The World Offshore Renewable Energy Report 2002-2007

summary of a report by Douglas-Westwood Limited for Renewables UK

report number 197-02

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Introduction

This report summarises results of a study commissioned by Renewables UK from energy industry business analysts Douglas-Westwood Limited to meet a growing number of requests to quantify the prospects available to British industry in the offshore sector of the renewable energy industry.

Although offshore renewable energy has a history that stretches back many decades it has until recently been regarded as 'tomorrow's potential'; a huge source of energy that the world may need sometime in the future.

In recent times, environmental and related legislation, enacted in an effort to reduce the impact of energy production on climate change has led to a dramatic rise in the use of onshore renewable energy. However, in small countries such as the UK, the economically and environmentally acceptable onshore sites are rapidly being developed and as the pressures to produce increased levels of renewable energy have intensified, national Governments and developers are looking to the offshore environment to provide this.

To date less than 100MW of capacity has been operating worldwide, but the last three years has seen a dramatic change in the scale and scope of offshore renewable energy projects as years of research and development is turned into commercial reality. As one example, within the past 12 months the total number of future offshore wind projects under consideration has grown from twenty-two to ninety-six. Whilst some of these projects are for the period beyond 2007, this is indicative of the speed of change and current levels of activity.

Compared with other countries, the UK has a number of distinct advantages in this rapidly developing business sector:

- a government determination to increase the share of power generated from renewables
- one of the world's best offshore resources in terms of wind, wave, tide and currents
- a highly experienced industrial base developed to serve the offshore oil and gas industry.

Project information used within this report was sourced from the *Offshore Renewable Energy Database* on the 1 August 2002. This is a global database maintained by Douglas-Westwood Limited and contains information on all known offshore wind, wave and tidal/current stream projects.

The full report is available on CD-Rom or for download from the Renewables UK website: www.dti.gov.uk/renewable

We would like to thank the numerous individuals in both Government and industry who contributed to this study.

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Foreword, by Brian Wilson,

Minister for Energy & Construction

I am delighted to welcome this key publication which represents an excellent compendium of opportunities for UK industry in Offshore Renewable energy projects both in home and overseas markets over the next five years.
In DTI we are continually looking at future opportunities and Renewable Energy sources are perhaps the most exciting of these representing not only opportunities for industry but also helping to meet new Sustainable Energy targets. Currently there is a target of having 10% of the UKÕs electricity supplied from renewable sources by 2010. The recent PIU review has recommended that this target be increased to 20% by 2020. These targets represents a real step change in terms of the UK energy mix and will create demand for competitive products and services.

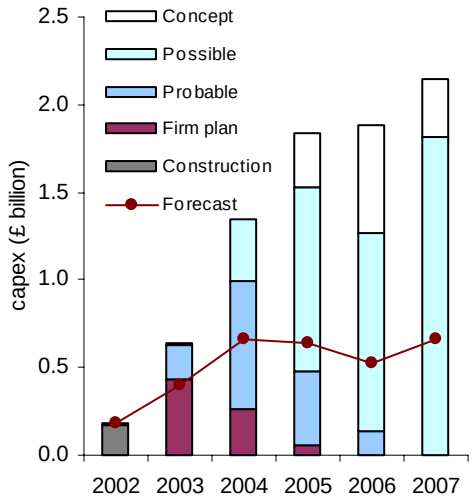
The expected multi billion growth in the worldwide Renewables market offers opportunities for UK companies to create investment and jobs in manufacturing, services and supplies at home and improve our capability to win exports.

This is a very exciting time for UK industry with the recent announcements of capital grant awards of £10m each to National Wind Power and Powergen for the North Hoyle and Scroby Sands offshore wind projects. Early projects like these are important in building up momentum in the UK Ð setting standards for future projects and also allowing the UK supply companies to demonstrate their own skills and capabilities.
As you will see from this report Wave & Tidal projects will also be an important part of the world market. The UK has a track record in this field and an approach to technology & innovation which gives our industry a great chance of competing globally.

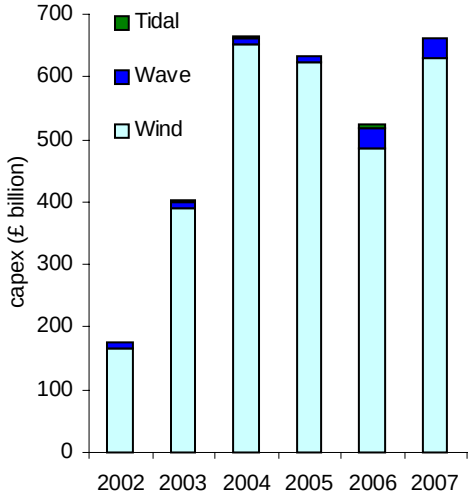
Within my Department, Renewables UK been set up to assist industry in the challenges faced within the supply chain. This involves close interaction with industry, other Government Departments, Regional Development Agencies, the devolved administrations and Trade Associations. If you would like to talk to any member of the Renewables UK Team about this report and the opportunities identified I would encourage you to contact them below. With best wishes for future success.

Brian Wilson
Minister for Energy & Construction

Overview



Global offshore renewable energy CAPEX



Global CAPEX 2002-2007 by energy source

Capital expenditure by the world's offshore renewable energy industry is forecast to grow four-fold over the period 2002-2007, increasing from £150m in 2002 to £644m in 2007. The total expenditure is forecast at £3.1bn over the period with the European market accounting for 90%. Whilst this growth is impressive the chart illustrates that this is a conservative forecast. If all the projects currently under consideration become reality a £8bn market would be created.

The market has developed at a remarkable pace. For example, over the past 18 months the number of future offshore wind projects identified on our database has increased from less than twenty to over one hundred, sixty-one of which are scheduled for installation in the period to 2007.

Europe is the world's largest prospective market with expenditure forecast to grow from £177m in 2002 to £413m in 2007, although there are a small number of large projects forecast within North America towards the end of the period to 2007.

A number of national governments have put in place market mechanisms and legislation that positively supports the development of offshore renewable energy. In particular, the United Kingdom and Germany are very active and this is reflected in the number of offshore projects being considered in the period to 2007; UK – 16 wind, 5 wave, 4 tidal; Germany – 19 wind.

The scale and sheer number of offshore wind developments make it the largest sector, accounting for over 97% of the forecast expenditure. Whilst wave and tidal/current stream energy are promising technologies and will both experience growth in expenditure over the period, they are still in their early stages of market development.

The period 2002-2006 is likely to be one of the most fundamental in the long-term development of offshore renewable energy as it transforms from a niche activity into an industry in its own right.

Whilst overall expenditure may show a slight dip in 2006 this is related to our belief that a brief period of reappraisal of financial support mechanisms will occur. With the continual development of technological solutions and increasing experience it is then expected that towards 2007 projects will continue to grow in scale and diversity and show improved economic fundamentals.

Financial support and subsidies will continue to play a crucial role during this development period and while the economic viability of projects is likely to improve over time, radical and unforeseen changes in government policies and financial mechanisms may serve to destroy the current high levels of investor confidence. It is hoped that the key national players will work together to maintain the stability required to develop this exciting new industry.

Market Drivers

There are a number of market drivers for the renewable energy industry in general and specific drivers for the offshore sector.

Renewable Energy Drivers

Environmental Driven Markets
These are generally comprised of the OECD countries, who, in order to meet mandated emission targets emanating from the UN Kyoto Protocol, will sharply accelerate their use of renewable energy. These markets are expected to provide the largest gain in the use of renewables in the short-term.

Energy Driven Markets
Particular examples are the Asian and developing economies where demands for new energy resources are being propelled by population growth, industrialisation and urbanisation. Governments and industry are predisposed to meet requirements from renewable sources, which are indigenous and have relatively short installation timeframes. The demand from these markets is expected to overtake that of the OECD countries beyond 2002 and become significant by 2007.

The Green Consumer
The liberalisation of energy policy and the rise of the political and "green" consumer are also driving demand. The break-up of state energy monopolies has spawned competition and allowed businesses and individuals to choose their provider of electricity. In many markets, the options include "green energy" programmes. While still a minor part of the mix, these will gradually cause increased market demand from some customer segments.

Economic Drive
The market is increasingly being influenced by traditional (principally economic) drivers rather than by political forces. In some situations onshore wind, biomass and small-scale hydro are becoming viewed as *complimentary* to fossil fuels not as a replacement.

Security of Supply
Over the past year the issue of national security of supply of energy has increased in importance. The value of a diversified energy mix is now regarded by most national governments of being of strategic importance both in the short and long term.

Offshore Renewable Energy Drivers

Whilst the market for offshore renewable energy has the same overriding macro drivers as other renewable energies, there are also a number of specific drivers that are influencing the speed and nature of development of the sector.

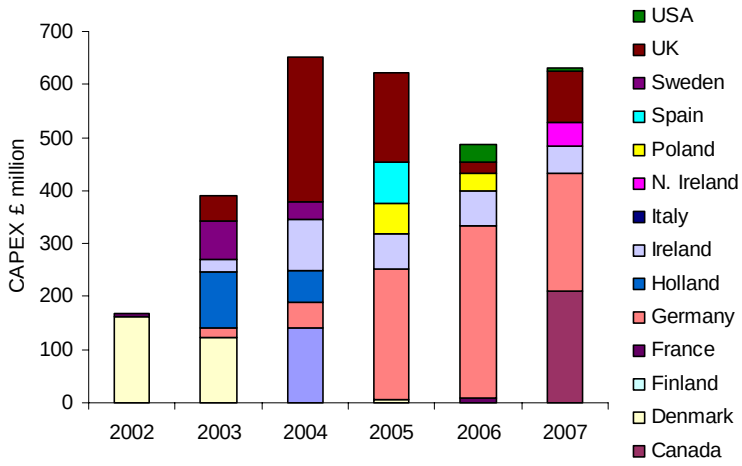
Resource Harvesting
It has been acknowledged for many years that the renewable energy resource available within the offshore environment is huge and that the key issue has been its exploitation. The value of the potential resource has often been ignored or undervalued as governments and developers have pursued easier and cheaper onshore alternatives. However, the past two years has seen a fundamental shift by several national governments and the necessary mechanisms, structures and legislation for successful exploitation are either now in place or under development in most of the major potential markets for offshore renewable energy.

Industrial Development
It is rare that complete new industrial markets such as offshore renewable energy are created and a number of national governments are pursuing development strategies specifically designed to foster an industrial base to serve this market.

Diversification
The gradual decline of offshore oil and gas opportunities within Europe has seen suppliers examining diversification opportunities. The combined skills and experience built up over the past 30 years of offshore oil & gas development could enable many of these companies to operate within the renewables sector. They may also bring a range of ideas and solutions to improve the overall economics of offshore renewables.

Technology
The cost-effective exploitation of offshore renewable energy is very difficult but the past few years have seen the proving of enabling technologies that are acting as a catalyst to market development. Whilst some of these are relatively new or appear new, the key change has been the application of decades of offshore experience (oil, gas and marine) into the marinisation of established technologies.

Offshore Windpower



Global offshore windpower CAPEX forecast

Major Growth in Prospect

In 2002 we expect 165 MW of windpower generating capacity to be installed offshore. We then forecast the rate of growth to increase dramatically with annual installations exceeding 900 MW by 2007.

Europe will be the largest market accounting for 92% of forecast capital expenditure, the remaining 8% being in North America.

Denmark is leading the market with a forecast 300 MW over the period 2001 to 2003, but the removal of government subsidies to what is now regarded locally as a mature industry has bought new project proposals to a halt. This is in stark contrast to Germany and the UK where a more positive stance has led to an explosion of prospective projects and forecast expenditure.

The UK is now the next major growth market and we expect it to account for 42% of generating capacity installed in 2004. Over the complete 2002-2007 period the UK is likely to install 907 MW, which is 21% of total global new capacity.

Germany will then follow in 2005 with a major programme totalling 1,295 MW that will make it the largest market over the period with a 37% share.

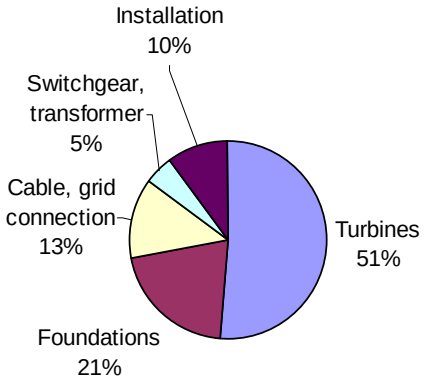
In 2005 we also expect to see the beginnings of activity in North America with a project in US waters, followed in 2007 by 317 MW being installed offshore Canada.

We forecast a total global capital expenditure over the period of £2.9 billion. However, the upside could be greater, as in total we can identify £7.7 billion of prospects.

Offshore Windpower Components

The cost of components offshore differ from their onshore counterparts with the requirement for marinisation and remote operations in a hostile environment. With onshore installations the turbine can typically constitute up to 70% of the overall unit costs, offshore this ratio is typically half of the unit costs.

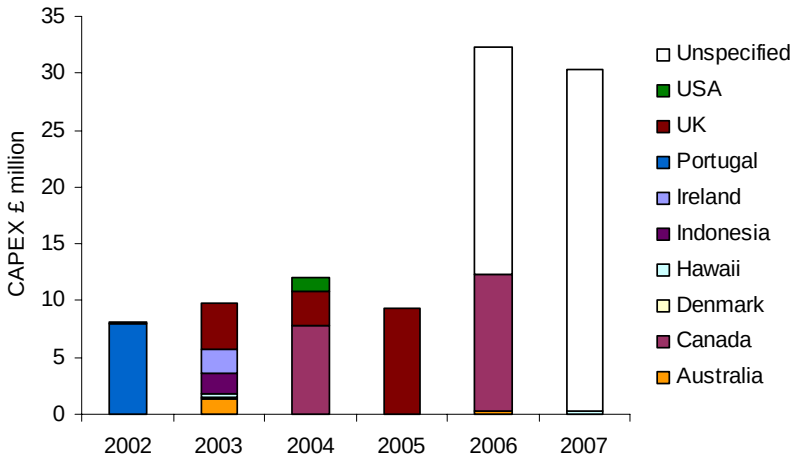
Over time it is anticipated that overall costs will fall as experience grows and new technology such as larger turbines is deployed.



Offshore windpower CAPEX by component

Turbines are expected to account for over half of the total capex, with foundations as the next largest component at 21%. In comparison with onshore windfarms, offshore installation and cabling are a relatively expensive element of a development.

Wavepower



Global offshore wavepower CAPEX forecast

Emerging Technologies

Wave energy is now routinely used to power navigation buoys throughout the world but as yet the potential for larger scale energy generation remains unrealised. Of the three distinct forms of wave energy device; shoreline, nearshore and offshore, problems of accessibility and lower cost grid connection have ensured that to date shoreline devices predominate.

The UK and Japan have dominated the development of wave energy devices over the past fifteen years and currently account for over 60% of worldwide development expenditure. The UK arguably has one of the greatest potential wavepower resources in the world combined with an academic impetus that has spawned many patented devices, an active development scene and an embryonic industry, despite inconsistent levels of support from past governments.

Over 250 differing wavepower devices have been designed and/or deployed but no one device has yet to reach either universal acceptance or widespread commercial use. The last decade has, however, seen significant developments in efficiency, reliability and cost reduction that has brought wavepower from a conceptual to a development phase. In a situation not dissimilar to the early developments of the windpower market there is now growing local, national and international support for the fledging industry that should lead to competitive commercial applications before 2010.

Strong Growth From a Small Base

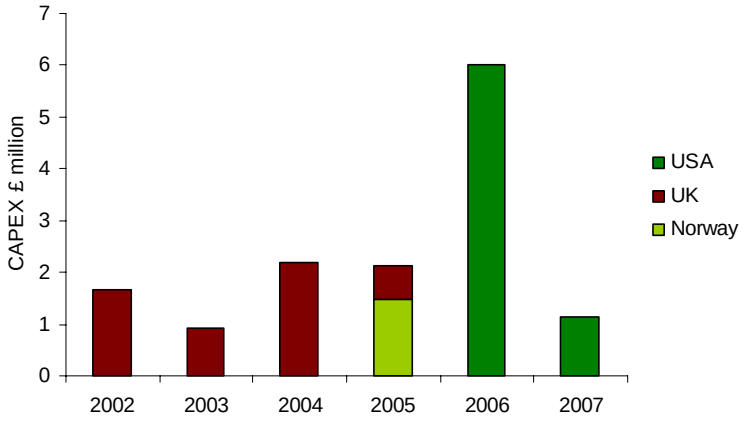
There are currently 18 identified wave projects within the *Offshore Renewable Energy Database* for the period 2002-2007. The period to 2007 can best be described as a pre-commercial phase of the development cycle for the wavepower industry with many significant technologies undergoing full-scale testing and concept proving.

Wavepower is a small but growing sector. In 2002 we expect a total capital expenditure of £8 million, increasing to exceed £ 30 million by 2005. Installations off Portugal in 2002 will be followed by ones off the UK beginning in 2003 then Canada in 2004. There are then a number of installations planned in 'unspecified' (at present commercially confidential) locations.

Compared with offshore wind turbines where developments are being planned using multi-megawatt units, the average unit size under consideration in the period to 2007 is 1MW with the largest rated at 2MW.

We note that much of the technology that is being deployed throughout the world is of UK origin and involves UK companies. This suggests that the UK has a lead in this sector that should be strongly supported.

Tidal & Current Power



Global tidal & current power CAPEX forecast

A Change in Approach

Widely acknowledged as one of the greatest untapped energy resources of the planet, engineers have been trying for hundreds of years to effectively harness the potential of this huge energy source. Tidal and current stream energies are predictable and consistent. While 3000GW of tidal energy is estimated to be available worldwide, less than 3% is located in areas suitable for power generation.

Tidal systems generally require a tidal range of over 7m, most potential development sites are poorly located with regard to potential users and often in areas of high ecological value.

Despite the success of the 240MW tidal barrage power plant at Rance, Brittany, there are concerns regarding further similar designs. These are in part due to the restrictions a barrage places on shipping and fisheries and the environmental impacts that result in the inter-tidal zone. Interest has therefore turned to the potential offered by tidally-generated coastal currents using tidal fences and tidal turbines.

Technological developments of the last decade coupled with the growing acceptance of the need for renewable energy should ensure that tidal and current stream power systems finally move out of their development stage and into commercial reality. Unfortunately, the excruciatingly slow process of planning and approval means that many potential schemes could take years to reach a successful outcome.

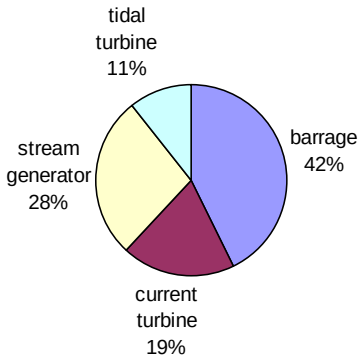
At this early stage, forecast expenditure is fairly evenly split between the main device types with no clear market leader yet emerging.

Prospects of Commercial Systems

As we progress through the period 2002-2007 the forecast expenditure is a reflection of current development plans rather than large-scale commercial schemes.

If all of the prospects currently listed on our database came to fruition the total expenditure over the period to 2007 would be close to £80 million. However, we forecast that the actual total tidal and current power systems installed will be closer to £14 million.

For the next three years, it is likely that the UK will form the largest market. We then expect Norway to bring projects online in 2005 and that this will be followed by the USA in 2006 and 2007. (Our forecasts exclude academic expenditure.)

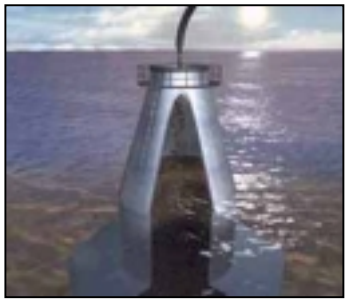


CAPEX forecast by device type (all status)

It is likely that one barrage will initially dominate expenditure. However, considering the environmental impact, other technologies may have the greatest long-term potential.

Changing Technologies

Lattice tower
picture: Pyramatrix Structures



Gravity base foundation
picture: Corus

Wavepower system
picture: OPD

Windpower – enabling technologies

The heart of a windpower development is the turbine and in the offshore environment turbine size and reliability are key. Fewer units and reduced maintenance lead to lower levels of both capital and operational expenditure and a subsequent improvement in project economics.

The past few years has seen the major manufacturers design specifically for the offshore market with new models pushing the 5MW+ boundaries. Whilst these very large machines are still undergoing early prototype testing, 3.5MW+ machines are already being actively considered for projects in 2003/4.

With hub heights in excess of 85m and rotor blade diameters up to 115m, numerous problems are presented and manufacturers are looking to increase the use of carbon fibre and other specialist materials to reduce weight whilst improving strength and performance.

Some of these new megawatt machines have a nacelle weighing up to 500t and the basic tower designs are being reconsidered in efforts to further reduce weight and size whilst improving strength. These large structures also offer new challenges in installation that will require new vessels with specialised cranage.

With larger structures and moves into deeper waters further offshore, foundation design is of critical importance. New and innovative designs are being offered that aim to both reduce costs and installation times.

Wavepower – commercialisation

The impending commercialisation of wavepower can be exampled by the first full-scale pre-production prototype currently under construction by OPD. Following on from Wavegen's 'Limpet' shoreline device, the 'Pelamis' from OPD is an innovative offshore design using proven technology.

In 2002 OPD signed a memorandum of understanding with BC Hydro to develop a 2MW project using the 'Pelamis' off the coast of Vancouver Island, Canada as part of a 20MW demonstration project. Completion for all phases is expected in 2003/4.

With the 2MW 'Archimedes Wave Swing' device from AWS also being installed off Portugal in 2002 with further units planned, wavepower is now moving towards commercialisation.

Tidal & current – full-scale deployment

September 2002 has seen the first full scale deployment of a current stream device designed to generate several megawatts. The Engineering Business 'Stingray' device has been successfully deployed and retrieved having proven the basic concept and is now moving to the next stage in its development. Again, the key success of the Stingray design is the application of proven technology in an innovative manner.

With a number of other devices waiting in the wings for deployment, the tidal and current stream is now finally moving out of its R&D phase.

Conclusions

We foresee a future of increasing global demand for energy set against a long-term background of depleting oil & gas reserves. At the same time there is a strong desire to reduce the environmental impact of energy production. More recently there have been growing concerns over security of energy supplies and a growing recognition of the strategic value of diversified energy sources.

For all of these reasons we expect increasing numbers of governments to regard renewables as an essential part of their nation's energy mix.

For some countries, and the UK is a prime example, offshore renewable energy offers abundant resources awaiting harvest.

The offshore renewable energy sector has changed substantially over the past three years to the point that it can no longer be regarded as promoting 'tomorrow's potential' but as a developing industry in it own right. Distinct from its onshore cousins, offshore renewable energy presents a new set of challenges, problems and opportunities.

Across Europe, and particularly in the UK, there is a pool of skills and knowledge that can significantly aid the speed of industrial development. With over £8 billion of identified potential (all sources), offshore renewable energy is about to move from a long period of academic research into its first phase of commercial realisation.

The UK is particularly fortunate not only in having a vast untapped offshore energy resource, but also current government policies that will allow it to be harnessed.

The offshore renewable energy sector does not operate in isolation and shares a number of common concerns with the onshore sector. Onshore power distribution infrastructure capacity constraints may act as a real brake on developments which by their nature may be far from points of connection to main power grids.

The licensing and planning constraints and requirements placed on developments, whilst necessary, can be overly burdensome and act as a dissuader to developers.

It is clear that over time governments that deal with these wider issues in the most proactive manner will attract the investments of potential developers, even if subsidy levels appear slightly less attractive.

The need to quickly move developments from concept to reality is pressing, and for many developers the present 3-5 year development cycle is too long.

At least until the advent of 5MW+ machines, with the present price of fossil fuels the offshore renewable energy sector is reliant on subsidies to underwrite the financial viability of most projects. Ultimately it is likely that fossil fuel prices will rise, but in the meantime the key determinate is the need for commitment and consistency. With a 15-20 year project life, financial changes within the early years not only affects existing projects but serve to undermine the confidence of investors and financiers in future projects.

The large number of developers looking to operate in the sector bring with them a depth of knowledge of operating onshore renewable energy schemes within tightly regulated markets, but the majority lack knowledge of operating offshore.

UK suppliers to the offshore oil and gas industry have decades of experience in operating within a demanding and difficult environment but lack the experience of operating effective low-cost electricity generation systems. However, the oil and gas industry has a wealth of solutions in design, management and construction that can have a positive effect on the viability of many of the new and innovative renewable energy concepts being pursued by developers.

Offshore renewable energy is a sector undergoing substantial change as it experiences strong growth. With continuing support from national governments and the coming together of the required industrial knowledge this sector has the potential to develop into a new and distinct industry that not only generates clean electricity but also brings major long-term economic benefits.

Over the next few years, it is likely that the UK will develop into the world's largest market for offshore renewable energy technologies and expertise. The challenge is to develop a UK-based industry that can not only successfully address the home market, but also the considerable export opportunities that will emerge as other nations follow the UK's lead into offshore renewable energy.