STAKEHOLDER ANALYSIS
DECOM TOOLS 2020

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Overview

1. Introduction to the Project and the Participating Regions

For a successful transition of the energy market, a significant expansion of wind power is necessary to replace fossil energy. In quantitative terms, wind energy emits up to 175 times less CO2 than most modern gas plants. Therefore, a successful transition to clean energy will not work without wind farms both onshore and offshore (Belgian Offshore Platform, 2019). However, most wind turbines are designed for a life span of only 20-25 years, due to limited licences, and in the offshore sector, due to extreme weather conditions, their durability is expected to be even lower. Accordingly, a sustainable decommissioning process is of major importance to reduce the overall CO2 footprint of an offshore wind farm. Producing green energy by avoiding CO2 emissions faces a drop in its sustainable effect when large fuel-powered ships are required to inefficiently take down an offshore wind farms, even more if the decommissioned materials are not recycled afterwards. Wind energy as a source of green energy should keep in mind the ecological optimisation also regarding the last stages of a wind farm's lifecycle.

The number of offshore wind farms to be decommissioned will increase significantly in the coming years. But while dismantling processes on land are known and tested, extensive experience in the offshore sector is still missing and an overarching and sustainable approach for dealing with offshore wind farms at the end or their life span is significantly less developed. After the termination of their life span, wind turbines either have to be decommissioned or their accredited operational lifetime needs to be extended, often accompanied by repowering (partial refurbishment). So far, in the offshore wind sector only the offshore wind farms Yttre Stengrund and Utgrunden (Sweden) as well as Vindeby (Denmark) and recently Blyth (UK) have been dismantled, plus two single near-shore turbines, namely Windfloat 1 (Portugal) and Hooksiel (Germany) as well as four offshore turbines at the Lely farm (Netherlands).

An overall sustainable approach to the offshore wind farms' end of lifecycle is still missing. The Interreg North Sea Region (NSR) project "DecomTools"[1] shall assist in closing this gap by devising and developing eco-innovative concepts that:

- Reduce decommissioning costs by 20 per cent and environmental footprint by 25 per cent (measured in CO2 equivalents),
- Increase the know-how and expertise of North Sea Region (NSR) involved stakeholders.

The project consortium consists of thirteen partners from six NSR countries, namely Denmark, Germany, Belgium, The Netherlands, United Kingdom and Norway. The four-year project will carry out research, demonstrate pilots and develop working tools in different areas such as logistics, infrastructure, ship design, safety or up-/re-cycling. Already available technologies will be combined to tackle some of the major aspects of the decommissioning challenges, including optimization of existing (port) infrastructure. Transnational cooperation and multidisciplinary cross sector competences will improve framework conditions for innovation and technology transfer in this specific niche area and help the sector to become more sustainable.

[1] https://northsearegion.eu/decomtools/about/

To organise the decommissioning process, not only practical topics and logistical questions will have to be dealt with. When it comes to recycling of wind turbines, one stakeholder being interviewed in Denmark stated that around 85 to 90 per cent of the mass of a wind turbine was recyclable, leaving 10 to 15 per cent as currently non-recyclable. The non-recyclable parts are mainly the blades and other parts, e.g. the nacelle, which are made of glass- and carbon-fibre composites materials. Therefore, apart from solving legal and logistical questions of the decommissioning process, recycling will also be a major focus to ensure a truly green lifecycle of a wind turbine.

The report at hand aims to provide an overview on stakeholders' perception of the status quo of offshore wind energy and offshore decommissioning in the NSR as well as the stakeholders' needs and proposals for shaping the future market for decommissioning offshore wind infrastructures. The report can be seen as a qualitative supplement to the quantitative market analysis which has also been published in the scope of the DecomTools project.[2] The stakeholder report at hand focuses on the perspective of companies, institutions and people engaged in the offshore wind energy and decommissioning sectors in the NSR. The report is based on a variety of stakeholder consultations covering a set of questions on the market situation, potential barriers and internationalisation as well es on expectations of the stakeholders on the DecomTools project. The set of questions was dealt with in all NSR countries participating in the DecomTools project (excluding Sweden). Sweden is not part of the project consortium and therefore not covered.

[2] See https://northsearegion.eu/media/11753/market-analysis_decomtools.pdf

2. Stakeholders in the Regions

In order to categorize the different kinds of stakeholders, meaning people with an interest in the field of decommissioning of offshore wind energy and related activities, a set of stakeholder mapping theories have been applied. The process of stakeholder identification ideally follows a collaborative approach of research, debate and discussion drawing from multiple perspectives. By doing so, a key list of stakeholders is identified. In the scope of the DecomTools project, the process of stakeholder group identification has been pursued in discussions, in physical partner meetings as well as through online participatory possibilities.

The selection of stakeholder groups followed an extended helix model that is the inclusion of not only the traditional quadruple helix of stakeholders, namely academia, industry, government and civil society, but also groups at the edge of particular groups (Frizen, 2018). As a further perspective, the value chain underlying the offshore wind and decommissioning industry has been introduced. This led to the following main stakeholder groups which constitute the framework of the subsequent analysis:

- Owners of offshore wind farms (investors, shareholders, agents, analysts, rating agencies),
- Customers (direct / indirect customers, advocates),
- Employees (current employees, potential employees, retirees, representatives, dependents),
- Industry (suppliers, competitors, industry associations, industry opinion leaders, media),
- Community (residents near company facilities, chambers of commerce, resident associations, schools, community organizations, special interest groups),
- Environmental sector (nature, animal species, future generations, scientists, ecologists, spiritual communities, advocates, NGOs),
- Government (public authorities, local policymakers, regulators, opinion leaders),
- Civil society organizations (NGOs, faith-based organizations, labor unions).

These groups have then formed the basis for regional lists of stakeholders which are graphically described further below. The different stages of stakeholder mapping (1. Identifying relevant groups and organisations, 2. Analysing perspectives in order to understand interests, 3. Mapping relationships to objectives and particular stakeholders, 4. Prioritising stakeholder relevance and identifying issues) has been done by the DecomTools partners in the participating NSR regions (BSR, 2019).

On the basis of the stakeholder group identification, all partner regions from the DecomTools project have been asked to prepare a stakeholder list of companies that are related to the economic sector in the particular region (see the template in Annex 1). The stakeholder lists of each partner region are to be considered as a valid section of the stakeholders in that particular region and not as a comprehensive list of stakeholders. Therefore, it might be possible that some relevant stakeholders might not have been listed while other sectors are well defined due to different specialisations of the partner organisations.

The stakeholder groups include several sub-groups namely owners of wind farms, project development agencies, consulting, design & engineering, construction & installation, maintenance & service, logistics, personnel & training as well as cable companies for the sector of offshore wind energy. Since most of the stakeholders are located in one of these sub-sectors, it has been decided to prepare two different figures for each region so that the relations remain appropriate. The figure with related sectors includes the following: pure decommissioning (sub-sectors: decommissioning, recycling), government (politics & administration), infrastructure (ports(, representation of interests (environmental lobby organisations, economic interests, social interests), science & R&D (universities, scientific institutions).

The graphic representation of the stakeholder lists highlights some interesting features about regional specialisations in certain sectors related to offshore wind and decommissioning. It is to be noted that the figures are not meant to allow for comparisons between the regions since there is no objective scientific standard working as a foundation. Instead, the lists have been prepared separately and can only give indications. What the figures represent is the relative significance of sectors compared to the absolute number of stakeholders. For example, figure 2 shows that Denmark has a relatively high number of stakeholders from the logistic sector relative to the overall number of stakeholders on the list. This might indicate that Denmark has a significant amount of knowledge and expertise in this sector. In the case of not having information on a certain stakeholder group in a region the column has been left blank. This does not mean that there are none of these stakeholders in a region.

Figure 1: Stakeholder Representation in Offshore Wind Decommissioning, Denmark

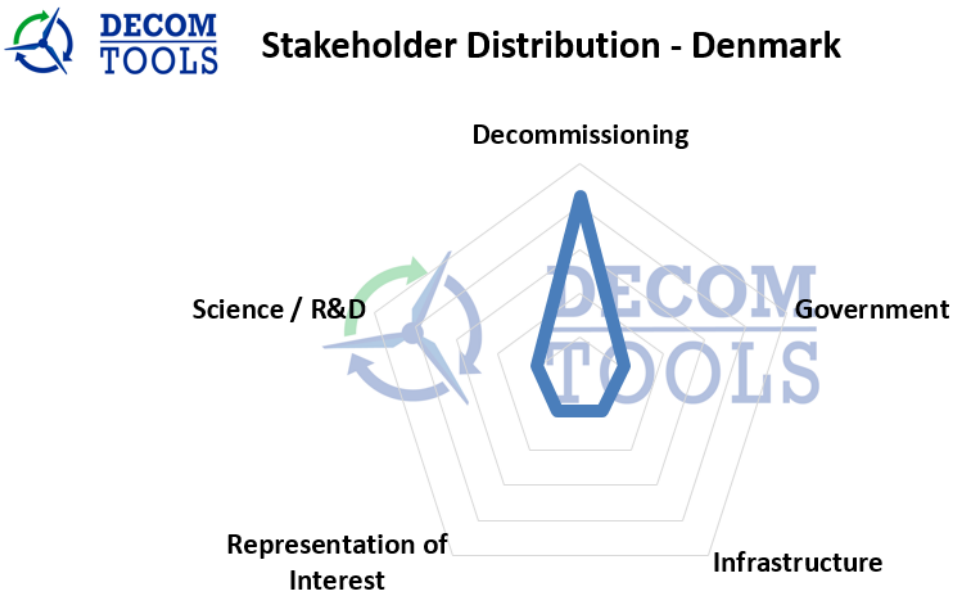

Figure 2: Stakeholder Representation in Wind Energy Related Sectors, Denmark

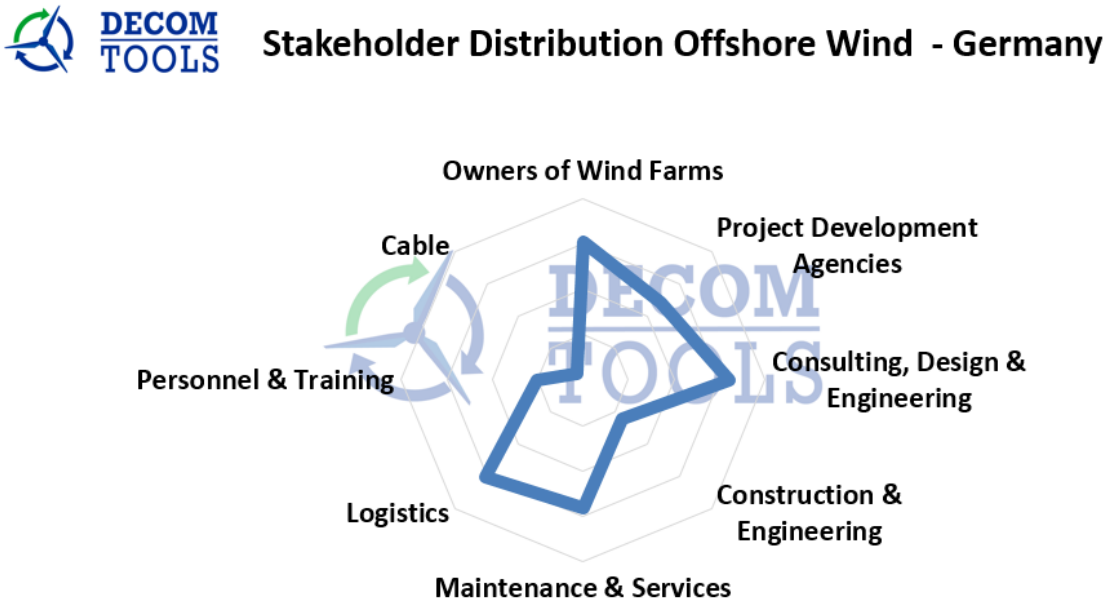

Figure 3: Stakeholder Representation in Offshore Wind Decommissioning, Germany (Leer Region)

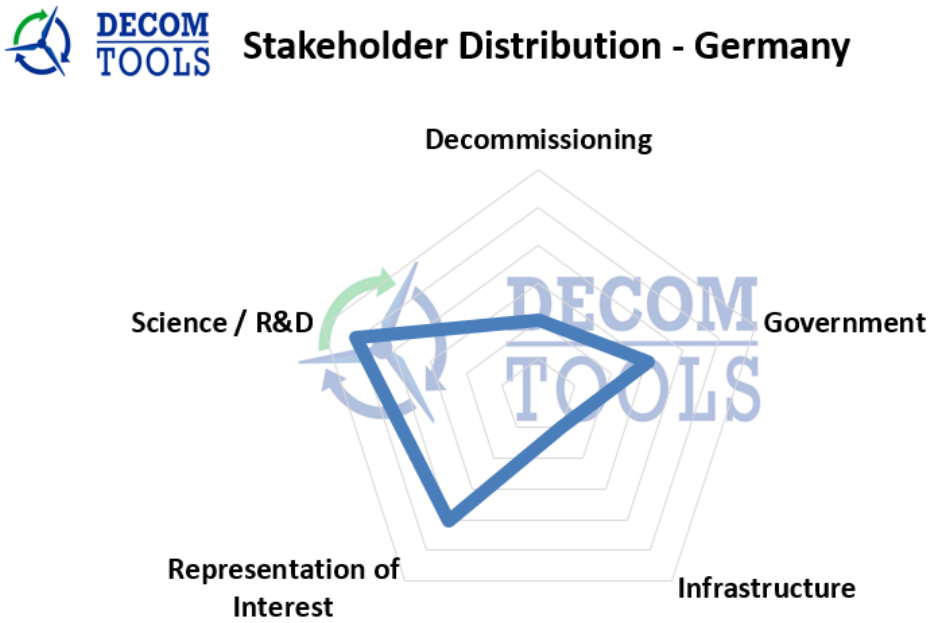

Figure 4: Stakeholder Representation in Wind Energy Related Sectors, Germany (Leer Region)

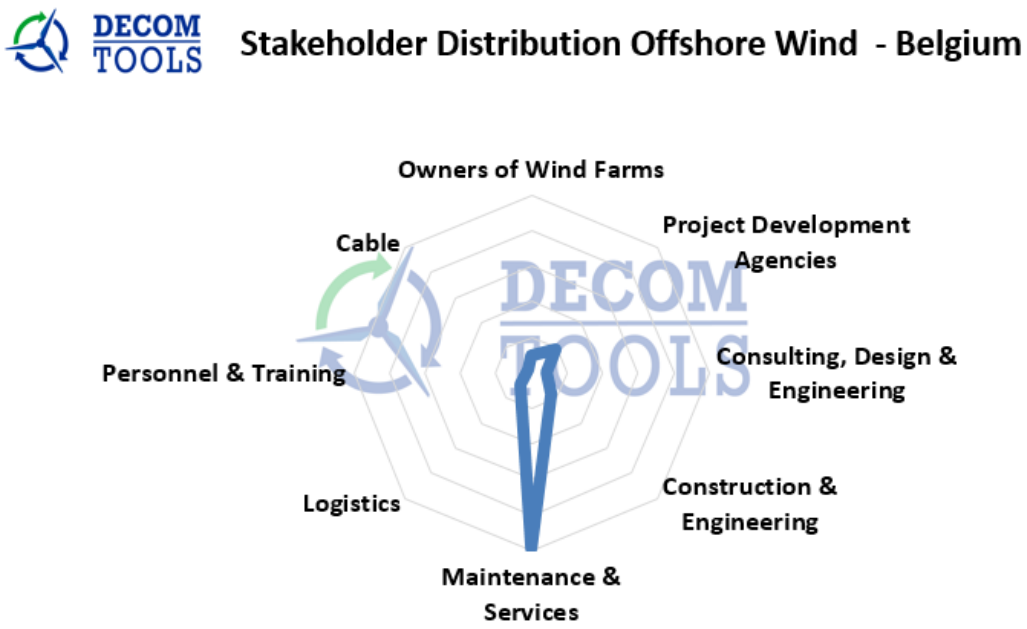

Figure 5: Stakeholder Representation in Offshore Wind Decommissioning, Belgium

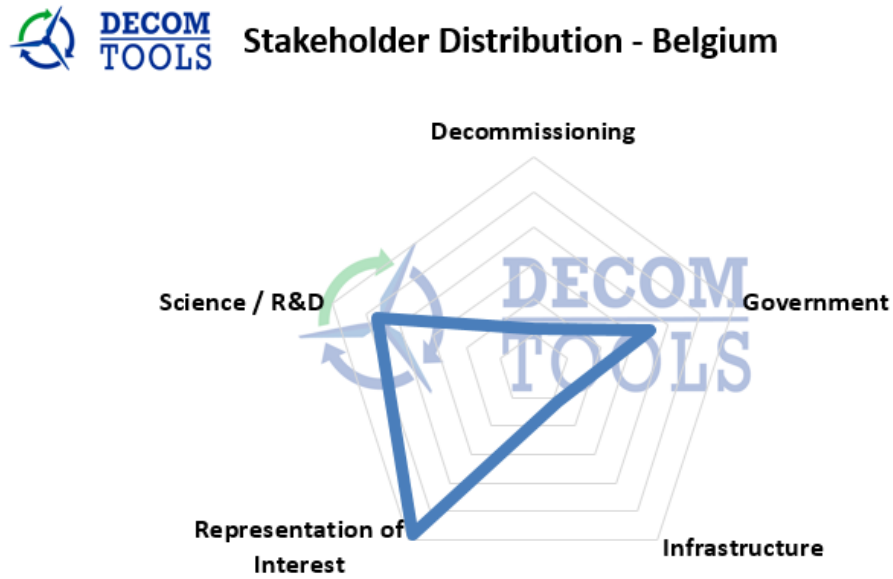

Figure 6: Stakeholder Representation in Wind Energy Related Sectors, Belgium

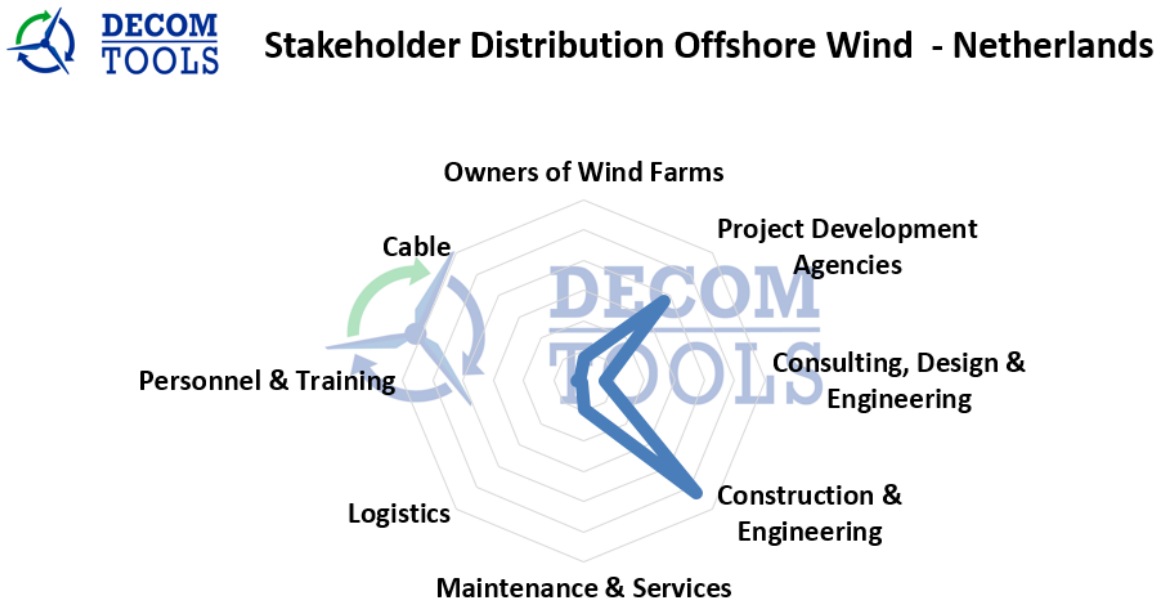

Figure 7: Stakeholder Representation in Offshore Wind Decommissioning, Netherlands

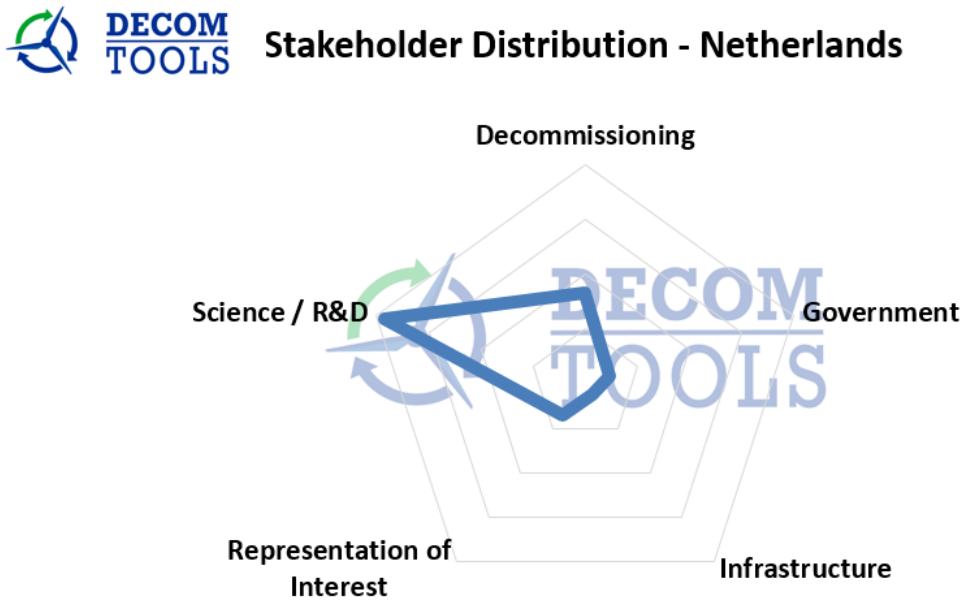

Figure 8: Stakeholder Representation in Wind Energy Related Sectors, Netherlands

Figure 9: Stakeholder Representation in Offshore Wind Decommissioning, Norway

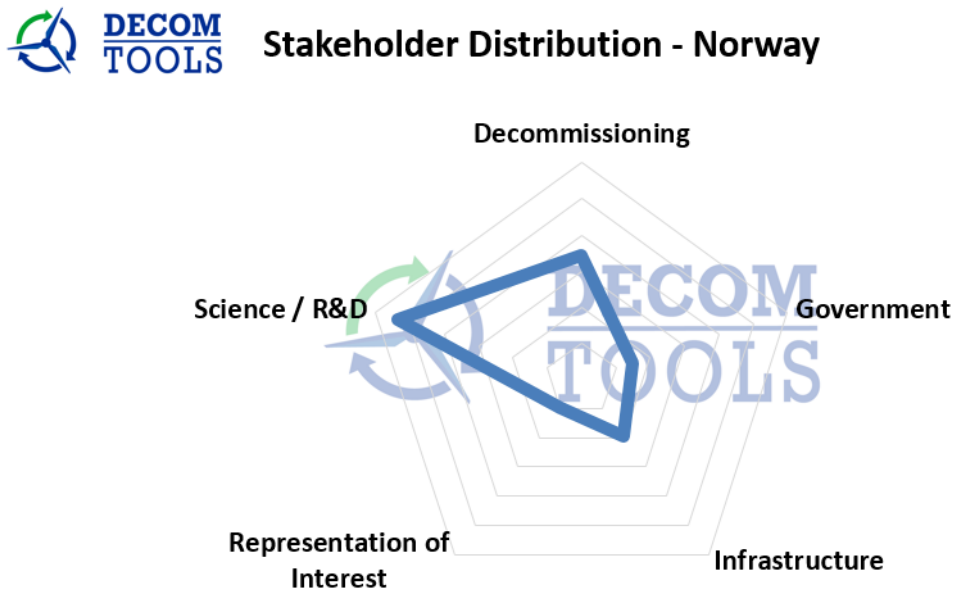

Figure 10: Stakeholder Representation in Wind Energy Related Services, Norway

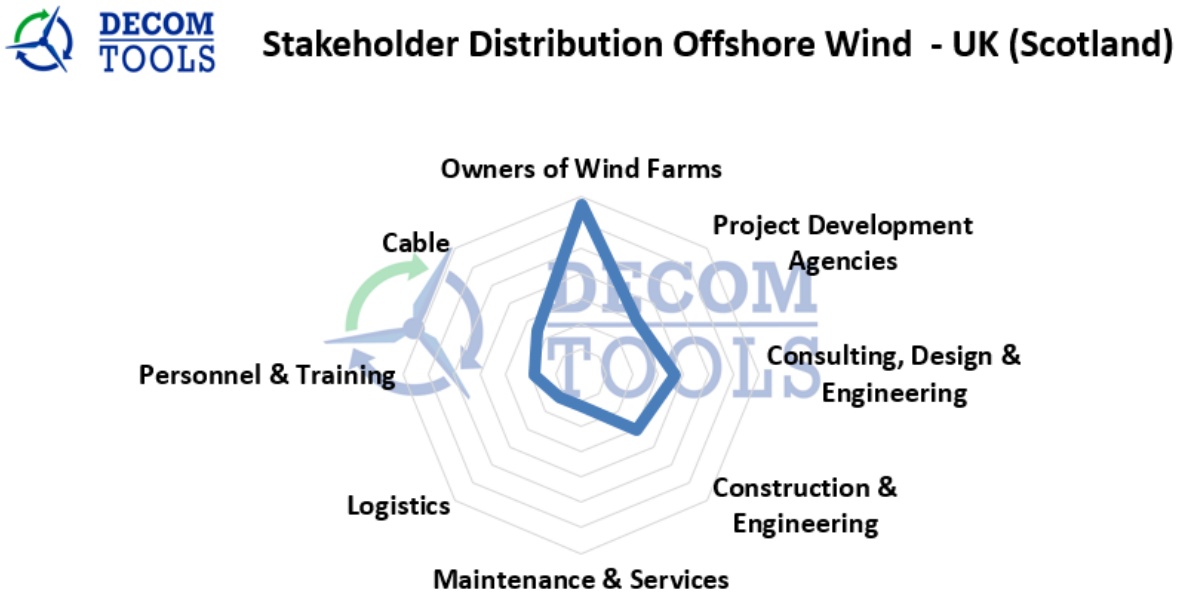

Figure 11: Stakeholder Representation in Offshore Wind Decommissioning, UK (Scotland)

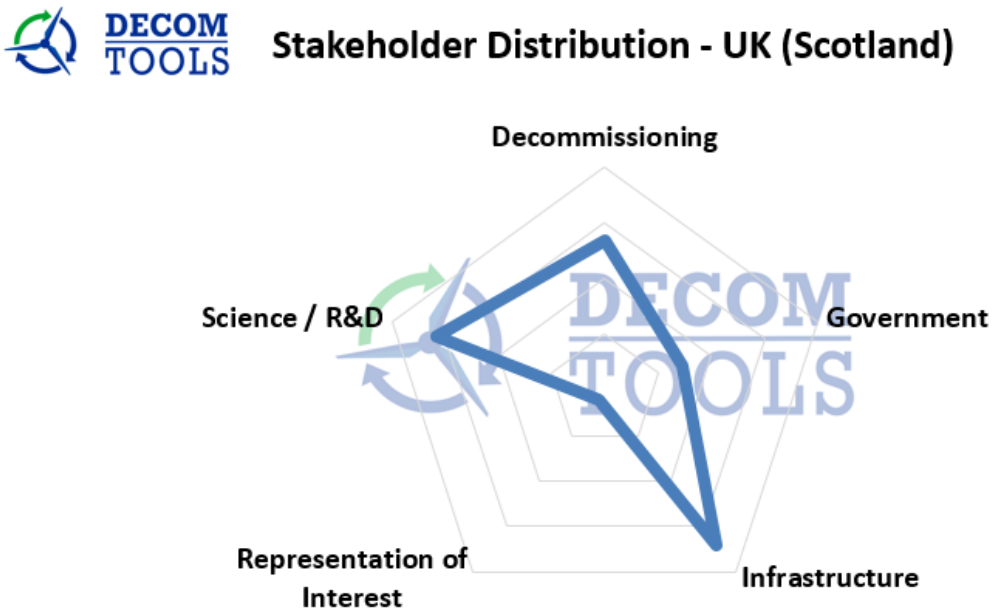

Figure 12: Stakeholder Representation in Wind Energy Related Services, UK (Scotland)

3. Findings from Stakeholder Consultations

In order to understand the stakeholder's perspective on the offshore wind energy market as well as the potential of decommissioning in this field, a structured set of questions has been prepared and provided to each DecomTools partner. Each region had the task to organise a regional workshop inviting the different stakeholder groups analysed above. The aim was to present the DecomTools project and to moderate a discussion. For the corresponding reporting template, see Annex 2. The discussion notes on the different questions are listed on the following pages without valuation. A conclusion of points particularly emphasized or discussed in several regional workshops will be given under point 4.

In Denmark, there was no central workshop but instead several interviews have been conducted with particular companies dealing with offshore decommissioning and related activities such as recycling. For anonymity reasons the names of the companies are replaced by substitute names counting from D1 to D11. The interviews have taken place between June 28th and November 4th, 2019. The number of participants in the particular interviews varied between 2 and 3 persons.

The workshop in Germany was held on April 6th, 2019 in Emden. It attracted 17 participants overall, thereof 6 from research, 8 from the business sector, 1 from administration and 2 from business organisations.

The Belgian workshop was organised on August 29th, 2019 in Oostende. It counted 22 participants, thereof 4 from research, 15 from business, such as farm owners, operators and suppliers, and 3 from administration.

The Dutch workshop was organised on June 19th, 2019 in Eemshaven. It was visited by a total of 40 participants, whereof 20 of them participated in the interviews. Of these 20 participants, 4 were representing consultancy, 1 the building sector, 4 maintenance, 1 the legal sector, 1 transport, 8 finance and 1 another sector. The majority of participants was related to oil and gas (7) and offshore wind (6).

The stakeholder workshop in Norway was organised on April 26th, 2019 in Haugesund and counted 18 participants (plus 9 in separate meetings with local companies), thereof 11 from the research sector, 3 from business, 1 from politics, 1 from administration, 2 from business organisations.

The workshop in the UK (Scotland) was held on May 27th, 2019 in Aberdeen. The number of participants was 25, thereof 18 from research, 3 from business, 1 from administration and 3 from business organisations. The workshop also covered the topic of decommissioning in the oil and gas field. Here, discussions were held in smaller groups prior to a discussion in the plenum.

3.1 Is the topic of decommissioning present for the stakeholders? For which stakeholders? Has the perception changed recently? Is decommissioning considered a business opportunity?

In Denmark, stakeholder D1, a company from the recycling sector, has not yet worked with offshore wind farms. Nevertheless, they see the recycling of wind blades into new material as an interesting business opportunity. Said new material may be used for several new products such as roof tiles, furniture, sea walls or infrastructure products such as bridges. The highest share of costs is expected to be related to transport and handling of wind turbines rather than to the recycling process. Stakeholder D2, a supplying company, has already been engaged with work on offshore wind farms. In former projects, they provided personnel, equipment as well as various other products in this context. D2 considers decommissioning of wind turbines to be a business opportunity in the whole process. The highest cost is assumed to be connected to pulling down the wind turbines and removing the concrete and steel foundations of old wind turbines.

Company D3, engaged in projects with focus on repair and optimisation of gears onsite, has already been involved with work on offshore wind farms. D3 considers offshore wind turbine decommissioning a business opportunity but also states that risk was significantly smaller in onshore wind as the market here was in favourable condition. The company's focus will therefore remain on repair and recycling of onshore wind facilities. The largest cost of decommissioning offshore wind turbines is, from D3's perspective, linked to the risk working offshore with the expensive equipment. Also, transportation and labour hours are considered to be large cost burdens in the overall cost calculation of decommissioning. The most important role in the value chain is attributed to the offshore part of activities and transportation.

D4, a company working in scrapping and recycling business, has been involved in projects on decommissioning of offshore wind turbines. The company considers itself to be a subcontractor being able to arrange the full scrapping of wind turbines. Most of the competencies are held within the company but for particular projects partners are needed, for instance in terms of logistics. For D4, decommissioning of offshore wind turbines is a business opportunity although the company is not dependant on volume (numbers) of wind turbines.

Stakeholder D5, a supplying company from Denmark, has experience in the field of working with offshore wind farms, mostly in the scope of providing workforce for construction. For the company, decommissioning is a business case insofar that an important role is attributed to taking the full scope responsibility and having a strong supplier network for last and efficient decommissioning, reuse and recycling. The largest share of cost in decommissioning is seen in logistics and transportation. Important stakeholder groups are considered to be vessel owners, port infrastructure providers as well as government approvals. Another interviewed Danish recycling company, D6, has not yet been involved in the decommissioning of offshore wind farms but has several decades of experience in decommissioning of oil and gas facilities. In the long run, D6 considers decommissioning of offshore wind farms a business as an EPC contractor. Stakeholder D7, also being involved in the recycling industry, has not been directly involved in decommissioning but agreements on the recycling of offshore wind farm blades have been signed underlining the attractiveness of the company's recycling approach also for wind farm owners.

The company D8 interviewed in Denmark is engaged in grouting solutions and has not yet been involved in decommissioning activities in the offshore wind sector. Instead, D8 is from time to time involved in projects related to repair, lifetime extension and re-fitting. The company describes itself to be a sub-supplier to foundation suppliers and will not be directly involved in the decommissioning process. Stakeholder D9 is a supplier of wind turbines both onshore and offshore with a focus on design, manufacturing, installation and service provision. D9 has not been involved in decommissioning projects due to the fact that the company focuses on the development of projects and supply of wind turbines. However, D9 acknowledges its responsibility for ensuring the sustainable decommissioning of its turbines. Although not being engaged in decommissioning for now, D9 explains that the company is always exploring the possibility to extend their service offerings within the life cycle of the wind turbines. Since a part of the company's operation is already repair and refurbishment of wind turbines, they recognise the need for reusing turbine parts whenever economically feasible and technically possible.

D10, a Danish stakeholder from the recycling sector, has been involved in offshore wind projects but only in the recycling part after offshore components have arrived in ports. Since the company's track record is already relatively long for both onshore and offshore wind recycling the area is expected to remain of high importance for the company. The largest cost share is considered to be labour wage (man hours), equipment and transportation. Other companies with an important part in the value chain expected to be the reuse industry as well as the offshore and transportation part of the supply chain. The last Danish stakeholder being interviewed for the report, D11, is a company specialised in producing wind turbines and a large part of the related value chain, thereunder design, manufacturing, installation and service for wind turbines. D11 has not been involved in any decommissioning projects since the focus usually is on development of projects and the supply of wind turbines. However, the company, as the other interviewed producer of wind turbines, D9, underlines the responsibility to ensure that the produced turbines can be decommissioned in a

sustainable way. The company does not see decommissioning as a business for itself as such. Instead, further engagement in repairing and refurbishment of turbines is held out in prospect.

In Germany, decommissioning activities in different contexts have been part of business activities for various stakeholders already for a longer time period. However, the focus of the participating stakeholders in the workshop is not decommissioning of offshore wind parks because the market for offshore wind park installation is considered to be almost non-existent in Germany (anymore) and has shifted to other countries such as Denmark instead. Companies with a focus on decommissioning in North-West Germany have therefore reportedly taken up new niches. Moreover, rising construction targets for offshore wind energy in Germany are not expected. To the contrary, even declining targets are anticipated as well as a generally more complicated market environment in Germany. If the current regulation, imposing an artificial burden on the offshore wind energy sector by defining unambitious but binding targets, is not changed fundamentally, it is far from certain that all jobs in the industry will be secured. Even now, the workload is far from working to capacity.

In Belgium, companies report to have difficulties in making concrete plans due to a high degree of uncertainty related to permits related to offshore wind and decommissioning. All investments, new machines or new techniques depend on permits and regulatory decisions on what is going to happen to the physical location of wind farms after decommissioning. Without having these in place, companies struggle to make a business case to move forward. Most of the participating stakeholders (47 per cent) consider decommissioning an interesting business opportunity and already have concrete plans to enter the market. Thereby, 24 per cent share the initial interest but see the market

as still too small and young to enter decommissioning business. 18 per cent are already active in the market and 12 per cent are not immediately interested but exploring the field with interest. Therefore, all in all, 89 per cent of the stakeholders see decommissioning as a business opportunity or are either active or plan to do so. However, the numbers are not representative since a workshop on decommissioning topics naturally attracts those companies already interested. However, one can observe a high degree of curiosity among different kinds of stakeholder groups.

In The Netherlands, the participants exclaimed a strong interest in the field of decommissioning in general and the DecomTools project particularly. Most of them have already been engaged in decommissioning projects and therefore gathered a certain degree of experience with offshore activities. On Dutch territory, there are currently new investments into the construction of new offshore wind farms increasing the relevance of offshore activities and the topic of decommissioning in the future However, the market for construction of new wind turbines and maintenance is considered to become very serious and is seen as a significant business opportunity in The Netherlands. Nevertheless, it is seen to be difficult by the participants to get newly involved in the offshore market at least for the moment.

The Norwegian workshop revealed that some companies had the impression that the potential market for decommissioning offshore wind installations in a significant volume was too far ahead. Nevertheless, other companies regard it as a serious business case already.

Decommissioning in oil and gas, which is the main decommissioning experience in Norway, is part of the main business for some of the Norwegian companies invited to the workshop. Other companies focus on subsea operation and installation. Hence, they consider decommissioning of offshore wind parks as a business opportunity although they are sceptic about the volume of the market and if it is going to be profitable. Since decommissioning of oil and gas is a very competitive market with low margins, companies are not willing to take the risk in other markets if they do not see a clear opportunity to compete with the price of their service. The perception of the market for oil and gas decommissioning has not changed drastically. In general, Norwegian companies participating in decommissioning projects for oil and gas are well established. The companies foresee a moderate but stable growth for the decommissioning market in oil and gas for the next five years. This includes both the Norwegian and UK sector since Norwegian companies have linkages there.

Most of the Norwegian companies have already participated in projects both in Norway and in Europe. The scope of the work is described to be related to subsea and topside activities for decommissioning in the oil and gas sector, including cutting and lifting of structures and transport to special ports for further dismantling and recycling of oil platforms and large structures. Also, the companies have conducted projects in other regions such as the Gulf of Mexico. Some Norwegian companies have participated in the installation of offshore wind farms.

In the UK (Scotland), companies from the oil and gas industry report that decommissioning has been a part of their business for quite some time. Work in this field is done on a case to case basis. Most of

the UK based companies have participated in decommissioning projects in Europe and abroad. The scope of work is mainly related to topside and subsea structures with the main activities being cutting and lifting of structures (or parts of it) which were then transported to designated ports for further dismantling and recycling.

The discussion on climate change is expected to further push for an increase in offshore wind. Ultimately, there will accordingly be higher demand for decommissioning or life extension of offshore wind parks. It has been discussed whether a pick up of oil and gas would affect the wind farm industry. Another discussion about the cost of energy for offshore wind has taken place. It was shown that both the cost to deploy and generate has changed as has the support framework.

In general, the initial position in Europe for offshore business is considered to be complicated since new players such as China now dominate the offshore market or are expected to do so. China, for instance, benefits from larger volumes and dimensions being realised in the offshore sector, lower regulation boundaries and relatively low cost for production factors. On the contrary, Europe still not only has several times the offshore wind capacity compared to China but also has ambitious plans. However, the dimensions in terms of size of offshore operations realised in China cannot be handled in Europe which is therefore seen as a mere follower in terms of offshore wind energy by some of the stakeholders.

Nevertheless, Europe has its unique selling point when it comes to work safety and minimising the environmental impact of operations underlining that it is of high importance for Europe to remain engaged and set its own agenda. Moreover, valuable knowledge has been accumulated in European regions when it comes to offshore wind. This can be the foundation for upcoming business when it comes to selling knowledge and experience to other regions working with offshore wind energy such as Asia or the US. The same might hold for decommissioning of offshore wind farms where Europe can set the standard when blueprints for economic and ecological decommissioning processes are developed.

3.2 What are the stakeholders' needs in daily business?

In Denmark, stakeholder D1 complains that there was no legal pressure from the Danish government to ban landfilling and to push companies towards recycling. Accordingly, the company expects the government and its representatives to ensure that rotor blade producers and owners of wind farms take their responsibility on recycling of decommissioned parts. Old wind turbines are currently still being sold to countries where landfilling is still allowed so that disposed turbines are only stripped off their precious materials and dumped afterwards. This is not only considered as a waste of resources that can be used for other purposes but also goes hand in hand with ecological problems of disposed waste and unknown consequences for local ecosystems.

D2 also claims that there was no pressure on the producers and owners of wind turbines to clean off their wind turbines after the end of their life cycle. There are no fixed laws yet on the removal of old wind turbines in Denmark inducing a high degree of uncertainty into the decommissioning process.

Another barrier in daily business that has to be overcome from the perspective of Danish stakeholder D2 is represented in the high risk for cost miscalculations for the offshore part of decommissioning of turbines and structures together with the relative low prices for doing this kind of work. Company D3 sees the investment cost, risks and the uncertainty of the market outlook for decommissioning of offshore wind turbines as the major obstacle in getting involved in the sector. Further barriers are seen in the discussion about extension of offshore wind farms as well as the lack of clear EU law on the decommissioning process.

D5 sees the main reasons for not being involved in decommissioning in a lack of knowledge and streamlined approval processes throughout Europe. Stakeholder D6 claims that offshore wind farms will remain a limited business with a lot of fluctuations in the activities. Danish stakeholder D8 calls for the companies delivering the grout material for offshore wind turbines to be obliged to document the grout's components. The documentation should be taken into consideration when it comes to planning the decommissioning process in order to ensure the elimination of any risk of hazardous substances being released into the environment.

D10 highlights the fact that economies of scale will be high looking at full offshore wind parks. An industrialisation process for each component is expected to cut recycling costs. New techniques will come with the ability to make larger investments for recycling. Moreover, the know-how and investment cost for the industry might act as a barrier for market entry of new companies. Furthermore, the market itself is considered to be problematic since no one actually knows where the "big market" starts. However, in the recycling sector, the barriers for the moment are relatively small. Instead, the offshore decommissioning sector in general lacks a harmonised legislation and work methods in order to function efficiently.

In Germany, the market environment for offshore wind operations has changed dramatically over the last years: Since the first 0-cent-bids have been in place and a tendering model was introduced for offshore wind energy, the costs decreased significantly. On the other hand, smaller operators might not be able to compete in the future due to a lack of economies of scale increasing the threat of increasing concentration within the market and increasing market power for larger companies. In order to ensure planning security for the involved companies, at least an expansion of the construction targets for offshore wind in Germany should be launched fast.

Moreover, uncertain regulations are also observed in the sector of decommissioning itself: For instance, depending on the kind of sediment, the decommissioning of 1.5m of wind park structures below the water surface is legally required but stronger regulations are possible in certain cases. Also, there are different opinions whether 1.5m are sufficient to ensure ship travel or later uses for wind parks. According to the stakeholders, a high degree of flexibility in regulation is required not only in daily business but also in terms of changing regulations and flexible market developments.

It was further remarked that the contact to the operators of wind farms is very limited. The problem of missing linkages is not only limited to most networks but also holds for other stakeholder groups as reported in the workshop. Possible solutions such as an increase of networking beyond traditional linkages as well as more cooperation in clusters were discussed. Clustering might also be a solution for the problem of attracting qualified employees to peripheral regions, for instance in Northern Germany. Other solutions that were discussed were specialised master programs on university level.

Belgian stakeholders underline in the regional workshop that their needs regarding daily business mostly cover four large areas:

- Clarity in permits. By now, it is not put down clearly to what depth a monopile needs to be cut or when the turbine is to be decommissioned (after termination of the permit or just before the end). This kind of information is described to be crucial for companies when it comes to looking for technology solutions, availability of the vessels or, generally, to define an actual business case.
- Related to the first bullet point: Lack of step-by-step explanations and procedures on what to do to obtain the permits for lifetime extensions. Although there is already monitoring in place, it turns out that these mechanisms are not sufficient for the final lifetime extension decision. Moreover, it might be too late to obtain data or to perform relevant analysis to make decisions.
- Decision for what is going to happen to the wind farm site after decommissioning. For instance, a further use as a marine agriculture would imply that some of the infrastructure could be reused. If a new wind farm is to be constructed at the location some of the cables might be reused. Knowing about future plans for the location can heavily influence what the companies are to be prepared for.
- Large storage space requirements. Storing the decommissioned parts of turbines before having them sent to other locations requires large storage in the coast areas. It might also be an option to send the parts to large ports (such as Vlissingen in the Netherlands). Again, it is not possible to proceed to the next steps of storage or recycling without information whether the parts which might be classified as waste are allowed to be shipped to other countries or whether or not there will be new recycling plants in nearby locations.

In The Netherlands, the stakeholders report a need to be better informed about the possibilities to become a partner in offshore wind projects. They would particularly appreciate the chance to be able to participate in the engineering work and logistic activities of projects that are going to be developed in the future. According to Dutch stakeholders, after preparation of plans, subcontracting work should give full attention to make regional companies part of developments and give them a chance to participate. By doing so, the international aspect would be strengthened and interregional cooperation between different stakeholders enhanced. In this context, it is also expected from lawmakers to be more precise and clearer about the qualifications required. A higher amount of regional investment in smaller companies is demanded to participate in niche markets within the major projects on offshore wind. The possible sectors coming into question mentioned at the workshop might be transport, catering, welding or other activities.

From the Norwegian perspective, rules and regulation on decommissioning offshore wind are not considered to be a large problem. The perception is of the kind that regulation from oil and gas will also apply to decommissioning of offshore wind farms. Moreover, there will be no special needs compared to what the companies are used to from the context of oil and gas decommissioning activities.

Scottish stakeholders in the UK underline that there were very clear rules and regulations for the oil and gas decommissioning sector which are believed to be followed by the wind energy industry. Current decommissioning plans are described to be of very high level. It would be required to issue a permit for the final removal, transport and waste disposal. Ideally, the plan should be looked at right at the beginning of the project. This means that there is a clear need for a decommissioning team at the start of the project which indicated principles that need to be clarified.

On a European level, regulation interfering with offshore wind expansion and decommissioning can also be detected in terms of recycling. The recent regulation in Europe is described to be that strict and inflexible that recycling of offshore parts from the wind industry is not economically feasible in Europe.

3.3 Which needs do the stakeholders identify in terms of labour market and infrastructure?

In Germany, the stakeholders put a strong emphasis in the topic of training of a qualified labour force. Even qualified employees such as engineers often lack an understanding of offshore specialities and vice versa. The focus on particular study objects is to be overcome by a more holistic view, further trainings and specific offshore qualifications. Among other research-related topics discussed in Germany were innovations such as new cutting technologies. Here, the required infrastructure for research is not present, according to the stakeholders.

In terms of infrastructure, German stakeholders expect the existing offshore vessels to be sufficient for the upcoming decommissioning challenges. Since the dimensions of projects handled and vessels used in China are steadily increasing, recent vessel types might be sufficient when it comes to decommissioning projects in Europe. Still, the development of new vessel types specifically for decommissioning activities might be considered if the process and its requirements differ from the offshore commissioning procedure.

In Belgium, 39 per cent of the interviewed stakeholders expect labour market and access to qualified employees to become a problem in the future while 44 per cent also consider the topic to rise in importance but trust their own employees to be able to deal with the new challenges if the right training is provided. 17 per cent of the stakeholders do not see a specific challenge regarding the labour force at all. However, the workshop did not produce a clearly formulated need for the labour market or for infrastructure.

In The Netherlands, better trained and schooled personnel is perceived to be a key challenge in terms of the labour market which needs to be solved. In order to do so, stakeholders expect more effort to be put into the availability of schooled workers. As a problematic issue it has been discussed that the value chain in the area of decommissioning work is not yet well developed. To solve the issue of not developed value chains, better laws are recommended and expected from the stakeholders.

Norwegian companies project their experience from oil and gas to decommissioning of offshore wind parks. Some companies already possess large infrastructure and relevant labour force, others possess specific technical capabilities for subsea operations. Hence, companies are more concerned about the economic challenges rather than the technical ones. Among the questions that arose in the discussion were:

- Will it be cost effective to bring decommissioned wind turbines to Norway for further dismantling and recycling?
- Is there enough volume in the decommissioning of offshore wind park turbines to be cost effective with the Norwegian prices for services?
- Norwegian companies in subsea operation have experience in trenching and cable installations so that there is a niche market for cable decommissioning.
- Companies have mentioned the necessity of an assessment of the value in the market in separate segments, for example cable above seabed and buried cable. Are cables the most valuable part?

The UK (Scottish) stakeholders consider larger vessels as crucial parts of infrastructure that are currently missing. Moreover, more and larger ports specialised to the needs of decommissioning (storage, further dismantling, transport, recycling) are mentioned. There was a discussion whether the port structures for decommissioning offshore wind structures could be in synergy with oil and

gas decommissioning facilities. Later uses of the assets are of large interest for the stakeholders, for example a transfer to late life owners as it is done the oil and gas sector. Also, regarding ports, it was mentioned that there was a push to get ports ready for roll out of wind but that did not happen. All in all, a balance between the cost of infrastructure and environmental impacts is considered to be an important point.

3.4 How important is international cooperation in offshore wind energy business in general and for the stakeholders particularly?

The Danish stakeholder D1 is not yet cooperating with other companies in the field of decommissioning of wind turbines but is very interested to do so. Moreover, they are planning to exploit the potential of internationalisation seeing the company's future not only in the national market. D2 from Denmark is already cooperating and working with other companies in relation to decommissioning of wind turbines. However, the future focus of the specific stakeholder will be the Danish market rather than Europe in general or the rest of the world.

Company D3 states to be constantly willing to cooperate with other companies in decommissioning projects. Internationalisation, however, depends on the market as of now the onshore wind business appears to be more promising due to lower uncertainty. But since sometimes onshore and offshore business connect to each other through the same clients, D3 will also have a look at the development on the offshore wind decommissioning market. D4 sees itself to be flexible but is mainly looking at Danish projects. However, they have already been involved in several international projects, in the Baltic and North Sea Region underlining the relevance of internationalisation in decommissioning.

D5 from Denmark has established cooperation relations with other companies in the field of decommissioning and show interest in further strengthening these connections as well as establishing new relationships. However, when it comes to internationalisation, the focus for the next five years will remain to be Denmark since most business cases are related to the national level. Still, the company's track record and knowledge within the field would qualify it also for business outside of Denmark which the company presents itself open to. D6 is not limited to the North Sea in its operations but considers the whole world as a potential market. Further international cooperation is appreciated. For D8, internationalisation or cooperation with other companies is not a relevant topic.

Company D10 expresses to be open for further cooperation exceeding the level which is already pursued. Regarding internationalisation, the company explains to have a global approach to offshore wind decommissioning with a focus on Northern Europe for the moment. Since know-how and infrastructure of D10 are concentrated in Denmark, the openness for international activities is present but it would be preferred to process the recycling in Denmark in the company's own facilities.

In Germany, the stakeholders consider a high degree of internationality to be crucial for instance to attract new employees. Particularly peripheral regions in North-West Germany depend on looking

beyond borders to presents their own region. Among others, a mean to attract young offshore professionals is seen in the establishment of international study programs. Moreover, the international perspective helps to overcome the (politically induced) stagnation in the German offshore wind market. Cooperation with European neighbour countries as well as emerging markets in Asia are seen as a potential help to compensate the domestic problems, e.g. for training measures.

Moreover, new markets such as on the African continent offer a high development potential for offshore wind and in the long term for decommissioning. Also, experience from other countries, for instance from Norway in the oil and gas sectors, can benefit the domestic German offshore and decommissioning companies.

The vast majority of Belgian stakeholders participating in the workshops considers international cooperation to be important for their business: While only 7 per cent see a limited relevance since they were in possession of sufficient knowledge on the local level and another 7 per cent of stakeholders claim that international contacts were only needed when it comes to export activities, 21 per cent see a high importance to reduce the cost of decommissioning. Overall, the majority of 64 per cent looks on internationalisation as an important factor for technology and knowledge transfer.

In The Netherlands, the development of knowledge is based on international or national ruling and law-making. In this context, stakeholders have discussed the development of regional knowledge centres to be able to share acquired knowledge with other centres in other regions or countries. The basic idea of sharing knowledge and expertise in the field of decommissioning is strongly supported. It should be focused particularly on topics such as logistics, finance and law-making.

UK (Scottish) stakeholders were keen to learn from other international partners, for instance in the scope of the DecomTools project. Particularly policy regulations presented during the workshop are considered to be highly important for dissemination of good practice in other parts of the EU.

The overall market has changed from a strong focus on the North Sea to a more global view. Particular stakeholders try to learn from other projects elsewhere. In 2018, meetings in Norway and Germany have been organised with a focus on installation methods in pile driving and bird safety. This topic is considered to be promising insofar that lessons learned from the rest of Europe can be taken into account.

3.5 Is the project DecomTools considered to be relevant and helpful for the stakeholders? What do they expect from the project?

In Germany, the participating stakeholders consider the project to be interesting but, however, some open questions remain. It is questioned whether it will be successful to gather information from the wind turbine producers on which materials were used for the wind turbines (colours, coatings etc.). Additionally, it is mentioned as a problem that the contact to operators of wind farms in general is

insufficient and that a lack of feedback from one of the central stakeholder groups can at least complicate a project such as DecomTools.

Moreover, it has been discussed whether specialised vessels are to be developed. Depending on the kind of decommissioning, regular vessels would be sufficient if the turbines are simply cut and filled with inflatable instruments to be dragged off. Nevertheless, possible further use of the wind turbines (e.g. for export or new use in other contexts) would involve more careful handling and might therefore require special vessels.

In Belgium, the DecomTools project idea has been received positively by the stakeholders expecting the cost models to help in decommissioning business cases.

The Dutch stakeholders consider the project interesting since they will be able to keep up with the developments already being programmed in the field of offshore wind and offshore decommissioning. Informing the stakeholders in The Netherlands with updates as the project continues and develops is a major common interest. Moreover, the regional stakeholders expect to gain knowledge that goes beyond the regional boundaries of the Netherlands.

The Norwegian stakeholders see the project as relevant and interesting but still have difficulties to see the value of the project for stakeholders in a short term. Since companies have a short time perspective, they would be much less interested if the bulk of the market was 10 years apart. However, they still want to participate as stakeholders to receive information.

For Norwegian research institutions, the focus now is on design and installation of offshore floating wind turbines. Hence, the project seems not to be very relevant for their specific demands at the moment but still they explained their interest in being informed. Public offices in Norway are mainly concerned with activities that are carried out in Norway. Hence, if a large amount of wind turbines is coming to Norway for further dismantling and recycling, it will be relevant for the public side to know for instance about possible hazards for the environment.

However, it has been commented that the Norwegian decommissioning infrastructure in ports for oil and gas were already capable of handling large amounts of hazardous material such as asbestos, heavy metals and contaminated residues (including radiation and chemical contamination). Therefore, most likely wind farms will present less hazardous challenges to the local environment compared to oil and gas facilities. Still, large volumes of composite materials from the blades of the turbines might be a challenge.

In the UK (Scotland), the consensus among the participating stakeholders was that it is a good thing to have these kind of projects such as DecomTools and in particular there have been some clear suggestions on how to obtain more data on specific work packages that are worked upon by Scottish partners.

The questions that have been raised regarding the project included whether some of the Danish or German decommissioned wind farms can be used to benchmark the decommissioning model developed in Scotland. The open questions included:

- Should environmental aspects and questions be included?
- Is there a possibility to use existing oil and gas comparative assessment methods also for decommissioning of offshore wind facilities?
- Is there a question about removal and repowering and what will be used as the base line?

Again, the topic of data availability came into discussion with regards to offshore wind operators, their data and whether they might be willing to share these.

3.6 Other issues that have been discussed

In Denmark, stakeholder D4, a company dealing with scrapping of waste materials, remarked that more detailed information about the ingredients of turbine blades are required in order to make sure that the composite material can be recycled accordingly. Stakeholder D5 from Denmark proposed to industrialise the process and do a larger part of the decommissioning work offshore. By doing so, decommissioned parts could be sailed directly to recycling facilities driving down logistic costs which constitute the highest cost in such a project. Danish stakeholder D7 remarked that recycling measures for the composite materials of wind farm blades can also be applied to the recycling of

other products such as boats. Research in the scope of offshore wind will therefore also generate positive spill-over effects on other sectors.

Some companies at the German workshop were interested in the technical solutions for decommissioning while other companies did not consider the large challenges to be in the technical sphere but are more interested in the volume of the market and the schedule for decommissioning of wind parks in Europe. It has been remarked that offshore wind farms might also be decommissioned even if the complete lifespan is not yet reached due to public funding running out.

Particularly environmental questions are discussed in Germany when it comes to decommissioning. The question whether wind park foundations below the water surface become the habitat for marine life and should therefore not be decommissioned at all was not agreed upon.

When recycling of decommissioned parts is not an option, decommissioning is considered to be significantly easier compared to construction since the parts do not have to be handled that carefully. Still, when it comes to recycling, there is a difference between GRP (glass reinforced plastic) and CRP (carbon fibre reinforced plastic) as materials of blades. Since composite materials are almost impossible to recycle, profound knowledge about the materials used in the wind farms and their components is inevitable for the highest possible degree of recycling.

In Belgium, the stakeholders also discussed what parts of a wind farm were the main limitation of its lifetime. The majority of 44 per cent opted for towers and foundations, while 39 per cent chose rotor blades, 11 per cent electric systems and cables and 6 per cent mechanical and rotary components. Another question was about the greatest challenges when an offshore wind farm is decommissioned. Here, 41 per cent saw the largest challenges in recycling of materials, 29 per cent voted for logistics and transport, 24 per cent for environmental impact and 6 per cent regarded safety as the largest challenge.

When discussing the role of SMEs in the whole value-chain of decommissioning, 50 per cent of the stakeholders agreed that SMEs can play an important role if they are prepared, 11 per cent saw the role as limited since the area of decommissioning is mostly seen as a big player's playground while another 11 per cent saw SMEs even as the only way to reduce the costs. The remaining 28 per cent did not give an answer. A further question was about the potential need for innovation when it comes to decommissioning of monopiles and buried cables. Here, 31 per cent of the stakeholders agreed since today's technology is considered to be potentially harmful for the environment. Another 25 per cent agreed because today's technology is too expensive and 19 per cent consider the already existing technology as sufficient. The remaining 25 per cent gave no answer.

When it came to the discussion about new facilities being required for waste management and recycling, 11 per cent of the Belgian stakeholders considered the existing infrastructure to be sufficient, 44 per cent regarded new facilities to be required but only with limited additions and 28 per cent opted for complete new infrastructure to ensure a sustainable process. The remaining 17 per cent gave no answer. Regarding the question, how long before the "expiration date" of a wind farm decommissioning planning should be initiated, 33 per cent saw 2 years as the optimal starting

point, 40 per cent voted for 5 years and 27 per cent even opted for 10 years. None of the stakeholders saw one year as sufficient to plan the decommissioning process before the lifecycle of a wind turbine expires.

In The Netherlands, a major challenge is considered to be the keep up of the now aroused interest: During the DecomTools project, updates have to be offered to interested companies and a network of participants must be created in order to send out progress messages. Communication in general is seen as a crucial challenge deciding on the impact of the project.

There are differences among the stakeholders on how to deal with decommissioned wind farms. One part of the discussants plans to scrap the parts and to recycle the removed raw materials while the other side looks at recycling possibilities of the turbines without destroying them since small repairs might make the plants fit for export or a new use in the onshore environment. This question has a high influence on the type of decommissioning method that is to be applied since turbines that are only to be used as a source of raw materials are to be handled with less care than those facing a new life in a new environment. Moreover, there might arise a certain level of competition between the oil and gas sector and companies focusing on decommissioning of offshore wind turbines when it comes to the limited number of specialised vessels.

The UK (Scottish) stakeholders at the regional workshop listed a variety of challenges that have to be addressed when dealing with offshore decommissioning in general and offshore wind particularly:

- There is more clarity or certainty about decommissioning of offshore wind than with regards to oil and gas meaning there are more opportunities for oil and gas to leave material in place compared to wind farm projects.
- Is it expected that in 25 years there will still be turbines built alongside decommissioning / repowering. Can they work together?
- Fishermen will not be keen to have large areas blocked off so that they cannot undertake their core business. Therefore, decommissioning of offshore structures either has to be done completely so that no remains are left that could hinder ships or fishermen or existing wind parks are to be repowered to most efficiently use the favourable spaces for offshore wind.
- How about new forms of energy in the future such as hydrogen? Would it be easier to be transported than electricity generated from wind farms? How will this change the infrastructure and decommissioning challenges?
- Planning for decommissioning will reduce the cost of the process due to a decrease of uncertainty.
- There is a potential for using new materials to improve CO2 reduction.
- How to deal with new designs for decommissioning moving forward?
- Challenges of repowering – the size of the wind farm will change so that foundations will have to be designed to take this change into account.

It remained an open question why the timescale is specified since if there is a 25 years consent there will still be new submission to decommission or repower.

3.7 Additional remarks

It was suggested during the workshop in Aberdeen to also look at the aircraft industry for recycling components. Moreover, UK (Scottish) stakeholders stated that current support frameworks require developers to have warranties in place for sufficient time or plan for replacement. This appears not to be the case for older wind farms which have a shorter warranty period. It was doubted whether all parts have to be repowered at the same time. Instead, it has been proposed that particular parts should be replaced as they fail, making a continuous monitoring either manually or technology-based inevitable.

One central field of discussion in Scotland (UK) has been whether a functioning wind turbine should be decommissioned if it still generates steady electricity. A new consent condition was proposed to include a statement that if the turbine in question does not generate for a period of time only then it should be decommissioned. In this context, it has been explained that the 25-year license for offshore wind farms is generally based on bird population and environmental issues. Expanding the time of 25 years would therefore not only be a question of mechanical conditions or stiff regulation but also of environmental concerns that must be kept in mind.

Moreover, some warranties only have a duration of 15 years raising the question whether a new warranty should be bought after termination of the initial warranty or just run as best as possible for the remaining 10 years of the expected life time of a wind turbine.

4. General Conclusion

The stakeholders in the workshops show a high degree of curiosity related to decommissioning of offshore wind farms becoming a potential business opportunity. Although this is, to a certain degree, related to the fact that the workshops only attracted those stakeholders with an initial interest in decommissioning, it shows that the development of the decommissioning sector is monitored very closely. As the volume of offshore wind decommissioning projects is expected to rise more in the mid- rather than the short term, there is some scepticism on the right timing to enter the market. Due to the related uncertainties, mostly those companies already being involved in decommissioning of oil and gas facilities show a vital interest here.

It was regularly mentioned that a major share of decommissioning cost will be attributed to transportation and the logistic side of decommissioning. This will be dealt with in another work package of the DecomTools project. Moreover, concerns regularly mentioned were related to legal uncertainties. While there is no streamlined legal consensus across Europe on decommissioning, there are also gaps in national regulation and differences between the different countries that make European or even international cooperation complicated in this field.

When it comes to recycling, European and national regulations are considered not to be strict enough obliging owners of wind farms and decommissioning companies to really recycle the largest possible amount of resources from each wind turbine. Although there are certain parts which are hardly recyclable, e.g. the nacelle housing or the blades being constructed from composite materials, the problem of landfilling rather than recycling parts is still present particularly when parts are exported. To tackle the issue of unrecyclable wind turbine blades, the DecomTools project will focus on the development and testing of new recycling solutions.

Both access to qualified labour force as well as the availability of adequate infrastructure (ports with sufficient size and capacities, storage space, hinterland connection etc.) are broadly considered to be critical potential bottlenecks for the future. Since there is still sufficient time to adapt to the arising new needs for decommissioning, port authorities and educational institutions such as universities are in a position to adjust accordingly beforehand.

5. Sources

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Annex 1

Template for the Regional Market Player Inventory

OFFSHORE WIND INDUSTRY

Owners of wind farms

-
-

Project Development Agencies

-
-

Consulting / design and engineering

-
-

Construction and Installation

-
-

Maintenance / service

-
-

Logistics

-
-

Personnel & Training

-
-

Cable

-
-

DECOMMISSIONING

Decommissioning

-
-

Recycling

-
-

GOVERNMENT

Politics and Administration

-
-

INFRASTRUCTURE

Ports

-
-

REPRESENTATION OF INTERESTS

Environmental Lobby Organizations

-
-

Economic Interests

-
-

Social Interests

-
-

SCIENCE / R&D

Universities

-
-

Scientific Institutions

-
-

Annex 2

Reporting Template for the Regional Stakeholder Workshops

Date, Location and Time of the Workshop:
Number of Participants: Thereof from research: Thereof from business: Thereof from politics: Thereof from administration: Thereof from business organisations: Thereof from NGOs:
Agenda of the workshop:
Feedback on the preliminary results of the market analysis or the project in general:
Is the topic of decommissioning present for the stakeholders? For which stakeholders? Has the perception changed recently? Is decommissioning considered a business opportunity?

What are the stakeholder's needs in daily business?
What needs do the stakeholders identify in terms of labour market and infrastructure?
How important is international cooperation in offshore wind energy business in general and for the stakeholders particularly?
Is the project DecomTools considered to be relevant and helpful for the stakeholders? What do they expect from the project?
Other issues that have been discussed:

Additional Remarks: