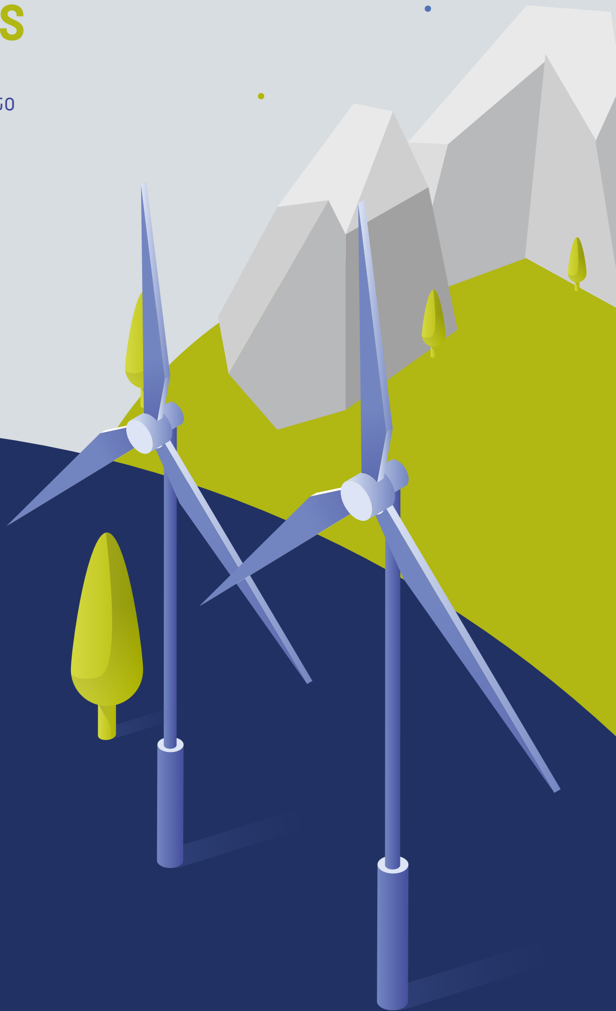
XPRESS

XPRESS LCA FACTSHEET (2/5)

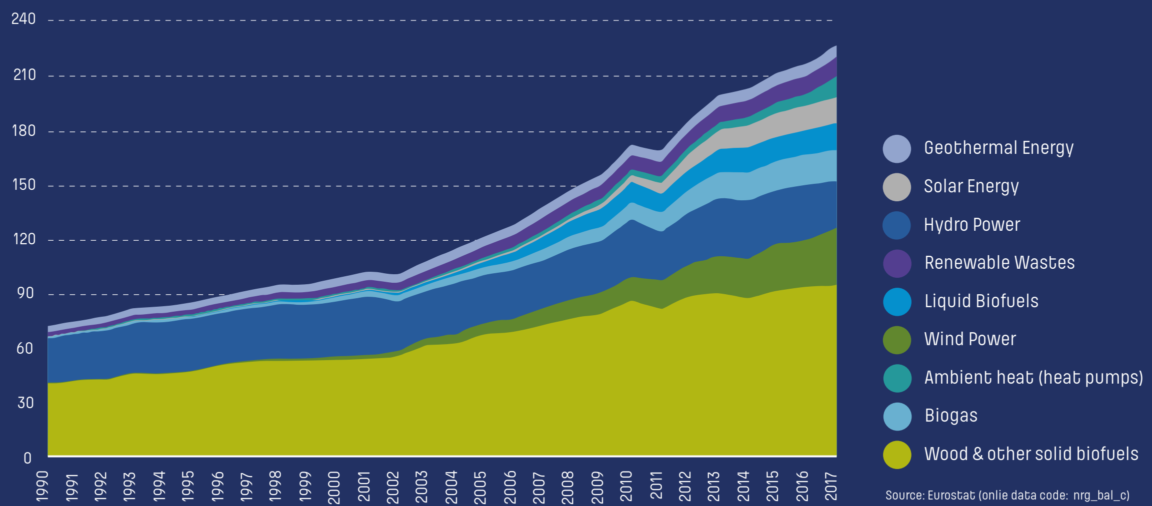
RENEWABLE ENERGY TECHNOLOGIES

The XPRESS project has adopted the LCA attributional modelling approach to look at existing good practice Renewable Energy (RE) technology examples related to past Green Public Procurement tenders found in the TED (Tender Electronic Daily) database.

This factsheet outlines good practices and LCAs related to **Wind Power** technologies.



Wind Power



Source: Eurostat (onlie data code: nrg_bal_c)

Wind power is one of the RE technology sectors that has experienced a sharp increase in installed capacity and its contribution share to the national electricity grids in Europe has grown considerably in the last two decades. It is now the second largest contributor to the RE mix in EU-28, representing around 14% the of the total primary production and 37% of the total RE electricity production.

Wind is a clean, free and abundant energy source that is used to generate electricity, as wind turbines capture the kinetic energy created by airflows to power a generator supplying an electric current. Several wind turbines are typically configured into windfarms that can cover several square kilometres of land or sea to harness both onshore and offshore wind.

Continued improvements in manufacturing and turbine design, as well as improved capacity factors, have driven down the costs of wind power and confirmed its position as a key driver of the clean energy transition.

The XPRESS project focuses on onshore wind power as the projects in which Public Administrations are involved are more aimed at this kind of RES. According to The Wind Power Database 2014, around 3% of the capacity is installed offshore. Solar panels and onshore wind turbines are now a common sight across the EU, which in large part is due to increased market activity. The cost of solar power production has for instance decreased by 75% between 2009 and 2018, and in 2014, onshore wind became cheaper than coal, gas and nuclear.

Onshore wind power

For the modelling of the power production of an onshore wind turbine, a medium size model (2 MW installed capacity) was selected, as this is the most common one in Europe (the Wind Power database). The LCI model is based on the environmental assessment of a Vestas V80/2 MW turbine (Elsam Engineering A/S., 2004), in which the Danish wind park Tjaerborg is analysed.

This type of wind turbine is taken as reference technology of the turbines class with a capacity range between 1 and 3 MW. The dataset includes moving parts such as nacelle, rotor, rotor blades, generator, gear, main shaft, yaw system, etc., as well as fixed parts such as the tower and the foundation. The dataset also includes an estimated energy consumption for the assembly of the turbine of 0.5 kWh/kg material input, as presented in Sacchi et al., 2019. The LCI includes some operation and maintenance activities, like the change of lubricating oil every year, as well as infrastructure inputs, but not the change of replacements like the gearbox.

For the amortization of the emissions, resource consumption and embodied impacts in all the materials and processes necessary for the construction and installation of the wind turbine, a 20-year lifetime was assumed. Even though the design lifetime might be higher, around 25 years for commercial wind turbines (Bonou et al., 2016), a more conservative estimate was deemed more appropriate, following the findings of a recent statistical analysis and a spatially-explicit LCI study carried out for the Danish wind park (Sacchi et al., 2019). There, an average lifetime period of 18.4 years was found based on the actual decommissioned wind turbines in Denmark between 1977 and 2016.

Impact Category	Unit	BE	DE	DK	ES	IT
Climate change	kg CO2 eq	1.01E-02	9.17E-03	7.31E-03	1.04E-02	1.18E-02
Ozone depletion	kg CFC11 eq	8.19E-10	7.46E-10	5.95E-10	8.45E-10	9.64E-10
Ionising radiation	kBq U-235 eq	6.93E-04	6.31E-04	5.03E-04	7.14E-04	8.15E-04
Photochemical ozone formation	kg NMVOC eq	4.81E-05	4.38E-05	3.49E-05	4.96E-05	5.66E-05
Particulate matter	disease inc.	8.33E-10	7.59E-10	6.05E-10	8.59E-10	9.80E-10
Human toxicity, non-cancer	CTUh	6.68E-10	6.09E-10	4.86E-10	6.89E-10	7.87E-10
Human toxicity, cancer	CTUh	4.72E-11	4.30E-11	3.43E-11	4.87E-11	5.56E-11
Acidification	mol H+ eq	6.62E-05	6.03E-05	4.81E-05	6.83E-05	7.80E-05
Eutrophication, freshwater	kg P eq	6.06E-06	5.52E-06	4.40E-06	6.24E-06	7.13E-06
Eutrophication, marine	kg N eq	1.31E-05	1.19E-05	9.53E-06	1.35E-05	1.54E-05
Eutrophication, terrestrial	mol N eq	1.31E-04	1.20E-04	9.54E-05	1.35E-04	1.54E-04
Ecotoxicity, freshwater	CTUe	4.40E-01	4.01E-01	3.20E-01	4.54E-01	5.18E-01
Water use	m3 depriv.	3.40E-03	3.10E-03	2.47E-03	3.51E-03	4.01E-03
Resource use, fossils	MJ	1.29E-01	1.18E-01	9.38E-02	1.33E-01	1.52E-01
Resource use, minerals and metals	kg Sb eq	1.16E-06	1.06E-06	8.45E-07	1.20E-06	1.37E-06

Impact Category	Unit	NO	PT	SK	SE	UK
Climate change	kg CO2 eq	6.86E-03	1.10E-02	1.31E-02	9.11E-03	6.76E-03
Ozone depletion	kg CFC11 eq	5.59E-10	8.93E-10	1.07E-09	7.41E-10	5.50E-10
Ionising radiation	kBq U-235 eq	4.72E-04	7.55E-04	9.03E-04	6.27E-04	4.65E-04
Photochemical ozone formation	kg NMVOC eq	3.28E-05	5.24E-05	6.27E-05	4.35E-05	3.23E-05
Particulate matter	disease inc.	5.68E-10	9.08E-10	1.09E-09	7.54E-10	5.60E-10
Human toxicity, non-cancer	CTUh	4.56E-10	7.29E-10	8.71E-10	6.05E-10	4.49E-10
Human toxicity, cancer	CTUh	3.22E-11	5.15E-11	6.16E-11	4.27E-11	3.17E-11
Acidification	mol H+ eq	4.52E-05	7.22E-05	8.64E-05	5.99E-05	4.45E-05
Eutrophication, freshwater	kg P eq	4.13E-06	6.60E-06	7.90E-06	5.48E-06	4.07E-06
Eutrophication, marine	kg N eq	8.94E-06	1.43E-05	1.71E-05	1.19E-05	8.81E-06
Eutrophication, terrestrial	mol N eq	8.95E-05	1.43E-04	1.71E-04	1.19E-04	8.81E-05
Ecotoxicity, freshwater	CTUe	3.00E-01	4.80E-01	5.74E-01	3.98E-01	2.96E-01
Water use	m3 depriv.	2.32E-03	3.71E-03	4.44E-03	3.08E-03	2.29E-03
Resource use, fossils	MJ	8.80E-02	1.41E-01	1.68E-01	1.17E-01	8.67E-02
Resource use, minerals and metals	kg Sb eq	7.93E-07	1.27E-06	1.52E-06	1.05E-06	7.81E-07

• Estimation of the annual production potential

	BE	DE	DK	ES	IT	NO	PT	SE	SK	UK
Annual production potential (GWh)	5.86	6.43	8.06	5.68	4.97	8.59	5.37	6.47	4.49	8.72
Capacity or Load Factor (%)	33	37	46	32	28	49	31	37	26	50
Weibull shape parameter	2.04	2.31	2.33	1.49	1.37	1.93	2.04	1.49	1.94	1.85
Mean windspeed at 50m (m/s)	6.8	7.16	8.16	6.7	6.2	8.8	6.52	7.42	5.94	9.04

The results shown in the previous tables represent thus a "good practice" of wind power production from a 2 MW onshore high-class wind turbine, installed in good sites in Europe.

Comparing our results to other analysis from literature, it is observed that the reported carbon footprint in Guezuraga et al., 2012 for a similar 2 MW wind turbine (5.98 GWh annual production) is of 9.7 g CO_2e/kWh, which would be close to our results from Germany and in the range of the scenarios of Belgium, Spain and Sweden.

Consortium

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