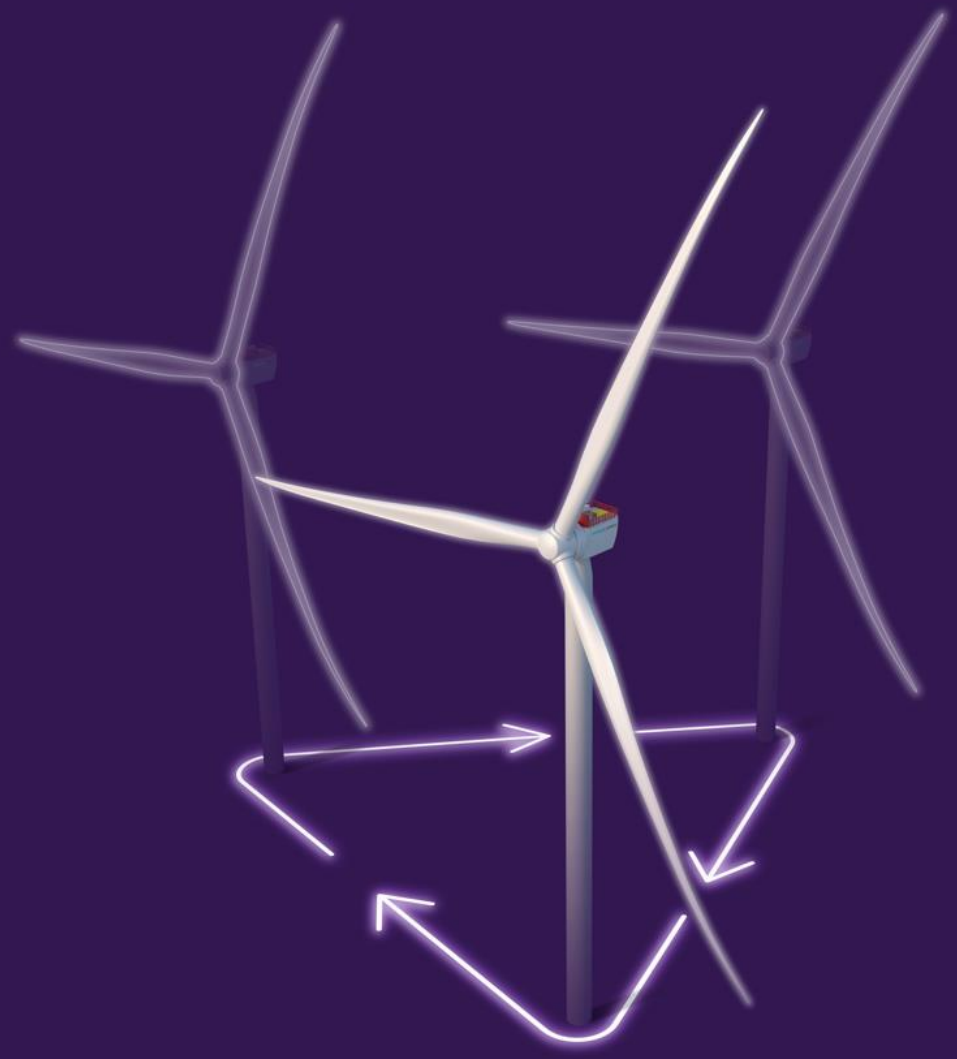
RecyclableBlade

Taking responsibility.
Blade by blade.

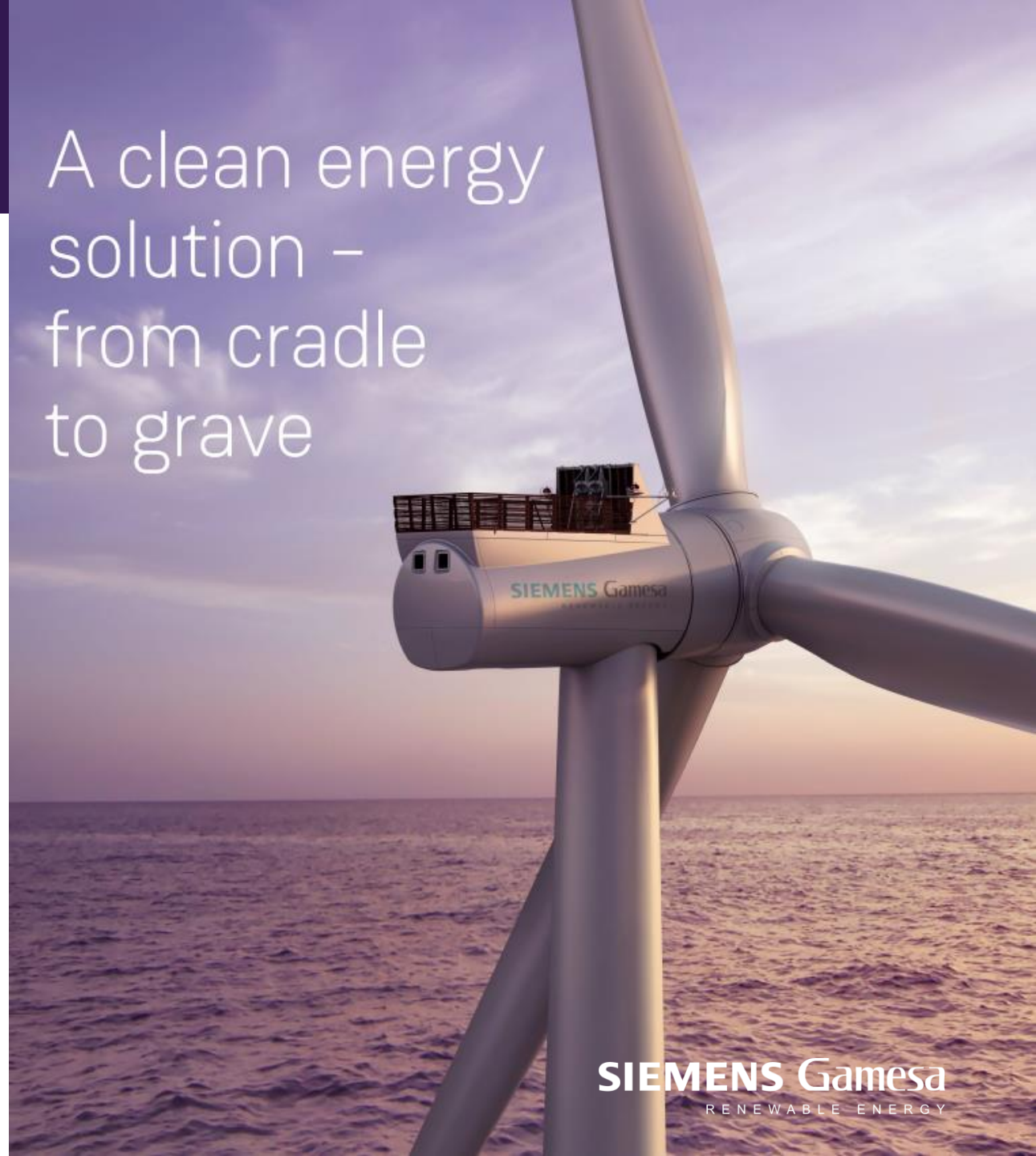


Sandia Blade Workshop 2022
Evan Bonny
On Behalf of Lars Hedegaard

SIEMENS Gamesa
RENEWABLE ENERGY

Siemens Gamesa unlocks the power of wind. For more than 40 years, we have been a pioneer and leader of the wind industry, and today our team of 26,000 colleagues work at the center of the global energy revolution to tackle the most significant challenge of our generation – the climate crisis.

With a leading position in onshore, offshore, and service, we engineer, build and deliver powerful and reliable wind energy solutions in strong partnership with our customers. A global business with local impact, we have installed more than 110 GW and provide access to clean, affordable and sustainable energy that keeps the lights on across the world.

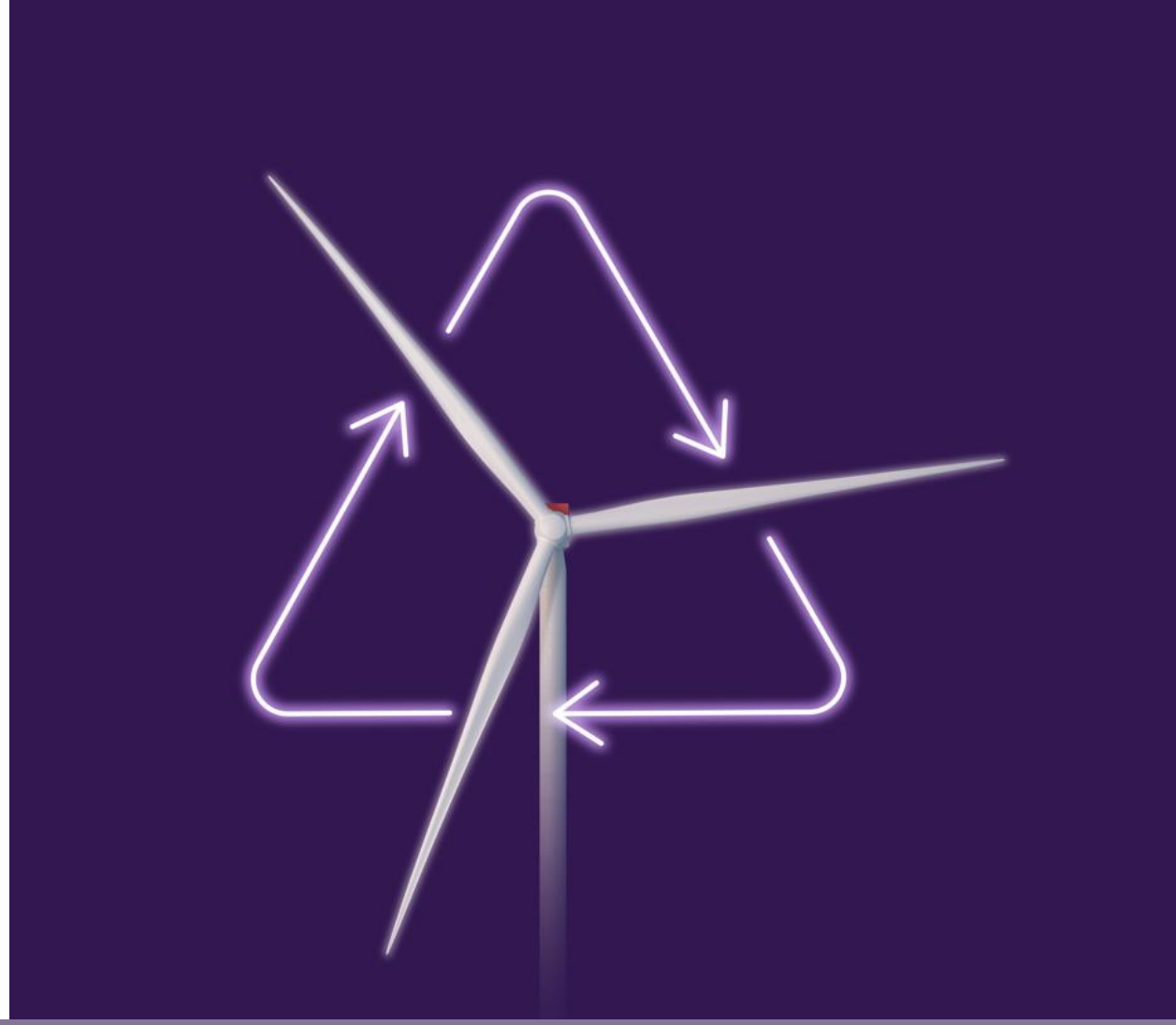


Background

The RecyclableBlade – a Breakthrough Technology for Blades Recycling

CO2 Emission Reduction with RecyclableBlade

The Future is Recyclable



RecyclableBlade

SIEMENS Gamesa
RENEWABLE ENERGY

Increasing regulation, opportunities, and demand

Societal and regulatory focus on circular economy ie.:

- Landfill bans in a range of countries including the Netherlands, Germany and other European countries
- Specific circularity legislation in France.
- Increasing auction focus on sustainability

Selling the recycled materials instead of paying to get rid of them could turn part of the decommissioning cost into revenues.

The energy transition in progress, means that Offshore wind power is expected to grow to nearly 1000 GW total installed capacity by 2050 .

Ambitious target for fully recyclable blades and turbines

Siemens Gamesa has set a target to have fully recyclable blades by 2030 and fully recyclable turbines by 2040

Siemens Gamesa is working with WindEurope and other major players in the industry on a call for action to have a Europe-wide landfill ban and to support the road towards full recyclability.

Siemens Gamesa is part of the DecomBlades project with other major players, to find joint solutions to tackle the decommissioning and recycling of already installed blades.

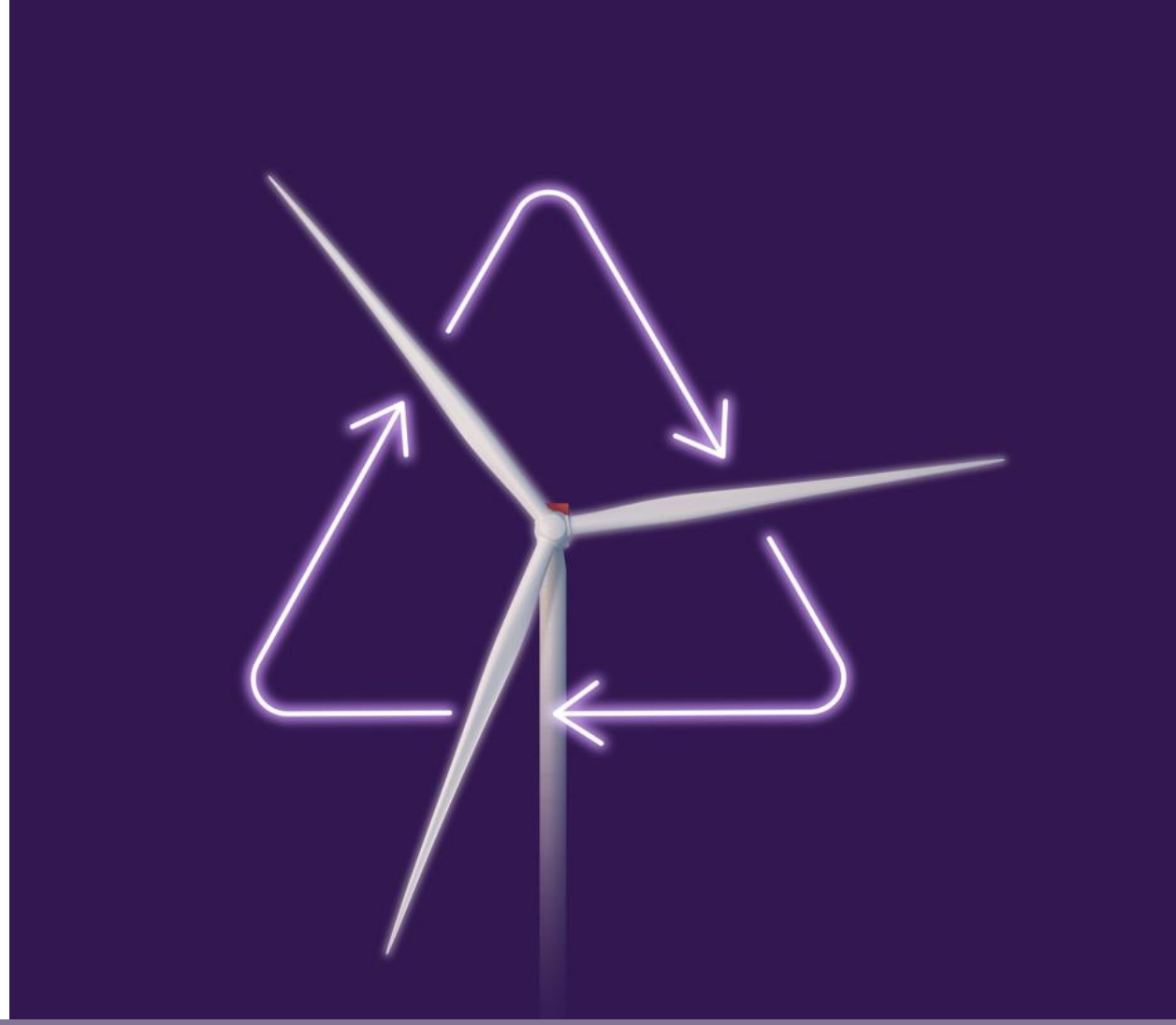
SIEMENS Gamesa
RENEWABLE ENERGY

Background

The RecyclableBlade – a Breakthrough Technology for Blades Recycling

CO2 Emission Reduction with RecyclableBlade

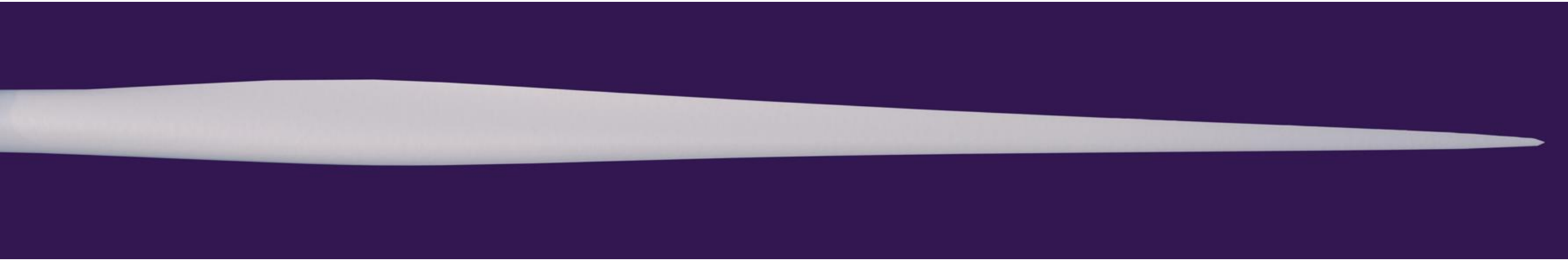
The Future is Recyclable



RecyclableBlade

SIEMENS Gamesa
RENEWABLE ENERGY

RecyclableBlade is a pioneering blade solution that enables blade materials to be recovered and recycled



Siemens Gamesa has developed the RecyclableBlade, which utilizes Aditya Birla Chemicals´ Briozen resin based on Recyclamine technology. The six first blades have been produced in our factory in Aalborg (Denmark) early 2021 and will be installed on projects from 2022.

The industrialization is planned for 2022, with production capacity continuously increasing until fully ready for bigger offshore projects in 2024.

RWE will be our first customer to install in these blades in the project Kaskasi (Germany).

SIEMENS Gamesa RENEWABLE ENERGY

Same means same – product quality, strength, warranties, and service process

The RecyclableBlade utilizes the same IntegralBlade design criteria as previous, and the only change is the recyclable resin.

The recyclable Briozen resin is structurally equal to current resin systems, with the added benefit that it can be dissolved again after decommissioning.

Using the RecyclableBlade in a wind power plant is no different from any other SGRE blade.

SIEMENS Gamesa
RENEWABLE ENERGY

The RecyclableBlade process from initial idea to full scale production

Initial idea

- The initial idea behind the RecyclableBlade concept was developed in 2018 in cooperation with Aditya Birla Chemicals who had already performed initial resin and recyclability testing.

Qualification process

- A standard and detailed qualification process was undertaken, and the resin was fully validated.
- The manufacturing of blades has been successfully demonstrated on a number of B81 blades during 2021.

Full scale

- Industrialized setup for manufacturing is expected to be completed in the course of 2022.
- A resin factory is to be built to support full commercialization which is expected to be possible from 2024.

SIEMENS Gamesa RENEWABLE ENERGY

The recycling process for our RecyclableBlade is simple and fast

Decommission

Disassemble and transport.

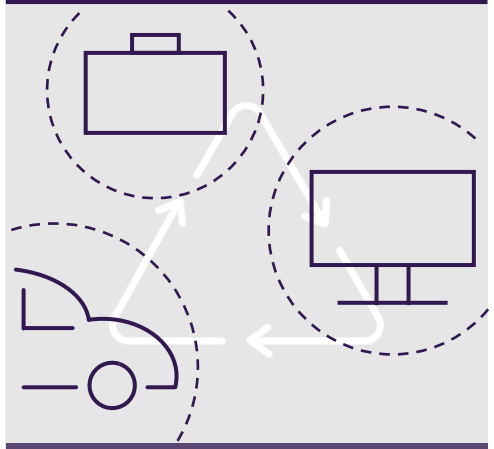
Immerse in mild acidic solution

Resin dissolves in aqueous acidic solution at elevated temperature after a few hours.

Reclaim separated components

Filter and coagulate resin + rinse and dry glass fiber etc.

Reuse



Glass fiber, resin, wood and metal can now be reused in other industries.

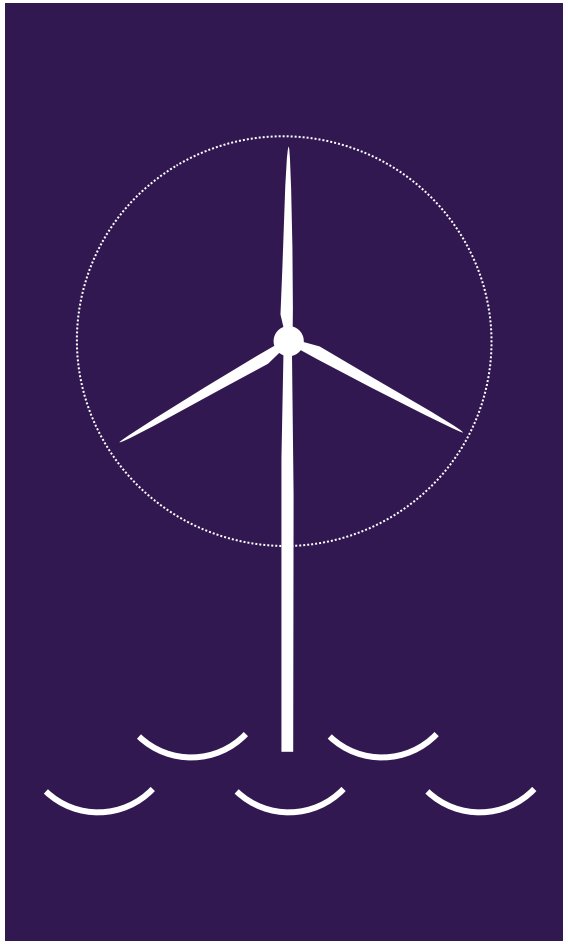
SIEMENS Gamesa RENEWABLE ENERGY

The RecyclableBlade has been validated in a thorough standard qualification process – business as usual

As part of blade certification, the resin lives up to a set of parameters and tolerances. These need to be fulfilled when validating second source resin.

The validation includes areas such as: mechanical static and fatigue tests, HSE evaluation and process conditions for manufacturing.

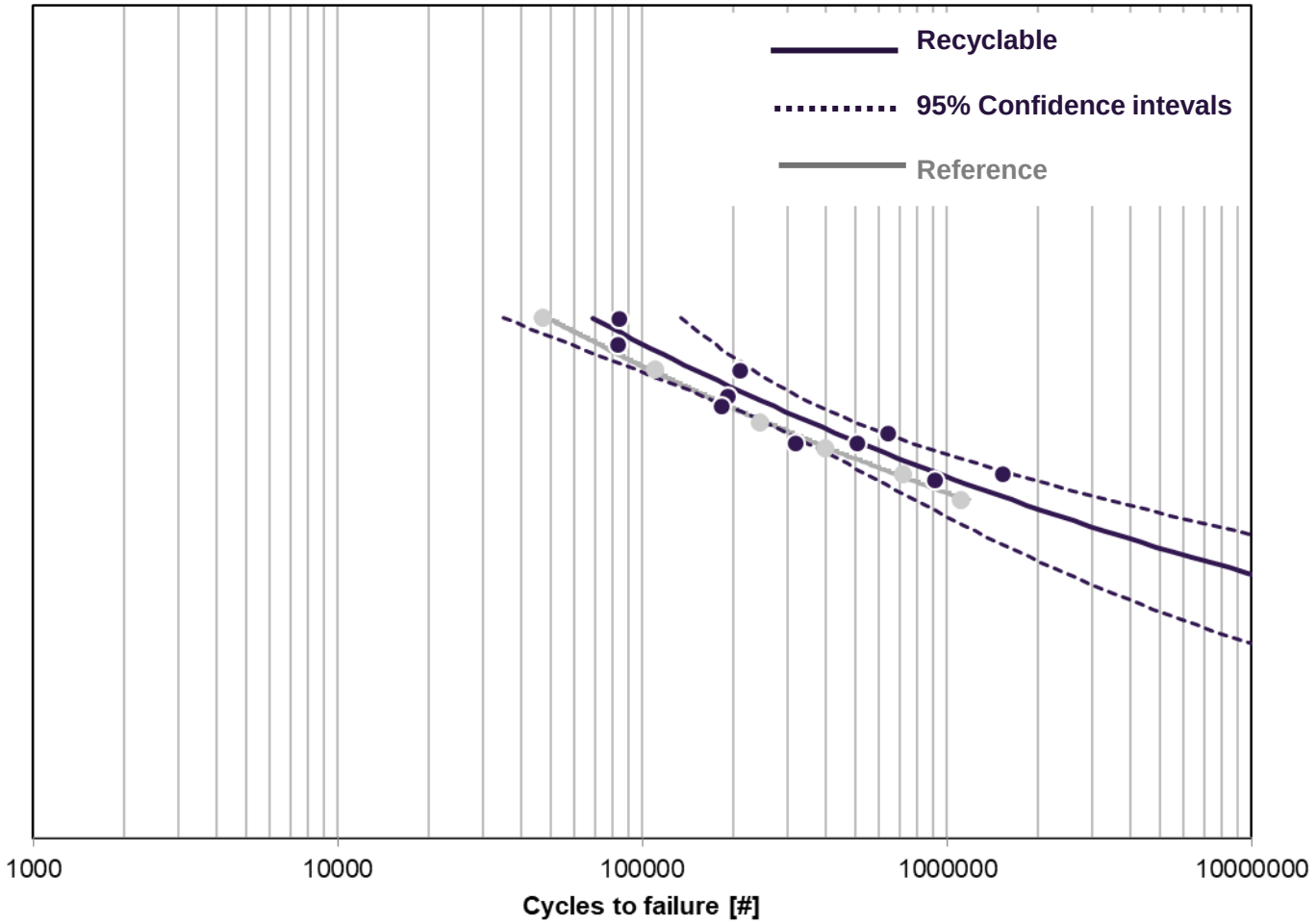
The validation was firstly performed by the supplier of the resin, secondly by SGRE, and lastly with support from third parties such as DTU (Danish Technical University).
→ The resin used for the RecyclableBlade has now been fully validated and we are ready for full scale manufacturing.



SIEMENS Gamesa
RENEWABLE ENERGY

The RecyclableBlade performance

Neat resin mechanical properties	Recyclable resin vs reference
Tensile strength	+ 5 %
Tensile modulus	+ 3 %
Tensile strain	- 2 %
Flexural strength	+ 8 %
Flexural modulus	+ 6 %
Flexural strain	+ 6 %

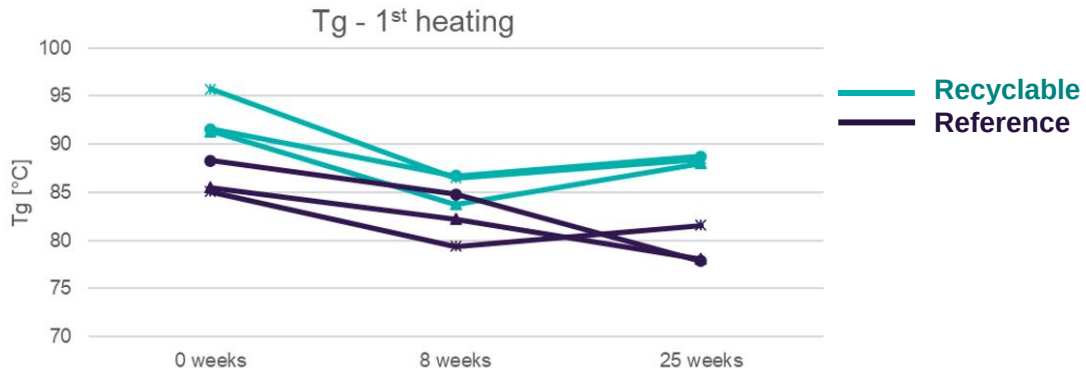


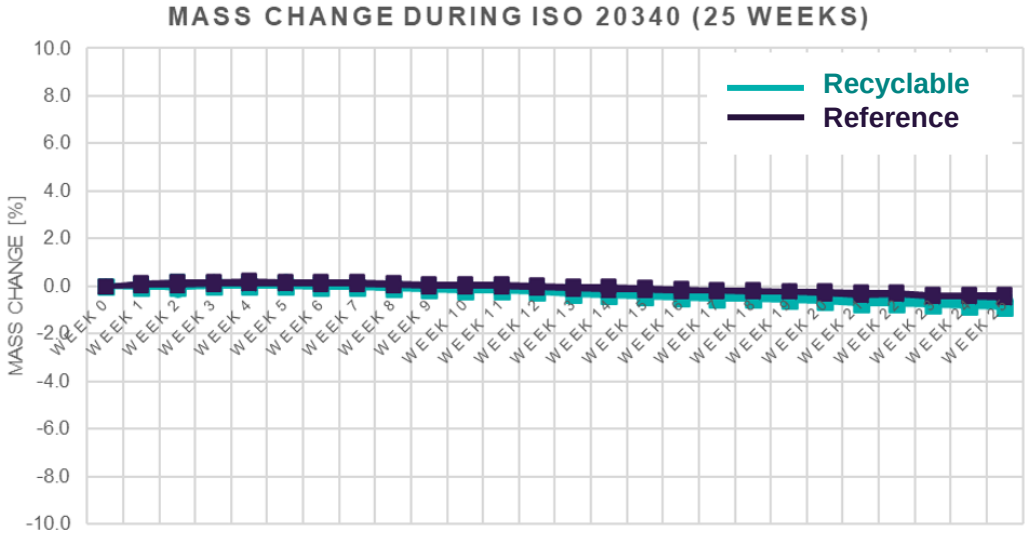
Shell laminate fatigue test (recyclable resin purple vs. reference grey)

SIEMENS Gamesa RENEWABLE ENERGY

The RecyclableBlade environmental stability

Weathering test (following ISO 20340) of uncoated laminate - 25 cycles = 25 weeks

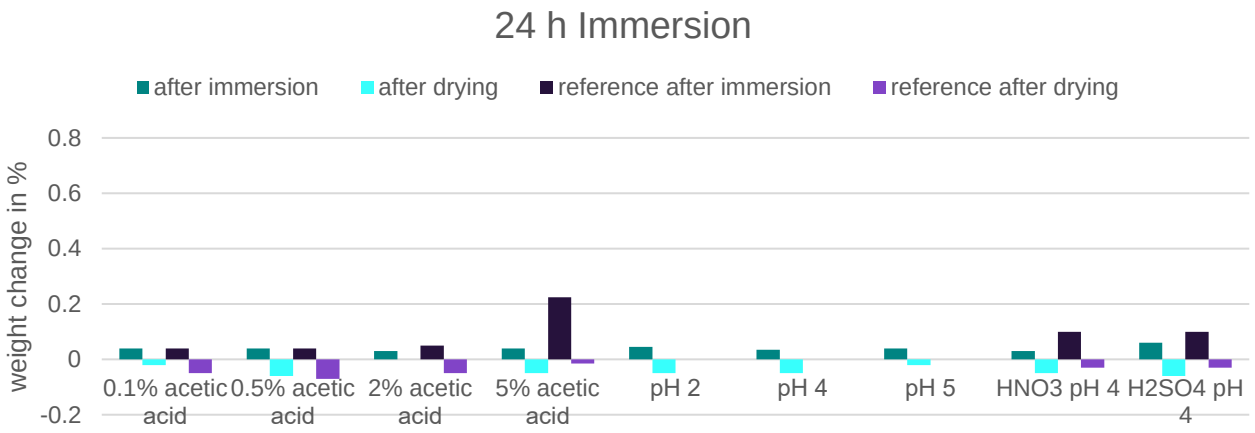


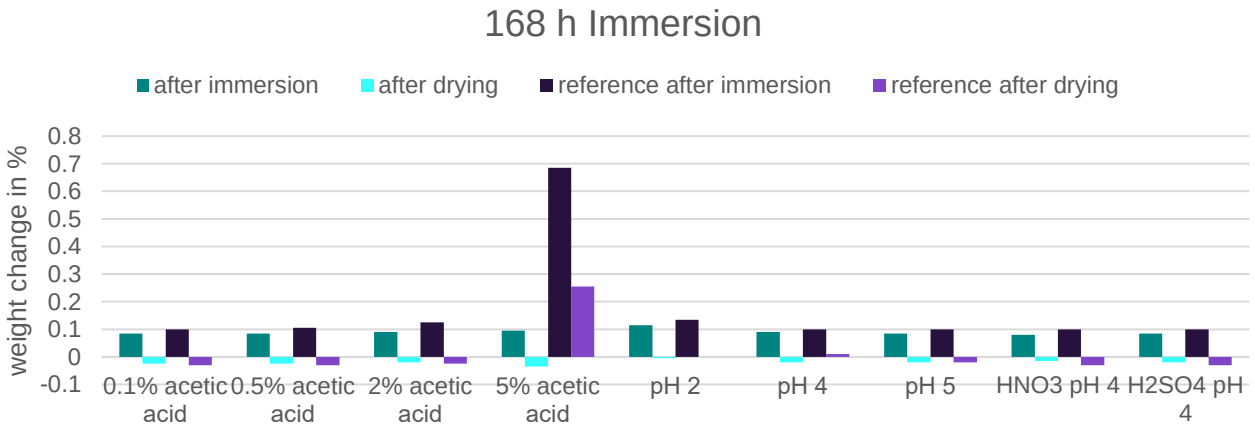


SIEMENS Gamesa RENEWABLE ENERGY

The RecyclableBlade stability

Full immersion test (following ISO175)





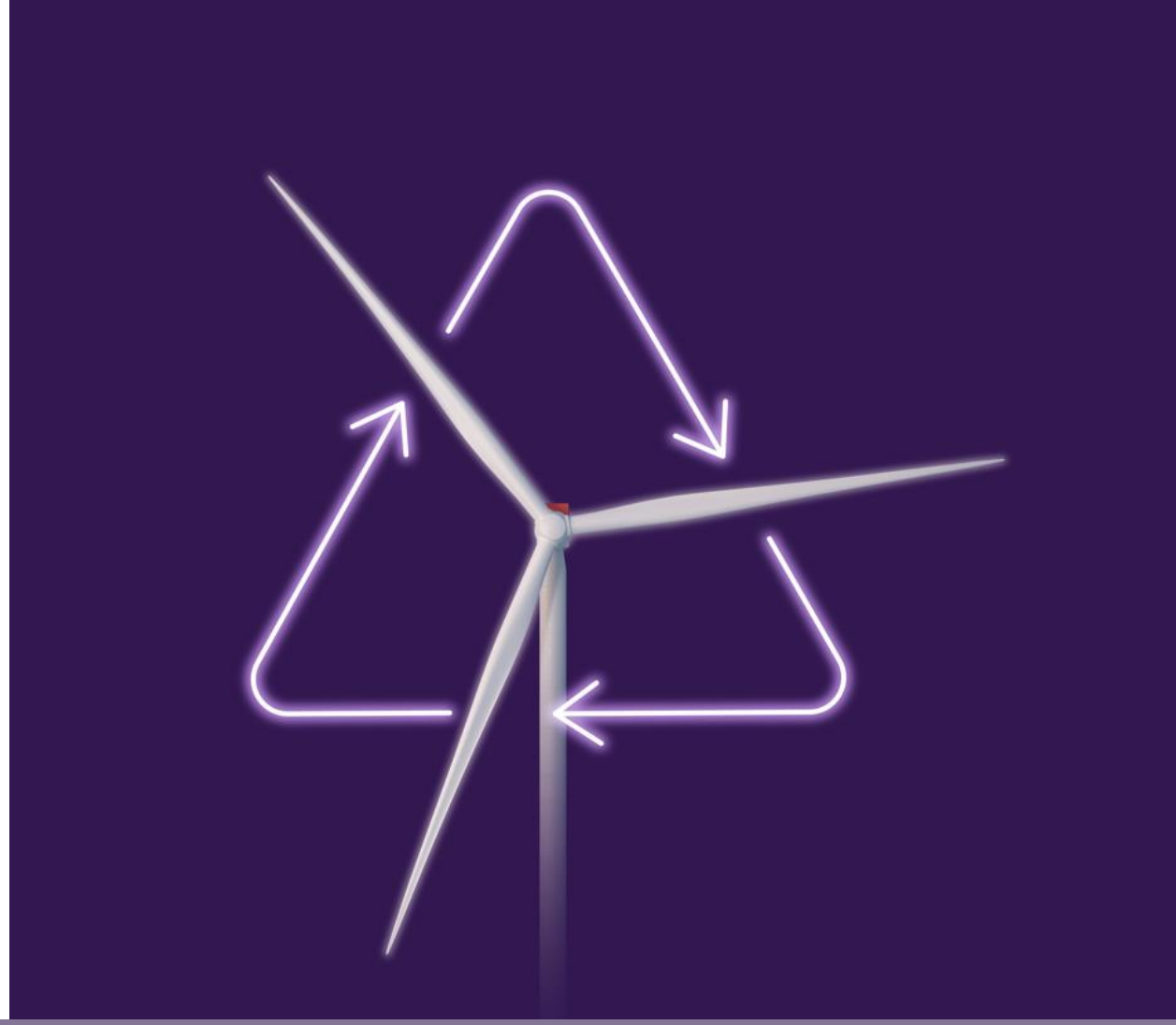
SIEMENS Gamesa RENEWABLE ENERGY

Background

The RecyclableBlade – a Breakthrough Technology for Blades Recycling

CO2 Emission Reduction with RecyclableBlade

The Future is Recyclable



RecyclableBlade

SIEMENS Gamesa
RENEWABLE ENERGY

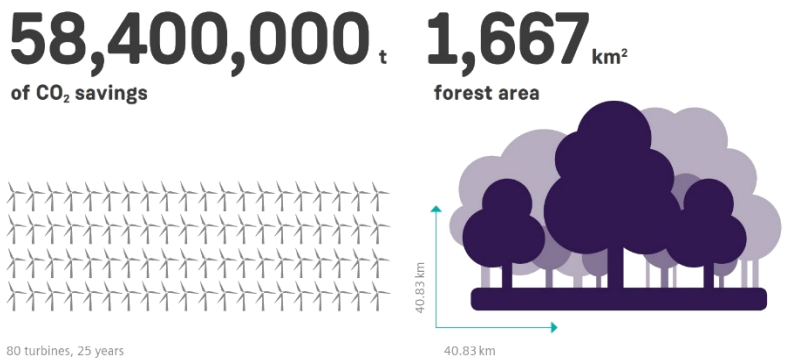
LCA analysis on a SG 8.0-167 DD wind power plant

LCA analysis on a **80 SG 8.0-167 DD turbines** wind power plant for an estimated lifetime of **25 years.** It encompasses raw material extraction, materials processing, manufacturing, installation, operation and maintenance, and dismantling and end-of-life (EPD SG 8.0-167 DD),

LCA results show the wind power plant:

- Produces 68,035,000 MWh – **41 times** more energy than it consumes,
- Energy payback time less than **7.4 months**,
- Saves 58,400,000 tons of CO2 – equal to the CO2 absorbed over 25 years by a **1,667 km² forest**,

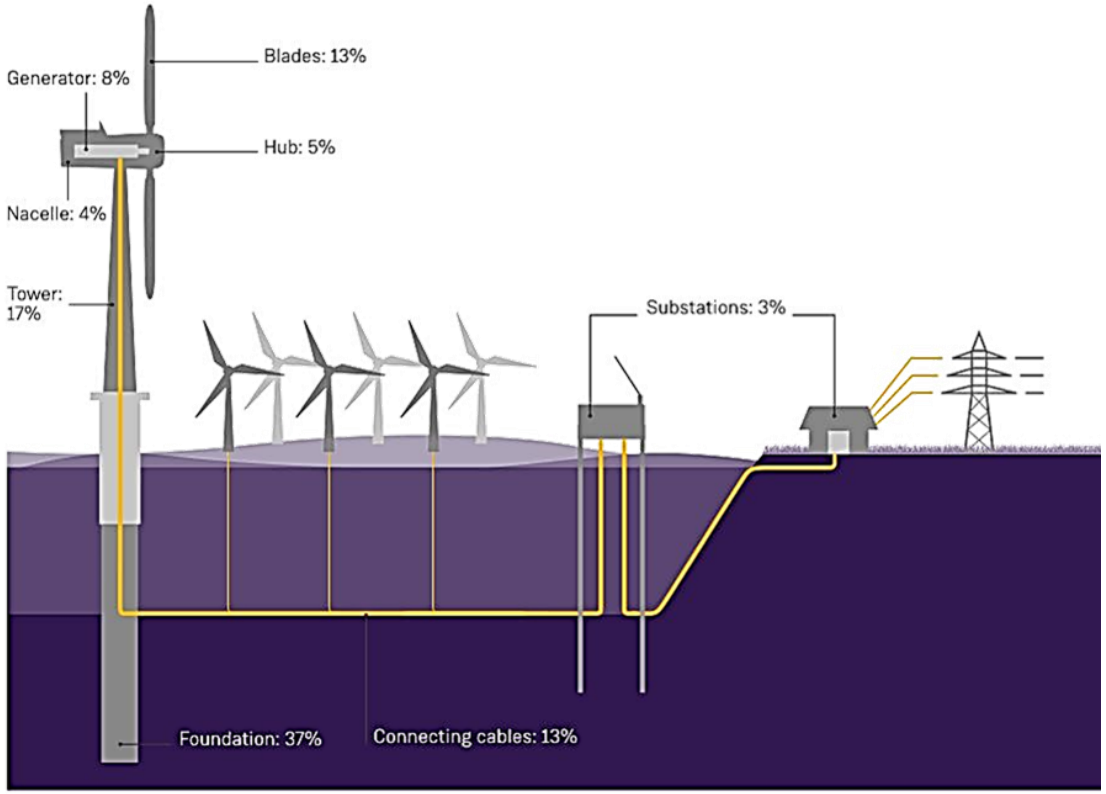
CO_2 emissions from the wind power plant versus global fossil power production (IEA World Energy Outlook, 2012)

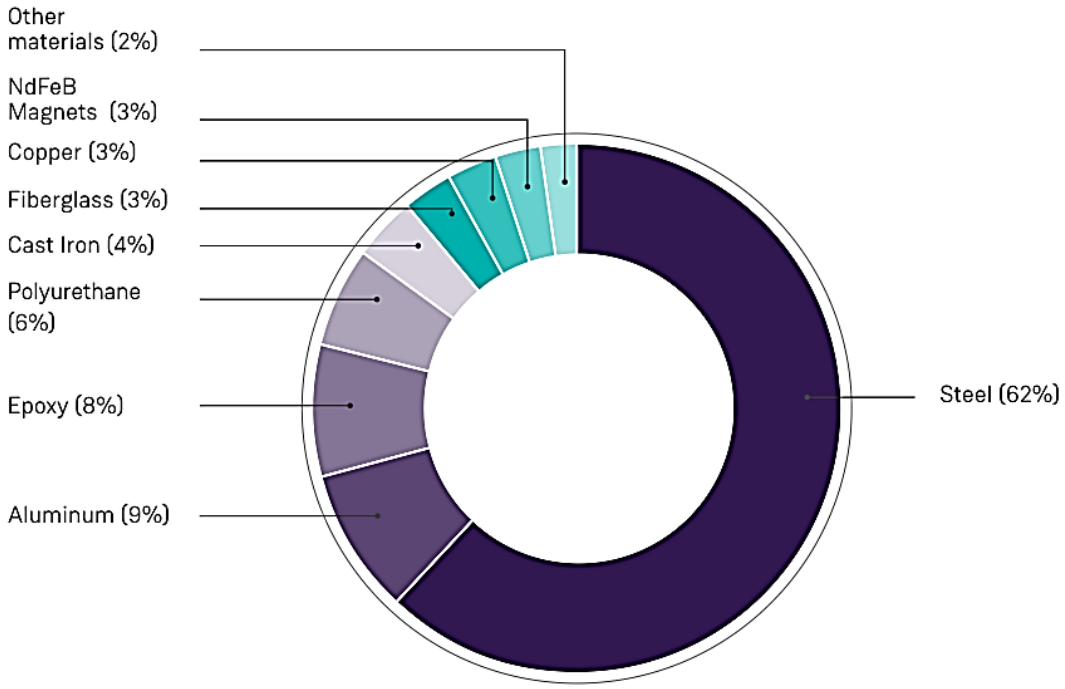


SIEMENS Gamesa
RENEWABLE ENERGY

Wind power plant components CO2eq contributions

Percentage of global warming contribution (gCO2eq/kWh) divided into main components in the wind power plant and material types for(EPD SG 8.0-167 DD).

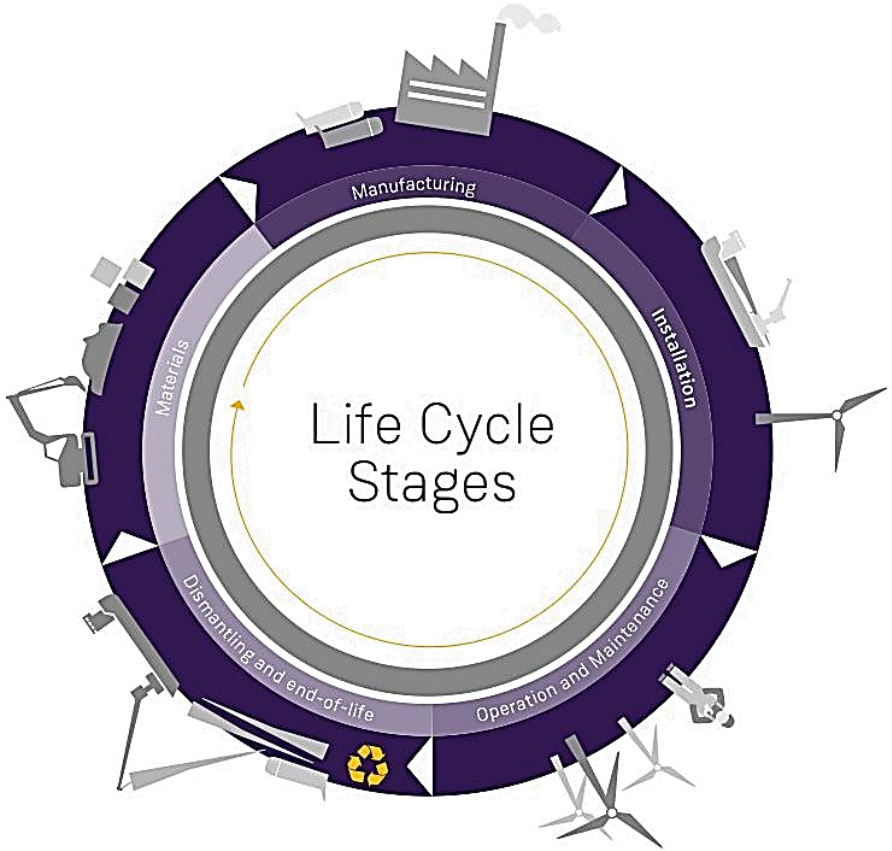




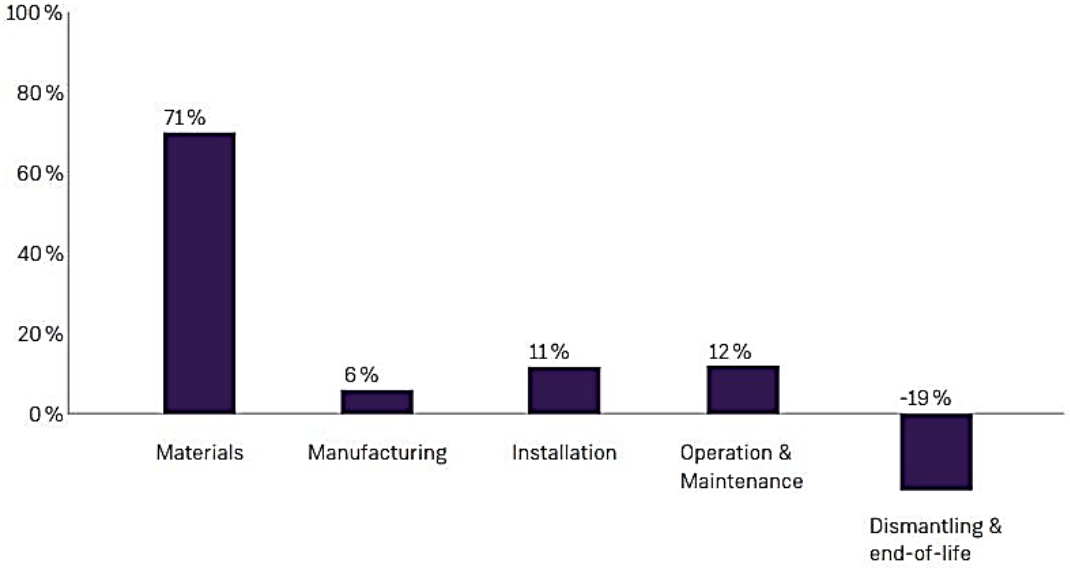
SIEMENS Gamesa
RENEWABLE ENERGY

CO2eq contributions throughout turbine lifecycle stages

Percentage of global warming contribution (gCO2eq/kWh) divided into each life cycle stage (EPD SG 8.0-167 DD).



Blades 81 m (fiberglass, epoxy)
Tower 92 m (steel)
Foundation 925 t (steel)
Substations 12,700 t (steel, concrete)



SIEMENS Gamesa
RENEWABLE ENERGY

LCA case study recyclable matrix

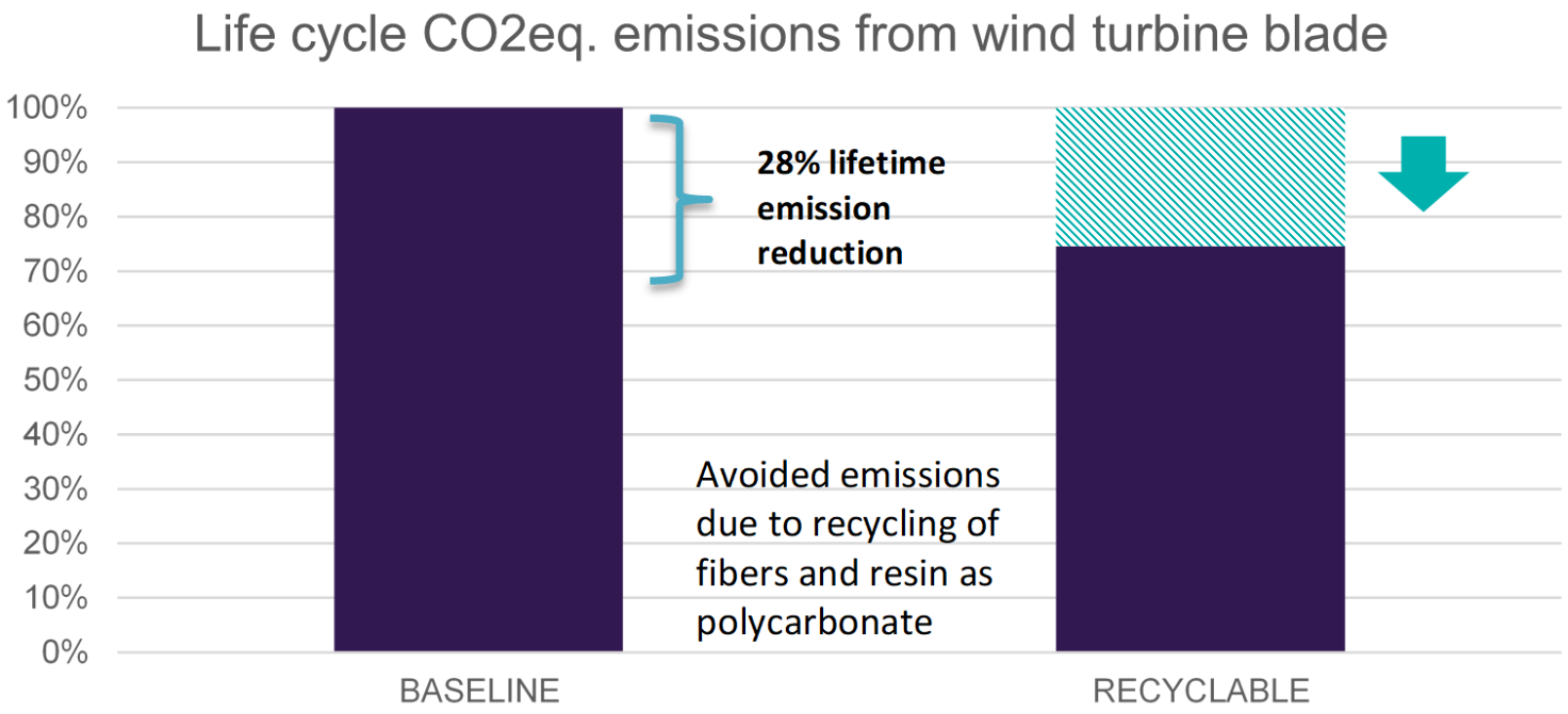
Table 1. LCA comparison study assumptions.

	Baseline assumptions	Recyclable alternative
Materials	• Fibres ~60% • Resin ~28% • Wood ~8% • Plastics ~2% • Paint ~1%	Main difference is in the hardener, so the resin system is modelled as similar to baseline with the exception that production waste is being recycled instead of incinerated
Transportation	Modelled from suppliers to Aalborg and from Aalborg to Esbjerg pre-assembly site	Similar to baseline
Manufacturing	Manufacturing in Aalborg, use of real production data	Similar to baseline, however, waste can be recycled
Installation	Use of installation data from recent projects	Similar to baseline
Operations & Maintenance	Use of O&M data from installed base regarding maintenance need, change of component, etc.	Similar to baseline
End-of-life	Non-recyclable • 90% landfilling, 10% incineration	Recyclable • Resin can be recovered and used as replacement for Polyamide or Polycarbonate thermoplastics • Glass fibres can be recovered, with expected 10% lower properties (due to sizing removal, fibre misalignment etc) and recycled • Metals can be recycled • Paint, coating and core materials will be incinerated

SIEMENS Gamesa RENEWABLE ENERGY

CO2eq comparison

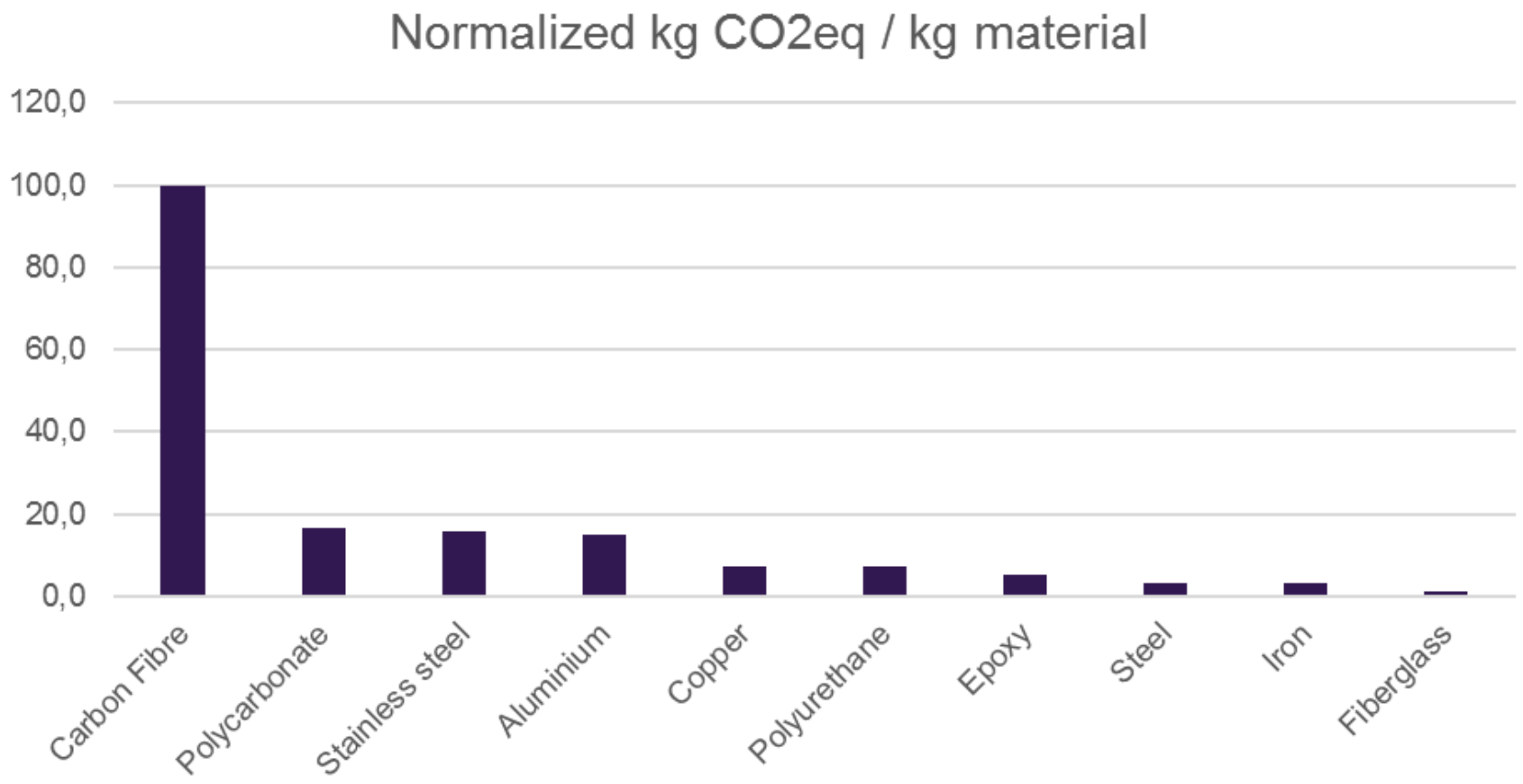
Estimated tons of CO2eq saved per blade (SG 8.0-167 DD) by using a recyclable resin system as opposed to a conventional epoxy resin system



SIEMENS Gamesa
RENEWABLE ENERGY

CO2eq contributions divided per materials

Index of carbon footprint (kg CO2eq/kg) divided per material class.



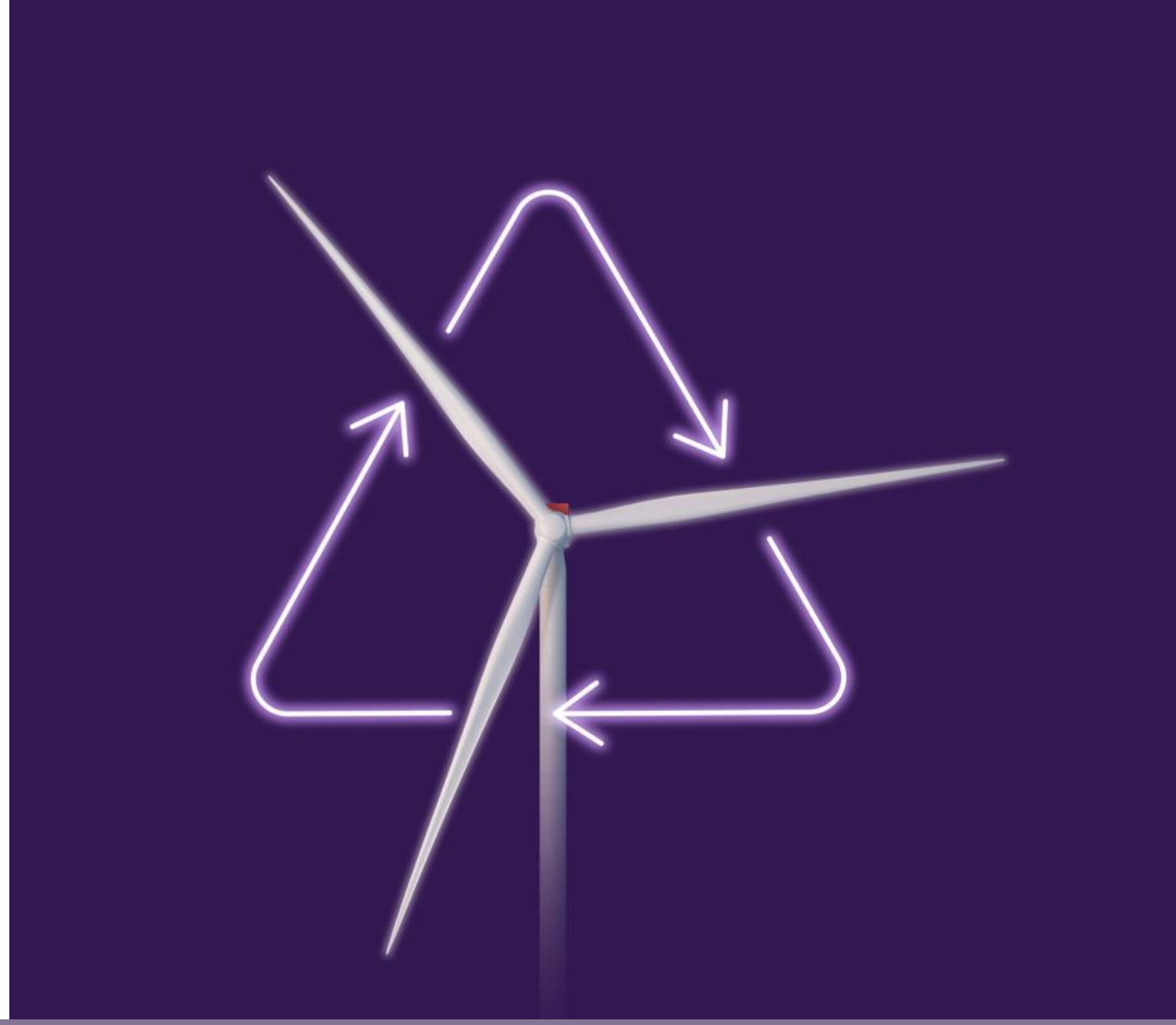
SIEMENS Gamesa
RENEWABLE ENERGY

Background

The RecyclableBlade – a Breakthrough Technology for Blades Recycling

CO2 Emission Reduction with RecyclableBlade

The Future is Recyclable



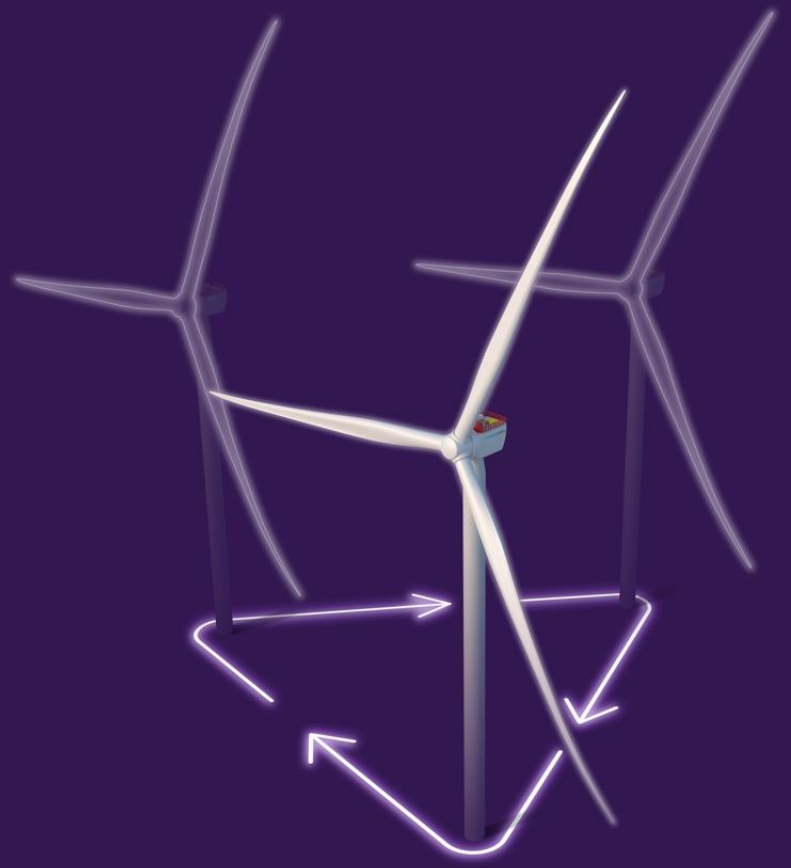
RecyclableBlade

SIEMENS Gamesa
RENEWABLE ENERGY

Siemens Gamesa has taken a big step towards our 2030 goal – already now.

The RecyclableBlade is one big step closer to our vision of a fully recyclable blade –ready for the market today.

The recycled materials can be used for new products after having produced clean energy for many years.



Increased recyclability with simple processing lowers end-of-life costs.

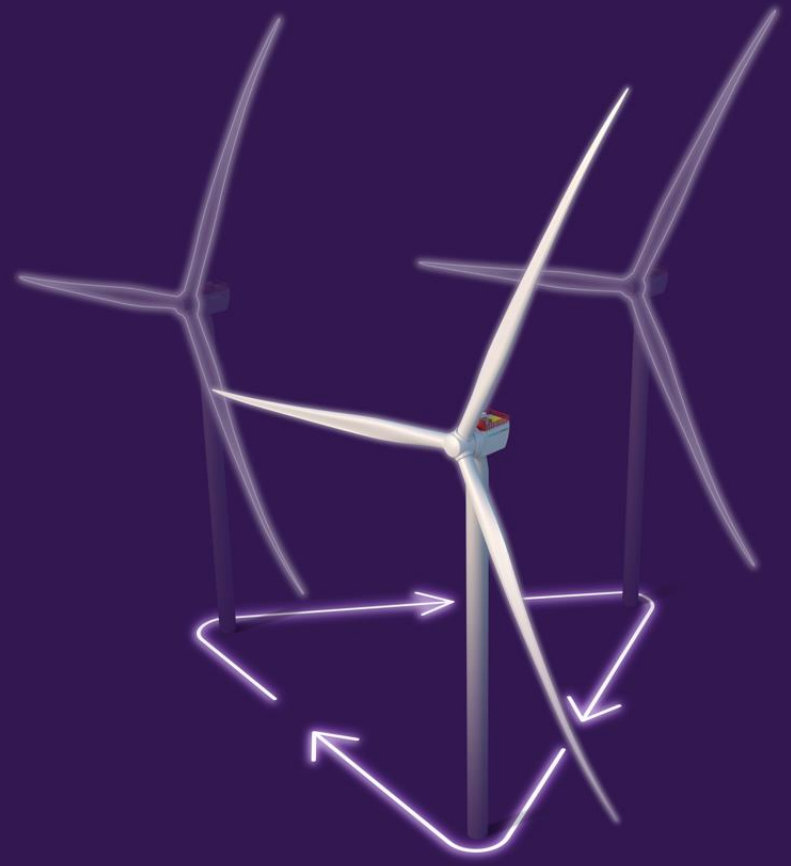
Environmental impact assessment shows an improvement due to the recycling of the materials and use of these in new applications.

SIEMENS Gamesa RENEWABLE ENERGY

It is a big achievement, but still some way to go…

Recyclable blade repair solution

Recyclable surface protection system



Recycling solution for pultruded carbon elements

Permanent or reusable process materials

SIEMENS Gamesa RENEWABLE ENERGY

Imagine if we could apply the SG 14-222 DD with the RecyclableBlade to all new offshore projects until 2050

+200,000

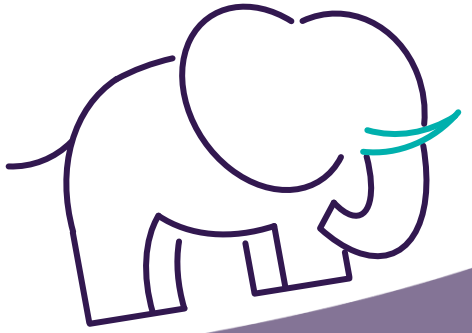
blades would be recycled and avoid ending their life as e.g., landfill.

+22,000 km

is the length of all blades stretched out in a line, reaching more than halfway around the world.

+10,000,000 t

of recyclable blade material, or the weight similar to 1,600,000 African elephants.



Communications

Siemens Gamesa online and on social media

www.siemensgamesa.com

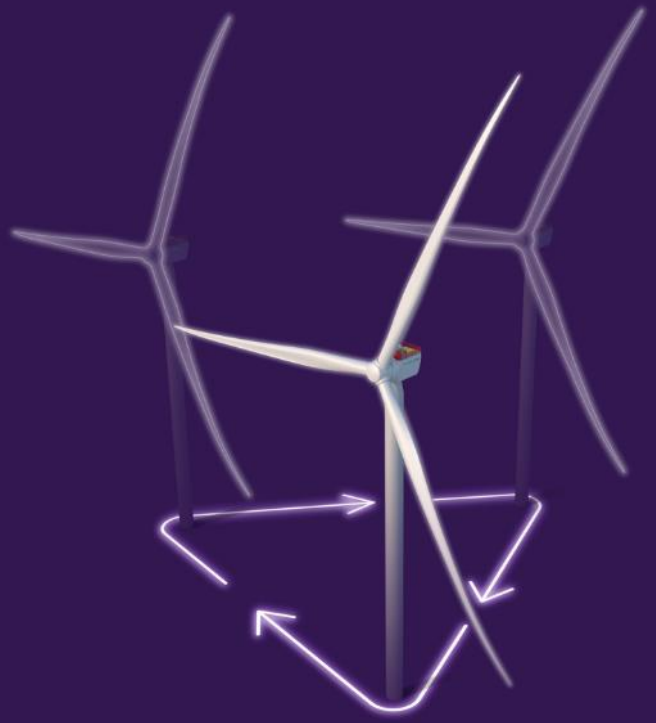
Siemens Gamesa

SiemensGamesa

@SiemensGamesa

SiemensGamesa

facebook.com/
SiemensGamesa



Thank you!

#RecyclableBlade

SIEMENS Gamesa
RENEWABLE ENERGY