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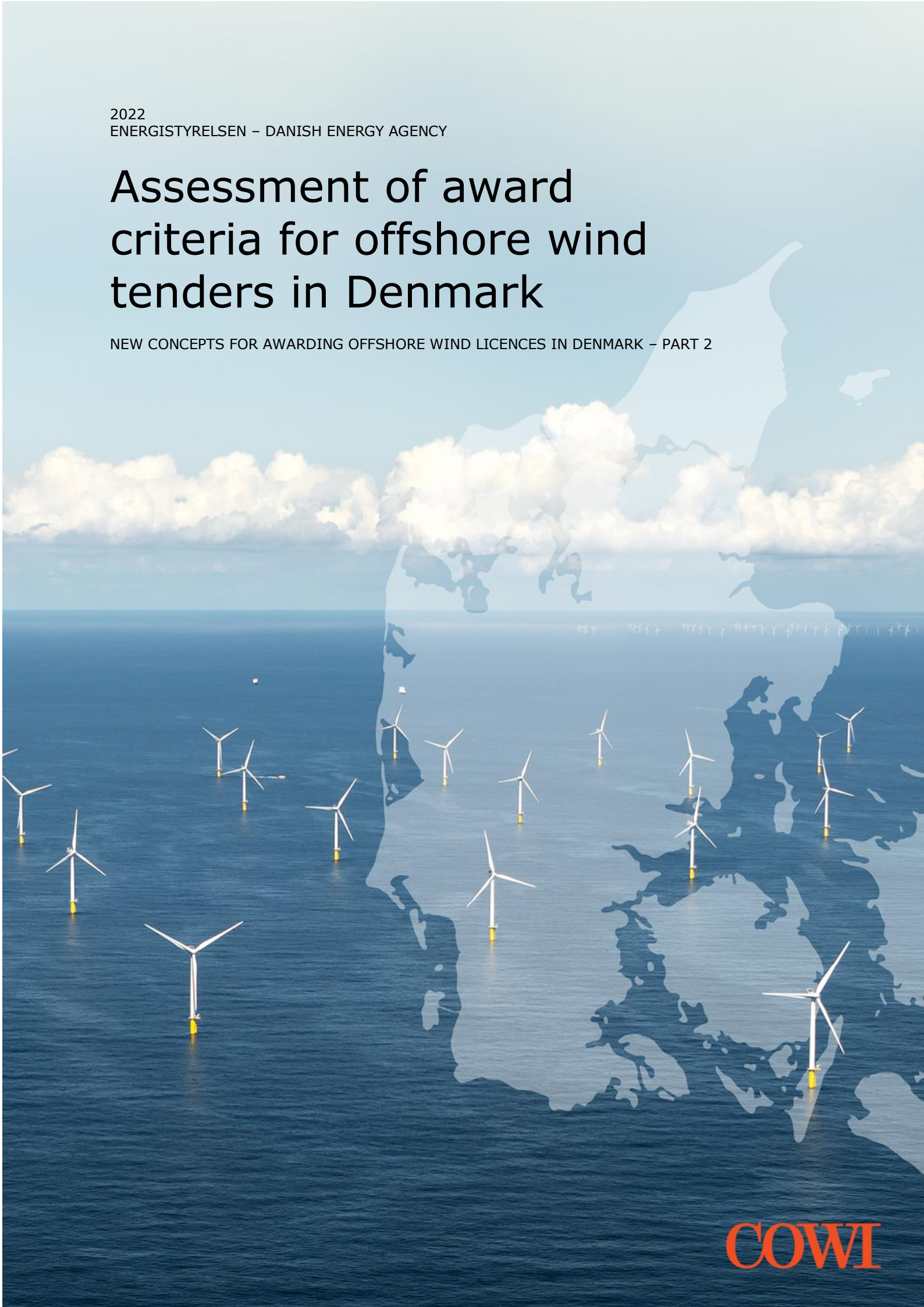
ENERGISTYRELSEN – DANISH ENERGY AGENCY

Assessment of award criteria for offshore wind tenders in Denmark

NEW CONCEPTS FOR AWARDING OFFSHORE WIND LICENCES IN DENMARK – PART 2



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SUMMARY IN DANISH AND ENGLISH

1 Summary in Danish

Danmark kigger ind i en meget ambitiøs plan for udbygning af havvind med op til 9 GW inden 2030 og med yderligere udbygning op mod 2050. Energistyrelsen er i den forbindelse i gang med at fastlægge de kommende udbudsrammer og har derfor igangsat studier der, dels undersøger de praktiske erfaringer for udbud i udvalgte lande, dels gennemgår mulige tildelingskriterier. Det er aftalt politisk, at nyttiggørelsen af Danmarks havvindsressourcer skal forene ambitioner om massiv grøn omstilling med "godt købmandskab" og samspillet med vigtige samfundshensyn.

Denne rapport gennemgår mulige tildelingskriterier i forskellige udbudsmodeller og analyserer alternative tildelingskriterier for havvindsudbud sammenlignet med ren pristildeling. Analysen belyser mulige modeller, hvor udbud tildeles udelukkende på pris (og hvor fx. systemintegration, bæredygtighed, miljø-/naturforhold og innovation indgår som minimumskriterier), men især modeller hvor både pris og kvalitative kriterier inddrages som tildelingskriterier.

Analysens omdrejningspunkt er følgende fem områder udpeget af Energistyrelsen: systemintegration, bæredygtighed, natur og miljø, innovation og økonomi (herunder benævnt "fem søjler"). Analysen belyser også tidsrammen for udvikling af kvalitative (ikke-pris-relaterede) tildelingskriterier. Havvindudbuddet i midt 2023, hvor parkerne skal etableres inden 2030, omtales i rapporten som på kort sigt, mens havvindparker, som skal etableres efter 2030, er på lang sigt.

De europæiske erfaringer er beskrevet i denne analyses rapport del 1: Foreign experiences for awarding offshore wind. Rapporten viser, at for allerede installerede og tildelte havvindsprojekter er de fremherskende udbudsmodeller baseret på pris, men at landene generelt er i gang med at revidere både modeller og tildelingskriterier. Kvalitative kriterier planlægges at indgå som tildelingskriterier i fx. Tyskland og Belgien fremadrettet. I Holland er kvalitative kriterier (bl.a. natur-miljø og systemintegration) allerede implementeret og anvendt for 2 tildelinger i nov. / dec. 2022. Pris indgår fortsat i tildelingen med varierende vægtning. For kvalitative kriterier er der især fokus på størrelsen af den installerede kapacitet, systemintegrationen og at det lokale arbejdsudbud og -kompetencer øges. Øvrige kvalitative kriterier er primært relateret til bæredygtighed samt natur og miljø. Krav til ansøgernes/tilbudsgivernes økonomiske og finansielle- samt tekniske formåen sikres ved at stille minimumskrav til ansøgernes/tilbudsgivernes egnethed.

COWI's analyse i denne rapport del 2 (nærværende dokument) er baseret på praktiske erfaringer fra analysens 1. del og på strukturerede skriftlige og mundtlige spørgsmål til udviklere af havvind, industri, interessenter og andre eksperter. Følgende udviklere og leverandører var samlet i en referencegruppe: Ørsted, Vattenfall, RWE, TotalEnergies, Copenhagen Infrastructure og Offshore Partners, European Energy, Vestas, Siemens Gamesa, Copenhagen Energy. Et spørgeskema blev besvaret skriftligt af alle, hvorefter der blev afholdt et opfølgende møde med plads til refleksioner. Særligt i forhold til bæredygtighed har Dansk Industri givet input og Niras har lavet en rapport[1] hvis konklusioner er inddraget. I forhold til systemintegration blev Energinet inddraget, og for natur og miljø blev Århus Universitet, DTU, Miljøstyrelsen samt Dansk Ornitologisk Forening og Tænketanken Hav inddraget.

I overvejelserne om bæredygtigheds rolle i udbudsmodeller indgår emner som bæredygtighedsledelse, livscyklusanalyse, mængde af CO_2 som projektet samlet udleder (carbon footprint) og cirkulær økonomi. Bæredygtighed bruges allerede i dag i udbudsmodeller for større infrastrukturprojekter. Resultatet af analysen viser, at bæredygtighed er muligt som minimumskriterie på kort sigt, særligt i form af krav om: efterlevelse af FN's Global Compact, systematisk tilgang til bæredygtighed, bæredygtighedsledelse, beregninger af klimaaftryk, plan for reduktion af klimaaftryk, plan for cirkulær økonomi, begrænsning af brug af

[1] NIRAS: Udkast til "Analyse af bæredygtighedskrav til vindmøller"

kemikalier skadeligt for havmiljøet. Disse potentielle krav er imidlertid ikke uproblematiske. Bl.a. i forhold til om de rent faktisk giver bedre bæredygtighed, muligheder for kontrol og opfølgning, og manglende objektive standarder.

Bæredygtighed kan også implementeres som tildelingskriterie, forudsat at der udarbejdes evalueringsmodel og at der er faglige kompetencer inden for de specificerede kriterier til evaluering. Tildelingskriterier kunne være evaluering af systematisk tilgang til bæredygtighed, evaluering af oplyst klimaaftryk, evaluering af plan for reduktion af klimaaftryk, samt point for brug af "grønne" kemikalier. De samme problemer, som nævnt i afsnittet før vil dog også være gældende for disse kriterier som tildelingskriterier. Specifikke krav kan også reducere antallet af bydere, som har den nødvendige teknologi. Dette gør kravene mere realistiske at gennemføre på lang sigt. På langt foreslås det generelt at udvikle standarder inden for beregning af klimaaftryk, brug af livscyklusanalyse og cirkulære løsninger.

Systemintegrations rolle i udbudsmodellerne omhandler hvordan udviklingen af havvind kan bidrage til at sikre den samlede energiproduktion og funktionaliteten/stabiliteten af energisystemet fx. ved at inkludere projekter inden for grønne brændsler (Power-to-X, PtX), forskellige lagringsløsninger eller overplanting.

Resultatet af analysen viser at systemintegration som et tildelingskriterie ses som meget attraktivt af udviklerne og industrien, hvis det giver en øget frihed og indtjeningsmulighed. Muligheden for derigennem at få subsidier til udvikling af PtX projekter eller lagringsløsninger ses også som attraktivt, da der ikke forventes subsidier til havvind. Der er dog et modsætningsforhold til ønsket om at et tildelingskriterie skal sikre at projekterne leverer øget systemintegration på en industriel skala. Det vurderes at dette ikke er muligt på kort sigt, bl.a. fordi der mangler infrastruktur til grønne brændsler.

Det er muligt, at overplanting på kort sigt benyttes som minimumskriterie sammen med et eventuelt tildelingskriterie relateret til PtX eller lagringsløsning for at sikre innovation på området. På lang sigt kan systemintegration på en række områder udvikles til at virke både som minimumskriterie og som tildelingskriterie.

I overvejelserne om hvordan natur og miljø kan indgå som kvalitative kriterier i forbindelse med tildeling er også overvejelser om innovation for området inddraget. Traditionelt i udbud på havvind både i Danmark og i Europa har natur og miljø været et minimumskriterie relateret til miljøkonsekvensvurderinger. Minimumskriterier tilskønner dog ikke til nye og innovative tiltag. I analysen inddrages områder som afbødende tiltag (både i forhold til fuglekollisioner på vinger, undervandsstøj og kunstige rev), sameksistens, naturrestauration inden- og uden for havvindparken, samt innovative natur-venlige designløsninger.

Resultatet af analysen viser at der er stor interesse og opmærksomhed på natur og miljø også fra udviklere og industri, og der er stor vilje til at tilbyde nye løsninger. Kriterier der handler om bevaring og beskyttelse af natur kan i et vist omfang inddrages umiddelbart også på kort sigt som minimumskrav mens kriterier der handler om at fremme natur-løsninger, er bedre egnede som tildelingskriterier. Analysen viser også at der vil være behov for samarbejde med forskere og eksperter både i forbindelse med udvikling og udvælgelse af kriterierne, muligvis i forbindelse med udvælgelse af arealer og forventeligt også for at evaluere projekter ved tildeling. Derudover vurderes det som ressourcekrævende at udvikle transparente og objektive natur- og miljøtildelingskriterier i en dansk kontekst. Det anbefales at dataindsamling og monitering indgår især som minimumskrav og dette kan igangsættes på kort sigt mens det anbefales at der på lang sigt udvikles en dataplatform.

I de økonomiske overvejelser indgår at i tidligere udbudsmodeller er tildeling baseret på "pris". For en ny udbudsmodel er der blandt adspurgte aktører i referencegruppen en god interesse for og også relativ bred enighed om, at en udbudsmodel baseret på en koncessionsmodel kan være en interessant ny model for

kommende udbud af havvind i Danmark. Koncessionsmodellen kan udbydes med et minimum- og et maksimum-grænsebeløb/cap på kompensationen til staten. Det skal nævnes, at selv om der er relativ bred enighed om dette blandt interessenterne, er der ikke fuld enstemmighed. Der er også stor interesse blandt aktørerne i referencegruppen for kvalitative kriterier for tildeling.

2 Summary in English

Denmark is looking into an extremely ambitious plan to expand offshore wind by 2030, with up to 9 GW and further expansion towards 2050. In this connection, the Danish Energy Agency is in the process of determining the future tender frameworks. They have initiated studies which partly examine the practical experience of tenders in selected countries and partly review possible concepts for award criteria. It has been agreed politically that the utilisation of Denmark's offshore wind resources must combine ambitions for a massive green transition with a "good business understanding" and interaction with important social considerations.

This report reviews possible concepts for award criteria in different tender models and analyze alternative award criteria for offshore wind tenders compared to a price auction. The analysis sheds light on possible models where tenders are awarded solely on price (and where, for example, system integration, sustainability, nature and environment and innovation are included as minimum criteria), but especially models where both price and qualitative criteria are included as award criteria.

The focal point of the analysis is the following five areas selected by the Danish Energy Agency: system integration, sustainability, nature and environment, innovation and economy (from now on referred to as the "five pillars"). The analysis also sheds light on the time frame for developing qualitative (non-price-related) award criteria. the planned tendering of offshore wind contracts in mid-2023, where the parks must be established before 2030, is referred to in the report as short-term, while offshore wind parks to be established after 2030 are long-term.

The European experiences are described in this analysis' report part 1: Foreign experiences for awarding offshore wind. The report shows that the prevailing tender models are based on price for already installed and awarded offshore wind projects. However, the countries are generally in the process of revising both models and award criteria. Qualitative criteria are planned to be included as award criteria in, for example, Germany and Belgium going forward. In the Netherlands, qualitative criteria (including nature and environment and system integration) have already been implemented and used for 2 awards in Nov./Dec. 2022. Price is still included in the award with varying weighing. For qualitative criteria there is a particular focus on the size of the installed capacity, system integration and increasing the local labour supply and skills. Other tender criteria are primarily related to sustainability, as well as nature and environment. Requirements for the economic and technical capacity of the applicants/tenderers is covered either by minimum criteria or through a prequalification process.

COWI's analysis in this report part 2 (present document) is based on the practical experiences from the Part 1 of this analysis and on structured written and oral questions to offshore wind developers, industry, stakeholders, and other experts. The following developers and suppliers were gathered in a reference group consisting of Ørsted, Vattenfall, RWE, TotalEnergies, Copenhagen Infrastructure and Offshore Partners, European Energy, Vestas, Siemens Gamesa and Copenhagen Energy. Everyone answered a questionnaire in writing, after which a follow-up meeting was held with room for reflection. Particularly in relation to sustainability, the Confederation of Danish Industry has provided input, and Niras has drawn up a report[2] and included their conclusions. In relation to system integration, Energinet was involved, and Aarhus University, the Technical University of Denmark, the Danish Environmental Protection Agency, DOF BirdLife and the Copenhagen-based think tank Ocean Institute were involved in nature and environment.

Considerations about the role of sustainability in tender models include topics such as sustainability management, life cycle assessment, the overall amount of carbon dioxide the project emits (carbon footprint)

[2] NIRAS: Draft "Analysis of sustainability requirements for wind turbines"

and circular economy. Sustainability is already used today in tender models for major infrastructure projects. The analysis shows that sustainability is possible as a minimum criterion in the short term, especially in the form of requirements for: UN's global compact goals, systematic approach to sustainability, sustainability management, calculations of carbon footprint, plan for reducing carbon footprint, plan for circular economy, limiting the use of chemicals harmful to the marine environment. These potential requirements are not unproblematic. Among other things in relation to whether they provide better sustainability, opportunities for control and follow-up, and lack of objective standards.

Sustainability can also be implemented as award criterion, provided that an evaluation model is prepared and that there are professional competencies within the specified criteria for evaluation. Award criteria could be evaluation of systematic approach to sustainability, evaluation of carbon footprint, evaluation of plan for reducing carbon footprint, as well as points for use of "green" chemicals. However, the same problems as mentioned in the section before will also apply to these criteria as award criteria. Specific requirements may also reduce the number of bidders who have the necessary technology. This makes the requirements more realistic to implement in the long term.

In the long term, it is proposed to develop standards in the area of climate footprint calculation, use of life cycle analysis and circular solutions.

The role of system integration in the tender models deals with how the development of offshore wind can contribute to ensuring the overall energy production and the functionality/stability of the energy system, for example, by including green fuel projects (Power-to-X, from now on referred to as PtX) or various storage solutions. This includes considerations that more offshore wind can be installed in the individual area (overplanting) than what needs to be delivered to the grid at the planned connection point. The excess power can then be sold by the developer outside the grid or used for, for example, PtX.

The analysis shows that system integration as an award criterion is considered extremely attractive by the developers and the industry if it provides increased freedom and earnings potential. The possibility of obtaining subsidies for developing PtX projects or storage solutions is also seen as attractive, as no subsidies for offshore wind are expected. There is, however, a conflict of interest in the desire for an award criterion to ensure that the projects deliver increased system integration on an industrial scale. It is assessed that this is not possible in the short term, among other things, because there is a lack of infrastructure for green fuels.

It is possible that, in the short term, that overplanting is used as a minimum criterion together with a possible award criterion related to PtX or storage solution to ensure innovation in the field. In the long term, system integration in several areas can be developed to act both as a minimum criterion and as an award criterion.

In the considerations about how to include nature and environment as qualitative criteria in connection with the tender award, considerations about innovation for the area are also included. Traditionally, in tenders for offshore wind in Denmark and Europe, nature and environment has been a minimum criterion related to environmental impact assessments. Used exclusively as a minimum criterion, however, new and innovative measures are not awarded. The analysis includes areas such as mitigating measures (both in relation to bird collisions with wings, underwater noise and artificial reefs), coexistence, nature restoration inside and outside the offshore wind park and innovative nature-friendly design solutions. The analysis shows that there is great interest and attention to nature and environment, also from developers and industry, and there is a great willingness to offer new solutions. To a certain extent, criteria that deal with conservation and protection of nature can be included immediately, even in the short term, as minimum requirements, while criteria that deal with promoting natural solutions are better suited as award criteria.

The analysis also shows a need for collaboration with researchers and experts in developing and selecting the criteria, possibly in connection with the selection of areas and, expectedly, to evaluate projects and thus in the tender award. In addition, it is considered resource-demanding to develop transparent and objective nature and environment award criteria in a Danish context. It is recommended that data collection and monitoring are included as minimum requirements, and this can be initiated in the short term. Furthermore, it is recommended that a data platform is developed in the long term.

The economic considerations include the fact that in previous tender models, allocation is based on "price". For a new tender model, there is a positive interest among the actors in the reference group and a relatively broad agreement that a tender model based on a concession model can be an attractive new model for future tenders for offshore wind in Denmark. The concession model can be offered with a minimum and a maximum cap on the compensation to the state. It should be mentioned that although there is a relatively broad agreement among the stakeholders, there is not complete unanimity. There is also great interest among the actors in the reference group in the qualitative criteria for tender award.

Reference group

The reference group was invited by COWI to provide reflections and input on a potential future tender model that not only focuses on price but also contains minimum and award criteria towards the five pillars (sustainability, system integration, nature and environment, economics, and innovation). A questionnaire was sent to the reference group and was answered by all. Following the questionnaire, follow-up meetings were held to ensure that reflections were captured correctly.

For the sustainability section, the Confederation of Danish Industry - Dansk Industri was approached to give input and reflections. DI has a 2030 plan in which they present concrete political proposals that will position Denmark better in 2030 on three crucial points: greener, richer, and more skilled. NIRAS, a multi-disciplinary engineering consultancy fundamentally committed to sustainable progress and service delivery, was included in our analysis based on their work on analysis of sustainability requirements for the tendering of offshore wind farms.

Green Power Denmark who represents companies in the renewable energy industry, provided input and reflections on the upcoming tender framework to ensure acceleration, and still ensure that the five pillars are addressed.

For system integration, Energinet contributed with input and reflections on the possibilities for future offshore wind system integration. Energinet is an independent public enterprise owned by the Danish Ministry of Climate, Energy and Utilities. They own, operate, and develop the transmission systems for electricity and gas in Denmark.

For nature and environment, Aarhus and the Danish Technical University, Birdlife Denmark, The Danish Society for Nature Conservation, think tank Ocean Institute, and the Environmental Protection Agency were included to provide input, sparring, and reflections of the industry needs in terms of nature and environment.

NEW CONCEPTS FOR TENDER AWARD IN DENMARK

COWI

3 Sustainability

3.1 Why sustainability?

The Danish climate agreement on more green power and heating from June 2022 aims to accelerate the expansion of offshore wind capacity towards 2030. According to the agreement, it shall be ensured that:

"Increased sustainability is included in the tenders taking the principles in the EU taxonomy for environmental sustainability, the Danish climate goals and tools for ESG and life cycle assessment into account".

Sustainability requirements should aim at ensuring a focus on all three dimensions of sustainability – economics, social, and environmental – and improving the sustainability of all three dimensions, e.g., to decrease the carbon footprint of the object of the contract.

This chapter addresses sustainability management and carbon footprint, LCA, circular economy, and other sustainability topics. Chapters 5 and 6 includes, respectively, nature, environment, and economics. The social aspect is not included in the scope as it is taken care of by other parties.

Sustainability management: Sustainability is commonly described along the lines of three dimensions (also called pillars): environmental, economic, and social. Sustainable management is defined as a systematic approach comparable with environmental management working with sustainability in relation to all planned activities.

Carbon footprint is the total amount of greenhouse gases that are generated by our activities which both counts for the embodied carbon (carbon footprint of a building or structure amongst others from materials and production of these before it becomes operational) and the operational carbon (carbon from the energy and material use during operation and maintenance). There are several guidelines for preparing a carbon footprint as ISO 14067 and the GHG Protocol.

Life-cycle assessment (LCA) is defined as a systematic analysis of the environmental impacts of products or services during the entire life cycle from generating resources from raw materials to decommissioning. The ISO standard 14040 describes the principles and frameworks for LCA, and ISO 14044 specifies requirements and provides guidelines for LCA.

Circular economy is a model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishment and recycling existing materials and products as long as possible. In this way, the life cycle of a product is extended (Ref. Circular economy: definition, importance and benefits | News | European Parliament (europa.eu)*)*

Other sustainability topics with special focus on the marine environment could be contamination either by marine litter or discharge of hazardous chemical, non-indigenous species, sea floor integrity, alteration of hydrographical conditions, and underwater noise (Ref. the Danish Marine Strategy Directive II and the EU Taxonomy).

Figure 3-1 Sustainability topics included in the analysis

Sections 3.2 to 3.4 sum up on dialogue with the reference group representing the industry regarding sustainability requirements in tenders, conclusions in the NIRAS draft report from August 2022 "Analyse af

bæredygtighedskrav ved udbud af havvindmølleparker", and remarks from the sustainability work group in the Confederation of the Danish Industry (DI) also on sustainability requirements in tenders. In all sections, we present COWI's reflections hereto. Section 3.53.5 covers experiences from the inclusion of sustainability award criteria or minimum requirements in other large Danish projects. Suggestions for potential sustainability tender requirements are listed and discussed in section 3.5.

3.2 Industry viewpoint

A meeting was held with the reference group including the industry, where members of the group have answered the following two questions on sustainability:

- *How does your company see that sustainability can be integrated in the tender evaluation criteria?*
- *Which sustainability criteria (e.g., commitment to UN Global compact, carbon footprint, environmental product declarations, and life-cycle assessments) should be implemented (if any), and should it be minimum requirements only or qualitative and quantitative criteria? How should the follow-up be on these criteria during the lifetime of the project?*

In general, the reference group members support the idea of including sustainability requirements in the tender criteria. But as a starting point, they believe that sustainability criteria are best suited as minimum requirements.

Qualitative award criteria would add more complexity to the evaluation than quantitative award criteria, and it is important to define and describe an evaluation model that is transparent, objective, and indisputable.

Life-cycle assessment and carbon footprint are considered as objective tools, but standards in relation to offshore wind are yet to be prepared. Given the lack of tools and standards, including an award criterion on the lowest carbon footprint or LCA as part of a tender is not relevant in a short-term perspective.

In general, the companies are positive towards sustainability requirements on company level.

Sustainability requirements should support wind turbines and leave room for innovation.

The reference group believes that qualitative criteria may leave more room for innovation than quantitative criteria. The reason for this is, that the complexity of the challenges that society and nature face are high and only few robust quantitative metrics has been developed to catch this complexity. You need involvement of experts to catch these nuances. On this basis, it is the view that qualitative criteria hold the potential to foster innovations - not stimulated by price competition and quantitative criteria - that will mitigate externalities and maximize broader value for society. Similar lines of thoughts seem to be the rationale behind the most recent Dutch tender

The reference group also suggested to include the following minimum requirements or award criteria in tenders:

- Minimum requirements for preparing a carbon footprint or a LCA for the object of the tender/contract
- Minimum requirements for a plan for reduction of sustainability impacts.

3.2.1 COWI's reflections

The idea of including sustainability requirements in the tender process is in line with COWI's observations on large infrastructure projects and practices in other countries in general.

Including sustainability requirements as minimum requirements can support a certain minimum level of sustainability performance from the bidders. On the other hand, too high requirements can also result in a limited number of bidders which can fulfil the requirements and thus potentially less bidders and less competition.

If sustainability is included as an award criterion, it should be associated to the project deliveries and have a certain ambition level in order to work as a differentiator as also specified in section 6. In addition, it should also be clearly defined what is considered as positive in the evaluation of the tender and what descriptions shall be included in the proposal.

The literature search showed that in the Netherlands and Germany, both economy and a set of quality criteria are to be applied. Although quantitative criteria are easier to evaluate than qualitative criteria, quantitative criteria may allow bidders to describe i.e., their focus and process management of sustainability. The quantitative criteria need to be transparent, and it should be clear when the criteria are met if they are minimum requirements, and how the criteria are evaluated if they are included as award criteria.

An example of a scoring system in relation to qualitative criteria is included in Table 3-1 below.

Table 3-1 Example of scores in relation to evaluation of qualitative criteria

Score	Description
100%	The submitted tender is of excellent quality and no deficiencies have been identified. The tender gives complete assurance of satisfactory fulfilment of the assignment.
80-90%	The submitted tender is of good quality and only minor deficiencies have been identified. The tender gives assurance of satisfactory fulfilment of the assignment.
50-70%	The submitted tender is of acceptable quality. Minor deficiencies have been identified, where improvements are needed before the tender gives assurance of satisfactory fulfilment of the assignment.
40-50%	The submitted tender is below acceptable quality where extensive improvements are needed before the tender gives assurance of satisfactory fulfilment of the assignment.
0-30%	The submitted tender is of poor and insufficient quality and does not demonstrate sufficient security for fulfilment of the assignment.

Evaluation of the quantitative minimum requirements or award criteria are to be performed by experts within the specific fields of sustainability. These experts could be engaged at DEA, at consultant or as in the Netherland by an appointed expert group.

Calculation of carbon footprint for the project or LCA can be included as a minimum requirement. However, the minimum requirements for the calculation method must be defined in the tender material, and the bidder should be requested to include a LCA method description.

If LCA or lowest carbon footprint should be an award criterion, a specific LCA tool should be pre-defined/developed. When all bidders use the same tool, this will ensure comparable LCA results in a tender evaluation process. The defined tool can include more or less of the predefined phases (ref. Table 3-2). The carbon footprint will typically be based on the following information:

- Amount of material used
- Emission factors for the material based on EPDs for the specific product or databases
- Amount of fuel used
- Emission factor based on inputs from the fuel suppliers or from databases

It should be noted that all incoming bid calculations need to be thoroughly evaluated. The complexity of the evaluation of the carbon footprint from the tenderer is depending on the complexity of the specific tool. Although requiring the tenderer to use the same tool makes it easier to compare the proposals and supports a fair competition.

Developing the tool will require competent resources either at DEA, from external consultant or from an expert group, **which can be time consuming**.

Table 3-2 Specification of carbon footprint and different phases according to EN 15804

Carbon Footprint
The term *carbon footprint*, for a project, refers to the sum of Embodied carbon and Operational carbon. The amount of carbon that is released during the construction of an asset, contributes to the Embodied Carbon. This includes the product phase, the construction process phase of the product or structure, and the deconstruction and disposal of materials at the end of life. The amount of carbon emitted during the operational or in-use phase of an asset, is the Operational Carbon. This includes the use, management, and maintenance of a component or structure. Carbon footprint can be calculated at different stages as defined in the standard for EPDs EN 15804: <u>Product stage:</u> A1: Raw material supply A2: Transport to the production site A3: Manufacturing phase <u>Construction Process Stage:</u> A4: Transport to the construction site

A5: Installation process

Use stage:

B1: Use
B2: Maintenance
B3: Repair
B4: Replacement
B5: Refurbishment
B6: Operational energy use

End of life stage:

C1: Deconstruction, demolition
C2: Transport to waste processing
C3: Waste processing for reuse, recovery and/or recycling

Our experience from tender processes is that it is in compliance with EU tender legislation to require companies to implement management systems according to recognized standards, such as the ISO standards. However, setting other requirements for the companies is not acceptable unless it is directly related to the delivery specified in the tender. As a consequence of this requirements on company level are not further discussed in the present report. COWI's conclusion is, that introduction of qualitative criteria as minimum requirements or competitive requirements has the potential to promote innovation in relation to sustainability and sustainable solutions as part of the development of offshore wind farms.

Quantitative minimum requirements can limit the focus to certain areas as low carbon footprint for steel, reusing of blades, etc. and by that exclude other areas which can have the possibility to make an even bigger impact positive or negative in relation to sustainability. During the lifetime of a wind power project new and even better solutions can be developed but not implemented in the projects due to the limited focus on certain quantitative, very specific requirements.

3.3 Draft results – the NIRAS report

The Danish Energy Agency has engaged NIRAS to identify how criteria within sustainability can be included in coming tenders for offshore wind projects. The results are discussed and presented in the NIRAS draft report from August 2022 "Analyse af bæredygtighedskrav ved udbud af havvindmølleparker". The main focus in the draft report is the evaluation of criteria within carbon footprint.

Initially, NIRAS has evaluated where in the lifetime of a wind farm and in relation to which components setting requirements may contribute to the largest impact on the carbon footprint.

A summary of the findings in relation to analysing the carbon footprint from a wind farm was:

- The main carbon footprint from an offshore wind project is in the fabrication and installation phase
- The foundation, the tower, the blades, and hub and cables are the main components in the carbon footprint

- Steel is the major material component in relation to embedded carbon contributing with around 57 per cent of the total footprint.

NIRAS has presented and evaluated criteria on company level, project level, and product level. Suggestions for sustainability requirements in a tender model in a short-term perspective:

- Requirements on company-level, e.g., environmental management systems, commitment to Science Based Target initiative (SBTi) or similar, 3rd party verified carbon footprint calculation according to the GHG protocol including scope 1, 2 and 3.

- Minimum requirements for the capacity to prepare LCA: to support the capability to prepare LCA and prepare for future minimum requirements or evaluation criteria on minimising the carbon footprint.

- Requirements for the use of sustainable fuels for transportation. This may especially be relevant during operation and maintenance as installation equipment presently will not be capable of using sustainable fuels, at least not in the short-term perspective.

- Requirements for a plan for recyclability, the fulfilment of which can be difficult to document as it can be in 30 years.

Suggestions for sustainability requirements in a tender model in a longer-term perspective:

- Requirement for a project specific carbon footprint to be below a threshold level

- Requirements for a LCA below a threshold level

- Environmental product declarations (EPD) as an award criterion

- Requirements for sustainable fuels.

The summary is based on a draft report and may not be in line with the final report approved by DEA.

3.3.1 COWI's reflections

The reflections from the industry included in the NIRAS report are in line with the reference group involved in the present project.

Setting short-term requirements for preparing carbon footprint calculations has been included in the description of possible minimum requirements in the present report in 3.6. Competing on the lowest carbon footprint based on the carbon footprint calculations is included as an award criterion in a longer-term perspective. If the award criteria for the lowest carbon footprint should be used in short-term it will require a calculation methodology and tool to be developed and included in the tender to be able to compare the proposals from the bidders.

Heavy vehicles and ships for transportation of crew and goods are mainly using fossil fuels. Lowering the carbon footprint from heavy transportation during construction, installation, and operation and maintenance is based on the possibility of using green fuels or an electrically driven fleet. Many stakeholders are investing in transforming the transport sector into a greener industry. A requirement for using green fuels – biofuels or e-fuels - for the heavy vehicles may be relevant in the long-term perspective while using

green fuels for the smaller crew transfer vessels or supply vessels for the O&M phase will be possible as the vessels are smaller, and the O&M phase is more far out in the future. The price of biofuel is among others depending on the price of biomass. The price of biofuels is at present 70-130% higher than the prize of fossil fuels (Biofuels twice as expensive as petrol and diesel in most cases - Transport & Environment (transportenvironment.org). The production of e-fuels is still too immature to estimate a price at the time when large scale production is implemented.

The planning of the design of the wind farm where the main components will be easy to remove and recycle is considered a relevant requirement to include in the tender although the fulfilment of goals for recycling or using specific recyclable components can be complex to document and difficult to predict as the decommissioning will take place more than 20-30 years after the offshore wind farm has been commissioned. Possibilities for reuse of steel, concrete, metals in cables are well known. Possibilities in relation to reuse of blades are developed although still in an early phase as only one supplier is available. Developing quantitative criteria for recycling of waste from wind farms will take time and further analysis to develop. It will although be possible to set a minimum requirement for the tenderer to include a plan for reuse of materials after end of use.

Environmental Product Declaration (EPD) for materials and products is relevant at least as a minimum requirement for the main products as for example steel for the foundation and the tower, cables, blades. In areas with only a few suppliers, it may lead to higher material and product costs. EPDs for the specific material and products used on the project can serve as source for a more project specific calculation of carbon footprint compared to more generic data from LCA databases.

3.4 Viewpoints from the sustainability workgroup

The Confederation of Danish Industry (DI) has established a work group to discuss and identify tender requirements within the sustainability field in relation to the planned energy island. Several workshops have been held, and suggestions for criteria on an overall level have been made.

DI suggests that commitment to UN Global Compact is included as a minimum criterion to ensure a minimum level within human rights, labour rights, environment, and anti-corruption.

A note "Kvalitative krav i fremtidens havvindsudbud" was prepared by DI for a workgroup meeting August 2022.

Below is presented a summary of the note

"DI recommends that an evaluation concept be established that includes qualitative requirements that weigh to such an extent that it can affect the ranking of bids.
Regardless of the method and the design of the scoring system, it is crucial that evaluation criteria are fully transparent for bidders, so that it is possible to optimize the bid submitted based on the state's wishes for price, innovation, sustainability, and social conditions, etc."

DI emphasises that it would be relevant to investigate the possibilities for:

- Sustainability requirements within the full supply chain to ensure labour rights
- Requirements for Life Cycle Assessment (LCA) including aspects as carbon footprint and reuse of components

- Requirement for Green House Gas Protocol certification
- Requirements for a sustainable decommissioning plan.

3.4.1 COWI's reflections

Setting minimum requirements within labour rights through the full supply chain can be included in the tender e.g., by requiring that the company and the suppliers shall adhere to the 10 Principles – UN Global Compact during the execution of the project.

LCA and carbon footprint calculations are included as possible minimum requirements or award criteria as specified in 3.6.

The Greenhouse Gas Protocol has prepared a corporate accounting and reporting standard including guidance for companies and other organisations for preparing a corporate level GHG emission inventory. The guidance in the standard can be used as a methodology for calculation of GHG emissions although its main purpose is for inventories on corporate level. A number of GHG calculation tools and global warming potential values are made available for the companies. A GHG Protocol is also prepared for project accounting, which can be useful as basis for a minimum carbon footprint requirement for the specific project.

The purpose of including a minimum requirement or award criteria for a decommissioning plan would be to evaluate the possibilities for reusing or recycling structures or materials in the project design after end of use. As mentioned earlier, it is difficult to evaluate if the plan is fulfilled in the tender phase as decommissioning will take place after 20-30 years of operation. However, it may be relevant to require a description of the bidders' process for including circular economy and design for disassembly in the design of the wind farm as a minimum requirement or award criterion.

3.5 Experience from setting sustainability requirements

COWI has worked with specifying tendering models within sustainability on projects within different sectors. Sustainability in the building sector has been developed during the last couple of decades and assessing and setting sustainability requirement are common and well-defined in certification systems such as DGNB, BREEAM, and LEEDS. The infrastructure sector is less mature as sustainability requirements in tenders and certification schemes are scarce or not in place yet. Nevertheless, when setting requirements, experiences from other sectors as well as from the large infrastructure sector can be of relevance and ensure and support maturation of the sector.

The following reflections COWI experiences with setting sustainability requirement in large infrastructure projects and in the building sector. These can be of relevance for offshore wind tendering schemes as well:

- In the long term, it will be possible to evaluate quantitative award criteria such as the lowest carbon footprint.
- Evaluation of carbon footprint calculations should be based on the same calculation model for all the bidders.

- On short term as well as long term, it is relevant to set requirements for continuous calculation of LCA/carbon footprint during the development and construction of the project. The information will support further development and matureness of sustainability in the sector.

- If possible, all materials used should have an environmental product declaration (EPD). This will support the validity of the LCA/carbon footprint calculation and ensure development in the sector.

- Requirements for an environmental management system to ensure a systematic approach during the project including an evaluation of sustainability competences and inclusion of sustainability in the organisation management can be used as a minimum requirement or award criterion.

- A project specific sustainability management and action plan for the deliveries of the contract. The plan is to include a suggestion on how bidders intend to continuously improve sustainability during development, construction, and operation and maintenance of the project. E.g., how to continuously reduce CO_2 footprint from the project. All suggestions in the plan are to be included in the price.

- Requirements for a continuous follow-up on sustainability including actions described in the bidders' sustainability management plan and the LCA/carbon footprint calculation.

It is important to include the possibility to follow up on all requirements and criteria during the execution of projects, e.g., by including the evaluation as a minimum requirement in the contract. Minimum requirements in a contract are to be fulfilled not only as part of an evaluation process but during the full execution of the project.

3.6 COWI's analysis

Introduction of sustainability measures in tender models is a general tendency in European and Danish tenders for large scale infrastructure projects including offshore wind-projects. Requirements to secure compliance with applicable Danish and international standards and increased sustainability in coherence with "The Climate Agreement from 2022" sustainability measures could be applied as minimum requirements in a future tender model for OWF. However, to some degree, sustainability as a qualitative award criterion possibly in combination with minimum requirements could also be applied to motivate more innovative solutions in the tender as seen in the Netherlands. Some of the mature qualitative award criteria stated in the table below may come in play, and some degree of certainty could possibly be achieved by negotiations with the bidders during the tender process.

A number of different types of sustainability criteria with pros and cons are described in the following section and summarised in Table 3-3.

Sustainability management

A sustainability management system is in line with an environmental management system and includes requirements for a systematic approach to working with sustainability through a project. A sustainability management system covers e.g.:

- Deciding on a strategy, policies, and rules

- An organisational structure defining roles and responsibilities within sustainability

- Mapping of focus areas within sustainability and setting a baseline
- Integrating sustainability into processes
- Requirements for continuous improvements
- Communication about sustainability
- Verification activities and management review of the system.

Requirements related to a sustainability management system and a systematic approach to working with sustainability could be:

- The bidder shall describe a systematic approach to working with sustainability through the project:
    - How competences within sustainability are included in the project organisation
    - Method for LCA
    - Method for identification of focus areas within sustainability
    - Method for including awareness in relation to sustainability in the project organisation
    - Method for including sus- tainability consideration in relation to evaluation of project solutions
    - Method for identifying and adhering to relevant legislation within sustainability
    - Method for setting requirements to sub-suppliers.

When including minimum requirements or qualitative criteria in the tender, it can be ensured that sustainability is a part of the topics to be included throughout the project, thus allowing for focus areas to be identified along the development of the project. A sustainability action plan that describes how the focus areas will be managed through the project is to be developed. The consequences of including specific sustainability topics on economy, resources, timeline, etc. must be evaluated as basis for decision-making.

Carbon footprint

Understanding a project's impact on the climate can be increased by developing a carbon footprint calculation including all the project phases for the project. The carbon footprint can give an insight in the components including materials and products that have the largest impact and what areas should be focused on to decrease the footprint.

The stakeholders in the industry are familiar with carbon footprint calculations and have methodologies in place. However, the carbon footprint prepared by the different bidders may be difficult to compare if the calculation has been prepared according to different standards and with different emission factors from different sources. Therefore, it makes sense to detail requirements to which standard should be used or to provide bidders with a carbon footprint tool for the calculation. When evaluating the bids, the calculations are to be scrutinised.

Carbon footprint from specific products can be calculated according to a standardised procedure e.g., the standard for preparing EPDs. EPDs can also be subject for 3rd party verification. However, it could be argued that EPDs are only required by DEA as part of the tender for major components as steel and generic data can be used for other components.

Setting requirements on a product level narrows the perspective to a material focus and away from the broad focus on all sustainability aspects. This can lead to solutions which are not the best from an overall perspective or only the best in a short-term perspective.

In general, very specific requirements on product level may have the risk of reducing the number of material suppliers and limiting the competition, thus increasing the price of producing offshore wind energy and increasing the risk of delays.

Including sustainability requirement in tenders will be depending on resources and competences available to prepare the requirements and later evaluate the proposals and follow-up on requirements during execution.

Circular economy

The purpose of introducing circular economy is to eliminate waste and pollution and to keep the products and materials in circulation at end of use so that the use of new natural resources is reduced.

Circular economy can be difficult to specify as a minimum requirement or award criterion, but it can be defined as a principle to adhere to in the project. The bidders can be asked to describe how they work with circular economy and define possible initiatives that are relevant for the project.

Other requirements

In the Danish part of the North Sea, oil and gas installations have been present since 1972. Although the oil and gas industry and the wind industry are different in many ways, both industries have structures present in the marine environment, and they have some of the environmental impacts in common, e.g., underwater noise, footprint on the seafloor, use and discharge of chemicals and sewage, emission from transportation of goods and crew, marine litter, non-indigenous species, etc. The experience from the more mature oil and gas industry and their cooperation with the authorities to decrease the environmental impact on the marine environment can to some extent be transferred to the wind industry.

Both industries are supposed to prepare an Environmental Impact Assessment (EIA) that describes the project, the surrounding environment, expected planned and unplanned impacts on the marine environment, and possible mitigating actions to reduce or minimise the impact. The EIA shall also include an impact assessment in relation to international appointed protected areas and species.

All the requirements in the EIA permit will by their nature as legal requirements serve as minimum requirements in a tender. However, it can serve a purpose of directing the focus on the most extensive impacts and include these as award criteria. Examples within hazardous chemicals and waste are described below. Requirements related to nature and biodiversity are described in more details in section 5 Nature and environment.

OSPAR (OSloPAR commission) is a cooperation between 15 governments and the EU to protect the marine environment of the Nort-East Atlantic including the North Sea. OSPAR has prepared a number of conventions and recommendations in relation to discharge of chemicals to the marine environment, biodiversity,

monitoring programmes, yearly reporting, etc. Among others, a system for classification of chemicals related to the environmental hazards of offshore chemicals has been defined. In Denmark, DEPA has adopted the system and classifies the chemicals in black, red, yellow, and green chemicals. This system has been used in discharge permits in the oil and gas industry. The chemicals classified as black are forbidden, and from 2008, the red chemicals have been substituted with yellow and green chemicals except if documented that substitution with a less harmful product is not possible. A system for classifying chemicals discharge to the marine environment can be adopted by the wind industry and included as minimum requirement in tenders to be aligned with the OSPAR requirements (OSPAR Recommendation 2017/01 on a harmonized pre-screening scheme for offshore chemicals). Discharge of hazardous chemicals may not be a major impact on the marine environment from offshore wind but is included to show examples of requirements used in other offshore industries and there may be a need for alignment across all offshore sectors.

Handling of waste produced offshore is restricted by international conventions (International convention for the prevention of pollution from ships (MARPOL)), and minimum requirements for taking waste to shore must be included in the tenders.

The oil and gas industry has agreed with the environmental authorities to conduct a seabed monitoring programme around the offshore oil and gas installations. The monitoring programme consist of a baseline survey before installation of an offshore structure and repetition of the monitoring programme every third year for a number of appointed installations. The seabed monitoring programme has taken place since 1989. Included in the monitoring programme is taking samples of the seabed from 100- to 5000-meter distances to the installations. Chemical, physical, and biological analyses of the samples are also a part of the monitoring programme. A monitoring programme is further discussed in the nature and environment section (see 5 Nature and environment).

Table with most suitable criteria incl. pros and cons

Below is a table of sub-criteria within the criterion "Sustainability", valuation of minimum requirements (M) or award criteria (A), and pros and cons for each sub-criteria. The sub-criteria could be either minimum requirements or award criteria. However, a great part of the sub-criteria can be characterised as both minimum requirements and award criteria (A/M). Furthermore, the sub criterion could be to let the bidders compete on "overdelivery" on the minimum requirements, and thus compete on the minimum requirements, it could be characterised as an award criterion (M/(A).

Table 3-3 Overview of award criteria (A) or minimum requirements (M) in relation to sustainability

Criteria	Detailed description	A/M	Pros	Cons	*Short-term/ Long-term*
S1 UN Global Compact	Adhering to the 10 principles of the UN Global Compact means operating in ways that meet fundamental requirements within human rights, labor rights, environment, and anti-corruption throughout the execution of the project.	M	Easy to evaluate if the company has signed up to the 10 principles. Requires that fundamental rights are included in the company's policies, strategies, and procedures.	The wording of the requirement shall be related to the specific delivery. Difficult to check whether companies actually live up to the 10 principles.	Short-term
S2 Description of systematic approach in relation to sustainability	The bidder shall describe a systematic approach to working with sustainability through the project	M Include specific requirements in the tender for how to apply systematic approach throughout the project towards sustainability.	Gives DEA the possibility to follow the supplier's work with sustainability through- out the project. Leaves room for the bidder to specify specific initiatives within sustainability which are of relevance to the project Gives the possibility to focus on the most important and relevant areas within sustainability throughout the project.	Requires competences and resources to evaluate the description.	Short-term if resources available for description, evaluation, and follow-up on requirements. Long-term if these resources are not available at present.

Criteria	Detailed description	A/M	Pros	Cons	*Short-term/ Long-term*
		A Evaluate of the ambition level of the description to ensure that the systematic approach is described	Leaves room for the bidder to specify specific initiatives within sustainability which are of relevance to the project.	DEA can only follow the supplier's work with sustainability throughout the project if the criteria are also included as minimum requirements. Commitment for implementation of the initiatives is only ensured if they are also stated as minimum requirements.	Short-term if resources available for description, evaluation, and follow-up on requirements. Long-term if these resources are not available at present.
S3 sustainability management and action plan for the deliveries of the contract	The bidder shall prepare a sustainability action plan describing sustainability initiatives and actions planned throughout the project.	M	Forces the bidders to define relevant initiatives to be included in the project.	Requires resources at DEA to review initiatives and follow up throughout the project.	Short-term if resources available for description, evaluation and follow-up on requirements. Long-term if these resources are not available at present.

Criteria	Detailed description	A/M	Pros	Cons	*Short-term/ Long-term*
S4 Prepare carbon footprint for the specific project and update through the project	The bidders shall prepare a carbon footprint according to a specified methodology. It can either be specified by DEA, or the bidder can specify a method. Carbon footprint and description of methodology to be included in the proposal.	M The bidders shall provide a carbon footprint calculation according to the specified methodology	Gives a preliminary in- sight into the overall CO_2 footprint from an OWF. Shows the capability at the supplier to prepare a carbon footprint. Possibility to document the carbon footprint through the project.	Difficult to ensure data quality and correctness.	Short-term if resources available for description, evaluation, and follow-up on requirements. Long-term if these resources are not available at present.
	The bidder shall prepare a carbon footprint meeting specified criteria:	A If specific requirements to the carbon footprint calculation are included, it can be used as an award criterion.	Shows the supplier's capability to prepare a carbon footprint. Possibility to document the carbon footprint throughout the project.	Not possible to compare the bidders carbon footprint if the calculation is prepared according to different methods. Requires competences to evaluate if the carbon footprint meets the minimum requirements and to follow up during the project. Possibility to include on a longer term when standards for carbon footprints for wind farms have been developed.	Short-term if resources available for description, evaluation, and follow-up on requirements. Long-term if these resources are not available at present.

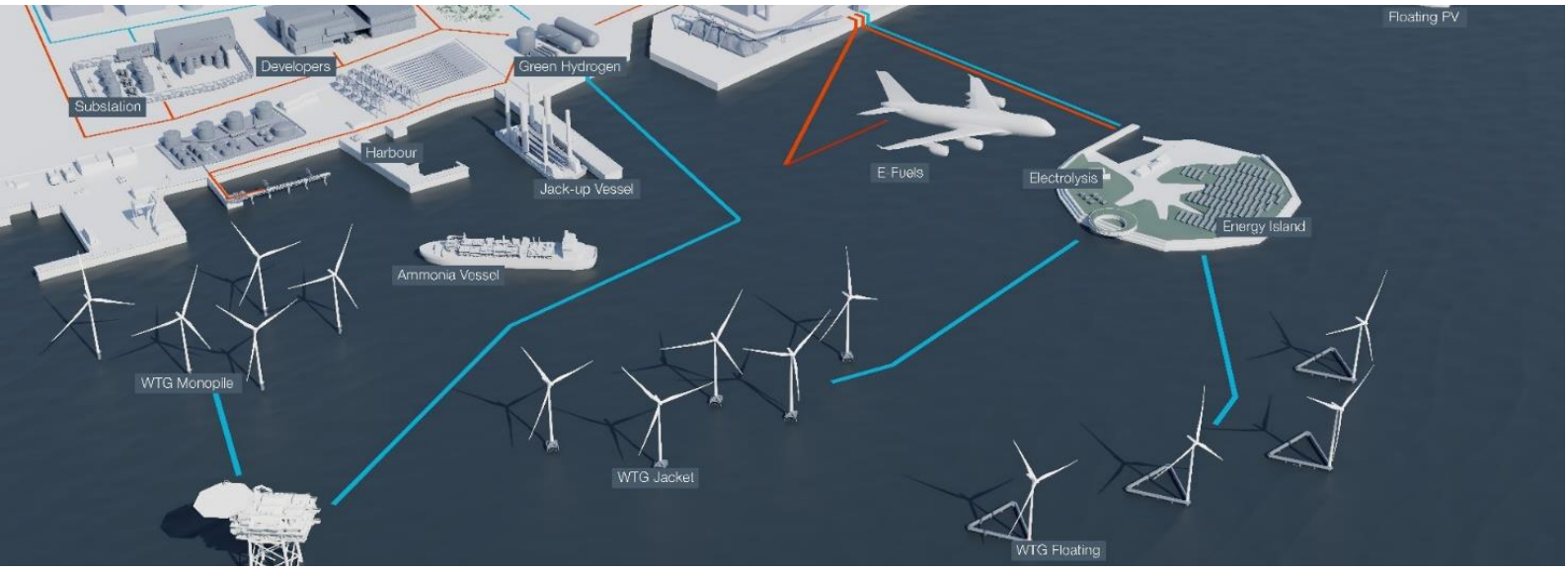
Criteria	Detailed description	A/M	Pros	Cons	*Short-term/ Long-term*
S5 Plan for re-duction of carbon foot-print on the project	A plan including initiatives to be considered to lower the carbon footprint of the project. The pros and cons in relation to each of the initiative to be included. A requirement to update the plan for reduction of the carbon footprint regularly during the project could be included.	M	Easy to evaluate that the plan is included. Shows the bidders focus on reducing the carbon footprint	Requires competences and resources to evaluate the plan. The plan is either non-binding in which case there will be no commitment to reduction according to the plan. Or the plan is binding - in that case, it must be accompanied by a sanction regime as well as an increased need for resources from the authorities to follow up.	Short-term if resources available for description, evaluation, and follow-up on requirements. Long-term if these resources are not available at present.
		A	Shows the bidders focus on reducing the carbon footprint.	A baseline must be prepared in order to be able to evaluate. Complex to evaluate the ambitions of the plan if included as award criteria.	Short-term if resources available for description, evaluation, and follow-up on requirements. Long-term if these resources are not available at present.

Criteria	Detailed description	A/M	Pros	Cons	*Short-term/ Long-term*
S6 Reduction of carbon footprint in relation to transport	Include requirements for using fuels with a low carbon footprint or with fuels considered as sustainable according to the EU Taxonomy for the vessels and vehicles used in the project. List of vessels and vehicles including type of fuels to be used to be included in the proposal.	M	Possibility to require electrically driven tools and vehicles with low power consumption. Pushes the development to use green fuels or electric vessels and vehicles.	Limited access to green fuels. Limited number of large vessels and vehicles that are electrical or can be driven by capable green fuels. Higher costs in relation to fuels and vessels.	Long-term
S7 Requirement for environmental product declarations (EPD) for main components	Environmental Product Declaration (EPD) according to EU standard for main components. 3rd party verified EPD to be included in the proposal.	M	Transparency of environmental impact from product. Data can be used as part of carbon foot- print calculation. Possibility to compare environmental impacts from products.	Limited number of suppliers.	Long-term

Criteria	Detailed description	A/M	Pros	Cons	*Short-term/ Long-term*
S8 Use of "green steel"	Requirements of using" green steel" or steel with a low carbon footprint. Minimum requirements for carbon footprint of the steel to be included in the tender requirements. Average CO_2 emission from steel produced in Europe could be specified as minimum requirement.	M	Reduction of carbon footprint from project. Positive impact on society as motivation for using low carbon foot- print materials. Certification of the steel should be used as documentation.	Difficult to set a specific requirement defining when steel is considered to be green. The availability of "green steel" is limited. Higher prices.	Long-term
S9 Plan for circular economy	Bidder to prepare a plan for how to include circular economy and specific initiatives in the project execution.	M	Supports a development in relation to circular economy. Supports innovation within circular economy.	Does not ensure solutions with reuse or recycling of materials or products.	Short-term if resources available for description, evaluation, and follow-up on requirements. Long-term if these resources are not available at present.

Criteria	Detailed description	A/M	Pros	Cons	*Short-term/ Long-term*
S10 Recyclable blades	Including blades that can be recycled to a specified level.	M	Supports a development in relation to circular economy. Solves a future problem in relation to placing used blades at disposal yards.	Limited number of suppliers. Higher costs. Additional cost is estimated to below 0,5% for a wind farm and below 2% per WTG. Difficult to check if the requirement is met. Requires a clear definition of recyclable blades.	Long-term
		A It will be evaluated positively if a method for recycling of blades is included in the proposal.	Supports a development in relation to circular economy. Solves a future problem in relation to placing used blades at disposal yards.	Limited number of suppliers. Potential higher costs. Difficult to check if the requirement can be met.	Long-term

Criteria	Detailed description	A/M	Pros	Cons	*Short-term/ Long-term*
S11 Environmental requirements according to the EIA for the project	Requirements in the EIA permit and preconditions in the EIA application to be specified.	M	Meets the legislation. No delays due to authorities pausing activities if requirements are not met.	If requirements in EIA is limiting innovation or not covering suggested solutions, a new application must be sent which may cause major project delays.	Short-term
S12 Chemicals to be discharged to the marine environment	Including requirements to the selection of chemicals that might be discharged to the sea to be classified as yellow or green.	M	Raises awareness in relation to selection of chemicals.	Difficult to get sufficient documentation from chemical suppliers.	Short-term
		A Higher evaluation when the supplier plans to use chemicals in the green category.	Only discharge of chemicals which pose little or no harm to the environment.	Difficult to get sufficient documentation from chemical suppliers.	Short-term



4 System integration

4.1 Why system integration?

With the increased electrification of the Danish society, the large-scale expansion of offshore wind could make an even more substantial contribution to the system stability and resilience. Today there already is a well-functioning market for system integration. Developers have an economic incentive to install batteries, to use PTX to balance electricity production and so forth. However, given the massive expansion and reinforcement of the transmission grid that is necessary to achieve the ambitions of decarbonization of the energy system, it could be considered to further incentivize system integration. With the addition of large-scale flexible consumers located before the Point of Connection (PoC), it is possible to build more offshore wind compared to the accessible grid capacity. An overplanting in combination with flexible consumption will make it possible to deliver more production hours at the PoC capacity. In addition, there is a possibility to maximize the use of existing capacity and postpone future capacity reinforcement of transmission lines and at the same time further enhance decarbonization via sector coupling. Furthermore, it could contribute to maintain the high security of supply that exists today. However, this additional complexity might challenge the overall objective of speeding up the OWF tendering/contracting process, which will be reflected in this section. Also demanding more system integration from the developers could entail overinvestment in system integration from a socioeconomic point of view.

COWI were tasked with the assignment of looking into which minimum requirements or award criteria could be specified in the tender material in order to make the developers contribute to system integration. COWI were not tasked to look at the general tender conditions, the planning of hydrogen infrastructure and the like. However, to the extent that the reference group has advanced such viewpoints it is reflected in this report and analysed accordingly.

The chapter is structured as follows: In section 4.2, the dialogue that has taken place with developers is reviewed. Answers to the questionnaires they have responded to are presented. COWI reflects on the answers in section 4.4. Input from other countries is presented in section 4.3. COWI has obtained input from the authorities in each of the countries separately and reflections as well as advantages and disadvantages to possible criteria within system integration. Having assessed these inputs and

supplied with own assessments, COWI has created a catalogue of criteria with reflections to consider in relation to the individual criteria and in relation to advantages (pros) and disadvantages (cons). It is also considered whether the criteria should be minimum requirements or award criteria (4.5). The sub-criteria will also reflect whether there is a time critical aspect and potential impact on the competitive situation (and thereby the price).

In order to set the context for system integration, the following must be clarified / assumed:

- System integration does not only relate to electrical energy production/demand but targets the whole energy mix/chain from production including balancing of surplus production and further enhancement of system resilience.
- System integration can utilise production of alternative energy sources (e.g., green fuels), production of fertilizers (e.g., ammonia), and energy storage in any form.
- Overplanting of an OWF relates to developers being allowed to install and produce more capacity [MW] than the TSO can absorb at the PoC.
- A competitive market for ancillary services for system stability support toward Energinet's grid exists today.
- Centralised distribution/transmission systems for PtX-offtake (e.g., H2) is not available for the developers today or in the near future.
- The prevailing Danish regulatory frame and legislation only allow for tendering and evaluation based on a single point of PoC.
- There are other important measures to power the development of PtX projects in Denmark, e.g., to subsidize PtX projects.

4.2 Industry viewpoints

Integration with PtX has several benefits, which include a smaller need for electrical backbone grid capacity, a reduction in losses (when placed offshore), export potential to other countries of PtX green gasses products, etc. The below questions were presented to the developers:

- How can integration with PtX projects be specifically implemented and integrated in the tender model and the evaluation criteria, respectively?
- What is your experience and preferred arrangement in respect to offering system stability support services to the TSO?

The replies from the suppliers and developers are summarised in the following

- An overplanting approach is welcomed by all developers.
- If a system integration approach is adopted, it should be open to and include all technologies such as batteries, heat utilization or storage, Compressor Air Energy Storage (CAES), etc. as

well as Renewable Energy System (RES) assets such as PV, wave, etc. Furthermore, a combination of these energy systems should be considered to optimize both power duration curves and/or the total capacity factor of the OWF.

- In addition, a set of capacity targets should be formed for electrical and PtX production to the respective onshore connection points. This would allow for the developer to overplant on site to optimise the use of available grid capacity and wind resources.

- Requirements for minimum secured off-take through PPA's (a different PoC's) will improve flexibility and options for an optimised system integration of the OWF and combined energy systems.

- Subsidies for PTX/storage/H2 project components should be a possibility as OWF tenders are expected to be on full market terms in the future. Subsidies for PtX/storage/H2 projects instead of OWF can accelerate the development of future system integration solutions thus reducing the cost for future power grid expansions.

- Some developers prefer the open and transparent market for offering system stability support instead of incorporating this into the tender material.

- The majority of developers and suppliers can meet and will respond on requirements for system stability support. This however is already addressed in the grid code requirements and prevailing market tenders managed by Energinet.

- A set of **minimum targets** for the developers regarding PtX (or storage facilities) could be defined, and perhaps extra points can be received in the scoring for creating extra off-grid capacity. These can be qualitative (e.g., new technologies) although such a firm evaluation framework may be challenging to develop.

Having assessed the answers and combined with own assessments, COWI has created the catalogue of minimum requirements and award criteria in section 4.5.

4.3 Input from other countries

The following table presents other countries' initiatives in respect to system integration.

	Observations	Reflections
UK	Overplanting or system integration are not addressed with any significant importance in the tender process.	None
US		None
Germany	Quality points can be given for: - a) Contribution to decarbonization - b) Amount of energy produced - c) Noise emissions - d) Secure jobs in Germany	a+b (and d) can be impacted by introducing new technologies/solutions based on energy storage or PtX production facilities. These new technologies/solutions will also have a positive impact on the system integration.

Netherlands	Model 3, award Criterium 4 addresses the "contribution to the integration of the windfarm into the Dutch energy system" (100 points out of total 200 can be allocated). A strong focus on system integration and innovation is observed and the market have reacted very positively.	Exemplified by an extra offshore platform comprising a 2,5 MW electrolyser for H2 production and 5 MWh battery storage powered from the OWF and 0,5 MW floating PV plant. The H2 can be converted back to electricity/grid via a 1 MW fuel cell. Such design is considered to be an innovative pilot project for testing pre-mature technologies in an up-scaled version and in an offshore environment. However, this system integration is on a very small energy scale. It is important to critically assess the maximum weight of criteria which allows for high score of innovative solutions in a small energy scale to ensure value for money for the overall project.
Belgium	Overplanting or system integration are not addressed with any significant importance in the tender process.	Award criteria points are given in accordance with the energy produced. It is not understood if this also addresses the energy produced from any PtX facilities.

4.4 COWI's analysis

4.4.1 Electrical system integration

The developer can design an energy production mix (wind, PV and other) combined with energy storage and PtX load demands before the PoC. This could increase the capacity factor for power/energy delivered to the power grid since variable renewable energy (VRE) from the storage can be released to the power grid during periods where VRE plants do not produce. This can be considered a system integration improvement.

It is not assumed that system stability support services form part of the tender model or evaluation criteria since these are already managed on prevailing market conditions. Therefore, it is assumed that:

- The developer's overall business case will be based on energy prices for electricity sold to the grid on a competitive market basis and thus not directly related to system integration contribution.
- Only improvements that can be categorized as innovative to boost the system integration of the energy systems could form part of the tender model and evaluation.
- The OWF developer can set up an energy production mix.

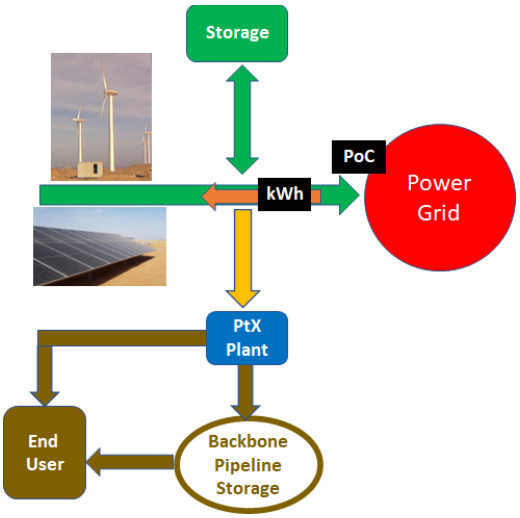


Figure 4-1. Example of an energy production mix connected before PoC.

4.4.2 Power-to-X system integration

It is noted that if there is an interest in further integrating PtX in OWF tendering, the following overall considerations should be observed. There are several important boundary conditions which impact the possibilities of successfully integrating PtX in Danish OWF tendering and corresponding evaluation models:

- 1) The expected time frame for developing a firm offer for PtX projects including all permits is minimum 1.5 to 2 years.
- 2) Generally, PtX plants require significant economy of scale in order to provide value for money/viable business models.
- 3) To which degree PtX projects are viable on market conditions in Denmark is currently subject to a number of unknowns/risk factors, e.g., what will be the final CAPEX, market price of green fuels, no current available commercial price for biogenic CO_2, project specific availability of utilisation of the vast amount of waste heat (district heat network availability), etc.
- 4) Denmark does not currently have any hydrogen piping infrastructure.

Ad 1) Allowing minimum 1.5 to 2 years to develop offers for OWF with integrated PtX plant will slow down the entire process of OWF tendering/contracting and is in contradiction with the overall objective of speeding up the OWF tendering/contracting process. If adequate time is not allowed to develop the PtX offers (and it is required by the tender model minimum requirement or the evaluation model gives significant credit to PtX integration), this is likely to lead to tenders with reservations (non-compliant tenders) and/or the market is likely to have no/less interest in such competition.

Ad 2) As PtX plants generally require significant economy of scale to enable viable business models, this will require that the CAPEX involved to establish a PtX plant will be in the same order of magnitude as the CAPEX required for the OWF.

Ad 3) Over the coming years, it is anticipated that a number of large-scale PtX plants will be built and taken into commercial operation in Denmark. The experience harvested from these facilities combined with the general experience of large scale PtX facilities worldwide are expected to remove a large degree of uncertainty from the PtX market.

Ad 4) The development of a H2 piping network in Denmark can contribute to the creation of a market for hydrogen and other PTX-products and improve the business case for offshore developers. However, the development of a H2 piping network in Denmark will likely last a substantial number of years and imply considerable costs and risk as there is a lot of uncertainty about the future market for green fuels. It is doubtful whether a H2 piping infrastructure can be developed in due time to be relevant for the upcoming tenders regarding OFW to be established in 2030.

Short term

The new Danish OWF tender structure and corresponding evaluation model are scheduled to be issued to the market in the 1st half of 2023.

Based on the above overall considerations for PtX framework conditions, there are several key issues which clearly work against PtX system integration into the OWF tendering in the short term. This is better enabled in the long term (see below), however allocation of area(s) that can be utilized at a sequential timeline could be taken into account as an award criterion to further push for system integration at a later stage where e.g., piping infrastructure is established. In this way small-scale pilot projects can be avoided but prepare for large scale solutions.

Long term

When adequate H2 piping infrastructure has been established (and assuming that Energinet will be the owner of this infrastructure), it could be considered that future OWF tenders will include H2 interface connection points (whenever possible). Minimum requirements and/or evaluation model that significantly enhance H2 supply to this pipe infrastructure would be an advantageous update to the future OWF tender documents when taking the accessible electrical transmission grid capacity into consideration.

In addition, as mentioned above, it is foreseen that a large degree of uncertainty from the PtX market will be removed and there will be a better understanding of to which degree PtX plants will be viable on market conditions/need of incentives.

The maturation of the PtX market and the establishment of H2 piping infrastructure are likely to significantly reduce the time needed to develop firm offers for PtX plants, thereby removing/reducing this barrier for PtX system integration into OFW tendering.

The OWF tender structure and evaluation model should be revised/adjusted in relation to changes in the above boundary conditions to accommodate the PtX system integration in the long term.

4.5 Minimum requirements and award criteria

Developers' options to contribute with system integration initiatives that are not already addressed in the current competitive market are considered minor. Only if a combination with large PtX or

storage solutions is obtainable, a sound business case without dedicated subsidies could be realized (given that the timeline for the tender process allows for sufficient development of the PtX/storage facilities prior to the tenderers' submission of proposal).

Consequently, the tender model can consider the following elements regarding system integration:

- Allowing the developers offering OWF's with overplanting and utilize the excess power/energy in front of the PoC. This could include innovative PtX technologies at the WTGs or possibly connected via a 66 kV system at the offshore substation, thus avoiding expensive 220-275 kV equipment for a modest energy production.

- Being based on PoC at one or more grid substations allocated by Energinet for the OWF with maximum defined power for developers' sale and purchase (in case of PtX plant).

- Allowing for consideration of innovation at a sequential timeline and combining with award criteria.

- Overplanting and the associated system integration on a small scale based on either energy storage and/or PtX-plant facilities may not be attractive for the developers if they are forced to connect in front of the PoC. Unless the PoC (or the onshore export cables) are located near areas that can accommodate a PtX facility with good options for delivery of the produced green energy is considered viable. The CAPEX for either 220-275 kV power transmission lines or possible pipelines to the suitable energy storage and/or PtX-plant facilities will very likely provoke an unattractive business case for the developer. Also seen from a national perspective, major investments in parallel major energy transmission systems would not be sound.

- Large scale overplanting and combined system integration based on either energy storage and/or PtX facilities behind the PoC can be more attractive but will be challenged by the OWF tender timeline that presumably will not allow the developers sufficient time to plan and obtain necessary consents for the storage and/or PtX-plan, however it have been realized in the recent offshore tender in the Netherlands.

- With the prevailing regulatory framework and legislation, it is not considered likely that the developer can offer overplanting incl. system integration options without imposing a less attractive business case compared with a 100 per cent OWF plant.

- A limiting factor (others may exist) is the MW transfer capacity that the PoC is designed/agreed for. To overcome this the developer could agree to a larger capacity fee for the additional power transfer capacity in the power grid. Energinet might then need to implement reinforcements in the power grid. Furthermore, other PPA's and an energy transit fee between the OWF PoC and the PtX/Storage PoCs shall be set up. A combined frame for such arrangements is not established today, and it is not anticipated to be in place for the first OWF Tenders in 2023.

Based on the above mentioned COWI conclude that system integration only to minor extent can be adopted in the 2023 OWF tender model. The options identified by COWI are listed in the below table.

Table 4-1. Minimum requirements and award criteria

Criteria	Detailed description	A/M	Measure of Criteria	Pros	Cons	*Short-term/ Long-term*
1 WTG Overplanting	WTG overplanting allowed regarding Energinet's permissible MW offtake at the PoC.	M	Energinet will define the conditions and amount of allowed power flow at PoC.	Will optimize the developers' ability to maximize the energy output from a given site area and can be implemented in the short term.	The developer takes the risk for energy sale/use beyond Energinet's maximum allowed MW sale at PoC.	Short-term
2 Overplanting with variable renewable energy (VRE)	Quantitative evaluation of overplanting with variable renewable energy (VRE) based on energy delivered to power and possibly PtX end users	A	A point score based on % additional energy [MWh, PJ] delivered from the production mix with the OWF energy production.	Inclusion of other VRE technologies in the energy production mix could improve developers' business case and boost the VRE portion further.	Potential risk of limiting the competition in the prevailing market depending on the weight of the evaluation criteria. Furthermore, the expected time for development of a firm offer for PtX including all permits is in the order of minimum 1.5 to 2 years, which is in contradiction with the overall objective of speeding up the OWF tendering/contracting process	Long-term considering

A: Award criteria // M: Minimum requirement.

Criteria	Detailed description	A/M	Measure of Criteria	Pros	Cons	*Short-term/ Long-term*
3 Timeline / PtX plant and off-take arrange-ment.	Sequential timeline for OWF development to accommodate with timeline for PtX plant and off-take arrange-ment. No firm commitment on PtX plant/storage based on the OWF area allocated. Additional OWF area will be allocated for PtX plant/storage within a certain time limit. If not utilized for PtX plant/storage in due time, this area shall be returned (for possible retender by DEA in new OFW pro-ject).	M	The sequential timeline could further ease up re-strictions imposed by the environmental and con-cept/approval processes that are not likely to be implemented within the "short OWF tender pe-riod". E.g., 0 points: Zero utili-zation of additional area Max points: Amount of ad-ditional energy [MWh, PJ] delivered from the produc-tion mix with the OWF en-ergy production	Avoid slowing down tender-ing/contracting period caused by the PtX plant in-tegration. The expected time for development of a firm offer for PtX including all permits is in the or- der of minimum 1.5 to 2 years. Will also be attractive to de-velopers offering only pure wind energy sale (without system integration) to en-sure competition/ realiza-tion of the project.	No firm commitment on PtX plant/storage => objective tender evaluation of this part will not make sense. May give the developer a less attractive business case and thus impact the com-petitive situation.	Long-term however could be imple-mented in the short-term as an award criterion for utiliza-tion at a later stage to ensure large scale PtX plant/storage fa-cilities

A: Award criteria // M: Minimum requirement.

Criteria	Detailed description	A/M	Measure of Criteria	Pros	Cons	*Short-term/ Long-term*
4 Production balancing	Production balancing services are provided by developer's energy storage as an evaluation criterium.	A	Improvement of electrical plant capacity factor/increased full load hours at PoC can be assessed with/without energy storage. Either measured as energy or with a point score in respect to innovation of new technologies/ systems. E.g., 0 points: Annual energy delivered to PoC without storage. Max points: Annual energy delivered to PoC with developer's storage as a percentage of the maximum energy offered by the range of developers (who will be granted maximum point on this element).	Energy provided from the storage during periods with low wind/solar production will give a higher total plant capacity factor/improved power duration curve. Even though it gives an incentive over and above market prices, which in the short run may be sub-optimal, in the long run this point may spur new technology development in the sector since low-wind energy is needed for sure.	Firm tender on energy storage facility is expected to impact the timeline of the tendering. Furthermore, it's difficult to develop a transparent and objective evaluation method which might prolong the evaluation time.	Long-term

A: Award criteria // M: Minimum requirement.

Criteria	Detailed description	A/M	Measure of Criteria	Pros	Cons	*Short-term/ Long-term*
5 Support to establishment of new manufacturing industries	Qualitatively evaluation of committed local cooperation/support to establishment of new manufacturing PtX industries for pilot test projects.	A	Point score on an expert assessment on appropriateness for the technology and impact on local society could be developed. A low weight of this evaluation criterion should be foreseen.	Initiative could set off potential local production and development of new technologies in DK.	Difficult to develop a transparent and objective evaluation method which might prolong the evaluation time. It is also unclear whether this would be in line with EU-regulation	Long-term and requires specialized resources/ consultant to evaluate.
6 Minimum energy storage requests.	Minimum energy storage requests.	M	A minimum of energy storage facilities which can provide black start (e.g., energy equivalent to 1 h full production of max. MW at PoC) could be formulated.	Will boost the development of pilot test project storage plants and improve the production/load balancing and resilience in the transmission system.	May give the developer a less attractive business case and thus impact the competitive situation. The request for a minimum-sized storage facility may impact the timeline of the tendering.	Long-term and requires specialized resources/ consultant to evaluate.

Criteria	Detailed description	A/M	Measure of Criteria	Pros	Cons	*Short-term/ Long-term*
7 Evaluation of PtX/ storage facilities.	Qualitative evaluation of PtX/storage facilities.	A	To be further developed. Starting point could be the qualitative assessment procedures established in the Netherlands but with further emphasis on frontier innovation technologies, e.g., high efficiency electrolysers etc. It should be made clear that these high-risk innovative solutions are only foreseen for a relatively small energy scale of the total project. In order to provide value for money, the max score of this criterion should be quite low.	Can contribute to some innovation elements of the PtX/storage technology/ development.	Could be a beauty contest contribution. It may be preferable to tender such frontier technology innovation projects separately based on subsidizing.	Short-term if resources and competencies are available.

5 Nature and environment

5.1 Why nature and environment

The upcoming large-scale expansion with offshore wind has increased the need for scientifically based knowledge about the impact of offshore wind farms on nature and the environment and ways in which negative impacts can be mitigated. In addition, there has been a significantly increased focus on whether and how OWF can contribute positively to a better marine environment and contribute to achieving nature and environmental objectives.

This pillar deals with the interaction between the expansion of offshore wind farms in Denmark on the one hand and the Danish marine environment and nature on the other. The specific purpose of the pillar is to identify and propose recommendations within the area of nature and the environment for a future tender model for offshore wind in Denmark, that can help to ensure that the development of offshore wind takes place while taking natural values and the marine environment into account.

The chapter is structured as follows: In section 5.2, the dialogue that has taken place with developers is reviewed. Answers to the questionnaires they have responded to are presented, and COWI has reflected on these. Dialogue and workshop with authorities, universities, and non-governmental organisations is presented in section 5.3. Each has separately provided their input, reflections as well as advantages and disadvantages to possible criteria within nature and environment. COWI has assessed that knowledge and created a catalogue of sub-criteria within nature and environment with reflections to consider in relation to the individual sub-criteria and in relation to advantages (pros) and disadvantages (cons), It is also considered whether the sub-criteria should be minimum requirements or award criteria (5.4).

5.2 Industry viewpoints

Through dialogue based on four specific questions, we collected the responses from the developers. The questions were:

- How do you believe nature and environment can be evaluated in a future tender model? Does it apply only as minimum criteria?
- How can innovation be integrated into nature and environment in a future tender model?
- Should the nature and environment requirements be site specific or general?
- How do you envision the improvement of biodiversity in a specific area?

Having reflected on the responses, COWI has extracted the input and incorporated it into the criteria catalogue (Section 5.4).

How do you believe nature and environment can be evaluated in a future tender model? Does it apply only as minimum criteria?

Answers and comments from the reference group/industry:

- Installation of offshore wind should not have any irreversible effect on nature, biodiversity, and/or the environment. Specific requirements that preserve and protect nature and the environment should be included as minimum criteria.
- Future tenders may require bidders to propose additional ecosystem-scale restoration projects. Specific initiatives to promote the coexistence of offshore wind farms with marine ecosystems and other maritime uses could be evaluated in a future tender model.
- Detailed avoidance or mitigation of impacts depends on site-specific project characteristics and must be elaborated in the environmental impact assessment.
- By introducing qualitative criteria as a competition parameter, it is important that the evaluation is transparent, objective, and quantitative. If qualitative criteria are predefined in the tender documents, it will reduce the complexity of the evaluation as the competitive parameter remains lowest price.
- It could be part of the prequalification that the developers must prove that they work actively with the nature and impact of OWF and whether the developer has experience with previous biodiversity projects.

COWI's reflections

Offshore wind turbines, as they are traditionally designed, affect the physical marine environment in many ways, e.g., in the construction phase, seafloor, habitat destruction, and sediment suspension in the water column. But they also create new substrates and habitats, change the current conditions around the turbines, and make noise and vibrations in both construction, operation phase and in the decommissioning phase. In this last phase strategies could also be evaluated.

Mitigation measures and so-called 'marine tools' could contribute to mitigate permanent physical harm or disturbance to animals living at or in the sea, such as sea birds, bats, marine mammals, fish, and the local

environment in general. Marine tools can be used to reduce and modify this environmental impact in both the construction and operational phases (Dahl, Hansen, Pedersen, Lønborg, & Göke, 2022; Bruhn, et al., 2020).

For examples, studies have shown that the mitigation action of 'shutdown on demand' can reduce bird mortality through collisions with wind turbines. 'Shutdown on demand' is a practice whereby selected turbines have their rotation halted at specific set times, e.g., migratory periods or other periods of high activity (Lucas et al., 2012). Also, research is focusing on the effects of painting turbine blades, and if this will help reduce the number of bird victims.

Effects of artificial light pollution on marine animals, such as birds, bats, fish, invertebrates etc., can among other things be; navigation, vision, migration, dispersal, egg-laying, mating, feeding and camouflage.

Recommendations to minimize any impacts of artificial light on marine animals and develop a strategy for influencing stakeholders in their choice of lighting equipment and other materials. Also, awareness should be raised of the negative effects that artificial light poses to the marine wildlife.

These mitigating and marine tools are all relatively new, and not much knowledge is accumulated yet. Nonetheless, some of them are already in use, such as optimal soft start procedures, following the sound emission standards. Also, methods used to limit the level and/or spread of underwater noise during the construction phase, such as use of bubble curtains that emit air bubbles to reduce the noise in connection with the impact of monopiles into the seabed as a foundation for turbines.

Other methods such as "shell-in-shell" and "hydro sound damper" are also being used (Wagenknecht, 2021) to limit underwater noise. While we have some experience with the limitation of noise in the construction phase, we have not much experience with noise and vibration emitted by OWFs during the operational phase and its potential impact on, e.g., fish and benthic fauna (Popper, et al., 2022).

Also, other marine tools can come into play, such as planting of eelgrass, establishment of stone reefs or biogenic reefs, use of bio-huts or other add-ons, cultivation of shellfish and seaweed in the water column, areas protected from trawling (MPAs), and use of nature-based solutions (Figure 5-1) (Timmermann, et al., 2022; Dahl, Hansen, Pedersen, Lønborg, & Göke, 2022).

A strategic environmental assessment (SEA) of the specific plan will always be carried out in accordance with the rules in the Environmental Assessment Act. Some of the animals that are potentially harmed are protected species (e.g., birds, marine mammals, bats etc.) and must be strictly protected, e.g., through the Habitats Directive. To avoid potentially negative effects on these species, increased costs may be expected for the individual projects.

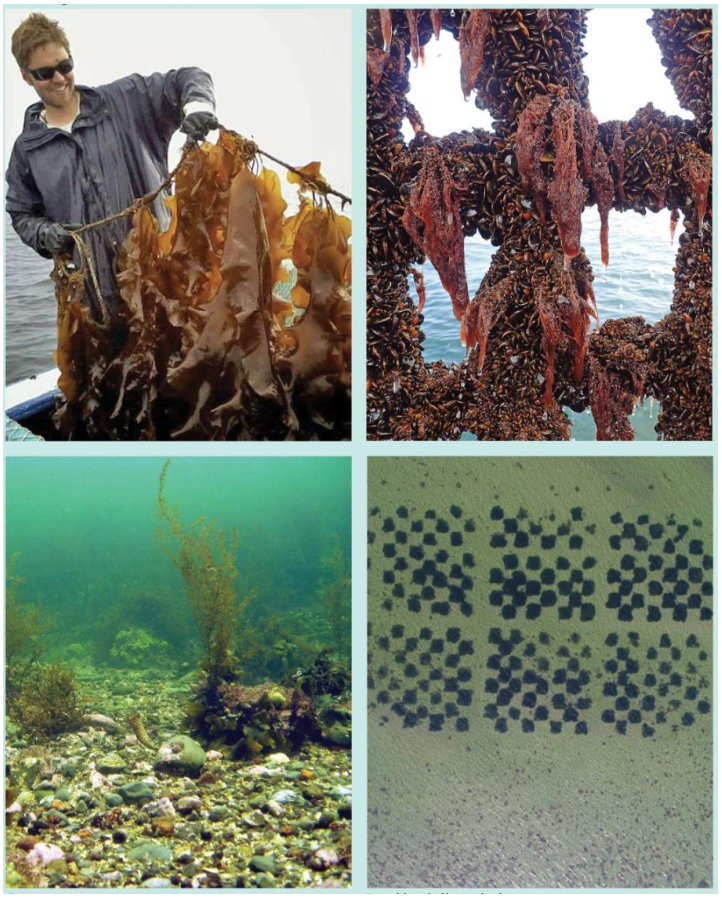


Figure 5-1. Examples of marine tools, growing of seaweed and mussels in the water column, reestablishment of stone reefs, and planting of eelgrass beds (from (Bruhn, et al., 2020)).

However, it should be noted that the individual sites should be evaluated before using the specific methods. For example, artificial reefs that are constructed around turbine foundations for scour protection can have a beneficial effect and bring back the original biodiversity in one location, while in other locations it can attract non-native species and thus create fauna pollution. The non-native species can use these areas as 'stepping stones' to spread even further to larger areas. Therefore, one should be careful in making general requirements about mitigating measures and marine tools. Also, many of these methods are only relevant in coastal/shallow areas, as eelgrass, for example, needs light to grow, and therefore does not grow in greater water depths where there is no light. One measure is to prevent or reduce the growth of attached epifauna and macroalgae on construction surfaces (windmill foundations and erosion protection), another is to not create attractive hard bottom habitats in areas without natural hard bottom.

An important focus point in relation to the use of nature and environmental initiatives as competition parameters is to have transparent criteria that are "easy" to evaluate, and therefore can be evaluated against each other in the different projects. It is important that there are clear targets for which criteria should be prioritised.

How can innovation be integrated into nature and environment in a future tender model?

Answers and comments from the reference group/industry:

- If qualitative criteria that focus on innovative technologies as a competitive parameter are introduced, it is essential that evaluation design is transparent, objective, and quantitative.

- The Dutch tender (Dutch Hollandse Kust West site VI) is a good example of how innovation within nature and the environment has been integrated as a differentiating criterion in a competitive tender.

- A new tendering model has the potential to promote rethinking of how we work with nature and biodiversity to ensure that tenders do not just provide the bare minimum (such as EIAs, noise reduction practices during construction, etc.) but go beyond to provide a positive impact on nature. For example, R&D on specific materials and foundation additions that make it easier for invertebrates to colonise.

COWI's reflections

The specific Dutch tender is one of the first examples of how innovation actions within nature and environment have been integrated as criteria in a tender. An attempt has been made to incorporate innovation into the tender, and an evaluation panel, consisting of nature and environmental experts, must ensure an impartial and credible professional evaluation. An introduction of qualitative criteria/model would be a different approach than for the "Thor Offshore Wind Tender" and would probably be more time consuming and costly, and would require a different setup than today.

An increasing demand for coastal protection and renewable energy production considering climate change and aquatic food provision is likely going to drive the development and deployment of co-located nature-based solutions. Coastal waters, shelf, and open oceans present multiple options for testing new and up-scaling known nature-based solutions, which could support both environmental restorations simultaneously with addressing multiple societal challenges, thus paving the way for a new level of ecosystem-based management (Riisager-Simonsen, et al., 2022).

Nature-based solutions can refer to options that can be integrated in or added to the design of an offshore wind infrastructure, optimised scour protection layer, and optimised cable protection layer (Figure 5-2) to create suitable habitat for native species (or communities) whose natural habitat in the specific area has been degraded or reduced.

Examples of habitat or nature restoration inside og outside the OWF, could be laying out stones in former stone reef areas or planting eelgrass beds on sandy substrates. As both methods will only be effective in low water depth, they will have the greatest relevance in the coastal part of cable corridors or coastal OWF. The area distribution of both habitat types has declined considerably in Danish waters. Use of these tools in selected locations is in good line with ongoing initiatives to improve the aquatic environment but also for the restoration of very valuable habitats and ecosystem services in many links in the food chain (Dahl, Hansen, Pedersen, Lønborg, & Göke, 2022).

The choice of restoration initiatives often depends on the individual area. In such restoration initiatives, the risk of introducing new habitats that can be used by non-native species must be considered. These species can use the area as a stepping stone to other areas and thus spread over greater distances. Therefore, focus should be on restoring nature back as close to the original as possible to avoid this introduction of non-native species.

This could include farming of marine species with low environmental impacts within OWFs with foundations built to restore lost habitat features to conserve threatened species inhabiting such habitats. Examples of species could be releasing the European lobster (*Homarus gammarus*) or establishing European oyster (*Ostrea edulis*) banks (Dahl, Hansen, Pedersen, Lønborg, & Göke, 2022; Smaal, Kamermans, Kleissen, Van Duren, & Van der Have, 2017) (Figure 5-2). Depending on the area, there could be reasons to install or promote fauna-repellent design of the turbine foundation and erosion protection (Dahl, Hansen, Pedersen, Lønborg, & Göke, 2022). The first to prevent colonisation of non-native or invasive species in the specific

area, the latter to promote species diversity for communities linked to the hard bottom (Dahl, Hansen, Pedersen, Lønborg, & Göke, 2022).

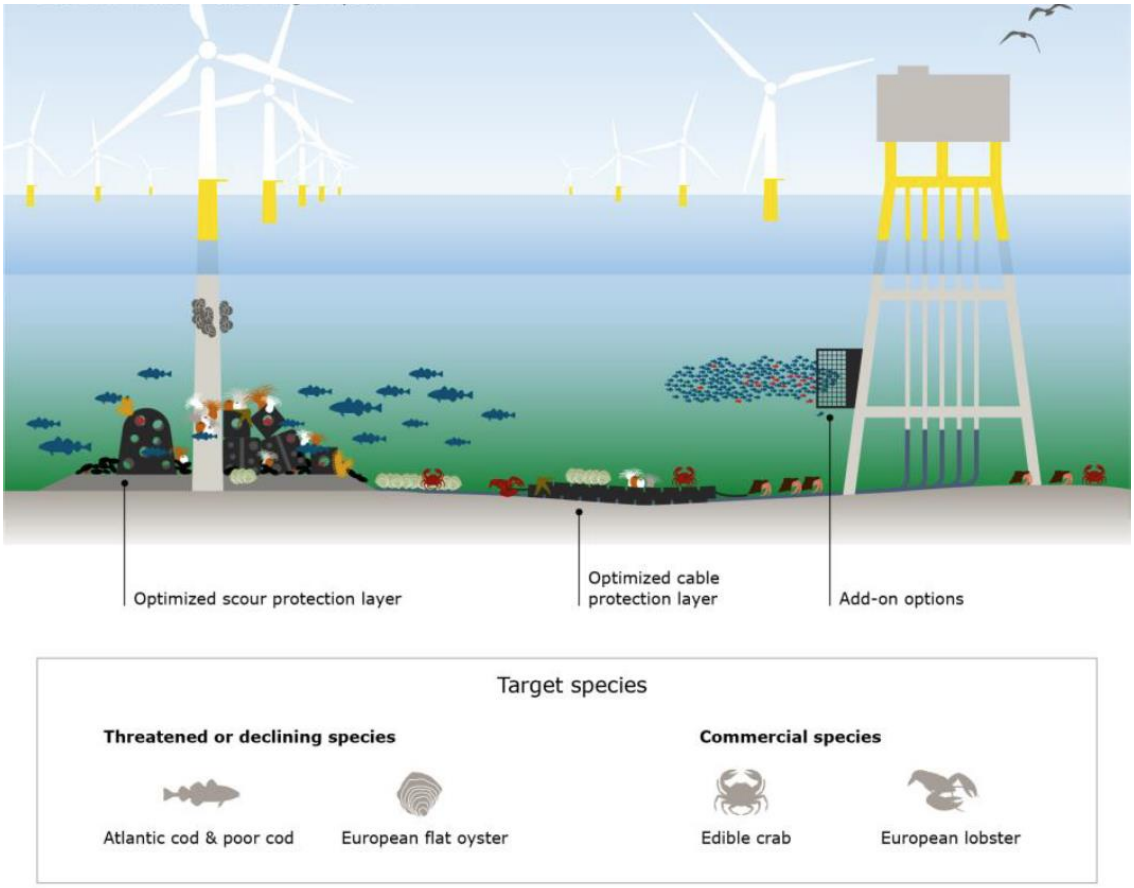
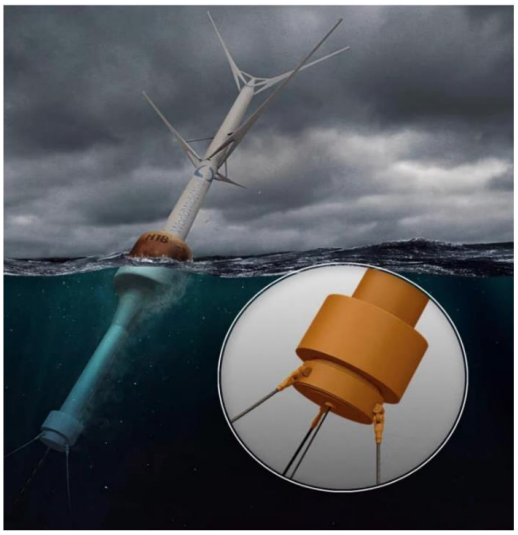


Figure 5-2. Use of nature-based solutions (illustration from Hermans, Bos & Prusina (2020).

There may also be a focus on changes in the design of the traditional OWF (Figure 5-3). The changed designs have the potential to be more environmentally friendly because of less impact in the form of the foundation taking up a smaller area on the seabed, less impact on birds and bats, as well as potentially less noise during the operation phase, etc. The changed design may also introduce requirements or criteria with a focus on the application of increased use of recyclable materials and a promotion of how to work with nature and the environment in general.



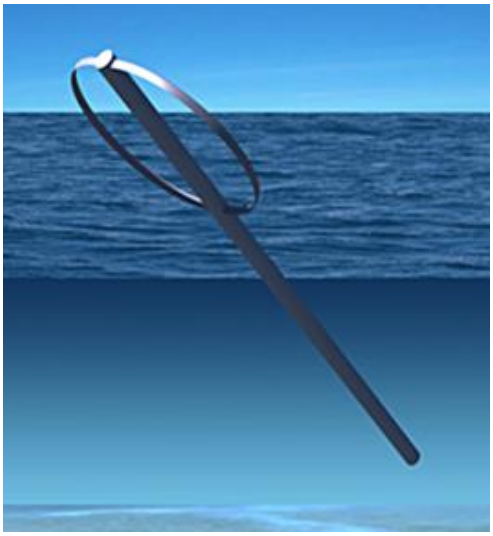


Figure 5-3. Examples of different designs of OWF. (Illustrations from World Wide Wind Tech AS and Deepwind).

Should the nature and environment requirements be site specific or general?

Answers and comments from the industry:

- Some general requirements for impact reduction measures (e.g., reduction of underwater noise from piling) could be defined.
- Natural and environmental requirements depend on the specific biodiversity features, specific species, or habitat restoration goals identified by the authorities for the site in question. Project screening identifies key biodiversity features which are then confirmed through baseline data collection.
- Definition of site-specific requirements/scoring criteria based on local conditions (baseline data) and the occurrence of sensitive species and/or habitats in each area, e.g., a local population of breeding birds.
- The requirements are based on the result of the environmental impact assessment (EIA). For example, if the EIA shows that there is a vulnerable seabird species in a potential offshore wind farm, it should be required to mitigate the impacts that an offshore wind farm may have on the specific bird species.

COWI's reflections

It is essential to implement a monitoring programme of the environmental effects of OWF. Some effects will need to be assessed also during construction. Baseline monitoring, inside and outside the specific OWF, before establishment and monitoring of the effects in the operational phase, would contribute to assess and close knowledge gaps, also in relation to cumulative effects. Also, it gives the opportunity to share and access data with other EU members states. As a minimum, requirements in relation to the EU's environmental directives and Common Fisheries Policy should be met. To ensure a fair distribution of costs for different developers, the monitoring programme must be strategically planned and distributed on different projects.

It must be defined how specific is site-specific? (Van Dam, Hogan, Harford, & Humphrey, 2019). Also, it could be defined what makes one specific site different from another site, comparing differences in physical

chemical conditions (ocean currents, waves, temperature, salinity, precipitation, and CO_2), ecosystems, and biodiversity etc. This would help define the right measures for the individual areas.

How do you envision the improvement of biodiversity in a specific area?

Answers and comments from the reference group/industry:

- Thus far, the Netherlands has decided to frame the requirements in a broad fashion. However, the bids are evaluated by an expert committee that is supposed to judge the quality of the various proposals based on the specific site context. Taking up more specific requirements in a tender would make evaluation of bids easier and less time-consuming as "what constitutes success" has already been more clearly defined pre-bid.

- The identification of key biodiversity features is identified at the site during project screening. These features are validated by site-specific studies in consultation with relevant stakeholders.

- Actions to restore and offset residual impacts on specific features should focus on positive interventions that generate biodiversity gains, either through avoided loss (such as managing threats elsewhere, e.g., reducing predation on seabirds) or through restoration (such as improving the quality of degraded habitats not affected by the project, e.g., restoration of coastal seagrass habitat away from the project area). Offset should be considered after the implementation of the mitigation hierarchy.

- To be credible and in line with leading global practice, biodiversity offsets could meet certain principles to ensure that there is a fair trade-off between losses and gains based on reasonable and prudent forecasts (see BBOP Principles on Biodiversity Offsets).

- Monitoring is subsequently essential to any initiative that seeks to rebuild ecosystem health and biodiversity in the face of multiple anthropogenic stressors. Thus, metrics could be developed to estimate losses and offset gains. Losses and gains could be assessed for each key element of biodiversity.

COWI's reflections

There is a growing attention to ideas of how to build with nature confronted with marine constructions, also called nature-based solutions or nature-inclusive design, e.g., the marine tools already mentioned. Not all tools work in all areas, some work only in shallow areas (e.g., planting of eelgrass), and some are supposed to work in all areas (e.g., fauna-repellent design of the turbine foundation and erosion protection).

Evaluating on more broad requirements is more time-consuming. Thus, there is a trade-off between time for the creation of the wind farm and any considerations to include broader evaluation criteria in the tenders.

5.3 Input from universities and authorities

- A standardised data collection is essential inside and outside the offshore wind farm to be included in existing data collection programmes. Criteria should be established for standard tools, methods, and data to be used for data collection.

- Data collection can take place with research vessels which operate in all Danish waters or with the OWF crew vessels which operate in the areas.

- Data must be made available, quality assured, and stored in a central location, e.g., NOVANA. Developers should not own data (or areas).

- Preliminary studies must be carried out to have a reference state. Otherwise, it is not possible to measure an effect of the activity. In addition, there must be an impact monitoring programme after the park is set up so that it is possible to follow how an offshore wind farm affects the area, both during installation and during operation. E.g., if it affects fishing by pushing it into areas that can be affected thereby and where fishing does not take place today. An impact monitoring programme should be a minimum criterion.

- There is a lack of knowledge in relation to cumulative effects. Modelling tools will be one of the possibilities to follow what happens in the future. Can data play a role in modelling tools that can project what happens when several parks are set up and thus see the impacts in an overall perspective?

- What is the right biodiversity - high biodiversity is not always good? Focus on the right biodiversity can be an award criterion.

- A carbon trust fund should be created to support the collection of data and nature restoration activities, which the developers should support financially.

- It must be very simple to assess whether the criteria are met or not. The focus should be on very specific criteria. It should not require a large evaluation task afterwards.

COWI's reflections

More marine data is needed, and data from OWF can support and extend existing monitoring programs (e.g., NOVANA, ICES etc.), if the data collection is standardized to the existing data collection programs and time series.

Criteria should be established for standard tools, methods, and data to be used for data collection. On the other hand, if data are not standardized, and lack of a database platform, that makes data easily accessible, then the use of collected data is limited. It should be noted that it is costly in money and manpower to develop, validate, update, and maintain a data collection platform that exposes collected data. It requires clear standards that needs to be defined in the legislation, which are used by everyone in a broad sense.

It is also relevant to include open door OWF in the collection of marine data, especially because many of these are near the shore, and data are especially needed here. In combination, this could contribute to good distribution of data sites. The temporal and spatial distribution of monitoring stations for specific monitoring programs is carefully selected, and therefore the areas where OWF are located are not necessarily optimal for this monitoring. Hence relevant universities and authorities should be involved when planning monitoring programs in OWF areas.

To secure that the major sea area reservations for OWF will be open for research, developer will have to cooperate with researchers, to do monitoring, research, and evaluation, by providing lifetime access to the OWF and the seabed in the area. This to enable attachment of research and monitoring equipment in the OWF area and directly in the wind turbines. It can be difficult to define a clear framework for when developers are obliged to cooperate and when they are not. E.g., developers will not be obliged to cooperate if the consequences are that large parts of the park must be closed for an extended period.

It should therefore be defined more precisely, under which conditions the developers must contribute to the monitoring. E.g., developer could make crew transfer vessels available for authorities and research institutions to be used for research, monitoring, and evaluation. Use of vessels that is already at the site could save time and money, and the crew knows the OWF area well, which could reduce time used on safety and planning. This still needs to be carefully arranged between developer and researchers, to avoid accidents and secure that essential monitoring and research to be done. Crew vessels do not have standard monitoring and research equipment installed on board.

The use of modelling tools would be useful to measure knowledge gaps such as cumulative effects, OWF to be used as stepping- stones by invasive and non-native species, etc.

Future nature-based solutions aiming at piloting new, or relatively unexplored or undocumented concepts should be accompanied by consistent monitoring programs to document short- and long-term impacts and to enable evidence-based decision making about where to deploy and how to scale solutions most effectively. This is especially important in those cases where ecosystems are expected to develop by succession to an anticipated climax state. For example, given the recent EU strategy for significant upscaling of offshore wind energy production in the North Sea, it is highly unfortunate how little monitoring has been prioritized in e.g., North European waters to document broader impacts of wind farms (Riisager-Simonsen, et al., 2022).

New technologies and e.g., the use of sensors could be considered in a future programme, including modelling tools. Focus could also be on measures to prevent disturbance and/or permanent physical harm and/or effects to marine mammals and the mortality of birds, bats and fish. E.g., the underwater sound level during piling work for the construction of the wind farm should never exceed the applicable sound emission standards.

To finance nature-based solutions, new technologies and other innovations, establishment of a fund, could be an option. It could be supported by funds from the OWF industry, for the reestablishment of national marine areas and species. The fund can be applied for the development of local, regional, and national coexistence projects in areas with offshore wind. It would be able to boost local economic activities and nearby OWF, e.g., microalgae production and low-impact fisheries development. But in some situations, it may make better sense to use funds for regional or national projects. But it is unclear whether it is possible to instruct developers to restore nature outside the offshore farm, as these areas have nothing to do with the object of the contract. Also, lack of transparency in how the fund is being used can be a challenge.

5.4 COWI's analysis

Fundamental nature and environmental requirements to reduce the impact on the nature and environment to a minimum and to secure compliance with applicable Danish and international regulations could be applied as minimum requirements and/or award criteria in a future tender model. Minimum requirements can also be applied to ensure a more ambitious level of nature and environmental standards in the tender.

The use of minimum requirements and qualitative award criteria should be weighted with competitive considerations, since offers that do not comply with the minimum requirements are excluded from the tender. Furthermore, it should be noted that minimum requirements promote no competition amongst the eligible bidders, since all offers as a minimum should comply with the minimum requirements. On the other hand, introduction of qualitative evaluation criteria is not a guarantee that the developers will undertake any nature or environmental improvement measures. There is a need for some minimum requirements that must be met, to ensure that the developers carry out at least the specific minimum criteria such as nature and environmental improvement measures.

Based on the competitive nature of award criteria, bidders could compete on "overdelivery" in correlation with minimum requirements. There is a risk that the expansion of OWF in some areas will conflict with the efforts dictated by relevant directives, national and international legislation (e.g., HELCOM and OSPAR) to achieve good environmental status and favourable conservation status in Danish waters. Therefore, an example of an "overdelivery" could be that one developer due to the choice of turbine foundation design affects the seabed less than another developer. When the seabed is less affected, there will be less sediment loss, etc (see also Figure 5-3).

Also, it should be noted that authority development and the establishment of a relevant data platform could be considered to support transparency and availability in relation to the collection and use of data for authorities and research institutions. The downside of a data platform is that it is costly in money and manpower to validate, update, maintain, and develop a data collection/platform that exposes collected data.

The introduction of qualitative criteria as a competitive parameter has the potential to promote rethinking of how environmental, nature, and biodiversity concerns are ensured as an integrated part of the development of offshore wind farms. The use of qualitative criteria implies the use of "best ratio between price and quality" as award criterion, and the criteria must be transparent, objective, and proportional. It is demanding to develop transparent and objective criteria, and as far as is known, there are no other countries than the Netherlands who have tried to introduce such criteria in relation to nature and environment. However almost all other countries developing OWF in EU are in the process of introducing qualitative criteria as competitive parameters including nature and environment – at least to some extent. The Netherlands on the other hand has in fact opened to the possibility, that future tenders can be held without the use of qualitative criteria.

Table with most suitable criteria incl. pros and cons

Below is a table with the most suitable sub-criteria within the criterion "Nature and environment", valuation of minimum requirements (M) or award criteria (A), and pros and cons for each sub-criteria. The sub-criteria are grouped into data collection, research, monitoring, and evaluation, mitigating measures, and innovation and restoration. The sub-criteria could be either minimum requirements or award criteria. However, a great part of the sub-criteria can both be characterised as minimum requirements and award criteria (A/M), and to let the bidders compete on "overdelivery" on the minimum requirement and thus compete on the minimum requirements, it could be characterised as an award criterion (M/(A)).

Table 5-1. Evaluation of minimum requirements (M), and award criteria (A), pros and cons for the individual criteria. Also, arguments for the possibility to incorporate the criteria in short or long term.

Criteria	Detailed description	A/M	Pros	Cons	Short-term/ Long-term
Data collection, research, monitoring, and evaluation					
1 Monitoring Programme	Developer will cooperate to the monitoring programs	M	Data from OWF can support and extend existing monitoring programs.	OWF are not necessarily optimal data monitoring sites. Important to define the conditions for the developer.	Short-term if resources are available for description, evaluation, and follow-up on requirements
2 Baseline Monitoring	Baseline monitoring Modelling tools are useful to measure knowledge gaps	M	Share and access data with other EU members states. Knowledge gaps are assessed and closed	Monitoring programs must be distributed on different projects	Short-term
3 Data Collection	Standardized data collection Criteria for standard tools, methods, and data used in data collection.	M	Data must be collected and processed according to standardized collection programs Standardized collection programs already exist	The use of non-standardized data is limited A functioning database platform is needed It is costly to develop and run a data collection platform	Long-term. A data platform needs to be developed
4 Access to OWF	Developer provides access to the OWF and seabed for monitoring, research, and evaluation	A	OWF and seabed will be open for research Developers provide a plan for how to provide access to monitoring, research, and evaluation and to what extent	Attention on safety and planning Difficult to define a clear framework for when developers are obliged to cooperate Increased costs	Short-term

Criteria	Detailed description	A/M	Pros	Cons	Short-term/ Long-term
Data collection, research, monitoring, and evaluation					
5 Crew transfer vessels for monitoring and research	CTV's are available for monitoring and research	M	Economical and timesaving Higher level of safety and planning	Extra planning Increased costs. No standard research equipment installed Difficult to define a clear framework for when developers are obliged to cooperate	Short-term. Much of this are already defined in standardized monitoring programs
Mitigating measures					
6 Mitigating measures (physical)	Measures to prevent permanent physical harm, mortality, or disturbance	M	Strategic environmental assessment will be carried out	Increased costs and time	Short-term
7 Mitigating measures (collision)	Measures to limit collision among birds and bats	M	Ensure protection of birds and bats	Increased costs and time	Short-term
8 Mitigating measures (light pollution)	Measures to reduce light pollution	M	Light pollution should be limited to a minimum to protect effects on wildlife Recommendations to minimize any impact of artificial light	Increased costs Change of regulation and executive orders	Short-term

Criteria	Detailed description	A/M	Pros	Cons	Short-term/ Long-term
Innovation and restoration					
9 Innovation	Innovation and adaptations that will benefit the marine environment	A	Ensure development of nature-based design Increased biodiversity	Limited knowledge of the positive effects	Short-term
10 Nature restoration	Nature restoration measures inside or outside the OWF	A	Improve the marine environment in or outside the OWF area	Increased costs Unclear if developer can be instructed to restore nature outside OWF.	Long-term
11 Establishment of a fund	Establishment of a fund supported by OWF industry	M	Support local, regional or national coexistence and restoration projects	Site specific. Not always the best solution to do the projects in the specific OWF area It is unclear if it is possible to instruct developers to restore nature outside OWF Lack of transparency	Short-term

6 Economy and legal

Offshore wind is globally considered one of the primary solutions to the climate crisis. To meet Nationally Determined Contributions (NDCs), countries across the globe are looking to offshore wind to provide the bulk of the needed energy in the future. This risk is putting a tremendous strain on the entire supply chain for offshore wind as lead times currently are challenging. For instance, access to needed infrastructure and installation vessels are in high demand[3]. Although the massive global increase in offshore wind projects may stimulate a growth in the industry with the rise of potential new suppliers/developers[4], it may also risk allowing the developers to cherry-pick the best and most profitable projects. The ambitious Danish 2030 target shall be seen in this light. It is within this market reality that Denmark seeks to fulfil its own climate policy goals by installing a large amount of offshore wind before 2030. Partnerships have recently been developed with nearby states in the Baltic Sea and North Sea regions as most participating states share similar ambitious targets for offshore wind[5]. This calls for close regional coordination and a strategic tender approach (i.e., a tender approach based on a well-founded strategy) in order to attract the preferred bidders, to overcome the current supply shortage, and to ensure a timely process meeting the 2030 target.

A revision of the current tender framework and inclusion of new minimum requirements and award criteria will need to consider how those new requirements and criteria will potentially impact the cost of energy and the time for establishing new offshore wind capacity. This section will describe:

- How the tender framework is perceived by the European offshore industry
- How monetary bids can be combined with qualitative criteria in a points system

[3] See for instance https://windeurope.org/wp-content/uploads/files/policy/topics/offshore/Offshore-wind- vessel-avaia-bility-until-2030-report-june-2022.pdf

[4] See for instance https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-in- sights/how-to-succeed-in-the-expanding-global-offshore-wind-market

[5] The Esbjerg Declaration of May 2022, and the Marienborg Declaration of August 2022.

- How minimum requirements could impact the cost of energy from the project
- Input for a tender model based on pure price with possible minimum requirements, and a tender model based on price and qualitative award criteria
- Overall reflections on global competition
- Some concluding remarks - minimum requirements and award criteria.

6.1 Feedback from the European offshore industry

The feedback from the European offshore industry has been very clear. First, offshore wind is considered commercially viable, meaning no subsidies should be needed. It is COWI's assessment that this is very likely correct, but there may be exceptions for projects in clearly suboptimal locations with either poor wind resource or difficult local conditions. Likewise, the expected future market price of electricity could also impact the need for subsidies. Finally, the tender framework itself can increase project costs and thereby increase the need for subsidies. Commercial viability is highly relevant to the design of the tender framework as it will greatly simplify the consideration regarding the "price" component of the bidding.

Second, some developers are very clear in their wish for a cap on the "price" component of the bid. In a purely commercial tender, the "price" could be a concession fee paid to the Danish Government or a profit-sharing scheme. The argument provided for a cap on this "price" is to avoid a potential risk for a "race to the bottom" where aggressive bidding is rewarded at the risk of developing a clearly substandard project in terms of quality, technical life, and risk of non-completion. It is COWI's assessment that this is an overly bleak take on uncapped monetary bidding. If the bidders are provided sufficient avenues for demonstrating "quality" through other qualitative award criteria or minimum requirements, then uncapped monetary bidding should not be an issue.

Third, in general the industry is very clear with a few exceptions, in asking for a more nuanced competitive tender framework, where monetary bidding (the "price") is combined with qualitative award criteria. It is COWI's assessment that this is a request in line with well-established practices of major infrastructure projects world-wide, including offshore wind (e.g., as applied in the Netherlands, Germany, and Belgium as described in this report and part 1 report "new concepts for awarding offshore wind licenses in Denmark"). Also, according to the Danish Competition and Consumer Authority, more than two thirds (2/3) of all Danish EU tenders are awarded through the "best balance between price and quality" award criteria (i.e., most economically advantageous tender based on the best price-quality ratio)[6]. Asking bidders to compete on price as well as quality seems to be the norm as it is a tender approach familiar to most of the global industry. Such tenders that combine monetary and qualitative award criteria will provide the bidders the means to showcase their strengths relative to their competition, and it will provide the tenderer a much greater variety of competing solutions when evaluating the proposals. In terms of time spent on the procurement process, it is COWI's assessment that the industry should be able to submit proposals at roughly the same rate (same time plan, i.e., from publication of terms to deadline for submission of offers) regardless of qualitative criteria. However, on the bid evaluation side, evaluating qualitative criteria may require more time, maybe three-six months. This added time could be well spent considering the scale and timeframe of large projects such as offshore wind. Beforehand it must be noted that the criteria must be developed - alternatively, a framework must be established, and legislation created to enable an expert

[6] KFST (2022). Status for offentlig konkurrence 2021. Figure 3.1, p. 38.

committee to be set up. All these takes will be extra time consuming and most likely will not be ready in the short-term perspective.

In relation to the request to move away from pure price competition, the industry has concerns that it may not be possible to implement such a tender framework in time for tenders put out in 2023.

6.2 Awarding based on price and quality

Awarding contracts in tenders based on price alone only requires a binary assessment of minimum requirements (compliance or non-compliance) and awarding to the lowest (or highest) price. By contrast, awarding tenders based on a combination of price and quality necessitates a means to compare a monetary value with a points-based scoring of qualitative criteria. The simplest approach is to convert the monetary bid into points. Best bid (e.g., highest if a concession payment, lowest if a subsidy) receives the maximum points available. The next highest bid should receive points reflecting the relative difference between this bid and the best bid. There are many possible refinements to this conversion methodology, but the fundamentals remain the same: the relative difference between bids should be reflected in the points.

In COWI's experience, the most commonly applied methodology is called "Lineær pointmodel – laveste pris plus X%"[7]. In this case, it would be a variation where the highest price/bid is the determinant rather than the lowest price/bid. The mathematical representation is:

$$Points = Max_{points} - \left(\frac{Max_{points} - Min_{points}}{Xpct}\right) * (Max_{price} - price)/Max_{price}$$

In this equation, a high price is "good" resulting in more points. The Xpct is a constant defined by the tenderer to provide a signal to the bidders on the maximum allowed deviation from the best bid. If the expectancy is to have very similar bids, then a small value for Xpct will still allow differentiation in the points for the price.

The main weakness of this model is the significant impact that the highest bid has on the entire points award. This can be somewhat avoided with a variation on the above. This is a linear model around the average bid rather than the maximum bid. The formula would be as follows:

$$Points = Min_{points} + \left(Max_{points} - Min_{points}\right) * (1 - \frac{HP - price}{HP - LP})$$

Again, a high price is a "good" thing resulting in high points. HP is the average price plus Xpct resulting in the maximum points awarded. LP is the average price minus Xpct resulting in the lowest points awarded. In this case, extra care is needed in determining the Xpct as it is possible to get a score higher than the maximum points available. The Xpct must result in a HP at least as high as the highest bid.

There are other variations to the point model (see KFST (2019)), but the max/min price plus Xpct is probably the most commonly applied. This has the added benefit of having a high likelihood that the bidders are well acquainted with the model.

[7] KFST (2019). Evalueringsmodeller, Praktisk Vejledning til Offentlige Indkøbere. P. 22

Once the price/bid has been converted into points, they can be weighed together with the points from other qualitative award criteria. Here it is important to note that the points range, i.e., the minimum and maximum possible points should be the same for all award criteria. Otherwise, the points and the weighing of the criteria cannot be kept separate.

The awarding of points and the choice of weighing of criteria are a detailed political, legal, and economic exercise. Inspiration and examples for evaluation models, including point systems and weighing of qualitative criteria related to, e.g., environmental benefits, sustainability, and system integration, can be found in the cases of the Netherlands, Germany and Belgium presented in this report, especially in Part 1. The precise formulation of such evaluation models depends on policy preference and the outcome of a detailed deliberate procurement strategy as part of the tender preparations (subject to state-aid regulation, where relevant). No exact off-the-shelf generic model applies as the points award and weighing must reflect the political and economic objectives of the tenderer. It is also important that award criteria leave room for real competition and hence, differentiation in the points award. If it is too easy to deduct the path to and to achieve the maximum points for an award criterium, then the criterium loses its value as a differentiator in the tender, as all bidders will seek to maximise these points.

As illustration, the detailed break-down of the Dutch model in points/weighing and qualitative award criteria, including sub-criteria, can be found in Part 1 of this report, especially in Appendix B *Detailed scoring on criteria (the Netherlands).* The Dutch model (particularly model 3 and 4) stands out by its active use of qualitative award criteria to address nature and environment, sustainability, and system integration (including PtX and energy production) as discussed in the chapters above and with the modifications and caveats presented. Any direct application to a Danish context must be approached with caution as the weighing and use of criteria may detail differently in a Danish context.

Also, the new point/weighing models as introduced in Germany and Belgium, based on qualitative award criteria, may serve as illustration. The details of these models are presented in Part 1.

Table 6-1 Germany: A new 2023 points system.

No.	Criteria	Max. points
1.	Bid value [€]	60
2.	Quality:	40
2a.	Contribution to decarbonisation for offshore wind energy	10
2b.	Amount of energy produced	10
2c.	Noise emission during foundation installation and seabed area that is covered by the foundation structure	10
2d.	Contribution to secure skilled workers	10

Table 6-2 Belgium: The suggested scoring system.

	2-sided CFD outside of Nature 2000	Zero Bid out-side of Nature 2000	2-sided CFD inside of Nature 2000	Zero Bid inside of Nature 2000
Strike price	70 points	0 points	70 points	0 points
Energy production	0 points	0 points	5 points	17 points
Citizen participation	10 points	33 points	10 points	33 points
Local benefits	5 points	17 points	5 points	17 points
Sustainability and multi-use	5 points	17 points	5 points	17 points
Nature impact	0 points	0 points	5 points	17 points
Innovation and system integration	10 points	33 points	0 points	0 points

6.3 The impact of minimum requirements

An award model either based on price only or qualitative criteria, non-compliance with minimum requirements is grounds for disqualification. Minimum requirements are non-negotiable. For that reason, there will be no variation between the bidders on the basis of minimum requirements. They will simply comply or not comply on a pass/fail basis.

Minimum requirements will result in screening out potential bidders. Some bidders may not be able to document that their methods or suppliers comply with the requirement. As an example, bidders from outside EU may not be able to document that their equipment complies with EU regulation or similar regulation, if so required. In such cases, the impact of minimum requirements may be more indirect by reducing the number of bidders and thereby increasing the risk of strategic bidding/lower bidding.

It is important to assess the impact of imposing minimum requirements when defining the procurement strategy. It should be considered whether the set thresholds may limit or deliberately define the competitive field, whether it may limit the bidders' possibility for differentiating themselves (keeping in mind that such differentiation is further encouraged through competition where a model based on qualitative award criteria is chosen), and whether it may add cost to the project.

In a fast-track approach meeting the 2030 target, minimum requirements may prove beneficial in terms of minimising time and resources. Minimum requirements demand an effective, however often fast and simple verification process, whereas qualitative award criteria call for a refined evaluation process, which can be timely and carries a certain process risk as the evaluation may be subject for time-consuming challenges, complains, and review. If a fast-track approach is desired for an area already well-regulated, such as the environment in the Baltic Sea, it could be considered (as already is the case) to emphasise minimum requirements based on the stringent requirements following EU, HELCOM and national legislation, and deliberately include additional qualitative award criteria only in order to enhance competition, if and where so desired, for instance on the critical environmental parameters where market initiatives are desired, as presented in the Nature and Environment section above.

6.4 The impact of qualitative award criteria

By use of qualitative award criteria, the bidders should show off their individual strengths on more criteria than simply price. They also allow the tenderer to evaluate bidders on many different parameters and to choose a winner based on a balance between price/bid and other parameters. Regardless of the choice of procurement route, the qualitative award criteria and related evaluation model should encourage the bidders to present their optimal bids. The complexity of major-size renewable energy infrastructure projects addressing innovative solutions to green transition often even call for an active involvement of shortlisted bidders in the tender stage, such as based on competitive negotiation or competitive dialogue, where the bidders are encouraged and rewarded by providing competitive innovative solutions outranking their competitors.

Well-designed qualitative award criteria should lead to real competition amongst the bidders based on elaborated scoring allowing only the highest score for the most optimised solutions presented. If such real competition is not achieved, for instance if all criteria easily can be met by all bidders, there would be a risk for "maxing out" on all the qualitative parameters leaving price as the only competitive parameter.

In terms of project cost, qualitative award criteria may lead to a higher cost of energy for the project as compared to tenders based on price competition alone. In contrast to pure price competition, by widening the tender scope to also include qualitative parameters, it may be possible for the bidder, depending on the specific weighing involved, to compete successfully even though the price offer is not the lowest compared to the other bidders. A very low weighing of the price (say 20-30 per cent) may increase such risk for higher prices as it gives 70-80 per cent weight to qualitative criteria. In the other end of the scale (subject to state-aid regulation, where relevant), a too high weight on price may risk turning the tender evolution into a *de facto* price competition[8]. The upside of a higher price on energy may be that the project may contribute to economic benefits in other parts of society. This could be through improved marine environment, lower carbon footprint during construction, lower cost to the TSO, etc. The weighing and scoring of the qualitative award criteria are critical to ensuring that the trade-off between higher project cost and benefits to society are balanced properly.

In meeting the 2030 target and to attract the preferred developers, a tender process based on qualitative award criteria in a competitive field of more than five potential and eligible candidates may benefit by a prequalification stage in order to shortlist the eligible bidders. This has also been the Danish approach until now for most of the former offshore tenders[9]. A limited number of candidates will save time and resources and allow a focused approach on highly experienced and financially sound candidates only. To our experience, an open tender approach involving a high number of bidders requires significant time and resources in evaluating and managing the process; a process that can easily take long time. Also, the higher the number of bidders, the higher the risk for upsetting complains, reviews, and appeal processes. In addition, potentially valuable bidders may stay clear of bidding if the competitive field is too open from the outset, and if the actual number of participating bidders is too high. Too many players limit the winning chances compared to a narrow field of bidders. Also, participation in tender processes is costly. Applying for prequalification carries little costs whereas preparing for a tender is significantly more expensive. It follows that a

[8] See for instance https://cleverbuying.com/tender-evaluation-red-flags-7030-pqm-wasting-your-procurement-budget/

[9] Prequalification is used in 6 out of 8 tenders, see p. 12 at https://ens.dk/sites/ens.dk/files/Globalcoop- eration/the_danish_offshore_wind_tender_model_final.pdf

high number of participants in an open tender may discourage the individual bidders from investing the costs needed for producing a winner proposal.

6.5 Global competitiveness of Danish projects

This section reflects in brief and non-exhaustive terms over some of the main aspects related to the competitiveness of Danish offshore wind projects. As mentioned previously, the global market for offshore wind is growing rapidly which creates bottlenecks. This may allow developers to cherry-pick the best projects where the likelihood of making profit is highest, and where the developers successfully are able to manage the current challenges to various degrees, such as shortage of supplies, challenging lead times, rising prices and inflation, disruption of supply lines, pandemics, and global geopolitical unrest. As such, the bid decision for an individual project is not just a matter of price and profit as it also involves the risk of meeting a strict deadline for successful completion of construction and commissioning by 2030. These conditions need to be considered when designing a tender attractive for the market.

- As a starting point, Denmark is in a good position to attract eager bidders. The following is a non-exhaustive list of benefits of developing projects in Denmark:
- The wind resources are very good leading to a highly bankable project.
- The regulatory regime and risk regime are very stable. There is no risk of frequent changes to regulation endangering the project.
- Permitting is highly streamlined and a lot of data is already available. This shortens development time and reduces development cost.
- The pipeline of future projects/further market expansion is strong and committed. The developers and equipment manufacturers can see a business case in setting up local subsidiaries thereby lowering cost.

From this list, it should be evident that Denmark is in a position to attract highly motivated bidders. However, this good position can be compromised by designing an overly restrictive or risky tender framework, or by addressing unsuccessfully the current global challenges as mentioned above. The risk allocation should be fair and transparent. Timelines in terms of project implementation should be ambitious but realistic.

It is not within the scope of this report to further discuss the implications of the competitiveness amongst the global offshore wind industry, and how in best possible ways to attract sufficient and qualified market interest for the Danish offshore wind projects. However, it shall briefly be noted that competitiveness may call for a differentiated approach taking the local and regional characteristics into account. An offshore wind tender in the Baltic Sea may attract different interest amongst developers compared to an offshore wind tender in the North Sea. Besides the location itself and other characteristics dictated by the physical conditions, bidder interests may differ due to competitive advantages such as benefitting from the experience of operating already established own wind farms in the region, profiting from already established service and supply facilities (ports, vessels, staff resources, etc.), managing already established knowledge of local/regional regulatory schemes, and optimising the prospect of further business expansion in the same region, and other commercial factors. A differentiated approach may also be needed in order to strategically address the regional and local competition amongst owners and tender models in the region and to attract

and secure the interest of the preferred bidders to choose the Danish offshore project (in case the bidders prioritise which tender to go for in a region where two or more offshore projects are being tendered simultaneously). As such, a Danish tender model in the Baltic Sea region may call for competition against German, Swedish, Polish, etc. tender models, whereas in the North Sea regions such competition involves the Dutch and UK tender models.

6.5.1 Some concluding remarks - minimum requirements and award criteria

The findings of this chapter, together with the outcome of the chapters on sustainability, system integration, and nature and environment, provide inputs for a tender model based on pure price with possible minimum requirements and a model based on combined price and qualitative award criteria. The specific design of the latter based on points and weighing applied is determined by a detailed political, legal, and economic exercise. As such, no exact off-the-shelf generic model applies as the points award and weighing must reflect the political and economic objectives of the contracting authority. Further, it must be ensured that the trade-off between possible higher project cost and benefits to society are balanced properly. Also, when applying qualitative award criteria, and to ensure the optimal playing field, COWI can relay the Confederation of Danish Industry's (DI) viewpoint of August 2022, as mentioned in the sustainability chapter 3.4: "DI recommends that an evaluation concept be established that includes qualitative requirements that weigh to such an extent that it can affect the ranking of bids. Regardless of the method and the design of the scoring system, it is crucial that evaluation criteria are fully transparent for bidders, so that it is possible to optimize the bid submitted based on the state's wishes for price, innovation, sustainability, and social conditions, etc."

As such, the pros and cons presented in the sections and chapters above on the specific minimum requirements and qualitative award criteria serve as inspiration and as a catalogue when formulating the detailed tender model for the upcoming OWF. By use of a deliberate mix of stringent minimum requirements and qualitative award criteria, it is possible to enhance competition and raising the bar for protection of the nature and environment to stimulate sustainability and to promote optimal system integration.

Also, the foreign tender models as presented in Part 1-report are inspirational. The comparative study of tender models in other countries shows that several of these countries already have, or are about to introduce, a tender model based on qualitative award criteria and not just price award only. This is the case of the Netherlands, Germany, and Belgium as presented in detail in Part 1-report. Especially the Dutch model (particularly model 3 and 4) stands out by its active use of qualitative award criteria to address nature and environment, sustainability, and system integration (including PtX and energy production) as discussed in the chapters above and with the modifications and caveats presented. Any direct application to a Danish context must be approached with caution as the weighing and use of criteria may detail differently in a Danish context. In this context, from the market feed-back we take note of a clearly expressed interest for a tender model based on qualitative award criteria and not just award based on price only.

It follows from the sustainability chapter that sustainability measures can be introduced as both minimum requirements and award criteria. As seen in the Netherlands for inspiration, minimum requirements and qualitative award criteria can also be applied in combination to motivate a more ambitious level of sustainability in the tender. Some of the mature qualitative award criteria stated in the chapter may come in play, and some degree of certainty could possibly be achieved by negotiations with the bidders during the tender process.

Nature and environment may use a mix of minimum requirements and qualitative award criteria, as detailed in the section. Monitoring and data gathering should be based predominately on minimum requirements.

Regarding system integration, it is found that innovative system integration only to a minor extent can be adopted timely in the 2023 OWF tender as such detailed tender design may prove difficult within the 2030 target. However, we take note of a significant expressed interest by the market in addressing system integration by qualitative award criteria at least in the long term.

The short time horizon of 2030 may raise concerns for introducing a time-consuming and/or innovative tender design deviating from the up-to-now preferred Danish tender model for offshore wind based on price competition. Any deviation from the tried-and-tested approach (e.g., as applied lately for the Thor offshore tender) may result in a need of further time and resources for both industry and authority in preparing for an upcoming tender and managing the tender process. As outlined in the chapter on system integration, the 2030 target may be compromised if the tender shall include a promotion of innovative system integration. As also described, the involvement of qualitative award criteria related to system integration and the establishment of a sound business case require further certainty in terms of the development of the relevant future infrastructure, which calls for overall national and regional planning and most likely the involvement of further political processes and regulatory reforms. Without such certainty, it may prove difficult for the industry at the current stage to commit to solutions and to respond to any related binding requirements. However, the chapter indicates that elements of system integration may be addressed in the coming tender model based on award criteria, finding inspiration in the Dutch and German tender models, although, as described, the overall benefits of such inclusion may be limited.

As argued in the system integration chapter, on a longer term, competition should be based on the qualitative award criteria on optimized solutions (e.g., by delivering power to the grid and/or to PtX facilities and similar avenues) in parallel to the development of the needed infrastructure. When defining such qualitative award criteria, the developer could be awarded according to the innovative nature and the risk allocation involved from a commercial and business perspective. As for any tender requirement and award criteria defined, it is important that such requirements and criteria and the evaluation methodology hereof are clearly formulated and do not give cause for any uncertainty in scope and terms. The related point systems as applied by the Netherlands, Germany, and Belgium may serve as illustration for including system integration on such overall terms in the long term.

4

APPENDIX A: Questionnaire

APPENDIX A - QUESTIONAIRE

The five pillars	Indicator	Description/question
Sustainability (lifecycle evaluation, CO_2)	**Sustainability**	How does your company see that sustainability can be integrated in the tender evaluation criteria? Which sustainability criteria (e.g. commitment to UN Global compact, carbon footprint, Environmental product declarations and life cycle assessments) should be implemented (if any), and should it be minimum requirements only or qualitative and quantitative criteria? How should the follow-up be on these criteria during the lifetime of the project?
System integration	**System integration with PtX**	Integration with PtX has several benefits, which include that there is a less need for electrical backbone grid capacity, there will be reduced losses (when placed offshore) and it will provide export potential to other countries of PtX green gasses products etc. How can integration with PtX projects be specifically implemented and integrated in the tender model and the evaluation criteria, respectively? What is your experience and preferred arrangement in respect to offering system stability support services to the TSO?
Innovation (techno-economic)	**Innovation**	What experiences do your company have in describing new or alternative technical/economic solutions in connection with making offers for projects? How have alternative solutions been included/evaluated in tenders? What experiences do your company have in involving universities or other educational institutions right from the start of projects? or involving universities or other educational institutions for concrete tasks on projects?
Economics (auction, risk picture, global	**Pricing model**	Different pricing models are used in different countries / markets. Which pricing element(s) should be used in the tender model? How would you see a pricing model for concession(s) areas in DK would look like? Do you see other pricing models could be applied (i.e. other than pricing for concession(s) areas)?

competitiveness, cost of criteria)	**Tender model and process**	Which tender model does your company see as the tender model that works the best and motivates your company's bid submission? Please give reference to an actual tender model and/or describe the model that fulfils it. Can this model be further improved? How? Would you prefer tender processes involving negotiation or competitive dialogue, prefer tenders based on prequalification, and/or do you prefer open tenders? Do you prefer a one or two-stage tender process (e.g. a two-stage approach as applied in UK)
	Permit and granting process	How do you see the permit and granting process in relation to the tender process? Can the permit and granting process be improved to optimize time and costs? Can you see possibilities for changing the responsibility for different parts of the permit processes in a different way between the parties/stakeholders? Would you be willing to accept (more) own risk related to studies, investigations and assessments needed to fasten processes and award of contract?
	Tender size (GW) and determination of location of site(s)	What is the optimum size (in GW) of each project included in the Tender in terms of optimization with regard to cost, time schedule and integration with PtX projects? Should the Tender include multiple projects or option for multiple phases from a single developer? Should selection of the actual location of the wind farm site(s) be determined by the developer or by DEA?
	Open Door	As an additional mechanism, can the Open Door model be used to accelerate offshore wind in Denmark and how should this model look like in this case going forward?
Nature and the environment	**Nature and the environment**	How do you believe Nature and Environment can be evaluated in a future tender model? Does it apply only as minimum criteria? How can innovation be integrated into Nature and Environment in a future tender model? Should the nature and environment requirements be site specific or general? How do you envision the improvement of biodiversity in a specific area?

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