AFRY
ÅF PÖYRY

Offshore wind roadmap for Åland

A REPORT TO ÅLANDSBANKEN AND HELEN

DECEMBER 2021

About this study

This report has been prepared by AFRY Management Consulting in fall 2021 for Ålandsbanken and Helen.

Ålandsbanken has been a forerunner in launching green initiatives such as the Åland Index, the first carbon footprint tracker based on bank card transactions. Ålandsbanken has a strong local presence in Åland and wish to promote and sponsor renewable development in the Åland region. Ålandsbanken Funds launched the first Finnish open-ended fund investing in wind power, Wind Power Fund, in 2020 and is currently planning to set up a new fund focusing on offshore wind power.

Helen and the city of Helsinki have a target to become carbon neutral by 2030, with wind power being a fundamental part of Helen's strategy. Helen is currently taking significant steps towards reaching the goal of a carbon-neutral energy system, wind power being key in the move to zero-emissions electricity production. Helen is investing heavily in wind power and other sustainable energy solutions, and is creating an ever cleaner, more flexible and smarter energy system for the future.

Purpose of the study

Åland is institutionally going through the process of defining its approach to offshore wind.

Åland has a range of strategic options it can follow to realize the value and benefits that the potential offshore wind industry beholds. This study identifies and evaluates the choices Åland has in developing an offshore wind sector and creates an understanding of the value it could bring to the island.

This report is intended to be used to support discussions and dialogue with policy makers and other stakeholders in establishing an Åland specific approach to offshore wind.

AFRY team

AFRY's core project team for the study has been the following:

- Esa Holttinen, Business Director, Wind Power at AFRY – lead sector expert in the study with over 25 years' experience of wind sector as business developer, business manager, project developer and technical expert in the Nordics and global markets.
- Oliver Pearce, Senior Principal, project supervisor of the study with over 10 years of experience supporting clients in the Nordic energy sector with a focus on wind.
- Joel Sarasti, Consultant – project manager of the study with several years of management consulting experience in the Nordic energy sector with a focus on wind.
- Sini Toivola, Analyst - has experience from wind projects through transactions, market studies and strategy work.

All views presented in this report are AFRY's.

Acknowledgements

Stakeholder interviews were an integral part of the study. AFRY interviewed some 40 experts from a variety of stakeholder organisations as follows:

- Project developers, including both global and Nordic focused developers: senior executives (e.g. lead developer, senior developer, investment manager).
- Transmission system operators: head of grid development and grid manager from Fingrid, Svenska Kraftnät and Kraftnät Åland.
- Ministries: representatives from Finland and Åland ministries.
- Augusta & Co for providing their insights and support from a financing perspective.

AFRY would like to extend our warm thanks to all participants who gave their time to the interviews conducted in this study.

Key Messages

Opportunity and value of offshore wind

A strong offshore sector would create material economic benefits to Åland and position the island among key suppliers of green electricity, and in the long-term possibly hydrogen, for decarbonising industries in the Baltic Sea region.

Decarbonisation targets in the Nordics will require unprecedented amounts of renewable electricity, while the **expected cost development and scale of offshore wind positions the technology and Åland in a prime position** to address the growing offtaker demand.

Key challenges for offshore wind in Åland

Åland faces many challenges with offshore wind, which require an unique approach to sector development.

- Scale of the offshore sector (6-10GW) is well beyond Åland's domestic demand base for electricity (<0.1GW) and therefore a solution is needed for exporting the electricity.
- Åland has very limited capability to financially support the sector or provide revenue stabilisation mechanisms.
- Most governments in Europe have taken a central role in the offshore sector with having i) a government backed revenue stabilisation mechanism in place and ii) notable institutional capacity from e.g. TSOs and permitting authorities to support the sector – both pillars are missing in the Åland context.
- At the same time, neighbouring markets in Finland and Sweden have seen an increasing interest in offshore wind, raising the threat of competition and time pressure.

Recommended approach to offshore wind

A decentralised approach to offshore wind would be a good fit for Åland at this stage - Åland should aim to leverage developer competences to maximise competitiveness of offshore wind while maintaining control of key decision points.

- Developers would be responsible for wide range of development scope from site selection to developing and building the grid connection and securing offtake arrangements. This would enable developers to optimise project competitiveness. Åland would facilitate the development process by removing obstacles to developers. Åland would remain in control of key decision points e.g. granting site leases, approving developers and permits.
- Under the decentralised approach, as Åland would leverage the expertise of developers in solving the challenges, the scheme would be faster to implement with a lower institutional capacity investment requirement and administrative burden.

By allowing experienced developers to find the most feasible designs and solutions, and closely interacting with them, Åland would incorporate learnings from developers and improve its capabilities to support the continued growth of its offshore wind sector.

Introduction

Current situation

Offshore wind is an opportunity for Åland. Build-out of the full offshore wind potential would position Åland as one of the key enablers of decarbonization in the Baltic-Nordic region and create annual revenue streams in the order of hundreds of EUR million for Åland.

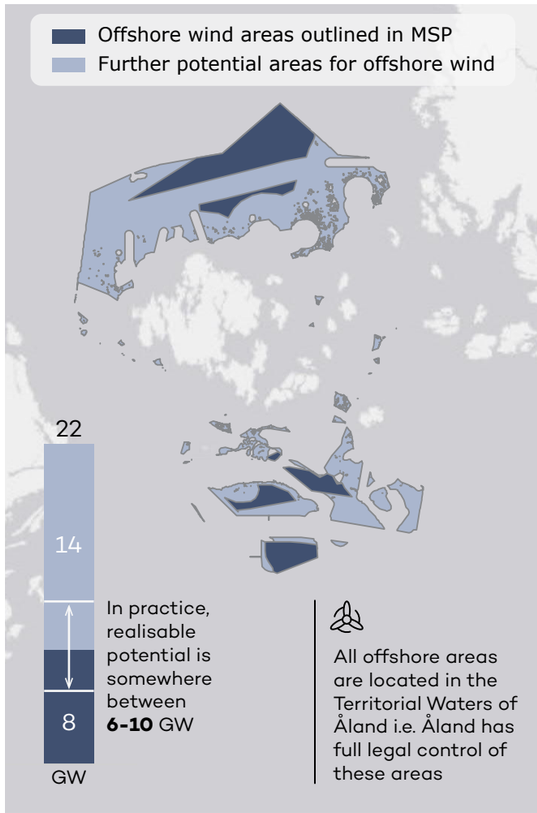
Natural conditions in Åland are generally seen as well suited for offshore wind; wind resources are good in the Baltic-Nordic context, and water depth and seabed soil conditions convenient for offshore wind. Åland also has less severe ice conditions compared to for example Northern Gulf of Bothnia.

Åland has a maritime spatial plan (MSP) in place, which defines potential zones for wind energy production. Offshore wind areas outlined in MSP alone allow for some 8GW of offshore wind capacity. There are also areas beyond MSP well suited for offshore wind sites, increasing the theoretical potential to c. 20GW. In practice, the realisable potential is likely in the range of 6-10GW (Figure 1).

Åland's location between Finland and Sweden – two markets with industrial sectors expected to require significant volumes of green energy to achieve carbon neutrality targets – provides offtake opportunities.

The offshore wind industry in the northern Baltic Sea is showing signs of development from a low activity stage, as suggested by the large volumes of grid connection applications received by Fingrid (20GW) and Svenska Kraftnät (120GW).

FIGURE 1 - OFFSHORE WIND POTENTIAL IN ÅLAND



Challenges

Åland faces unique challenges with offshore wind:

- Scale of the offshore sector (6-10GW) is well beyond Åland's domestic demand base for electricity (<0.1GW) and therefore a solution is needed for exporting the electricity.
- Åland's ability to support projects directly e.g. through feed-in-tariffs and/or other revenue stabilisation mechanisms is very limited. Furthermore, Åland has limited institutional capacity from government, permitting and TSO perspectives to support the sector. In addition, the target offtakers are located in the neighbouring markets.
- The offshore wind supply chain in the Northern Baltic Sea is currently underdeveloped and first projects in Åland will likely face more lead time and cost risk.
- At the same time, neighbouring markets have seen increase in offshore wind interest raising the threat of competition and time pressure.

The key challenge for Åland offshore sector:

- How should Åland leverage its strengths to convince developers to commit significant development expenditure in Åland offshore wind?

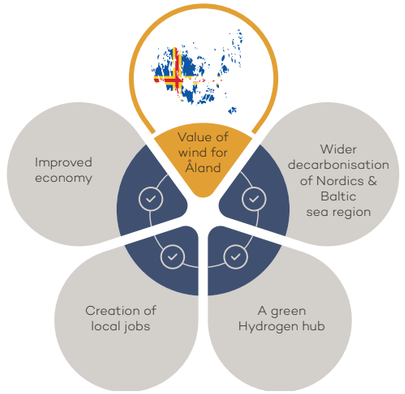
Value of offshore wind for Åland

Åland is in control of its territorial waters with realisable potential of some 6-10GW offshore wind. Establishing a wind sector of this scale would not only have material benefits for the economy of Åland, but would also position Åland as a key player in enabling and accelerating the decarbonization of the Nordic industry.

More concretely, Åland could expect to achieve the following benefits with the offshore wind sector in the long-term:

Improved economy through multiple revenue streams from the offshore industry. These revenue streams comprise of property and corporate taxes, site leases and possible developer licenses. Additional possible revenue streams could comprise of returns from development investments and dividends from ownership shares of project companies. Site leases, property taxes and assumed local O&M income alone could amount to annual revenues in the order of 200 EUR million for Åland (Figure 2).

Creation of local jobs supporting the offshore industry. Developing some 8GW offshore wind would result in direct investments in the order of 15-20 EUR billion to Åland. It is realistic to assume that the supply chain for delivering these investments such as ports, assembly hubs and installation vessels would be developed and shared together with the wider offshore market area of the Northern Baltic Sea. However, some parts of the value chain are likely to be sourced locally from Åland. For example, offshore wind projects require operational and maintenance personnel, which are typically the most appropriate for localization. The share of locally sourced supply chain is expected to grow as the sector size increases.

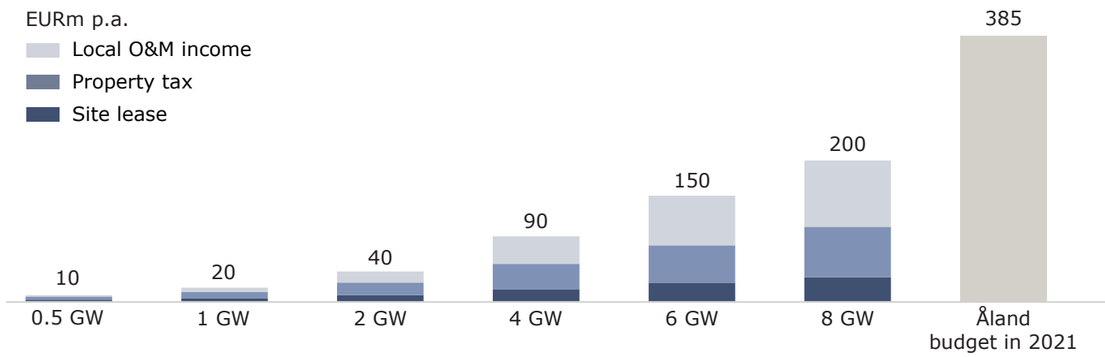


Supporting the wider decarbonization of Baltic Sea region. Åland offshore wind would become one of the key energy resources enabling decarbonization of the Baltic sea region, fuelling the transition with green electricity and in the longer term, possibly hydrogen. Electricity would be exported to Finnish and Swedish markets in the first stages. Export routes via a Baltic sea offshore grid may become a possibility in the 2030's and 2040's.

Potentially becoming a green hydrogen hub in the Baltic Sea area. Åland could use a share of electricity generated by offshore wind for the production of hydrogen and E-fuels i.e. higher refined products from hydrogen. These fuels could for example be used to fuel the maritime transport sector within and around Åland. As an island, the economy of Åland is strongly founded on imports and exports through its ports.

A ambitious, but achievable, target for Åland would be to install some 6-10GW of offshore wind capacity during the 2030's. Decarbonisation targets in the Nordics, e.g. Finland's target of 2035, will require unprecedented amounts of renewable electricity, while expected cost development and scale of offshore wind positions the technology and Åland in a prime position to address the growing offtaker market.

FIGURE 2 - ILLUSTRATION OF ANNUAL REVENUES TO ÅLAND AS A FUNCTION OF OFFSHORE WIND SECTOR CAPACITY



Key assumptions: O&M income is based on high-level assumption of 10-30% of annual O&M costs being directed to Åland – share growing gradually as capacity increases. Property tax has been estimated for illustrative purposes by applying current tax model in Finland. Site leases are based on high-level assumptions of 2% of revenues and 40 EUR/MWh as revenue basis.

Offshore wind roadmap

The process for setting up the Åland offshore sector comprises of four discrete stages as follows:

1. **Setting vision and strategy**
Åland should set a vision with explicit capacity targets and timeline. A strategy is needed to define Åland's approach to achieve the vision. Key decisions within the strategy include defining the institutional role and involvement in the sector. The vision and strategy should convince the market of the seriousness towards offshore wind.

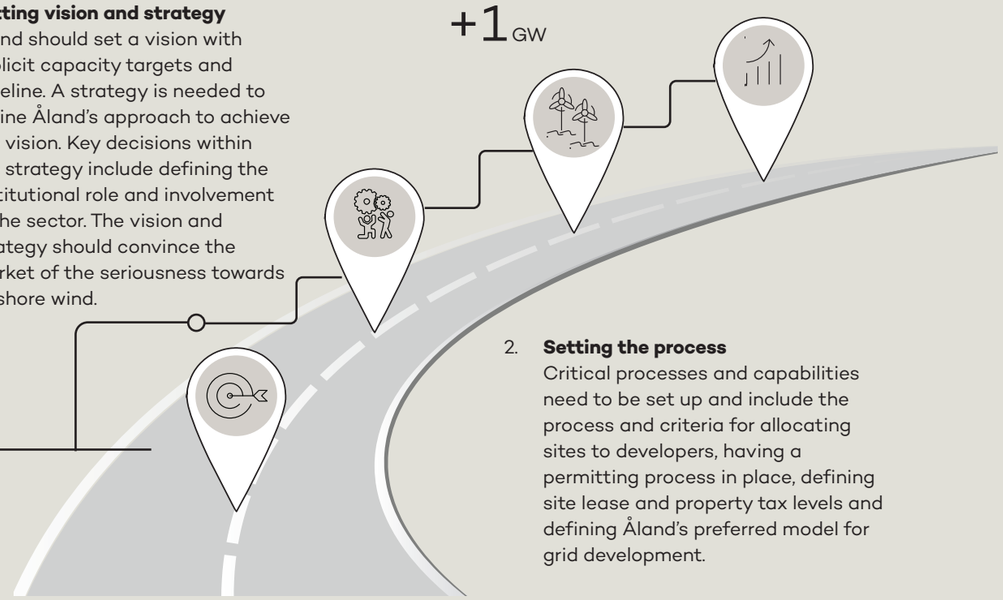
2. **Setting the process**
Critical processes and capabilities need to be set up and include the process and criteria for allocating sites to developers, having a permitting process in place, defining site lease and property tax levels and defining Åland's preferred model for grid development.

3. **Developing first sites**
A phased approach to sector growth is seen as the most feasible route for Åland. Allocation of development responsibility between Åland and developers is subject to choices defined in the strategy and approach.

+1 GW

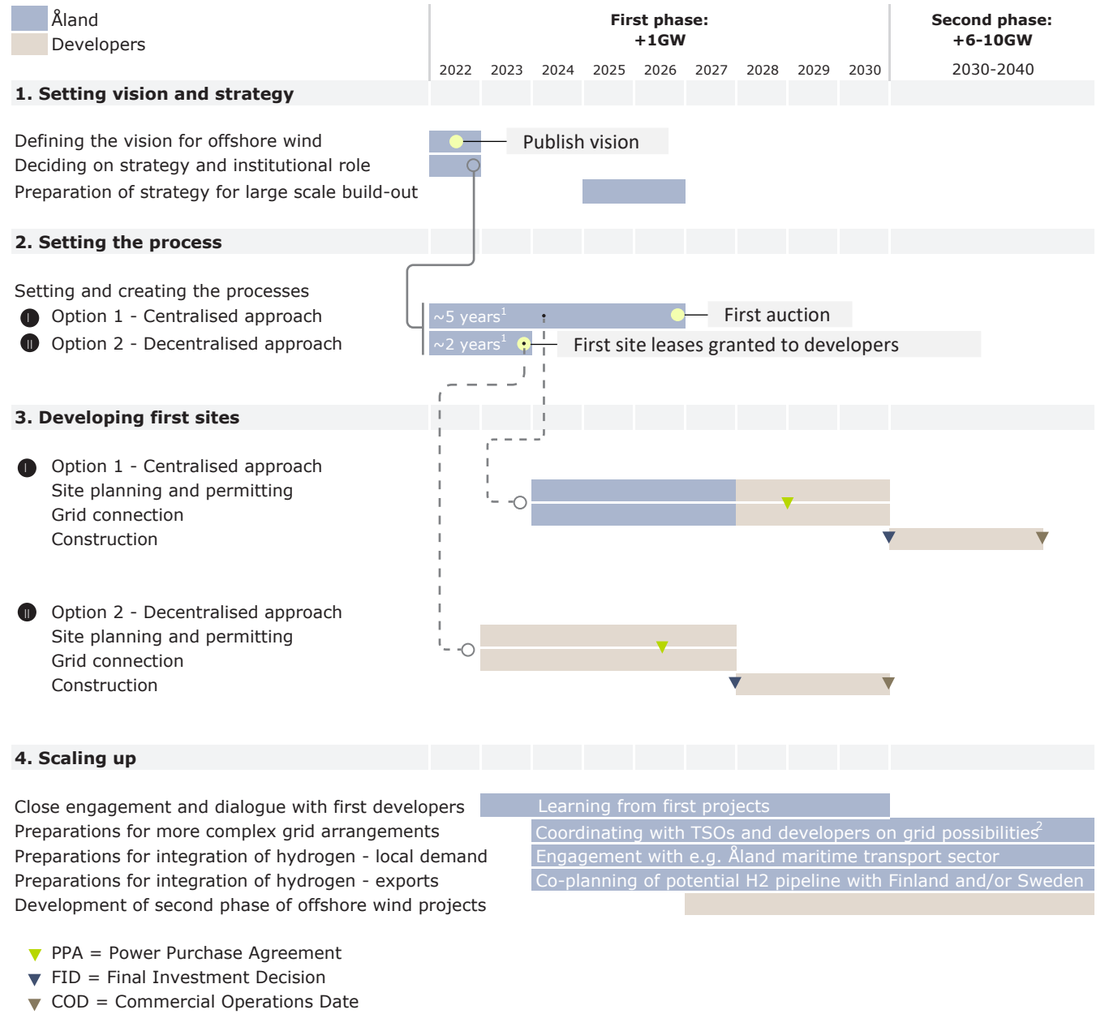
4. **Scaling up**
Fulfilling the long-term vision may require more complex solutions for integrating large volumes of wind generation to the Nordic-Baltic markets. Elements such as hydrogen and E-fuels, and grid connections to Finland, Sweden and Baltic offshore grid could all be part of the long-term vision.

+6-10 GW



The offshore wind roadmap for Åland is presented in Figure 3

FIGURE 3 - OFFSHORE WIND ROADMAP FOR ÅLAND



▼ PPA = Power Purchase Agreement
▼ FID = Final Investment Decision
▼ COD = Commercial Operations Date

Setting the process:
Creating a process for selecting and pre-investigating sites
Creating a process and selection criteria for allocating site leases to developers
Setting a framework and calculation methodology for site lease and property tax
Defining the preferred approach for allocation of development and cost responsibilities of grid connection
Creating a (streamlined) permitting process for offshore wind projects

[1] High-level view on possible timeline
[2] TSOs: Fingrid, Svenska Kraftnät, Elering, Kraftnät Åland

1. Setting vision and strategy

As the very first step of setting up the sector, the Åland government should define a vision for the offshore sector. The vision should include an explicit capacity target and timeline.

The vision is intended to communicate a strong message to the market of i) the seriousness of Åland about the sector development and ii) that the plan is backed by political support.

Showcasing institutional commitment to the sector can take many forms, crucially also beyond financial support. Committing to being actively in close dialogue with developers and addressing the industry needs are all means to increase attractiveness of Åland market towards developers. Examples of support include supply chain infrastructure such as ports, workforce training, easy to navigate authority interaction and general willingness to support the sector to overcome challenges along the project development phases.

Convincing the market is important because development expenditure during a single offshore project is easily in the order of tens of million EUR; therefore developers require a level of certainty to provide comfort around investments in project development.

A clear and stable market environment backed by government support is seen to reduce developer risks for initiating early planning work. A strong expectation of project pipeline is important to sustain locally set-up development teams. The Åland pipeline alone may be unable to sustain multiple large developers and therefore developers are expected to look at the Baltic-Nordic market region and pipeline as a whole.

Recommendation:

- Publish a capacity target for 2030 e.g. 1 GW
- Publish a long-term target for 2040 e.g. 8 GW
- Publish a roadmap on how Åland plans to achieve the targeted pipeline

2. Setting the process

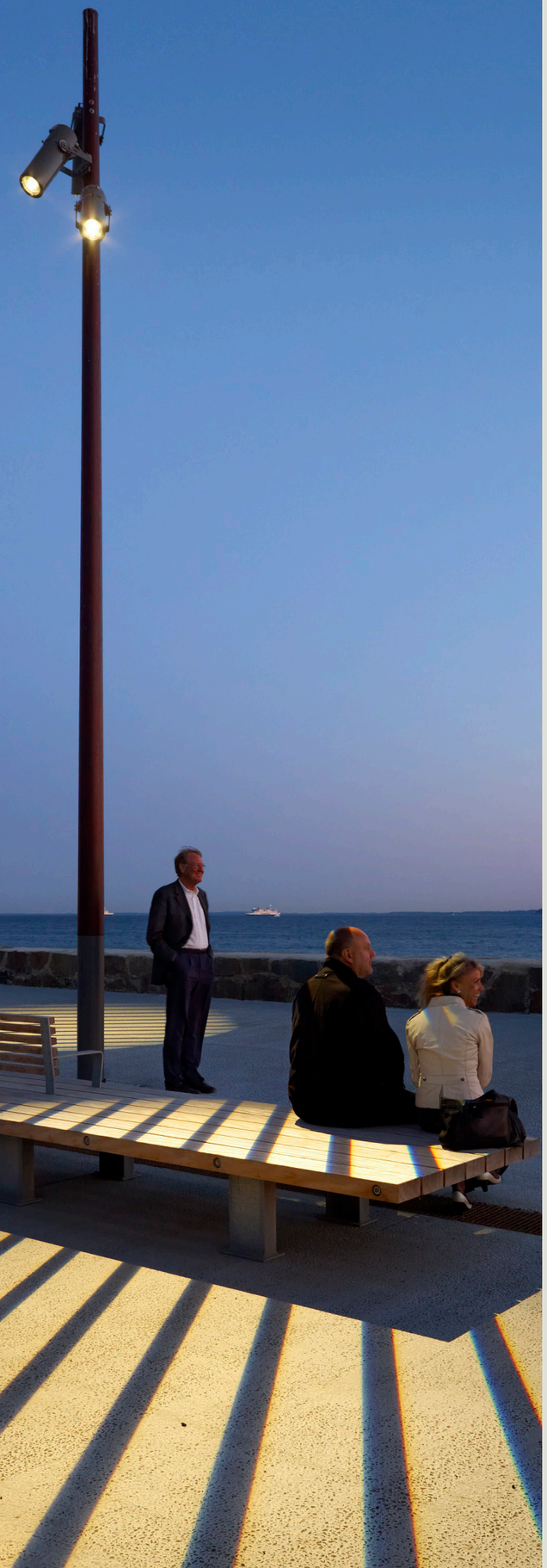
A number of pillars need to be in place to enable development and construction of offshore wind projects in Åland. How these pillars are built and combined defines the development scheme for Åland and also determines how responsibilities, costs, risks and value are shared between Åland and developers. Key actions within the development scheme are summarized in Table 1.

There are two interlinked themes that Åland should address in the approach:

1. **Institutional involvement of Åland.** The strategy routes for Åland can be broadly categorised into a *centralised or decentralised* approach. In practice, there can be varying degrees of institutional involvement within different elements in the scheme.
2. **Targeted timeline and trajectory.** The expected timelines for setting up the schemes for centralised and decentralised approach are different. For example, an auction-based scheme requires notable preparatory work ranging from pre-development of sites to defining auction methodology and rules etc. Hence, the decision on approach sets the whole sector on different development trajectories and timeframes. Åland's approach for sector development should be aligned with the timeframe it is targeting, while also considering the development and timeline of the wider Baltic Sea region offshore wind sector.

TABLE 1 - KEY ACTIONS AND DESIGN OPTIONS IN ÅLAND DEVELOPMENT SCHEME

THEME	KEY ACTIONS	OPTIONS
Site selection and allocation	Defining a process and responsibilities for selecting and investigating sites	– Centralised approach: investigating and splitting the seabed area into sites is centrally led by Åland government – Decentralised approach: developers independently screen and define sites they wish to develop
	Defining a process and selection criteria for allocating site leases to developers (Criteria may include for example rights and obligations attached to lease, local content requirements, revenue sharing and other commercial terms etc.)	– Centralised approach: site leases are granted through an Åland led process e.g. auction. Further decisions include the scope of what is being auctioned e.g. generation and/or transmission and the development stage of the site e.g. preliminary measurements at sites or partially permitted. For the auction process to be successful the sites should be pre-developed to lead to a competitive auction with several credible and experienced bidders – Decentralised approach: Site leases are granted following an "Open door" approach, where developers apply for leases on sites they have investigated and defined – Combination of the approaches: for example Denmark has made both routes possible for developers
Site lease and property tax	Setting a framework and calculation methodology for site lease and property tax	– In general, the combined cost level of the two should be set competitively in the Nordic-Baltic context
Revenue support scheme	Making the political decision whether the offshore sector will be founded on a subsidy scheme or will the sector be built on a merchant basis	– Subsidized scheme: scheme defining the subsidy structure, payment duration and overall support level. Different variations of Contracts for Difference (CfD) are the most commonly applied structure in offshore sectors across Europe – Merchant scheme: no government based subsidy scheme in place. Developers find revenue stabilisation mechanisms e.g. Power Purchase Agreements (PPAs) from the market
Grid arrangement model	Defining the preferred approach and model for allocating responsibilities and cost of grid connection arrangements for offshore projects	– Super-shallow model: developer is responsible for development and costs of connecting wind farm to offshore connection point – Shallow model: developer is responsible for development and costs of connecting wind farm to onshore connection point – Deep model: developer is responsible for development and costs of connecting wind farm to main grid and related grid re-enforcements
Permitting process	Creating a streamlined permitting process for offshore wind projects	– A one-stop-shop model has been recognised as being efficient and appreciated by developers for being easy to navigate through. All authority interaction is through one authority



The objective of Åland's strategy for offshore wind should be to increase the market attractiveness for developers. Åland's agility in political decision making is considered its key institutional strength, while limitations in institutional resources and capabilities relevant to the offshore industry are seen as key weaknesses. Åland's resource and capability profile should be considered when evaluating the best fit approach.

There are trade-offs between centralised and decentralised approaches, which should be considered when defining the role of Åland within the development scheme.

Centralised approach

The centralised approach would have the main advantage of providing Åland with a high degree of control over sector development.

- Åland would have full control over defining site locations, deciding when and how to lease sites, and have control over selecting developers either through quantitative or qualitative criteria.
- Leasing of centrally pre-developed sites could also allow for higher returns for Åland via site leases or other mechanisms such as development licenses.
- All of more advanced offshore sectors in Europe have followed some variation of the centralised approach. This originates from technology costs necessitating a state-backed support scheme to set sector growth in motion as a means to meet RES targets - this is not the case for Åland and Nordics today.

The disadvantages of the centralised approach in the Åland context are related to resource and timeframe implications:

- The scale of the offshore sector is considered to be well beyond Åland's financial capacity and therefore revenue subsidies or grid cost socialization are not realistic options. It is realistic to assume that projects are most likely to be financed via PPAs, a decentralised concept.
- The ability to optimise the project envelope is an important value lever for developers. There is a risk that Åland pre-selecting sites would remove this value lever from the control of developers thereby limiting the potential upside developers would add to projects.
- A centralised scheme comes with a significant administrative burden to Åland. The time to build the institutional capabilities will be significant in terms of resources and timeframe, which counts against Åland's ability to make efficient political decisions as a means to move ahead of offshore wind developments in neighbouring markets.

Decentralised approach

The decentralised approach has the main advantage of enabling Åland to use the expertise of developers to optimise project competitiveness and drive offshore wind forward quickly while still retaining control over the key decisions related to permitting and leasing. The model could also mean that projects would have different owners, with developers in the initial stage then selling projects to larger developers at the stage when significant financing would be required for site specific investigations.

The main advantages:

- Enabling project developers to fully optimise the project envelope would promote their ability to create value and improve general attractiveness of Åland offshore sector.
- Enable Åland to better leverage the expertise and capabilities of developers in finding solutions to the challenges of progressing offshore projects, especially in the early development stages, while also implying a relatively low institutional and cost commitment to test if offshore wind will work in the Åland context.
- From an administrative perspective, the scheme could be implemented faster and with fewer administrative resources compared to a more centralised alternative.
- If well designed, would still enable Åland to keep control of the main decision points and e.g. award sites or permits on a total value basis.

Disadvantages of the decentralised approach include

- Giving up some degree of control and thereby limiting ability to centrally coordinate.
- Decentralised approach exposes developers to a higher level of development risks. Developers that do take the risk to drive projects forward would likely expect a higher return.

A decentralised approach is seen as a better fit for Åland at this stage, given its institutional resource and capability profile. Åland should aim to leverage developer competences while still maintaining control of key decision points to ensure offshore wind is developed in an efficient and effective manner.

Åland offshore development scheme may be adapted along with changing market environment and requirements. For example, sector upscaling may introduce new challenges that require different degree and type of institutional involvement.

Recommendation:

- **Site selection and allocation:** Deployment of a decentralised approach is considered the fastest route to establishing an offshore wind sector in Åland and leverages on the capabilities of developers for selecting sites. A process and selection criteria for allocating site leases to developers needs to be defined.
- **Site lease and property tax:** Methodology and rates for property tax and leases need to be defined. Level of property tax and site lease should be set at a competitive level in the Baltic Sea context as over-pricing may diminish attractiveness of the market. Finland is reviewing its property tax on wind sites and the general development of this process is recommended to be followed.
- **Revenue support scheme:** Merchant based scheme where developers find PPA offtakers is seen as the only realistic option for Åland.
- **Grid arrangement model:** Responsibility and costs for developing grid connection should be appointed to developers. Kraftnät Åland is not in a position to finance the scale of network infrastructure required and furthermore, would have limited involvement in the process of radially connecting projects directly to Finland or Sweden.
- **Permitting process:** Åland has a permitting process in place which is yet to be tested for offshore projects. There is an ongoing review of streamlining the process. A one-stop-shop could reduce permitting lead times, reduce project risk and increase attractiveness of the market. However, the effort of creating a one-stop-shop is expected to take time and may be challenging to implement in the short-term.

3. Developing first sites

Grid connection is one of the key design choices in the development of offshore wind projects in Åland.

Offshore wind is founded on economies of scale and projects are typically dimensioned in the order of 500-1000MW. Åland has peak demand of around 80MW which is insufficient to sustain offshore projects. Offshore generation has to be exported and the first projects have the option of connecting to either Finland or Sweden power grids.

An illustration of possible grid connection arrangements is presented in Figure 4. Locations of potential onshore connection points in Finland and Sweden have been selected on the basis of the local network being generally strong enough to sustain connections in the range of c. 1GW. As illustrated in the figure, offshore wind site substations could be either i) constructed offshore and connected to main grid of Finland or Sweden or ii) constructed onshore at Åland and connected from there to Finland and Sweden.

Competition is expected to these connection points from other offshore projects. Fingrid and Svenska Kraftnät (SVK) have received some 20GW and 120GW of connection applications for offshore wind farms, respectively.

Connecting to Finland is expected to be a more viable option until the mid-2030's, despite connection points in Sweden being located closer to potential wind site areas in Åland. Connecting offshore projects to Sweden market prior 2033-2035 is challenging according to SVK. This is due to backlog of transmission grid strengthening investment in Sweden. However, timeframe constraint of connecting offshore projects to Swedish market is fundamentally a resourcing issue which could be resolved with sufficient political support to reform the process of grid development.

Åland offshore projects are not expected to receive financial support for grid connections from either Finland or Sweden. Sweden has recently (10/2021) announced transitioning to a scheme where the TSO (SVK) covers grid connection costs for projects located within territorial waters of Sweden. Finland does not have such a scheme in place and all costs are allocated to the developer. The Finnish Ministry of Economic Affairs and Employment (TEM) indicated that a review on wind sector grid connection arrangements will take place around 2025. No significant changes to grid connection cost allocation is expected in Finland.

Recommendation:

- Developers have a wide range of grid connection options. Allowing developers to find the most feasible solutions for grid connections is seen to improve the general market attractiveness of Åland. Any set requirements should be avoided.

The capital requirement in the late development phase can be managed with developer's own equity, external equity e.g. from a strategic partner and/or short-term debt financing. Securing PPAs at a relatively early project development stage will likely be fundamental for Åland offshore projects.

Illustration of offshore wind development expenditure (DEVEX) profile and typical means of financing are presented in Figure 5.

Offshore wind projects require notable cash expenditure already in the development stage, typically in the order of tens of EUR million. The late development stage is particularly cash-intensive due to the need for location specific assessments e.g. drilling investigations of the seabed at each turbine location.

Depending on developer's financial resources and preferences, the later development phase may be financed either by developer's own equity, partnering with external equity provider, or by debt. Some developers may choose to sell the project at this phase to other developers with the resources to take project further to construction and manage the increasing project costs.

In other European markets, the offshore industry is supported by state-backed revenue support schemes. Åland does not have the resources to finance such schemes and therefore the offshore sector will need to find merchant based solutions such as PPA offtake agreements. In comparison to onshore wind, PPA offtake agreements for offshore wind differ both by the volume scale and timing, with offshore PPAs expected to be agreed earlier in the process.

Prospects for potential PPA offtakers are generally considered positive, as Åland is located in between two markets where electrification of industry sector and envisaged growth of hydrogen economy are expected to increase demand for electricity.

However, offshore wind PPAs will compete in the market against other renewable generation, most importantly Nordic onshore wind. At present, offshore wind costs are still expected to be positioned at the high-end of onshore wind LCOE range (Levelised Cost of Energy) compared

FIGURE 4 – ILLUSTRATION OF POSSIBLE GRID CONNECTION ARRANGEMENTS

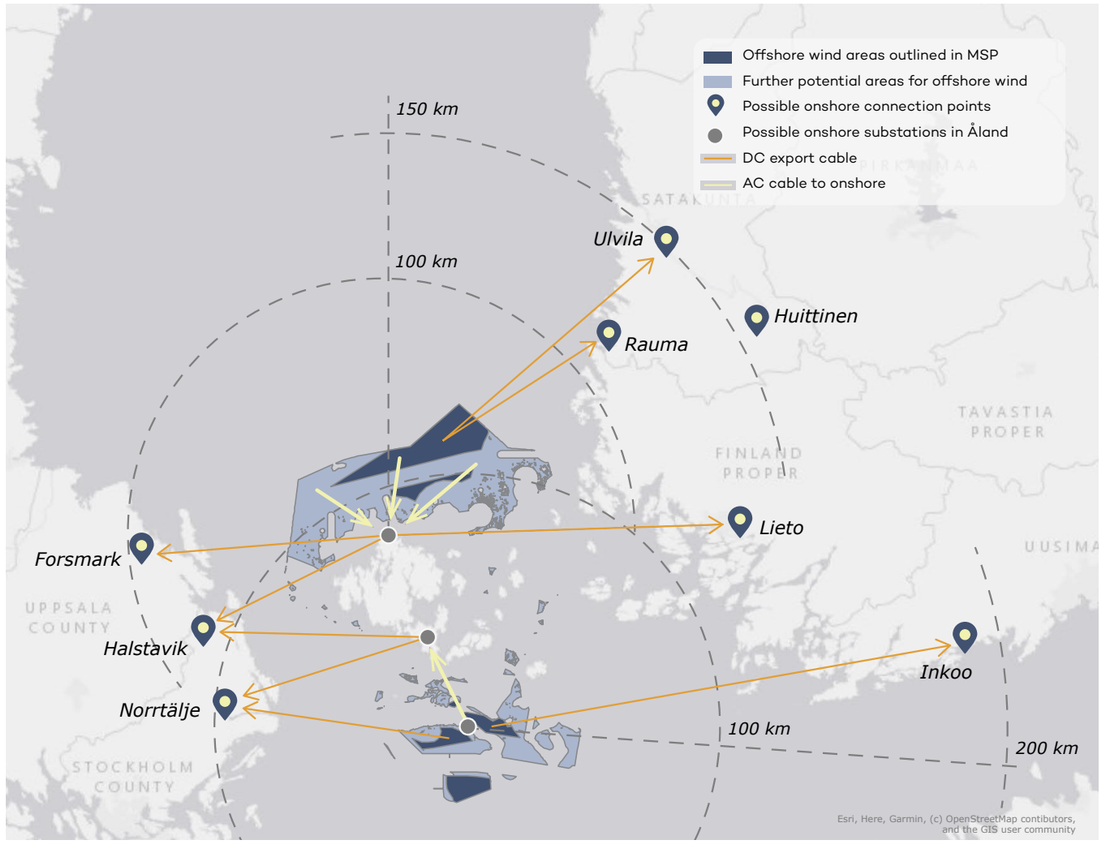
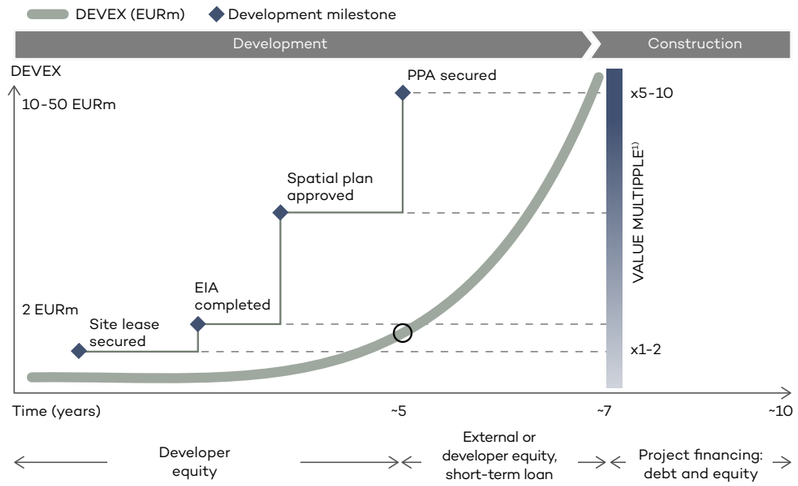


FIGURE 5 – ILLUSTRATION OF DEVEX PROFILE AND PROJECT FINANCING STAGES



First development stages can be completed with limited cash outlay. Latter development stages are cash-intensive with seabed soil investigations etc.

Project value increases step-wise as the project reaches development milestones. Spatial plan and PPA are key value adding milestones.

Securing PPAs at a relatively early project development stage will likely be fundamental for Åland offshore projects.

[1] *Value multiples are high-level indications and have been included in the figure for illustrative purposes*

to onshore wind, meaning that Åland offshore wind will need to utilize all advantages to optimize project costs and also other levers such as scale and technology cost reductions to be competitive.

Recommendation:

- In the case that developers will not finance development expenditure themselves or with a strategic partner, a PPA is needed for securing external capital - especially debt financing.
- Creating a development scheme which enables developers to design and construct projects efficiently and cost competitively will improve the cost-competitiveness of PPA offerings for Åland offshore projects.

First projects will face more lead time and cost risk due to underdeveloped local and regional supply chains.

The supply chain for offshore wind in the Baltic Sea region is currently underdeveloped. Supply chain elements such ports, assembly hubs, installation vessels, O&M hubs will need to be established during the first phases of sector growth. As a result, first projects will likely be more expensive and face more risks.

Åland would share the same supply chain with the wider Baltic Sea region and therefore realization of cost benefits from advancements in supply chain is subject to the offshore industry growth of the wider Baltic Sea region.

Recommendation:

- Åland should avoid setting any firm target on local content requirement. Developers having higher degree of freedom in selecting which parts of project to source locally would improve management of risks and costs in the first projects. Local jobs will develop naturally to the parts of the value chain which are most viable.
- Developers and Åland should engage in active dialogue already in the early development phases to establish common understanding on the supply chain infrastructure, such as ports and logistics related, needed to be in place before construction of first projects, and begin working towards these goals together with the municipalities.

4. Scaling up

Scaling up Åland's offshore sector in the 2030's may bring new challenges. Challenges relate to the scale of generation capacity that needs to be integrated to the energy system in Baltic-Nordic region. Solving these challenges will likely require more complex solutions such as hybrid offshore grids and Åland based production of hydrogen and e-fuels. This stage may also require Åland to take a more active role in the sector development.

Hybrid grid solutions

A transition from radially connected offshore projects onshore towards a more coordinated approach for offshore grid arrangements may be required for establishing route-to-market for large capacities of installations in the upscaling phase (+7GW).

More concretely, in the case of Åland, this could mean for example clustering grid connections of two or more offshore projects into hubs and connecting these hubs onshore to Finland and/or Sweden. Furthermore, such connection arrangements could include interconnector elements and function for dual purpose of enabling trade between markets, while providing an transmission route for offshore generation. In general, such wide range of grid arrangements are categorized as hybrid grid solutions. In a wider scope, such hybrid grid arrangements could form part of the envisaged Baltic Sea offshore network.

Advantages of hybrid grid solutions in the Åland offshore sector include for example

- limiting the number of connection points onshore;
- possibility to achieve capex savings through cost synergies from shared grid infrastructure of multiple projects; and
- wider benefits in Nordic-Baltic power systems through dual-purpose nature of cables.

Challenges of hybrid connections relate to increased complexity in planning and regulation.

- Planning of hybrid grid arrangements requires more coordinated approach with multiple stakeholders such as TSOs, developers, ministries, national permitting authorities etc. involved in the process, consequently leading to longer lead times.
- Hybrid grid connections may also create need to develop new market design rules for defining congestion, bidding and dispatch principles.

- Investor consortiums - typical for offshore projects - imply multiple owners of site and transmission grid, which adds complexity of the contractual arrangements and may require new EU-level regulatory concepts for cost, benefit and ownership allocation of transmission grids.

More advanced offshore sectors in Europe - such as United Kingdom, Netherlands and Denmark – are reaching the stage where a transition towards hybrid grid concepts is being planned. For example, planned Danish energy island projects Bornholm and North Sea Energy hub, are expected to showcase how to overcome some of the underlying hurdles of hybrid grid solutions. Danish Energy Agency has set up a dedicated team to support the projects overcoming these regulatory challenges.

Envisaged Baltic Sea offshore grid could also become an export route for Åland offshore generation in the long-term and hence widening the market radius for potential offtakers. However, the timeline of development is highly uncertain despite strong ambitions around the concept.

Recommendation:

- More advanced grid solutions are an opportunity - and potentially a requirement - for upscaling the offshore sector in Åland. Planning and development of such solutions requires for a more coordinated approach compared to radial connections, have longer lead times, and planning should therefore be initiated already in the 2020s.
- Kraftnät Åland and potential developers should participate actively in the discussions with the Nordic and Baltic TSOs on the possibilities of joint grid development plans.

Hydrogen and E-fuels

Hydrogen and E-fuels are other possible energy carriers for integrating GW scale offshore generation in Åland to the surrounding Baltic Sea energy systems.

Åland and developers have several options in pursuing a hydrogen route-to-market.

- Åland has a notable maritime transport sector - with four large ferry companies operating in the area – and decarbonisation of this sector provides hydrogen offtake opportunities for offshore wind projects. As an high-level estimate, the domestic demand in Åland maritime sector could cover some 2-5 TWh of electricity if fuel oil use of this fleet was replaced with hydrogen via e.g. fuel cells in ships.
- Another option is to export hydrogen to Finland, Sweden, Baltics or e.g. Germany via pipeline. Offtake demand for hydrogen is subject to many uncertainties and material sector growth is not expected to occur before 2030's. At the time of writing this report, Finland and Sweden are defining their vision and strategy for hydrogen.
- Hydrogen could also be refined to other end-products such as "Power-to-liquids" e.g. ammonium and methanol, or synthetic fuels refined further from methanol i.e. "E-fuels". Lack of local CO_2 supply is a key constraint for producing E-fuels in Åland. In theory, CO_2 could be sourced with e.g. a pipeline from Sweden, but economic feasibility of this option is highly uncertain.

Hydrogen may provide another route-to-market for offshore wind production. Integration of hydrogen to offshore wind projects is generally expected to increase, as evidenced by several planned offshore projects in e.g. Denmark and Netherlands. It is realistic to expect hydrogen to play a role also in the Åland offshore sector – timing and scale of integration is still uncertain and is subject to the general development of offtake demand, paying capability of offtaker base and cost-competitiveness of Åland produced hydrogen and/or E-fuels.

Recommendation:

- Hydrogen is expected to play a role in the Åland offshore sector, more likely in the period beyond 2020s. Åland and developers should actively take part in hydrogen pipeline discussions around Finland, Sweden and Baltic Sea, as well as initiate discussions with Åland maritime transport sector and other potential offtakers already in the 2020s.

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