The future of onshore wind decommissioning in Scotland

Summary

What is the future of onshore wind decommissioning in Scotland?

Background

Onshore wind is a key element in Scotland's transition to renewable electricity, providing 70% of its generation capacity in 2019. However, while the electricity produced is renewable, the materials used to manufacture the turbines are not. Scotland was an early adopter of this technology, and with an average lifespan of 25 years, many of the first turbines installed are now coming to the end of their life. We must now seek to maximise the value of the materials within existing turbines and reduce the carbon emissions associated with their disposal and the manufacture of replacement turbines.

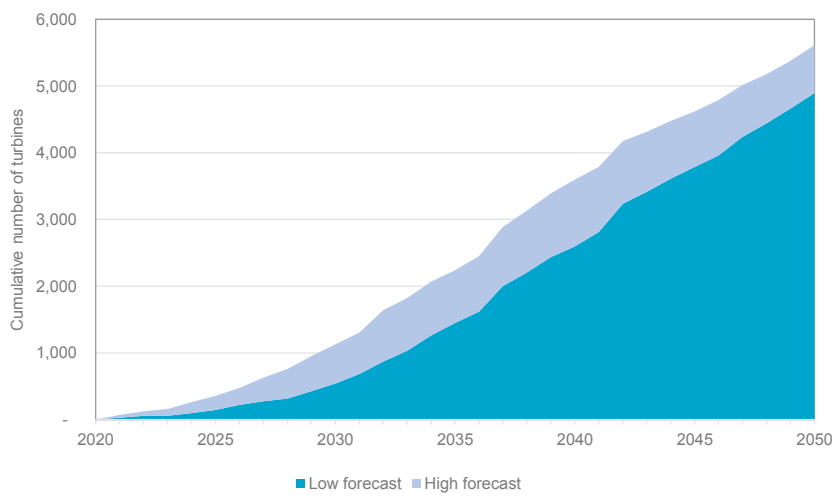
This paper provides projections for the number of onshore wind turbines in Scotland that will be decommissioned up to 2050 and the corresponding quantity of materials. The opportunities for maximising the value of these decommissioned turbines, and their relative merits and practical considerations, are then explored.

Forecast for onshore wind decommissioning

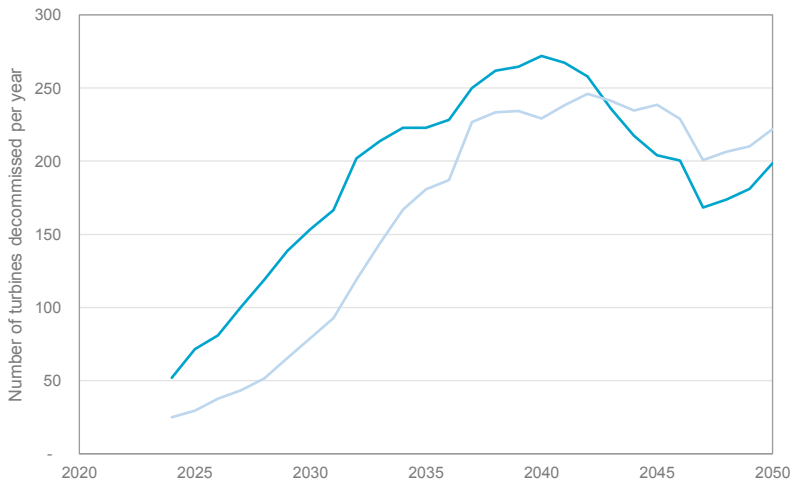
There are over 800 wind turbine locations in Scotland, ranging in size from 1 to 150 turbines, and these are located across the geography of the country, with a significant proportion spread across Highland, and concentrated clusters in Aberdeenshire, Dumfries and Galloway and the Central Belt.

Based on sites that were either consented, in construction, or operational in 2002, and taking into account different phrasing and magnitude of repowering efforts, our projections estimate that a total of between 4,894 and 5,613 turbines will be decommissioned by 2050. Year by year projections show significant fluctuation, primarily due to large wind farms reaching their end of life, but the five year average shows by 2040 there could be around 250 turbines per year being decommissioned.

Scottish Onshore Wind Decommissioning Forecast (2020-2050)



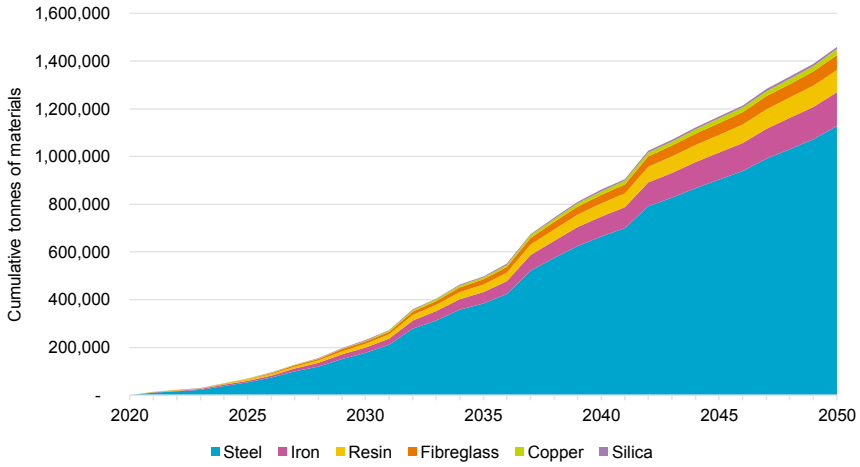
High vs Low 5 year average



Materials breakdown and forecast

Turbines are made up of a mix of recyclable (iron, steel and copper) and non-recyclable (fibreglass and resin) materials. Steel is the dominant material by weight in a turbine; ferrous metals in total make up around 90% of the asset. Based on the projections, by 2050 onshore wind decommissioning in Scotland could have generated in excess of 1.4M tonnes of materials, including 1.1M tonnes steel, 142,000 tonnes iron, 24,000 tonnes of copper, 63,000 tonnes of fibreglass and 94,000 tonnes of resin and balsa wood.

Material arisings from turbine decommissioning (high forecast)



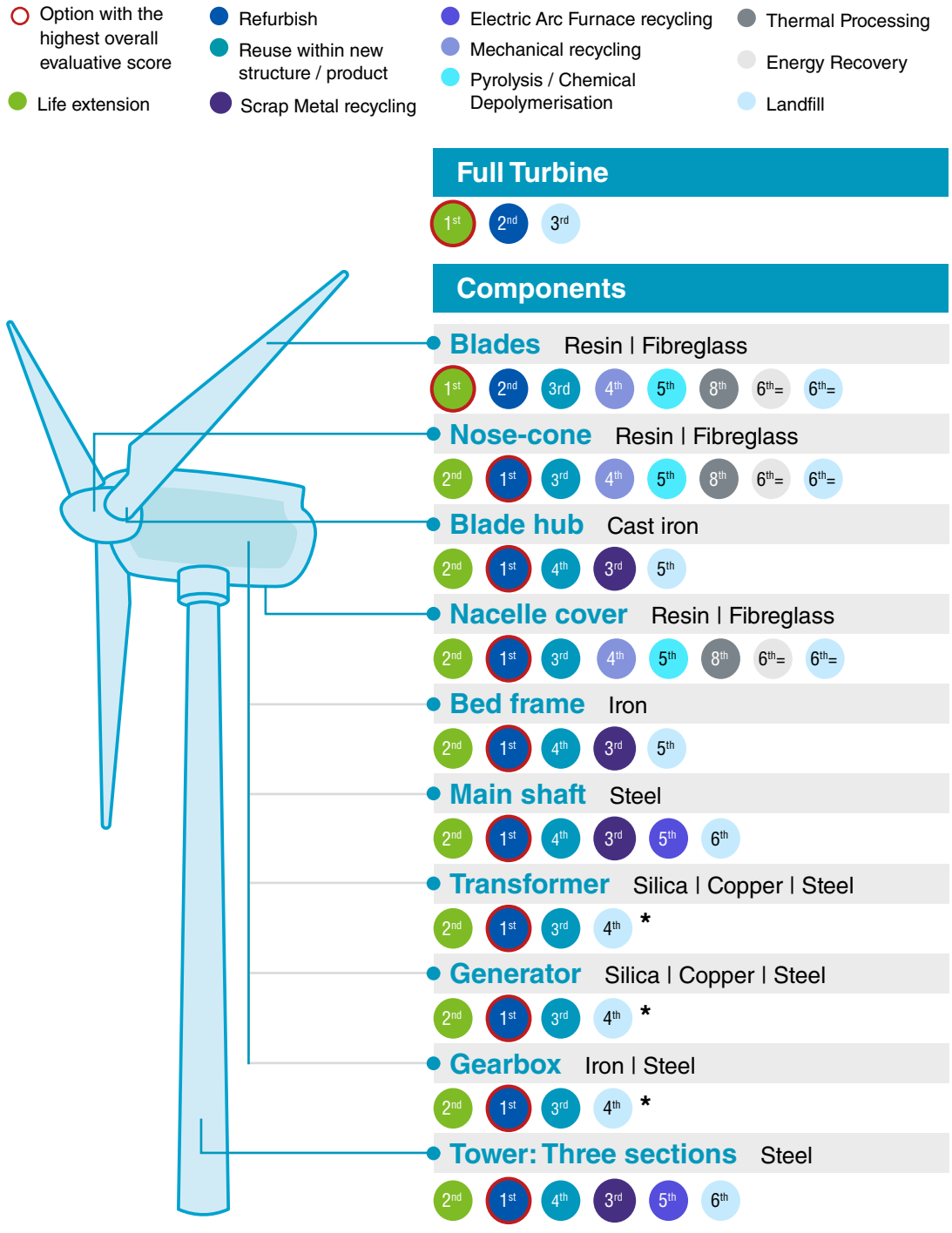
Around 80% of a wind turbine is currently recyclable; however, the biggest size categories of turbine may still require ~100 tonnes of material to be landfilled, per asset. Furthermore, there is extremely limited data available to confirm actual disposal or recycling destinations of materials from decommissioned assets.

Opportunities to maximise resource use

As wind turbines near their end of life, there are a number of opportunities to reduce their material impacts. The multi-criteria analysis used in this report takes into account variables including (but were not limited to) carbon intensity, cost, availability of infrastructure, scalability, employment generated, value retention in Scotland, and demand for output. This concludes that the best options are to:

- Extend current life of the turbine
- Where possible, decommission and refurbish the turbine for installation in a new location
- Decommission and refurbish components to be used as spare parts

Turbine Material Treatment Options

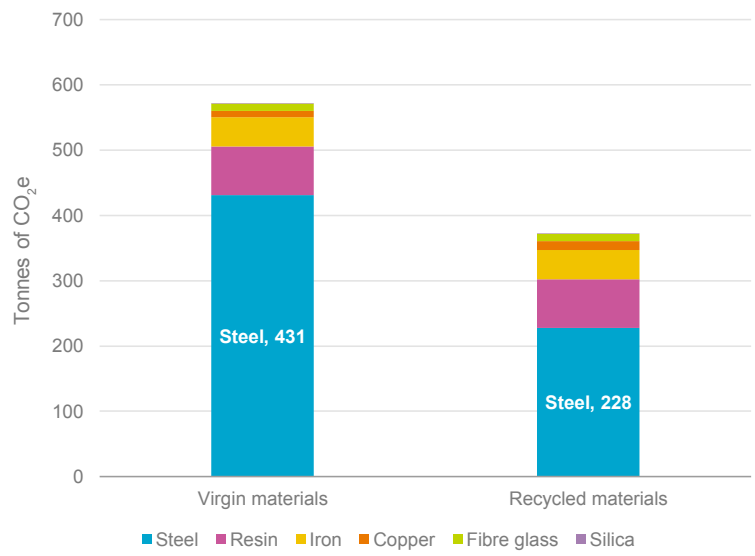


Transformers generators and gearboxes consist of multiple components and materials that cannot be processed as one, therefore recycling options are not addressed in the infographic. The treatment methods for materials within these components are addressed in Table 3.4.

These options are also considered to be the most practical and the most economical options, offering the greatest value to Scotland and the industry through economic growth and retention of resources as well as the development of skills within the Scottish economy.

Where reuse is not an option, materials from the turbine should be recycled - steel, iron, cast iron and copper can be readily re-smelted at end of life. If these recycled materials were then used in the manufacutring of new turbines, it could save emissions of 35% compared to virgin materials. Steel is the most prevalent material in turbines, accounting for 75% of manufacturing emissions when using virgin steel - and also has the biggest potential for emissions savings.

Manufacturing emissions for a typical 2MW wind turbine



Barriers to more circular decommissioning are a lack of reprocessing infrastructure (including dismantling and transport) and storage locations. The annual fluctuations in quantities of decommissioned turbines may cause an issue for refurbishment and recycling activities and storage will be required to smooth out the peaks in decommissioning. This could prove logistically difficult but is considered to be one of the biggest decommissioning challenges, alongside transportation. Ports across Scotland are well placed to respond to these infrastructure needs and could provide a suitable location for a decommissioning hub as they have the potential space and may already have experience with the wind industry.

Alongside the lack of infrastructure is the lack of Scottish expertise and skills. Many of the original equipment manufacturers are based abroad and they hold much of the necessary information and skills required for refurbishment and reuse.

Conclusions

The lifespan of wind turbines should be maximised as far as possible with whole turbines and components being refurbished and reused in Scotland. Reprocessing infrastructure and storage facilities will be required to enable this and the quantified projections detailed in this research will support the planning for these activities. The development of a decommissioning hub at one or more ports could provide a suitable location for this infrastructure. A focus on increasing the skills and expertise of reuse and refurbishment of wind turbines in Scotland will be required to enable an increase in circularity.

Where reuse and refurbishment are not an option the materials should be recycled. While the metals in wind turbines are already commonly recycled, only approximately 40% of recycled scrap metal is retained in the UK. Other materials such as resin, silica and fibreglass are less widely recycled and mechanical recycling technologies and facilities will need to be developed.

Read the full report here.

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