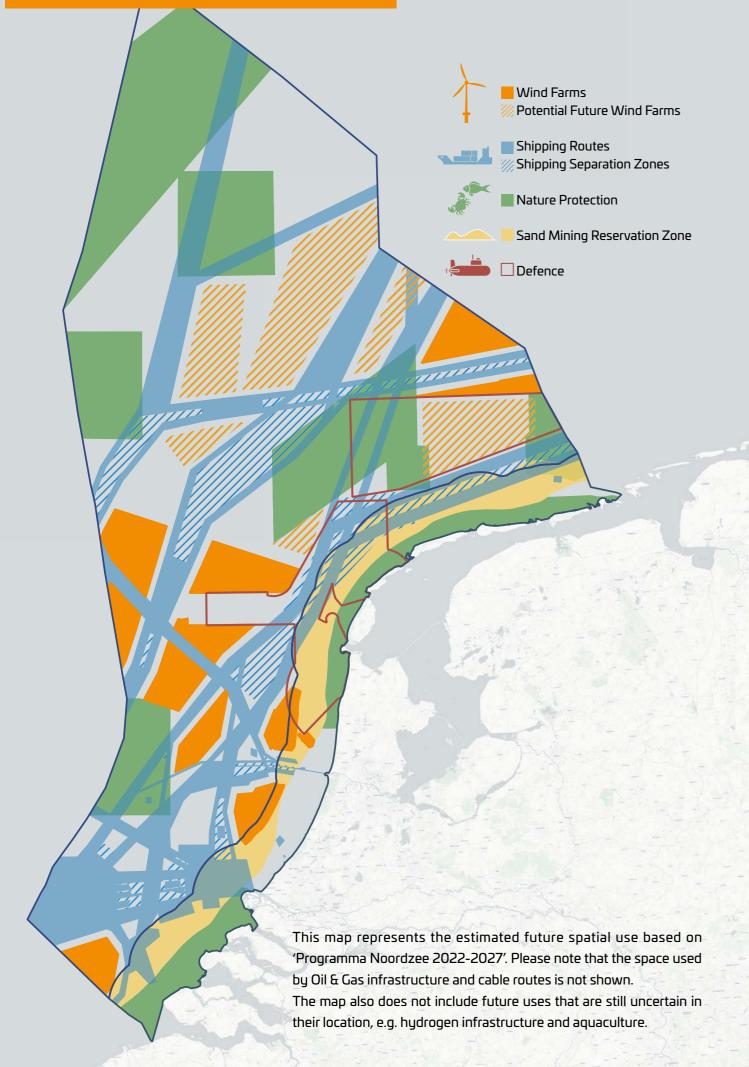


Advancing multi-use in offshore wind farms Roadmap for the Dutch North Sea



USE OF SPACE IN THE DUTCH NORTH SEA



The Dutch North Sea: a small home to many transitions

The North Sea is playing a major role in transitioning towards In addition, space is needed for future renewable energy a more sustainable European economy. Only within the infrastructure other than wind energy that will support the Dutch EEZ, 70 GW of offshore wind are foreseen up to generation of solar and wave energy generation, as well 2050 as an answer to climate change. The area required for as hydrogen production. this development is vast, but the available space is limited.

And all that in a degraded ecosystem that is also For one, offshore wind farm areas are competing for space transitioning and needs to be protected and restored. with traditional fisheries, while options for transitioning Extracting sand to protect the coasts from rising sea levels, partly towards different types of food production at sea allowing space for safe navigation, as well as for defence are now being considered. and recreational activities complete the puzzle.

Multi-use: a solution to the "problem" of limited space?

Multi-use inside offshore wind farms is broadly While possible synergies between different uses promise recognised as a (partial) solution to this challenge and a great future, there are a few technological, economic, can be achieved by designing in such a way that co-use ecological, and regulatory challenges that need to be of space is facilitated, as opposed to exclusive use only for overcome before a seamless symbiosis is achieved. wind energy production.

This project

The Road2SID project (Roadmap for technological advancements needed for Symbiosis-Inclusive Design in Offshore Wind) focuses on technological, regulatory, business case and ecological aspects of symbiosis in offshore wind farms.



Road2SID Roadmap - read the full report You can download the full report at grow-offshorewind.nl/project/road2sid

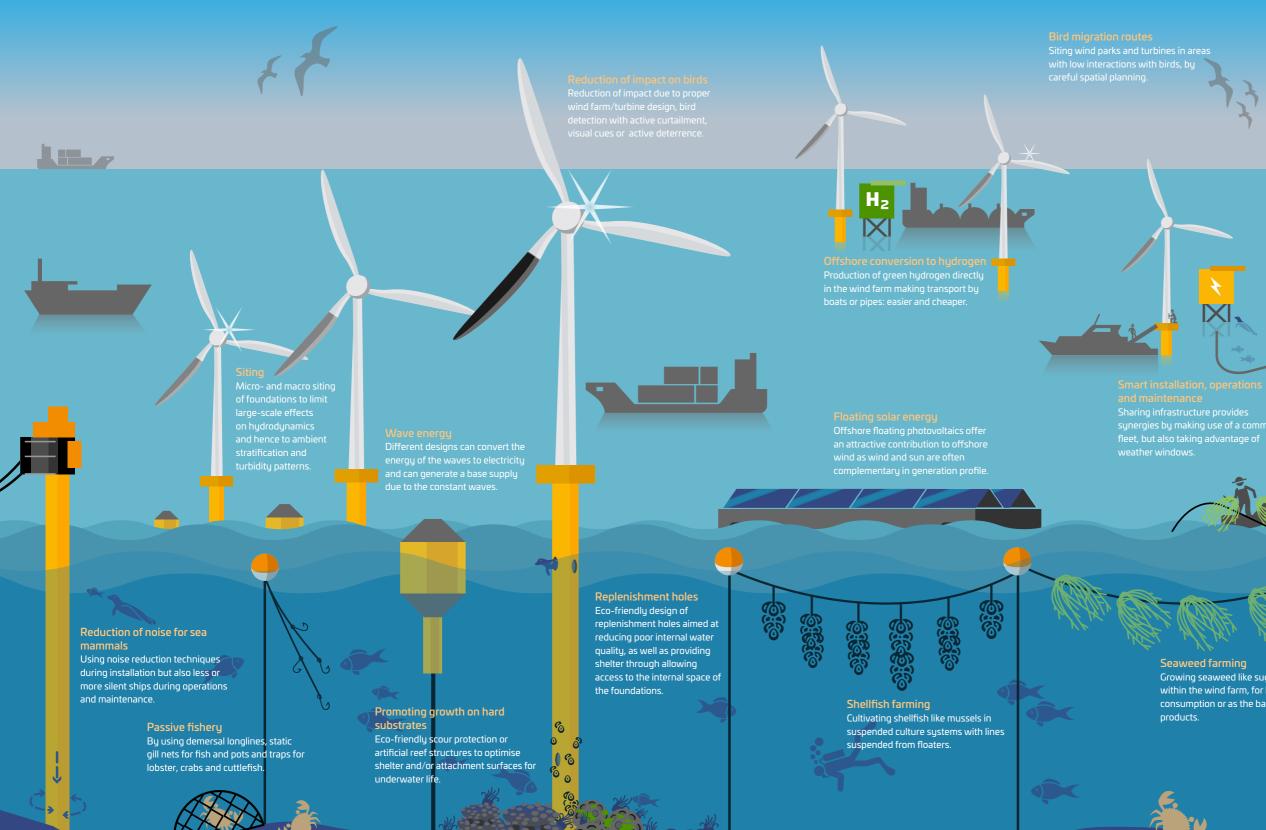
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The roadmap aims to:

- summarise available knowledge
- identify the various stakeholder perspectives
- and finally propose actions for advancing co-use
- in offshore wind farms.



3



Available practices for the symbiosis of nature, energy and food production at sea

multi-use in offshore wind farms is presented in the graphic developing fast, especially in the case of energy generation above for the context of the Dutch North Sea.

There are many developments underway in all three types of multi-use: nature restoration, food production

A visual overview of current knowledge and practice on and alternative energy. Both policy and technology are (technology) and nature restoration (policy).

The Netherlands is one of the leading countries on the topic Symbiotic projects involve many stakeholders whose of marine multi-use, primarily driven by the scarcity of interests need to be aligned. The visual can inspire multi-use space and long-term experience with the marine economy. possibilities and be a starting point for further discussions However, the field of symbiosis between functions or developments. inside wind farms is relatively young, with many unknowns.







Sharing experiences between stakeholders and setting goals for a more efficient and sustainable use of

State-of-the-art sensors can gather extensive data that is needed to monitor, facilitate and optimise for



Seaweed farming Growing seaweed like sugar kelp within the wind farm, for human consumption or as the basis for other

Cables

Minimising electromagnetic fields which might affect the behaviour of sharks and rays by cable design, changing burial depth or proper routing of electricity cables.



Technical details must still be sorted out, also concerning the environment, and other socioeconomic aspects. The industry cannot do this alone, as the expertise of the NGOs is needed, and the support of society in general.

> These concepts need to be proven viable before we can upscale. If this requires speeding up, then it should be made a priority in tender requirements to ensure quicker innovation and application.

Participation and communication are very important, especially since legal frameworks and ecosystem impacts are sometimes not quite clear yet.

North Sea energy transition cannot take place without strong international stimuli to overcome most stringent problems.

Political will, strong stakeholder management and a increased innovation pace is essential to overcome most stringent issues.

Research & consultancy

Applying new installation methods/technologies to facilitate upscaling presents both risks and opportunities. To avoid financial risks standing in the way of the development of more innovative method/technologies, risk sharing mechanisms between installation contractors and offshore wind developers are needed.

Installation contractors

symbiosis between offshore wind farms and other users. Not only the greatest challenges but also the biggest opportunities Offshore wind developers for synergy are in the co-use of the North Sea. To enable the development of tools and procedures for new installation activities, claritu on Regulatory bodies T&I contractor scope is required. To ensure efficient and safe Food production facilities and offshore installation, close engineered reefs should be cooperation with the (technology) New technologies are not installed for an indefinite period. developers is required. This profitable, the learning curve needs to reach the make-break requires early involvement of key point. Until that time, we need stakeholders, including installation contractors, to ensure installation financial sector and government Offshore wind farms should aspects are considered in the earlu support, to be paid back after onwards intrinsically be planned commercialisation. phases of new initiatives. with more than one energy source, increasing the societal value Multi-use innovators & startups

Exploring stakeholder perspectives on symbiosis; challenges and opportunities

Efficient use of space within

intensively used North Sea.

efficient use of space is a

prerequisite.

For an equitable way forward

and acceptance of stakeholders,

offshore wind farms is important as space is limited in the very

Symbiotic projects involve many stakeholders whose interests need to be aligned. Therefore, we have asked the stakeholders about their perspectives on the individual themes Nature, Food and Energy and their feedback on the opportunities they see, the challenges they face, and the responsibilities they feel.

Sharing of knowledge is key to understanding the system and

We should assure that the

stand in the way of the

development.

regulatory framework does not

As such, we see that the stakeholders believe that combining offshore wind with nature, food or other energy aspects creates opportunities for utilising the marine space more efficiently. On a technical level, the stakeholders see opportunities in shared infrastructure, mooring and also operating the vessel fleet.

unfavourable regulatory framework, for example concerning permitting and decommissioning. In terms of finance, they see that the costs of multi-use are high, with high insurance costs, high offshore operation costs and a lack of business case and/or track record of technologies.

6

We want to see a sustainable use of the sea, both within and outside of offshore wind farms Spreading awareness but also working together with the industry to create nature-proof designs

Current regulatory system is not made for nature but for people. We have to combine the two to come to a sustainable future. We can only do this by collecting knowledge, learning and sharing, innovating and creating awareness.

In terms of challenges, the stakeholders identify an Most stakeholders see it as their responsibility to advance innovation in the field of multi-use, both in terms of nature as well as energy. With respect to the former, the stakeholders saw a role for themselves in advancing stakeholder engagement, and awareness and they expect action from developers and even more from the government in terms of a regulatory framework.

NGOs

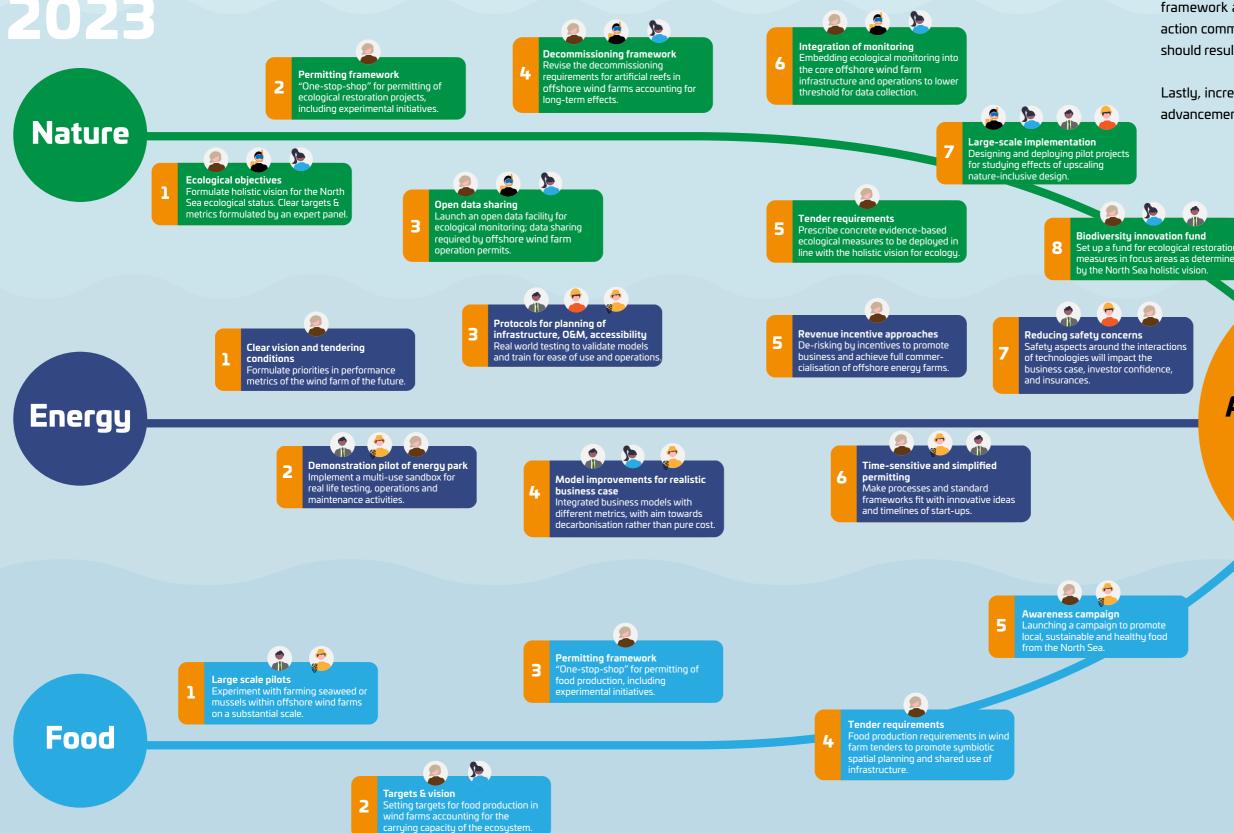
Key actions to advance symbiosis towards 2030

Based on the literature review and stakeholder consultation, opportunities, risks and challenges are defined. Currently, these are separate for the three types of multi-use activities in wind farms: nature protection, multi-use. food production and alternative energy generation. The actions presented here share common timelines (up Specific actions are defined that have the potential to

accelerate the development of multi-use offshore wind farms and bring the three types further towards integration. The actions are presented below per type of

to 2030), topics (technological, regulatory, economical)

and to a large extent action owners. Balancing between In terms of timeline, nature enhancement is the most realism and ambition, we suggest to initiate all these actions advanced; several pilots have been performed already, before 2030. The presented order is approximate, but in whereas first pilots are on the list of actions for both food general, a vision is deemed necessary as a starting point. and energy production. Installing pilots is a common action An integrated toolbox is presented in case study 3 that between all three themes. addresses symbiosis on the long term (e.g., 2030-2050). Most actions are defined in the governmental areas. Next to the pilots, common actions are defined based on



permitting all multi-users mentioned a clear permitting framework as an urgent action. Another governmental action commonly identified is an integrated vision which should result in tender requirements for multi-use.

Lastly, increasing safety and business case by technical advancement is required for all themes.

2030

Advanced multi-use in offshore wind farms in the Dutch North Sea.

MAIN ACTION OWNERS

Regulatory bodies NGOs ß Research & consultancy -۲ -3

Installation contractors

Offshore wind developers

Multi-use innovators & startups

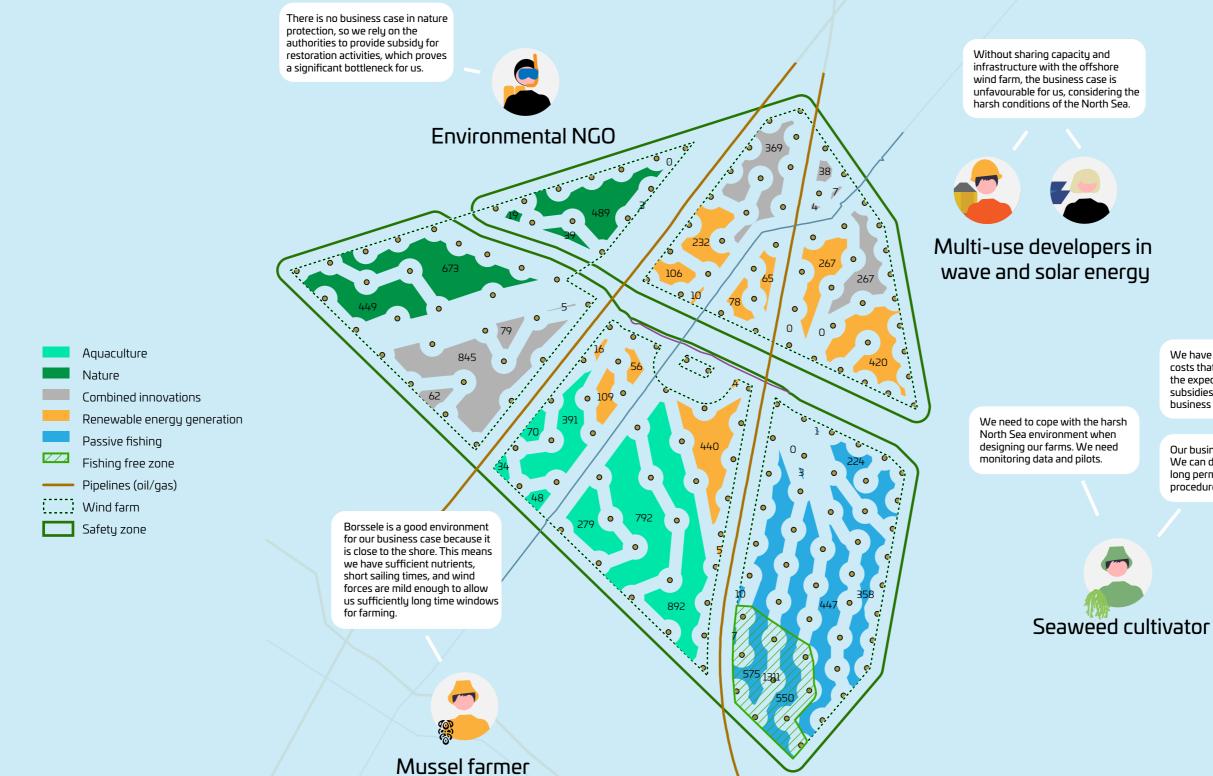
Experiences from symbiosis in Borssele

Since 2020 there is an "area passport" in place, assigning a preferred multi-use option to the various plots of the Borssele offshore wind farm and a legal framework in which multi-use developers can submit a permit application. • wave and solar energy production Three years later, there is only one initiative related to mussel farming.

This case study investigates how the parties involved in multi-use are looking at the Borssele wind farm site in setting up a multi-use business case for:

- food production and
- nature restoration activities.

Below, some quotes are presented based on the interviews held with various multi-use developers.



We have to face high operational costs that are not in balance with the expected yield. We need subsidies to make a viable business case.

Our business case is relatively new. We can do it, but we struggle with long permitting and insurance procedures.

Making information systems symbiotic

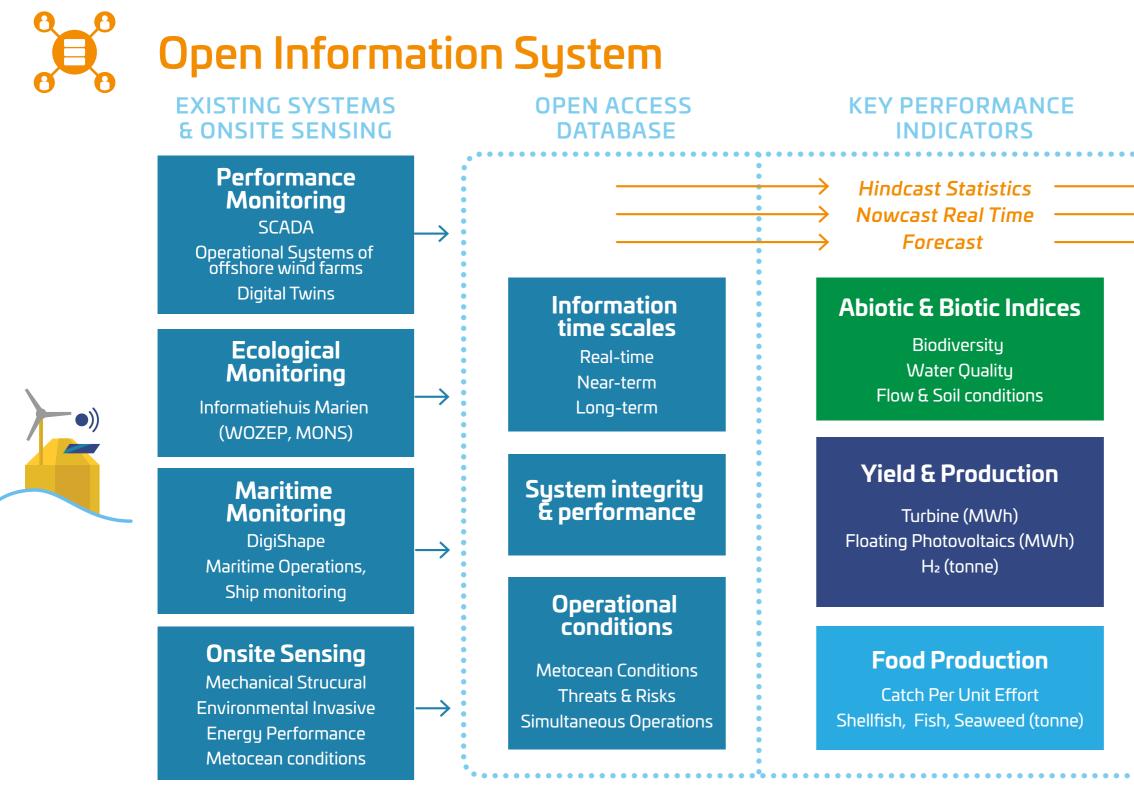
Many measurement, monitoring and information systems are in place in the North Sea and within wind farms. However, not all multi-use stakeholders have access to all relevant information. A holistic Operational Information System (OIS) is envisaged to enhance symbiosis and multi-use activities. The goal of the OIS is to make present and upcoming multi-use operations more efficient and safer by sharing information and thereby increasing multi-use business case potential.

The OIS is an open-access information system that provides metrics and Key Performance Indicators for decision-making.

Information consists of system performance data and operational information and can be retrieved on various time windows: long-term, near-term, real-time. The system allows to retrieve various types and depths of information depending on the interest of the specific users.

Types of information available provided through the OIS are: There are several information systems available. The • Yield and production: energy and food presence of these systems demonstrates the need for open-access information on biotic and abiotic metrics; the turbine, floating photovoltaics or aquaculture structure plurality of systems demonstrates the lack of one central system. In addition to monitoring KPIs for decision-making are required.

- System integrity and performance (long-term): Wind
- Operational conditions, such as weather conditions (near-term; real-time)
- Safety and incident status (real-time).



The blueprint, from a functionality perspective, of the Operational Information System is given below.



Integrated vision for symbiosis in 2050

"By 2050, a revolutionary era of Dutch Offshore Wind Farms has emerged. Through harmonious integration, ecological measures, alternative forms of renewable energy generation and storage, as well as food production within offshore wind farms, have fully matured to the maximum of their potential and are the standard, ushering in a new era

of holistic, inclusive, and transboundary spatial planning that respects the carrying capacity of the North Sea. In this new era, symbiotic offshore wind farms act as the catalyst to achieve the climate and biodiversity targets set by the Dutch and European policymakers."

With this case study, a fully symbiotic offshore wind production grid is envisioned. To establish this vision, a toolbox of ideal outcomes is summarised in the visual below. This visionary scenario for the implementation of sustainable integrated multi-use in offshore wind farms beyond 2050 highlights the importance of holistic international integration, data-driven decision-making, and

By 2050, we have developed offshore wind farms where Energy, Nature and Food are optimally integrated, maximising benefit for society and the earth.



INTEGRATED TOOLBOX

Panel of experts

that coordinates activities for advancing multi-use, through research, stakeholder consultations, yearly state-of-the-art reports, introduction of targets and metrics to be incorporated in the tender criteria.

Life cucle

of multi-use infrastructure accounted for to minimise environmental footprint and maximise the lifetime of symbiotic added values by employing end-of-life evaluation protocols, clear guidelines, and contingency management.

Protocols, safety & ease of access

by space allocation, joint approaches to operation, safety and liability management aiming towards autonomous & intelligent operations and maintenance

Pilots

at a small and large scale to experiment with stakeholder interactions and advance TRL of innovations, thereby contributing to the upscaling of multi-use.

Business/value case

identification per use to properly encourage symbiosis through awareness campaigns, tender requirements, public investments, joint private ventures, and stakeholder engagement.

Tenders

acting as a catalyst with timely criteria, and a participatory process that sets requirements for proven nature-inclusive designs and provides incentives for upscaling multi-use innovations.

Monitorina

in a symbiotic and transboundary approach to share relevant information and employing multi-purpose O&M vessels and measurement stations powered by offshore wind based on standard requirements included in the permit of offshore wind farm infrastructure.

Easy permitting

procedures for testing multi-use innovations by providing timely information & advice to SMEs and

all-encompassing permits from an one-stop-shop regulating office.

Open & Joint research

to co-create, develop and validate promising symbiosis concepts that contribute to the general policy objectives following the holistic and transboundary approaches for integration of offshore wind into the environment.

innovation. By adopting a unified approach, harnessing the power of data, and embracing innovative solutions, offshore wind farms of the future will not only contribute to global sustainability but also serve as harmonious (artificial) infrastructure ecosystems that thrive in symbiotic coexistence with nature.

Open database

multi-use metrics at a basin scale, using innovative techniques (real-time, AI, public science) and following FAIR data principles.

Sharing capacity by integration

of multi-use equipment and activities within offshore wind infrastructure, installation, operation and maintenance.

Partners

Deltares MARIN TNO Boskalis RWE Seaway7 Shell TenneT Van Oord

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More information on the GROW/Road2SID project webpage

grow-offshorewind.nl/project/road2sid





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