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IEA Wind TCP Task 45

Deliverable 4.2

Guideline for Legislation and Policy on End-of-Life Wind Turbine Blade Waste

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IEA Wind Task 45 Wind Turbine Blade Recycling
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WIND TURBINE BLADES AT END-OF-LIFE

Guideline for Legislation and Policy on End-Of-Life Wind Turbine Blade Waste

IEA Wind Task 45 – Work Package 4.2

April 2024

Executive Summary

This document represents the second deliverable from the Work Package 4 working group. Its purpose is to present for critical discussion four options for regulating end-of-life wind turbine blade (WTB) waste. Three comprise proposals for legislative provisions (i.e., 'hard' law measures) and one comprises development of tender requirements. The latter may operate as a something of a bridge between 'hard law' requirements and 'soft law' (voluntary) intentions or targets. Each option is presented according to a similar format: summary, proposed drafting and a commentary on the rationale for the option's various components. The aim is to facilitate dialogue with stakeholders on (i) the option's appeal from a regulatory and commercial perspective; (ii) its strengths and weaknesses; and (iii) how the option could be revised to aid its commercial viability. It is to be stressed that these options are presented as mere starting points to aid discussion and dialogue amongst stakeholders.

The following four drafting options were developed:

Option 1: Reuse and Recyclability Requirements for Wind Turbine Blades

This option caters for creation of a legislative provision detailing reuse and recycling requirements for wind turbine blades. These are, under the current drafting, imposed on blade manufacturers. There are four issues for consideration: (1) the percentage thresholds for the reuse and recycling targets; (2) the time period over which these requirements are to be met; (3) whether the obligation should, in fact, be placed on the manufacturer or whether imposition on another party, such as the Owner, may be better. (4) how should we define the party responsible (e.g., 'manufacturer').

Option 2: Extended Producer Responsibility for End-of-Life Blades

This option caters for creation of a legislative provision detailing an extended producer responsibility (EPR) scheme requirement for end-of-life WTBs. There are five issues for consideration: (1) the definition of 'producer'; (2) whether producers are to bear: (i) financial or (ii) financial *and* organisational responsibility for the management of end-of-life blades, i.e., can producers just pay another entity to take responsibility and execute the necessary services and/or actions on their behalf or must producers incur direct costs and must perform or cause the performance of the end-of life obligations themselves; (3) whether producers can fulfil the obligations of the EPR scheme individually or collectively; (4) whether producers need to evidence possession of the necessary financial means or financial and organisational means to meet their EPR obligations and, if so, how and when; and (5) applicable economic instruments and incentives.

Option 3: Landfill Ban for Wind Turbine Blades

This option caters for creation of a legislative provision imposing a ban on the landfilling of end-of-life WTBs. There are five issues for consideration: (1) the technical and commercial viability of such a ban; (2) whether there should be exemptions permitted to the ban; (3) the scope of the ban, i.e., is it to be EU wide or relate to the particular countries only; (4) the need to prohibit export of WTB waste; and (5) the sanctions for failing to comply with the ban once implemented.

Option 4: Tender Requirements for Circularity

This option caters for the implementation of circularity requirements for WTBs in government-initiated competitive tenders for the right to develop and run wind farms. Criterion covering raw material consumption, environmental impact and value retention at different stages of the project (i.e., design, operational and decommissioning) are examined to illustrate how such requirements could be deployed to reduce end-of-life blade waste. The 'Proposed Drafting' example is not intended to be inclusive of all relevant (circularity-focused) and focuses solely on WTBs.

Introduction

Research on wind turbine blade recycling has been ongoing for more than a decade, but recycling solutions are still rare, and the few existing solutions are not implemented on large scale. As a result, in many countries recycling solutions for wind turbine blades are not available. The technical difficulty of recycling glass fibre reinforced thermoset composite, the low cost of landfill and the precise assessment of waste volume are some of the challenges preventing the implementation of sustainable recycling solutions. To tackle these various challenges, the expertise of several disciplines and a unified approach across countries have been assembled in an international effort under the IEA Wind Task framework, specifically Task 45 – Enabling Wind Turbine Blade Recycling.

The purpose of IEA Wind Task 45 on wind turbine blade recycling is to identify and mitigate the barriers to the recycling of wind turbine blades. The task will focus on three main areas:

- The technical aspects of recycling wind turbine blades;
- The analysis of the recycling value chain and its environmental, social and economic impact; and
- The standards, certification and legislation framing the activities related to recycling wind turbine blades.

IEA Task 45 is divided into four work package groups, each with specific action plans, areas of focus, and deliverables, when combined will form the final deliverable. The work packages are as follows:

- WP1 Management, coordination and dissemination
- WP2 Technical focus
- WP3 Analysis and Value chain
- WP4 Standardization, certification and legislation focus

First Deliverable from Work Package 4

There were four main conclusions drawn in the preliminary study.

First, landfilling and incineration remain the most common disposal practices for WTBs in many countries, including most Member States within the EU and across North America. Few jurisdictions have a legal regime in place that is dedicated specifically to decommissioned WTBs. Within the European Union, for instance, as a general observation, there is, at present, limited legislation in place to regulate treatment of composite or WTB waste, both at EU and Member State level. French law provides the exception for WTB waste explicitly and directly and may be considered a global leader in this regard. Under its domestic legislation (i.e., legislation which was enacted by its own legislator, without being a requirement of EU law), which came into force on 22 June 2020, from 1 July 2022, at least 35% of the mass of the WTBs must be reused or recycled, increasing to 45% after 1 January 2023 and 55% after 1 January 2025. The strategy of the French government is to implement reuse and recycling targets across a 5-year window, providing time for the sector to plan for, and acclimatize to, its requirements. The downside of this approach, however, is that the reuse and recycling target is 'capped' at 55%, meaning that incentive to exceed these targets may be less than optimal. Nearly half of the mass of the WTB can still, it seems, be landfilled or incinerated. This may be a political compromise to ensure the passing of the relevant legislation.

Second, it was more common for jurisdictions to deploy their general 'waste' laws to deal with the treatment of composites at end-of-life, but without making specific reference to WTBs within the legal

framework or associated guidance for industry. The EU's Waste Framework Directive, the primary piece of waste legislation within the EU, is a prominent example of this practice.

Third, a handful of EU Member States – Germany, Austria, the Netherlands, and Finland – have not only enacted rules making clear references to composite waste in their domestic waste laws but have prohibited the landfilling and incineration of composites. However, as has been recognized in the Netherlands, with rising incineration costs and industrial scale alternatives often being unavailable, a landfill ban will have significant financial implications for the sector. This paved the way for the somewhat troublesome exception in the Netherlands whereby landfill disposal would still be permitted when there is no economical alternative other than landfilling. The extent of the 'ban' is therefore questionable. The Dutch experience does expose the reality of the creations of landfill bans before the pertinent technological solutions are available at cost tolerable by industry.

Four, despite the lack of legislation in many countries dealing with end-of-life WTBs, a number of companies within the sector have committed to an array of voluntary initiatives in this regard. These measures include immediately ceasing the landfilling of WTBs, recyclability targets for WTBs that increase with rigor over several years, prohibiting export to foreign markets for landfilling or disposal, and a drive for fully recyclable WTBs by a specified deadline (e.g., 2030). The Corporate Social Responsibility (CSR) practices of the sector, thus, provide a crucial means of addressing the gap in 'hard law' measures across the globe. The major advantage of these type of 'soft law' measures is that they span legal jurisdictions, meaning that dominant players in the sector can abide by rules that they set globally, without waiting for the jurisdictions in which their infrastructure is located to enact relevant legislation. This could take time, be politically contentious where there is extensive lobbying by the sector and, as a result, fail to go as far as necessary to address the environmental concerns. However, we must bear in mind that these are soft-law measures, meaning that there is no distinct legal sanction should the company fail to meet their recyclability targets or breach claims made in their policies (e.g. exporting to foreign markets for landfilling or disposal when they asserted that they would not do this). The tolerability of soft-law measures must, therefore, comprise a significant element of trust by both domestic legislators and society alike.

Second Deliverable from Work Package 4

This document represents the second deliverable from the Work Package 4 working group. The purpose of this document is to present for critical discussion four options for regulating end-of-life WTBs waste. Three comprise proposals for legislative provisions (i.e., 'hard' law measures) and one comprises development of tender requirements. The latter may operate as a something of a bridge between 'hard law' requirements and 'soft law' (voluntary) intentions or targets. Each option is presented according to a similar format: summary, proposed drafting and a commentary on the rationale for the option's various components. The aim is to facilitate dialogue with stakeholders on (i) the option's appeal from a regulatory and commercial perspective; (ii) its strengths and weaknesses; and (iii) how the option could be revised to aid its commercial viability. It is to be stressed that these options are presented as mere starting points to aid discussion and dialogue amongst stakeholders.

Content and Terms

The working group developed the following four drafting options:

Option 1: Reuse and Recyclability Requirements for Wind Turbine Blades

This option caters for creation of a legislative provision detailing reuse and recycling requirements for WTBs. These are, under the current drafting, imposed on WTB manufacturers. There are four issues for consideration: (1) the percentage thresholds for the reuse and recycling targets; (2) the time period over which these requirements are to be met; (3) whether the obligation should, in fact, be placed on

the manufacturer or whether imposition on another party, such as the Owner, may be better. (4) how should we define the party responsible (e.g., 'manufacturer').

Option 2: Extended Producer Responsibility for End-of-Life Blades

This option caters for creation of a legislative provision detailing an extended producer responsibility (EPR) scheme requirement for end-of-life WTBs. There are five issues for consideration: (1) the definition of 'producer'; (2) whether producers are to bear: (i) financial or (ii) financial *and* organisational responsibility, for the management of end-of-life blades, i.e., can producers just pay another entity to take responsibility and execute the necessary services and/or actions on their behalf or must producers incur direct costs and must perform or cause the performance of the end-of life obligations themselves; (3) whether producers can fulfil the obligations of the EPR scheme individually or collectively; (4) whether producers need to evidence possession of the necessary financial means or financial and organisational means to meet their EPR obligations and, if so, how and when; and (5) applicable economic instruments and incentives.

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Option 4: Tender Requirements for Circularity

This option caters for the implementation of circularity requirements for WTBs in government-initiated competitive tenders for the right to develop and run wind farms. Criterion covering raw material consumption, environmental impact and value retention at different stages of the project (i.e., design, operational and decommissioning) are examined to illustrate how such requirements could be deployed to reduce end-of-life blade waste. The 'Proposed Drafting' example is not intended to be inclusive of all relevant (circularity-focused) and focuses solely on WTBs.

Option 1: Reuse and Recyclability Requirements for Wind Turbine Blades

Summary

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Proposed Drafting

Reuse and Recyclability Requirements for Wind Turbine Blades

1. Manufacturers of turbine blades to be used in wind energy projects, whether for a new development or a repowering of, or significant modification to, an existing development, must satisfy the following requirements in terms of a blade's reuse and recyclability:

(i) by 1 January [2025], at least [X %] of its mass must be reused or recycled,
(ii) by 1 January [2027], at least [X %] of its mass must be reused or recycled,
(iii) by 1 January [2029], [X %] of its mass must be reused or recycled.

2. Wind turbine blades that do not meet these requirements by the specified dates are prohibited from being placed on the market [in any country].

3. Manufacturers that fail to comply with the requirements set out in sub-section 1 and proceed to place the blades on the market contrary to sub-section 2 may be prosecuted and made subject to (i) a fine to the value of [specify figure] per turbine manufactured contrary to them, and (ii) a conviction.

Commentary

The proposed drafting of Option 1 is based on a decree in France which amends requirements applicable to blades and creates new reuse and recycling obligations (*Order of 22 June 2020 amending the Order of 26 August 2011 on electricity production installations using mechanical wind energy within an installation subject to declaration under heading 2980 of the legislation on installations classified for environmental protection*).[1] These requirements apply from 1 July 2020. These developments may be considered to render France a global leader in the area of blade reuse and recyclability. This is significant as it is identified as possessing significant amounts of end-of-life onshore wind turbine blades (along with central regions in Spain, Finland, Sweden, the United Kingdom, Italy and Romania).[2]

[1] Arrêté du 22 juin 2020 modifiant l'arrêté du 26 août 2011 relatif aux installations de production d'électricité utilisant l'énergie mécanique du vent au sein d'une installation soumise à déclaration au titre de la rubrique 2980 de la législation des installations classées pour la protection de l'environnement. The text of the legislation can be found here: https://www.legifrance.gouv.fr/loda/article_lc/LEGIARTI000042064061

[2] J. Beauson, A. Laurent, D.P. Rudolph, J. Pagh Jensen, 'The complex end-of-life of wind turbine blades: A review of the European context' (2022) 155 Renewable and Sustainable Energy Reviews Volume 111847, 3.

Article 20 of the amended decree provides that:

- on 1 July 2022, at least 90% of the total mass of dismantled wind turbines, including foundations, when all foundations are excavated, or 85% where the excavation of foundations is subject to a derogation…, must be reused or recycled.
- *by 1 July 2022, at least 35% of the mass of the rotors must be reused or recycled*.

And where wind turbines, for which the complete authorisation dossier is submitted after the following dates and wind turbines put into service after that date as part of a significant modification of an existing installation, must have at least:

- after 1 January 2024, 95% of their total mass, all or part of the foundations included, reusable or recyclable,
- *after 1 January 2023, 45% of the mass of their rotor reusable or recyclable, and*
- *after 1 January 2025, 55% of the mass of their rotor reusable or recyclable*.

The drafting of Option 1 should reflect four main aims. First, provision of clear thresholds to be met in terms of the percentage of the mass of the wind turbine blade to be reused or recycled. A regulatory strategy could be for these to increase incrementally, ultimately leading to a 100% reuse or recycling requirement. The technical and commercial viability of this is, however, a key discussion point. One of the criticisms of the approach in France is that after January 2025, 45% of the mass of the blade does not need to be reusable or recyclable. It could, therefore, be considered to lack ambition in addressing a significant gap in the circularity of the wind energy sector. The approach in France may also be considered to lack ambition given that the requirements move from 35% of the rotor mass to 45% and then to 55%. That equates to an increase of 10% for each time period.

Second, provision of a clear timeline over which the reuse and recycling requirements are to be met. This would help manufacturers to adjust to the new legal obligations. At least X % of their mass must be reusable or recyclable by 1 January 2025, at least X % by 1 January 2027, and X % by 1 January 2029. With a hypothetical implementation date for Option 1 of 1 January 2024, if the aim was, for the sake of discussion, to secure 100% reusability or recyclability, this provides manufacturers with a 5-year window to secure a fully reusable or recyclable blade. This time period is provided as a discussion point and no account is taken of its technical feasibility.

Third, clear articulation of the party responsible for delivering on the reuse and recycling requirements. The proposed drafting of Option 1 places the legal obligation on manufacturers to (i) meet the reuse and recycling requirements, and (ii) to prevent blades that are not in compliance with those requirements from being placed on the market in any country. As detailed above, a key discussion point relates to (i) whether imposition of the responsibility upon manufacturers is well placed, and (ii) if so, how we might define ‘manufacturer’. Another option is to make the reuse/recycling requirement the Owner's responsibility. They would then contract with a third party to ensure that these requirements were met during the design and manufacturing process. The imposition of a fine has been catered for in order to deter non-compliance. It is not productive at this discussion to propose a level for the fine.

Fourth, prevention of blades with low levels of reuse and recycling potential from being manufactured and exported through a prohibition on their being placed on *any* market. If the requirement was limited to a specified country or to projects within a designated country, manufacturers located in those jurisdictions could bypass reuse and recycling requirements through export.

Option 2: Extended Producer Responsibility for End-of-Life Blades

Summary

This option caters for creation of a legislative provision detailing an extended producer responsibility (EPR) scheme requirement for end-of-life wind turbine blades. An EPR scheme is a set of measures 'requiring producers of products to bear financial or financial and organisational responsibility for the management of the waste stage of a product's life cycle including…treatment operations.'[3] Key points for discussion: (1) the definition of 'producer'; (2) whether producers are to bear (a) financial or (b) financial *and* organisational responsibility for the management of end-of-life blades, i.e., can producers just pay another entity to take responsibility and execute the necessary services and/or actions on their behalf or must producers incur direct costs *and* must perform or cause the performance of the end-of life obligations themselves; (3) whether producers can fulfil the obligations of the EPR scheme individually or collectively; (4) whether producers need to evidence possession of the necessary financial means or financial and organisational means to meet their EPR obligations and, if so, how and when; and (5) applicable economic instruments and incentives.

Proposed Drafting

Extended Producer Responsibility for End-of-Life Blades

1. Definitions

(1) "extended producer responsibility scheme" means a set of measures to be taken by producers of wind turbine blades to ensure that they bear [financial responsibility ***or*** *financial and organisational responsibility] for the management of the waste stage of an end-of-life blade's life cycle.*

(2) "end-of-life blade" means a wind turbine blade which is waste [see. e.g., the definition of 'waste' in Art 3(1) of Directive 2008/98/EC: 'any substance or object which the holder discards or intends or is required to discard'].

(3) "producer" means the wind turbine blade manufacturer or the professional importer of a blade on to the market, or the wind turbine original equipment manufacturer.

2. General minimum requirements for extended producer responsibility scheme

(1) Producers of wind turbine blades should set up systems for the collection of end-of life blades and transferral to authorised treatment facilities.

(2) Producers should meet all of the costs of implementing the measure set out in subsection 1.

(3) Producers should evidence to [insert relevant regulator] possession of the [necessary financial means ***or*** *financial and organisational] means to meet the obligations in subsection 1.*

[3] Directive (EU) 2018/851 of the European Parliament and of the Council of 30 May 2018 amending Directive 2008/98/EC on waste, recital 14.

(4) Producers should ensure that a reporting system is in place to gather data on (i) wind turbine blades placed on the market; and (ii) the collection of the end-of-life blades and treatment of waste resulting from them, with results submitted to [insert relevant regulator] annually.

Commentary

Extended producer responsibility (EPR) is an environmental policy approach under which a producer's responsibility for their product is extended to the post-consumer stage of its life cycle (i.e., its end-of-life).[4] The shifting responsibility facilitated by an EPR scheme has a variety of aims. Two of the most pertinent to wind turbine blades are as follows. The first is that it requires producers to *integrate* EPR costs into the cost of producing their blade (i.e., 'internalize' them).[5] Whilst consumers (of the WTB) may ultimately bear EPR costs indirectly through higher product prices, some producers may retain pre-existing prices to avoid losing sales in a competitive market.[6] Therefore, a price increase need not follow implementation of an EPR scheme. *Post*-cost internalization, with the market now presumed to reflect the product's impacts more closely, consumers can make a more informed product selection.[7]

The second objective of EPR is to generate *incentives* for producers to invest in Design for Environment (DfE) (i.e., eco-design) to minimise waste management costs.[8] This is where the real power of EPR lies. DfE is an approach to a product's design that aims to reduce environmental impacts generated by it over its lifetime, from its production to end-of-life.[9] From the extraction of virgin materials, to the product's disposal, the full life-cycle impacts of a product are determined by the producer's *design* decisions.[10] EPR seeks to alter these decisions through the provision of incentive structures to engender environmentally beneficial outcomes, especially (re)designing for improved end-of-life management. As we have seen, producers will internalize the product's EPR costs, with the prospect of a price increase being determined by the elasticity of demand.[11] Where the level of internalization is substantial, producers will have an economic incentive to change the product's design to reduce its EPR costs.[12] This may include redesigning the blade for increased durability or for enhanced reuse, recycling and recovery potential.[13] This can convey positive environmental outcomes, with the potential for reduced volumes of waste going for final disposal and, correspondingly, lessened environmental impacts of waste treatment (i.e., 'downstream') and resource extraction and refining ('upstream').[14] The reuse and recycling of end-of-life blades will contribute to a circular economy and result in a attenuated environmental impact.[15] It will lessen the need for virgin materials to be extracted (an upstream benefit) also reduce the volume of waste going to landfill (a downstream benefit).

The dominant reason for ascribing responsibility to the 'producer' is that usually they are the actor with greatest access to 'technological expertise, propriety information and product knowledge'

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[4] OECD, *Extended Producer Responsibility: A Guidance Manual for Governments* (OECD 2001) 18 <https://www.oecd-ilibrary.org/environment/extended-producer-responsibility_9789264189867-en>.
[5] ibid 161.
[6] OECD, *Extended Producer Responsibility: Updated Guidance for Efficient Waste Management* (OECD Publishing 2016) 161 <https://doi.org/10.1787/9789264256385-en.>.
[7] OECD, *A Guidance Manual for Governments* (n 4) 18.
[8] OECD, *EPR 2016* (n 6) 161.
[9] ibid 67.
[10] Noah Sachs, 'Planning the Funeral at the Birth: Extended Producer Responsibility in the European Union and the United States' (2006) 30 Harv. Envtl. L. Rev. 51, 66.
[11] OECD, *A Guidance Manual for Governments* (n 4) 60.
[12] ibid.
[13] OECD, *EPR 2016* (n 6) 31-32.
[14] ibid 163.
[15] ibid 4.

and so are in the *best position* to make environmentally beneficial product changes.[16] Whilst expertise and knowledge is clearly crucial, the OECD has also acknowledged that 'an EPR scheme is most effective if the producer is designated as the entity with the greatest *control* over the decisions relating to materials selection and product design.'[17] This is known as 'leverage'.[18] For Kalimo et al, '[t]he producer is a useful target…because of its central role in *designing* (and, subsequently, creating and marketing) the product, on the one hand, and its *close interrelationships* with most of the other crucial stakeholders in the product's ecosystem (e.g., consumers, retailers and recyclers), on the other.'[19] Therefore, we may say that the producer ought to be the party with not only the expertise and knowledge, but also the actor with the greatest control – or leverage – over the product's *design*.

There are a variety of key discussion points in relation to Option 2. Three of the most significant will now be considered. First, the most important aspect of EPR for generating incentives for improved design is the distinction between individual and collective producer responsibility.[20] This is particularly pertinent to sections 2(1)-(2) of the drafting of Option 2. With Collective Producer Responsibility (CPR), responsibility for collecting and recycling waste sits with the *group* (i.e., an collection of wind turbine blade producers in a given country or group of countries).[21] As there is no direct relationship between a producer and its actions, it is seen to dilute, if not entirely remove, incentives for DfE.[22] This is because DfE investment will accrue no direct benefit to individual producers. As most EPR systems are based on CPR, DfE incentives have been found to be very weak.[23] In contrast, under Individual Producer Responsibility (IPR), each producer is responsible for the EPR obligations associated with their *own* products.[24] As the costs accrue to the individual producer, economic theory suggests that IPR regimes provide better incentives for DfE than collective ones.[25] Direct-take back may be seen to offer the 'purest' incentive as the producer would have to arrange for reuse, recycling, recovery and/or disposal and pay the actual costs associated with doing so.[26] When combined with a financial assurance requirement (FAR) (i.e., provision of a bond, such as a cash deposit, prior to the blade being placed on the market) for the full EPR costs, then the cost internalization which this facilitated would provide a powerful stimulus for eco-design. If the pecuniary level of the FAR was *responsive* to reduced EPR costs flowing from improved product design then 'the most environmentally-progressive companies [would be] better off.'[27] A wind turbine blade producer that could push down the costs associated with dealing with their end-of-life blades through enhanced design (e.g., to deliver a higher proportion of recyclable components) would, other things being equal, gain a competitive advantage over those who could not as they would be permitted to post a smaller bond. This mechanism would 'pay back' upfront DfE investments in reduced end-of-life costs incurred decades later, something that a CPR system cannot. Responsive FARs would ensure that the benefits of DfE would become clear to all.

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[16] OECD, *A Guidance Manual for Governments* (n 4) 54.
[17] ibid.
[18] Harri Kalimo, Reid Lifset, Atalay Atasu, Chris Van Rossem, and Luk Van Wassenhove, 'What Roles for Which Stakeholders under Extended Producer Responsibility?' (2015) 24 Review of European Comparative & International Environmental Law 1 40, 44.
[19] ibid 44 (emphasis added).
[20] Atalay Atasu, Reid Lifset, Kieren Mayers, Chris van Rossem and Luk van Wassenhove, 'Greening the economy through design incentives: Allocating extended producer responsibility' (2012) 21 European Energy and Environmental Law Review 6 274, 280.
[21] OECD, *EPR 2016* (n 6) 21.
[22] Atasu et al (n 20) 281.
[23] OECD, *EPR 2016* (n 6) 161.
[24] ibid 164-5.
[25] ibid 32.
[26] G. A. Davis, 'Principles for application of extended producer responsibility' in OECD Joint Workshop on Extended Producer Responsibility and Waste Minimisation Policy in Support of Environmental Sustainability (OECD 1999) 101-107, 104 <http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?doclanguage=en&cote=env/epoc/ppc(99)11/final/part1>.
[27] Atasu et al (n 20) 291-2.

Whilst IPR present more efficient DfE incentives from a theoretical perspective, the OECD found that 'few IPR schemes have been implemented.'[28] This is due to the economies of scale and sheer convenience of industry-wide CPR schemes.[29] This may be a barrier to their widespread use for end-of-life blades. And whilst it was found that EPR systems 'contribute[d] to eco-design…other factors sometimes have a more important triggering role.'[30] For instance, factors beyond EPR can drive DfE, including material or transport costs.[31] And there is an important trade off to be made when selecting between IPR and CPR. IPR may 'worsen market distortions due to monopoly power' as the economies of scale in managing waste enable incumbent firms with large market shares to augment their competitive position.[32] Smaller producers may, therefore, be prevented from entering the market.

Second, the definition of 'producer' is crucial. The somewhat straightforward definition detailed above was adopted from the End-of-Life Vehicles Directive, a legal framework that caters for an EPR Scheme. Other legal frameworks, such as the Waste from Electrical and Electronic Equipment (WEEE) Directive, which also implement such a scheme, adopt a far broader definition which includes designers and resellers. A key consideration, therefore, relates to how broadly or narrowly it is defined. Wind turbine blades are produced by either 3rd party manufacturers who are contracted by wind turbine OEMs to manufacture specific blade models or by business units owned and operated by the OEM directly. Often OEMs use a mix of 3rd party manufacturers and their own blade factories to meet blade supply requirements along with complying with local production requirements (where present). The definition of a wind turbine blade producer in a EPR scheme will need account for the global network of blades supplied into a given country or region.

Third, there will a need for coding standards or design information to be submitted to environmental regulators or authorised treatment facilities. One option is for authorised treatment facilitates, at the point of delivery of the end-of-life blade, to make contact with the producer to establish information on the blade to enable proper treatment. A code would need to be imprinted on the blade to establish the producer. This may, however, be problematic should the producer become insolvent or otherwise cease trading. An alternative option is to enable the appropriate regulator (e.g., local land use planning authority) to impose a condition on the applicant for a license, permit or other authorization for a wind development specifying that they must supply product information on the wind turbine blade prior to construction commencing. This could either remain confidential for the life of the project or it could be made publicly available via the planning authority's website. The key point is that product information must be available to enable proper end-of-life treatment.

[28] OECD, *EPR 2016* (n 6) 175.
[29] ibid 161 and 175.
[30] ibid 32.
[31] ibid 175.
[32] ibid 165

Option 3: Landfill Ban for Wind Turbine Blades

Summary

This option caters for creation of a legislative provision imposing a ban on the landfilling of end-of-life WTBs. Key points for discussion include: (1) the technical and commercial viability of such a ban (i.e., there is little point in imposing a landfill ban if the technology is not yet in place to deal more effectively with WTB waste); (2) whether there should be exemptions permitted to the ban; (3) the geographical scope of the ban, i.e., is it to be EU wide or relate to a particular country only (4) the need to also prohibit export of WTB waste, and (5) the sanctions for failing to comply with the ban once implemented.

Proposed Drafting

Landfill Ban for Wind Turbine Blades

1. Definitions

"end-of-life blade" means a wind turbine blade which is waste [see. e.g., the definition of 'waste' in Art 3(1) of Directive 2008/98/EC: 'any substance or object which the holder discards or intends or is required to discard'].

'landfill' means a landfill as defined in [specify legislation detailing the legal definition of a landfill, e.g. Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste].

'waste producer' means anyone whose activities produce end-of-life blades;

'waste holder' means the waste producer or the natural or legal person who is in possession of end-of-life blade(s);

2. It shall be prohibited to dispose of an end-of-life blade in a landfill.

3(1). The competent authority may through addition of a condition within the environmental permit of the waste holder or waste producers permit the storage of end-of-life blades for a maximum period of [ ] year[s].

3(2). If the waste holder or waste producer demonstrates to the satisfaction of the competent authority that the storage of end-of-life blades is to be followed by the recovery of that waste, the competent authority may permit its storage for a period not exceeding [] years.

4. It is forbidden to place end-of-life blades, other than as permitted for the purposes of storage in accordance with Articles 3(1) and 3(2), on or in the ground.

5. It is forbidden to mix end-of-life blade waste in any form (e.g., shredding) with other waste streams to avoid the need to comply with the obligation set out in Article 2.

6. It is forbidden to export end-of-life blades to a country outside the scope of the prohibition set out in Article 2.

6. A failure to comply with the requirements of this Act shall be an offence and result in the imposition of a penalty in accordance with [insert title of legislation that deals with environmental permitting].

Commentary

The proposed drafting of Option 3 is based on a landfill ban set out in Dutch law (*Landfill and Landfill Ban Decree on Waste Regulations (Besluit stortplaatsen en stortverboden afvalstoffen, 'BSSA'*). Whilst this does not explicitly refer to WTBs, but it does have detailed provisions for categorizing waste components contained in WTBs.[33] It will, therefore, apply to WTBs. It also sets limits on analytical parameters, such as Total Organic Carbon (TOC), to determine which waste can be landfilled and which cannot. It is important to note that under the Dutch landfill ban landfilling of waste is not absolutely prohibited as a range of exemptions are listed in article 11, more on which is said below.[34] Thus, a criticism of the Netherland's approach is that the exceptions mean, in effect, that the ban is not a genuine 'ban'. It is, in fact, a heavily caveated one. As applied to WTBs, it could be considered to lack ambition in addressing a significant gap in the circularity of the wind energy sector. Austria, Finland and Germany also have landfill bans in place for composites, which will capture WTB waste. Scotland has consulted on implementing a landfill ban on WTBs but has, to date, not taken any further action on this.[35]

The trade organization, Wind Europe, has previously called for a Europe-wide landfill ban at EU level on decommissioned wind turbine blades and other large composite components in the nacelles of modern wind turbines by 2025, with the need for an associated commitment to re-use, recycle, or recover 100% of end-of-life blades.[36] Such a ban was perceived to 'further accelerate the development of sustainable recycling technologies for composite materials.'[37] Wind Europe's proposed ban also sought to related commitment not to send end-of-life WTBs from Europe to countries outside of Europe for landfilling, a furtive means of bypassing the presence of a landfill ban in Europe.

The drafting of Option 4 should reflect four main aims. First, the technical and commercial viability the ban. There is little point in imposing a landfill ban if the technological processes are not yet in place at the require scale to deal cost effectively with WTB waste. This will just push WTB waste into storage or towards energy recovery. In Scotland, for instance, whilst there is no national ban on landfill blades in place, certain leading industry players are, it seems, implementing their own voluntary landfill bans. However, almost 100 WTBs from Scotland's first wind farm are being stored while SSE works to identify how the materials can be repurposed.[38] This exposes an obvious risk associated with implementing a landfill ban before the technology is in place to deal with the waste at costs that affordable to the sector. This is perhaps the major issue with implementing a landfill ban on WTB waste. Whilst, as Wind Europe notes, a landfill ban might accelerate development of sustainable recycling

[33] See e.g. BSSA, art 1. The details of waste categorization can be found in the appendix of the BSSA.
[34] See e.g., BSSA, art 11(f).
[35] Scottish Government, <https://www.gov.scot/publications/delivering-scotlands-circular-economy-consultation-proposals-circular-economy-bill/pages/6/> (accessed 10 April 2024).
[36] Wind Europe, *How to build a circular economy for wind turbine blades through policy and partnerships* (November 2020) 5 <https://windeurope.org/wp-content/uploads/files/policy/position-papers/WindEurope-position-paper-how-to-build-a-circular-economy.pdf> (accessed 10 April 2024).
[37] Wind Europe, *Press Release: Wind industry calls for Europe-wide ban on landfilling turbine blades* (*windeurope.org*, 16 June 2021) https://windeurope.org/newsroom/press-releases/wind-industry-calls-for-europe-wide-ban-on-landfilling-turbine-blades/ (accessed 10 April 2024).
[38] 'Blades from Scotland's first wind farm sent into storage' (The Scotsman, 11 September 2023) <https://www.scotsman.com/news/environment/blades-from-scotlands-first-wind-farm-sent-into-storage-4287220> (accessed 22 March 2024).

technologies for WTBs and/or the design of recyclable WTBs, a variety of factors have to be in place first before it can have its desired effect, including development of specialist WTB treatment facilities.

Second, and relatedly, there is an important question over whether there should be exemptions permitted to the ban. As we have seen, whilst the Netherlands has implemented a landfill ban that has the potential to capture WTB waste, there are exceptions that may result in WTB waste being permitted to go to landfill. For instance, under article 11(f)(2) of BSSA, the prohibition on accepting waste in a landfill that has not undergone treatment does not apply with regard to 'inert waste' if the treatment is 'not technically feasible'. WTB waste will likely be treated as inert waste. If, as is currently the case, treatment of that waste is not technically feasible, the landfill ban will not apply to it. There is, therefore, a rather large regulatory gap in the approach of the Netherlands that any EU wide landfill ban proposal should avoid. In the drafting of Option 3, an exception is catered for which would allow WTB waste to be stored for a specified period until appropriate technological processes emerge.

Third, the geographical scope of the ban is a key factor to consider. There is an important choice to be made as to whether any landfill ban to be imposed across the EU or within designated countries only. As we have seen, there are four European countries at present that have a landfill ban that may capture WTB waste. There is clear sense in harmonising the ban across the EU, as this would ensure parity of treatment of waste producers and waste holders across all Member States. The risk with a country-specific ban is that it presents a competitive advantage to those waste holders and waste producers in countries not impacted by the ban. They can deal with WTB waste more cheaply than those in the country to which the bad applies. For this reason, an EU wide ban would appear to be the most sensible.

Fourth, it is important to cater for the need for WTB waste from being prevented from being exported to a country outside the jurisdiction scope of the landfill ban. If the ban was limited to a jurisdiction (e.g, the EU or a specific countries), waste holders and waste producers located in those jurisdictions could bypass the landfill ban through exporting the end-of-life WTBs to countries not impacted by the ban. Unless this potential is guarded against in any proposed law, this loophole could be taken advantage of by waste holders/waste producers looking to discard WTB waste at lower cost.

Finally, the sanctions for failing to comply with the ban once implemented must be considered to ensure that there is a sufficiently robust incentive to ensure compliance. The proposed drafting of Option 3 does not set out what those sanctions ought to be. However, it does recommend that these be connected to the existing regulation of environmental permitting for waste-related activity at either EU level (if the ban is to be EU-wide) or at the domestic level (if the ban is only to apply to a specific country). It is important that there is consistency with other waste-related offences under these legal frameworks.

Option 4: Tender Requirements for Circularity

Summary

This option caters for the implementation of circularity requirements for WTBs in government-initiated competitive tenders for the right to develop and run wind farms. Criterion covering raw material consumption, environmental impact and value retention at different stages of the project (i.e., design, operational and decommissioning) are examined by way of case-study to illustrate how such requirements could be deployed to reduce end-of-life WTB waste. The 'Proposed Drafting' example is not intended to be inclusive of *all* relevant (circularity-focused) tender requirements for wind projects, nor is it intended to cover all components of wind turbines. It is, given the scope of this report, focused on WTBs. The option is provided to generate high-level discussion amongst interested stakeholders as to the most appropriate model for governing end-of-life WTB waste in the sector.

Proposed Drafting

Criterion 1: Raw material consumption, environmental impact and value retention in the design, operation, maintenance and decommissioning of rotor blades

1.1. Circular design and circular strategies
In relation to the rotor blades, the applicant must show how a circular design enables: (1) use of raw materials to be reduced, (2) raw materials and components to be substituted, (3) raw materials to undergo high-quality processing and (4) the life of the blades to be extended, based on a recognised standard or circular design methodology.

1.2. Smart maintenance
In relation to the rotor blades, the applicant must show which technology is, or technologies are, to be used for smart maintenance and for which distinct purpose(s).

1.3. Design phase
Following guidance in the [insert reference document], and no later than one year after the permit becoming irrevocable, the applicant must indicate the specific variables and methodologies the permit holder will provide insight into in relation to the rotor blades.

[Note: A similar requirement to Criterion 1.3 (Design Phase) would be required for the Operational (1.4) and Decommissioning (1.5) phases.]

Commentary

The drafting of Option 4 is based on the latest offshore wind farm tender requirements set by the Dutch Government for the IJmuiden Ver Wind Farm Zone. Whilst an entirely new set of requirements could have been created, it was logical to work from a recent, high profile template for illustrative purposes. For IJmuiden Ver, circularity is part of the tender criteria on the Alpha and Beta sites, both of which are 2 GW capacity. The tender criteria are the same for both. A crucial and distinctive feature of the requirements for this tender is that circularity criteria are established against which the bid is to be evaluated. By integrating circularity criteria relating to, for example, WTBs into tender requirements, governments can encourage (albeit not mandate) more sustainable practices in a sector.

It is important to note from the outset that a tender requirement could comprise a whole of host of factors that might enhance circularity in the sector. We saw in Option 1 (reuse and recycling requirements for blades) and Option 2 (Extended Producer Responsibility for End of Life Blades) that legislation was presented as the vehicle through which to operationalise these requirements. Either (or both) of these options could, however, be implemented via government-initiated tender requirements.

Strengths of Tender Requirements for Circularity

Tender requirements for wind farms, and more specifically, in respect of the WTBs, present a genuinely powerful means of enhancing circularity in the sector. There are three main reasons for this. First, increased circularity can be generated through the imposition of legal requirements (i.e., requirements that must be in place to satisfy a criterion in order to submit an eligible tender) without the need for a new law to be enacted (or for an existing law to be revised). We saw in relation to Option 1 that France has chosen the latter strategy. As a result, circularity requirements can be introduced at far greater speed through tender requirements than would be possible if they were implemented through legislation. Relatedly, they can also be revised quickly as practices – and expectations – within the sector evolve and mature in terms of circularity requirements. If legislation was the chosen means of implementing such requirements, revisions would need to be made to that law. This takes time to action.

Second, through its focus on scoring, tender requirements are likely to be able to strike a balance between (i) the provision of detailed expectations and (ii) conferring flexibility to applicants to satisfy their requirements. With legislation, the regulatee would be required to 'comply' with the requirements set out in the line but may not be incentivised to proceed *beyond* mere compliance where there was no immediate business case to do so. Tender requirements differ as there would be an obvious advantage to excel as the applicant would benefit directly from this (i.e., through enhanced scoring). They can, therefore, also encourage applicants to invest in research and innovation for circular economy solutions. There is, of course, a tipping point at which there may be no further economic advantage to seeking a higher score on the circularity elements of the criteria. Nevertheless, the advantage of tender requirements over legislation is clear: the former create conditions – regulatory and psychological – which drive the applicant to towards obtaining a *higher* score, thereby providing incentives to go further than would be required under a 'one size fits all' legal requirement set out in legislation.

Thirdly, whilst stringent tender requirements may result in higher upfront costs for applicants, they can contribute to long-term value for money for them. Circularity requirements for blades may lead to reduced maintenance costs, increased durability and an overall increased level of performance. This, however, is an empirical question and would need to be subject to financial analysis.

Weaknesses of Tender Requirements for Circularity

Speaking more widely than the 'Proposed Drafting' example set out above, given the capacity for tender requirements to deal with whatever priority a government wished for them to deal with, there are no automatic, de-stabilising weaknesses associated with them. Put another way, it is difficult to criticise an empty vessel. We can, however, make some general observations in relation to their use to deal with the circularity of rotor blades specifically. First, they only *encourage* applicants to reach for a desirable level of circularity. Unlike a requirement implemented in legislation which mandates that a specific level of compliance be attained by all regulatees in the sector, with the prospect for sanctions being

imposed should a regulatee fail to reach or maintain that standard, tender requirements cannot, with the exception of retaining the option of failing to grant the project to the applicant, really impose a *sanction* as such. Whilst legislation enacts an industry-wide standard, and that standard might encourage a 'mere compliance' mindset, the advantage of it is that it does necessitate that industry-wide standard be met.

Second, the tender requirements for IJmuiden Ver refer to specific documents, such as the 'Circular Manufacturing Industry's Circular Product Passport Guide'. The tender requirements may, therefore, only be as robust as these documents require. We must, therefore, look beyond the criterion of the tender, into the concrete statements provided in these further documents. In essence, the tender requirements can only be as effective as these documents enable them to be. The main work to be done, therefore, in developing tender requirements is the groundwork in developing the documents which underpin them. The Dutch ones may provide a baseline from which to work from. However, if, as is necessitated by the above drafting example, the tender requirements at to apply to WTBs specifically, more specific documents will be needed to deal with this as this is not covered under the Dutch approach.

Third, stringent requirements may discourage some potential applicants from participating in the tender process, leading to reduced competition. Those applicants that are able to remain in the market are likely to incur additional costs to meet stringent requirements, such as investing in new technologies, certifications, or compliance measures This could, in turn, limit the pool of available options and potentially result in higher costs for the procuring government.

Finally, if tender requirements advance faster than industry capabilities, there may be unintended consequences, added costs, or other implications that impact the sector's competitiveness.