→ gas service companies reflect the cost of the ability to work in the North Sea all year round and the typically "one off" nature of the oil and gas industry. Several offshore wind projects have already suffered major delays and additional cost by selecting "cheap" solutions and have had to change to more appropriate vessels and procedures during the installation phase, indicating that the offshore wind industry has, in this area, not been willing to learn from the oil and gas industry. However, there is no logical reason why the repetitive nature of designing, manufacturing and installing offshore wind farms should not result in significant cost savings. The opportunity to optimize the supply chain and installation techniques as a result of the experience of installing multiple identical units is not an opportunity that the offshore oil and gas industry has had.

The major oil companies exploiting the North Sea have not competed for offshore technology, they have adopted an open and cooperative approach to many of the problems of working in the North Sea. This is particularly true of safety systems and the technology associated with the installation and maintenance of North Sea structures. The oil companies' collective strategy has been to support collaborative research projects and resist technology developments which are protected by intellectual property rights. Their preference has been to foster a competent and highly competitive service sector, and encourage active competitive tendering, thus allowing market forces to control prices.

In contrast, the offshore wind industry is still dominated by turbine manufacturing companies who tend to be secretive and are unwilling to share their experience in installing and operating offshore wind turbines. A more open approach may help to reduce risks and the perception of risk as seen from an investor's point of view.

Many oil companies have transferred the operation and maintenance of offshore facilities to service companies, who are selected by competitive tender. This has led to the reduction in oil companies' in- house offshore engineering expertise, and their ability to control the technology, equipment and procedures used to exploit their offshore oil and gas reserves. This trend has been highlighted in the recent oil spill disaster in the Gulf of Mexico, where BP had contracted virtually all the equipment and services being used to drill the well. This strategy reduces cost, but it also reduces the oil company's ability to control the technology, equipment and procedures used. However, it does not change the company's ultimately liability for the whole operation and leads to a situation where a company has liability but only limited control. Unfortunately, some owners of offshore wind farms are following the trend of subcontracting most aspects of developing, installing and operating offshore wind farms, preferring to place contracts on the basis of price of a per mega watt of offshore wind turbines installed.

This is probably, in the long term, a high risk strategy for the wind farm owners, especially when the relatively immature status of offshore wind farm technology is taken into account. It is probably better for wind farm owners to take more in-house responsibility for the technology on which they will rely for long term financial prosperity.

Whilst the offshore wind industry can and has learnt many things from the offshore oil and gas industry and there are areas where both industries can collaborate to their mutual advantage, the offshore oil and gas industry will compete with the offshore wind industry for resources, and because fossil fuel energy prices are likely to rise as demand rises and supply is constrained, the offshore oil and gas industry may well be able to out bid the offshore wind industry. This element of competition and the associated higher prices for resources, may prevent offshore wind from installing the planned capacity and make it harder for offshore wind energy to reduce its cost of energy.

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The Interreg IVB North Sea Region Programme
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Overcoming Challenges for the Offshore Wind Industry and Learning from the Oil and Gas Industry

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Executive Summary

The development of the offshore wind industry in Europe is driven by two key factors:
- **Security of supply**
- **Global warming**

The EU currently imports more than 50% of its energy, often from unstable parts of the world within a global energy market where demand may exceed supply. There is an obvious strategic requirement to reduce the EU's dependence on imported energy by exploiting sources of energy from within the EU. Offshore wind energy is one component of the future energy mix which can reduce the EU's reliance on imported energy, but it has no automatic right to be part of that energy mix. Offshore wind energy must, in the long term, become competitive with other European sources of energy.

It is generally accepted that man made sources of atmospheric pollution, often referred to as green house gases, and in particular carbon dioxide, are accelerating the rate at which the earth's atmosphere is warming. Generating electrical energy from offshore wind is one way of producing electricity with low carbon dioxide emissions, which will help to reduce Europe's carbon footprint. It also has the potential to generate a substantial proportion of the electricity Europe requires. In addition offshore wind farms are located away from and often out of sight of the general public and this generates a lower level of opposition to the construction of offshore wind farms than might be expected for onshore wind farms, This makes offshore wind an attractive way for Europe to reduce carbon emissions and comply with its obligations under the Kyoto protocol.

Challenges Faced by the Offshore Wind Energy Industry

Safety, how it is maintained and improved, is a very important issue and particularly important in an offshore environment where there are more risks and it is more difficult to get help if an accident occurs. The offshore oil and gas industry has faced these challenges for more than forty years and has developed safe systems of work and methods to ensure that these systems are constantly reviewed and updated in the light of the experience gained during operations. This experience is available for the offshore wind industry to adopt and adapt. In discussions with senior managers in the offshore industry one of the key issues facing the offshore industries is complacency, which can lead to lapses in concentration and failure to follow procedures, i.e. by taking short cuts to save time. This tends to happen when an experienced service engineer has to follow a repetitive series of tasks. The challenge is to improve safety and in particular eliminate accidents caused by complacency in an industry where there may be many hundreds of identical machines to be serviced and maintained.

Recent consultants' reports indicate that offshore wind has one of the highest costs of any energy generating technology which is currently available on a commercial scale, this still seems to be true even when the estimated costs of carbon capture and storage are included in the cost of fossil fuel powered thermally generated electricity. The high cost of energy generated by offshore wind farms is probably the biggest single challenge facing offshore wind and it is imperative that the industry reduces these costs as rapidly as possible. There is no "magic bullet" which will reduce the cost of offshore wind energy, it can only be achieved by optimizing every stage of development, manufacture, installation and operation. However, because wind energy does not require the purchase of a fuel, the anticipated increase in the cost of fossil fuels, caused by market forces and carbon taxes, is likely to make offshore wind power more competitive in the future.

The high cost of energy generated by wind farms means that a subsidy of approximately Ð100 per MW hr is required to make the electricity generated by offshore wind farms commercially viable. Subsidies are awarded by national governments and this brings an element of political uncertainty into the economics of offshore wind. Banks and financial institutions view this as a commercial risk i.e. subsidies may be reduced or removed by government, and this may affect the ability of wind farm owners to raise the capital required to build offshore wind farms.

The ability to raise the capital to build offshore wind farms is also hindered by the legacy of poor reliability for some early offshore wind farms, which makes offshore wind look "too risky" to investors, and the constraints resulting from the recent global financial crisis. Although the offshore wind industry cannot control the financial markets, it can and must improve the reliability of offshore wind farms and reduce the cost of energy, making it less reliant on subsidies. This is likely to be difficult to achieve because of the inherent conservatism of the financial community who like to see many years of successful track record, the incremental approach to the development of offshore wind farm technology which is still rooted in an onshore paradigm, and the absence of long term testing of new designs in the marine environment.

Because many renewable energy sources are intermittent, and based on the assumption that conditions will be favorable for renewable energy generation somewhere in Europe for most of the time, geographic dispersion of renewable energy generation will help to reduce intermittency. To achieve this on a European scale requires the construction of a super grid. Offshore farms can play an important role in the development of a super grid, by acting as connection nodes and using the export cables which have to be installed to make the wind farm operational as part of the super grid. For example, the UK Round 3 Dogger Bank wind farm is more or less in the centre of the Southern North Sea and could form a node in a super grid and allow the UK to be connected to Denmark, Germany, the Netherlands and Belgium. This would facilitate international trade in electricity and allow the Dogger Bank wind farm the option of exporting to five countries and the European grid. A super grid is likely to improve the utilization of offshore wind energy by allowing access to multiple markets with different demand profiles.

The offshore wind industry faces a series of challenges from the global supply chain, in particular the supply of:
- **Copper, for cables, transformers, generators etc**
- **Rare earth minerals, for high permeability permanent magnets**
- **Large casting and forging, for bearings, shafts and gearing systems**
- **High powered semiconductors, for control, power conditioning and AC/DC conversion**
- **High modulus carbon fibre, for wind turbine blades**

The offshore wind industry will have to compete with other industrial sectors for these materials, this may have the effect of increasing the capital cost of wind farms. There are also opportunities associated with these shortages to develop alternative technical solutions, e.g. the shortage of copper may lead to the development of aluminum conductors for submarine cables and super conductors for transformers and generators.

There are very few suitable harbours with long deepwater quays, lay down areas for marshaling components, and areas for assembling wind turbines (a minimum of 6 hectares is required) and additional space for factories to produce wind farm components, (because most wind turbine components are too big to be easily transported by road). Because large harbour developments take a long time to plan and construct and generally require national or regional government financial assistance, there is an urgent requirement to start planning, funding and building these facilities if the EU 2020 targets for offshore wind are to be met.

There is a concern about the supply of suitable vessels capable of installing offshore wind farms. The market has responded by building new wind turbine installation vessels, so there is less concern about the capacity to install foundations and turbine assemblies. However, there is still a shortage of vessels capable of installing cables, both within array cables and export cables. The offshore oil and gas industry operates vessels capable of installing these cables but the global offshore oil and gas market is buoyant, so these vessels may not be available to install wind farm cables. Further, there is the potential for competition from the oil and gas industry for existing and new vessels, because the planned peak for installing offshore wind farms (2015 to 2020) is likely to coincide with a peak in oil and gas decommissioning activity and the installation of what will probably be the tail end of the construction of gas production platforms in the Southern North Sea.

There is insufficient capacity to manufacture the quantity of submarine cables required for the planned offshore wind farms. One industry source suggested that if all the existing submarine cable manufacturing capacity was added together and then multiplied by ten, there still wouldn't be enough capacity. Whilst this may be an exaggeration, it does point to a significant shortfall in manufacturing capacity. Cable manufacturers have recognized the market opportunity and have or are building new quayside factories; however, several cable manufacturers have reported current backlogs of two years or more, which indicates that current supply is only just keeping up with demand.

There is a similar shortfall in the capacity to build offshore wind turbines, and an urgent need to build new factories adjacent to suitable harbour facilities. One turbine manufacturer reports the ability to manufacture approximately 200, 5MW or larger turbines per year from its factory. To achieve the EU 2020 targets, it is likely that between three and five turbines will have to be installed per day, or between approximately 1,000 and 1,800 per year. These quantities are for the offshore market and exclude the demand for onshore turbines, so there is currently a significant shortfall in the capacity to build offshore turbines.

A large offshore wind industry will require engineers and technicians to install and operate them. There is a concern over the availability of suitably qualified people which leads to a requirement to establish education and training courses to provide a supply of qualified personnel. There is an associated concern that because many of the basic qualifications required for the offshore wind industry are very similar to the offshore oil and gas industry there will be competition between the two industries for personnel. Operators of offshore wind farms are already reporting a migration of skilled workers from the offshore wind sector to the offshore oil and gas sector, because this sector is offering better pay and conditions. In the long term both industries have to attract more young people to offshore industries and to encourage them to take science and engineering subjects at school and university. A joint approach to this problem, coordinated by a group of trade and industry associations, is more likely to be successful and should aim to promote common courses in basic offshore technology, safety systems and survival techniques are offered, because it would provide young people with career options, before they have to take a specialist course in a particular technology.

Newly installed offshore wind farms normally have a five year manufacturer's warranty, backed by an insurance policy and a five year service contract. During this period the original equipment manufacturer supplies spare parts, consumables and is responsible for any repairs required. After the warranty expires the wind farm operator is free to select a different service contractor and to source consumables and spare parts and repairs from the open market. This is an opportunity to grow an independent and competitive wind turbine service and repair industry. Because wind turbine companies tend to be very secretive, and don't normally release detailed technical information, it is likely to be a challenge to establish independent service companies with access to the technical information required to provide an effective service.

Learning from the Offshore Oil and Gas Industry

Most of the technology developed for offshore oil and gas, and relevant to the offshore wind industry, is available in the public domain. A large part of this technology is directly available through existing companies, this is particularly true in design, where most of the learning has been incorporated into standard engineering practice.

The technologies developed for offshore construction vessels, dynamic positioning systems, saturation diving, ROVs, heave compensated winches and cranes etc. are all available, either in existing vessels or as components, which are available commercially, and can be incorporated into new vessels.

The supply chain which supports the day to day operation of the offshore oil and gas industry is readily transferable to a future offshore wind industry when permanently manned offshore installations are operational. Industry contacts have indicated that they are ready and waiting for the commercial opportunities to arise.

The perception that offshore wind can't afford oil and gas prices is at best, only partly correct. The offshore oil and gas industry is highly competitive and has successfully addressed cost reductions through pan industry initiatives. The prices charged by oil and →