BUYER GROUP

CIRCULAR ONSHORE WIND FARMS (CIRCULAIRE WINDPARKEN OP LAND)

MARKET VISION CIRCULAR ONSHORE WIND FARMS
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COLOPHON

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1 INTRODUCTION

Circularity is a hot topic in the international wind sector. Over 230 stakeholders worked on accelerating this topic in 2020–2022 in the circular wind hub program. Divided over 3 hubs, Industry, Knowledge and Policy, the stakeholders worked together to research and identify the specific actions that are necessary to advance the wind industry towards full circularity. This has, amongst others, lead to circularity becoming one of the themes for the IJmuiden Ver Offshore Wind tender that is being launched in 2023.

The onshore wind sector has also been an integral part of the circular wind hub. Within the industry and knowledge hub the outcomes for on- and offshore wind were the same. For the policy side, however, a difference was discovered between the policy for onshore wind and for offshore wind early in the process, leading to splitting the policy hub into an International (offshore wind) hub, and a National (onshore wind) policy hub.

The main challenge uncovered in the National (Onshore wind) Policy Hub was the lack of knowledge on the role of governmental bodies in this process and how these could help accelerate the transition to a fully circular wind sector. Contrary to the offshore sector in the Netherlands, where the government is in the lead with setting all tender requirements, for onshore wind the role of the government bodies is much smaller. To further investigate what's possible and at the same time stay in touch with the market, the Buyer Group Circular Onshore Wind Farms was founded halfway through 2022.

Within the buyer group, the onshore wind team of the Netherlands Enterprise Agency (RVO) collaborated with the Provinces of Flevoland, North-Holland, and South-Holland to search for and specify the policy instruments that can facilitate the transition to a fully circular wind economy. Eneco and Vattenfall, the developers within the buyer group, not only provided support but also explored ways to incorporate circularity more deeply into their procurement practices. During both processes several suppliers were consulted, including turbine manufacturers and end of life solution providers. By expressing their needs, capabilities, and future plans, these actors played a significant role in shaping the process.

Purpose of this market vision

With this market vision report we aim to reach two groups of stakeholders. First of all the Provinces not directly involved in this buyer group. And second the onshore wind developers that have not been actively involved in the group but are looking into future developments within the sector. For both groups following two goals have been set.

The objective of this market vision is first of all to give insight into the current developments regarding circularity in the onshore wind sector. This is done by presenting the status quo on both technical developments within the sector and policy instruments in use to shape a fully circular wind sector.

The second goal of this market vision is to inspire both groups, get them to think about future developments that are relevant for them and get them into action to work on these themes. For the Policy makers this means looking ahead at the opportunities the circular economy offers for companies in their area and how they can support this through policy instruments. For developers in the onshore wind sector this means looking ahead at the opportunities the circular economy offers for their organization and giving insight in the first steps they can set in this direction. Second to that they will have insight in the potential policy developments, giving them the opportunity to adjust their business strategy to the potential upcoming instruments.

Scope

The group identified two primary roles: the Provinces participated as policymakers and consenting parties for onshore wind, with RVO serving as the primary point of contact for Provinces not directly involved in the group. And the developers that participated as buyers of the products that collectively form an onshore wind farm. The buyer group for circular onshore wind farms examined the entire wind farm from a product perspective. This encompassed not only the wind turbines, but also all components of the Balance of Plant, such as foundations, cables, and park roads, as well as the potential impact the group might have on these elements. From a lifetime, two distinct moments have been distinguished. Currently, there are about 2.000 onshore wind turbines in the Netherlands. After 20–25 years these turbines reach the end of their lifetime after which they are decommissioned. At this moment in time there are opportunities to process the turbine according to circular strategies based on the R-ladder. Also, old turbines are quite often replaced by new turbines. By taking circularity into account from the design phase onwards steps can be taken as well. Within the buyer group both phases have been examined.

Reading guide

Chapter 2 gives the context in which the buyer group operates. This is relevant for public and private parties. Chapter 3 presents the vision on the market, first of the public participants, followed by the private participants. Chapter 4 presents the market strategy, first of the public participants, followed by the private participants. Finally, chapter 5 presents the answers to Frequently Asked Questions.

2 CONTEXT

The development of circular onshore wind farms has been shaped by various goals established in recent years by different stakeholders:

- The Government of the Netherlands has set the goals of 50% less primary raw materials in 2030 and a 100% circular economy in 2050 in the 'Circular Economy Implementation Program', giving a strong impulse to circularity in all sectors.
- The Netherlands aims for a 60% reduction in CO_2-emissions in 2030 (compared to 1990), and an almost 100% sustainable energy by 2050. This means that by 2050 CO_2 emissions should be 80% to 95% lower than in 1990, according to the Dutch Climate Act. Wind energy will deliver significant part of this CO_2 reduction.
- The Dutch Climate Act aims for an annual production of 35 TWh by onshore wind and solar. In 2022, 30,6 TWh of energy was produced by these sources. Space for the production facilities for the additional 4,4 TWh is sought in the RES programme (Regional Energy Strategies). An unknown amount of this production will be by new wind turbines.
- Large manufacturers of wind turbines have set goals to reach Zero-waste turbines by 2040 (Vestas) and Provide fully recyclable blades by 2032 (Nordex). On international level the WindEurope working group on Circularity is trying to align the targets for the entire sector.

All these stakeholders acknowledge the challenge to transition to a fully circular wind sector and give guidance towards a goal in the distant future.

Market description

From a policy perspective the Dutch onshore wind market is divided by project size:

- For development projects up to 5MW the Municipality is the competent authority for the permitting procedure.
- For development projects over 5MW up to 100MW the Province is the competent authority for the permitting procedure.
- For development projects over 100 MW the National government is the competent authority for the permitting procedure.

Most onshore wind development projects in the Netherlands are in the category between 5–100 MW, ranging roughly from 2 to 20 turbines. This means that for most times the Provinces are the competent authority, this allows them to have the greatest influence on a larger number of projects. This also means that we'll only focus on wind farms with at least three wind turbines in this market vision.

Their influence is however limited compared to offshore wind developments. This is due to the fact that within offshore wind developments, the National Government is also in charge of leasing the ground on which the development will take place. This gives them more options compared to onshore developments where Provinces almost have no ground on which wind turbines can be developed.

From a developer's perspective a large variety of stakeholders can be identified, which can roughly be split into four groups:

- Utilities that develop and operate wind projects onshore, often with a fairly large portfolio of assets, making these interesting stakeholders for both new-build projects as well as decommissioning of end-of-life projects.
- Independent developers that only develop projects and sell these when the operational phase is reached. These organisations do not own any assets after development and are only interested in new developments.
- Independent asset owners that buy wind farms after completion to operate these. These organisations are also responsible for the decommissioning at the end of the lifetime.
- Cooperative developers of local stakeholders. These organisations usually work with either of the two developers to bring their project to success. They own a (small) part of the assets, so their power is limited. However, they can have a strong voice in the project development and lifetime, making them an import stakeholder to keep in mind.

From the buyer group perspective, both Eneco and Vattenfall fall in the first category of developers, with both existing assets and new projects under development. On many projects they work together with the fourth type, the cooperative developers.

Apart from these parties involved in the development, also organizations involved in the purchasing of electricity can influence the development. Corporate Renewable Power Purchase Agreements (PPAs) have the opportunity to specify the place of production of energy. This means that buyers of electricity can purchase electricity generated at a circular wind farm. Currently this is not yet an option since these parks do not exist yet. This can however become a point of interest for future wind PPAs.

From a product perspective, it is crucial to distinguish between the two primary components of a wind farm: the turbine and the Balance of Plant. The turbine consists of everything build on top of the foundation. This includes the tower, generator, blades and all other parts of the turbine. On the suppliers sides there are only four manufacturers active in the Netherlands (six in total in Europe). All turbine suppliers operate on a worldwide level, and challenges in specific markets might lead them to more attractive markets elsewhere. For them a sufficiently large market is needed to work on innovations including circularity. Policy is an important driver for this.

The balance of plant consists of all the civil works of a wind farm. These include foundations, cables and roads. The construction of this part of the wind farm is often done by local suppliers, creating a supply chain with more companies to work with. These suppliers are also involved in other infrastructure projects, giving them the opportunity to also work with the outcomes of other infrastructure buyer groups such as CO_2-low concrete, sustainable road pavements and zero emission building equipment.

Sector association

On a national level in the Netherlands the Netherlands Wind Energy Association (NWEA) is the leading association for all wind related subjects. Their members include the entire value chain, from developers to maintenance and decommissioning experts. Circularity is a topic of discussion, though not the highest priority.

On a European level WindEurope is the sector association aimed at the wind sector. They have named circularity as a focus point, with special attention for the recycling of wind turbine blades. Together with European Chemical Industry Council (Cefic) and the European Composites Industry Association (EuCIA) they have investigated the best ways to recycle wind turbine blades at the end of life.

Sustainability

Sustainability is an important point of attention for the wind sector. Attention is given to this subject on many different topics. First of all, as a source of renewable electricity, wind energy is an important source for reducing the CO_2 emissions of the electricity sector. Next to that, designing more sustainable wind turbines has been a topic for the past few years. This includes examples like finding alternatives for greenhouse gasses such as SF6. This is however also out of scope for this buyer group. Within this buyer group specific attention is given to the material use within wind turbines. Other aspects of sustainability are out of scope and therefore not part of this buyer group.

Currently turbines are 85–90% recyclable (WindEurope). The largest mass comes from the steel towers that have existing recycling practices. However, to be able to recycle it into high quality steel the product may only contain a certain percentage of contamination. When the contamination is within limits the alloy can be reused for towers. The more pure the product is, the easier it is to reuse. The main challenge for this part of the wind turbine therefore is the focus on how to keep the steel on a level so that it can be used to remanufacture new steel towers.

One of the two biggest remaining challenges in recycling wind turbines concerns the blades. These are made of composite materials which are currently hard to recycle. Much research is currently taking place on how to better recycle composites and specifically wind turbine blades. The first sector wide aim therefore is to make sure that there is a ban in place on landfilling of all decommissioned blades by 2025. Also, large turbine manufacturers have presented fully recyclable blades to be used on new projects. Next to that, many other sectors use composites, making it a challenge that is also covered broader in a cross-sectoral platform together with the European Chemical Industry Council) and EUCIA (the European Composites Industry Association).

The third and final big challenge within recycling of turbines lies in the recovery of rare earth minerals that are being used in the generator. Complete re-use of generator parts is most of the times not possible since turbines have grown significantly in size. This means that new ways are being sought to separate these materials to re-use them in new generators.

On the balance of plant of the wind farm the biggest challenge lies in the concrete used for the foundations. With over 90% of the mass of the foundation this is the biggest emitter of CO_2 in the Balance of Plant. The main goal therefore with concrete is to reduce the emissions during the production, less material use during design and to reuse the material as efficiently as possible at the end of life. Since this problem is also known within the rest of the construction sector much research is taking place on how to lower these emissions.

International responsible business conduct

Sustainability and circularity are both part of the larger theme of International Responsible Business Conduct (IRBC). Within the Netherlands a large group of organizations have signed the International Responsible Business Conduct Agreement on Sustainable Energy. This agreement promotes International Responsible Business Conduct and involves partnerships between businesses, trade associations, government, unions and NGOs. Together, these partners work to identify and prevent abuses like exploitation of local communities, child- and forced labour, and environmental damage. Within the sustainable energy agreement this specifically focusses on solar- and wind energy. By applying IRBC standards, solar and wind energy companies, developers and manufacturers of wind turbines, solar panels and their components can limit actual or potential negative impact of their operations and supply chains on people and the environment. Within the buyer group both Eneco and Vattenfall have signed this agreement, thereby marking the importance of this subject for their organizations.

3 MARKET VISION

Currently there are many small initiatives working on circularity in the onshore wind sector. All participants in the group have their own aims, but to maximize our impact, it is essential to consolidate all efforts into a unified and cohesive approach. This creates a sufficiently large market to motivate the supply chain to continue their work and potentially accelerate this. This can already be achieved on a small scale by setting up ambitious goals for the Netherlands but can be best done by setting EU-wide goals so a level playing field on this topic is created.

To help creating the sufficiently large enough market, the buyer group aims to start the following changes:

Public participants

- To create a common understanding of often used terms in the field of circularity in the wind sector. For this a list of definitions was drawn up that can be used publicly by all stakeholders so we all speak the same language and less communication errors will be made. For this an overview of often used definitions has been made, included as annex 1 to this document.
- On an EU level the topic of circularity in the wind sector should become known to the civil servants and relevant stakeholders working on the Ecodesign directive. By familiarizing them with the challenges in the wind sector, it is more likely to be included in the revised directive as relevant and proactive sector by the end of 2023.
- On a national level the topic should be on top of mind with the relevant stakeholders by the end of 2023. These stakeholders should ultimately become ambassadors that advocate for circularity in the wind sector at the levels that they operate, including National and European Level, which is a goal for the end of 2024.
- Secondary to the National goal, on a Provincial level in the Netherlands the topic of circular wind should become top of mind by the relevant stakeholders at the end of 2023. The aim of this secondary trajectory is to have every Province include it in their Environmental Vision (Omgevingsvisie), thereby officially stating the importance of circularity for them. This can then also serve as a basis for any instruments to be included in the Environmental regulation (Omgevingsverordening). This aim is set to be reached at the end of 2025, dependent on the renewal of the Environmental visions per province.

Private participants

- Material passports have become a requirement in the upcoming Dutch Offshore Wind Tender ‘IJmuiden Ver’. All participating companies in the tender are asked to provide a material passport for the wind farm. This will be based on the ‘Leidraad materialenpaspoort’. The participating buyers will share their lessons learned from the offshore tender after award of the tender. These lessons learned during the tender will be used to assess the option to use this type of material passport for onshore wind farms. The lessons learned will be shared in Q3 or Q4 2024, depending on the timeline of the tender.

- A general set of KPI's is defined that can be used by all buyers in the European wind sector to stimulate OEMs in their development of fully circular wind turbines. These KPIs will be based on the chapter on wind energy in the 'Advised roadmap towards a circular economy in the manufacturing industry' as presented in 2022 to the Dutch Government and checked with the sector. These KPI's are presented later in this document and the target is to have them known in the Dutch wind sector at the end of 2023.

Sustainability aspects

The buyer group aims to further reduce the CO_2 emissions and virgin material use of the wind sector. This will be done by focusing on achieving higher level R-strategies for the turbines at the End-of-Life, by focusing on the reduction of virgin material use in new wind turbines and by aiming to create a fully recyclable wind turbine.

Cooperation

During the research phase of the market vision, the participants of the buyer group worked together to define the scope of the project and parties to be involved. They together defined which parties outside of the group should be included, as well whom should be consulted.

This led to several market dialogue sessions with manufacturers of wind turbines, processors of wind turbines at the end-of-life phase and related buyer groups to hear the developments, challenges and wants in their developments towards a circular wind sector.

Besides that, the aim of this vision is to get the supply chain of the OEMs on board. Both OEMs are in constant dialogue with their suppliers to improve on many different items including circularity. With the market vision in hand, they can inspire their supply chain to start developing new circular solutions and/or improve upon their current solutions.

Expected results

Public Participants

For the involved public participants, it is expected to have a set of standardized texts available at the end of 2023 that can be used by all provinces in the Netherlands. Implementation of these texts is however not expected by all parties in the short term due to the long processes and times it takes to make changes to spatial policy.

Private participants

For the involved private participants, it is expected that within new development processes, circularity will be a standard topic of discussion between the buyer and supplier (both for the turbine and the Balance of Plant). The Buyers have the option to make use of the proposed KPIs, adapt these to fit to their own system or can use their own internally developed KPIs. For current developments they can use the roadmap as a starting point for discussion with the supplier to understand their path to market and how they can support the supplier on this path.

Material passports for wind are named as important upcoming development. It is currently in the early stages. The first large scale implementation is currently taking place in the offshore wind tender 'IJmuiden Ver'. It is expected that at the end of 2024 this Material Passport will be used onshore as well, depending on the current tender.

Expected impact on sustainability topics

The group expects that only a qualitative assessment can be made of the expected impact on these topics. It is expected that lower energy use can be expected in the longer term due to the lower amount of virgin material use and higher recycling rate. Also, higher R-strategies can help lower the CO_2-footprint due to a longer lifetime of products. Due to a lack of transparency within the sector it is however impossible to create a quantitative assessment on this topic.

4 MARKET STRATEGY

To reach the goals for the Provincial impact, European impact and for the Buyers three different strategies have been defined. Each of these have an impact on each other, therefore all three strategies will be rolled out simultaneously.

Public participants

National/EU policy strategy

During the market dialogues it has been stressed many times that the best way forward is a harmonized European policy, thereby creating an EU-wide level playing field. By doing so, the wind turbine OEMs have a sufficiently large market to earn back their investments in innovations. That is why first of all the aim is to strive for harmonized policy on an EU-level.

The Dutch government has named the transition towards a circular economy as one of the main themes that it works on. From a policy perspective they, however, rely mostly on common European policy to create a level playing field. To have success with this strategy it is important to work together with the influential stakeholders in the National government. These stakeholders can liaise and influence stakeholders on the EU level for this subject. The work done in this Buyer Group can help them in their discussions. The combined work of the public and private participants shows that both groups are actively working on this transformation. This helps make the case for the importance of the subject.

On the EU level it is expected that the circular economy will become part of the updated Ecodesign directive. The directive is part of the Circular Economy Action Plan. In the directive goals will be set for specific sectors. Which sectors will become part of the updated directive is currently under discussion, giving space for the wind sector to become part of this. The Buyer Group recommends the Dutch Government to support the inclusion of wind in the Ecodesign directive on the EU-level. They can do so through the regular channels used for their activities on this subject within the EU.

Besides the Ecodesign directive it is suspected that there are many more options. It is currently unclear what full range of options there are in EU-wide legislation and policy. To be able to influence existing and potentially new legislation and policy developments, it is recommended to do further research on this topic. The outcomes of this research can be used to further improve policy and legislation on the EU level.

On a European level the Big Buyers initiative shows similarities to the Dutch Buyer Group program. The Solar PV market is currently investigating how they can participate in this program. For the onshore wind farms the options to join the program will also be investigated.

Next to that it is recommended to include other stakeholders that influence the EU level including the sector association WindEurope and potentially the representation of the Dutch Provinces in Brussels.

National policy strategy

Within the building code all requirements for buildings are stated. Circularity is in here not named as a requirement, making it impossible for policy makers to use this to enforce circularity within the build environment. However, wind farms don't fall under the building code. This might give options to enforce circularity through likewise policy that is applicable to wind farms. It is however unclear what these options are. It is advised to do further research on this topic by the Dutch Government to clarify the options.

Next to policy requirements, also financial support instruments can be used to help developers make the decision to make the higher investment on a more circular wind turbine. Within the SDE++ subsidy scheme the options for 'Social Requirements' (Maatschappelijke Eisen) are being investigated. This research is commissioned by the Ministry of Economic Affairs & Climate Policy and performed by external parties. Details on the outcome will be provided by the Ministry. One of these requirements might focus on circular options for wind farms. The extra costs for this will then be taken into account when defining the subsidy level, thereby also providing a financial incentive to the developers to choose for the more circular option with the OEMs/ construction company for the balance of plant.

Provincial policy strategy

Due to the long lead times and uncertainty of success on the EU-level, a second simultaneous strategy is proposed to evoke change. This strategy is a bottom-up strategy where the Provinces take the lead by making a change, thereby inspiring all others involved to help make this change.

To identify the opportunities to get this change started, research was conducted on the policy options that might be used to accelerate circularity in the onshore wind sector on behalf of the Province of Noord-Holland and the municipality of Amsterdam. The outcome of this research is presented on the website Circulaw.nl.

Based on these outcomes a workshop was held with the Provinces to determine the best options from their perspective. The outcome of this workshop was that the best options lay in the environmental vision and the associated environmental regulation. To have a level playing field in the Netherlands on this topic it has been decided to draw up a standardized vision text that can be used by all Provinces in the Netherlands. This standard text will be developed by the Provinces and RVO, and shared with the other Provinces after competition, set to be during the summer of 2023.

Based on the Environmental vision it could be possible to implement distinct regulations on the topic of circularity and wind farms. 2023 will be used to create clarity on this, check the potential of these regulations with the impacted stakeholders and create a set of standardized texts that can be used by all Dutch provinces. The goal is to present this at the end of 2023, after which the Provinces can use these as a basis when updating their own environmental visions and -regulations.

Private participants

Buyer strategy
Simultaneously with the further development of policy, the buyers of the buyer group can set the first steps to including circularity in their buying practice. They can do so on both the wind turbine, as well as on the balance of plant.

Wind turbine
For the wind turbine, the buyers will focus on the use of Material Passports. These passports detail the material use of a product and track this over the lifetime. As a first, the passport is currently requested in the tender for the offshore wind farm 'IJmuiden Ver'. In this tender all participating companies are asked to provide a material passport for the plan they are submitting. The tender criteria require the use of the 'leidraad circulair productpaspoort maakindustrie' (guide circular product passport manufacturing industry) to create this passport.

The buyers are looking into using this same system for onshore wind. To do so, they will first focus their efforts on the offshore tender. The lessons learned on the material passport in this tender will be shared to assess the use for onshore wind. These lessons learned on the use of the passport will be shared after awarding the tender (expected Q3–24). Next to that the buyer group is investigating the options to have RVO and/or the Ministry of Economic Affairs share their overall lessons learned from all tendering parties.

Balance of Plant
For the balance of plant the buyers will look into the options to integrate the strategies and lessons learned from the buyer groups low carbon concrete, circular road pavings and zero emission building equipment. Specifically the following instruments are named in these buyer groups:

- Low carbon concrete instruments:
  1. Environmental Cost Indicator
  2. Requirements on circular demolition
- Circular road pavings instruments:
  1. Environmental Cost Indicator
  2. Additional requirements for the quality of implementation
  3. Additional requirements with regard to circularity: reuse of asphalt within the asphalt chain
  4. Push for verification of ECI through the As Built protocol.
- Zero emission building equipment instruments:
  1. Environmental Cost Indicator
  2. CO_2-performance ladder
  3. AERIUS calculation
  4. Specification deployment construction equipment
  5. European emission standards and minimum requirements
  6. Action plan
  7. Open post
  8. Training 'Het Nieuwe Draaien'

A monitoring tool is available within the buyer group zero emission building equipment to monitor the progress on the projects within an organization and the wider buyer group.

For the exact details reference is made to the market visions and documents of the specific buyer groups.

Additional criteria to help set kpis for oems

Second to the Material Passport requested, the buyers are in constant dialogue with their suppliers on the topic of circularity and how to improve this. To help the buyers in this dialogue, the overview of opportunities and developments in the wind sector that acted as the basis for the 'Advised roadmap towards a circular economy in the manufacturing industry' has been used. This overview (presented in annex 2) presents 20 general opportunities for more circularity in the wind sector, as well as 21 specific items based on parts of the wind farm. For each of these opportunities the current status and expected development was assessed up to 2030, providing insight in the opportunities for developers to act on these.

Based on these insights, developers can set their first steps to encourage the OEMs by using a set of KPI's for circularity based on the currently commercially available options in the report:

- Supplier delivers within SET TERM the complete material passport of the items build/purchased.
- Supplier delivers within *SET TERM* the complete LCA of the purchased product.
- Supplier delivers within SET TERM the complete EPD of the purchased product.
- Supplier shows that research is taking place within the company on mass reduction for new products, with an explanation of why certain topics are part of the research.

For the other opportunities that are currently under development, it is suggested to have discussions with suppliers early on to discuss how buyers can support the further development of an opportunity. This discussion can be guided with annex 2 as a basis.

As it is expected for buyers to have regular conversations with the OEMs on this topic, they can assess the potential to add new KPIs based on the outcomes of these conversations. In there they can also discuss the impact of changing policy on Provincial, National and/or EU level and how this impacts the OEMs.

5 FAQ

Can we expect higher costs as an organization for our products when we implement the outcomes of this market vision?

Looking purely at the financial business case on a short term, higher prices can be expected. Considering the wider business case including CO_2-costs, loss of biodiversity etc. the costs are expected to be lower by implementing these outcomes.

What risks can I expect when trying to implement the outcomes?

Information sharing between buyers, suppliers and policy makers is key to the successful roll-out of the market vision. This asks for regular and open communication between all parties, and the willingness to share information with one another. This also prevents impossible requests from buyers to suppliers.

What's the view of the supply chain on this market vision?

During the process of setting up the vision several sessions were held with important players in the supply chain. During these sessions the concept behind the group was explained and feedback was given by these parties. Next to that they gave insight into their developments and needs from the sector, which have used to further refine this vision document.

I have a question, who can I reach out to?

For more information and contact details, please visit the website of the buyer group here.

ANNEX 1 LIST OF DEFINITIONS

Environmental Product Declaration	An EPD — environmental product declaration — is a document which presents the environmental performance of a product. EPDs are a formal and internationally recognized way to present these impacts. Typically, Life Cycle Assessment is the method that calculates the impact data that supports the EPD. The completed EPD therefore serves as an environmental label or declaration. The LCA data calculations behind an EPD uses Life cycle inventory analysis (LCI). These calculations and processes follow the ISO 14040 standard. The ISO 14040 is the standard developed to describe the principles and framework of conducting LCA.
LCA	Life Cycle Assessment, also known as Life Cycle Analysis (Cradle to gate/cradle to grave), is an analysis method for evaluating the potential environmental impacts of a product or service over the course of its entire life cycle. LCA can be used to compare various products in terms of environmental sustainability.
Material Passport	The materials passport contains information about the type of material, the quantities, the method of assembly and the location of objects. Adjustments to the product during the use phase are also registered in it.
Material Flow Analysis	An evaluation method which assesses the efficiency of use of materials using information from material flow accounting. Material flow analysis helps to identify waste of natural resources and other materials in the economy which would otherwise go unnoticed in conventional economic monitoring systems.
Cradle2cradle	The principle literally means "cradle to cradle" and it describes the safe and possibly infinite circulation of materials and nutrients in cycles. All substances in the product are chemically safe and can be recycled. Waste in the modern sense, which stems from the previous take-make-waste model, no longer exists; there are only useful nutrients left.
Recycability	The ease with which a material can be recycled in practice and at scale.
Recycable blade	Recyclable blades are defined as rotor blades designed and produced with the purpose of increasing the recycling at end of life, keeping materials at the highest possible stage in the waste hierarchy and recovering high-value building blocks for either same or other applications.
Supply Chain analysis	Supply chain analysis is the process of evaluating every stage of a supply chain starting from the time the business acquires raw materials or supplies from its suppliers to the delivery of final products to the customers with the goal of assuring quality, heightening the certainty of delivery and or improving the efficiency.

Refuse and rethink	Refuse and rethink include forgoing products, delivering a product function with a radically different product, and intensifying product use through product sharing or use of multifunctional products.
Reduce	Reduce involves manufacturing products more efficiently by using fewer raw materials and materials in the product or in its use.
Reuse	'Re-use' means any operation by which products or components that are not waste are used again for the same purpose for which they were conceived.
Recycling	Any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes. It includes the reprocessing of organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations.
Upcycling	Upcycling is to use (waste) material in a way that adds value to it, and that allows it to be recycled again in the future.
Downcycling	Downcyling is to use (waste) material in products of lesser quality or that avoid the reinsertion of the material in its original cycle.
Energy Recovery	The strategy of energy recovery involves recovering energy from materials. For example, waste incineration plants convert residual flows into heat and electricity.
Value hill	The Value Hill proposes a categorisation based on the lifecycle phases of a product: pre-, in- and post- use. In the context of the Value Hill, value is added while the product moves "uphill" and circular strategies keep the product at its highest value (top of the hill) for as long as possible. Products are designed to be long lasting and are suit- able for maintenance and repair, thus slowing resource loops (Bocken et al., 2016) and prolonging the use phase of the product. When a product is ready to start it's downhill journey, it is done as slowly as possible so that its useful resources can still be of service to other systems.
Design for circular economy	Circular design focuses on creating products and services for the circular economy, hence its very close linkage. The key lies in rethinking the process from the beginning, so that matter, like biological processes themselves, have a regenerative life cycle for the sustainability of the planet, i.e. it becomes useful repeatedly by being repaired, reused, recycled or transformed.
Data and information	Data refers to data (about business processes, products and customers), which are (usually) available in digital form. Only when the context, meaning and coherence of data is clear can it be properly interpreted and the data can be used as information. Characteristic of information is that it is interpretable. Interpreting and integrating information results in knowledge.
Recertification	The act or process of certifying or being certified again.

Dematerialisation	Dematerialization is delivering the same product or service using a percentage or none of the mass or material types, or entirely without the material. There are a few pathways to dematerialize a product: Optimize – maximize resource effectiveness by reducing the mass or material types in the product. Digitize – sell the product electronically or virtually Servitize – sell the utility of the product as a service
Waste prevention	'Prevention' means measures taken before a substance, material or product has become waste, that reduce: (a) the quantity of waste, including through the re-use of products or the extension of the life span of products; (b) the adverse impacts of the generated waste on the environment and human health; or (c) the content of hazardous substances in materials and products.
Modularisation	Modularity helps facilitate durability (longevity), repairability & maintainability, recyclability, sharing, and upgradeability. Most often modularity requires design changes, or for new products, design considerations.
Maintenance	Maintenance are routine activities meant to prevent damage and prolong the life of appliances, fixtures, and the property itself.
Repair	Repairs are restoration work for when something gets broken, damaged or stops working.
Reuse and Repurpose	Reuse as to use again especially in a different way or after reclaiming or reprocessing. Repurpose is to use something for a different purpose to the one for which it was originally intended.
Refurbish	Refurbish means collecting discarded products or materials that can be refinished and sanitized to serve their original functions. Refurbishment results in a product that, although in good condition, may not be comparable with new or remanufactured products.
Remanufacturing	Remanufacturing is the process of recovering, disassembling, repairing and sanitizing components for resale at "new product" performance, quality and specifications. By remanufacturing products, components or parts, a company contributes to the circular economy by extending the lifetime of those elements and creating value.
Lifetime extension	Lifetime extension is the counter-strategy to planned obsolescence, in which products are designed to fail after a specific time. In other words, longevity means that a product is designed to last as long as possible.
Repowering	Repowering a wind farm means replacing the old turbines by more powerful and efficient models that use the latest technology.
Decommissioning	Decommissioning means that the wind turbines, site office and any other ancillary infrastructure is removed from the site allowing the area to be returned to its former use. In specific cases, not all parts need to be removed (e.g. in line with soil or water protection guidelines, in agreement with responsible authorities) to accomplish decommissioning.

Site recovery	Returning sites to a similar state as before wind farm development.
Disassembly	The process of dismantling a machine or structure into its different parts.
Recycling	The recycle strategy revolves around the collection, processing and offering of raw materials that are released at the end of the lifespan of product (parts)s.
Energy recovery	The strategy of recover involves recovering energy from materials. For example, waste incineration plants convert residual flows into heat and electricity.
Onshore Windfarm	An area of land with two or more wind turbines.
Wind turbine	A wind turbine is a power generating device that is driven by the kinetic energy of the wind. Wind turbines general fall into one of two categories: Horizontal axis wind turbines (HAWTs) and vertical axis wind turbines (VAWTs). HAWTs, the more common type, consist of propeller-like rotors fixed around a central hub and facing into the wind, like a windmill. In a VAWT, blades surround the drive shaft of the turbine. Both types use bladed rotors of various designs driving a shaft to a generator that uses electromagnetic induction to produce a voltage. The main parts of a windturbine are the tower, the nacelle, and the rotor. WIthin the nacelle the generator is placed that turns the windenergy into electrical energy. The rotor consists of a nose cone and two or three blades.
Balance of plant	Balance of plant (BOP) is the term used to describe all the infrastructure and facilities of a wind turbine installation except for the turbine itself. It, therefore, encompasses all aspects of the project not covered in the turbine supply contract. This includes project management, ground condition surveys, crane pads / hard standings, foundations, substation and electricals as well as roads.
Developer	The organisation that enters into a wind option agreement or wind energy agreement with the owner of the real property for the purpose of developing a wind energy project.
OEM	An Original Equipment Manufacturer or OEM is a company that manufactures and sells products or parts of a product that their buyer, another company, sells to its own customers. Turbine manufacturers are a typical example in the wind sector.
Contractor	A contractor is any individual or organization that is hired to perform work for another individual or organization on a contract basis.
Landowner	An owner of land on which a windproject is developed.
Anterior agreement	The anterior agreement is a common mean of settling agreements between governments, initiators of sustainable projects, and landowners.

PPA	A Power Purchase Agreement (PPA) often refers to a long-term electricity supply agreement between two parties, usually between a power producer and a customer (an electricity consumer or trader).
Transport	Transportation of wind turbine components and all BOP items.
Policy maker	Someone, especially in a government or political party, who decides on new policies.
Legal condition	A lawful or legal condition is one made in consonance with the law. This must be understood of the law as existing at the time of making the condition, for no change of the law can change the force of the condition.
Non-statutory (requirement)	Non-statutory is essentially another term for common law. Therefore such bodies are formed by executive resolution or action, which means that they are formed only by the Government's action.
Permitting authority	Administrative body authorized to grant the permit.
Building nitrogen free	Utilising material during the construction that don't emit any nitrogen compounds.
Biodiversity	The variety of plant and animal life in the world or in a particular habitat, a high level of which is usually considered to be important and desirable.
Supply chain responsibility	Supply chain responsibility: preventing or addressing abuses in the areas of working conditions, human rights and the environment in accordance with the OECD Guidelines for Multinational Enterprises.

ANNEX 2 OVERVIEW OF DEVELOPMENTS

Overview of developments on circularity in the wind sector, based on the 'Advised roadmap towards a circular economy in the manufacturing industry.'

Op basis van de 'ADVIESROUTE NAAR EEN CIRCULAIRE ECONOMIE VOOR DE MAAKINDUSTRIE' (Transitieteam Advies Circulaire Economie, 2022) zijn de relevante kansen voor wind op land uit de tabellen gefilterd.
De kansen kunnen zich in vier verschillende fases bevinden:

1. **Pre-industrieel onderzoek** (in het rapport Principes). In deze fase wordt er op overkoepelend niveau naar de kansen en mogelijke uitwerking gekeken.
2. **Industrieel onderzoek** (in het rapport Business modellen). In deze fase kijken bedrijven naar de mogelijkheden om met een bepaalde kans aan de slag te gaan.
3. **Pre-competitieve samenwerkingen** (zelfde naam in rapport). In deze fase werken verschillende bedrijven samen aan proefprojecten om de nieuwe kansen verder te ontwikkelen.
4. **Op de markt verkrijgbaar** (in het rapport Institutionaliseren). In deze fase is een kans verkrijgbaar op de markt en wordt deze onderdeel van de standaard die alle partijen kunnen leveren.

Voor elke kans is in de tabel aangegeven in welke fase een kans zich op dit moment bevindt (Huidige fase), wat de verwachting is dat deze zich bevindt in 2030 (2030, beide gebaseerd op het rapport) en de mogelijke doorontwikkeling naar 2050 (indien niveau 4 niet eerder is behaald)
Daarnaast is voor de algemene kansen aangegeven voor welke partij de meeste invloed heeft met een bepaalde kans. de private partijen (bedrijfsleven) of publieke partijen (overheden).
Bij de specifieke onderdelen is er per kans aangegeven in welke fase van de levensduur van een windpark deze kans zich voordoet (nieuwbouw, midlife of end of life)

Hoe kun je als organisatie aan de slag met deze kansen?
De kansen zijn gevalideerd bij het bedrijfsleven in 2022. Inkopers kunnen aan de hand van de algemene of specifieke kansen in overleg met de verkopende partij om te kijken wat hun huidige status is op bepaalde onderwerpen.
Samen kunnen zij vervolgens gerichte samenwerkingen aangaan om bepaalde kansen verder te ontwikkelen.

	Oplossing	Bedrijfsleven/ overheid	Potentiële KPI	Huidige fase	Doel 2030	Doel 2050	R-strategie
A5	LCA ten behoeve van circulariteit	Bedrijfsleven	Leverancier verstrekt binnen TERMIJN een LCA van het product	Commercieel verkrijgbaar			R0-R7
A6	EPD ten behoeve van circulariteit - middels digitale informatiedeling	Bedrijfsleven	Leverancier verstrekt binnen TERMIJN een EPD van het product	Commercieel verkrijgbaar			R0-R7
A3	Hergebruik windturbine	Bedrijfsleven	Bij afbraak van een turbine wordt het percentage hergebruik van volledige onderdelen en percentage recycling meegewogen in de scoring	Commercieel verkrijgbaar			R3
A16	Massavermindering	Bedrijfsleven	Leverancier toont aan dat er onderzoek plaatsvindt naar massavermindering bij nieuwe producten, inclusief uitleg waarom bepaalde onderdelen onderdeel zijn van het onderzoek.	Commercieel verkrijgbaar			R4
A14	Tendercriterium: Innovatief circulair design	Bedrijfsleven		Industrieel onderzoek	Commercieel verkrijgbaar		R1
A13	Tendercriterium: Vermindering van uitstoot van broeikasgassen	Bedrijfsleven		Industrieel onderzoek	Commercieel verkrijgbaar		R2
A10	Recyclebaarheid verhogen	Bedrijfsleven		Pre-competitieve samenwerking	Commercieel verkrijgbaar		R8
A4	Gestandardiseerd Materiaalpaspoort ten behoeve van circulariteit	Bedrijfsleven		Pre-industrieel onderzoek	Commercieel verkrijgbaar		R0-R7
A12	Stimuleren van circulariteit via tendercriteria	Bedrijfsleven		Pre-industrieel onderzoek	Commercieel verkrijgbaar		R0-R9
A8	Modulair ontwerp van het totale systeem	Bedrijfsleven		Pre-industrieel onderzoek	Commercieel verkrijgbaar		R1
A15	Circulair decommissiong plan	Bedrijfsleven		Pre-industrieel onderzoek	Commercieel verkrijgbaar		R1
A18	De CO2 impact in de verschillende fasen van de value chain verminderen	Bedrijfsleven		Pre-industrieel onderzoek	Pre-competitieve samenwerking	Commercieel verkrijgbaar	R2

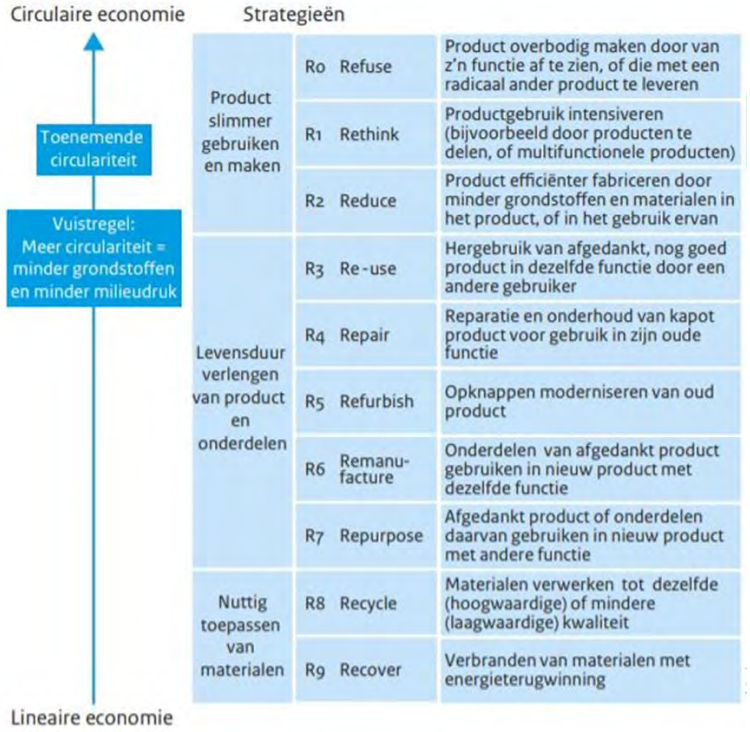
	Oplossing	Bedrijfsleven/ overheid	Potentiële KPI	Huidige fase	Doel 2030	Doel 2050	R-strategie
A19	Emissiearme installatiewerkzaamheden door middel van installatieapparatuur die kan draaien op emissiearme brandstoffen/ elektriciteit	Bedrijfsleven		Pre-industrieel onderzoek	Commercieel verkrijgbaar		R2
A20	Reduce/verminderen virgin materiaal	Bedrijfsleven		Pre-industrieel onderzoek	Pre-competitieve samenwerking	Commercieel verkrijgbaar	R2
A7	Het labelen van gedecommisioned materiaal met de data verzameld tijdens de levensduur van de windturbine, zodat materiaal- en onderdelenverlies voorkomen kan worden	Bedrijfsleven		Pre-industrieel onderzoek	Commercieel verkrijgbaar		R3-R7
A11	Sturing op/verplichting bepaalde recyclebaarheid van windturbine	Overheid		Pre-industrieel onderzoek	Commercieel verkrijgbaar		R8
A9	Herdefinitie van "afvalstoffen" in regelgevingskaders	Overheid (EU)		Pre-industrieel onderzoek	Commercieel verkrijgbaar		R0-R9
A17	Maximaliseren en standaardiseren tiphoogte	Overheid (EU)					R1
A1	Stortverbod op afval	Overheid (Landelijk/EU)					>R9
A2	Verbod op verbranden van afval	Overheid (Landelijk/EU)					>R9

Onderdeel		Oplossing	Levensfase windpark	Potentiële KPI's inkoop	Huidige fase	Doel 2030	Doel 2050	R-strategie
Bladen en andere composieten	**B1**	Bladen gemaakt uit andere materialen	Nieuwbouw		Pre-industrieel onderzoek	Pre-competitieve samenwerking	Commercieel verkrijgbaar	R1
	B2	Bio-based materiaal	Nieuwbouw		Pre-industrieel onderzoek	Industrieel onderzoek	Commercieel verkrijgbaar	R1
	B3	Slimme materialen	Nieuwbouw		Pre-industrieel onderzoek	Industrieel onderzoek	Commercieel verkrijgbaar	R1
	B4	Hergebruik van de bladen voor andere doeleinden	End of Life		Industrieel onderzoek	Commercieel verkrijgbaar		R7
	B5	Verlenging van de levensduur van het ontwerp	Midlife		Industrieel onderzoek	Commercieel verkrijgbaar		R5
	B6	Bevordering van de waardeketen voor recycling van composiet"afval" uit alle sectoren.	End of Life		Industrieel onderzoek	Commercieel verkrijgbaar		R7
	B7	Mede-verwerken in cement	End of Life	De bladen worden aan het einde van de levensduur zo hoogwaardig mogelijk verwerkt, met als minimaal uitgangspunt mede-verwerking in cement	Commercieel verkrijgbaar			R8
	B8	Pyrolyse	End of Life		Industrieel onderzoek	Commercieel verkrijgbaar		R8
	B9	Versplintering door middel van hoogspanningspulsen	End of Life		Pre-industrieel onderzoek	Commercieel verkrijgbaar		R8
	B10	Solvolyse	End of Life		Industrieel onderzoek	Commercieel verkrijgbaar		R8
	B11	Gasification (Fluidised bed)	End of Life		Pre-industrieel onderzoek	Industrieel onderzoek	Commercieel verkrijgbaar	R8

Onderdeel		Oplossing	Levensfase windpark	Potentiële KPI's inkoop	Huidige fase	Doel 2030	Doel 2050	R-strategie
Bladen en andere composieten	**B12**	Sensoren inbouwen in turbinebladen om de conditie van het materiaal te bewaken en de conditie te voorspellen.	Nieuwbouw		Pre-industrieel onderzoek	Commercieel verkrijgbaar		R1
Generator	**G1**	Verlenging levensduur	Midlife		Industrieel onderzoek	Commercieel verkrijgbaar		R5
	G1	Vermindering van het gebruik van zeldzame aardelementen in de windturbine	Nieuwbouw		Industrieel onderzoek	Commercieel verkrijgbaar		R1
Toren / Monopile	**T1**	Andere materialen (groen staal) Toren (end-to-end)	Nieuwbouw		Pre-competitieve samenwerking	Commercieel verkrijgbaar		R1
	T2	Verlening levensduur	Midlife		Industrieel onderzoek	Commercieel verkrijgbaar		R5
	T3	Gebruik van beton elimineren	Nieuwbouw		Pre-industrieel onderzoek	Pre-competitieve samenwerking		R0
Fundering	**F1**	Hergebruiken van onshore fundaties	End of Life		Pre-industrieel onderzoek	Pre-competitieve samenwerking		R3
Kabels	**K1**	Hergebruik kabels	End of Life		Pre-industrieel onderzoek	Pre-competitieve samenwerking		R3
	K2	Hoogwaardige recycling van koperdraad	End of Life	De kabels van een windpark worden aan het einde van de levensduur van het windpark verwijderd en aangeboden aan een partij die kan zorgdragen voor hoogwaardige recycling van de materialen waaruit de kabels bestaan.	Commercieel verkrijgbaar			R8

Onderdeel		Oplossing	Levensfase windpark	Potentiële KPI's inkoop	Huidige fase	Doel 2030	Doel 2050	R-strategie
Kabels	**K3**	Recycling van kunststoffen uit isloatie- en mantelmateriaal	End of Life	De kabels van een windpark worden aan het einde van de levensduur van het windpark verwijderd en aangeboden aan een partij die kan zorgdragen voor hoogwaardige recycling van de materialen waaruit de kabels bestaan.	Commercieel verkrijgbaar			R8

Tabel komt uit rapport 'ADVIESROUTE NAAR EEN CIRCULAIRE ECONOMIE VOOR DE MAAKINDUSTRIE', status Quo en doel 2030 volgen daaruit



Bron: RLI 2015; bewerking PBL