ETIP Wind

EUROPEAN TECHNOLOGY & INNOVATION PLATFORM ON **WIND ENERGY**

Report of workshop "Delivering on circularity through innovative materials and recycling technology".

WindEurope

May 2021

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1 Context

1.1 Background

As promised in the grant agreement, the ETIPWind secretariat will organise meetings and workshops for the wind energy community. The workshops will support the design and implementation of the platform's key deliverables, most notably the 2021 Strategic Research & Innovation Agenda and the thematic factsheets. This workshop report (deliverable D3.3) relates to the ETIPWind activities described in Work Package 3, task 3.1.

1.2 Scope

On 4 May the European Technology and Innovation Platform on Wind Energy (ETIPWind) with the support of WindEurope's Sustainability Workshop held an online workshop entitled: "Delivering on circularity through innovative materials and recycling technology".

The aim of the workshop was to connect experts from various industries of the wind energy supply chain to design a cross-sectoral approach to wind turbine circularity. This comprises the development of new materials that will be more circular-by-design and of new technologies to recycle those materials used in wind energy today that are currently hard to recycle. And to share best practices and insights on how technology and policy can stimulate circularity.

The target audience therefore included on the one hand technical experts from the entire wind energy, composite, copper, cement, and rare earth mining sectors and on the other hand policymakers from national and European institutions.

2 Agenda

Time	Item
10:00 – 10:05	**Introduction** Adrian Timbus, ETIPWind Executive Committee
10:05 – 10:20	**Keynote presentation** Milan Grohol, European Commission (DG GROW)
10:20 – 11:10	**Session 1: Mapping material use in wind** ***Interactive session with entire audience***
11:10 – 11:20	**Coffee Break**
11:20 – 12:20	**Session 2: The economics of materials for wind energy** **Moderator:** Adrian Timbus, ETIPWind Executive Committee Chair **Speakers**: Modvion, Supernode GreenSpur Wind Ltd.
12:20 – 12:30	**Warm-up for afternoon part on Sustainability/circularity** **Adrian Timbus**, ETIPWind
12:30 – 13:30	**Lunch Break**
13:30 – 15:00	**Session 3: Finding a second life for wind turbine components: recycling challenges and Opportunities** **Moderators:** Claudia Grotz, WindEurope Sustainability Working Group and Ben Drogt, European Composites Industry Association (EuCIA) **Speakers:** Vestas, Boliden, Geocycle Europe/LafargeHolcim, University of Strathclyde
15:00 – 15:10	**Coffee Break**
15:10 – 16:10	**Session 4: Research Landscape- Leading research projects and upcoming funding opportunities** ***Presentations and Q&A*** **Moderators:** Claudia Grotz, WindEurope Sustainability Working Group and Ben Drogt, Managing Director, **Speakers:** SUEZ, LM Wind Power, European Commission (DG RTD)
16:10 – 16:30	**Closing remarks and next steps** Adrian Timbus, ETIPWind Executive Committee and Claudia Grotz, WindEurope Sustainability Working Group

3 Minutes of the workshop

3.1 Introduction

Adrian Timbus, Chair of the ETIPWind Executive Committee, opened the workshop. He welcomed all the participants and explained the house rules of the workshop. As the workshop was held virtually participants could send their questions and feedback via the chat function. Some questions were answered during the panel discussions, others were answered by the panellists directly in the chat. See Annex 2.

He then proceeded with a broad introduction to wind energy in Europe and the challenges and opportunities ahead. In 2020 there was 197 GW of installed wind energy capacity in the EU-27 and UK. By 2030 this will be almost 400 GW. And to become climate-neutral by 2050 we would need up to 1,200 GW. So we will need to significantly accelerate the deployment of wind.

At the same time European citizens want and deserve energy that is 100% sustainable. The wind industry is committed to provide it. But to deliver 100% circular wind turbines we will need more research & innovation (R&I). Especially in material research and recycling technology.

This is where ETIPWind plays a vital role. It helps develop the technologies necessary to support the wind industry and deliver on climate-neutrality by 2050. The platform has identified five pillars of wind energy R&I. And published a detailed roadmap that includes several research priorities on material circularity.

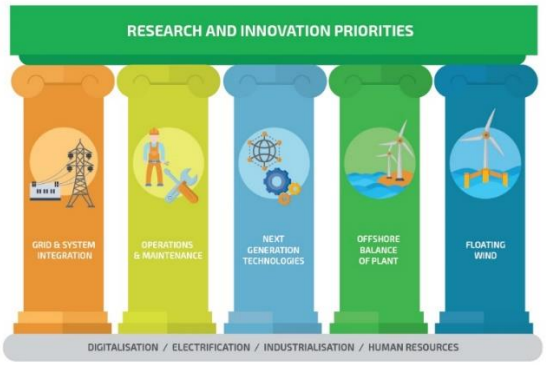

Figure 1: The five pillars of wind energy Research & Innovation.

This workshop took a deeper dive into the topic of material circularity. In the morning sessions participants identified the most critical materials and how we can make our materials supply chain more sustainable. In the afternoon sessions they looked at how the wind and other sectors deal with the materials at the end of their designed life. And explained which materials we can already easily recuperate and for which materials we need new solutions.

In this sense the workshop also builds and expands on previous ETIPWind and WindEurope reports. Most notably the 2019 ETIPWind publication "How wind is going circular – blade recycling?" and the 2020 WindEurope, Cefic and EUCIA publication "Accelerating Wind Turbine Blade Circularity".

3.2 Keynote presentation: Raw materials and circularity for wind energy

Milan Grohol, Policy Officer at the European Commission (DG GROW), presented recent policy developments in renewable energy and the circular economy. He highlighted the European Commission's priorities on raw materials used in strategic technologies and sectors (see publication). There was an in depth look at the rare earth elements used in the magnets and batteries the wind sector relies on.

Critical rare earth elements such as neodymium and dysprosium – sourced in China – are essential to the permanent magnets used in the generators of wind turbines. In 2018 30% of onshore turbines and almost 100% of offshore turbines installed in the EU used permanent magnets synchronous generators. According to the Joint Research Council, this number is expected to grow to 52% for onshore turbines and reduce to 95% for offshore turbines by 2030.

But today Europe only provides 1% of the raw materials used for permanent magnet synchronous generators. In addition, there is not a single EU producer of permanent magnets that can provide for the European wind industry. And the demand for rare earth elements will only continue to grow. The current data shows that Europe is not ready to source the necessary materials from the domestic market.

In 2020 the European Commission identified 30 critical raw material (CRMs) for strategic technologies and sectors in the EU. The list includes several rare earth elements used for permanent magnets. Europe is dependent on imports from a select number of countries for most of these materials. Global supply is highly concentrated in China which poses a risk on continuity of supply continuity and market speculation.

So the European Commission launched the European Raw Materials Alliance to ensure a more stable and secure supply of all critical raw materials. The Alliance put forth a 10-point action plan. Among others it promotes EU-based mining and recycling of critical raw materials. As well as R&I to develop new substitute materials that can reduce EU dependency on third countries.

3.3 Morning sessions: Materials and technology for a more sustainable wind energy

The first session of the workshop was an interactive consultation with the audience. The ETIPWind secretariat moderated the session. The aim was to get the audience's feedback on what the most critical raw materials are for the wind industry today, what risks are associated with those materials, and how to mitigate or resolve these risks.

To this end, the ETIPWind Secretariat prepared a live survey. The participants responded via an online tool and could also see the poll results live. They were asked to provide more details on the risks and mitigation strategies for three materials.

- **Glass fibre reinforced polymers (GFRP)**: 76% of the participants believed social and political acceptance due to limited recycling solutions for GFRP was the biggest risk associated to this material. Participants were clear that improving recycling technology, stimulating re-use of recycled materials and the development of new materials were equally important to mitigate this risk.
- **Copper**: 48% of the participants believed there would be insufficient copper supply to meet the growing demand of the wind sector. Mostly due to increased demand from other sectors. 42% answered that stimulating circularity to would be essential to mitigate this risk.
- **Rare earth elements**: 71% of the participants believed that geo-political tensions and supply chain dependency pose the biggest risk. And 50% believed that stimulating the re-use of recycled materials within the wind sector would the best way to mitigate those risks.

See more results in Annex 3.

The second morning session saw presentations on technical solutions that contribute to a more sustainable wind industry. The presentations focused on the economic and environmental benefits of using new materials and the challenges to implement and integrate them in the already existing wind energy supply chain.

Modular Wooden Towers for Tall Wind Turbines

Modvion developed a new wind tower concept based on laminated wood. Laminated wood has several advantages over the current materials used (steel and, to a lesser degree, cement).

First, the laminated wooden towers are lighter and cheaper than steel. It can deliver the same strength of steel with 35% less mass. This advantage is proportionate to the size of the tower. The taller the tower, the higher the benefits. Tall steel towers are overdesigned (extra mass) to carry their own weight.

Second, the laminated wooden towers are made of small modular segments, which would ease transportation and installation.

Last, laminated wood production is more sustainable than steel today. Producing a wooden tower requires 90% less CO_2 emissions than a traditional one made of steel. And it acts as a carbon sink holding CO_2 from the atmosphere. In addition, this wood can all be produced in Europe.

With recent industry demand for taller onshore wind turbine towers (to access more stable and stronger winds) laminated wooden towers could have a business case.

Superconductors for MVDC Connections

Today the best renewable energy resources are found in Europe's periphery. The largest demand centres are more central (e.g. Bavaria). There is no clarity on how we would transmit the renewable energy from the periphery to where it is needed. Shipping large volumes of electricity across great distances cost effectively will require new transmission technologies.

Supernode developed a superconducting MVDC transmission technology. Superconductor materials, and High Temperature Superconducting (HST) materials in particular, have real potential. They could be cost-competitive for offshore wind farms of 2 GW and more. Superconducting technology would reduce the overall cost of the electrical infrastructure needed for the wind farm, be more robust operationally, and have a better performance (i.e. higher cable availability).

Superconducting technology and materials are being applied more and more. Also in the energy sector. The EcoSwing project developed the first full-size direct drive superconductive generator for a wind turbine. This generator was 25% smaller in size and 40% lighter than other comparable generators. These are significant results for a sector where managing the weight of ever-larger components is paramount to its success.

But there are two challenges to deploying superconducting technology. First, demand for HTS tape cannot be met by current supply. Prices have risen and this halted large-scale deployment. Second there is no clear view on investment in transmission capacity past 2030. Without a clear investment and project pipeline new technologies will struggle to enter the market. Especially in infrastructure markets that rely on government-based planning.

The GreenSpur Rare Earth Free Permanent Magnet Generator

The offshore wind sector is exposed to risks in the rare earth element supply chain. The magnetic material used per unit in offshore wind is high compared to other technologies, including onshore wind. One 14 MW wind turbine would use the same amount of magnetic materials as 1,000 electric vehicles. The expected and

necessary growth of the offshore wind market makes only puts further stress on the supply chain. Demand is forecasted to outstrip supply in the medium term.

So GreenSpur designed a rare earth free permanent magnet generator. The material used in this generator was ferrite, a ceramic material that can be magnetised and is widely available and used. In addition, the GreenSpur generator had an axial-flux design versus the more widely used radial-flux design. This could lead to a smaller design. However, the first design the generator was heavier than its PMSG counterparts. This is because the ferrite magnets only had one third of the magnetic strength of rare earth magnets.

The challenge is therefore to make the technology and design more material efficient, cost effective and scalable to deliver on the long-term growth targets for the wind industry. The expected benefits a more environmentally friendly, and circular solution that uses materials that are widely available.

3.4 Finding a second life for wind turbine components: recycling challenges and opportunities

In the afternoon session participants looked into what the sector does and can do with end-of-life turbines to improve the sustainability of the wind energy sector. Wind turbines – like all machines – have a limited lifetime. 36 GW of onshore capacity installed in Europe will reach the end of its operational life in the next 10 years. And while some turbines will get a lifetime extension, a significant number will also be decommissioned (and some of these decommissioned turbines could be repowered).

Today around 85 to 90% of wind turbine's total mass can already be recycled. There are well-established recycling practices for most materials and components of a wind turbine.

One such material is copper as shown by Boliden. 95% of the copper used in wind farms can be recycled. There are well-established practices to recycle rotating machines, power transformers and power cables. Cables make up 60% of a wind farm copper use. A single wind turbine contains between 2.5 and 6.4 tonnes of copper per MW. Recycling copper components from the blades (about 50 kg per MW, used in, among others, lightning protectors) proves to be more difficult.

The cement used in the foundations of wind turbines can also be recycled. Geocycle already uses concrete recycled from wind turbines. Concrete can be turned into granulates which could substitute the gravel used in for making virgin concrete. However, the granulates are porous and contain various impurities. This makes the recycled cement unsuitable for re-use in the wind sector, which requires high strength concrete.

And magnets are also recyclable. Through the VALOMAG project (for "value of magnets") Suez recovers scrap magnets and produces second-hand magnets and rare earth oxides. There is little material that can be recovered today, but we need to put dismantling processes in place and create a value chain for recycled rare earths magnets now. As of 2032 they estimate 1,100 tonnes of magnetic material can be recovered from the wind sector each year. By 2044 this would be almost 2,000 tonnes. At the same time more permanent magnets will be recovered from other sectors too.

But wind turbine blades are still challenging to recycle. Because they are made of complex composite materials. Solving blade recycling is a top priority, and many EU companies are working on different innovative solutions.

For now, the blades could be grinded and used in the cement sector. This would significantly reduce the CO_2 emissions of the cement plant. And the concrete would be strong enough to build the foundations of new wind turbines. Still, the sector is looking for a more sustainable so solution by improving material recovery in the short term and producing zero-waste blades in the long term.

Vestas presented the DECOMBLADES project that brings together manufacturers, utilities and recycling companies. DECOMBLADES looks at how to recover more valuable materials from the blades. Existing recycling technology alters the material properties as shown by the University of Strathclyde. Recovered materials are less performant than virgin material. Extracting higher performant fibres from recycled blades will be essential to s increase demand for recycled glass and carbon fibres. In addition, recycling technologies need to become more energy efficient.

LM Wind Power presented the ongoing ZEBRA project that explored the technical, economic and environmental relevance of producing zero-waste full-scale thermoplastic wind turbine blades. The blades ware manufactured with an eco-design approach to facilitate recycling at end-of-life. The project provided three recommendations to move towards a 100% sustainable wind energy sector:

- Map and evaluate the potential of sustainable materials for manufacturing wind turbine blades;
- Develop new high-performance materials matching or that are also easily recyclable at end of life; and
- Demonstrate the newly developed materials in a sustainable design of wind turbine blades.

3.5 Next steps: EU funding opportunities

All participants agreed that to further support these different initiatives the EU needs to continue investing in R&I. On the one hand to diversify and scale-up recycling technologies and on the other hand to develop new, high-performance materials. Funding should also focus on developing solutions that improve the circularity of wind turbines at design level. It will help Europe maintain its technological leadership, increase its competitiveness, and help deliver on its climate targets in the most sustainable way.

The European Commission assured the participants that a sustainable expansion of wind energy is one of its top priorities. Several EU-funded projects such as MODVION, MAREWIND, FibreEUse or REFIBRE, are already supporting this objective by creating new instruments and technologies to tackle the current sustainability concerns the industry has.

Furthermore, Horizon Europe – the EU's next framework programme on R&I – will contain dedicated calls for projects to increase blade recycling and wind turbine circularity in general. These calls will be made public in June 2021.

4 Statistics

- 475 people registered to the workshop:
  - 167 registered to the morning sessions;
  - 237 registered to the afternoon sessions; and
  - 71 failed to complete their registration.
- 310 people attended the workshops (77%):
  - 76% of the attendees identified as “Industry”;
  - 11% of the attendees identified as “Academia”; and
  - 13% of attendees identified as “Others”.
- Morning sessions:
  - On average 130 people attended the morning sessions (78%); and
  - The recording has 51 additional views on YouTube.
- Afternoon sessions:
  - On average 180 attended the afternoon sessions (76%); and
  - The recording has 35 additional views on YouTube.