Summary From Assembly to Action

Recommendations for Development of a Green Offshore Industry in Denmark

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Alliancen for Grøn Offshore Energi
The Alliance for Offshore Renewables

Introduction

The below report has been prepared by Innovayt A/S on behalf of the Alliance for Offshore Renewables.

The report is based on written sources and a continuous dialogue with the Alliance working committee for the preparation of a national investment strategy.

The members of the committee are: Vindmølleindustrien (The Danish Wind Industry Association), DI (The Confederation of Danish Industry), Offshore Center Danmark, Lindø Offshore Renewable Center (LORC), and the Alliance secretariat. Additionally, the report has gone out for consultation by the Alliance members.

Vejle, December 2010.

1. Executive summary

In this report, the Alliance for Offshore Renewables calls for the adoption of a national investment strategy for the development of a wind and wave power offshore renewables industry up to 2020. A national investment strategy is necessary if we wish to secure continued growth in exports and employment within the offshore renewables industry.

Denmark's leading position within the offshore renewables industry is under pressure. In recent years, major international players have chosen not to make new development and production investments in Denmark. Instead, they have preferred our neighbouring countries in the North Sea region. At the same time, major Danish companies are under pressure in Europe and have reduced their number of employees in Denmark.

In order to counter this tendency and make sure that the Danish offshore renewables industry preserves its leading position, the Alliance will present a number of specific recommendations of focus areas and investments which should be made to facilitate a joint effort by Danish industry, the government, and the research communities to maintain and develop the offshore renewables industry in Denmark.

1.1 | The future scale of the European offshore renewables industry

The future expansion of the offshore renewables industry will be immense. From a starting point of only just over 3 GW of installed offshore wind power capacity today, approximately 40 GW of offshore wind power capacity and 2.1 GW of wave power capacity will be installed up to 2020, based on the objectives of the EU member states. And according to EWEA (the European Wind Energy Association), the capacity will increase to 150 GW of wind power before 2030. For wave power, it is estimated that something like 33 GW could be installed before 2030. And up to 2050, the total offshore wind and wave power capacity may increase to 514 GW. That would require massive investments in the establishment of offshore wind farms and wave power facilities, and at the same time, it would mean the development of an industry which would – already in 2020 – employ approximately 165,000 individuals of which more than 40 per cent are expected to be highly educated.

Table 1: Outlook for offshore renewable energy capacity in Europe in 2020, 2030, and 2050

	Year	Total capacity installed (GW)	Total investment (billions of euros)	Jobs
Offshore wind energy	2020	40	60	150,000
	2030	150	136	215,000
	2050	420	466	341,000
Wave energy	2020	2.1	5	15,000
	2030	33	78	62,000
	2050	94	225	157,000
Total offshore renewables industry	**2020**	**42.1**	**65**	**165,000**
	2030	**183**	**214**	**277,000**
	2050	**514**	**691**	**498,000**

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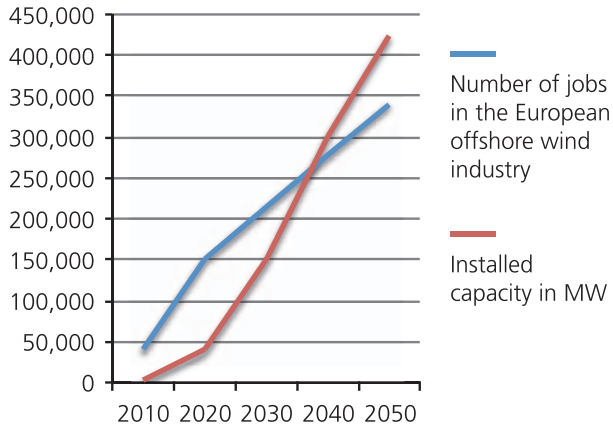
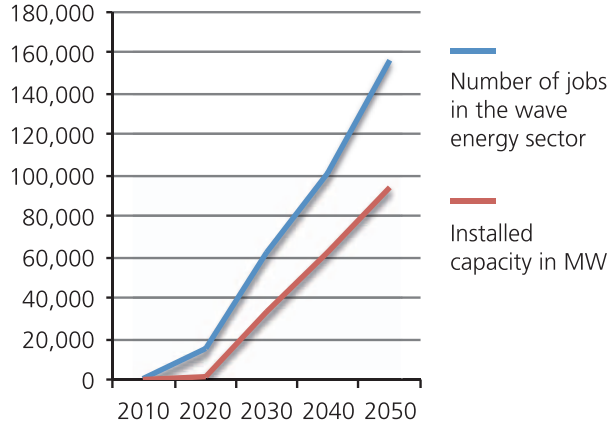
Figure 1: Development in European jobs and offshore wind power capacity in the EU up to 2050



Based on: Wind at Work, 2009, EWEA and Oceans of Opportunities, 2009, EWEA. The 2050 total installed capacity has been estimated by keeping the installed capacity per year constant as from 2030. The 2050 number of jobs has been calculated by linear extrapolation of the growth of 2020-2030.

Figure 2: Expected development in the number of jobs and installed offshore wave power capacity in Europe up to 2050



Based on: Oceans of Energy (2010), extrapolation by the European Ocean Energy Association, including a conservative correction for the 2030 and 2050 scenarios. The 2020 scenario is based on the European Environment Agency report "Renewable Energy Projections as Published in the National Renewable Energy Action Plans of the European Member States", 2010.

1.2 | We intend to create 47,000 jobs in Denmark before 2020

Based on the above market potential, the Alliance for Offshore Renewables has laid down its objective: Denmark should preserve and develop an offshore renewables industry which will be able to undertake as much of this task as possible, triggering off a great potential for growth and employment in Denmark based on the development and installation of offshore renewables technology.

Today, Danish industry and research are dominant in the global market for offshore wind energy. This dominant position cannot be preserved in the long term, but in this report, the Alliance for Offshore Renewables draws up a "wind & wave" scenario with the aim of preserving Denmark's position as the centre of European offshore wind energy and make Denmark a first mover wave power nation. In this scenario, we have an ambitious, however realistic objective of the Danish offshore industry employing

- approximately 47,000 individuals in 2020,
- approximately 65,000 individuals in 2030,
- and possibly 90,000 individuals in 2050.

The jobs will be distributed all over the offshore renewables industry, i.e. they will not be confined to the development and production of offshore wind turbines and wave power facilities and components. That means that we expect to see a considerable increase in the number of people employed in related industries such as planning, project work, onshore support facilities, development and establishment of offshore electricity grids, installation of offshore wind turbines and wave power facilities, and the operation and maintenance of offshore wind turbines and wave power facilities plus disposal and reuse.

To a very high extent, offshore wind energy will be the driving force behind this entire development. However, the Alliance believes that wave power will have a commercial breakthrough around 2020. Consequently, we recommend that Denmark aim to assume the same leading position within wave power that we were competent enough to obtain within wind power 20 years ago and which places Denmark in a very advantageous situation today and in the future when wind power will really be a major factor in global energy supply.

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At the same time, the report demonstrates that the investments which are to be made for the benefit of the offshore wind industry will also represent a number of synergy effects in the development of wave power, i.e. in areas such as the development of power grids, harbour development, maritime installation, and not least the ability to benefit from former experiences concerning price settling methods and supply models in offshore wind energy.

1.3 | Three general recommendations

The report contains an analysis of the main challenges facing the sectors within the offshore renewables industry, and conclusions are made in the form of three general recommendations which should be observed if Denmark is to preserve its leading position in 2020 and 2050. Those recommendations will require considerable strategic investments by industry and the government.

1. Denmark should see to it that the overall energy sector framework conditions in Denmark and Europe will encourage the installation of renewable energy resulting from wind and wave power

- First of all, this implies that Denmark should back an expansion of the electricity grid in the North Sea and the Baltic Sea which could connect the surrounding countries and future-proof the grid by enabling the connection of offshore renewable energy parks in the North Sea and the Baltic Sea. In other words, a joint North European investment of 20-30 billion euros up to 2030.
- At the same time, Denmark must back the modernization of the European electricity grid. The investment in a modern electricity grid in Europe based on smart onshore and offshore grid technology is a prerequisite for massive integration of fluctuating renewable energy sources such as wind in the electricity grid.
- Thirdly, Denmark must be a first mover within wave power. Denmark should secure that there is a basis for planning and connectivity in connection with the installation of 500 MW of wave power on the west coast of Jutland and in the North Sea before 2020.
- Fourthly, Denmark must secure that there is a continuous incentive for utility companies to set up offshore wind and wave power facilities.
- Fifthly, investments must be made in seed funds and support for entrepreneurs in the offshore renewables industry allowing more industry start-ups to become high-growth companies.
- Sixthly, institutional investors such as pension funds should be invited to invest in the expansion of offshore wind farms and the establishment of the offshore electricity grid through new ownership models.

2. Up to 2020, Denmark must invest a double digit amount in billions in research, innovation, and demonstration within the offshore renewables industry

- The investment in pools and schemes that support research, innovation and demonstration projects should be increased from 1 billion kroner in 2010 to 4 billion kroner a year in 2020. Approximately half should go to projects in the offshore renewables industry.
- During the next 10 years, money should be invested in strengthening the wind and wave power research communities.
- A separate financial facility should be set up to support the testing of offshore wind turbines, foundations, and wave power facilities.

3. Massive investments should be made in the education of qualified personnel for the offshore industry

- The necessary investments should be made in education and supplementary training that could provide the required supply of new and better qualified personnel for an offshore renewables industry employing approximately 47,000 individuals in Denmark in 2020. The education of the required 20,000 engineers will cost 16 billion kroner, bearing in mind that the advantage to society of one engineer has been proven to be approximately factor 20.
- Analyses must be carried out of the exact number of employees needed within the different sectors of the offshore renewables industry.

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1.4 | Elaboration of recommendations concerning the framework conditions for the offshore renewables industry

The framework conditions for the offshore renewables industry are very much a national political issue which is regulated in collaboration with the EU through bilateral agreements with the neighbouring countries.

In order that the Alliance's wind & wave scenario can be realized by 2020, Denmark must push for securing the European and international investments which must be made to permit the transition to a society which is highly based on electricity originating from renewable energy sources. That is especially true for offshore wind energy and – in the long term – for wave power. Secondly, Denmark must make national investments to secure that the Danish framework conditions will encourage the establishment of 2.2 GW of installed offshore wind energy capacity and 0.5 GW of installed wave power capacity before 2020.

Establishment of an electricity grid in the North Sea and the western part of the Baltic Sea: 20-30 billion euros

The European Wind Energy Association (EWEA) has estimated that the implementation of an electricity grid in the North Sea and the western part of the Baltic Sea, which will partly connect the surrounding countries, partly make it possible to connect energy parks in the North Sea and the western part of the Baltic Sea directly to the grid, will cost 20-30 billion euros up to 2030. The Alliance for Offshore Renewables finds it essential for the development of the offshore industry in Denmark that the countries surrounding the North Sea and the Baltic Sea will have a shared grid which can facilitate the growth in offshore wind and wave power.

That would partly drive the market forward, partly secure the Danish offshore renewables industry a central position in the testing and development of High Voltage Direct Current cable solutions, which could open the way for exports of technology and knowledge in the field.

In that context, Denmark should also press for securing that the Kriegers Flak offshore wind farm becomes the first to secure a connection to the electricity grids of several countries.

We are talking relatively heavy investments with a long repayment horizon. Consequently, it should be considered whether parts of the funding of a grid expansion in Denmark and Europe could be borne in public/private cooperation between governments, electricity grid owners, and institutional investors such as pension funds. This could be realized by letting pension funds with long investment horizons become co-owners of parts of the grid.

The European electricity grid to be modernized to a smart grid

The upgrading of the European electricity grid is a prerequisite for massive integration of fluctuating renewable energy sources such as wind in the European electricity grid. Today, Denmark and the EU are facing the challenge of integrating 30 and 20 per cent respectively before 2020.

The principle behind intelligent energy systems and a smart grid is that houses, businesses, and electric cars could be connected to for instance CPH plants, wind farms, and district heating plants, allowing all units to produce energy which will be delivered where it is needed without anything being wasted.

At the same time, considerable focus on the development and establishment of the smart energy system will make it far cheaper to secure the green switch-over which is necessary on the way towards a society which is not dependent on fossil fuels. If we are not simultaneously focusing on the development of a smart energy system, the increasing percentage of renewable energy in the energy system will continuously mean that a series of cost-intensive regulation instruments will have to be put to work in order to maintain the security of supplies.

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Incitement structure for the establishment of offshore wind farms and wave power facilities

Based on the Danish Commission on Climate Change Policy's recommendation that approximately 2.2 GW of offshore wind energy should be installed in Denmark before 2020, it is necessary that an incitement structure is continuously used which makes it interesting for utility companies to establish offshore wind farms in Danish waters. The investment in this is difficult to estimate precisely, but it is important to find a balance between providing incitements and securing that the wind farms which have been established will provide the cheapest and most efficient electricity generation. The Danish supply model seems to work. However, constant observation of other European incitement models is recommended, securing that the Danish establishment of offshore wind energy will not run aground because of drawbacks in the incitement structure.

As for wave power, a similar model should be introduced, which could secure the installation on the west coast and in the North Sea of 500 MW of wave power before 2020. Consequently, Denmark should prepare a basis for planning the expansion of wave power in Denmark as soon as possible, and grid connectivity should be secured. In that connection, the possibility of establishing wave power facilities in connection with offshore wind parks should be considered where it is technically and practically possible, as this could be instrumental in keeping the set-up costs to a minimum. By acting now, Denmark could generate first mover advantages in relation to the technological development of wave power. In this case, it would also be advisable to keep an eye on the models introduced in other EU member states. Several countries have already introduced high feed-in tariffs on wave power.

It is important to point out that the physical location of offshore wind parks is an important factor for the settling price of wind energy. The deeper the ocean and the greater the distance to the shore, the higher the price. Consequently, it would be natural to aim at establishing offshore wind parks in relatively shallow waters and close to the coast, until the set-up costs in deeper waters and further away from the coast have been considerably reduced.

In connection with the incitement structure, it should also be considered whether institutional investors such as pension funds could be invited to a larger extent to invest in the establishment of wind farms and wave power facilities and thus become electricity suppliers.

Seed capital and support for entrepreneurs: 300 million kroner

The offshore renewables industry – and specifically the generation of wave power, maritime installation, maintenance, and operation – is characterized by a lot of entrepreneurs and start-up companies. These players will be able to pass from the start-up stadium to high-growth companies in a growth market. At the same time, the private capital market is reluctant to support promising projects in several of the sectors. Consequently, a seed capital fund should be set up for entrepreneurs within the offshore renewables industry, and specifically for those working with wave power. If possible, the fund should be based on venture capital from both public and private sources. At the same time, there is a need for goal-oriented entrepreneur support for the upgrading of start-ups within the offshore renewables industry in order that promising technological solutions and business concepts are not lost in the sands.

Harbour development

It is recommended that the economic rationale of the development of Danish harbours allowing them to handle the installation of offshore wind turbines and wave power in the North Sea and the Baltic Sea be analysed.

Today, the harbour of Esbjerg is the only Danish North Sea port which meets the EWEA infrastructure requirements for harbours which aim to play a decisive role in the installation of offshore renewable energy. At the same time, the harbour of Esbjerg already has a development plan covering the period up to 2015. Based on the experiences of Esbjerg, it would be fair to assume that the investment in the development of other harbours would amount to billions of kroner. Consequently, it should be established to what extent the EU Structural Funds could co-finance harbour development in peripheral regions of Denmark.

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1.5 | Elaboration of recommendations concerning research, innovation, and demonstration

Investments in research, innovation, and demonstration are necessary in order for the wind & wave scenario to become reality. Primarily, the costs of generating offshore renewable energy should be reduced considerably. In the case of offshore wind power, the industry aims to halve the *cost of energy* in connection with new offshore wind parks. In the case of wave power, the initial priority is to ensure a technological breakthrough allowing the generation of considerable quantities of energy for the commercial market. In this process, the wave power industry will also aim at a *cost of energy* which is comparable to the offshore wind energy level.

Until today, Denmark's leading position within offshore wind energy has been based on the development of high tech and competitive products which are the result of years of research. And while Denmark and Danish industry held the top position for a long time, our European neighbours and countries such as China, the US, and Korea have begun investing huge sums in research and development of both wind and wave energy. If Denmark is also to be found among the leading research players in 10-20 years, increased investment is a must.

In the EU's Strategic Energy Technology Plan (SET plan) and the European Commission's related Technology Roadmap, it is estimated that up to 2020 there will be a need for total investments by the industry, the EU, and the EU member states in research, innovation, and demonstration of energy technologies of 67.5-80 billion euros. Of the total investment, the Commission estimates that approximately 6 billion euros are needed for innovation and development within wind energy, including 2 billion euros for offshore technologies. Moreover, it is estimated that 2 billion euros are needed for the technological development of electricity grids. The Commission has not published a specific framework amount when it comes to wave energy, but the European Ocean Energy Association (EU-OEA) estimates that 2.6 billion euros should be invested in research and development in this area up to 2020.

Consequently, the total estimated investment need in research, innovation, and demonstration of technologies within the wind energy and wave power industry in Europe amounts to 10.6 billion euros over the next 10 years. In other words, an increase of more than 50 per cent compared with the present research and development investments in the field.

Industry will have to finance the major part itself, but the European Commission estimates that the market will not be able to generate the necessary technological innovation itself nor make the venture investments necessary to facilitate a sufficiently rapid phase-in of renewable energy.

The Danish wind industry is already (2010) investing more than 1 billion kroner in research and development, and this investment will increase steadily during the next 10 years. However, it is necessary that the Danish government follow suit and increase its funding of research, innovation, and demonstration within the offshore renewables industry.

In order to secure that the wind & wave scenario for the offshore renewables industry in Denmark can be realized, the Alliance proposes that the following investments be made to promote research, innovation, and demonstration.

Research and demonstration projects: The annual pool should be increased from 1 to 4 billion kroner by 2020

In 2010, approximately 1 billion kroner will be allocated to research and demonstration projects within the field of renewable energy and energy efficiency in Denmark. It is recommended that this amount be progressively increased to 4 billion kroner a year up to 2020 and that efforts be made that approximately 50 per cent of these funds will go to wind and wave energy projects and the development of other technologies in support of the offshore renewables industry. At the same time, it is recommended that the funds go to business oriented projects in order to secure the participation of businesses to the greatest possible extent. In future, the money should keep on being allocated through the existing funds and pools: EUDP (the Energy Technology Development and Demonstration Programme), ForskEL, ELforsk, ForskVE, Højteknologifonden (the Danish National Advanced Technology Foundation), and Det Strategiske Forskningsråd (the Danish Council for Strategic Research).

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An increased effort to preserve and develop Denmark's position as a leading player in wind and wave energy university research: 500 million kroner up to 2020
It is recommended that the general grant for the existing wind and wave energy research communities be increased considerably. The Danish research communities are leading players today, but if we wish to future-proof this position, it is necessary to invest even more in basic research and the education of researchers during the next 10 years.

The set-up of a new financial facility to fund the testing and demonstration of offshore wind turbines, foundations, and wave power facilities
It is recommended that a financial facility be set up to support the testing of offshore wind turbines, foundations, and wave power facilities. The facility should function on the basis of competition and co-financing principles that allow testing of the most promising technological solutions. The facility should not restrict the testing to a specific geographical location, but should facilitate testing in different locations chosen by the applicants.

It is important for the development of wave power in Denmark that the facility will co-finance at least three full-scale tests of wave power facilities before 2015. If possible, the demonstration of wave power concepts should include well-known and well-proven offshore wind turbine technologies.

A strengthening of DanWEC (the Danish Wave Energy Center) in Hanstholm allowing it to develop into an international center for testing, demonstration, and development of commercial wave power: 50 million kroner up to 2020
DanWEC must develop into an international wave power test centre which will attract international developers of wave power facilities to Denmark.

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1.6 | Elaboration of recommendations concerning educational needs

It has been estimated that for every 10,000 new employees in the offshore wind industry, at least 40 per cent will be engineers or other highly educated personnel.

Table 2: Expected manpower distribution by educational level and field per 10,000 employees within the offshore wind industry in Europe

Educational level/field	Annual demand in the offshore wind industry
University graduates	1,000
Engineers	3,000
Technicians	4,000
Unskilled workers	1,000
The rest (management, administration, finance, etc.)	1,000

Based on a presentation by Professor Gerard van Bussel, head of Delft University of Technology's centre for wind energy, at the Power Cluster Midterm Conference, May 2010.

It is the objective of this report to set up the framework for an offshore renewables industry which – in Denmark – may employ approximately 47,000 individuals in 2020, increasing to approximately 65,000 individuals in 2030. If the distribution of jobs in Denmark matches the above, there will be a demand for approximately 20,000 highly educated individuals and approximately 30,000 skilled and unskilled workers in the Danish offshore revewables industry before 2020.

The education of 20,000 engineers will cost 16 billion kroner, but this should be seen against the background of one engineer representing an average factor 20 advantage to society.

It is necessary to make specific analyses of the educational needs within the different sectors of the offshore renewables industry in order that investments can be made to improve the skills of the existing manpower base and secure the demanded supply of well-qualified individuals for the offshore renewables industry.

In relation to the improvement of the skills of the existing manpower base specifically, it should be established to what extent the EU's Structural and Social Funds may co-finance the expenses.

1.7 | An important input in the debate

It is the hope of the Alliance that this report and its recommendations can raise a debate concerning the need for making an active effort to secure the preservation of Denmark's position as the international leading player within the offshore renewables industry. By showing the potential for growth and employment in the future offshore renewables industry in Europe, and by demonstrating the consequences of Denmark being passive and not making the necessary investments in time, the Alliance wishes to point out that Denmark is forced to take an active approach to the future of the offshore renewables industry. The choice of an offensive investment plan – as presented in the strategy – will be decisive for securing a positive social development in Denmark in the decades to come, including growth, employment, and environmental sustainability.

Making the national investment strategy our starting point, the Alliance for Offshore Renewables and its members will be continuously working to secure that Danish industry and Danish society will benefit the most from one of the greatest industrial adventures in Europe since the development of the North Sea oil and gas industry.

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