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OFFSHORE WIND ONSHORE JOBS – A NEW INDUSTRY FOR BRITAIN

A report by Energy for Sustainable Development (ESD) Ltd for Greenpeace UK

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Printed on 100% post-consumer waste – environment-friendly paper

© Energy for Sustainable Development (ESD) Ltd

October 2004

ISBN 1 903907 12 8

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Design by Paul and Julia Hamilton @ oneanother

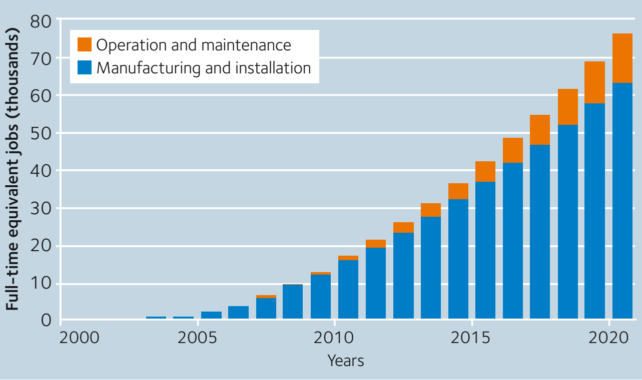
EXECUTIVE SUMMARY

This report assesses the potential job benefits arising from offshore wind power development in the UK, and in particular the North-East of England. Input/output modelling is used, in conjunction with conservative assumptions on the rate of growth of electricity supply and other variables, to ensure that job creation estimates are defensible (see Annex A). To illustrate the potential for future offshore wind growth, three scenarios are used in which the contribution from offshore wind power provides 10%, 20% and 30% of the UK's total electricity supply by the year 2020. The principal findings are as follows:

- The rate of growth of offshore wind power will need to increase rapidly, reaching around 5 gigawatts (GW) per year by 2020 in order to achieve the highest scenario.
- Under the highest scenario, employment from offshore wind power would reach 76,000 additional full time jobs by 2020, compared to the 2003 level. The majority of these (some 64,000) would be in manufacturing and installation, as illustrated by Figure 1.

Figure 1

Cumulative additional employment, assuming 30% of electricity supply by 2020



- We estimate that more than 50% of the manufacturing jobs created would be near the top of the supply chain and therefore likely to be physically situated close to the centre(s) of turbine production. Therefore, in order for the maximum jobs benefit to be realised in the North-East, it is essential that new wind turbine manufacturing be located in the region.
- Operation and maintenance jobs have long-term stability and will grow in line with installed capacity. Manufacturing and installation jobs are less permanent, but the North-East has a good opportunity to create manufacturing jobs that can be sustained throughout the period of growth in the European market, and can be supported into the longer term assuming that contracts are awarded for refurbishment and replacement as early turbines reach the end of their design life.

The North-East is in a very strong position to exploit the opportunity presented by the new growth in the offshore wind power industry:

- The region's ports enjoy easy access to the large proposed wind development areas on the east coast, and to other European sites.
- The long industrial history and established manufacturing capacity of the region, coupled with its strong skills base and competitive labour costs, makes the North-East a natural target for inward investment.
- An existing regional renewables supply chain is well coordinated and supported.
- Underlying unemployment rates mean that the North-East's workforce could support the rapid growth of wind turbine manufacturing, and benefit greatly from the economic activity so created.
- Some important players are already established in the region, and targeted public support to the renewables sector is growing, enhancing the North-East's research, technology and skills base.

Although projections are necessarily approximate and uncertain, it is possible that with appropriate policies and incentives as much as half the projected new jobs could be brought to the North-East.

1. FOREWORD BY MINISTER OF STATE FOR ENERGY MIKE O'BRIEN MP

Climate change is for real. It poses a threat to the world we are living in. We must make every effort now to leave our children a better world to live in. The Government has committed to the development of clean renewable energy and set targets of 10% of UK electricity to be generated from renewables by 2010, rising to 15% in 2015. At present offshore wind power is one of the fastest-developing renewable energy sectors and offers important electricity generating potential in the UK.

So far two leasing rounds for offshore wind project proposals have been held. In the second round, 15 offshore wind farm lease applications were approved by the Crown Estate. If all these proposals proceed to approval and completion they could represent up to 7.2 gigawatts of capacity, potentially generating enough electricity to power one in six households in the UK.

In the 1980s the UK led the way in wind technology and we can do so again. We have a long tradition of expertise in offshore engineering, we have led the way in offshore oil exploration and can lead the way in offshore wind development and technology.

Given the massive potential for offshore wind in the UK we must also recognise the social and economic benefits to be gained from developing a UK-based offshore wind industry, as well as the problems that arise.

This report highlights the jobs and industry that could be generated in the UK by a successful offshore wind programme. It identifies the skills that would be needed for a UK-based offshore wind industry. The North-East of England is already home to the world's first purpose-built offshore wind installation vessel; Marine Projects International's ship Resolution. In addition the region has the skills, the expertise and the location to develop a UK-based offshore wind industry.

I hope you find the report interesting and informative – it is only by working together that Britain will reap the social, economic and environmental rewards of the burgeoning offshore wind sector.

CONTENTS

2. GREENPEACE PREFACE

Greenpeace has long believed that the urgently needed clean energy solutions to the threat of climate change also offer benefits beyond those of protecting the environment.

Wind power is the world's fastest-growing energy source, with installed generating capacity increasing by an average 30% annually between 1997 and 2003. A record 8.1 gigawatts (GW) of new wind power capacity was installed worldwide in 2003, representing €8 billion worth of technology development. The leap in capacity drove total global wind power installation to over 39GW, enough to power 18 million average European homes. Around 88% of the additional wind power capacity installed was in Europe and the United States, and worldwide 90% of capacity is found in those two regions.

Wind power is growing fast in the UK too. The Government's Energy White Paper of 2003 set out the first ambitious commitment to the development of renewable energy in the UK – and none too soon. As a result of the measures now in place wind power is really taking off in Britain. More onshore wind capacity was given consent in 2003 than ever before and around a gigawatt's worth of onshore wind turbines are now awaiting construction.[1] Meanwhile, the announcement of the second round of offshore wind farms makes the UK's planned development among the most ambitious of any country. If realised, these plans will put the UK firmly in place as the world leader in offshore wind development.

There is still a long way to go to get from today's small UK renewables capacity to the 2020 target of 20% of total national capacity to which the Government aspires. But this challenge is also an opportunity – for the wind industry, for UK manufacturing and for the North-East of England in particular.

Greenpeace commissioned the present study from Energy for Sustainable Development Ltd to determine whether this boom in wind power, initially driven by the need to find clean, secure, safe supplies of energy, can bring social and economic benefits to the UK in addition to the environmental gains it offers. Most British people support wind power. In a survey of opinion polls over a decade the British Wind Energy Association found that consistently, over the whole period up to and including the present, eight out of ten British people have wanted more wind farms. Greenpeace's own experience engaging with the public, both directly and through the website yes2wind.com, fully backs up this conclusion.

People are rightly worried about climate change and they do not trust the nuclear industry. They support wind power because they know it is the right choice. What they may not realise is that wind power, and other renewable energy technologies, are not just the right choice in environmental terms. In fact wind power delivers dividends on all three pillars of sustainability – the environment, the economy and society. This report focuses on the positive employment effects of offshore wind and shows that the North-East could and should be a major recipient of those dividends.

The Government's Energy White Paper has set a context for large-scale growth of wind power in the UK. The UK is in a position to take this forward into Europe and to play a leading role in setting ambitious European targets for renewables. This would increase still further the enormous potential markets for clean energy. There is already a big pie to slice, with huge markets for the many industries that form part of the wind energy supply chain. Now it is essential, if the UK is to benefit fully, that the industry that will build these wind farms is encouraged to develop in the UK. For years the UK has trailed behind Germany, Denmark and Spain; now, with the right decisions and the proper investment and support, this country could at last become a major player.

The great majority of the proposed UK round two offshore wind farms are off the North Sea coast of Britain. Most offshore wind projects in other European Union Member States will also be very accessible from North Sea ports. The North-East region is at a great geographical advantage when it comes to providing the skills and industrial capacity to deliver, not just the UK's, but Europe's wind energy ambitions.

The take-off of offshore wind has handed UK industry and the North-East an amazing economic opportunity. Now we must take action to seize that opportunity for the benefit both of the North-East and of the UK as a whole.

Greenpeace is calling for:

- Government support and investment in the development of the supply chain industries based in the UK that could benefit from the offshore wind revolution. Areas with an established maritime and manufacturing skills base, such as the North-East, and especially those that have suffered with the decline of traditional manufacturing, must be helped to make the most of the huge markets that will be generated by the growth in wind power.
- Suitable conditions to encourage multinational wind developers to site their facilities in the UK. The practical geographical incentive is there with the need to be close to one of the major European centres for wind expansion. Now the economic conditions must be attended to so that manufacturing facilities are established in the UK, benefiting those skilled UK workforces, such as that in the North-East, who are ready to deliver our wind energy vision.

3. INTRODUCTION

Objectives

Energy for Sustainable Development Ltd (ESD) was commissioned by Greenpeace UK to undertake an analysis of the potential job creation benefits of offshore wind power development in the UK.

In particular ESD was asked to assess how growth in this new industry could benefit the North-East of England, given the region's highly developed skills base and traditions in many industries relevant to the offshore wind sector.

The report comments on how the opportunities offered by the accelerating growth of wind power in the UK, stimulated by UK government policies, can be seized on by industry, development agencies and government to provide maximum benefit for the North-East.

Context

Following several years of uncertainty over government financial support for renewables in the wake of the Non-Fossil-Fuel Obligation, the Renewables Obligation (RO) came into effect in April 2002. The RO is an obligation on electricity suppliers to secure a growing percentage of their total supply volume from renewable sources. Renewables Obligation Certificates (ROCs) are awarded to renewable generators for each unit of energy output, and purchased by suppliers to prove compliance with the RO. The current shortage of ROCs raises their price and makes renewable generation more valuable. Whilst it is premature to declare the long-term success of the RO, the initial fears of the financial sector and renewables developers over ROC price risk have been at least partially assuaged.

In February 2003 the UK Government published its Energy White Paper (EWP).[2] At that time there was no specified commitment to growth in the RO after 2010, but the EWP did give a strong underpinning to the existing political commitment to renewables and to the UK's commitment to cut carbon dioxide emissions. The EWP set an aspirational target of achieving 20% of UK electricity supply from renewables by 2020. It also accepted the Royal Commission on Environmental Pollution's recommendations that the UK must reduce its carbon dioxide emissions by 60% compared to 1990 levels by 2050. Through the White Paper the Government has committed to putting the UK on a path to achieving that 60% cut.

The EWP was among the firmest statements of support for a transition to a low carbon economy and for renewable energy and energy efficiency yet made by any government. Nevertheless, uncertainty over the potential price of ROCs once the 2010 obligation is met was widely held to be an obstacle to investment in renewable energy technologies. In response to this concern, the Government has since increased the RO target and it now stands at 15% of electricity supplied from renewables by 2015. There is therefore a strong driving force behind the development of renewable energy in the UK and behind offshore wind in particular, since the UK is especially rich in that resource.

Wind energy is now the fastest-growing sector of the power industry worldwide, with average annual growth in Europe over the last five years reported to be 28%.[3] In 2003 global growth was 26%, representing around 8.1GW of additional capacity with an investment cost of €8 billion (of which around €5.4 billion was in Europe).[4] With this growth, total worldwide installed capacity at the end of 2002 stood at some 39GW, or enough to power about 18 million typical European homes.

In Europe the total installed wind power capacity grew 23% to some 28GW in the year to December 2003,[5] with almost 75% of this growth occurring in just Germany and Spain. European direct and indirect wind industry employment has also grown significantly, from 25,075 jobs in 1998 to 72,275 jobs in 2002.[6] The German wind energy association, Bundesverband WindEnergie e.V., estimated in 2004 that there were approximately 45,400 wind industry jobs in Germany alone (of which about 37,200 were in manufacturing and installation, and the remaining 8,200 in operation and maintenance).[7] According to a recent report from the Department of Trade and Industry published through Renewables UK, there are currently approximately 8,000 jobs sustained by the renewables industry in the UK, of which around half are in onshore and offshore wind.[8]

The UK has the best wind resource in Europe, but the UK's current total wind power installed capacity (both offshore and onshore) remains small at around 767 megawatts (MW) by mid-2004 (expected to reach 1,690MW by the end of 2005),[9] with 60MW offshore at North Hoyle wind farm. According to the British Wind Energy Association over 2GW of onshore and offshore wind capacity has consent and is currently waiting to be built, about half of which is offshore capacity.[10] The current UK capacity represents only 2.3% of total European capacity;[11] however, current UK project proposals for offshore wind, if completed, are set to make the UK the world leader in offshore wind development over the coming decade.

The manufacturing base for the utility-scale wind industry in the UK is currently small. Examples include the Isle of Wight blade factory and the Machrihanish turbine factory, both owned by the

Danish company Vestas;[12] the new DeWind turbine production facility in Loughborough; and the proposed wind turbine manufacturing facility in Fife recently announced by Nordic Windpower.[13] As a result of the underdeveloped status of the UK industry, wind turbines currently being installed in the UK are predominantly being manufactured in Germany and Denmark, and this is likely to continue for most of the UK's offshore wind capacity that was permitted in the first leasing round.

Methodology

This report examines three different scenarios for the development of offshore wind power in the UK between now and 2020. These scenarios, all of which are practicably achievable, are based on offshore wind generating 10%, 20% and 30% of UK electricity demand by 2020.[14] Using an input-output analysis specially developed over a number of years for this type of study (see Annex A), the potential total number of jobs that could be created under each scenario has been modelled. Where those jobs occur will depend largely on what steps are taken to encourage the growth of an indigenous UK manufacturing industry and supply chain to meet the demands of the growing offshore wind market in the UK. By the same token the regions in the UK that benefit most from the new economic activity will be partly determined by policies at both national and regional levels designed to encourage inward investment in particular areas.

Opportunities for the North-East

UK-based manufacturing of wind turbines and turbine components is currently limited. However, experience from around the world suggests that such manufacturing activity will tend to migrate to those countries or regions where the local growth of wind power is the strongest. It is clear therefore that the scale of the UK's offshore wind potential, coupled with its ease of access by sea transport to other parts of northern Europe, makes it a natural home for a new offshore wind manufacturing industry.

At the end of 2003 these conditions were enhanced by the announcement of the second leasing round for offshore wind farms in UK waters. Adding to the 1.5GW of offshore wind power planned under the first round, the second round comprises proposals totalling as much as 7GW of wind farms. These proposals include individual projects in excess of 1GW and could create a UK market for the offshore wind supply chain of over £7 billion. The second round proposals are focused in three key strategic areas, two of which are on the east coast of England – the Wash and the Thames Estuary.

In 1999 Greenpeace commissioned a report from ESD entitled Offshore wind, onshore jobs, in which the potential for generating new employment in the North-East through offshore wind power was assessed. Many of the most critical manufacturing activities in the North-East identified in that report, including offshore engineering, steel fabrication and marine transport, are still present.

The potential role of the North-East in the renewables sector is further strengthened by a variety of publicly supported initiatives, including:

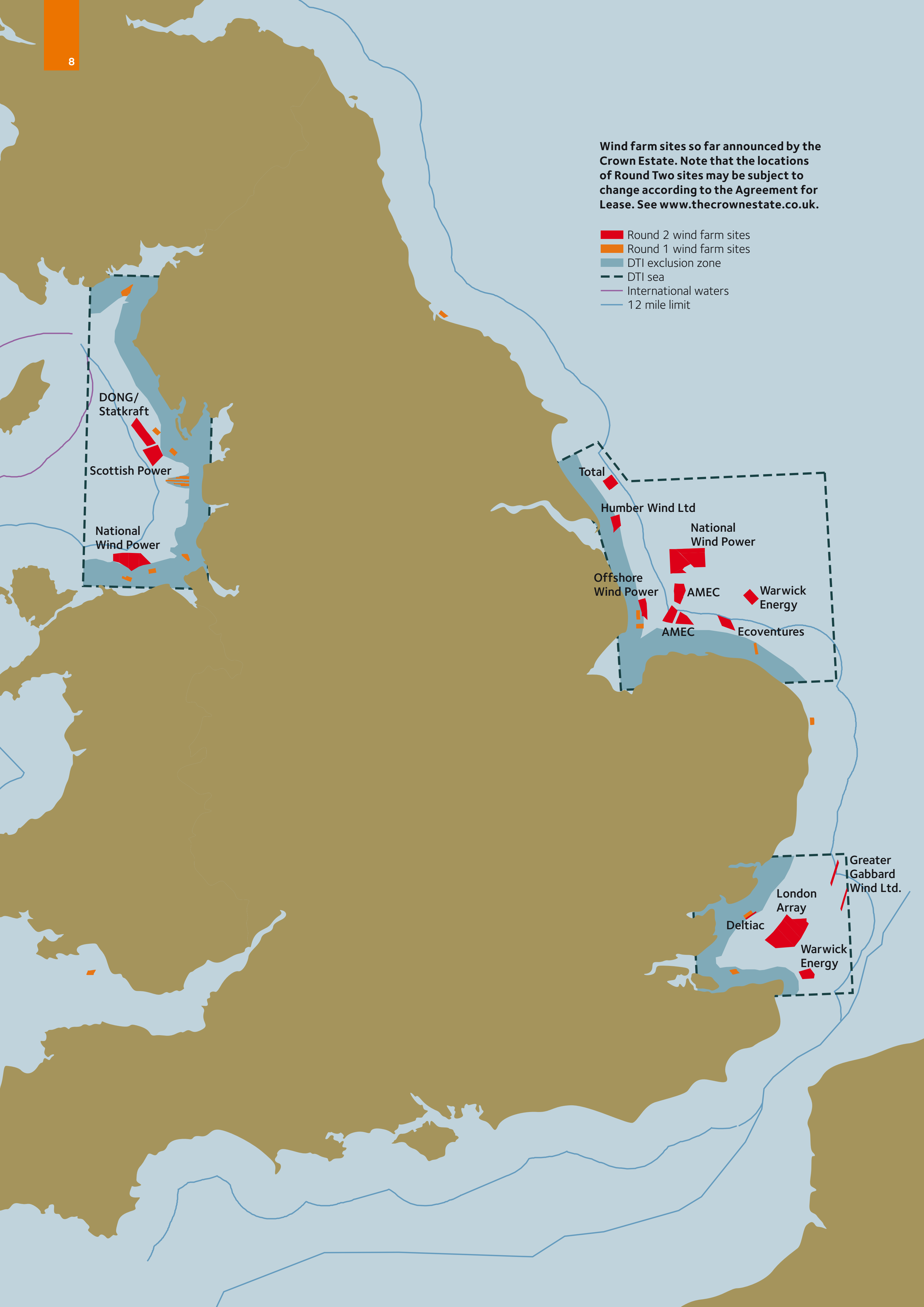
- the New and Renewable Energy Centre (NaREC),[15] a centre of excellence in renewable energy technologies created in the context of the One North East (ONE) Strategy for Success, with its investment in Blyth, Northumberland, providing wave and tidal power dock facilities (already operational and currently being upgraded), wind turbine blade testing facilities (due to open in October 2004 and believed to be the largest in the world), an electrical power laboratory (due for completion in late 2004) and seminar facilities (already open)

- NOF[16] (formerly the Northern Offshore Federation) with its coordination of companies in the renewable energy supply chain though the North East Renewables Club

- economic development organisations such as ONE[17] and the Tees Valley Development Company.[18]

The decision by Marine Projects International[19] to locate its offshore wind operations in Middlesbrough is a strong symbol of the potential of the region to prosper by servicing a new growth industry. The consistent support given to the sector in recent years puts the North-East in a strong position to compete with any other region or country as the most attractive location in which to build a long-term offshore wind manufacturing industry.

In the UK a sharp increase in activity in offshore wind development is beginning. The UK is also well placed to reap the maximum benefit from the development of the offshore wind power industry across Europe. Given the right incentives from government, offshore wind power (both generation and manufacturing) can become a major new industry for Britain. The North-East can be at the forefront of this renewable energy revolution.



Wind farm sites so far announced by the Crown Estate. Note that the locations of Round Two sites may be subject to change according to the Agreement for Lease. See www.thecrownestate.co.uk.

4. OFFSHORE WIND FOR THE UK

Context

The UK's offshore wind resource is the largest in Europe. Although the UK is starting from a very low base, the conditions now exist for a significant acceleration in the exploitation of this resource, through the existence of the RO and capital grants for offshore wind development.

Commercial interest in this opportunity is demonstrated by applications to the Crown Estate for the grant of site leases for wind development. In the first round of awards, 18 companies were awarded offers of leases under the Crown Estate procedures, having demonstrated adequate commercial preparedness to develop the sites. Of these projects, National Wind Power's North Hoyle wind farm is now operational, while Powergen's Scroby Sands project is under construction at the time of writing and will be fully commissioned by the end of 2004. Several other projects will also be constructed during 2005.

In December 2003 the Crown Estate announced the results of the second leasing round, for which 29 companies had registered about 70 sites with a total potential capacity of some 27GW, about half of which were in the Greater Wash area, close to the North-East. Fifteen projects, representing between 5.4GW and 7.2GW of capacity, have been offered leases. Of these 8 are in the Greater Wash and total a potential 3.6GW of capacity. Among the Greater Wash projects is what would be the world's largest offshore wind farm with a capacity of 1.2GW. When completed the 15 projects nationally will provide electricity equivalent to the demand from four million homes, or one in six of UK households.

German and Danish companies are the dominant EU manufacturers of wind turbines at present and it is likely that the bulk of offshore wind developments permitted under at least the first round of the Crown Estate procedures will employ turbines from these countries.

The EWP acknowledged that more policy strengthening would be needed to achieve the target of 10% renewably generated electricity by 2010. Originally the Government intended to review progress under the RO by 2005/06 and then elaborate a strategy for the decade 2010–20. Due to concern over investors' willingness to invest in offshore wind projects, the Government increased the RO from 10% by 2010 to 15% by 2015 to give longer-term regulatory certainty. This move was widely welcomed as an important reinforcement of policy. Further strength has come from the EWP's statement of a longer-term aspiration to increase the share of renewably generated electricity to 20% by 2020. The commitment to a further £60 million of capital grant funding in the period 2002/03–2005/06, with offshore wind a specific target for this expenditure, enhances the measures.

It is clear that offshore wind will play a major part in achieving a 15% or higher proportion of UK electricity supply from renewables. It is also clear that the Government sees offshore wind as a key part of the strategy to reduce carbon dioxide emissions. Onshore wind and other renewables still face planning hurdles and it is as yet unclear whether new planning guidance[20] will effectively remove this barrier.

Offshore wind development does face some uncertainty over cost and lacks the long-term proof of performance enjoyed by other renewable energy technologies. Nevertheless, the sheer scale of the resource, and the prospect of cost reductions through scale effects and experience, mean that it promises to make a major contribution to the UK's renewable energy targets.

The *Sea Wind East* report,[21] published in 2002, made clear the technical feasibility of achieving a much bolder scenario than the EWP suggests, namely that 25% of the UK's electricity supply could be produced from wind power off the coast of East Anglia alone by 2020. Many of the assumptions made in that report are carried through in the present report. Applications to the Crown Estate for development leases confirm the potential of the east coast of England, and emphasise the scale of the opportunity for companies in the North-East to service this area.

Other nearby European countries also have plans for the exploitation of offshore wind resources: for example, wind farms are proposed on the North Sea coasts of Germany, Belgium and the Netherlands. These coasts are readily accessible from the North-East of England, further increasing the potential size of the region's market for offshore wind manufacturing and services. A recent report by Garrad Hassan, written for Greenpeace, has shown how offshore wind could deliver 30% of total present-day EU electricity demand by 2020, with significant social and economic benefits across the EU. This reinforces the point that the market for industries in the offshore wind supply chain is both international and potentially enormous.[22]

Scenarios of offshore wind growth

Three scenarios of future offshore wind growth have been analysed. The scenarios assume that offshore wind output reaches 10%, 20% and 30% of total UK electricity supply by the year 2020.

Each scenario assumes that the necessary financial incentives and permitting arrangements are in place to drive the growth in offshore wind power such that it reaches the projected levels by the year 2020. Moreover, it is assumed that offshore wind growth will continue beyond 2020, driven by, for example, larger renewables targets and a more extensive European emissions trading regime with tight caps that continue to reduce over time. It is further assumed that, during the modelled period, no significant limits to development are encountered, for example in the form of electricity market penalties for intermittency or limits to transmission infrastructure upgrading.

The capacity installed annually (Figure 2) and cumulative capacity (Figure 3) assume an increasing rate of growth that reflects the ability of an expanding industry base to service the demand for offshore installations, growing from the present low base. The maximum rate of annual installation under the 30% by 2020 scenario is around 5GW/year, broadly consistent with the *Sea Wind East* report.

Figure 2

Offshore wind capacity installed annually under three scenarios.

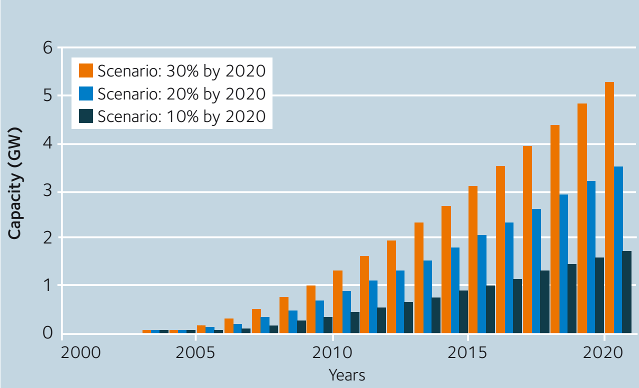
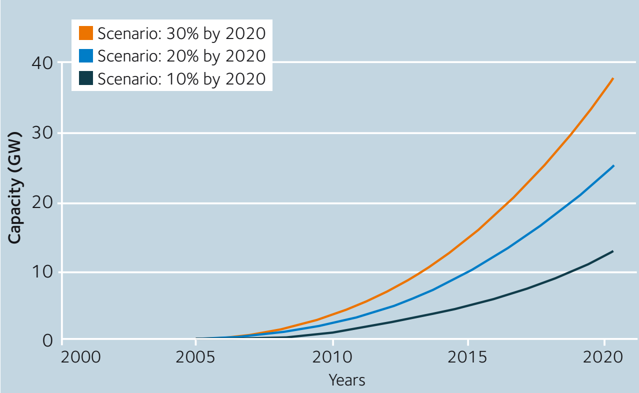


Figure 3

Cumulative offshore wind capacity under three scenarios



5. JOB CREATION POTENTIAL

Modelling approach

Employment creation has been modelled in this study using an input/output (I/O) analysis developed over several years specifically to model the renewable energy sector, and used previously by ESD to determine the impact of renewable energy on employment and economic growth in individual countries in the EU.

The I/O analysis is explained fully in Annex A. Briefly, it is a standard approach to determining the number of jobs created in all areas of the economy as a result of increased investment in the activity of interest. The I/O model in this case is driven by capital and operation and maintenance costs for offshore wind in each year. These projections take account of expected reductions in cost over time due to scale effects and 'learning curve' efficiencies, taken from published literature and from discussions with individual companies. I/O analysis furthermore provides a projection of net jobs, taking account not just of jobs created but also of jobs lost by displacement from existing economic activity. In the case of a dramatic expansion in offshore wind power capacity, some jobs would be lost through, for example, the closure of fossil fuel-powered or other power stations. The results below indicate that the net job creation position is still strongly positive.

The I/O model uses standardised definitions of industrial sectors, based on the Standard Industrial Classification (SIC) (see Annex C). The SIC is a comprehensive and detailed coding system which classifies businesses by their main type of economic activity, based on the types of products made or the service given. It is revised from time to time as new products and the new industries that produce them emerge, and as emphasis shifts in existing industries. The latest 1992 revision, SIC(92), is based on the revised version of the European classification (NACE Rev 1).[23]

Job creation

The UK offshore wind sector has significant potential to generate new employment. Using the stated assumptions on rate of growth of offshore wind capacity, the I/O modelling suggests that under the highest scenario (assuming that 30% of the UK's electricity supply is provided by offshore wind by the year 2020), additional employment would be created at around 17,000 full-time equivalent (FTE) jobs over and above the 2003 level by 2010, and 76,000 by 2020. The majority of these jobs (around 80%) would be created in the manufacture and installation of wind turbines, and the balance would be created in offshore wind farm operation and maintenance. Job projections are presented as net figures, ie inclusive of the effects of job losses and gains in different economic sectors. The net results for all three growth scenarios, and for the 'snapshot' years 2005, 2010 and 2015, are given in Table 1.

Table 1

Total net additional employment, by scenario (FTE)

Scenario	Job type	Year 2005	2010	2015	2020
10% by 2020	M&I	680	4,985	11,726	20,151
	O&M	63	518	1,873	4,414
	Total	**744**	**5,504**	**13,599**	**24,565**
20% by 2020	M&I	1,352	9,909	23,307	40,050
	O&M	84	998	3,001	8,828
	Total	**1,436**	**10,907**	**26,308**	**48,878**
30% by 2020	M&I	2,130	15,613	36,723	63,106
	O&M	105	1,479	5,568	13,241
	Total	**2,236**	**17,092**	**42,291**	**76,347**

M&I = Manufacturing and installation
O&M = Operation and maintenance

These results are shown graphically for all years in Figures 4, 5 and 6 (overleaf). The numbers of jobs under the three offshore wind growth scenarios are presented to the same scale, to permit easier comparison.

Short-term and long-term job creation

The number and duration of manufacturing and installation jobs is tied to the rate of installation. If installation were to cease after the year 2020, or if the rate of installation were to fall, some or all of these jobs would be lost. However, in conditions of a stable or rising market for offshore wind turbines, it is to be expected that manufacturing and installation for the wind power industry would provide stable, long-term employment. The likelihood of creating long-term jobs in manufacturing and installation is increased by the fact that the need to refurbish and replace wind turbines will begin to take effect by around 2025 (outside the period modelled here). Furthermore, a larger future European market is expected to provide greater opportunity and stability

Figure 4

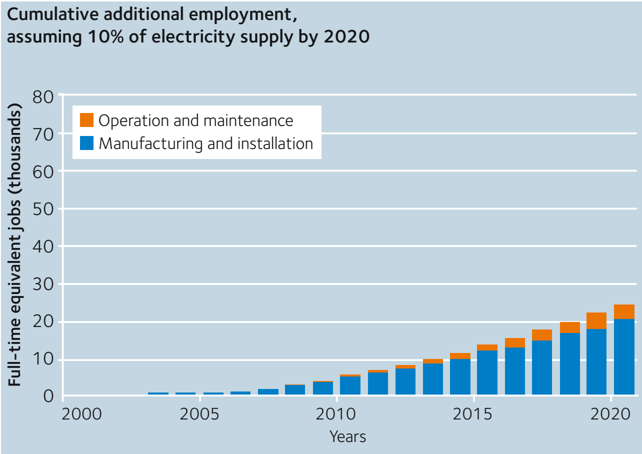


Figure 5

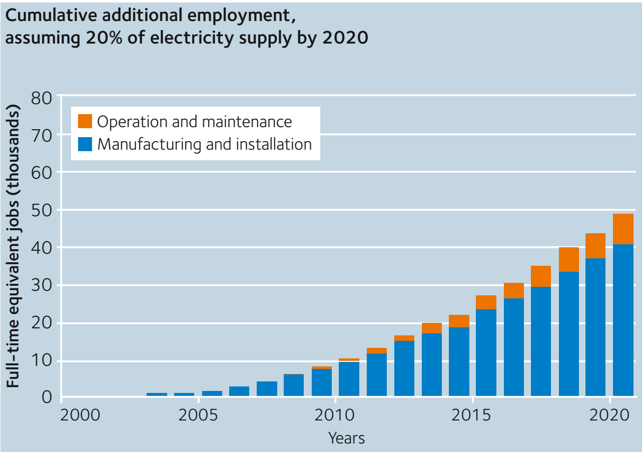


Figure 6

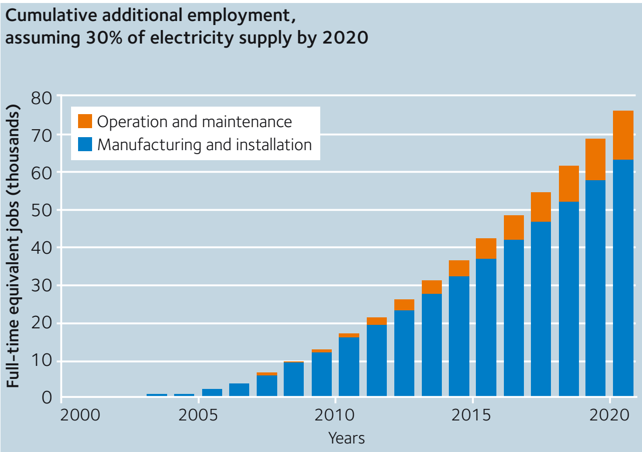
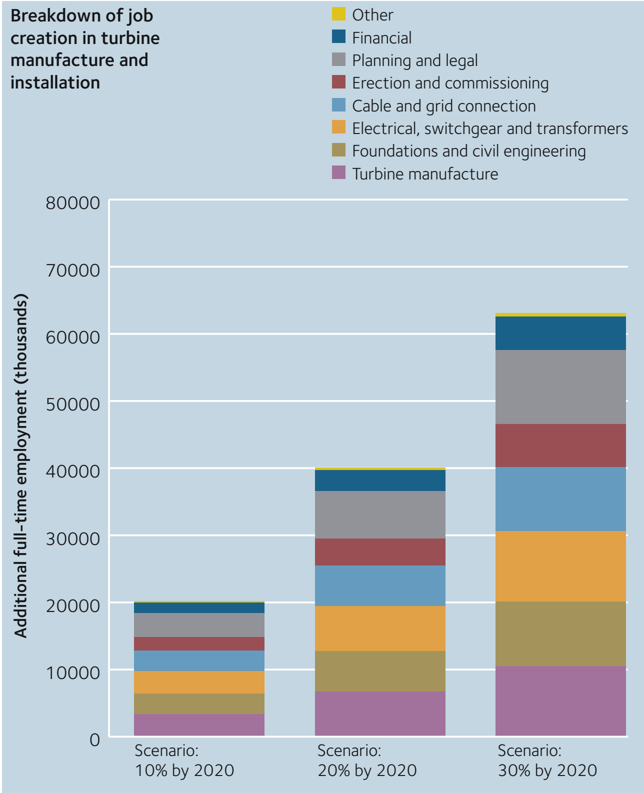


Figure 7



for turbine manufacturing and installation as time goes on.In contrast the operation and maintenance jobs, some 13,000 by 2020 under the 30% scenario, are by definition long-term and will be sustained for the lifetime of the installations (between 25 and 30 years), and beyond if installations are refurbished or replaced ('replanted').

Analysis of job types

For each job created directly in a wind turbine manufacturing plant, many more will be created 'indirectly' in the supply chain that feeds both that plant and the installation, operation and maintenance of the turbines. I/O analysis works by estimating the net effect on direct and indirect employment in the full range of industry sectors that feed a given supply chain. In this analysis, employment in 26 individual industry sectors (see Annex C) is seen to be affected to varying degrees, and the net jobs position is the sum of changes across these sectors.

There is, broadly, a good correlation between those sectors where the most employment stands to be created and the sectors that characterise industry in the North-East.

The breakdown of jobs by industry sector may be analysed in two ways:

a) by looking at the jobs required to provide the different components of a manufactured and installed wind turbine

b) by estimating the extent to which particular manufacturing and services will need to be delivered in geographical proximity to the primary wind turbine manufacturing and installation process.

Breaking down the manufacturing and installation jobs by component and operation shows that there are roughly equal numbers of jobs created in building the turbines themselves; foundations and civil engineering; electrical and switchgear; cables and grid connection; and planning and legal services. Fewer jobs are created in erection and commissioning, and in financial and related services. This breakdown is summarised in Figure 7.

Regional characteristics of job creation

It is possible to distinguish, on a very approximate basis, between those activities that are primarily connected to the manufacture, installation, operation and maintenance of offshore wind turbines, and those more distantly connected. The division of jobs between 'primary' and 'secondary' manufacturing and services is made on the basis of the underlying industry sector (SIC code) in which the jobs would occur.

It is reasonable to assume that primary activities (for example the production of electrical and mechanical equipment, sea transport, etc) are more likely to be located in proximity to the main centres of manufacturing and installation. In contrast, 'secondary' activities (for example communications or the production of chemicals etc) are less likely to occur in proximity to these main centres.

This analysis suggests that something over half of all jobs created could be in reasonable proximity to any centre of turbine manufacture and installation. This in turn implies that for the North-East to derive the full jobs benefit possible from the projected growth in UK offshore wind power, it is essential to attract turbine manufacturing to the region.

This analysis is summarised in Table 2.

Table 2
Estimated division of offshore wind employment into primary and secondary manufacturing and services

Primary manufacturing	The manufacture of wind turbines and components, along with those manufacturing activities and sectors directly connected, eg industrial machinery, electrical machinery, metal processing, etc. Such related activities can be regarded as close to the top of the offshore wind supply chain, and are likely to take place in reasonable proximity to the actual wind turbine manufacturing and installation sites.	**57%**
Secondary manufacturing	Activities and sectors only indirectly connected, eg mineral extraction and processing, chemicals, raw plastics, paper, etc. Such activities can be regarded as further down the supply chain, and are more likely to be geographically dispersed.	**7%**
Primary services	The installation of wind turbines, along with activities directly connected to servicing the offshore wind manufacturing and installation, and operation and maintenance businesses, eg land and sea transport. Such activities are generally likely to be based in proximity to the main manufacturing and installation activity and/or to the wind farms themselves.	**11%**
Secondary services	Activities not directly connected to offshore wind power. This category includes, for example, banking and communications. Such services do not need to be delivered in close proximity to the primary activity.	**25%**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6. OPPORTUNITIES IN THE NORTH-EAST

The strength of the region

The North-East has substantial opportunities to gain from the expected growth in offshore wind power:

- The east coast of England, from the Thames Estuary northwards, is set to be one of the largest offshore wind development areas in the country, with strong competition for leases from wind farm developers.
- Ports in the North-East provide ready access to wind farm sites along the east coast of England, and the North Sea coasts of other European countries with offshore wind development plans are within easy reach.
- The North-East has a long history of, and well-established capacity in, manufacturing industry, and provides ready access to world-class capabilities in the marine, offshore oil and gas, and power generation sectors.
- The renewable energy sector in the North-East is already supported by economic development initiatives to enhance the research, technology and skills base, such as NaREC, NOF and ONE (see Section 3).
- An existing regional renewables manufacturing supply chain is well coordinated and supported by NOF (see Annex E).
- The North-East is currently completing the New and Renewable Energy Centre (NaREC) at Blyth, Northumberland, benefiting from £10 million of investment and helping to create a nucleus of renewables industry activity. This centre will have the biggest wind turbine blade test facility in Europe, and include wave and tidal dock facilities and a photovoltaic technology centre.
- The industrial and research skills base is strong in the North-East, and is augmented by large numbers of technical graduates from universities in the region.
- The unemployment rate among the industrial workforce is relatively high, meaning that skilled workers are available to support rapid growth in the offshore wind industry.
- The region already has offshore wind capability, for example in the form of Marine Projects International (based in Middlesbrough)[24] and AMEC Wind (based in Hexham, Northumberland).[25]
- The region already hosts the UK's first offshore wind turbines at Blyth.

In addition to these strengths, a fast expansion in offshore wind jobs will make an important contribution to reducing the North-East's economic deprivation, caused by years of steady decline in traditional manufacturing.

Available skills in the North-East

A skilled industrial workforce exists in the North-East. Of the one million people employed in the region, some 16%, or 159,000, are directly employed in manufacturing industries (see Table 3).

Table 3[26]
Local Area Labour Force Survey – North-East

Sector	Jobs	%
Agriculture and fishing	5,000	0.5
Energy and water	10,000	1.0
Manufacturing	159,000	15.9
Construction	54,000	5.4
Distribution, hotels and restaurants	228,000	22.8
Transport and communication	54,000	5.4
Banking, finance and insurance	133,000	13.3
Public administration, education and health	304,000	30.4
Other services	54,000	5.4
Total	1,001,000	100

Data on unemployment rates can be contradictory, but recent data (2003) indicates unemployment at 6.5% in the North-East as a whole, or around 74,000 workers.[27] In 2002, almost 18,000 of the region's unemployed were science and engineering professionals, skilled workers in construction, engineering and other trades, or plant and machine operators, demonstrating a high availability of potential skilled labour for a new North-East wind energy industry.[28]

Technical skills in the North-East are fed partly by higher education institutions in the region that in 2001 (the most recent year for which figures are available) produced a total of some 82,000 graduates, of whom around 28,500, or 35%, graduated in technical or related subjects (see Table 4).

Table 4[29]
Technical graduates in the North-East 2000/01

	Total all subject areas	Physical sciences	Mathematical sciences	Computer science	Engineering and technology	Business and administrative studies
University of Durham	13,205	1,630	325	550	480	1,380
University of Newcastle upon Tyne	18,175	975	355	450	1,875	785
University of Northumbria at Newcastle	22,045	695	130	1,930	775	4,135
University of Sunderland	12,525	385	10	2,000	630	1,845
University of Teesside	16,090	335	10	3,800	1,250	1,775
	82,040	**4,020**	**830**	**8,730**	**5,010**	**9,920**
	Total technical graduates:					**28,510**

This data suggests that the North-East has an immediate skills availability from unemployed workers capable of servicing the entire year 2020 demand for jobs created under the 20% of supply by 2020 scenario. By extension, the early years of offshore wind expansion under any growth scenario could be immediately supported and a manufacturer coming into the region would find no constraints on growth from a personnel or skills shortage.

As well as skills availability, the cost of employment is an important factor in considering the creation of new manufacturing facilities in the North-East. Based upon available statistics for 2002 or 2003, average annual manufacturing wages in the region are comparable with the rest of the UK but are strongly competitive compared to wages in the countries where the main European wind power manufacturing capacity is based (see Table 5).

Table 5
Comparison of average annual wages in the manufacturing sector (£)

North-East England [30]	17,676
United Kingdom	17,564
Germany [31]	24,900
Denmark [32]	29,000

These figures show that manufacturing labour costs in the North-East are nearly 40% less than in Denmark, Europe's principal wind power exporter.

The potential for job creation in the North-East

The North-East has the ability to provide a strong long-term base to service the offshore wind power industry. The region can draw on long-established skills and infrastructure, and can comfortably service a high rate of growth.

The central importance of establishing turbine manufacturing and installation, as well as operation and maintenance activity, in the North-East should be emphasised. The presence of wind turbine manufacturing will have an important multiplier effect on employment, since regional engineering, steel fabrication and other activities are likely to form the local supply chain for finished turbines.

As UK offshore wind development grows it is very likely that more international players will wish to establish UK manufacturing bases that permit integration with established EU supply chains for critical components, that are strongly supported by local supply chains, and that offer good access to the main offshore resource areas.

An accurate projection of the number of jobs that could be created in the North-East is not possible since this is dependent on a large number of unpredictable variables. Nevertheless the foregoing analyses of regional skills and workforce availability, wage rates, geographical proximity to major offshore wind development areas, existing support to the sector, and the region's industrial capacity, make it reasonable to propose that the North-East could feasibly capture 50% of the total job creation implied by the growth in UK offshore wind power, or between 35,000 and 40,000 jobs by 2020 under the 30% of supply by 2020 scenario.

How many of the total UK jobs are created in the North-East will depend crucially on how far the region is successful in attracting inward investment and turbine manufacturing, and regional government policy and incentives will need to focus on these objectives.


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7. CONCLUSIONS

It is clear from the findings of this report that offshore wind power offers a model of sustainable industry for the UK. This fast-developing and cutting-edge technology fully meets the three key identified criteria for sustainability: it benefits society in terms of generating employment; it benefits the economy in terms of creating a new industry; and it benefits the environment by delivering clean energy without emitting carbon dioxide.

There is already significant employment generated by the wind industry. In the UK, of the 8,000 people employed in renewable energies, around half are employed by the wind power industry. Germany, with its wind development programme already far advanced, has an estimated 45,400 people employed in wind industry jobs.

This study concludes that the potential employment benefits from offshore wind development in the UK are very significant. Looking at three scenarios whereby 10%, 20% and 30% of present-day electricity demand are met by offshore wind power by 2020, the report concludes the following:

10% of electricity from offshore wind by 2020 will create additional employment of approximately **25,000 jobs** by 2020.

20% of electricity from offshore wind by 2020 will create additional employment of approximately **49,000 jobs** by 2020.

30% of electricity from offshore wind by 2020 will create additional employment of approximately **76,000 jobs** by 2020.

The UK Government has already made strides towards delivering renewable energy on a large scale. Current government support mechanisms and targets for renewables are intended to deliver 10% renewably generated electricity by 2010 and up to 20% by 2020. For the 2010 target the great majority of this generating capacity is likely to come from wind developments. In the second offshore leasing round the Government committed to over 7GW of new wind power development. However, the UK lacks a strong wind industry manufacturing base, meaning that the plant and equipment involved may end up being built elsewhere in Europe and imported, with a consequent loss of UK job creation potential. Accordingly, this report has highlighted the massive social and economic importance of developing a UK manufacturing base for wind technology.

Furthermore, once this manufacturing base is developed the UK will be in a position to gain access to rapidly growing European and world markets. While the UK's own targets will provide a large domestic market for offshore wind power, with the right policy decisions in the EU the potential markets will be considerably bigger. The UK must work to ensure that the inward investment necessary to develop its supply chain is achieved so that the demands of this new, dynamic industry can be met here in this country.

A more detailed analysis of the potential for wind technology manufacturing in the North-East of England has shown that this area is an excellent location for the industry. The North-East is not only geographically well placed to service two of the three major strategic areas for offshore wind power identified in the Crown Estate's second round of leases, but also has the industrial capacity to fulfil ambitions way beyond existing leases and targets. A long tradition of manufacturing and maritime industries means that the North-East is in a strong position to reap great benefits from the acceleration of offshore wind development in the UK and Europe. The North-East has:

- a large and available skilled workforce, both within active industries and currently unemployed
- strong educational and training resources, producing thousands of highly trained technical graduates annually
- highly competitive labour costs and productivity in terms of the European market
- well-developed manufacturing facilities, established industrial infrastructure and good communications networks
- deep-water ports with excellent levels of sea access not subject to tidal restrictions
- excess capacity in traditional manufacturing so that scaling up to meet the sharply rising demands of a new and expanding offshore wind industry is achievable.

The North-East offers a vision of how the offshore wind industry could bring huge social and economic benefits to the UK, creating new employment and reversing industrial decline by offering new market opportunities to established industries and businesses. The region's proximity to the North Sea's wind resources means that it is in a prime position to compete in the wider EU market for offshore wind manufacturing and services. As the market for wind power grows globally, and if its supply chain is ready, the region could lead the UK's entry into the global wind power market.

Conclusions for the UK Government

In order to secure economic and social benefits from the expansion of offshore wind power, and to help regions such as the North-East reap the social and economic benefits of clean energy, the UK Government should:

- give its full backing to the development of offshore wind projects already offered leases
- establish further leases to create a market beyond the second leasing round
- ensure offshore wind power is able to attract the necessary level of finance after the review of the RO in 2005
- encourage increased support for offshore wind power from EU institutions.

Conclusions for the North-East region

In order to maximise potential benefits for the region, the North-East's local and regional government, development agencies, businesses and population should build on their significant efforts so far and:

- encourage the UK Government to maintain a high level of ambition and targets for renewables both in the UK and in Europe
- encourage the UK Government to commit to awarding further leases to create a market beyond the second leasing round
- encourage the UK Government to ensure that offshore wind attracts the necessary levels of finance
- target turbine manufacturers as a priority, since the siting of turbine factories is the key determinant for winning investment in the region further down the supply chain
- encourage the development of onshore and offshore wind farms in the North-East and encourage people in the North-East to support wind power development
- encourage industries in the North-East to identify and meet the specific supply chain needs of the wind industry.


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ANNEX A – METHODOLOGY

Calculation method

Employment has been modelled in this study using an input/output analysis tool developed over several years specifically to model the renewable energy sector, and used previously by ESD to determine the impact of renewable energy on employment and economic growth in individual countries in the EU.

The basic analysis steps are illustrated in Figure 8.

Figure 8

- Review projections and determine UK electricity supply in 2020
- Review estimates and determine offshore wind turbine load factors
- Calculate installed capacity required to deliver electricity supply scenarios
- Determine likely build rate and build period to deliver installed capacity scenarios
- Collect data on current investment cost per MW installed, estimate variation over time
- Collect data on current annual O&M cost per MW installed, estimate variation over time
- Disaggregate installed cost into principle components
- Estimate production functions
- Perform input/output analysis
- Sense check, smoothing, interpretation

Public domain information and industry consultation (input to steps 2–6)

The principle of biasing assumptions to minimise employment projections

Wherever a range of projections or estimates was available for any input factor to the modelling, conservative values were taken in order to avoid overvaluing the scale of future offshore wind power and the employment generated. Systematically taking this approach has ensured that the final employment projections made here err firmly on the side of caution and are thus prudent and defensible.

The principles of input/output modelling

Input/output (I/O) models are one type of resource allocation economic model. The heart of I/O analysis is the table containing coefficients that systematically describe the interdependencies between different industrial sectors in an economy. I/O tables are produced in most industrialised countries, often disaggregating industrial activity into fifty or more sectors, typically characterised by Standard Industrial Classification (SIC) codes (see Annex C).

For a given quantity of output from a particular sector (in this case, the installation costs and operation and maintenance costs of offshore wind), the I/O analysis will indicate the quantity of economic inputs that are required from the other sectors in the economy to create the given quantity of output, focusing on labour.

Put another way, the I/O table enables the effects of an increase in demand for offshore wind power capacity to be modelled, not just in terms of direct wind turbine manufacturing jobs, but in terms of indirect increased employment through the entire supply web, from the extraction of raw materials onwards.

Data and assumptions

Electricity supply in 2020

UK annual electricity supply in 2020 was taken as the lower of two DTI scenarios,[33] at 387 terawatt hours, in order to ensure that job creation was not overestimated.

Load factor

Offshore wind load factor (defined as the proportion of the year that an offshore wind turbine runs at net full capacity) was assumed to be 35%. Taking a relatively high load factor effectively reduced the capital cost of achieving the chosen level of contribution to electricity supply, and in turn minimised the projected employment generation.

Build rate

The likely build rate to achieve the projected level of supply from offshore wind was assumed on the basis of practical limits to the speed at which the industry could grow, and in order to conform to other projections of growth rate. The growth rate assumed here is broadly in line with that proposed in the *Sea Wind East* report.

Assumptions as to build rate have a direct effect on projections of the number of jobs supported in any one year. For example, if installed capacity were to increase linearly to 2020, the number of manufacturing and installation jobs would remain static (at around 22,000 under the 30% scenario), reflecting a static rate of installation of some 1.8GW per year. The number of operation and maintenance jobs would increase linearly with the total installed capacity (reaching around 13,000 by 2020).

However, a linear increase in installed capacity is unrealistic. Manufacturing, installation, operation and maintenance, financial and services capacities all need to grow massively from their present low base, and this growth will take considerable time. The assumed rate of growth used in the present analysis reflects this, and is broadly consistent with other published opinions on the achievable rate of growth of offshore wind power.[34]

Technology costs

The I/O analysis is driven by the capital and running costs of offshore wind power. There are several published sources of data on offshore wind farm costs.[35] Some of these are broad estimates or derivatives of earlier work, rather than being based on original research. However, actual cost data from early wind farms cannot be used directly: installation and operation and maintenance costs incurred in early schemes are not representative of long-run costs, which are likely to be much lower, taking account of scale effects and learning curves.

Bearing in mind the limited value of published data, an attempt was made to consult companies engaged in offshore wind development. The UK offshore wind industry is still at an early stage. Two large offshore wind farms are complete, a third is under construction and more will follow. Nevertheless many of the cost models produced by developers for the purposes of business planning are as yet unproven, and considerable uncertainty still exists over the actual costs of current and future schemes. Notwithstanding this uncertainty, several developers

Figure 9

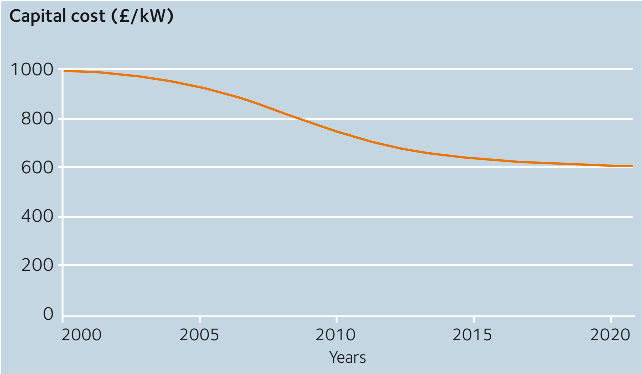
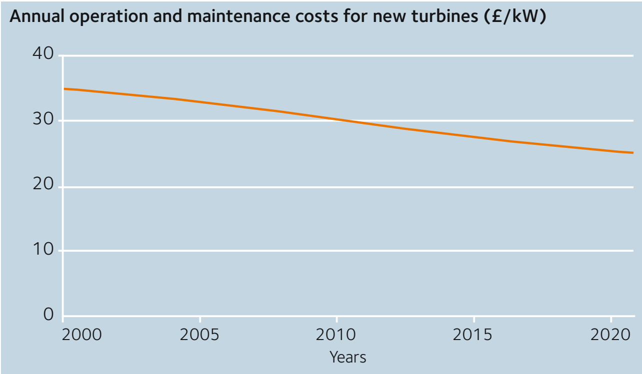


Figure 10



and product and service providers who were contacted during the preparation of this report provided useful information which has been incorporated into the cost estimates used here. There was broad agreement that the capital cost was around £1,000 per kilowatt of capacity installed, but there was more uncertainty over operation and maintenance costs.

Capital and operation and maintenance costs were assumed to reduce over time to reflect scale and learning curve effects as shown in Figures 9 and 10.

ANNEX B – THE LIFE OF AN OFFSHORE WIND FARM

Introduction

During its life, an offshore wind farm project will require the expertise and knowledge of a large number of people with a wide range of skills. The relatively simple concept of harnessing the offshore breeze to generate electricity contrasts with the large range of issues which need to be tackled through an offshore wind farm's development, construction and operation.

The development of an offshore wind farm project brings together a diverse team, including specialists such as meteorologists, planners, ornithologists, marine biologists and ultimately bankers, as well as the more obvious marine and electrical engineers. The construction and operation of offshore wind turbines around the coasts of the UK presents design engineers with a considerable challenge, as most of the sites designated for development are located in severe marine environments.

This section aims to describe the work required during each phase in the life of a typical offshore wind farm project, including the range of skills required and the length of time each phase can be expected to take. These phases are as follows:

- pre-consent phase
  - Environmental Impact Assessment
  - technical studies
  - consent determination
- procurement phase
- grid connection
- financial close
- construction phase
- operation and maintenance phase
- re-powering
- decommissioning phase.

The following skills are required at each stage during the project evolution:

- project management
- public relations
- legal
- health and safety
- environmental management
- offshore technical expertise.

Pre-consent phase

The activities in this phase are focused on progressing the project in a diligent and timely manner, through to the issue of the statutory consents (the equivalent of planning permission for onshore developments). This involves consultation with a wide range of government and public consultees, and the commissioning of an Environmental Impact Assessment and supporting technical studies, such as ornithological monitoring and seabed scour assessments.

Prior to obtaining its consents, a wind farm project is highly vulnerable to criticism from public and media lobbying. There must therefore be careful attention to public relations, including a proactive stance to providing the local population and media with correct information about the proposal.

Environmental Impact Assessment

Under government legislation, all offshore wind farm projects are required to submit to an Environmental Impact Assessment (EIA). The results from this process are summarised in an Environmental Statement (ES), which is a public document submitted together with the applications for statutory consents. The EIA is a detailed process involving many different disciplines, and can take from one to two-and-a-half years to complete. The main tasks involved in a representative EIA include the following.

EIA management
The EIA process is often managed by consultants experienced in this field. They are usually responsible for the compilation and production of the ES.

Ornithological assessment
In the assessment of the effects of the proposed wind farm on birds, both aerial and boat-based survey methods are employed to assess the number and distribution of bird species in and around the site. Boat-based surveys are usually undertaken once per month for a minimum of a year, using three to four people for one or two days per survey. Aerial surveys are usually undertaken during a selection of winter and summer months – one day of survey effort using three or four people in the aeroplane is usually sufficient for most wind farm projects. The results of these surveys, together with an assessment of the likely environmental impacts, are documented by an experienced ornithological consultant and form part of the ES.

Land and Seascape Visual Assessment
The effect of the wind farm on the visual environment is determined in a Land and Seascape Visual Assessment. This assessment, usually performed by landscape architects, involves the characterisation of the seascape in the vicinity of the development, the representation of the wind farm using such techniques as photomontages, the analysis of Zones of Visual Influence and an assessment of the effects of the development.

Noise
The likely effects of noise from the wind farm, during both construction and operation, are often assessed against the prevailing background noise levels at the coast. In such cases, background noise monitoring is undertaken by professional

acousticians at several locations for two to four weeks, and predictions on the likely environmental effects are include in the ES.

Safety of navigation
The safety of navigation is paramount, and much work is undertaken to ensure that the wind farm is properly located, designed, lit and marked, following discussions with a wide range of consultees. Such consultees include the Maritime and Coastguard Agency, Trinity House, the Royal Yachting Association, the Royal National Lifeboat Institution, local harbour authorities, commercial shipping operators, fisheries organisations, angling associations, and sailing and cruising clubs. A detailed Navigational Risk Assessment is performed, using on-site traffic surveys and input from the navigation community.

Commercial fisheries
The possible effects of offshore wind farms on commercial fisheries are investigated using analysis of catch records and consultations with local and national fishing organisations and individual fishermen. Sample trawls may be performed at selected times of the year to confirm information gathered from the fishing industry.

Marine ecology
A range of marine ecological surveys is undertaken within the EIA process, from fish trawls and marine mammal surveys to benthic sampling (ie sampling of life on and within the seabed). Benthic sampling requires the collection and analysis of small (0.1–0.2m3) samples from the surface of the seabed. Such surveys require a medium-sized vessel with three or four personnel aboard. The analysis of each benthic sample can take a person from half a day to one-and-a-half days to complete, and some projects may involve in excess of 150 samples. Determining the likely effects of the proposed wind farm on the marine ecology of the area forms a major part of the EIA process, and is undertaken by companies experienced in this field.

Coastal processes
Determining the likely effects of the wind farm (especially the turbine foundations) on the wind, waves and currents in the area, and thus its potential to influence the patterns of any nearby coastal erosion, may require specialist numerical modelling techniques. To increase the accuracy of these numerical models, wave and current data is collected at the site for a period of up to a year.

Cumulative effects
The effects of the proposed project have to be determined, not just in isolation, but when acting in combination with other projects and activities that have been or may be carried out. Projects or activities to be taken into account include existing completed projects, approved but uncompleted projects, projects for which an application has been made and which are under consideration by the consenting authorities, and projects which are reasonably foreseeable. They may include, for example, other offshore wind farms, harbour developments, dredging activities or offshore gas pipelines.

The range of skilled personnel contributing to this phase includes:

- landscape architects
- vessel operators
- engineers (marine, coastal, acoustic, civil, electrical)
- fisheries consultants
- ornithologists
- archaeologists
- marine biologists
- numerical modellers.

Technical studies

A range of technical surveys and studies is required to progress the project, and these can also support the EIA.

Geotechnical survey
In order to design the foundations for the wind turbines, sub-surface ground investigations must be performed. These involve a jack-up barge, with a crew of 10–20, drilling cores of material from the seabed. This material is then taken to accredited laboratories for analysis, the results of which are used in the detailed design phase of the project.

Anemometry mast
A monitoring mast is installed at the site to measure wind speed and direction. The structure, which can be up to 100m tall, comprises a lattice mast supported on a steel piled foundation fixed to the seabed. Installation of the mast is usually performed within one week of mobilisation, by a jack-up barge similar to that described above. The mast is instrumented with anemometers and wind vanes, and fitted with warning lights (to make it visible to both boats and aircraft) and sometimes a foghorn.

Geophysical survey
A non-intrusive geophysical survey is undertaken for the wind farm area and cable route(s) to shore to ascertain (among other things) the seabed topography and sub-bottom profiles. The survey is performed from small vessels towing measurement equipment below the water surface. Information from this survey is used to inform the marine ecology, archaeology and coastal processes assessments, as well as giving valuable baseline information for the wind farm site layout.

Oceanographic data acquisition
The gathering of oceanographic data provides the basis for understanding the existing physical environment within the site and its surroundings. Such information is used to inform the coastal processes assessment, with subsequent implications for the ecological studies and assessments of weather risk for the construction phase. The following data is usually taken:

- wind measurements
- wave measurements
- current velocity
- tidal elevations
- seabed sediment
- water quality.

The range of skilled personnel contributing to this phase includes:

- equipment suppliers (anemometry mast, offshore foundations, wave and current sensors, warning lights, etc)
- vessel operators

- marine construction contractors
- geotechnical consultants
- oceanographers.

Consent determination

Once the consent applications are submitted, a large number of bodies are invited to give their opinions on the project. These include statutory consultees (eg English Nature, Countryside Council for Wales, local authorities), local interest groups, non-governmental organisations, trade associations (eg fisheries bodies), commercial bodies (eg shipping companies) and members of the public. At this time, the developer usually organises public exhibitions to provide the local community with the opportunity to comment on the application.

The results of the consultation process, together with any supplementary information which may be submitted, provide the basis on which the regulatory bodies (notably the Department of Trade and Industry, the Department for Environment, Food and Rural Affairs, the Department for Transport, the National Assembly for Wales and the Environment Agency) then pass judgement on the project.

To date, the typical timescale for gaining the necessary statutory consents has been from six to twelve months, assuming that a Public Inquiry is not called.

The range of skilled personnel contributing to this phase includes:

- regulators
- statutory consultees and their environmental and technical agencies
- non-statutory consultees.

Procurement phase

The objective of this phase is to enter into a single contract or an ensemble of complementary contracts for the construction of the wind farm at minimum cost whilst managing the associated risks. There are many contracting options that are applicable to the construction of an offshore wind farm, and it is likely that more of these options will be employed as the industry matures. For example, contracts may span several summer seasons, or developers may split the scope of work into many discrete packages with the intention of managing overall cost and risk.

The award of the contract to construct an offshore wind farm comprises the following high-level steps:

- The developer advertises the contract(s) in the Official Journal of the European Commission, and invites expressions of interest. From the responses received, the developer scores the submissions using a consistent approach and draws up a list of potential tenderers (usually a minimum of three).
- The developer drafts the specification, selected for the form and specific conditions of the contract, and sends this to the tenderers.
- The tenderers submit their tenders within the time specified, a representative tender period being three months.
- The developer and tenderers enter negotiations concerning (among other things) technical and financial issues, contract conditions, timetable and price.
- The developer and successful tenderer(s) enter into the construction contract immediately following financial close (see below).

This entire process can be expected to take eight months or longer.

The range of skilled personnel contributing to this phase includes:

- procurement professionals
- wind turbine manufacturers
- construction contractors
- construction consultants
- offshore design engineers
- offshore consultants
- electrical consultants
- financiers
- insurers and underwriters.

Grid connection

Every offshore wind farm requires a connection to either the electricity distribution or the transmission system. The developer will agree with the operator of the relevant electricity network the extent, cost, timing, and contractual conditions of any works required for connection, and in some cases for the reinforcement of the network if the present network is unable to accept the whole projected output of the wind farm.

Technical studies are undertaken to determine the extent of work required to connect the development, based on the specifications of the type of wind turbine chosen. Once the above issues are agreed, the developer and the electricity network operator can enter into contract together for the connection of the wind farm.

The range of skilled personnel contributing to this phase includes:

- systems design engineers
- electrical engineers
- electrical systems modellers
- civil engineers.

Financial close

Financial close is the process whereby the developer, who has undertaken the necessary work to progress the project to this stage, decides whether to proceed with construction or not. The issues which are considered at this stage of the project include:

a) the completeness of the statutory consents obtained, and the implications of any conditions attached
b) any non-statutory consents or wayleaves required for the project to proceed
c) the terms of a construction contract, which will be in an advanced state and ready for signature
d) the terms of a grid connection contract, which may or may not already have been signed
e) the terms of any debt required to finance the project
f) project economic viability – the factors affecting the finances of a project include:

- capital cost
- operating cost
- predicted energy yield, this having been derived from data taken from the anemometry mast described above
- terms of any power purchase contract
- any government support, eg DTI capital grants.

The range of skilled personnel contributing to this phase includes:

- the developer's technical and commercial staff
- financiers
- insurers and underwriters.

Construction phase

The wind farm construction is the most intensive phase of the project, with input from many sources including equipment suppliers, onshore and offshore contractors, ports, consultants and electricity supply companies.

For large projects, the construction phase may span several years, with construction contracts potentially spanning two to three years. The main contributors to the construction phase, and their contributions (subject to the contracting route adopted) include:

- **wind turbine supplier** – the wind turbine supplier supplies the wind turbine blades, the nacelle and the tower, and may also be responsible for turbine erection
- **foundation supplier** – the foundation supplier generally supplies the foundations, transition pieces and other steelwork, for which the typical lead time is six months
- **subsea cable supplier** – the typical lead time for cable manufacture is five months
- **installation contractor(s)** – there is generally more than one contractor, as different skills and vessels are needed for installation of the foundations, turbines and cables
- **construction port** – the port rents quayside space and a storage area to the contractor(s).

In addition, given the large number of offshore crew and engineers, the project provides opportunities for local service companies, hotels, and restaurants throughout the construction phase.

Throughout the construction phase, the contractor(s) must make sure that working procedures safeguard the health and safety of the workforce, while at the same time ensuring that the environmental impact of the works is as low as possible.

The length of time from letting the construction contract(s) to the commissioning of the wind farm depends on the project size: for a development of 30–50 wind turbines a period of 18 months to two years (including manufacturing time) is reasonable.

The range of skilled personnel contributing to this phase includes:

- comprehensive project management teams within the developer and contractor organisations
- wind turbine manufacturers
- steelwork (foundations etc) fabricators
- offshore construction contractors
- subsea cable suppliers
- installation contractors
- port operating staff
- vessel operators
- back-up services staff (administrative, technical, health and safety, environmental)
- financiers
- insurers and underwriters.

Operation and maintenance phase

Once the commissioned wind farm has been 'handed over' to the developer by the contractor, the operation and maintenance phase commences. In general, the construction contract provides for the wind turbine manufacturer to operate and maintain the wind farm for a certain period – anywhere from two to five years. At the end of this time, the developer has to decide whether to contract out the operation of the wind farm or to take over this task.

During the operation and maintenance phase, regular inspection of turbines, foundations, cables etc will be undertaken and any necessary remedial work performed. The work falls into three categories:

- periodic overhauls
- scheduled maintenance
- unscheduled maintenance.

Periodic overhauls

Periodic overhauls will be carried out in accordance with the turbine manufacturer's warranty. They will be planned for execution in the periods of the year with the best access conditions, preferably in summer.

Scheduled maintenance

Scheduled maintenance refers primarily to inspections and work on wear, parts susceptible to fail or deterioration in between the periodic overhauls. A scheduled inspection of each turbine is likely to take place every six or twelve months.

Unscheduled maintenance

Unscheduled maintenance takes place in the case of any sudden defects. The scope of such maintenance ranges from small defects to complete failure or breakdown of main components. It may require the intervention of construction vessels similar to those used for wind farm construction.

The range of skilled personnel contributing to this phase includes:

- port staff
- vessel operators
- operation and maintenance staff (plus administrative and technical support)
- offshore construction contractors, for major refits.

Re-powering

In the latter part of the operational life of the wind farm, the client may decide to re-power the wind farm using new turbines. This decision will be based on the performance of the wind farm to date, and the likely returns of re-powering versus full decommissioning and removal of the project components.

It may be possible to reuse some infrastructure from the first phase to reduce the capital cost for the second (re-powered) phase. For example, much of the original subsea cabling may be utilised, along with the existing grid connection. The probable increases in turbine size between the present day and 15–25 years hence mean that it is unlikely that the foundations will be reused.

In order to re-power, a distinct financial close procedure will have to be undertaken, leading to a second construction phase and operation and maintenance phase, with all that these phases entail.

The range of skilled personnel contributing to this phase will be similar to those required in the financial close, construction and operation and maintenance phases above.

Decommissioning phase

The decommissioning of the wind farm is the final phase of the project. Although industry practice relating to the extent of decommissioning has not yet been determined, the aim of this phase should be to return the seabed to its original state as far as practicable.

Prior to construction of the first phase of the wind farm, the developer must submit to the relevant regulatory authority a decommissioning method statement, including the scope and method of decommissioning and consideration of health and safety and environmental protection issues. This statement will be updated nearer to the time of actual decommissioning.

It is likely that decommissioning will mean the removal (and potential reuse, recycling or scrapping) of the wind turbines and also (to a suitable depth with respect to the seabed) of foundations and ancillary structures. It may also potentially mean the removal of subsea cables, though it may be judged more environmentally sound to leave the buried cables undisturbed.

The range of skilled personnel required for decommissioning will be similar to that for the construction phase.

The environmental obligations of the wind farm operator may potentially continue after decommissioning if any latent issues should come to light after this time.

This annex was written by Dr David Bean. Dr Bean is a director of the independent consultancy Project Management Support Services (PMSS). Prior to joining PMSS in May 2003, he was Offshore Development Manager at National Wind Power, and was responsible for all its offshore wind developments. He was the Project Manager of North Hoyle offshore wind farm, the first commercial-scale UK project, from its inception in 1998 to the start of construction in autumn 2002.

PMSS is involved in the permitting and Environmental Impact Assessment of several offshore wind farms, and was the health and safety advisor during the construction of the Blyth Harbour, North Hoyle and Arklow Bank projects. PMSS also provided environmental management to Vestas Celtic Wind Technology and Mayflower Energy during the construction of North Hoyle, and is the appointed health, safety and environmental advisor to NEG-Micon on the Kentish Flats project.

David would like to thank Peter Clibbon of Global Renewable Energy Partners for his assistance during the final edit of this annex.

ANNEX C – SIC CODES USED IN INPUT OUTPUT ANALYSIS

Industry description	SIC Code references
Agriculture, fishery and forests	1, 2, 5
Food, beverages, tobacco	15, 16
Textiles and clothing, leather and footwear	17, 18, 19
Paper and printing products	21, 22
Fuel and power products	23
Chemical products	24
Rubber and plastic products	25
Non-metallic mineral products	26
Ferrous and non-ferrous ores and metals	27
Metal products except machinery	28
Agricultural and industrial machinery	29
Office and data processing machines	30
Electrical goods	31
Transport equipment	34, 35
Other manufacturing products	?
Building and construction	45
Recovery, repair services, wholesale, retail	50, 51, 52
Lodging and catering services	55
Inland transport services	60
Maritime and air transport services	61, 62
Auxiliary transport services	63
Communications services	64
Services of credit and insurance institutions	65, 66
Other market services	67
Non-market services	-

ANNEX D – ABBREVIATIONS

EIA	Environmental Impact Assessment
ES	Environmental Statement
ESD	Energy for Sustainable Development Ltd, authors of this report
EWP	Energy White Paper
FTE	full-time equivalent
GW	gigawatt(s): 1GW = 1,000MW
I/O	input/output
MW	megawatt(s): 1MW = 1,000kW
NaREC	New and Renewable Energy Centre
NOF	formerly the Northern Offshore Foundation
ONE	One North East
RO	Renewables Obligation
ROC	Renewables Obligation Certificate
SIC	Standard Industrial Classification

ANNEX E – COMPANIES IN THE RENEWABLES SUPPLY CHAIN IN THE NORTH-EAST, AND SUPPORTED BY NOF

Company	Description
AEI Cables Ltd	Manufacturer of electrical cables
AMEC (Wind Energy)	Offshore wind developer
Ashington Fabrication Co	Medium/heavy fabrication and welding
Ball Valves UK Ltd	Valve stockist/distributor
BEL Valves	High-pressure valves and associated equipment
Booth Industries Ltd	High-integrity doors, fire and blast protection systems
Cape Industrial Services	Insulation, fire protection, architectural fit-out, scaffolding and painting, HVAC
Caswells	Supplier of consumable items to industry
Chieftain Insulation Ltd	Insulation, architectural outfit, HVAC, fabrication work
CMP Products	Manufacturer of explosion-proof and deluge-proof cable glands and accessories
Corus	Steel manufacturer
CSD Sealing Systems Ltd	Fire safety systems
Darcherm Engineering Ltd	Passive fire protection for hydrocarbon, jet fire and blast conditions
Escape Safe UK Ltd	Health and safety products and services
The Expanded Metal Co	Expanded metal manufacturer
Fibregate Composite Structures	GRP manufacture, design, fabrication and installation
Formet Ltd	Precision open-die forgings and heat-treated and M/C components
Hawthorn Leslie Fabrications	Fabricator to the marine and offshore industry
Hypres (Industrial Services)	Industrial supplies
IDN Telecom	Telecommunications solutions
Imtech Marine & Industry	Electrical systems integrator to the marine and offshore industry
James Walker & Co Ltd	Manufacture/supply of packaging, seals, gaskets and associated Tico pipe support materials
JMD Engineering	Fabricator and CAD CAM CNC profiler
John Clark Valves	Valve stockist/distributor
Lionweld Kennedy Ltd	Open mesh flooring, handrailing and secondary structural steelwork
Marine Projects International	Installation of offshore wind turbines
MCE Plc	Fabricator to the oil and gas Industry
Mech-Tool Engineering Ltd	Design and manufacture of fire and blast protection and acoustic products and services
MGM Precision Engineering Ltd	Precision machining in all materials
NIM Engineering Ltd	Winches, lifting gear, mechanical handling equipment and general engineering
Park Electrical Distributors	Electrical wholesaler
Pelican Marine Projects	Diving, marine environmental clearance
Pipetawse Ltd	Pipework fabrication and process plant construction
PMC Supplies	Safety equipment supply – fire and spark
Protec - The Cap Company	Plastic protection caps, bolt and nut caps
QA Weldtech Ltd	Manufacturer of pipework, flow spools, weld inlay, pressure vessels
Ramsay Services Ltd	Precision seals and gaskets
RB Valvetech Ltd	Supply of subsea and process valve equipment
Rexel EMS Ltd	Specialist electrical supplier
Rollstud Ltd	Manufacturer of quality bolting
Shark Group	Manufacturer of survival products
Sovereign Access Services Ltd	Hire and sale of specialist access equipment, including mast climbers
Towne Northern Ropes	Fabricator and supplier of lifting equipment
Tyne Tees Lifting Ltd	Hire, sales, repair of lifting equipment
Victor Products Ltd	Manufacturer of hazardous area and industrial lighting and signalling
VINCI Services Ltd	Offshore and marine outfitting
Wilsons Safety Services	Safety footwear and clothing

Source: NOF

ENDNOTES

[1] British Wind Energy Association, 2004: *New wind power: Projects with consent and ready for construction*, available at www.bwea.com/planning/construction.html.

[2] Department of Trade and Industry, 2003: *Our energy future – creating a low carbon economy*, Energy White Paper.

[3] European Wind Energy Association, 2004: 'Wind power expands 23% in Europe but still only a 3-Member State story', press release, 3 February. www.ewea.org/documents/0203_EU2003figures_final.pdf.

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[9] British Wind Energy Association, 2004: *Wind farms of the UK: At a glance statistics*, available at www.bwea.com/map/index.html and www.bwea.com/map/2004.html

[10] British Wind Energy Association, 2004: New wind power: *Projects with consent and ready for construction*, available at www.bwea.com/planning/construction.html.

[11] European Wind Energy Association, 2004: 'Wind power expands 23% in Europe but still only a 3-Member State story', press release, 3 February. www.ewea.org/documents/0203_EU2003figures_final.pdf.

[12] Originally owned jointly by Vestas and NEG Micon; these two companies have recently merged (in early 2004) to become a single company.

[13] *The Scotsman* (website), 2004: 'Nordic to develop new wind site after landing wind turbine options', 1 August, available at http://business.scotsman.com/technology.cfm?id=880132004.

[14] The *Sea Wind East* report commissioned by Greenpeace in 2002 and researched by AEA Technology demonstrated that it is technically, practically and economically possible to build enough offshore wind capacity by 2020 off the coast of the east of England (predominantly the Wash and the Thames Estuary) to generate 25% of current UK electricity demand. The Government's recent Energy White Paper lays out policies that aim to deliver a target of 20% of UK electricity from renewables by 2020. It is likely that offshore wind will deliver over half that target.

[15] See www.narec.co.uk.

[16] See www.nof.co.uk.

[17] See www.strategyforsuccess.info.

[18] See www.tvdc.co.uk/newmenu.html.

[19] Marine Projects International was formerly Mayflower Energy.

[20] The Office of the Deputy Prime Minister has recently published new planning guidance on renewables (PPS22).

[21] AEA Technology, 2002: *Sea Wind East – How offshore wind in East Anglia could supply a quarter of UK electricity needs*, Greenpeace.

[22] Garrad Hassan, 2004: Sea wind Europe, Greenpeace.

[23] See the DTI website, www.dti.gov.uk/mbp/bpgt/m9n000001/m9n0000015.html.

[24] Marine Projects International provides installation, operation and maintenance capacity to the offshore wind industry, and has invested in special ships to carry out this role.

[25] AMEC Wind is an offshore wind developer with a 10-year track record.

[26] Office for National Statistics, 2004: *Region in figures: North East*, No. 8 , Summer 2004, available at National Statistics website: www.statistics.gov.uk/STATBASE/Product.asp?vlnk=10446

[27] Ibid.

[28] Office for National Statistics, Labour Force Survey Local Area Database, 2001/02 .

[29] Higher Education Statistics Agency, www.hesa.org.uk.

[30] UK and North-East data: Office for National Statistics, 2002: *Region in figures: North East*.

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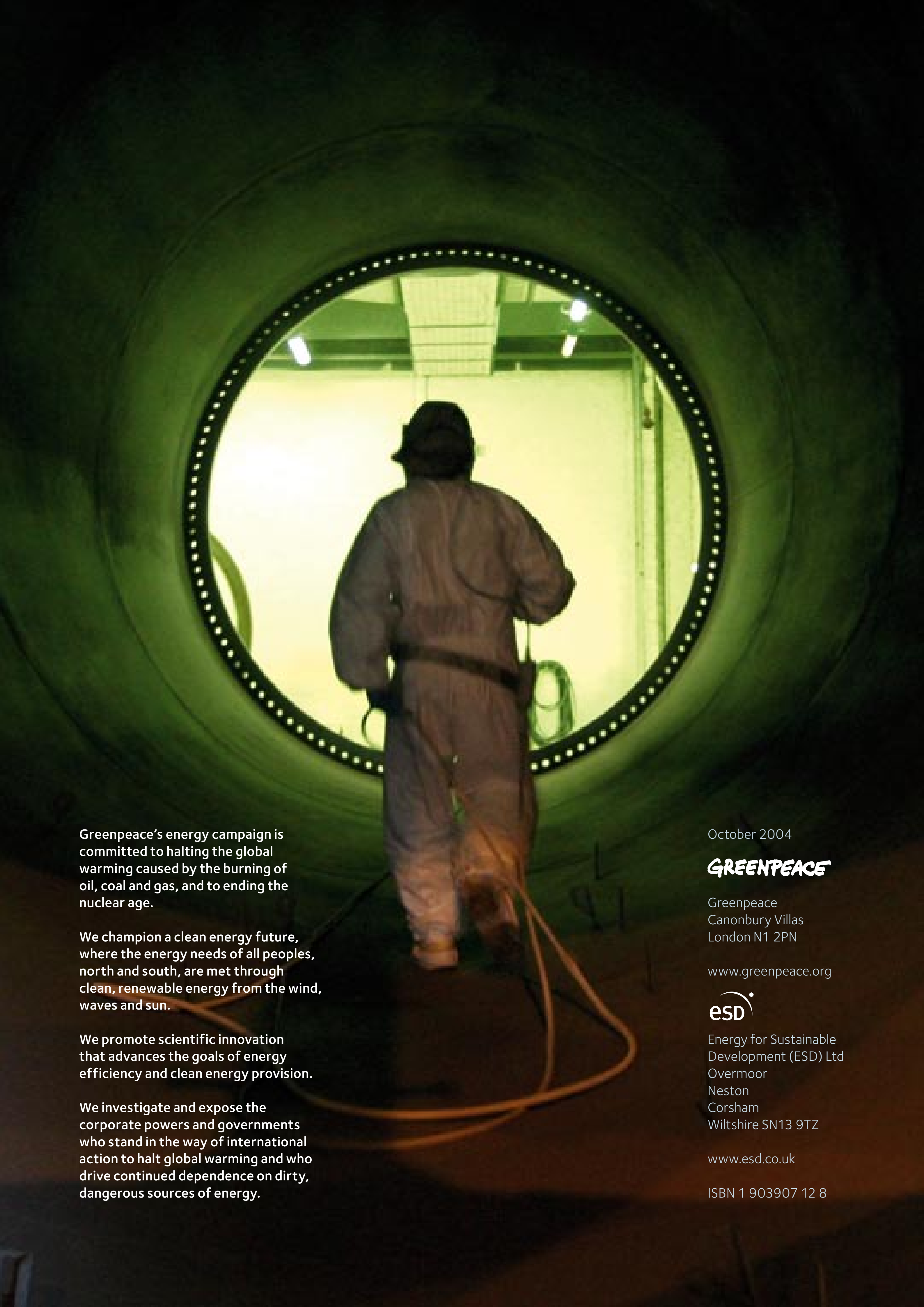

Greenpeace's energy campaign is committed to halting the global warming caused by the burning of oil, coal and gas, and to ending the nuclear age.

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October 2004

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ISBN 1 903907 12 8