Wind farms can offset their emissions within two years, new study shows

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After spinning for under two years, a wind farm can offset the carbon emissions generated across its entire 30-year lifespan, when compared to thermal power plants.

That's according to a new study published in the *Journal of the Royal Society of New Zealand*—which also shows within six months a turbine can generate all the energy consumed across its life-cycle.

The research uses data from the Harapaki onshore wind farm in Hawke's Bay, New Zealand—however the authors of the paper explain that their findings would be replicated across most, if not all, wind farms internationally.

"The wind turbine technology employed in New Zealand is consistent with that used internationally," explains lead author Isabella Pimentel Pincelli from the Sustainable Energy Systems research group, Wellington Faculty of Engineering, at Te Herenga Waka Victoria University of Wellington.

"Although the carbon offset depends on the exact older technology the wind turbines are replacing, we would expect a similar offset internationally. In New Zealand it is gas turbines, but many countries will be displacing fossil fuel generators.

"The outcomes of our study underscore the environmental efficiency of onshore wind farms and their important role in the energy transition. Notably, the manufacturing of wind turbines is the primary contributor to the carbon and energy footprints, highlighting a critical area for targeted environmental mitigation strategies."

The study reviewed current literature on wind farms, as well as using real construction data to take into account everything from the manufacturing of individual turbine parts, to transporting them into place, to decommissioning the entire wind farm at Harapaki—which comprises 41 turbines.

The results indicate that this particular farm will leave a carbon footprint

of 10.8 gCO_{2eq}/kWh, which equates to a greenhouse gas payback time of 1.5–1.7 years for avoided combined cycle gas turbines, and an energy payback time of 0.4–0.5 years.

Co-author Professor Alan Brent, Chair in Sustainable Energy Systems at Wellington, explains while the results underscore how onshore wind plants are aligned with the principles of sustainable development, more can still be explored with making the manufacturing process more eco-friendly.

"The environmental impacts of the installation and transportation phases are important. Together they accounted for nearly 10% of the overall emissions," states Brent, a Professor of Sustainable Energy Systems.

"It therefore remains crucial to continue implementing improvements aimed at limiting negative environmental impacts while maximizing positive contributions throughout the supply chain of onshore wind plants.

"Notably, the manufacturing of wind turbines is the primary contributor to the carbon and energy footprints, highlighting a critical area for targeted environmental mitigation strategies."

To address the carbon outlay of the process of developing such wind farms, the expert team recommend developing a recycling process for end-of-life blades.

Currently blades are disposed of in landfill due to commercial feasibility, but by recycling the blades—either mechanically or chemically—could drop the emissions from the current 10.8 gCO_{2eq} to a potential 9.7.

Additionally, the team recommend that research is carried out regularly

in this area as with the "rapid advancements of technologies" it will be "necessary to ensure research remains reflective of current practices to accurately inform decision-making processes."

This study has some methodological limitations. First, it focuses only on the energy intensity and emissions throughout the life cycle of the wind farm, even though there are other environmental impacts, such as ozone depletion, human toxicity, acidification, eutrophication, and resource depletion. Social, wildlife, or economic impacts were also not considered.

More information: Isabella Pimentel Pincelli et al, Developing onshore wind farms in Aotearoa New Zealand: carbon and energy footprints, *Journal of the Royal Society of New Zealand* (2024). DOI: 10.1080/03036758.2024.2344785

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