Policy Brief

Sustainable Approaches to Wind Turbine Decommissioning

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INTRODUCTION

European renewable energy policies must include specific guidelines for decommissioning wind turbines to ensure a sustainable approach to the end of their productive life cycle. The EU lacks regulations on wind turbine decommissioning and waste management of wind turbines. Our paper proposes several policies to address this critical gap in the existing European directives.

The European Union projects a massive increase in on- and offshore wind capacity from the current state of 221 GW today up to 500 GW in 2030 and 1.300 GW by 2050 (EU wind energy, EUR-Lex - 52023DC0669 - EN - EUR-Lex). Annually, that means an increase of thousands of newly installed wind turbines across the European Union. However, the estimated lifespan of wind turbines is only between 20 to 30 years. Planning the end of their productive life cycle is therefore necessary and establishing robust legal requirements and effective policy frameworks will ensure a sustainable approach to repowering, refurbishing, and dismantling.

This policy brief proposes several evidence-based measures. The recommendations are grounded in an extensive background study and a summary report conducted by Tractebel Engineering S.A., on behalf of the Province of Flemish Brabant within the framework of the Interreg Europe project, BIOWIND (Tractabel, 'Background Study on Sustainable Approaches to Wind Turbine Decommissioning' - May 2024). The analysis and conclusions were further enriched by contributions from policymakers, public servants and private companies, active in the decommissioning industry of 8 EU member states, during workshops and discussions in the project. (Tractabel, 'Summary Report of the Workshop on Sustainable Approaches to Wind Turbine Decommissioning' - July 2024).

KEY PRINCIPLES OF PRIORITISATION

The first policy proposal is to integrate a 'principle of prioritisation' of certain end-of-life scenarios over others. The Renewable Energy Directive does not address the issue of wind turbine decommissioning. The Waste Framework Directive (2008/98/EC) and Circular Economy Package of 2018 do apply when it comes to repurposing, recycling or disposal, but they are insufficient to deal with the challenge of wind turbine decommissioning. We propose that the next revision of the Renewable Energy Directive includes a chapter on decommissioning and that it integrates the following prioritisation when it comes to wind turbine end-of-life scenarios:

I. **Repowering**: once wind farms and turbines worldwide reach their end-of-life, there are 3 options that can be considered. The most favourable option, from an energy point of view, is to repower. It consists of decommissioning and dismantling the existing turbines and replacing or redeveloping the area with newer, bigger, better performing wind turbines.

II. **Refurbishing**: if for a justified reason repowering is not a feasible option and the end-of-life of the current equipment is reached, the second option consists of refurbishing the existing turbines. This means replacing or repairing the components that are most vulnerable to wear and tear. As such, the lifetime of the turbines and windfarms can be prolonged from 20 to 30 years or more.

III. **Dismantling**: whenever the end-of-life of most components is reached and repowering or refurbishing is not an option for justified reasons, a complete dismantling of the wind turbine and project zone should be required. In that case the zone and landscape are required to be restored to its original state.

IV. **Prioritisation regarding Reselling, Repurposing and Recycling**: once wind turbines and their parts are deconstructed, the decommissioned pieces should be processed in the most sustainable way following the Ladder of Lansink. (a) Reselling the turbines or its parts on a second-hand market has the priority over (b) repurposing the components. (c) Recycling should be considered only as a last resort, (d) whereas disposal should be forbidden.

POLICY PROPOSALS

FOR THE RENEWABLE ENERGY DIRECTIVE AND THE WASTE FRAMEWORK DIRECTIVE

1. **Deconstruction manual and dismantlement by design:** wind turbine developers will be legally required to provide a 'technical deconstruction manual' to facilitate the dismantling and refurbishing process. Future wind turbine designs will have to prioritize full dismantlement and easy refurbishment as core principles. This should be incentivized by EU policies in R&D and enforced through progressive targets. Consequently, deconstruction and refurbishing will result in minimal damage to wind turbines and their components, making them easier to sell on the second-hand market.

   Secondly, public information and consultation should be planned for both leading up to and during the decommissioning phase to ensure transparency and community involvement.

   Lastly, cross-sector partnerships will be encouraged to integrate turbine recycling into broader circular economy initiatives, fostering innovation and sustainability.

2. **Secure financial guarantees for dismantling the wind turbine infrastructure and full recovery of the project zone:** A predefined sum of money from the asset owner must be transferred to a blocked account or a state-owned fund as the final step before

operational permits are granted. This measure aims to prevent financial constraints on the part of the owner at the end of the turbines' life cycle.

3. **Require full excavation of the foundations and recovery of the project zone:** a complete demolition of the foundations will be required to bring the whole project zone back to the original state. Often the resource gain from the foundations does not outweigh the cost of demolition. Therefore, a clear legislation has to oblige the complete demolition of these components. The foundations should be replaced by earth with characteristics comparable to the land in place near the site.

   A policy exception can be made when an Environmental Impact Assessment (EIA) explicitly recommends against full demolition. This is particularly relevant for offshore wind farm projects due to biodiversity concerns. Over the lifespan of wind farms, biological communities establish themselves, making it impractical to determine the suitability of removing the foundations during the initial EIA phase. Therefore, it may be necessary to require an assessment of the animal and plant communities inhabiting the foundations at the end of the wind farm's lifespan to inform this decision. Additionally, monitoring during the operational phase of the wind farm could be implemented to support decision-making at the end of its lifespan. This would help determine whether to completely remove the foundations or to implement measures that support the long-term maintenance of the biological marine communities that have colonized these structures over the turbine's lifespan.

4. Develop and implement programs to **train local workers and social enterprises in turbine decommissioning** and recycling techniques. These programs will enhance local skills and create job opportunities, contributing to economic growth.

5. Provide support for **pilot projects** that demonstrate transferable solutions in turbine decommissioning and recycling. These projects will serve as models for best practices and encourage the adoption of innovative approaches.

6. **Improve turbine blade recycling:** wind turbines are primarily composed of steel, concrete, copper and plastics which are relatively easy to recycle. They constitute 90 percent of the turbine, but the composite materials used in the turbine blades pose a particular challenge due to the combination of resin and fibres, usually made from glass or carbon. 5 policy actions are needed regarding recycling:

   i. **Building permits for wind turbines should require a Material Identity Card**. That means that the composition of the composite materials of the blades is known from the project's start which allows for selecting the most suitable recycling techniques at the end-of-life. Already at the beginning of the project, an end-of-life roadmap for these materials must be specified.

ii. Create **Dedicated Waste Codes** in the next revision of the Waste Framework Directive that establish specific codes for composite materials to improve traceability and recycling processes. This improved traceability will help in understanding the quantities and types of composites used, which in turn is essential for managing and optimizing recycling processes.
iii. **A ban on landfilling composite material waste** by 2025: wind turbine blades are not biodegradable and persist for hundreds of years. By banning landfilling other options will be considered and will encourage the development of recycling technologies and promote circularity.
iv. **Regulate Cross-Border Waste Transport of composite material waste**: the aim is to prevent landfilling to be outsourced to non-EU countries.
v. Incentivise wind turbine developers to optimize blade design for complete recyclability by **setting progressive targets** (from 2025 to 2030) and by providing financial support for research and development on recycling composite waste.

This Policy brief presents findings, policy lessons and evidence-based measures on Wind Turbine Decomissioning. The recommendations are grounded in an extensive background study, roundtable discussions with stakeholders and a summary report conducted by Tractebel Engineering S.A., on behalf of the Province of Flemish Brabant within the framework of the Interreg Europe project, BIOWIND. This policy brief is written by Linus Vanhellemont and edited by Linde Smits and María-José Cebrián Tornero.

References

Tractebel (May 2024) *'Background Study on Sustainable Approaches to Wind Turbine Decommissioning'.* Province of Flemish Brabant.

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