EUROPEAN TECHNOLOGY & INNOVATION PLATFORM ON WIND ENERGY

ETIPWind Executive Committee

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etipwind.eu

July 2019

Agenda

TIMING	AGENDA ITEM
12:30 – 13:30	Lunch
13:30 – 13:45	Welcome Aidan Cronin, chair of the ETIPWind Executive Committee.
13:45 – 14:15	Input to AG meeting November 2019 Discussion.
14:15 – 14:30	State of play on Technology Roadmap ETIPWind secretariat
14:30 – 15:15	Technology roadmap messaging Discussion & approval
15:15 – 15:30	Coffee break
15:30 – 16:15	Finalisation of priorities (research ID kits) Discussion & approval
16:15 – 16:45	Evaluation & impact criteria Discussion & approval
16:45 – 17:00	Coffee break
17:00 – 17:15	State of play on Fact-sheet Blade Recycling ETIPWind secretariat.
17:15 – 18:00	Fact-sheet messaging and priorities Discussion & approval.
18:00 – 18:15	Next Steps ETIPWind secretariat.
18:15 -18:30	AOB
18:30	End of meeting

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ExCo input to Advisory Group meeting

Input to Advisory Group meeting

Recommendations from 01 April AG meeting

- Come up with a list of top 3 components suited to standardisation.
- The aim of standardisation is in the first place to develop of common interfaces (e.g. in logistics).
- Recommendations for European guidelines on spatial planning, permitting, installation, transportation and health & safety.
- Formulate clear policy recommendations on blade recycling.
- Develop a factsheet on bade recycling technologies focusing on environmental impact, prices and regulatory frameworks.

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Technology Roadmap

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State of play (1/2)

Overall narrative

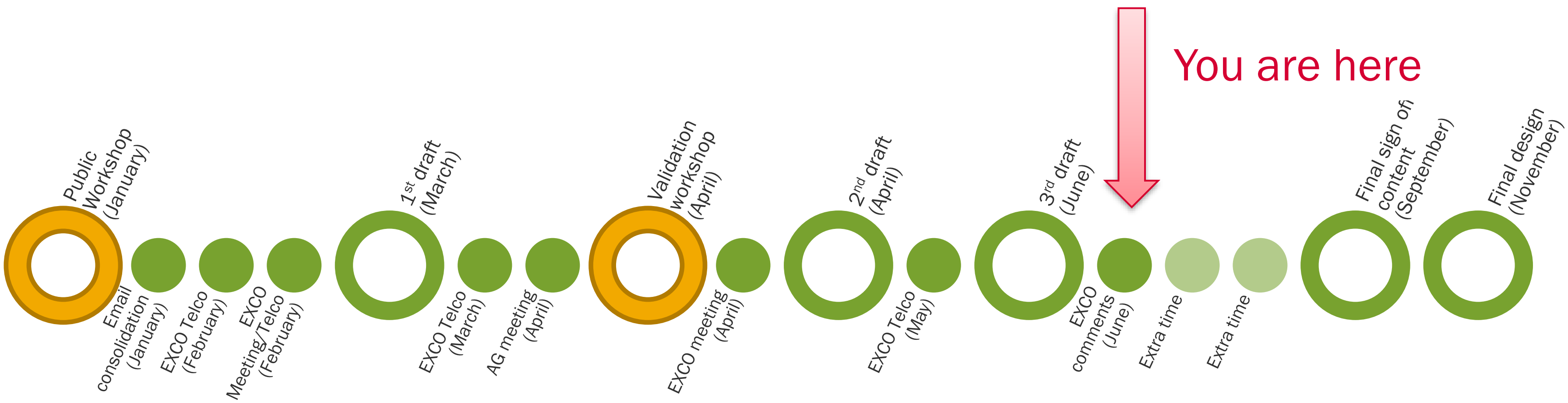
- Needs to be shorter.
- Argumentation to be refined.
  - Wind is a success <-> wind needs more support.
  - Brevity <-> robust analysis
  - …

Research Priority ID-Kits

- Very few comments received (good or bad?).
- Some ID-kits really need more substance.
- Too many to print all:
  - Online repository?
  - Interactive website?

State of play (2/2)

Timeline



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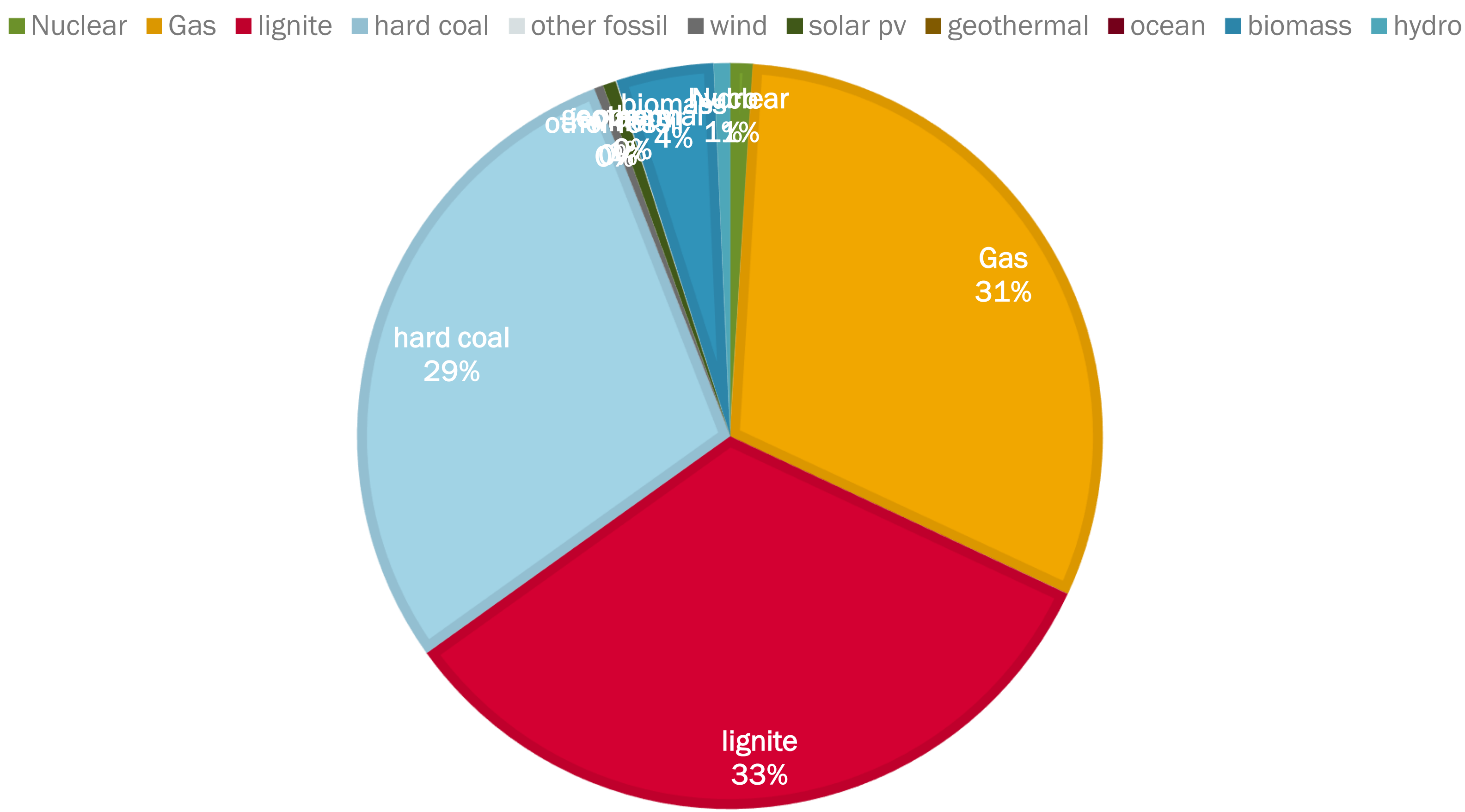
Overall narrative ()

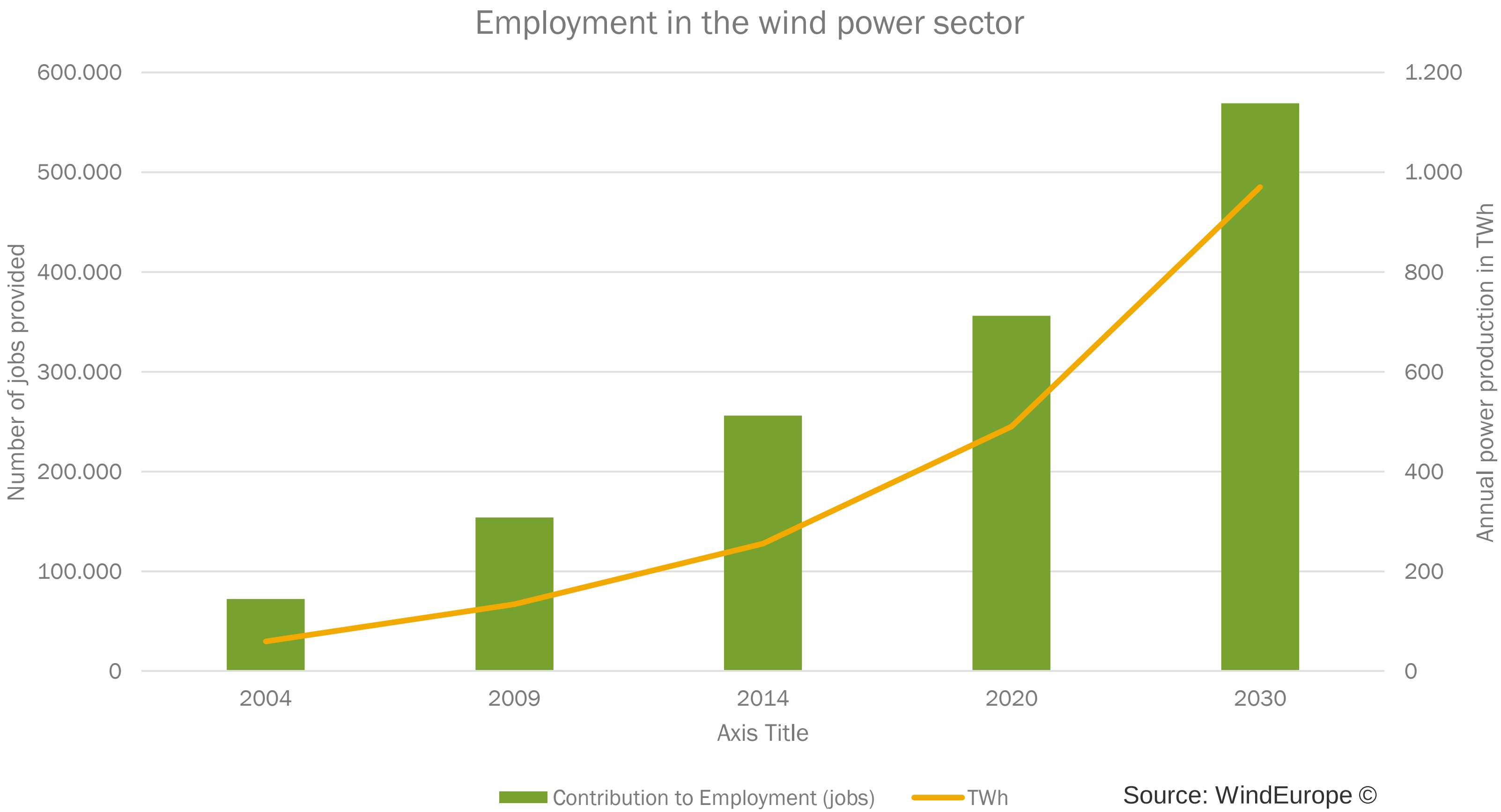
- Intro
- Urgency for energy transition investments
- Wind technology basics
- Why choose wind
  - Wind is the cleanest
  - Wind has low societal costs
  - Wind provides jobs
  - Support strategic sector in a global market
- Research priorities
  - 5 pillars
  - Skills

Power sector emissions (LCA) in 2017



Source: ETIPWind analysis based on EUROSTAT data and IPCC 2014 LCA analysis

Evolution of wind energy employment



Source: WindEurope ©

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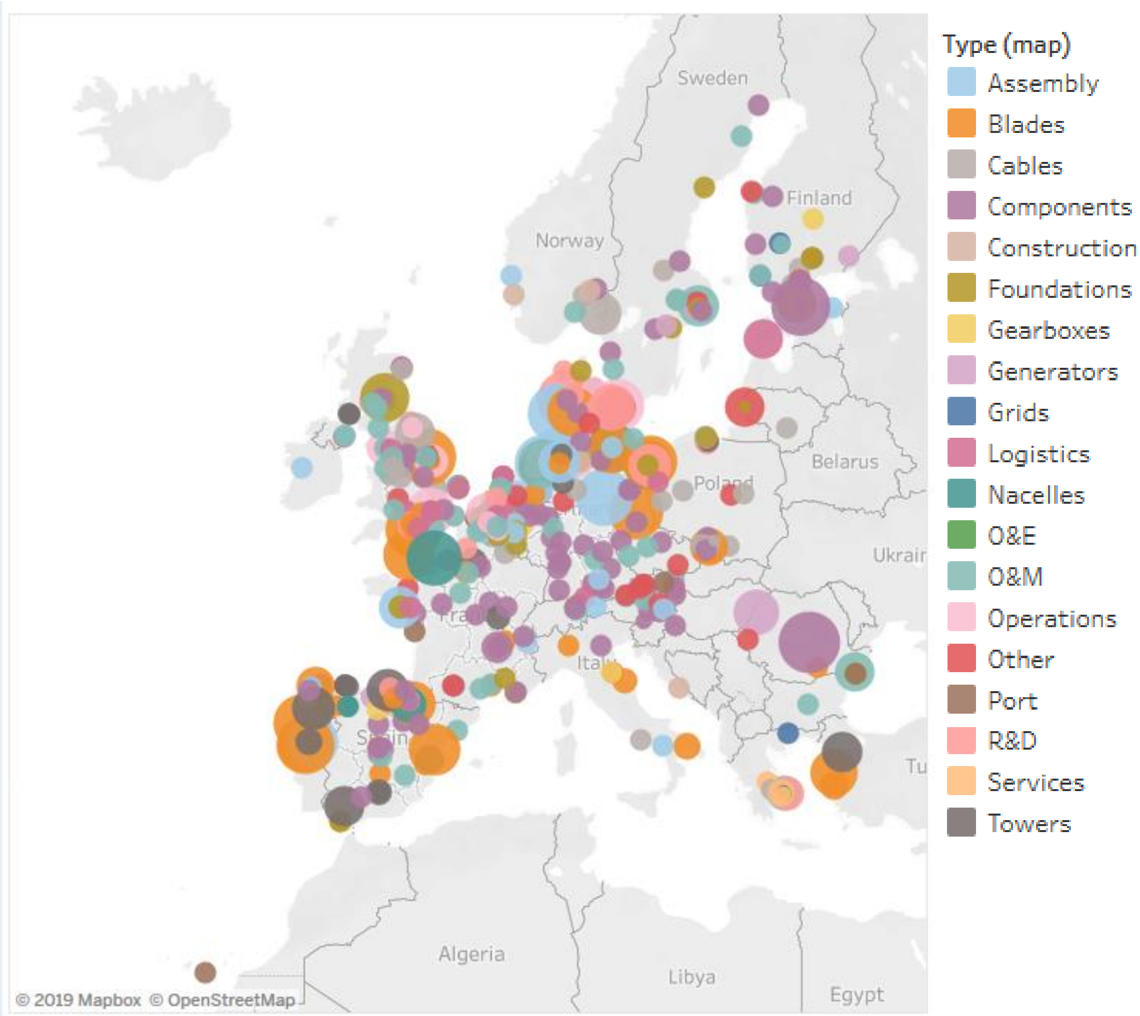
European wind industry supply chain



Source: WindEurope ©

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Finalising Research priorities

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Research Priority ID-kits

- Good quality input for all pillars.
- Only a few comments received (< 10).
- Some ID-kits could use more substance.
- Offshore Balance of plant still an issue.
- 7 new topics proposed.
- 2 substantial comments.
  - Hydrogen, sector coupling & seasonal storage.
  - Industrialisation on floating specific designs.

ID-kits that need just that little more love

- Power Quality (G)
- System services (G)
- Optimising current grid infrastructure (G) -> or remove it?
- Solutions for operating in extreme conditions (O)
- Robotic inspection methods (O)
- Industry transparency (N) -> or remove it?
- Extending the library (F)
- Park footprint (F) -> or remove it?
- Floating to floating installation… (F)

TF leaders to decide

Offshore BOP – still not enough content

- Floating/gravity based concepts / new concepts for shallow waters (merged)
- Installation procedures and logistics.
- Site conditions.
- Serial production – analysis of substructure production processes.
- Cross-industry agreements and standards.
- Lifetime of support structures (re-use).

Secretariat to circulate to TF & EXCO again

New topics proposed (NGT) - 1

Harmonics & resonance	xx	XX
DESCRIPTION OF THE PRIORITY (200 words) The wind farm that is far away from the main grid, e.g. offshore windfarm, is connected to the latter through a long cable. The cable impedance is thus relatively large, and it may lead to interactions between wind power converters of different turbines. In worst case, significant harmonics or resonance may happen and trigger accidents in the farm, which have been observed in several existing windfarms. Part B: specific research actions (100 words max). • "• Development of analytical models to enhance understanding and knowledge about harmonics and resonance in wind farms • • Development of advanced control strategies for harmonics mitigation and resonance damping • • Recommendations to grid code for low harmonics and resonance in wind farms"	MILESTONES "• Analytical models of harmonics and resonance in wind farms. • Control strategies to mitigate harmonics and resonance. • Formulation of grid code for wind farms."	

Partially accepted

New topics proposed (NGT) – 2

<table>
<tr><th>Wind Farm digital twin</th><th>xx</th><th>XX</th></tr>
<tr><td>DESCRIPTION OF THE PRIORITY (200 words)

Development of a wind-farm digital twin that encompasses into a real-time virtual environment all relevant physical scales in the wind-farm ranging from atmospheric conditions, wind-farm flow field, terrain details (and/or wave field), turbine and gearbox structural data and conditions, and generator and electrical devices. The digital twin is updated in real time based on SCADA measurements, weather data, and any additional Lidar, metmast, wave radars, load sensors, etc., and can be used for analysis and prediction of farm and individual turbine performance, given specific conditions and age of different components in the farm. Moreover, the synchronized flow, structural, power data over the operational lifetime of a turbine, will allow for advanced data mining that encompasses the full atmosphere-to-electrons system typical for wind energy applications.

Part B: specific research actions (100 words max)
• "• Develop a real-time state-estimation algorithm for the wind-farm flow field based sparse measurements (lidar, metmast, scada) and on fast flow models (coarse LES, reduced order models, simplified wake models with advection)
• • Develop a real-time structural representations of the turbines in the farm, that are coupled to the flow field based on actuator line or actuator sector approaches, and are synchronized to the actual turbine rotation speed and angular and yaw position based on SCADA measurements
• • Develop update strategies for the structural model that account for changing parameters (degradation (blades, fatigue, …), maintenance actions, …) over time
• • … etc – probably stuff related to gearbox, generator, power electronics, … "</td><td colspan="2">MILESTONES
"• Analytical models of harmonics and resonance in wind farms.
• Control strategies to mitigate harmonics and resonance.
• Formulation of grid code for wind farms."</td></tr>
</table>

Partially accepted

New topics proposed (NGT) - 3

Load case selection flexibility	xx	XX
DESCRIPTION OF THE PRIORITY (200 words) "To ensure a safe response of turbines to the loads they encounter, their design is tested against a set of standardized load cases. These load cases have been conceived with a limited number of environmental factors in mind (wind speed, wave height, current,...). For more realistic modeling, further environmental factors or interactions should be added (e.g., atmosphericstability) and more values considered. If all combinations are considered this leads to an exponential increase in the number of load cases. To make testing the load cases realistically possible, a flexible selection of the relevant ones must be possible." Part B: specific research actions (100 words max) • "• Inventorize the environmental factors relevant for (onshore/offshore) wind turbine load cases. • • Characterize load-case-relevant environmental factors in terms of their variation and correlation. • • Create overview of existing sampling techniques applicable to the space of possible load cases. • • Design new sampling techniques, specifically aimed at load case selection. • • Validate sampling techniques on specifically-constructed benchmarks."	MILESTONES "• 2025: Completion of informative guideline • 2028: Incorporation in standard"	

Accepted

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New topics proposed (BOP) - 4

Materials durability and protection	Medium term	Medium
DESCRIPTION OF THE PRIORITY (200 words) **Part A: generic description (100 words max).** Foundations material degrade, corrode and require frequent monitoring and maintenance. There is a potential to find alternative materials that are better in terms of costs, tensile strength (e.g. that can maintain their integrity and self-heal when deficiencies occur), light weighting, easiness to manufacture, environmental emissions or improved environmental performance. Potential cost reduction from this element are material cost or damage resistance that would decrease maintenance cost. Corrosion protection are generally applied on the outside and in some cases in the inner part of the structure. The best technique for corrosion protection is also yet to be found. **Part B: specific research actions (100 words max).** • Investigation into system reliability, operational procedures and requirement for air ventilation/water exchange to validate corrosion protection	MILESTONES • XYZ • XYZ •	

Partially accepted

New topics proposed (BOP) - 5

New towers construction	Medium term	Medium

Not accepted

DESCRIPTION OF THE PRIORITY (200 words)

Part A: generic description (100 words max).

A typical wind turbine tower currently consists of a 'thin walled' steel hollow cylinder, these are cost effective and simple to manufacture and also allow for access/housing of systems within the tower. A lattice tower is one with an array of crossing smaller diameter members, forming a framework to support a load. Such structures can be extremely effective at reacting high loads however are typically more complex to design and manufacture. Structurally a cylindrical column is effective at reacting the weight of the structure and the bending moments applied from environmental loading. However, as turbines increase in size, hence loading from environment also increases, the diameters and/or wall thickness of towers will also increase, as we scale up in turbine and rotor sizes the economic benefit of the simple cylinder shall decrease and a framework tower (lattice) may become competitive. Decreasing the mass of the structure while maintaining its stiffness should increase its natural frequency, thus having a positive effect on overall turbine design. This ensures that resonance in the structure is avoided and excessive loads which can decrease the structures fatigue life are not experienced. In addition to improving turbine design parameters, the reduction in tower mass will also provide cost reduction for manufacturing materials and commissioning costs as lower cost / lower capacity cranage could be used. Other challenges include validating lattice towers that are extremely effective at reacting high loads or concrete towers that could enable materials cost reduction.

Part B: specific research actions (100 words max).

- Validated design for lattice towers
- Validated design for concrete towers
- Validated design for lattice towers with multi-turbine towers

MILESTONES

- Demonstration of concrete towers for offshore wind turbines
- Demonstration of lattice towers

New topics proposed (FOW) - 6

NEW | Probabilistic design	Short term	High
DESCRIPTION OF THE PRIORITY (200 words) Part A: generic description (100 words max). Even if it is sometimes hidden, probability is at the heart of all engineering design. The safety factors required by design standards are founded on a probabilistic analysis of material strengths and load effects. The physical dimensions, material properties, environmental loading, operating state, component condition, and remaining lifetime of a floating wind turbine are all probabilistic quantities. The reliability of offshore wind turbines is of critical importance, due to the high costs of maintenance, and in order to "design in" reliability, one must be able to quantify the probability of failure. Part B: specific research actions (100 words max). Probabilistic analysis is difficult, because each variable is no longer a single value – rather, it becomes a field over all possible values. A simple summation like a + b becomes a convolution (an integral over all the possible values of the two variables) in the probabilistic world, and likewise all other mathematical operations are made more complicated. Research is needed on how to most effectively propagate joint probabilities through nonlinear dynamic models of floating wind turbines and plants, from inputs like the operating conditions to outputs like the failure probabilities of critical components. The tails of probability distributions – that is, improbable but possible events – are difficult to predict, and the results are sensitive to assumptions made about the nature of the probability distributions. Research is needed on the selection of probability distributions for the extreme response of floating wind turbines, and ways to accurately predict the tails of such distributions without running large numbers of Monte Carlo analyses. The deployment of probabilistic design methods for floating offshore wind turbines would benefit from the development or adaptation of open-source software tools for this purpose.	MILESTONES • Validate safety levels towards code and regulations • Instrumentation and modelling to enable lean digital twin operation	

Partially accepted

New topics proposed (FOW) - 7

Not accepted

NEW | Floating substation	Short-term	High
DESCRIPTION OF THE PRIORITY (200 words) Commercial scale floating wind farms require new substation solutions- floating or subsea Part A: generic description (100 words max). Part B: specific research actions (100 words max). • Identify technology gaps • Establish a technology qualification program	MILESTONES Feasible concept verified in lab by 2022	

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Discussion based on comments received

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Evaluation criteria

Evaluation & impact criteria (secretariat suggestions)

1. Benefits of research & innovation
   - Costs (LCOE, integration).
   - Leadership (Excellence, EU global R&D hub).
   - People & planet (environment and social).

2. Type of action
   - Research (academic led).
   - Innovation (industry led).

3. Funding sources
   - European solutions.
   - National competitiveness.

How
- Via an online survey?
- What level of detail to be shared?
- How do we ensure adequate responses?

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Fact-sheet recycling technologies

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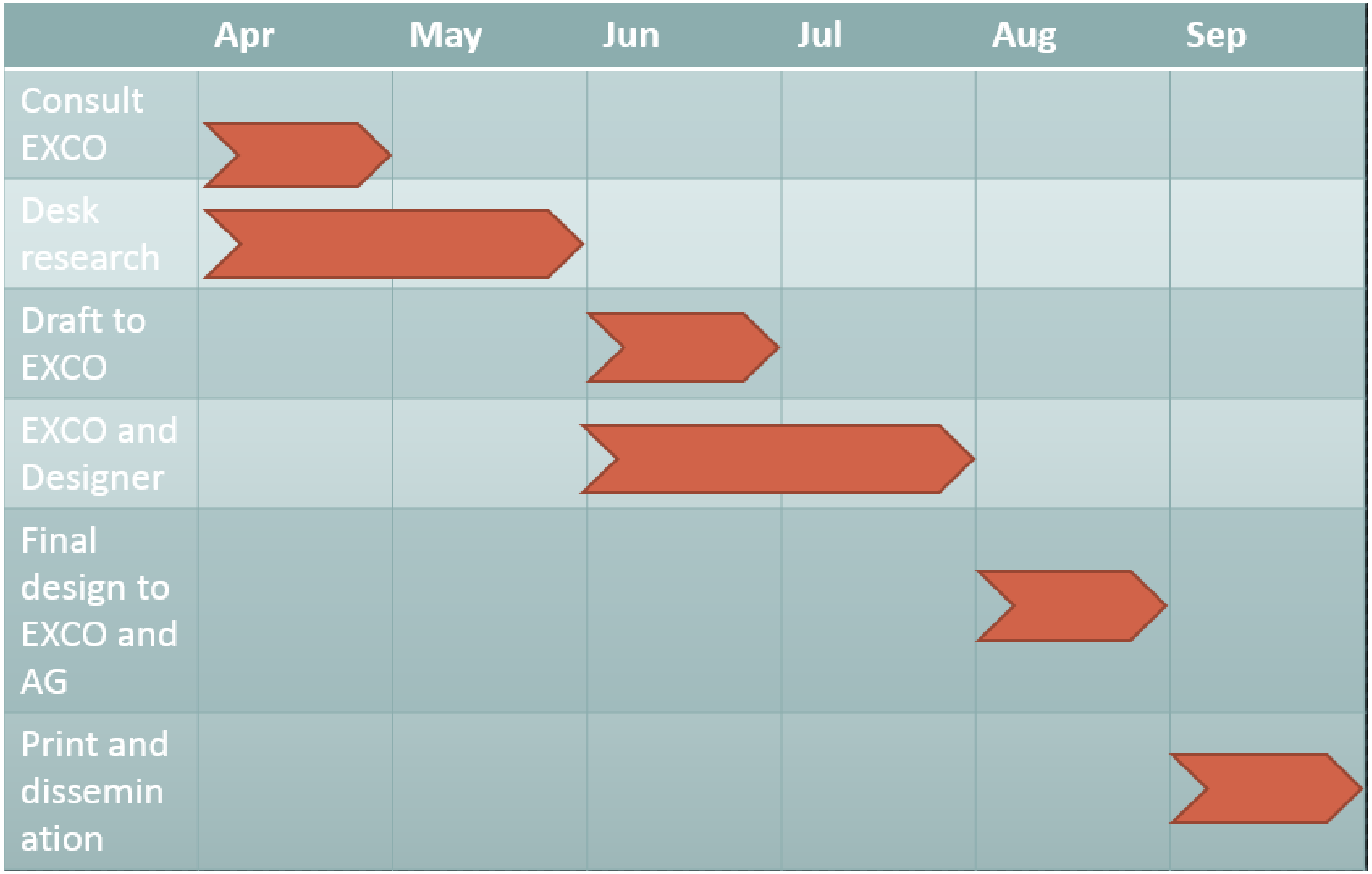
July 2019

Some important information

- **1st Fact-sheet of the renewed ETIPWind project**
- **Due:** end of September
- **Purpose:** Dissemination of thematic R&I topics for the wind energy sector
- **Audience:** policy makers, other relevant sector stakeholders, wider wind energy community

Timeline



Apr
May
Jun
Jul
Aug
Sep
Consult EXCO
Desk research
Draft to EXCO
EXCO and Designer
Final design to EXCO and AG
Print and dissemin ation

Fact-sheet objectives

- Provide detailed information on blade technology so that discussions on end-of-life are fact-based and technology driven;

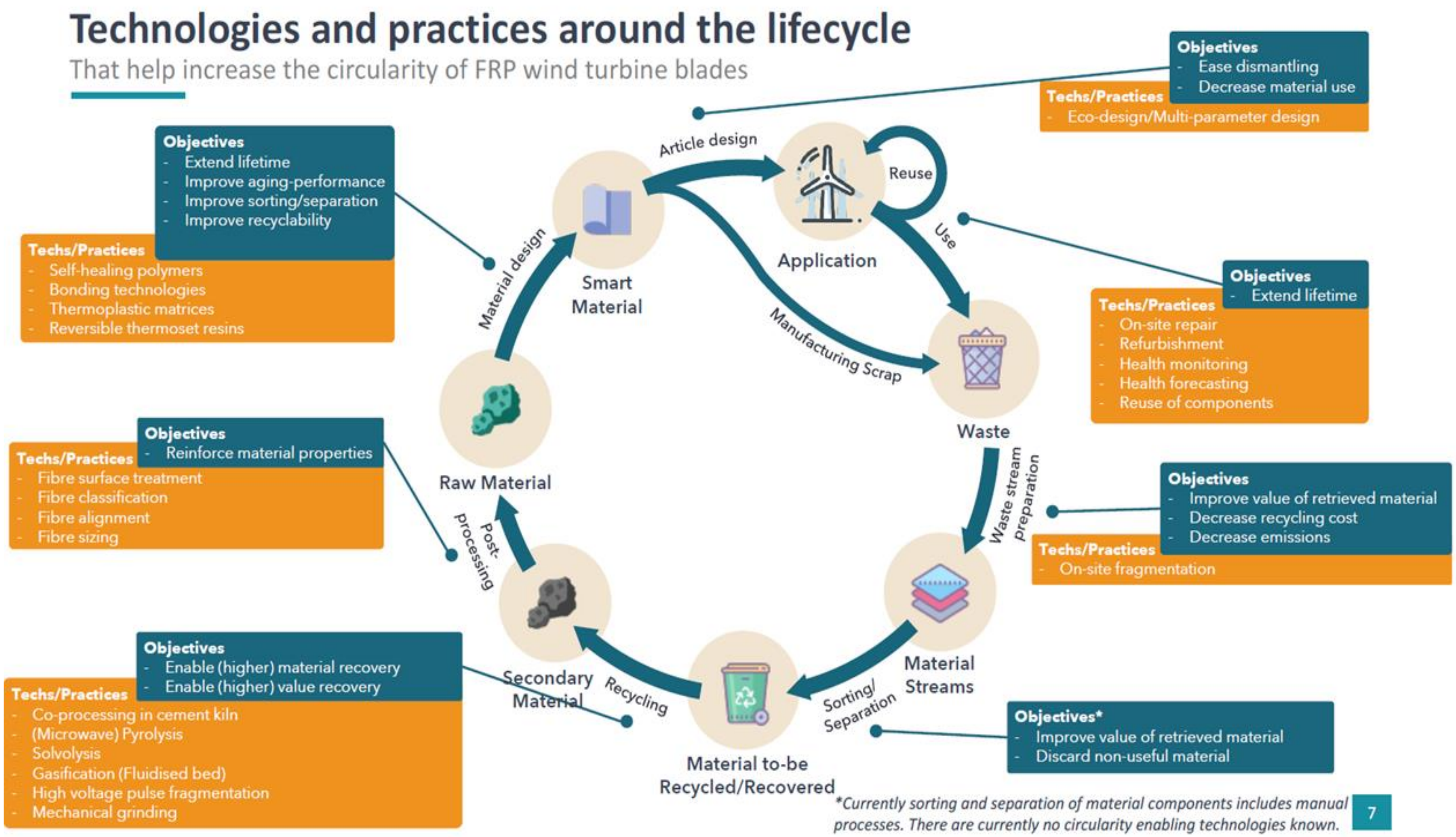
- Highlight opportunities for the sector to achieve circularity;

- Give tangible recommendations to policymakers on research topics related to blade recycling.

How are we going to achieve this?

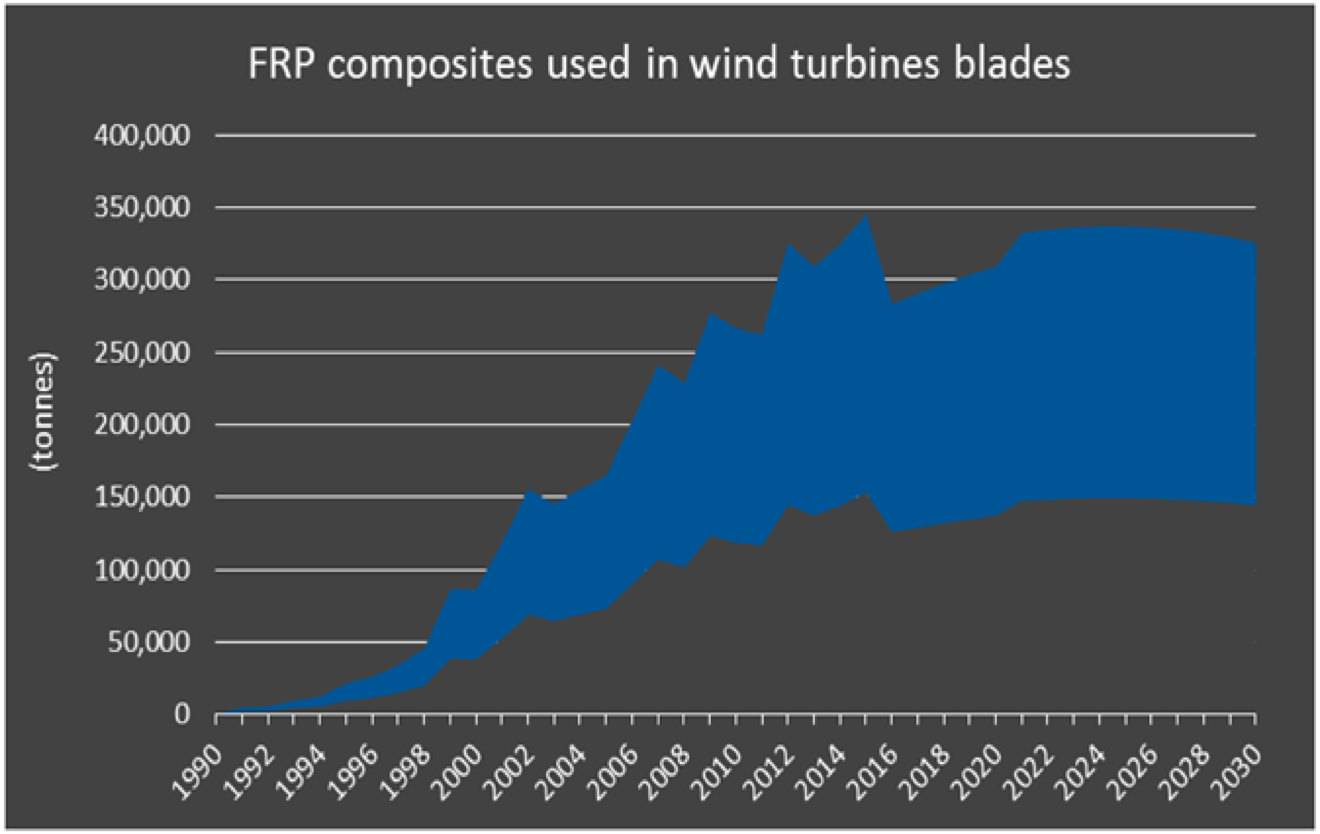
- Provide a description of a blade lifecycle;
- Provide a description of blade composition and upcoming volumes of composite waste;
- Compare composite waste volumes with other sectors;
- Describe the various available technologies today and their TRL level;
- Highlight current issues;
- Outline R&I priorities. (cfr. Technology Roadmap)

Blade lifecycle



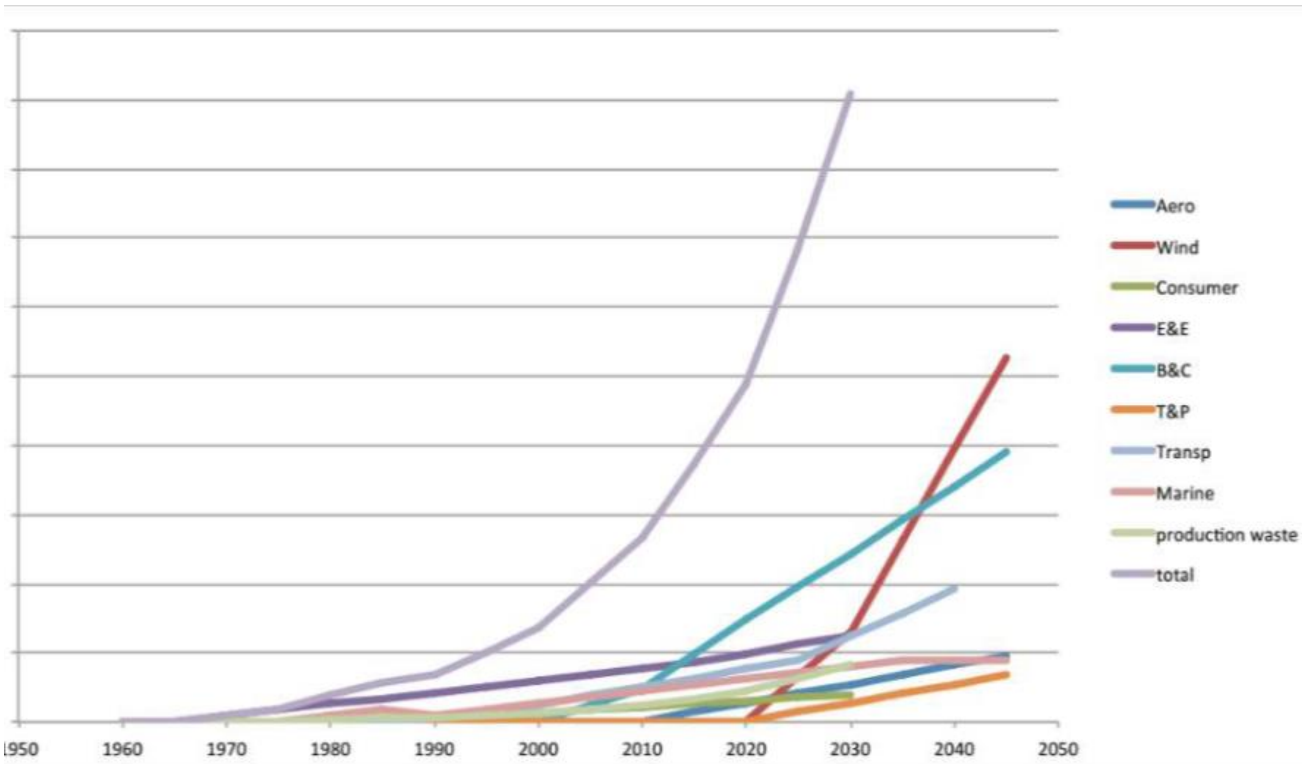
Source: Bax & company, 2019

Upcoming volumes of composite waste



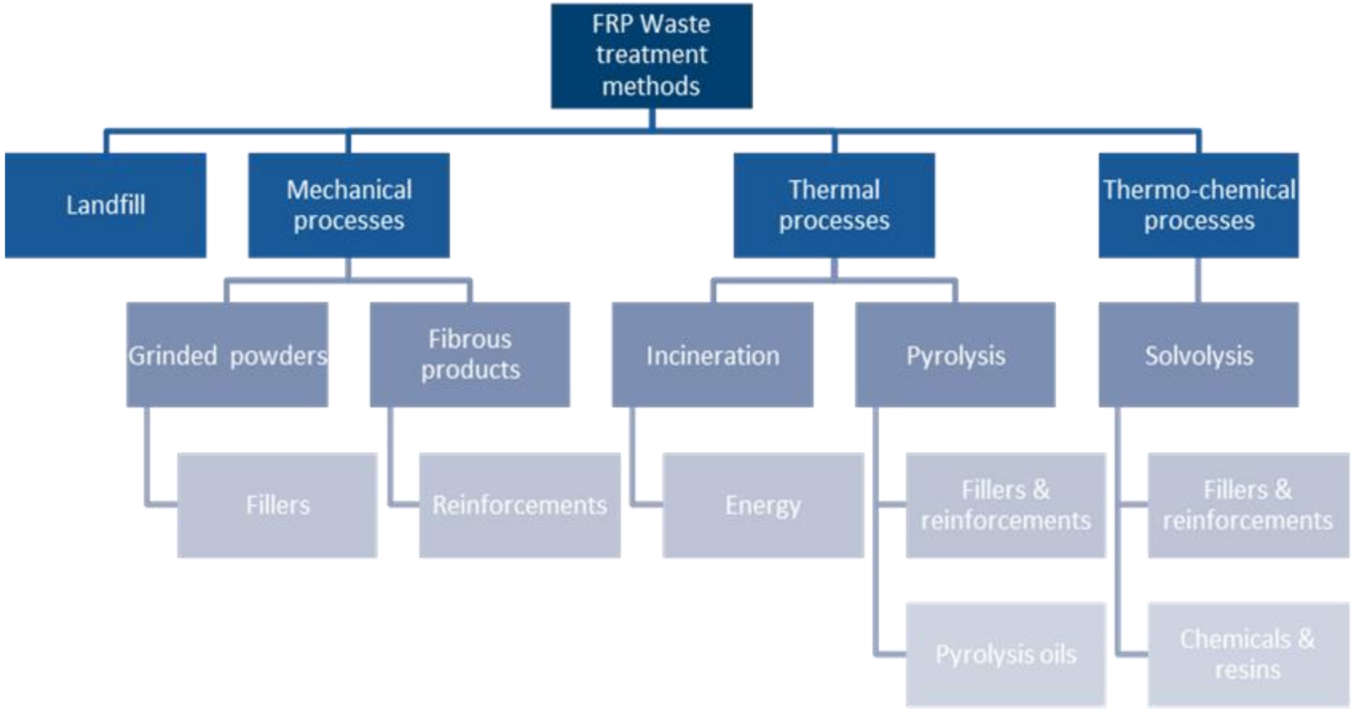
Source: WindEurope ©

Comparison with composite waste volumes in other sectors



Source: EUCIA ©

Waste treatment solutions



Mechanical grinding

- TRL 9 for GFRP ; TRL 6/7 for CFRP

- Strengths:

✓ Efficient waste management process (high throughput rates)

- Limitations:

✓ Cost efficiency;

✓ Fine dust released into the surrounding atmosphere;

✓ Potential of fibers to stick into human skin or mucous membranes causing irritation.

Pyrolysis

- TRL 9; TRL 4/5 for microwave pyrolysis

- Strengths:

✓ Pyrolysis gas and oil can be used as energy source -> self-sustained process;

✓ Easily scaled-up to multi-ton capacity.

- Limitations:

✓ For glass fibres it is currently not economically viable;

✓ Potential combustible gases leakage from waste treatment chambers.

Co-processing (Cement Kiln)

- TRL 9

- Strengths:

✓ Large quantities can be processed;
✓ Highly efficient and fast process: residence time of 4-5 sec in cement kilns.

- Limitations:

✓ Loss of original material form (fiber form);
✓ Pollutants and particulate matter emissions

Solvolysis

- TRL 5/6

- Strengths:

✓ Recovery of clean fibers in their full length

✓ Recovery of resin which can be reused.

- Limitations:

✓ Insufficient efficiency of the technology

✓ High energy consumption due to the high-temperature and high-pressure

✓ Gas emissions

High voltage pulse fragmentation

- TRL 6

- Strengths:

✓ Able to treat industrial quantities -> sufficient scalability of the process to treat larger capacities

✓ Low investments required to reach the next TRL

- Limitations:

✓ Only laboratory- and pilot-scale machines are available

✓ Working near high voltage

Gasification

- TRL 5/6

- Strengths:

✓ Highly flexible (in terms of different process capabilities) and simple process

✓ Gases are recovered: energy recovery for the reduction of energy demand, opportunity to recover precursol chemicals

- Limitations:

✓ Will only be economically viable if it reaches capacities of more than 10,000 tonnes per year

Issues with blade recycling

- Recycling FRP composites is technically possible but not cost effective;
- Technological maturity and scale of recycling methods;
- Differences in waste/recycling legislation between regions and how waste is defined;
- Scientific understanding of the environmental aspects associated with the different recycling methods (life cycle perspective, different impact categories).

Recommendations for R&I funding

- Cost-effective recycling processes;
- Technological advances in the recycling processes (e.g. energy);
- Regulatory measures and market mechanisms to stimulate business models for recycling, create secondary markets and increase OEM responsibilities for waste management;
- LCA studies comparing the different recycling process and technologies;
- Studies investigating the possible uses of recycled materials from blades;
- Research on efficient blade design.

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Thanks for your attention

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