from installation and operation constitute approximately one-fourth of the total CO_2 impact (23%). Due to a high recyclability rate of the turbine materials, there is an offset to emissions at end-of-life.

Component and material group contribution to CO_2 eq emission
Each component and material group contributes to the total CO_2 eq emissions of the wind power plant. Among the components, the turbine's tower and foundation contribute more than 50%, followed by connecting cables, blades, and nacelle. In terms of material group contribution, steel has the highest impact on global warming, followed by aluminum and epoxy. The category with other materials consists of minerals, various plastics, chemicals, and wood.

Global warming contribution of main components in the wind power plant (CO_2 eq)



Global warming contribution per material group in the wind power plant (CO_2 eq)



Designing with a holistic view

Lowering the Levelized Cost of Energy
Siemens Gamesa Renewable Energy is one of the first companies showcasing its commitment to lowering the Levelized Cost of Energy (LCoE) for offshore wind power. In relation to this, we strive to continually improve wind turbine performance by including considerations for LCoE as well as environmental requirements in our design phase. We focus on increasing the annual energy output of the turbines and improving the material efficiency of the components.

Our improvement projects also focus on optimizing processes related to manufacturing, installation, operation and maintenance, dismantling and end-of-life. All these initiatives contribute to lowering the CO_2 eq per kWh of electricity delivered to the grid and reducing the LCoE. Hereafter, we describe some of our approaches to minimizing the environmental impact and LCoE throughout the life cycle of a wind power plant.

Optimizing magnets

Siemens Gamesa Renewable Energy has, in collaboration with suppliers, improved the material use and manufacturing processes related to permanent magnets. After sintering, permanent magnets are conventionally ground from rectangular geometries into the desired shape needed for installation in the generator. This is a wasteful process because the grinding residue cannot be recycled 100%.

In collaboration with our suppliers, Siemens Gamesa Renewable Energy developed a new manufacturing method that allows the magnets to be shaped correctly from the start, which eliminates the extra grinding step. This involves pressing the magnet powder into new shapes that match the final product and therefore avoids unnecessary waste.

RoRo vessels for efficient installation

Further, Siemens Gamesa Renewable Energy works to improve the installation phase. The Roll-on-Roll-off (RoRo) vessel is a former container ship that has been rebuilt for its new purpose. Part of its new equipment is a large bow door that allows Ro-Ro access to the restructured cargo deck. The deck is covered by a telescopic roof to protect the nacelles from salty seawater spray during transportation.

Since the roof can be opened, the vessel's cargo can also be loaded via cranes at harbors without a Ro-Ro ramp. Due to the flexible layout of the deck, it can also carry up to nine wind tower sections per trip or three to four rotor blade sets. Savings of up to 15–20% in logistics are expected compared to existing transport methods.

Optimized maintenance with service operation vessels

To further optimize the operation and maintenance phase, Siemens Gamesa Renewable Energy launched the world's first Service Operation Vessels (SOVs) devoted to far-from-shore wind farms. The vessels are part floating hotels, part floating warehouses and when fully equipped, they are capable of remaining offshore at their respective wind farms for up to one month.

The vessels feature an innovative hydraulic walk-to-work gangway system that allows technicians to safely access wind turbines in extreme weather conditions. The specific improvements are illustrated below.

3 times higher availability at the wind farm compared to standard vessels

50% more operation days

20% less fuel consumption than projected

Disclaimer: Environmental improvements from RoRo vessels and SOVs have not been quantified in our LCA and are therefore not represented in our results or this EPD.

End-of-life is not really the end

Recycling turbine materials
When a turbine is dismantled, it has not necessarily reached its end-of-life. Turbines are often replaced by larger turbines, allowing the dismantled turbines to be refurbished and sold for installation elsewhere.

When disposing of wind turbines, recycling is the preferred solution. This not only prevents the materials from being sent to landfills, but also reduces the need for the extraction of primary materials.

Options for recycling or disposal
The metals in the wind power plant components are to a great extent recycled at their end-of-life. The blades, which are made of epoxy and fiberglass, may be shredded and incinerated. The burning of epoxy generates energy, which can be recovered. The residues from fiberglass incineration can be used in other secondary applications e.g. for cement production. Magnets from the direct drive turbines can be demagnetized, remagnetized and used or reused for new magnet production. Increasing recyclability of the turbine components is high on our agenda and we continually participate in projects to support development of more recycling options.

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