Our Energy Challenge

Securing clean affordable energy for the long-term

BWEA's response to the 2006 UK Government Energy Review

April 2006

THE BRITISH WIND ENERGY ASSOCIATION

BWEA - Championing the UK wind and marine renewables industry

The British Wind Energy Association represents over 310 companies active in the maturing onshore wind sector and the emerging technologies of offshore wind, wave and tidal stream, and wind microgeneration. BWEA's members will be delivering the bulk of the UK's renewable electricity growth in the period to 2020 and beyond, and so the Association welcomes the opportunity to contribute to the current Energy Review. The Government has a key opportunity to ensure that its targets and aspirations for renewable energy are achievable through targeted action following on from this Review. This will provide benefits in the form of enhanced energy security and reduced carbon emissions, as well as opportunities for UK investment and jobs. BWEA looks forward to working in partnership with Government to maximise these benefits as the conclusions of the Review are implemented.

The following submission first discusses BWEA's position on the headline issues before turning to detailed responses to the five questions and four issues on which Government sought views. We are also including four appendices, which address the development of onshore wind, offshore wind and marine renewables, as well as the combined contribution that these technologies plus wind microgeneration can make to our power supplies in 2020. We believe that the evidence we are presenting makes a strong case for setting a firm target of 20% of our electricity from renewable generators in 2020. If this is done it will show that the UK Government is serious in setting this country on a course towards its long-term carbon reduction goals as well as increasing the security of our energy supplies.

Yours sincerely

Marcus Rand

Chief Executive

BWEA

Executive Summary

- The renewable technologies of wind, both on- and offshore, wave and tidal stream can bring strategic benefits to the UK, since they are zero-carbon, fuel-independent, indigenous and not subject to political interference, and promote diversity of our generation portfolio. Wind in particular can deliver significant quantities of electricity in the period up to 2020, reducing the UK's reliance on imported gas and playing a key part in reducing the 'generation gap'. In fact, wind is the only low-carbon power source that can be built in sufficient quantities before 2015 to address the gap that retirement of coal and oil plant under the Large Combustion Plant Directive would otherwise create.

- Onshore wind is leading the way in the delivery of renewable power: there is already 1,800 megawatts (MW) operating or under construction, and projects either already consented or likely to be consented in the near future should result in a total capacity onshore of 6,200 MW in 2010, assuming current planning conditions remain. This amount of capacity would deliver just under 5% of the UK's power in 2010.

- While progress has been made on offshore, it has not been as fast as hoped for. With a new policy impetus it can still deliver up to 8,000 MW in 2015, providing 6% of our power in that year. Action by Government to support this new sector is required if this potential is to be realised, however.

- BWEA's research shows that in the period to 2020 a combination of on- and offshore wind, plus a significant contribution from the new marine renewables and smaller, distributed wind turbines, can alone provide 21% of the UK's projected power needs. This would be made up of 12,500 MW of onshore wind (generating almost 9% of 2020 demand), 11,500 MW of offshore wind (9.4%) and 3,000 MW of wave and tidal stream (2.1%), plus an additional (but at this point uncertain) contribution from small wind systems.

- This amount of renewables, if displacing gas-fired generation, would result in gas imports being reduced by 14.6 billion cubic metres annually, equal to 324 tanker-shipments of Liquefied Natural Gas, and carbon dioxide emissions of 32 million tonnes (mt) being avoided. This generating capacity would be providing the equivalent of two-thirds of all the electricity used in UK homes. There will also be major economic benefits from this investment: BWEA estimates that building 12,500 MW of onshore and 11,500 MW of offshore wind will result in direct economic benefits of £16.3 billion to UK plc in the period up to 2020.

- The renewable contribution of 20% in 2020 is deliverable, but the key to unlocking this potential is getting the financial mechanism right for emerging as well as existing lower-cost renewables. If no extra resources are provided for newer technologies or the Renewables Obligation (RO) not evolved to direct more resources to them, offshore wind will not be delivered in the quantities required to establish the sector and attract investment in the supply chain that will bring costs down. Should offshore wind not deliver, then it will be difficult for investors to show confidence in Government providing the right framework for the nascent technologies of wave and tidal stream; finding a solution for offshore, whether within or without the RO, will be a key test of the Government's resolve to set the UK on the path to a low-carbon future.

- Delivery of 20% of our power from renewable energy will require additional support. This should be done by extending the RO to 20% in 2020 and providing additional resources to the emerging technologies. Extending the RO to 20% in 2020 from its current top level of 15.4% in 2015 would increase the overall cost of the RO in 2020 from £1.9 billion/year to £2.5 billion/year, in 2006 money. For an average domestic consumer, this would mean an extra £8/year on top of the existing commitment of about £20/year for the 15.4% Obligation, or an additional rise of about 2% on top of the 6% pre-committed rise on a typical household bill of £400/year. The resources required to support the emerging technologies are of the same order of magnitude as the surplus being generated by the Non-Fossil Purchasing Agency – £0.5-1 billion cumulatively up to 2010 – and if this surplus were to be used to provide such support there would be no additional rise in consumers' bills.

- Concerning the RO, BWEA would prefer for it to remain as it is and the emerging technologies be given extra resources outside of that mechanism. However, should no or insufficient funds be forthcoming, then offshore wind will not deliver and the RO would be open to charges of underperformance. BWEA is thus open to the argument that the RO may need to be evolved to address these issues. The Association has reviewed options that are being debated as possible changes to the RO against five key criteria; at present BWEA is not in a position to endorse any shift from the status quo as it is not clear how investor confidence in onshore wind can be assured under any of the options reviewed. This is not to say that this cannot be done, but further work is required to ensure that any possible change to the system continues to support the healthy expansion of the onshore wind sector.

- Alongside certainty on the economic front, the realisation of the 20% contribution from wind, wave and tidal requires action on planning. With clear steps to reduce the decision times for onshore wind projects, current progress can be accelerated. In the near term, the issue of Section 36 consents for larger projects in Scotland must be addressed: developers have been awaiting decisions from the Scottish Executive on 4,250 MW of projects, some of which were lodged several years ago. Determinations must be made soon to allow this capacity to be brought forward. The offshore renewables require a strong planning framework from the Marine Bill currently being consulted on.

- Renewable development also requires grid issues to be addressed. New thinking is required on strategic planning as it takes longer to plan and build new transmission lines than it does to develop wind farms, both on- and offshore; thought will also have to be applied to how capacity can be provided for the new marine technologies or they will risk being squeezed out of the market, particularly in Scotland.

- The most obvious way that will communicate that Government is serious in tackling this ambitious agenda is to convert the current aspiration to source 20% of our power from renewable resources into a firm target. Government should make this a key result of the Energy Review and subsequently work with the renewable industry to implement the policies required to reach this objective, alongside the numerous agencies and administrations at all levels that will be required to deliver key parts of the agenda.

Contents

1 Preamble

With the largest wind resource in Europe and surrounded by surging seas, the UK is well placed to harness natural flows of energy. Harnessing these flows provides safe, secure and zero-carbon power for our country, and the investment and jobs that are starting to follow can strengthen our economy. The UK has embarked on the wind power path pioneered by our European partners in Denmark, Germany and Spain, and which is being taken up across the globe, from the US to China, New Zealand to Norway. Wind is leading the way to a diverse portfolio of renewable technologies, which together can deliver a fifth of our power in 2020, and more beyond that year.

But if we are to secure this future then action must be taken now to remove the last remaining barriers to the growth of onshore wind, and, even more importantly, to set out a clear pathway for the coming technologies of offshore wind, wave and tidal stream to achieve fully commercial status. We are at a crucial juncture for all the marine renewables: wind as it faces the challenge of building thousands of megawatts of capacity in the new and harsh environment of the sea; wave and tidal stream as they seek a long-term path from the current early steps into the market to being 5% of the UK's power and more. The nascent marine renewables are awaiting the fate of offshore wind, for if that technology fails to make the transition to the mainstream, then it is difficult to see why investors would choose them instead. Let us be clear: without clarity on their route to market, these emerging technologies cannot make the significant contributions to UK power supplies in 2020 that are necessary to meet our climate and security goals. Also at stake is a significant amount of industrial development and employment, which could boost UK plc. Building 6,200 MW of onshore wind by 2010 would result in economic benefits of £4.3 billion accruing to the UK economy over the period to 2020.

The UK has not yet reaped these economic benefits from exploiting its resources of renewable energy. While this is in part due to the fact that the UK has until recently been a small market for renewable generation equipment, there is much more that could be done to encourage local and inward investment. There is currently little incentive for developers to choose UK-made equipment and for manufacturers to establish manufacturing here. This can and should change; resources are available within Government and the Regional Development Agencies to support industry investment. BWEA looks forward to working closely with central and regional agencies to maximise the benefit to the UK economy, but there must be a renewed programme of coordinated action by Government and quasi-Governmental bodies if the potential is to be fulfilled. If this is implemented then developers will be able to choose UK-made equipment and further extend the benefits of renewables to the UK economy. In addition, the planning system must deliver a stable stream of projects, both on- and offshore, if the supply chain is to invest in the capacity required.

The Government has predicated the current Energy Review on the view that the world of energy has changed since the area was assessed for the 2003 Energy White Paper (EWP). BWEA would argue that in fact the review performed ahead of the EWP is still substantially valid and the key drivers of future energy policy have not changed; certainly the judgements on the four key goals of the EWP are still sound. However, it is clear that issues of energy security have become more prominent in the period since the publication of the EWP. What has become even clearer than the security issue is that the need for long-term clarity of the policy framework, not only for renewables but the whole energy sector, has become even more pressing. Government must plainly state how goals for renewable energy policy are to integrate with overall policy objectives.

Much of the debate around this Review has centred on the concept of 'the generation gap', i.e. the space in the power market created by the retirement of both nuclear and coal-fired stations over the coming years. While much has been made of the putative gap in 2020, it should be noted that without life extension of both existing nuclear, and coal and oil plant – the latter affected by the implementation of the Large Combustion Plant Directive – there will be a 'gap' in 2015. Following the principles of the 'Energy Hierarchy', the first action to take to avoid such a gap should be to reduce energy demand through conservation and efficiency. However, on the supply side, renewables are the only low-carbon technologies that can be implemented in sufficient scale to compensate for the retirement of existing capacity, and of the renewables wind, both on- and offshore, is the technology that can be expanded most in that time. If wind power is brought forward significantly in the 2015 timescale, then this resource can also contribute more towards the potential gap in 2020, so the arguments are strong for ensuring early delivery of wind power. Action now to kick-start the marine and microgeneration sectors will also maximise their contribution to the mix in 2020.

BWEA, in common with a number of other organisations in the sustainable energy field as set out in the common manifesto that Government will have received in multiple forms, believes that the priorities of the Government's Energy Review should be to:

> Uphold the vision, objectives and targets for sustainability, security, prosperity and fairness set out in the 2003 Energy White Paper. The Government should re-affirm its commitment to all related statutory and non-statutory targets and introduce supporting annual milestones.

> Develop the long-term policy framework necessary to provide enduring investment signals for businesses of all sizes to deliver the major changes needed to our energy system. This includes a long-term carbon market beyond existing emission trading schemes.

> Minimise the 'energy gap' before trying to fill it. The first priority is to reduce demand; followed by encouraging efficient energy production and usage; then boosting renewables. Incentives and support measures should reflect these priorities.

> Focus on sustainable heat and transport as well as electricity. Energy is an inter-related system and policy should pay equal attention to all parts of the mix.

> Structure Government and agencies to meet the objectives by identifying a single body responsible for achievement of sustainable energy targets. The primary duties of the regulator should reflect all national energy policy objectives.

This strategic framework should lead to the following policy actions:

> Reduced consumption through energy saving. Conservation is the most cost-efficient solution to energy security, fuel poverty and climate change. Government should implement a package of measures that deliver an absolute reduction in energy consumption in industry, transport and the home.

> Investment in decentralised energy systems. Integrated community systems and microgeneration deliver clean heat and electricity at the point of use, displacing inefficient production in conventional stations. Government should ensure a fair value for distributed energy and provide regulatory and fiscal incentives for consumers, installers and network operators. It should strengthen regulations to require all new buildings to be carbon neutral no later than 2015, and use standards to eliminate the most inefficient products from the market.

> Accelerated renewable energy capacity growth. Renewables produce low carbon energy without fossil fuels and stimulate agriculture and the economy. The Government should aim to put the UK in the top five EU members for renewable energy contribution by 2025. Coherent transitional support measures are needed to build scale and reduce costs.

> Champion sustainable energy at home and abroad. The Government should press for international policies to encourage energy efficiency, boost renewables and eliminate barriers to sustainable energy. It must lead by example in its own procurement policies and infrastructure developments. Government should invest in a sustained programme of education to achieve cultural change in energy use.

Individually and together these measures will enhance sustainability, boost UK industry and reduce fuel poverty. They can make a major contribution to energy security by reducing import dependence, maximising local resources and increasing the effectiveness of valuable fuels.

2 Towards 2020

One of the key dates in the Energy Review consultation document is 2020, when 'real progress' is meant to be achieved towards the overarching objective of a 60% cut in carbon emissions in 2050. This is also the year for which the Government has an 'aspiration' to increase renewable electricity to 20% of our supplies. To reach this aspiration there will need to be sustained investment in new renewable generating capacity across the whole of the intervening period. To ensure that this investment takes place and the aspiration is reached, the renewable industry requires a stable environment and clear action to remove remaining barriers. The Energy Review provides a key opportunity to enhance the current policy environment so the way is clear to consistent build-up both of the generating capacity itself and the supply chain that will provide the equipment and services necessary. The clearest statement of the Government's intent to create the right policies and drive their implementation would be to confirm the 2020 renewables aspiration as a firm target.

2.1 Onshore wind

The Government should make this move because it is clear that the renewable energy sector can deliver. New research conducted by BWEA in the last four months, set out in Appendix A to this submission, shows that the onshore wind sector is already delivering significant capacity: in addition to the 1,124 MW already operational, 665 MW will be commissioned in 2006 alone, and once projects which already have consent are built, there will be 3,000 MW in place. Onshore wind will also deliver more over the next few years and on into the next decade: BWEA's research indicates that there is enough capacity in projects within the planning system or about to be submitted for installed capacity to increase to 6,200 MW in 2010, as shown in Figure 1. Over half of the capacity BWEA expects to be built in 2010 will be in Scotland, highlighting the need for UK Government to work closely with the Scottish Executive. The other key recommendations of BWEA's research into onshore wind build are shown in Box 1, and further elaborated on in the following sections. With sustained action to ensure appropriate grid capacity, a well-functioning planning environment and solution of remaining barriers such as effects on aviation, this figure can be doubled again to 12,500 MW in 2020, providing 33 terawatt hours (TWh), or almost 9% of UK electricity supply.

Figure 1. Onshore wind capacity in the UK to 2010

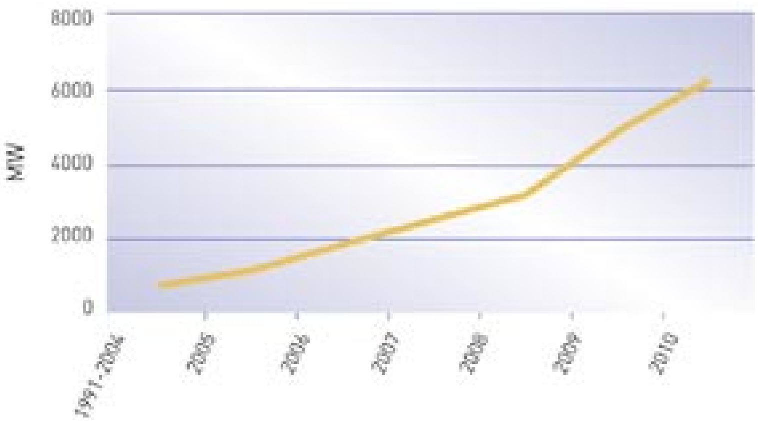
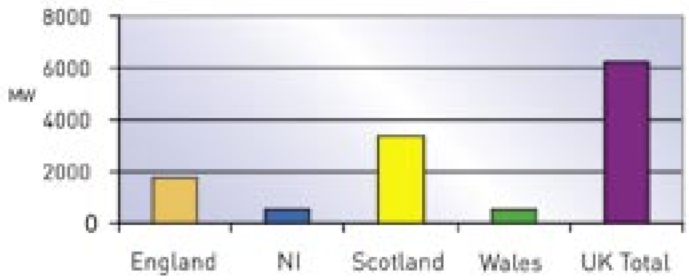


Figure 2. UK estimated 2010 build by country



Box 1. Recommendations on onshore wind from BWEA research

> UK Government and devolved administrations in Scotland, Wales and Northern Ireland must maintain a positive and robust approach to national, regional and local planning policy in accordance with the Government's renewable energy and climate change targets

> Action must be taken to address local planning decision delays across the UK, in particular Wales and Northern Ireland where additional contributions to the 2010 renewable energy targets are severely constrained

> With the average decision time for Section 36 applications moving upwards, prompt action is required to ensure the necessary resources and skills are put in place to ensure quality and timeliness of decision making

> In driving forward the Welsh 800 MW onshore wind target, the Welsh Assembly Government must:

- oversee efficient preparation of Supplementary Planning Guidance and ensure local planning authorities policy revisions are consistent with the Assembly's national policy on renewable energy as contained in Technical Advice Note 8: Renewable Energy (TAN8)
- encourage development activity outside Forestry Commission-owned land within the Strategic Search Areas
- oversee prompt decision making with the necessary resources being committed at the local level,

and for Section 36 projects, the Department of Trade and Industry should also ensure timely decision making and commit to additional resources in order to reflect the increase in development activity thus ensuring a greater contribution from Wales to the 2010 target

> To contribute up to £2.5 billion to the Scottish economy by 2020; ensure that 6,000 MW of onshore wind can be met in the UK, and provide the necessary confidence for future investment in all renewable technologies in Scotland, the Scottish Executive must:

- avoid a hiatus of onshore wind delivery towards the end of this decade and therefore bring forward the early delivery of Scotland's 2020 renewable energy target
- accelerate its decision making process for Section 36 applications - not all decisions are expected to be favourable but they must be made in realistic timescales

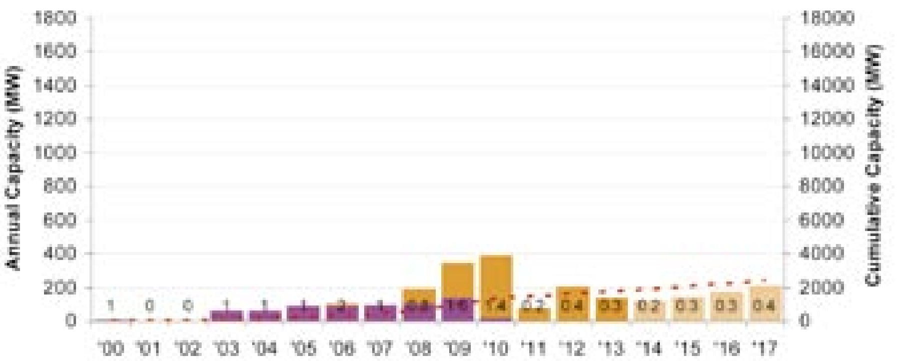
> Plans to reinforce the grid infrastructure in northern Scotland and mid-Wales should move forward urgently to facilitate the full utilisation of generating capacity; provide the necessary investor confidence for all renewable technologies and to avoid a hiatus early in the next decade at a time when momentum of onshore wind delivery must be maintained.

2.2 Offshore wind

The other major contributor in 2020 will be offshore wind. Further new research commissioned by BWEA in the last four months, set out in Appendix B, shows that there are the projects and the industrial capability to build 8,000 MW of offshore wind capacity in UK waters by 2015, from projects that are currently under development. With a clear system of site award, provided within the framework of Marine Spatial Planning foreseen under the planned Marine Bill, further build beyond 2015 could result in 14,000 MW installed by 2020. If one takes a conservative view that 1,500 MW is built by 2010 and annual installation proceeds at an average rate of 1,000 MW/year thereafter, this still results in 11,500 MW in 2020; this capacity would generate about 35 TWh or 9.4% of UK electricity supply.

Our research also indicates, however, that this potential will not be realised unless action is taken now to support this new industry. As discussed below, the Renewables Obligation is not delivering the economic framework that allows offshore developers to reach financial close on their projects: revenue risk under the RO compounds the technological and commercial risk inherent in developing a new sector, resulting in a risk-reward balance that is not conducive to investment. Without new measures, the sector will struggle to build on the scale that is required to drive investment in the supply chain and technological innovation – only 1,300 MW in 2010 and 2,000 MW in 2015, as shown in Figure 3.

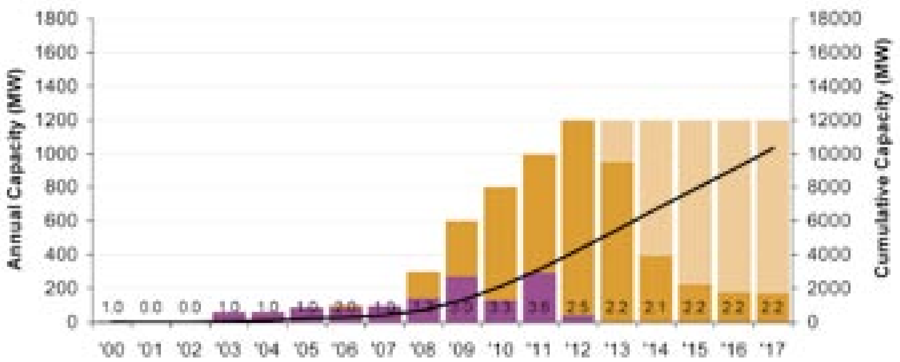
Figure 3. UK Offshore Wind Capacity under Scenario "Continuation of Current Policies"



Key: Pink bars: UK offshore Round 1 projects; Orange bars: UK offshore Round 2 and other projects.; Tan bars: UK offshore Round 3 and later projects; Broken red line: Cumulative capacity; Values: The number of UK projects forecast to be completed per year. Note that as Round 2 and later projects come to dominate, the size of a typical project will be much greater than those installed to date.

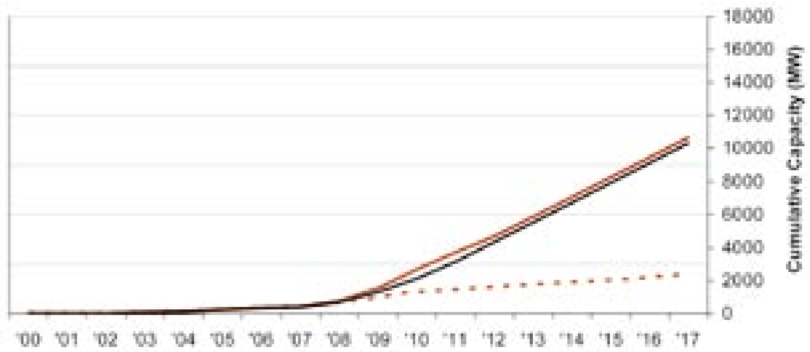
The result will be slow progress on costs and the risk that companies will walk away from the industry as it stalls. The wind industry is committed to resolving the commercial and technical issues that it faces, having started a process focused on cost-effective delivery of offshore wind. Government must commit to meeting the industry half-way with solutions that allow developers to build out their projects with a reasonable return on investment while the technology matures. We address issues surrounding economic support below, but it should be a key result of this Review that Government commits to a solution in some form. With such a new policy impetus, then development can follow the path shown in Figure 4. It is important to note that the supply chain stands ready to substantially deliver on developers' plans: in Figure 5, the solid black line shows the development which is possible given supply chain constraints; this is only marginally below the build that developers would wish given appropriate project economics.

Figure 4. UK Offshore Wind Capacity under Scenario "New Policy Impetus in 2006" (with supply chain limitations imposed)



Key: Pink bars: UK offshore Round 1 projects; Orange bars: UK offshore Round 2 and other projects; Tan bars: UK offshore Round 3 and later projects; Black line: Cumulative capacity; Values: The number of UK projects forecast to be completed per year. Note that as Round 2 and later projects come to dominate, the size of a typical project will be much greater than those installed to date.

Figure 5. UK Offshore Wind Cumulative Capacity under Scenario "Continuation of Current Policies" and "New Policy Impetus in 2006" (without- and with supply chain limitations imposed)

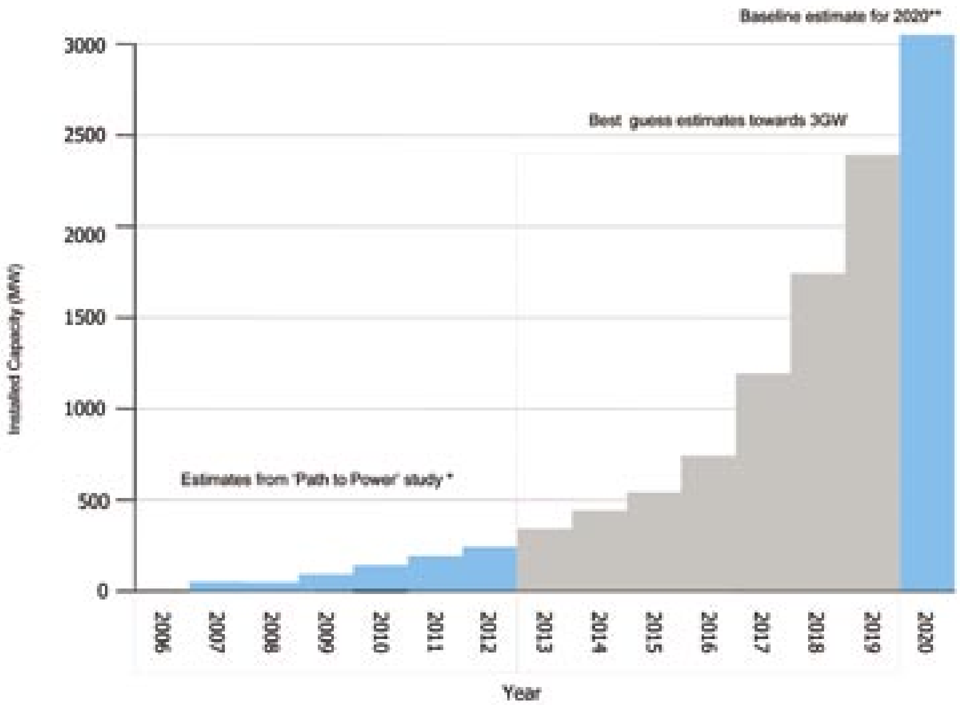


Key: Red line: Cumulative capacity Scenario "New Policy Impetus in 2006" (without any supply chain limitations imposed); Black line: Cumulative capacity Scenario "New Policy Impetus in 2006" (with supply chain limitations imposed).

2.3 Wave and tidal stream

Other technologies can also make contributions in 2020. Most notable here are the emerging marine renewable technologies of wave and tidal stream, which are analysed in detail in Appendix C. These sectors are at a very early stage of development, but could be contributing significantly by 2020. As much as 3% of UK power supply could be derived from these sources by this date, according to the Carbon Trust's Marine Energy Challenge[1], and 15-20% in the longer term. BWEA believes that 3,000 MW of these technologies are deliverable by 2020, providing 2.1% of the UK's power in that year, providing a clear path is laid out now for the development of the sector.

Figure 6. A Possible Development Path for Marine Renewables to 2020



* Figures from Stage 1 of 'The npower Juice Path to Power' following interviews with industry

** Based on conservative estimate of Carbon Trust Marine Energy Challenge figures for 2020

The opportunity is also available for these technologies to provide a major industrial activity for UK plc. As argued in Appendix C, however, for these developments to happen, there needs to be a clear path to commercialisation for the sector. BWEA is leading a research project called 'Path to Power', sponsored by the npower Juice fund, which aims to set out just such a road map, reporting in June 2006. Interim results from early phases of this work have informed BWEA's submission, and the Association will apprise Government of the final results when the project is complete. What is already clear is that several key barriers lie in

[1] *Future Marine Energy – Results of the Marine Energy Challenge: Cost competitiveness and growth of wave and tidal stream energy*, The Carbon Trust, January 2006. www.thecarbontrust.co.uk/carbontrust/about/publications/FutureMarineEnergy.pdf

the path, and Government should use the opportunity of this Review to indicate its intention to remove them. The earlier these are tackled, the more confidence this new industry will have to invest. Key will be providing a long-term 'market pull' mechanism to provide economic support while the industry moves from its current nascent state through the first commercial-scale deployments and into a mature sector. There will also need to be clarity on how marine developers can access sufficient grid capacity, given that many will wish to install generators in Scotland, where the current high interest in onshore wind is resulting in long waiting times for connection. It should be noted that confidence in this emerging sector will be badly affected if Government allows offshore wind to stall; an economic solution which works for both sectors would give confidence that Government is committed to bringing emerging renewable technologies into the mainstream.

2.4 Small wind

Much attention has been paid to the new microgeneration technologies, which include micro (1-2 kilowatts (kW)) and small (up to 100kW) wind turbines. These too can contribute to UK supplies by 2020. However, given the extremely early stage that this market is at, making definitive forecasts for the next 15 years is not possible. Our analysis shows that a conservative estimate of the possible contribution of microturbines in 2020 is about 0.5 TWh, though small turbines can provide more energy, perhaps another 2.1 TWh – altogether about 0.7% of supply. If the numerous barriers to implementing small wind can be successfully addressed, this contribution could be increased. Barriers include planning, network codes and metering.

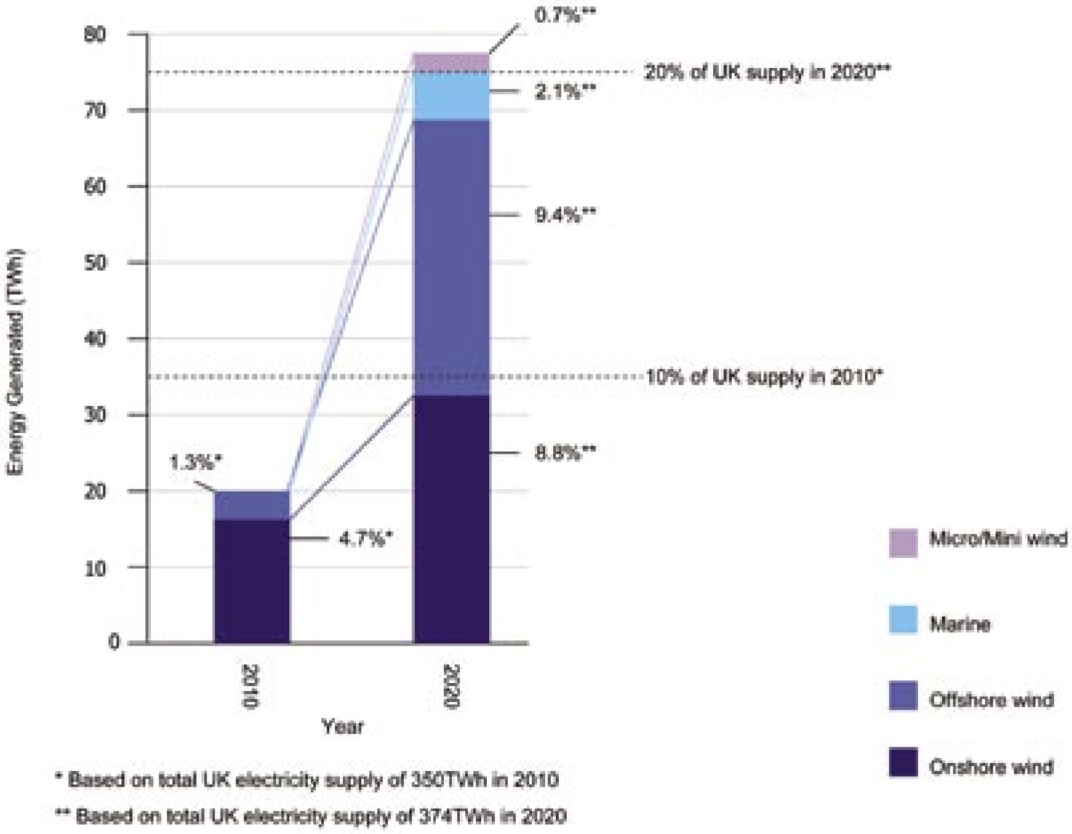
While these numbers are small compared to other technologies BWEA represents, the Association considers microgeneration to be of key strategic importance. Other microgeneration technologies will provide more power, and with them small wind can provide a useful amount of energy, avoiding transmission and distribution losses. Perhaps more importantly, there is evidence that installation of domestic generation promotes new awareness of energy use and encourages people to minimise their consumption, through behaviour change and investment in more efficient appliances. As yet, it is difficult to estimate the total effect this might have, as it is not clear how common this behaviour change would be once microgeneration reaches mass installation. This clearly merits further research; if that shows a significant effect then it would justify accelerating progress in this sector, including aggressive targets and Government action to provide a market, through enhanced grant programmes and/or commitments to install on-site generation in the Government estate. Planning will also be key to unlocking the potential of domestic generators.

2.5 Total contributions in 2020

The reasoning behind our estimates for these technologies' contributions in 2020 is set out in Appendix D. If one adds up these contributions, as is done in Table 1 and illustrated in Figure 7, then it can be seen that it is possible to get 21% of UK supply from these technologies in 2020, using a DTI projection of 374 TWh of demand in that year. This is to say nothing of the contributions that other renewable resources such as biomass can make to the UK generation mix in 2020.

A key question in whether this contribution is to be realised is the cost to the consumer. The cost is currently defined by the Renewables Obligation, which rises to 15.4% in 2015 and is then level until 2027. Key to driving a rise to 20% would be the additional resource that would be mandated into the renewables market by extending the RO by 1% a year beyond 2015 so it reaches 20% in 2020. If one takes the figure of 374 TWh for electricity demand in 2020 and the current buyout price of £33.24/megawatt hour (MWh), then in 2020 consumers will be paying £1.9 billion for a 15% Obligation in 2006 money; increasing the level to 20% would result in a rise to £2.5 billion in that year. In terms of the average domestic consumer, this translates into a rise of about £8/year on top of the £20/year the 15% Obligation level would mean, or an additional 2% on a typical household bill of £400/year. As discussed over, additional resources would be required for emerging technologies;

Figure 7. TWh Contributions from Wind, Wave and Tidal Power in 2010 and 2020



these could be provided from the surplus that is being generated by the Non-Fossil Purchasing Agency, which means there would be no additional burden on the consumer.

While there will be a direct cost in expanding renewables to 20% and more of our electricity, there are benefits in addition to acquiring carbon-free and secure power. The capital-intensive structure of investment in renewables results in high price certainty in the power produced, whereas fuel-based electricity generation is subject to volatility due to changes in the price of internationally-traded fuels. As detailed in Appendix D, this certainty results in lower overall costs of a power portfolio with significant fixed-cost output through avoiding the need to hedge against high fuel prices. In particular, Shimon Awerbuch of Sussex University estimates that the 'true' cost of gas, once price risk is properly accounted for, is 60-100% higher than generally believed, making investment in alternatives more attractive.

In addition to these portfolio benefits, BWEA estimates that considerable direct economic benefits will accrue to UK plc if investment in wind is made. Our analysis indicates that the building of 12,500 MW of onshore wind and 11,500 MW of offshore wind by 2020 will result in £16.3 billion of such benefits, made up of the capital spend that would be directed to UK companies, ongoing operational expenditure, business rates and income for landowners and communities.

Table 1. Capacity and energy estimates for wind and marine renewables

		2010		2020		Notes
		MW	TWh	MW	TWh	
Onshore	Lower	4,700		12,000		
	Upper	7,500		15,000		
	Baseline	**6,220**	**16.35**	**12,500**	**32.85**	1
	Percentage of supply		**4.7%**		**8.8%**	
Offshore	Baseline	**1,500**	**4.60**	**11,500**	**35.26**	1
	Percentage of supply		**1.3%**		**9.4%**	
Marine	Lower	70		2,000		
	Upper	70		5,000		
	Baseline	**70**	**0.21**	**3,000**	**7.88**	1
	Percentage of supply		**0.06%**		**2.1%**	
Micro & Mini	Micro				**0.5**	2
	Mini			1,200	**2.10**	3
	Percentage of supply				**0.7%**	
Total TWh			**21.16**		**78.60**	
Total supply (TWh)			350		374	4
Percent of supply			**6.06%**		**21.01%**	

Notes:

1. 30% capacity factor for onshore wind and marine renewables; 35% for offshore
2. BWEA estimate, based on reports by EST (Energy Saving Trust, Econnect and Element Energy, 2005; *Potential for micro generation: study and analysis*) and CCLRC (Dutton, A, Halliday, J and Blanch, M, 2005; *The feasibility of building-mounted/integrated wind turbines*: Part-funded Carbon Trust project), and further analysis
3. CCLRC estimate of capacity; 20% capacity factor
4. Source: DTI (DTI, 2006. *UK Energy And CO_2 Emissions Projections: Updated Projections to 2020*)

BWEA is aware that questions are likely to be asked regarding the ability of renewables to generate 20% of UK electricity, given the misinformation that often arises in relation to intermittent sources of generation. BWEA has long maintained that the available evidence demonstrates that the intermittent nature of renewable generation, such as wind, is not an issue for generation levels of up to 20% of demand. Most recently this was summarised in the BWEA briefing sheet *Wind Power and Intermittency: the facts*[2].

Recent work by Graham Sinden of the Environmental Change Institute (ECI) at Oxford University[3] has reinforced this message. ECI found that the output from geographically dispersed wind farms is less volatile than the outputs of the individual sites as the different variations in output from individual sites largely cancelled each other. ECI also found that different forms of renewables (such as wind, wave and tidal stream) are complementary to each other and that with the appropriate combination of renewable sources a greater volume of renewables can be added to the system than might be accommodated from any individual generation technology. This is a particularly pertinent finding in light of the projected generation mix for 2020 where generation technologies such as wave and tidal stream technology are predicted to provide increasing volumes of electricity.

The most recent piece of work on intermittency is also the most comprehensive. A report by the UK Energy Research Centre published in April 2006[4] reviewed all available literature on

[2] www.bwea.com/pdf/briefings/intermittency05-small.pdf

[3] See www.eci.ox.ac.uk/lowercf/renewables/index.html

[4] www.ukerc.ac.uk/content/view/258/852

the impact and costs of intermittent generation. Of particular note, the report found that:

> *"None of the 200+ studies we reviewed suggested that introducing significant levels of intermittent renewable energy generation on to the British electricity system must lead to reduced reliability of electricity supply. Many of the studies consider intermittent generation of up to 20% of electricity demand, some considerably more. It is clear that intermittent generation need not compromise electricity system reliability at any level of penetration foreseeable in Britain over the next 20 years. In the longer term much larger penetrations may also be feasible given appropriate changes to electricity networks, but we did not explore the evidence on this topic."*

In addition to this work, the European Wind Energy Association (EWEA) report *Large scale integration of wind energy in the European power supply*[5] analyses the issues in depth. The report's main conclusions are that the capacity of Europe's power systems to absorb significant amounts of wind power is determined largely by economics and regulatory rules rather than technical or practical constraints. Already today, it is generally considered that wind energy can meet in the region of 20% of electricity demand on a large electricity network without posing any serious technical or practical problems – as proven by the example of Denmark.

[5] www.ewea.org/fileadmin/ewea_documents/documents/publications/grid/051215_Grid_report.pdf

3 Key measures to ensure delivery

In order to realise these contributions, Government needs to maintain and strengthen existing measures supporting renewable energy, and implement a number of new measures. Other contributors to this consultation from the renewable field will be putting forward the measures required for their technologies, though many of these will be common to those required for wind, wave and tidal. BWEA's detailed suggestions are set out in the answers to the consultation questions below, but the main messages are as follows:

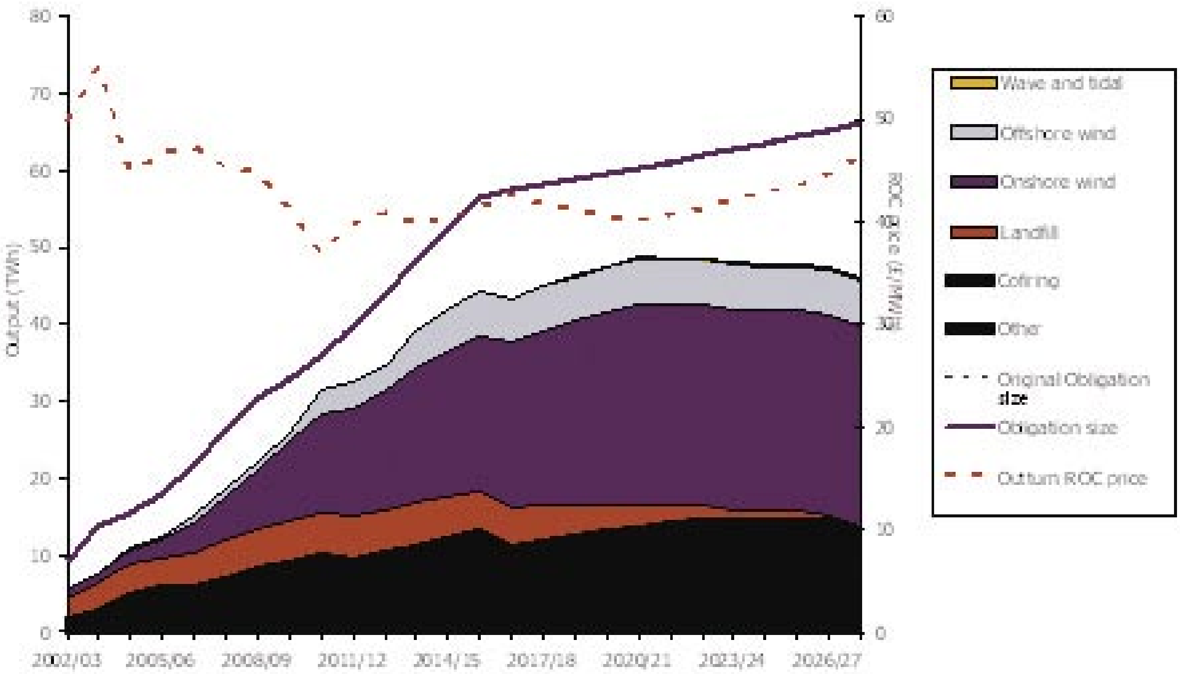
3.1 Economic support

The key to unlocking the potential delivery outlined above is getting the economic framework right for investment in renewable generating capacity. While a good start has been made in building onshore wind, it is becoming ever clearer that further action is required in order to bring forward the less mature technologies. First among these actions should be to extend the Obligation out to 20% in 2020, which will mandate the resource into the sector that is required to bring forward investment. However, this is not sufficient in itself to guarantee that the emerging technologies will be able to play their full part.

The renewable electricity sector is benefiting from the resources that the Renewables Obligation directs towards its business. The RO is doing well in bringing forward the lowest-cost renewable resources, notably co-firing and landfill gas as well as onshore wind. What it is not doing is providing suitable incentives for technologies that are, at the moment, more expensive or further away from the market, notably offshore wind and the new marine renewables, both of which have potential to deliver significant volumes of renewable energy.

In order to bring these emerging technologies into the RO, BWEA has a clear preference for leaving the mechanism intact and providing additional resources to them outside of the Obligation; this would maximise the effectiveness of the money already mandated to renewables by the RO through increasing delivery of renewable MWh. However, this requires subvention from the Treasury to support the newer technologies, and there is constant competition for Government funds.

Figure 8. Delivery of renewable energy under the RO as it stands, for a central underlying power price forecast. Source: Oxera research for BWEA.



The resources required to bring forward these new technologies are of the same magnitude as the money currently being extracted from the RO through the surplus being generated by the Non-Fossil Purchasing Agency's activities, which will total up to £1 billion in the period to 2010. BWEA argues that this money should be used to support emerging technologies, but so far these arguments have not been accepted by Government. Without the hypothecation of this revenue stream, reliance on ongoing Government subsidy exposes the emerging technologies to increased levels of political risk, since Government in the future may choose to redirect its funds, whereas the cost of the RO is borne by consumers and is mandated through legislation that is more difficult to change.

Also, if extra resources are not forthcoming, then only the lower-cost technologies will be built, and the supply of Renewables Obligation Certificates (ROCs) will continue to fall short of the rising Obligation levels, since non-economic barriers to onshore wind (planning and grid primarily) mean that it cannot meet the RO targets on its own. This is shown in Figure 8, which comes from research undertaken by Oxera for BWEA. It should be noted that this research is still work in progress, and does not reflect an official BWEA view of delivery: we are not sure that the non-economic constraints on delivery have been fully captured, particularly for the dedicated biomass generating plant that make up most of the 'other' category. Nonetheless, BWEA believes this analysis underlines the general point. Without new initiatives to bring forward the emerging technologies, they will not deliver the volumes required: under the 'business as usual' scenario shown, in 2010 there would be a 90% fulfilment of the Obligation, but this drops to 80% in 2015 and thence generation only increases with rises in power demand, which drives an increase in ROC demand; in 2020 fulfilment is still only 80% as offshore wind and marine deliver only a fraction of their potential, and this falls away as the end of the Obligation looms in 2027. This exposes the whole RO system to charges of underdelivery and unfairly implies that renewables are poor value for money; if offshore wind in particular fails to grow because the RO does not provide the income it requires, then the calls for the system to be reformed will only increase. Thus the risk increases that the RO will not provide the stable, long-term, sustainable mechanism that all the renewable technologies need.

Consequently, BWEA recognises that there are arguments for reforming the RO so that different technologies receive differing amounts of income from the system. This would provide more certainty to the emerging technologies, through ensuring the higher revenues they require without dependence on Treasury decisions. However, BWEA also recognises that change will affect investments already made on the basis of the RO as it currently stands. The RO is still a young mechanism and it has just been subject to a year-long review, so investors would look askance at fundamental change being put forward in the near future without strong protection of their investments, and even then confidence in future development may be affected through the introduction of change. Nevertheless, the Association has reviewed a number of options that are being put forward as possible reforms to the system, with five criteria used to assess them:

- Does it protect investor confidence in onshore wind?
- Does it successfully promote offshore wind and marine renewables?
- Does it ensure maximum renewable TWh delivery?
- Does it promote long-term stable markets for the supply chain?
- Does it enhance value for money for consumers?

At present BWEA is not in a position to endorse any shift from the status quo as it is not clear how investor confidence in onshore wind can be assured under any of the options reviewed. This is not to say that this cannot be done, but further work is required to ensure that any possible change to the system continues to support the healthy expansion of the onshore wind sector. BWEA looks forward to working with Government to find a way forward that satisfies the Association's five criteria and provides the stability that the industry requires for long-term investment.

One issue regarding the RO that needs to be addressed is its sudden end in 2027. Investment is already starting to be affected by the fact that ROC award will cease within the lifetime of projects currently being planned, and as 2027 approaches, investment will be discouraged further as the time available for earning ROCs reduces. This will particularly affect the emerging technologies of offshore wind and marine, as they will be looking to build later in the term of the RO. If the RO is to be reviewed, then attention should be paid to how the system could be phased out rather than simply cease. Alternatively, a clear system of pricing for carbon could support renewable capacity beyond 2027, but much would depend on the exact nature of that system and the long-term confidence it inspires in providing robust support for zero-carbon generation.

3.2 Grid

The electricity network is a key part of the energy future of the UK, one that has the ability to constrain or unlock our renewable and sustainable energy potential. The transmission and distribution network is designed to have a 40 year operational lifetime. The Energy Networks Association estimates that approximately 70% of the UK network is approaching the end of its design life[6]. This presents an opportunity for sustainable energy to be 'designed in' to the structure of the network; not to take this opportunity would mean the UK is locked in to an infrastructure which militates against realising our full renewable potential.

The widescale uptake of renewables presents challenges for network owners and operators at a number of levels. The large-scale development of renewables, such as on- and offshore wind and potentially the marine renewables, will take place where the resources are – and these places are generally where the grid is weak. Grid extension and reinforcement has to be planned several years in advance of when developers would want to connect due to long consent and build times for the infrastructure; strategic planning is therefore vital to ensure adequate grid capacity is in place at the right time. This leads on to the question of regulation, addressed below, but at the highest level developers need to know what the 'end game' for the grid is, and the way that the network will be developed to achieve the configuration envisaged. This will guide their search for suitable sites to where grid access is most likely to be available.

For offshore wind and the other marine renewables, if Government wishes to continue the 'strategic area' approach used for Round Two of offshore wind development, then provision of adequate grid capacity in a timely manner must be integrated into the process of selecting such areas. Round Two developers have been guided to the three designated areas, only to find that their projects face lengthy delays while adequate grid reinforcements are planned and implemented. Future rounds of offshore development, be it wind, wave or tidal stream, must be planned in conjunction with the evolution of the transmission network.

In the shorter term, there are issues to do with the system by which renewable generators are granted grid access, the 'queue' which has formed in response to this system, and the final sums liabilities that developers are expected to underwrite before accepting a connection offer. BWEA is pleased that there are ongoing efforts by Ofgem, the wind industry and the network operators to resolve these issues, in the timeframe of the transmission price control review, due to be implemented in April 2007. Initial talks indicate that a solution along BWEA's 'connect and manage' principles, as opposed to the 'invest and connect' philosophy currently used, is on the table. If such a solution is implemented, this should substantially deal with the issues. This outcome is not certain, however, and Government should work closely with Ofgem and all generators to ensure that a satisfactory solution materialises. While concerns over the management of connections have been highlighted by the situation in Scotland, there are other areas where the new thinking can provide timely grid capacity to unlock wind power potential. In particular, mid- and north Wales is lacking in the grid required to connect developments in the strategic areas identified in the TAN8 planning policy, and will soon encounter similar problems to Scotland unless new arrangements are put in place soon.

There are other areas where Government and Ofgem have acted to support renewable development through grid arrangements, and BWEA welcomes these initiatives. The

[6] Energy Networks Association (2006) *The state of our networks: Electricity and gas in the UK 2006 – 2050*.

consultation on capping transmission charges in the Scottish Islands and the proposed extension of this cap beyond 2014 currently before Parliament are particularly welcome. The recent announcement on the regulatory framework for offshore transmission is also a key part of the future grid regime that BWEA is pleased to see in place.

At the distribution system level, decentralised generators will increasingly wish to connect to networks which have hitherto acted only as a conduit for electricity from large power stations to consumers. In order to deal with multiple small contributions of power to the system, grids will have to be increasingly 'smart', from the meters at domestic households through to the substations and switches that regulate power flows in lower voltage networks. Investment in smart networks would not only facilitate the spread of microgeneration, smaller wind developments and combined heat and power plants, but would enable innovative demand management techniques, such as remote control of loads, to contribute to security and reliability of supply. At present, however, there is no 'road map' for the roll-out of the investment, which would be spread over a number of five-year distribution regulation periods. At this level too, strategic plans need to be made which clear the way to maximising the amount of electricity that can be gained from decentralised sources.

3.3 Regulation

Effective management and regulation of a future energy market will be key to ensure successful delivery of any UK Government Energy Policy. However, our experience following the 2003 Energy White Paper is that at present our regulatory regime hinders delivery. While Ofgem's core objective remains ensuring value to the consumer, energy policy needs to now deliver on four objectives: cost; environment; competitiveness; and energy security. Ofgem has secondary licence objectives such as protection of the environment, but these have lesser profile in its decision making than the narrow focus on cost.

If the Government wishes to see an enhanced energy policy delivered by the market, then there will be a continuing need for proper regulation of any resulting energy market(s). However, at the present time, Ofgem's objectives can frustrate delivery of these wider objectives. More appropriate would be for the UK Government to set a market framework that better takes account of wider energy policy objectives. This would start by changing the licence conditions of Ofgem, creating not one primary duty, but four equal duties of affordability, carbon, security and competitiveness.

This would not be an easy task for Ofgem, given the fact that the four objectives will not always sit well together. Instead, Ofgem will need to manage the creative tension between these different goals of energy policy. Expanding Ofgem's objectives would, however, allow it to lead the strategic planning for the electricity networks mentioned above, the principles for the process having been set by central Government.

The time horizons for necessary investment will need to be extended well beyond current five year cycles, and a longer regulatory framework must be put in place to better assess investment options. Because significant investment will be needed, the most effective way forwards will be incorporation of innovative solutions, technologies and grid architectures when planning and delivering new infrastructure. Replacing existing infrastructure on a like-for-like basis in isolation of wider considerations will be inappropriate. It will therefore be important to establish the right longer-term planning.

While there will be unforeseen challenges, we know enough about the emerging energy market to be able to plan out the next steps. Firstly we need to plan for the connection of new technologies and/or locations. For instance, decisions need to be made on provision of networks to the Scottish Islands to facilitate connection of significant levels of renewable generation. Secondly, we need to plan for greater levels of distributed generation by encouraging active network management, and facilitating connection of a more diverse mix of generation at the micro, small and medium scale (i.e. up to 10 MW). Thirdly, we need to design-in greater functionality and flexibility into our networks to allow for change of the use of our networks over time. Such changes could include storage; better power-flow management; power electronics and demand-side management.

We need to recognise that the current market structure will not proactively put in place new network solutions. In part the market will need to evolve to facilitate the necessary changes; in part the Government will need to directly manage or incentivise such change. For example, to deliver network assets to connect the Western Isles, Orkney Islands and Shetland Islands, developers must first ensure that sufficient connections are required in order to bring market demand for investment. However, there are very weak market incentives to encourage generators and network operators to work together in looking at network provision. There are also very weak market signals to ensure that capacity is available when needed for generation technologies, and in particular emerging technologies.

To overcome this problem the Government needs to assess what role it can play in allowing re-allocation of risk between generators seeking new connections and network operators to facilitate new investment by the latter. Without this intervention, provision of networks will lag behind demand for connection; this exposes the UK to an economic risk in the form of under-investment in grid infrastructure, a risk that far outweighs the potential downside of over-investment, which is in any case unlikely so long as suitable strategic planning and regulation is in place. This will also risk losing the window of opportunity to install renewable capacity – unless the Renewables Obligation is extended beyond 2027, the approach of that date will discourage investment if connections are delayed.

3.4 Planning for onshore wind

The introduction of planning policy which incorporates Government objectives on renewable energy, such as Planning Policy Statement 22: Renewable Energy (PPS22) in England, National Planning Policy Guideline NPPG6: Renewable Energy (NPPG6) in Scotland and TAN8 in Wales, has been a welcome development over recent years. Apart from TAN8, which takes a 'strategic area' approach, planning policy has been 'criteria based', allowing developers to bring forward projects which are then assessed according to the published policy on a site by site basis. This approach is generally supported by the wind industry, and results in good-quality projects being permitted. Any move to introduce strategic areas outside Wales would cause major uncertainty in the industry, and severe delays while the new policy is consulted on and implemented. There is also the risk that the areas chosen in the strategic approach may turn out to be unsuitable for technical or economic reasons, an issue which has led to a situation where the 2010 onshore wind targets in Wales will almost certainly be missed. While BWEA welcomed the TAN8 policy when it was adopted, on the basis that planning policy of some kind was necessary to overcome the complete halt to planning consents in the Principality, the Association was of the opinion that much of the land within the strategic areas would prove difficult to develop. Our analysis since then underlines this point, with at most only 221 MW out of the Welsh Assembly's target of 800 MW likely to be built by 2010. It is our firm opinion that wind developers are the experts in determining technical and economic viability of sites, while planners are good at land use planning. The current criteria-based approach plays to the strengths of each and should be retained and strengthened.

As part of this strengthening, greater attention needs to be given to managing the emerging issue of cumulative effect, which occurs when several developments are proposed in close geographical proximity. This will give certainty both to developers looking to bring forward projects in 'popular' areas, and to the populations of these areas, who need to know what to expect and how lines are drawn on this subject.

However, by far the greatest planning challenge to meeting Government targets for renewable energy is the time it takes for decisions to be made. In recent times this has been spiralling out of control with planning decisions taking many months and even years to obtain, with non-determination often resulting in time consuming and costly public enquiries, for both developers and planning authorities. Decision times vary from region to region: 10 months in England; 14 months in Scotland; 27 months in Wales and 28 months in Northern Ireland. It should be noted that planning decisions are meant to be determined within 16 weeks of application. BWEA is unaware of any decision on an onshore wind farm larger than 20 MW having been made within this time. There is also the issue of consents under Section 36 of the 1989 Electricity Act, particularly in Scotland, where decision times are stretching to several years. The development of our renewable energy capacity will benefit greatly from a reduction in these decision times. This may be helped by additional resources, skills and awareness – especially in the Scottish Executive's Section 36 team where decisions are simply not being made – and further work to improve local planning departments' ability to deal with applications for this rather unique form of development. Since the numbers of renewable energy project applications will only increase – not just from wind but many other technologies – educating local planning departments in the wider issues of climate change and renewables' place in energy policy is essential in any case. The wind industry does not always expect decisions to be favourable, but does expect timeliness and quality in the decisions that are made. If this can be promoted, then with 7,000 MW of onshore wind projects already in the planning system across the UK, this sector can lead the way in renewable delivery.

There has been some debate about the concept of 'pre-consenting' energy technologies, in order to speed up the process overall. This is primarily aimed at large developments, such as nuclear power plants or grid extension/reinforcement, where public enquiries can stretch to years as generic issues about the technology are re-rehearsed at length. However, while this clearly has a role to play for new grid infrastructure, BWEA does not consider pre-consenting would assist in reducing the determination times for onshore wind projects. It is our view that comprehensive consultation and detailed environmental impact assessments will always be required to assess the site specific characteristics of individual wind farm proposals, taking into account the impact on landscape, wildlife and residential amenity which are different in every case. The fast-tracking of a relatively limited number of generic issues through a pre-consenting process will be outweighed by the delay caused by an additional layer of decision making. It appears that much of the supposed benefit of pre-consenting is what existing planning policies such as PPS22 are supposed to deliver: clear direction to planning authorities that renewables are a key part of UK climate and energy policy goals, and that decisions on applications should strike the right balance between local and national environmental and economic issues. The contents of existing planning policy statements, and their enforcement, should be strengthened in order to speed up determination times and improve the quality of decisions in the short term.

Outside of policy measures, there is a lack of incentive for planning authorities to make timely decisions. There are a range of initiatives which BWEA propose the Government should promptly employ in response.

> The Government should issue new advice to local planning authorities stressing that the risk of appeal costs being awarded to a developer due to the failure of a local authority to determine an application, will increase over time.

> The Government should introduce a range of targets to incentivise decision making even after the 16 week deadline has passed. Under the current system, it is in the interest of local planning authorities to determine as many applications as possible within the 16 week target and therefore once the deadline has passed, it is in their interest to prioritise more recent projects rather than those applications which have already missed the target. New targets could be for 90% of projects to be determined in 30 weeks and 100% in 50 weeks.

> The Government should publish the statistical performances of local planning authorities on a regular basis to highlight non-performers while highlighting improvements in performance over time.

> Under Section 36 of the Electricity Act, there is currently no right given to the applicant to appeal for non-determination after 16 weeks. While larger projects arguably require longer periods of assessment, the Government should amend legislation to introduce recommended timescales for the determination of on- and offshore wind farms under Section 36 of the Electricity Act. Additionally, developers should be given the right to go to a public inquiry (noting here Section 6 of the Human Rights Act 1998).

In summary, for onshore wind the planning system is delivering wind projects, albeit slowly, using policies that have taken several years to develop. In order to speed up the process so that renewable build can be accelerated, further strengthening of existing policies should be implemented in an evolutionary manner, though care should be taken that in the process of strengthening there is no slow-down in decision making. Alongside additional training, skills and resources for planners and decision makers, a combination of incentives and disincentives should be introduced using financial mechanisms, targets and new legislation. This should result in timely consents, facilitating the meeting of Government targets for wind and other renewables. Of particular concern, and an area where action is urgently required, is the backlog of 4,300 MW of Section 36 projects being considered by the Scottish Executive: speeding up determinations here will aid greatly in reaching UK targets for renewables. BWEA would welcome proposals to speed up and improve the quality of planning decisions, and stands ready to cooperate with Government in reviewing the current planning system with a view to achieving these goals in the short term.

3.5 Planning for offshore renewables

The position for offshore wind is considerably different, particularly in that all consents are awarded by central Government or the Scottish Executive under Section 36 of the 1989 Electricity Act. The stakeholders and environmental impacts are different also, and understanding of the issues is at an earlier stage, which results in precautionary approach to the potential impacts of a project. The consenting regime has developed over the past few years, so that Department of Trade and Industry (DTI) acts as a single postbox for applications, but projects still need both a Section 36 consent and a licence under the 1985 Food and Environment Protection Act (FEPA). Consenting also requires detailed input from statutory consultees, who have resource constraints.

The offshore wind industry would welcome simplification of this system of consents, and the opportunity to do this is available in the form of the Marine Bill, consultation on the contents of which has recently opened. BWEA looks forward to contributing to the development of this important legislation. There may be a role for pre-consenting to play for offshore wind, though it is likely that the main area of contention for offshore projects will be the onshore infrastructure required to link these projects to the grid. If such enabling development can be speeded through the planning system, it would reduce development risk for offshore considerably.

The Marine Bill should also result in a new system of Marine Spatial Planning, which will play a key role in determining future areas for development of both offshore wind and the new marine renewables. While there remains much work to do in consenting and building the Round Two offshore wind projects, it is important that attention is paid soon to how future sites for offshore wind are awarded, so that the sector can see a steady pipeline of development into the future. Alongside steps to improve the economics of offshore wind, this will assure players in this market that it is a stable, long-term business. BWEA looks forward to starting dialogue with Government on this issue as part of the development process for the Marine Bill.

3.6 Planning for microgeneration

The planning system will also be important in creating markets for microgeneration technologies, particularly so for microwind. Currently the need for a full planning application for a wind turbine on a domestic roof is a major bureaucratic hurdle to widespread installation. BWEA calls for permitted development rights to be given to microgeneration generally, and microwind in particular.

The other key planning tool that can drive installation of on-site renewables is the take-up of planning requirements as pioneered by the London Borough of Merton. The spread of this kind of requirement, under which no new development is approved unless a certain proportion of the energy used in the building is provided by on-site renewables, is already prompting considerable activity, and this can only rise as more councils implement such policies. This planning tool has a double benefit, as it focuses developers' attention on the energy use of the building – the less energy is used, the less renewable capacity will be required to meet the standard.

3.7 Government leadership and organisation

While the Energy White Paper set out an admirable framework for the future energy policy direction of the UK, BWEA is concerned that responsibility for implementation of that policy and wider climate strategy is spread across several Government departments and a number of quasi-Governmental agencies. This leads to diffusion of effort and uncertainty over Government's commitment to tackling climate change in the face of competing political pressures. BWEA recommends that these dispersed responsibilities, primarily at DTI and Department for Environment, Food and Rural Affairs (Defra) but perhaps including some of the Office of the Deputy Prime Minister's (ODPM) planning functions, be brought together in one department with a cabinet minister tasked with driving forward the agenda. This would send an unambiguous message of Government's seriousness in mitigating climate change, and integrating its other three energy policy objectives with climate goals.

Bringing together Government responsibilities under one roof can also help in driving forward the planning agenda set out above. With a single department focusing on the need for zero-carbon energy and having a role in consenting projects which provide it, there will be added momentum and resources for speeding up decisions and improving consistency across planning authorities.

At the delivery level, there are different agencies, primarily the Carbon Trust and Energy Saving Trust, which are implementing different parts of the sustainable energy agenda. There needs to be clarity on how the different programmes for energy reduction and encouragement of low-carbon supply inter-relate and cohere. For this reason, BWEA supports the call in the common sustainable energy policy statement (repeated in the preamble to this submission) that the delivery of these programmes be brought together under one roof, in a 'Sustainable Energy Agency'. This would function as an executive arm of the 'Department of Energy and Climate Change' described above.

Apart from putting in place the institutions that are required to drive forward the energy and climate agendas, there is much else that Government can do to show leadership in this field. Setting clear targets for rolling out energy reduction and renewable energy installations in the Government estate would do much to create mass markets for these technologies as well as being clear indications of an administration putting its money where its mouth is.

Further leadership can be shown by driving through and extending the measures set out in the recent Microgeneration Strategy; currently there is high interest in the microgeneration sector, but it will need sustained focus if the potential for these technologies is to be realised. Government has already proved that it is willing to set long-term policies, most notably through the implementation of the Renewables Obligation; similar long-term frameworks are required for other parts of the sustainable energy field.

Detailed responses to the Energy Review questions

Q1 What more could the Government do on the demand or supply side for energy to ensure that the UK's long-term goal of reducing carbon emissions is met?

Q1.1 Introduction

It is worth stating clearly here that BWEA remains committed to the principles and targets set out in the 2003 Energy White Paper, as this Review confirms. Additionally, however, BWEA recognises the 'energy hierarchy', the top level of which is energy reduction, firstly through real cuts in energy use and secondly through increased energy efficiency. Next is the importance of reducing the impact of our energy through reducing carbon emissions associated with generation and use.

It is our view that renewable energy is the primary manner in which Government can help to deliver on carbon reductions from energy supply. While other technologies also need to play a role in contributing to carbon reductions, the Government must ensure that there is ongoing continued support for renewable technologies.

With ongoing support, the 2020 contributions from wind, wave and tidal stream set out in the Appendices to this submission can be realised. However, to ensure delivery of these contributions the following steps must be taken:

- Ongoing support and evolving market confidence by extending the current market framework
- Tackling key barriers to delivery; in particular regarding planning delays and lack of grid capacity for electrical generation projects
- Leadership in support for new technologies, including wave, tidal stream and microgeneration
- Clarity on the development of a carbon market within the UK, backed up by a 2050 Carbon Target, with key milestones set
- Financial incentives, including taxation, stamp duty and enhanced capital allowances
- Coordination of Energy Policy and Climate Change Action within one single Department, and rationalisation of delivery within a single agency
- A provision of clear and positive communication to the general public and key groups on the importance of renewable energy in tackling four Government energy objectives
- Enhanced action to ensure capture of industrial benefits for the UK economy.

Q1.2 Ensuring ongoing support and evolving market confidence

The current market support for delivery of renewable energy is contained within the Renewables Obligations set out in legislation by UK Government and the Scottish Executive. The overall target for the legislation is established by targets set by the UK Government. Currently these targets are to achieve 10.4% by the end of 2010 and 15.4% by the end of 2015.

In the Energy White Paper the UK Government stated it wished to double the 2010 target by 2020. As yet though this remains an aspiration rather than a firm target. It is our view that the UK Government should firm up this target, delivering a longer term signal of support for development of renewable energy projects. This will be particularly welcome by developers of emerging technologies looking at the period 2010-2020 as the period of expected delivery and mass roll out.

Underpinning the ability of the industry to meet this target will be extending the RO to 20% in 2020, which would mandate the resource into the sector that is required to drive investment. As noted previously in this document, this is not the only action that should be taken to ensure 2020 delivery, but it is necessary and would further bolster confidence in Government's seriousness of intent.

To ensure ongoing delivery through the RO, Government must also ensure that market confidence in the Obligation holds firm. To do this means firstly recognising that it is not weakness within the Obligation that is holding back delivery of particularly onshore wind, but other associated barriers, and secondly ensuring that any intervention or adjustment in this market mechanism that might be contemplated is introduced without disrupting the momentum of current build.

On the first point we note that delivery of the RO and associated targets trails the rising levels of the Obligation, but most of the reasons for this lie outwith the control of the market and the development community. For example, there has been slower progress in delivering onshore wind than originally hoped for due to slow determination times within planning authorities, followed by concerns about provision of necessary grid infrastructure.

Delivery of mature renewable projects such as onshore wind has been slower than hoped for, even though such projects are financially viable under the Obligation. Because of these associated problems and barriers, delivery risk and project cost has increased notably. At the same time the value of the recycle fund that sits alongside the Renewables Obligation has increased markedly. This recycle fund is designed to increase the investment signal to encourage further development. However, owing to barriers in project build, there has been limited up-scaling of project delivery, despite an up-scaling of project development activity. Therefore, Government must understand that while those projects that do materialise can benefit from this recycle fund, the extra income here is compensating for the increased cost of pre-consent project development and risk due to the barriers to market delivery. Action must be taken to remove these barriers so that delivery is maximised and project costs minimised.

On the second point, it has been noted earlier in this submission that BWEA is open to arguments that the RO may need to be evolved so as to maximise its effectiveness. Until such time as a proposal for reform is put forward that satisfies the five criteria set out in 3.1 (pp18), however, BWEA remains cautious on this point: the RO has been successful in incentivising the lower-cost renewables and this success must be safeguarded if confidence in the policy to support all renewables is to be retained.

PRIORITY ACTION: **To establish a 20% renewable electricity target for delivery by the end of 2020**
RESPONSIBILITY: UK Government and Scottish Executive

PRIORITY ACTION: To extend the Renewables Obligation level to 20% in 2020
RESPONSIBILITY: UK Government

ACTION: To recognise that slow delivery in meeting targets is not down to a failure within the existing Obligation, but to other barriers. Priority must therefore be on removal of these barriers
RESPONSIBILITY: UK Government and devolved administrations

Q1.3 Tackling key barriers to delivery

If the UK is to see major deployment of any new technology that is able to help meet our current and future energy needs in an affordable, stable and low-carbon manner, then it needs to recognise that at present there are many statutory, regulatory and administrative barriers frustrating effective delivery. Key here is:

- A workable planning framework able to ensure determinations are made within a reasonable timescale, and which effectively follow national planning policy

- A regulatory regime that guides the energy market that takes account of wider Government energy objectives
- Infrastructure – both in terms of physical assets and its management – that will ensure the system is available to support integration of renewable energy within a workable timescale.

We discuss in our answer to the Energy Review's Issue Two (pp39-40) how infrastructure and regulation need to be assessed to ensure they do not act as barriers on delivery of renewable energy development. Here our focus is on the barriers within planning.

Key issues within planning are as follows:

- Planning determinations are taking too long to (a) ensure sufficient momentum in delivery of new projects and (b) send appropriate signals to the developers on the types of schemes welcomed by planning authorities
- There is insufficient resourcing within the planning system or within statutory consultees
- Too many local authorities are not signed up to Government planning policy on renewables
- The principle of the need for renewables is not sufficiently recognised within planning
- A lack of consistency of approach over time within national planning policies.

Planning at the local authority level is guided by planning policy statements: PPS22 in England, TAN8 in Wales and NPPG6 in Scotland. Under these, the need for planning decisions to pay regard to central Government policy on renewables is clearly stated, but this principle is not being reflected consistently in decisions on the ground. Local authorities must buy in to the need to develop renewable generation capacity, and Government should consider how to promote this, perhaps through strengthening of current policy statements or additional resources being made available to planning departments to support their decisions.

Within Scotland a Planning Bill has been proposed by the Scottish Executive. The general thrust of this Bill has been supported by the renewables sector. The overall aim of the Planning Bill is to create a planning system that provides development management rather than development control. However, to be effective, the Scottish Executive will need to ensure that the planning system has sufficient resources to put in place this new planning culture, and to manage development appropriately.

At the same time, there is also a need for the Scottish Executive to ensure determinations are made within a reasonable time. Of particular concern to the UK-wide industry is the time being taken by the Scottish Executive in determining Section 36 applications, given the importance of Scottish development to meeting UK targets. While determination rates are very good, too many schemes are failing to be given any determination, so remain in limbo within the Scottish planning system.

The Scottish Executive therefore needs to urgently review its determination procedures and to set itself benchmarks on how to manage the Section 36 process. Establishing a working party consisting of the Scottish Executive, applicants and statutory consultees may assist in highlighting issues of concern and making recommendations on how the process can be improved, so that better, swifter determinations result.

A further frustration is that there is high variability in how local planning authorities have chosen to interpret and to implement national planning policy on renewable energy. This is currently problematic for a significant number of onshore wind scheme applications. However, this issue affects all technologies. A result of local planning authority reluctance to follow national planning policy is that the percentage rate for consents is falling in Scotland, and that a significant number of projects are now seeking appeal against local planning authority decisions. UK Government should ensure that such a fall-off in approval rates does not occur in other parts of the country.

While the appeals process is an important part of the planning process and cannot be avoided, its increasing use is a sign of a mismatch between local and national planning aspirations. There is also a danger that planning appeals become commonplace, and the system is therefore overloaded and eventually grids to a halt.

Too often within planning appeals, those arguing against a development seek to base their case on the appropriateness of the technology, or the need for renewable energy deployment. To remedy this we would like to see the Government set out an appeals framework in which only the individual issues associated within each application are discussed at appeal. Doing this would focus any hearing on the issues relating to that application, not the overall principle of development.

PRIORITY ACTION: **To set benchmarks to guide determination times within local planning authorities and the Section 36 process**
RESPONSIBILITY: UK Government and devolved administrations in consultation with local authorities, the renewables sector and key stakeholders

ACTION: To strengthen current planning policy statements for renewable energy, and also that local authorities have sufficient resources to make decisions consistent with that policy
RESPONSIBILITY: UK Government, devolved administrations and local authorities

ACTION: To establish a working group to assess operation of Section 36 in Scotland and make recommendations on system management and improvements
RESPONSIBILITY: Scottish Executive

ACTION: To limit planning appeals on rejected projects to issues relating only to the individual decision, not the overall need for renewable energy
RESPONSIBILITY: UK Government and devolved administrations

Q1.4 Leadership in support for new technologies

The UK has significant potential for the development of new renewable generation technologies, notably marine energy and wind microgeneration. Successful deployment of these technologies would make a significant contribution to UK energy needs. There will also be opportunities for the UK to act as a catalyst on the world stage through successful deployment and delivery of these technological opportunities. This point applies particularly to the successful development and deployment of wave and tidal stream technologies where the UK could lead the world in technology development, and secure real economic advantages as a result.

To ensure that a wide range of renewables are developed, the UK Government must ensure that sufficient market based mechanisms are developed for each technology, so that market pull will ensure that developers are sufficiently incentivised to deploy new technologies, to ensure that risk is shared between Government and the private sector, and to facilitate learning by doing and cost reduction. To achieve this, a long-term market framework is vital. The RO is such a long-term mechanism which allows capacity to be built without reliance on short-term Government funding decisions, but as currently structured it does not sit easily with the needs of emerging technologies. As noted elsewhere in this submission, there may be arguments for reform of the RO to allow these technologies access to sufficient revenue flows from the Obligation, but it may not be possible to craft a reform which satisfies all the criteria for success. If such a solution cannot be found, then alternative means will have to be found to provide suitable resources to these new technologies.

One important step in the development of a diverse range of renewables would be to establish a workable renewable energy target that was the sum of Government renewable targets for the electricity, heat and transport fuel markets. In the manifesto submission of renewable trade associations to parties for the 2005 UK elections, we called for the establishment of a 20% Renewable Energy Target for 2020, referring to the primary energy needs of the UK. Specific targets for the small wind energy sector and other microgeneration technologies are also essential if this fledgling industry is to have confidence to invest. Government targets within the Renewables Obligation have been crucial in the development of the UK's large scale wind energy sector and BWEA believes that a similar approach could help the small scale market enormously by committing the

Government and stimulating the microgeneration industry by providing long-term investor confidence in this sector.

ACTION: Establish long-term feeder markets to deliver generation in key emerging renewables markets; in particular for marine energy
RESPONSIBILITY: UK Government & Scottish Executive

ACTION: Establishment of an overall Renewable Energy Target for 2020
RESPONSIBILITY: UK Government

Q1.5 Development of a Carbon Market

The importance of reducing the carbon emissions that are the primary contributor to climate change has now been explicitly recognised by the UK Government. At the current time there are a number of conflicting policy mechanisms that are aimed at supporting the development of carbon-free or low-carbon generation fuels, or discouraging overall use.

The Government has established support mechanisms such as the RO, which add value to generation technologies such as renewables that are of benefit in reducing carbon emissions. These support mechanisms need to continue and be enhanced if we are to see continued delivery of renewables in the UK. However, these support mechanisms must be made to work as part of a wider market for carbon, itself integrated with other initiatives.

In particular, all sectors must be asked to play their part in reducing carbon emissions, and given the scale of the challenge the UK Government cannot expect the UK electricity generation sector to deliver carbon reduction needs in isolation.

There is experience developing within the EU Emissions Trading Scheme on carbon trading, but concern about the longer term future of this market. If carbon is to become integral to the functioning of an overall market, then there needs to be a level playing field created within the UK market that apportions costs of carbon in a unified way. Here Government must avoid picking winners, but instead seek to create a market framework that allows the investment community, manufacturers and developers to make long term investment decisions that will ensure carbon reductions over time.

Whatever mechanism(s) Government may decide to put in place to govern the carbon market, it should note that the value of renewables is not captured solely by focus on the carbon reductions they provide. They have the wider benefits of enhancing energy security, promoting new technologies and innovation, and strengthening UK industry and rural economies. Thus support for renewable generation should not be limited to what would be available from any 'single carbon mechanism', and in particular the RO should be retained as concrete recognition of this fact.

ACTION: UK Government to ensure delivery of objective, level playing field for a workable carbon market
RESPONSIBILITY: UK Government

Q1.6 Coordination of Energy Policy and Climate Change Action

Within the UK, delivery of energy policy is the responsibility of a number of departments and agencies. Much of energy policy remains reserved to the UK Government, but some key items are also devolved and therefore the responsibility of the Scottish Executive and Welsh Assembly Government. At UK Government level responsibility for energy is split across a number of departments. Furthermore, delivery of energy policy is then the responsibility of a number of departments and agencies.

Given the increasing importance of energy policy to helping meet future energy needs, ensure economic stability and help tackle climate change, we would like to see rationalisation of energy policy and delivery within a single department, which can help coordinate overall delivery. This would also allow more effective coordination between UK Government and the devolved administrations, where energy policy is more cohesively managed and delivered.

Furthermore, due to the iterative nature of policy development, a wide network of agencies and organisations now exist to promote and support action on energy efficiency and renewable energy. Users of this advice network must find this confusing, and such dispersal of expertise will bring duplication and inefficiencies. Given the increasing environmental and economic importance of energy, we see the time as being right to reconsider which agencies lead on energy advice and implementation of policy. Ideally, we would like to see the amalgamation of advisory bodies into one agency able to properly coordinate action on climate change and energy.

ACTION: To ensure one department within Government has the primary responsibility for energy and climate change policy
RESPONSIBILITY: Downing Street Strategy Unit

ACTION: To rationalise energy advice and support, both for efficiency and renewable energy within a single agency or network
RESPONSIBILITY: UK Government and devolved administrations

Q1.7 A provision of clear and positive communication

Until recently, energy policy was seen as a relatively arcane subject that had little relevance to most people's every day life. However, reaction and debate surrounding the Energy Review has shown that this is no longer the case. People are increasingly beginning to understand the importance of climate change, and increasingly concerned about where future energy supplies might come from.

It is not yet clear, however, that such concerns are influencing individual behaviour or influencing how people develop opinions on related projects or energy infrastructure. There has been controversy over a number of proposed renewable schemes and over proposals to upgrade the grid infrastructure. While surveys demonstrate that the clear majority of the general public are in favour or recognise the necessity of new developments, a vocal minority are attempting to dominate the debate.

It will therefore be important that the UK Government follows up its Energy Review with a communication campaign to emphasise the importance of an energy policy that follows its four key objectives; helps people make sense about what they can themselves do, and provides a context for the development of necessary projects and infrastructure. In particular, it needs to emphasise the climate change and security benefits of renewable energy. If this does not take place, then the heightened public interest and discussion on energy policy will not be capitalised on, and the public will not sign up to new policies or their implementation.

ACTION: To develop communication setting out clearly a future energy policy, so that the general public understands its role and is aware of effect of implantation
RESPONSIBILITY: UK Government & Scottish Executive

Q1.8 Enhanced action to ensure capture of industrial benefits

While the UK has made great strides recently in bringing forward renewable generating capacity, especially onshore wind, it has not yet captured the benefits of this activity in the form of industrial development and jobs. With continued expansion of onshore wind, and the promise of offshore wind and marine technologies to come, there should be key opportunities for UK companies to profit from this activity, as well as for bringing foreign direct investment into the UK economy. To capitalise on these opportunities, Government should take action to coordinate the activities of the Regional Development Agencies and other bodies, particularly the Carbon and Energy Saving Trusts, so that a compelling case for investment in manufacturing and service provision in the UK is made and supported. There are considerable funds available in particular to the RDAs, but there needs to be a focus at ministerial level on how the efforts of the agencies cohere and support each other in order to maximise the benefit for the country as a whole.

ACTION: To drive a new programme of action to capture the industrial benefits of renewable energy development
RESPONSIBILITY: UK Government (at ministerial level) in conjunction with RDAs and other agencies

Q2 With the UK becoming a net energy importer and with big investments to be made over the next twenty years in generating capacity and networks, what further steps, if any, should the Government take to develop our market framework for delivering reliable energy supplies? In particular, we invite views on the implications of increased dependence on gas imports.

Q2.1 Answer

Given likely increases in imports of gas for our electricity needs, the need to develop an increased level of domestic reliable sources of supply will be increasingly important. It is our view that renewable energy is well placed to play an important role in this.

As the evidence we have set out in the appendices to this submission makes clear, a combination of wind, wave and tidal power can provide over 20% of the UK's power needs in 2020. This is to say nothing of the contribution that other renewable technologies can provide. The more this potential is realised, the less the UK will be dependent on imported gas.

To ensure that renewables can contribute to the delivery of reliable energy supplies the following steps are needed:

- Ongoing support of investor confidence by maintaining and evolving the current market framework (see our answer to Question One)
- Development of a diversity of renewable sources, by ensuring that emerging technologies receive appropriate support (see our answer to Question One)
- Avoidance of distortions in the energy market, but allowing the market to make choices on how best to deliver this objective (see our answer to Question One).

Q3 The Energy White Paper left open the option of nuclear new build. Are there particular considerations that should apply to nuclear as the Government reexamines the issues bearing on new build, including long-term liabilities and waste management? If so, what are these, and how should the Government address them?

Q3.1 Answer

BWEA is agnostic on whether the UK Government should consider new nuclear build. We recognise that there are competing views on this topic. However, Government may decide it needs to support the development of other generation technologies through establishing support mechanisms. If the Government decides to support nuclear new build, there are various views about how best Government could support a future nuclear new-build programme.

Given Government has confirmed its commitment to renewable electricity, it must ensure continued smooth operation of current market support mechanisms, in particular the Renewables Obligation and Renewables Obligation (Scotland).

The RO & ROS are providing a stimulus to lower-cost renewable electricity projects, as evidenced by the rapid growth of new onshore wind capacity. As well as this, there is increased interest in offshore wind, wave and tidal stream electricity generation, though the RO & ROS as currently constituted will not bring forward these emerging technologies alone.

If the Government is looking to the financial sector to invest in new nuclear, it must ensure that the sector has confidence in Government and whether funding mechanisms are in place for the long term. Continuing the existing renewable energy support would ensure that the financial sector retains faith in Government direction and support within the overall electricity market.

Therefore, if Government decides to support new-build in other technologies it must do so without interference with any existing renewable support mechanisms. To do so would undermine confidence amongst developers and financiers and drastically increase risk in delivery of existing UK Government targets and aspirations.

It is also worth noting that BWEA is of the view that development of renewable energy within the UK provides a cost-effective, valuable contribution to climate change. Furthermore, renewable energy can ensure system diversity by increasing the portfolio of technologies in use for electricity generation. This will help ensure that costs of developing new technologies are reasonable.

Similarly, renewable energy can provide a reliable and secure source of renewable energy. The work of Graham Sinden of the Oxford University Environmental Change Institute demonstrates clearly that a diverse mix of renewable energy sources – in particular wind, wave and tidal – can provide a balanced electricity supply that matches demand patterns well.

This means that the UK Government can have confidence that an increasing level of renewable energy generation presents few system integration challenges, and only minor increased costs due to the need for balancing.

PRIORITY ACTION: **any support for other generation technologies to be established in a manner that does not penalise or undermine existing renewable targets and policy**
RESPONSIBILITY: UK Government

Q4 Are there particular considerations that should apply to carbon abatement and other low-carbon technologies?

Q4.1 Answer

As with nuclear, BWEA is agnostic on whether the UK Government should consider encouraging new carbon abatement or other low-carbon technologies such as clean coal or clean gas generation. We recognise that there are competing views on the costs of such technologies and their distance from market.

However, we also recognise that there are proponents who wish to see such technologies given support and asked to make an increasing contribution to future energy needs, and supporters who note that, like emerging renewable energy devices, such installations could help create a lead in a future world market for these technologies.

As with nuclear, Government may decide it needs to support the development of low-carbon technologies or carbon abatement through establishing support mechanisms. There are various views about how best Government could support a future low-carbon generation new-build programme.

The Government has confirmed its objective to reach a 2010 renewable electricity target of 10% and an aspiration to double this by 2020. We would note that if it wishes this to happen, it must ensure continued delivery of renewables, and must ensure continued smooth operation of current market support mechanisms; in particular the Renewables Obligation and Renewables Obligation (Scotland).

Therefore, if Government decides to support new-build in other technologies it must do so without interference with any existing renewable support mechanisms. To do so would undermine confidence amongst developers and financiers and drastically increase risk in delivery of existing UK Government targets and aspirations.

It is also worth noting that BWEA is of the view that development of renewable energy within the UK provides a cost-effective, valuable contribution to climate change. Furthermore, renewable energy can ensure system diversity by increasing the portfolio of technologies in use for electricity generation. This will help ensure that costs of developing new technologies are reasonable.

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This means that the UK Government can have confidence that an increasing level of renewable energy generation presents few system integration challenges, and only minor increased costs due to the need for balancing.

PRIORITY ACTION: **any support for other generation technologies to be established in a manner that does not penalise or undermine existing renewable targets and policy**
RESPONSIBILITY: UK Government

Q5 What further steps should be taken towards meeting the Government's goals for ensuring that every home is adequately and affordably heated?

Q5.1 Introduction

The UK has a long-standing problem on the issue of fuel poverty. The problem of fuel poverty relates as much to the low thermal standards of housing as it does the low incomes of householders and the cost of fuel. Within the UK, policy to tackle fuel poverty has focused on improving energy efficiency, increasing levels of householder income, and reducing the cost of fuel.

An issue of current concern for the UK Government and Scottish Executive is that while a significant number of households have been brought out of fuel poverty, increases in fuel costs due to international market changes threaten to take many households back into fuel poverty. While focus needs to stay on continuing work to increase thermal standards of housing to ensure that fuel needs become affordable by reducing the overall need for heating fuel, the UK Government needs to also understand what renewable fuel sources could contribute.

Renewable sources can provide reliable sources of energy with a high degree of cost certainty. This is in part because increasing penetration into the market will provide greater market diversity, and will therefore lower market costs, but also because for many microgeneration devices the fuel is free. Therefore, increased rates of installation will bring increased market share and facilitate further technological development, thus reducing installation and therefore running costs over time. This will be useful in guarding against price fluctuations brought on by rising market uncertainty.

Use of microgeneration sources could also reinforce energy efficiency messages, through making a clearer link in people's minds about the importance of using energy responsibly. Anecdotal evidence and qualitative research suggests that the presence of microgeneration in people's homes can engender responsibility for energy management.

However, to deliver a contribution from renewable sources to assist in providing UK homes with adequate and affordable heating the following is needed:

- Leadership in support of microgeneration

- Clear support for microgeneration & distributed generation in Building Regulations and the Code for Sustainable Homes
- Establishing a workable financial framework
- Providing Permitted Development Status
- Streamlining of advice and delivery Agencies.

Q5.2 Leadership in support of microgeneration & distributed generation

If the UK Government wishes to see microgeneration and distributed generation grow it must show leadership in work needed to mainstream the technology. The UK Government's 2006 Budget Announcement of additional funding for microgeneration as part of the Low Carbon Buildings Programme is very welcome in this regard, but it needs to be seen as very much a down payment for the future development of the sector.

If the UK Government wants to see microgeneration and small scale renewables become commonplace, it needs to put in place measures that will help build a long term market.

One important role is to look at how public expenditure on Government buildings and energy might be utilised. For example, Government agencies have significant purchasing power through social housing, yet installation of microgeneration is rare, and depends on the initiative of individual housing associations.

If the UK Government were to install micro or renewable sources within new buildings or major refurbishment programmes in Government offices, schools, hospitals and social housing, it could provide sufficient orders to facilitate development of a proper market that would in turn bring rapid cost reductions and so help encourage other participants into the market.

However, if this policy is to be successful, Government must also ensure that Public Private Partnership (PPP) funding mechanisms facilitate use of renewable sources of on-site electricity or heat generation. At the present time, PPP rules prevent adoption of such technologies, as building occupiers can only specify thermal performance standards, but not how electricity or heating needs are provided for.

Here it is worth noting that installation of technology into non-domestic public buildings will not directly contribute to providing adequate and affordable domestic heating. However, there will be a direct benefit, because rapid growth in installation levels will help to grow the market, and so more quickly help reduce capital and installation costs of such devices. Currently it is these high capital and installation costs which prevent this technology being used as affordable sources.

ACTION: Microgeneration and renewable sources of electricity and heat to be specified where possible in new build and refurbishment public building contracts.
RESPONSIBILITY: UK Government and devolved administrations

ACTION: Resolve barriers to installation of microgeneration and renewable electricity and heat technologies in PPP projects
RESPONSIBILITY: UK Government and devolved administrations

Q5.3 Clear supportive Building Regulations for microgeneration

Within England and Wales new Building Regulations are expected in 2006. In Scotland they are expected in 2007.

Given problems with increasing fuel costs, and the need to increase action on climate change, the UK Government and Scottish Executive need to ensure that revised Building Regulations significantly increase thermal performance standards of buildings and encourage installation of microgeneration technologies.

Utilisation of Building Regulations is important because it creates a level playing field that all housing providers can work within. Also it is worth noting that whilst turnover of housing stock is low, the cumulative impact of such a change will be significant.

Given the need to link energy efficiency and renewable energy, we would like to see progressive strengthening of Building Regulations towards low carbon, and ultimately carbon-neutral buildings. Carbon neutral Building Regulations could be achieved by 2015 with sufficient political willpower.

ACTION: Encourage installation of microgeneration through revised building standards
RESPONSIBILITY: UK Government and Scottish Executive

ACTION: Ensure that Building Standards are progressively tightened to deliver Carbon Neutral standards by 2015
RESPONSIBILITY: UK Government and Scottish Executive

Q5.4 Establishing a workable financial framework

Significant consumer behaviour change can often be encouraged through providing the right fiscal incentives and penalties. Options exist for the UK Government to use taxation instruments such as Council Tax, VAT, Enhanced Capital Allowances or stamp duty to incentivise people to seek out properties with higher thermal standards, or reward those that seek to install measures such as microgeneration in their homes. However, worth noting is how to better support microgeneration devices, and provide a more workable financial support framework.

As currently structured, the Renewables Obligation and Renewables Obligation (Scotland) work well to support delivery of larger scale generation projects, but not microgeneration. There is a need to look at better ways to open up the ROC market to microgeneration technologies. One possibility is that of deemed generation, where devices are given a rating depending on overall capacity and site of operation. For micro-wind this rating could depend on wind speed data for a particular location. Independent assessments would be needed to ensure proper workability, but if done correctly and in a similar manner to assessments in the Energy Efficiency sector, deemed generation could encourage greater utilisation of microgeneration by opening up financial support mechanisms. Furthermore, consumers might be given options of being paid this deemed generation on an annual basis or in advance of purchase to help offset capital and installation costs.

ACTION: To investigate greater use of fiscal measures to encourage positive consumer behaviour in the housing market
RESPONSIBILITY: UK Treasury

ACTION: To facilitate access to the ROC market to microgeneration through use of mechanisms such as deemed generation
RESPONSIBILITY: Department of Trade & Industry, Scottish Executive, Ofgem & Energy Supply Companies

Q5.5 Providing Permitted Development Status

At the present time a householder seeking to install microgeneration technology such as a microwind turbine will usually be required to seek planning consent. This requirement adds extra cost and bureaucracy, and disincentivises installation of such devices. Some local authorities use discretion in this area, but clearer direction is needed here.

Permitted development rights are contained within the Sustainable Energy and Climate Change Bill currently before Parliament, and Government should use its powers to ensure this private member's bill completes its passage without delay. It is BWEA's view that all microgeneration devices that can be building mounted should be given permitted development status.

The Office of the Deputy Prime Minister, the Scottish Executive and the Welsh Assembly should expedite work looking at permitted development rights for such technologies.

ACTION: Provide permitted development rights for microgeneration
RESPONSIBILITY: Office of the Deputy Prime Minister, Scottish Executive, Welsh Assembly

Additional issues

i The long term potential of energy efficiency measures in the transport, residential, business and public sectors, and how best to achieve that potential

i.1 Introduction

Energy efficiency is obviously important and needs to be the priority measure in cutting our carbon emissions by 60% by 2050. However, next in the energy hierarchy come renewables.

It is our view that renewable development and energy efficiency offer a complimentarity that could assist UK Government. While Government has struggled to find policy measures that make significant changes in overall energy demand, it has been able to increase the level of renewable generation across the UK. Recent years have seen an increasing level of interest in microgeneration. It is our view that microgeneration is where the renewable and efficiency markets cross.

There has been anecdotal evidence, confirmed by attitude studies commissioned by the Energy Saving Trust, that microgeneration can help to increase awareness of the importance of energy efficiency. Studies have demonstrated that households begin to rethink where energy comes from and to connect generation with use.

We would therefore like to see integration of microgeneration within UK Government energy efficiency programmes. In particular we would like Government to adapt and extend schemes such as the Energy Efficiency Commitment to encourage the installation of renewable heat measures.

However, to see that renewable technologies can play an important contribution to delivery of energy efficiency objectives, the following are needed:

- Recognition of the role of renewables as a catalyst for change
- Role of Smart metering in effective energy management (real time consumption info; automated reading; peak load management; integration of generating technologies).

i.2 Recognition of the role of renewables as a catalyst for change

Development of renewable energy is actively supported by a high proportion of the UK population. At the micro-scale there is growing qualitative evidence that installation of devices within the home increases awareness of energy issues, and in particular the relevance of energy efficiency. Moreover, research also indicates that increasingly responsible energy efficiency behaviour comes when there is understanding of energy use.

i.3 Role of Smart metering in effective energy management

Smart metering offers the potential for better management of energy use within households and businesses. There will also be opportunities to use Smart metering to assist in load management and active distribution system management, as well as to support integration of microgeneration into homes, offices and industrial premises. In particular, Smart metering will lower the transaction costs on payment for exported microgeneration. Smart metering also offers the chance to make energy usage feel real and more relevant to ordinary users.

The announcement of a £5 million trial by the UK Government of Smart metering is to be welcomed. To be successful it will be important that this trial considers the wider application of smart metering, and how it could be utilised to deliver wider energy policy goals, as well as better provision of information to the consumer.

ACTION: use the announced Smart metering trial to test out use of smart metering to deliver wider energy policy goals
RESPONSIBILITY: UK Government, Ofgem, energy supply companies and distribution network operators

ii Implications in the medium and long term for the transmission and distribution networks of significant new build in gas and electricity generation infrastructure

ii.1 Introduction

Effective management and regulation of a future energy market will be key to ensure successful delivery of any UK Government Energy Policy. In the electricity field we are likely to see a centralised network of transmission and distribution remain, though the pattern of generation is likely to change, with an increasing percentage of our needs coming from distributed generation sources.

Our experience of delivery following the 2003 Energy White Paper is that at present our regulatory regime hinders delivery. If the UK Government wishes to see the transmission and distribution infrastructure effectively utilised to ensure delivery of its Energy Policy it needs to ensure the following:

- Adjustment of Ofgem's licence to ensure market regulation works in tandem with overall Government policy
- Recognition by Government of the Strategic Nature of energy infrastructure
- Recognition of the scale of investment in infrastructure needed to ensure Energy Policy Objectives.

ii.2 Ofgem's role and obligations accord with overall Energy Policy

Previous to the 2003 Energy White Paper, Government Energy Policy – if defined – was that the market should decide on how best to manage and invest in generation assets and infrastructure. The only check that Government sought was that this be done in the most cost-effective way to ensure value for the consumer. This meant that energy policy was essentially policed through Ofgem and its regulatory licence.

However, as pointed out in this Review, energy policy needs to now deliver on four objectives: cost; environment, competitiveness and energy security. While Ofgem has secondary licence objectives such as protection of the environment, their core objective remains ensuring value to the consumer. A wider sustainability test might allow for an assessment of value to a future consumer. Difficulties in doing this within a robust economic framework, however, necessarily mean that Ofgem defines its objectives on a narrow basis.

If the Government wishes to see an enhanced Energy Policy delivered by the market, then there will be a continuing need for proper regulation of any resulting energy market(s). However, at the present time, Ofgem's objectives can frustrate delivery of these wider objectives.

For example, as part of the introduction of BETTA, National Grid set a series of new transmission charges. These were based on cost-reflective principles. While the renewable generation community has supported the principle of a cost-reflective element in transmission charging, it has not been supportive of the resulting transmission charging.

The charges, at least in part, are designed to incentivise generation that locates closest to areas of energy demand. However, renewable resources tend to be located in areas removed from centres of generation. While other feedstocks such as coal, oil and gas can be transported to the point of generation, most renewable generation has to take place at the resource location. The result is that renewable generation cannot respond to the market signal.

If when establishing a transmission charging system, the charges were calculated only on the basis of carbon saving, then it is clear that a very different set of charges would have resulted, and likely connection charges to renewable generation in, for instance, northern Scotland would have been low. No-one would suggest setting a transmission charging system based solely on carbon. However, given that carbon is one key aspect of Government energy policy, it is reasonable to ask why transmission charging does not take this into account.

Given the market framework in which we operate, it would obviously not make sense to unilaterally impose solutions onto the market. When the Government decided to set a transmission cap to limit the cost of connection to projects in the Islands of Scotland, BWEA expressed support, but noted that it would have wished to see a market solution to the original problem, and not an intervention. We saw the fact that the UK Government had to intervene as evidence of market failure.

More appropriate would be for the UK Government to set an appropriate market framework that better takes account of wider energy policy objectives. This would start by changing the licence conditions of Ofgem, creating not one primary duty, but four equal duties of affordability, carbon, security and competitiveness. This would not be an easy task for Ofgem, given the fact that the four objectives will not always sit well together. Instead, Ofgem will therefore need to manage this creative tension between these different goals of energy policy.

Rather than the UK Government seeking to impose such a change onto Ofgem, we also see it as important for the Gas & Electricity Markets Authority (GEMA) and Ofgem to engage openly and constructively in the debate on how to implement such market regulation, and to recognise its important role in ensuring that the different energy policy objectives can be reconciled within a market framework.

For Ofgem to take on this work will be important not only in the UK, but also in Europe, where other Governments and regulators are also beginning to grapple with a changing energy policy framework.

In the longer term, the involvement of Ofgem will be crucial if we are to establish a workable carbon market that creates a level playing field in the market for all technologies and industry players.

ACTION: Ofgem's licence conditions must be adapted to allow the policy objectives of affordability, carbon, security and competitiveness equal status
RESPONSIBILITY: UK Government

ACTION: Ofgem to engage constructively in this debate on how to ensure market mechanisms can deliver these wider energy policy goals
RESPONSIBILITY: GEMA & Ofgem

ii.3 The strategic importance of energy infrastructure is recognised and facilitated & the scale of necessary investment is understood

The transmission and distribution network is designed to have a 40 year operational lifetime. The Energy Networks Association estimates that approximately 70% of the UK network is approaching the end of its design life[7]. Alongside this, there is demand for increased use of energy in our homes and workplaces. When planned and constructed in the 50's, 60's and 70's, networks existed primarily to supply electricity for lighting. However, in the home electricity use has increased dramatically, while industrial and commercial loads have also risen.

Alongside this, is the demand for more varied and dispersed types of connection, changes in load management and peak demand and increasing challenges in network management.

[7] Energy Networks Association (2006) *The state of our networks: Electricity and gas in the UK 2006 – 2050*.

However, risks and uncertainty within the energy network industry are increasing, at a time when rapid change and increased investment are needed.

The UK Government must recognise the scale of the challenge, firstly by ensuring it is properly resourced to manage this change, and secondly by establishing the strategic framework in which such changes will take place.

The time horizons for necessary investment will need to be extended well beyond current five year cycles, and a longer regulatory framework must be put in place to better assess investment options.

Because significant investment will be needed, the most effective way forward will be incorporation of innovative solutions, technologies and grid architectures when planning and delivering new infrastructure.

Replacing existing infrastructure on a like-for-like basis in isolation of wider considerations will be inappropriate. It will therefore be important to establish the right longer-term planning.

While there will be unforeseen challenges, we know enough about the emerging energy market to be able to plan out the next steps.

Firstly we need to plan for the connection of new technologies and/or locations. For instance, we need to see decisions made on provision of networks to the Scottish islands to facilitate connection of significant levels of renewable generation.

Secondly, we need to plan for greater levels of distributed generation by encouraging active network management, and facilitating connection of a more diverse mix of generation at the micro and small scale (ie under 10 MW).

Thirdly, we need to design-in greater functionality and flexibility into our networks to allow for change of the use of our networks over time. Such changes could include storage; better power-flow management; power electronics and demand-side management.

We need to recognise that the current market structure will not proactively put in place new network solutions. In part the market will need to evolve to facilitate necessary changes.

In part the Government will need to directly manage or incentivise such change.

For example, to deliver network assets to connect the Western Isles, Orkney Islands and Shetland Islands, developers must first ensure that sufficient connections are in place to bring market demand for investment. However, there are very weak market incentives to encourage generators and network operators to work together in looking at network provision. There are also very weak market signals to ensure that capacity is available when needed for generation technologies, and in particular emerging technologies.

To overcome this problem the Government needs to assess what role it can play in underwriting risk, or sharing risk with generators and network operators to facilitate new investment. Without this intervention, provision of networks will lag behind demand for connection, meaning that the window of opportunity for delivery of renewable generation will close.

PRIORITY ACTION: A strategic framework to be established to facilitate long-term planning, development and management of our network assets
RESPONSIBILITY: UK Government, with support from Ofgem and wider industry

PRIORITY ACTION: Alternative investment models to incentivise provision and delivery of network capacity, focusing in particular on connection of island communities and marine technologies
RESPONSIBILITY: UK Government, Scottish Executive, island authorities and network operators

iii Opportunities for more joint working with other countries on our energy policy goals

iii.1 Introduction

The UK is clearly not alone in grappling with the new realities of energy policy, and in particular the twin challenges of climate change and security of energy supply. The realisation that the EU will be facing a future where its member states are heavily dependent on fuel imports, particularly from Russia, has driven the dialogue around a common European energy policy, with a green paper recently issued by the European Commission. The UK Government should champion renewable energy within this debate, in recognition of the key security benefits of these technologies, and in particular it should call for European renewable energy targets to be set for 2020 and beyond.

Other European initiatives are focused on specific technologies. One which shows particular promise is the Copenhagen Strategy for offshore wind. Given the key importance of offshore wind to meeting UK renewable targets, as set out in this submission, this process presents opportunities to share experience and spread the effort of developing this new sector. Since the UK is pioneering this technology, it will be contributing as much (if not more than) as it gets back, but other North Sea countries are devoting considerable resources to overcoming the barriers to its implementation. European cooperation is particularly desirable as the key turbine technologies are predominantly held by European companies, and supply chain networks will span borders and seas. UK Government should play a leading part in the Copenhagen Strategy process and ensure suitable resources and leadership are given to it. Specific projects concerning offshore wind, such as the POWER project (www.offshore-power.net) and possible workstreams stemming from the mooted 'Technology Platform' for wind power currently seeking funding from the Framework R&D programme, should be supported and their recommendations implemented swiftly.

In general, however, cooperation with our European partners will be much more about learning from their experiences and analysing how they have been successful in building renewable energy capacity and markets. Attention should be paid particularly to the experience of Denmark, Germany and Spain in incentivising onshore wind and building strong companies to service these markets, which are providing jobs and investment at home and export revenues abroad.

Outside the EU, there are key opportunities to promote the take-up of renewable technologies; the initiative involving developing countries such as Brazil, China and India that stemmed from the UK's presidency of the G8 in 2005 is one such forum which is to be welcomed. In time, cooperation of this kind will result in markets for UK companies to sell their products and services, so long as there is a strong market at home to develop their offerings, particularly in the emerging technologies of wave and tidal stream.

ACTION: Ensure EU policy developments promote the use of renewable energy, including setting long-term, pan-European targets
RESPONSIBILITY: UK Government

In addition to these higher-level processes, cooperation can be important to removing barriers at the implementation level. We would suggest the following actions:

- UK Government to use its influence to encourage rapid deployment of low carbon technologies internationally
- Adjustment of state aids to allow better targeted intervention in support of energy policy goals
- Ensuring that there is a level playing field in the implementation of relevant EU Regulations
- Establishing common standards for technology and equipment.

iii.2 Provide International Leadership

The UK Government and could play a key role within the international climate change and energy debates by demonstrating how adoption of energy policies that bring secure, affordable carbon free policies can have positive economic benefits, and also bring significant changes in the impact of energy use on climate change.

While it is clear that unilateral action on climate change will not deliver necessary changes, there is growing frustration within the UK about slowness of delivery on climate change commitments internationally.

One concern expressed internationally is the impact such changes could have on the economies of key countries. However, the UK Government can demonstrate that successful adoption of rigorous energy efficiency measures and rapid deployment of renewable technologies can be done successfully and bring economic benefits.

Expressed another way, such policy action could bring increased international competitiveness in the future. For example, support for the UK's emerging wave and tidal technologies could ensure future competitive advantage in what is seen as an important future international energy market.

ACTION: Champion sustainable energy at home & abroad
RESPONSIBILITY: UK Government

iii.3 Adjustment of State Aids to further delivery of energy policy

To ensure delivery of Energy Policy, the UK Government will need to provide significant investment – either directly or indirectly – to stimulate rapid change and investment. One block is often limits to State Aid, and concerns at EU level that Governments misuse support to create market distortions and secure competitive advantage for domestic companies.

Any policy support must avoid creating market distortions or barriers, but increasing intervention will be unavoidable. Therefore the UK Government will need to engage with the European Commission and other member states to ensure that shared objectives on tackling climate change and continued energy security are not held back through State Aid limitations that unwittingly prevent necessary change and investment. A key opportunity is currently open in the form of a review of environmental state aid rules, and the UK Government should work closely with the Commission and other member states to create rules which allow interventions that aid delivery of climate objectives without risking Commission action.

ACTION: Adaptation of State Aids to allow necessary investment and policy support of renewable energy
RESPONSIBILITY: UK Government, in partnership with other Member States and the European Commission

iii.4 Ensure a level playing field in implementation of EU Regulations

Successful delivery of renewable objectives can often be affected by European legislation. An example is the impact of the Habitats Directive on site selection, planning determinations and management of renewable schemes. Such Directives are important to ensure protection of the environment, but their implementation must also recognise that delivery of renewable energy objectives is also important to achieve environmental protection.

A further concern is that there is inconsistent implementation of such regulations across the European Union. Without this, the level playing field that the European Union attempts to provide is not delivered. The UK has a strong record of delivery of both the letter and spirit of many environmental directives. Consideration is needed on how best to ensure appropriate implementation at home and consistent implementation in the rest of the European Union.

ACTION: Appropriate implementation of European Directives
RESPONSIBILITY: UK Government Better Regulation Task Force

iii.5 Work cooperatively to develop Common Standards for Equipment

From experience gained through the development of more mature renewable technologies, the renewables sector has learnt that securing workable, internationally recognised standards is very important for successful market roll-out. In particular, standards bring investor confidence and allow independent assessment of performance of equipment. Furthermore, standards can also ensure that equipment can be installed and utilised internationally, so market barriers can be avoided.

For emerging technologies such as wave and tidal stream, microgeneration, and technologies related to distributed generation, the development of common standards will be important in assisting fast market growth. This is of importance to manufacturers, equipment users, research centres and Governments themselves.

We therefore see a role for national and international standards bodies, supported by industry and academia and backed by Government, to drive forward the development of workable standards for emerging technologies such as renewable energy.

ACTION: To develop workable standards for emerging renewable technologies
RESPONSIBILITY: Standards Bodies, with support from industry, academia and Government

iv Potential measures to help bring forward technologies to replace fossil fuels in transport and heat generation in the medium and long term.

iv.1 Answer

The technologies that BWEA champions generate electricity, which currently has limited applications in transport and a small share of the heating market. There are opportunities for renewable electricity to contribute more in these markets, but these are generally constrained by current technologies.

In transport, there are some electric vehicles on UK streets, which are particularly well suited for urban applications. Battery technology will need to advance somewhat in capability and reduction in costs if electric vehicles are to become widespread. It should be possible in future for hybrid cars to charge their batteries overnight on renewable electricity (so-called 'plug-in' hybrids), thus reducing further these vehicles' low fossil fuel usage – currently this option is not offered by car manufacturers in the UK. In general, though, until such time as hydrogen storage and fuel cell technology has become mainstream, and there is sufficient surplus renewable electricity to make the hydrogen, wind, wave and tidal power is unlikely to make a significant contribution to the reduction of fossil fuel use in transport.

On the heating side, using power to heat poorly insulated homes is not a good use of energy. However, in homes with low requirements due to advanced insulation, the small supplementary heating load can be satisfied with electrical heaters, which have the advantage of low up-front cost. Electricity can also provide heating efficiently through the use of heat pumps: if the power used in these devices is from renewable sources, then heat can be provided effectively with zero carbon emissions. Alongside other microgeneration technologies, however, much needs to be done to create a mass market for heat pumps, and Government should strive to ensure that this technology is given due attention within the Microgeneration Strategy.

Appendix A: Onshore Wind: Powering Ahead, analysis of UK onshore wind industry to 2010

1. Introduction

The renewable energy context

1.1 Climate change is the most serious environmental threat to the world, indeed Sir David King, the UK's Chief Scientific Officer, considers climate change to be the most severe problem we are facing today. Climate change caused by greenhouse gas emissions, in particular carbon dioxide, will put millions of people at risk and cause irreversible loss of many plant and animal species. Sea levels are expected to rise by over 40 centimetres by the end of the century with many of the poorest countries in the world experiencing flooding, drought, food shortages and disease.[3]

1.2 The Kyoto Protocol is a legally binding agreement that commits signatory countries to reduce greenhouse gas emissions, and was formally ratified in 2005. The UK is committed to a 5.2% reduction in greenhouse gases below 1990 levels by 2008-2012, and the Royal Commission on Environmental Pollution has called for a 60% reduction of carbon dioxide emissions by 2050[5]. The UK is also committed to providing 10% of its electricity from renewable energy sources by 2010. The Renewables Obligation places a requirement on electricity suppliers to provide an increasing proportion of electricity from renewable sources; the current obligation is 5.5%, rising to 15.4% by 2015. Table 1 sets out the UK's emissions and renewable energy targets.[4]

1.3 Onshore wind energy is the most economically and technically advanced of all renewables, able to compete in cost with other conventional generation and deliver on a large scale. This report demonstrates that onshore wind will the make the largest contribution to renewable energy capacity by 2010, at least 6,000 MW. Onshore wind is now a well established renewable energy industry offering significant benefits through the reduction of carbon dioxide emissions, meeting renewable energy targets, securing electricity supply and delivering investment to UK plc.

Table 1: UK emissions reduction targets

- Reduce greenhouse gas emissions by 12.5% below 1990 levels by 2008-2012 as the UK's agreed commitment to the Kyoto Protocol[3]
- Reduce UK CO2 emissions by 20% below 1990 levels by the year 2010 as an aspiration for the UK Government[3]
- Produce 10 per cent of energy from renewable sources by 2010 and 15 per cent by 2015, with an aspiration of 20 per cent by 2020
- Put the UK on a path to reduce carbon dioxide emissions by some 60% by 2050, with real progress by 2020[5]
- Reduce greenhouse gases by 15-30 percent by 2020 from 1990 levels as proposed by the European Union.

1.4 BWEA has reviewed the installed onshore wind energy capacity that can be delivered by 2010. The extent of delivery will depend on a variety of factors, with planning approval rates and decision delays being the key factor. In order to understand what is likely to be delivered onshore, an analysis underpins this report, which assesses how much of the wind energy capacity currently or shortly to be submitted within the planning system will be built by 2010 under different planning scenarios.

2. Methodology & objectives

2.1 Objectives

The key objectives of the study are:

- To provide an analysis of wind energy capacity in the planning system, and future submissions that may contribute to the 2010 target
- To determine how much local planning authority (LPA) submitted capacity might be approved in order to contribute to the 2010 target, according to average approval rates in each country taken over the last 4 years, and a more conservative 40% approval rate scenario
- To determine how much capacity submitted under Section 36 of the Electricity Act (applicable to projects over 50 MW) might be approved under different approval rate scenarios, and how this might be affected by different decision delay scenarios
- To assess the impact that restricted grid capacity may have on the 2010 forecast
- To assess the impact that continued non-determination of Section 36 projects in Scotland will have on the UK 2010 renewable energy target – current trends suggest that development may be constrained to 2,500 MW
- To assess the potential build scenarios in the Welsh Technical Advice Note 8 (TAN8) Strategic Search Areas
- To add the existing capacity which is built, under construction and consented to the investigations above to give a potential range of onshore wind development year on year to 2010 with cumulative totals and country breakdowns
- **To identify the most realistic assessment that onshore wind capacity can deliver in the UK year on year to 2010.**

2.2 Data assumptions

- Post-consent to build delays – the time taken between planning approval being granted and commissioning of the wind farm – have been factored into the entire analysis. A report[6] by Land Use Consultants (LUC) for the Renewables Advisory Board (RAB) identifies the average consent to build delay in the UK as 20 months. However these delays have been increasing since 1995, and are likely to continue to do so due to a variety of factors. In particular, the growing demand for grid connection coupled with the increase in the size and scale of projects is leading to greater delays. The LUC report identifies projects over 50 MW as having the longest consent to build delays; 35 months in England and 27 months in Scotland.

Using this information and data from BWEA's UK Wind Energy Database (UKWED), the most definitive dataset of wind energy projects in the UK, it can be concluded that the size of project is directly related to post-consent delay. In response to this, a conservative assumption has been made that projects up to 50 MW will have a post-consent delay of two and a half years, except for Northern Ireland where a two year delay has been applied (NI employs a different system with Section 106 agreements negotiated as part of the planning assessment process which leads to a shorter post-consent to operation delay). Projects of 50-100 MW have been assigned a delay of three years and projects of 100 MW+ have a delay of four years applied. The post-consent to build delay affects the date by which an application must be determined, in order to be built by 2010.

- At the time the research was conducted, the Section 36 approval rate was 94%. It is unrealistic that this approval rate will be maintained, particularly given the large amount of capacity submitted. Therefore alternate approval rate scenarios of 30%, 50% & 70% have been applied.
- A 10% 'attrition rate' has been applied to all applications in planning, and all projects that are consented but not yet constructed. This compensates for projects that are downsized post consent, projects that get approved but do not get built and projects that are withdrawn from the planning process.
- A 25% 'attrition rate' has been applied to all estimated forthcoming projects. This compensates for projects that do not actually enter the planning system, projects that are downsized post consent, projects that get approved but do not get built and projects that are withdrawn from the planning process.
- It has been assumed that the majority of projects have applied for connection to the grid and are therefore in possession of, or awaiting a connection offer.
- The number of MW's in planning that will be approved in order to be built by 2010 is based upon average approval rates and decision delays for each individual country and type of application (local planning authority, Section 36 or appeal).
- For 2006 forecast planning submissions, an estimate was made based on developer questionnaire responses on their anticipated forthcoming planning applications. For 2007 forecast submissions, an estimate was made by taking an average across the previous five years submitted capacity. Forthcoming applications have only been included where it is estimated that they could be built by 2010, which depends on planning decision delays, therefore in England and Scotland applications up to 2007 have been included, for Wales and Northern Ireland, only part of 2006 forthcoming applications are included, due to lengthy average decision times.

2.3 Data Analysis

- There are some minor differences between headline figures depending on how the data has been analysed (by year,by country, by approval rate and decision delay), due to the effect of decimal figures in the breakdown
- Average approval rates and decision delays have been calculated using data from UKWED, BWEA's comprehensive wind energy database
- Wind farm developer questionnaires were used to estimate future applications. Twenty-two wind energy developers contributed to the questionnaire research from October 2005 to January 2006
- The average figures for approval rates and delays that have been provided are for the period between 01/01/2002 to 31/10/2005
- Average approval rate was calculated by the number of megawatts decided rather than the number of projects

3. Planning approval rates

3.1 Average approval rates vary by country and the type of application – whether it is local planning authority (LPA), Section 36 (S36) or an appeal. The analysis in this report uses average approval rates between 2002-2005 for LPA applications and appeals by country, therefore the results obtained reflect the current conditions and do not account for future increases or decreases in LPA approvals and appeals. For Section 36 applications it is not expected that the current 94% approval rate will be maintained, therefore three different approval rate scenarios of 30%, 50% and 70% have been applied, representing worst, medium and best case.

Local planning authority applications & appeals

3.2 There have been historical differences by country in local authority approval rates. Approval rates are calculated by MW capacity rather than scheme because this more accurately reflects renewable energy targets. The lowest approval rates have been seen in Wales, with 0%, 10% and 20% approval rates in some years, whilst Scotland has had high approval rates at around 80%, however the approval rate in Scotland dropped to 40% in 2005 , and this has lowered the average. In England approval rates have been around 60-70%, and Northern Ireland so far has a 100% approval rate. Average approval rates for 2002-2005 are set out in Table 2 below.

Table 2: 2002-2005 average local planning approval rates by MW

	Planning applications	Appeals
England	77%	38%
Northern Ireland	100%	n/a
Scotland	59%	51%
Wales	63%	41%

3.3 It is not expected that the high approval rate in Northern Ireland will be maintained, therefore in order to provide a more conservative estimate an approval rate of 70% has been applied throughout the analysis.

3.4 The average time it takes for applications to be determined in each country has an impact on how much capacity can be delivered by 2010. For example it takes twice as long for an application to be determined in Wales than it does in Scotland therefore this has an effect on the amount of forthcoming planning applications that can be included for consideration. In Wales and Northern Ireland only a small capacity of forthcoming applications (that can be determined in time to be built by 2010) are included, due to the long average decision times in these countries.

3.5 Charts 1 & 2 illustrate existing planning applications and forthcoming applications (that could be built in time for 2010 taking into account decision delays), and of this, the capacity that is estimated to be built with the current average approval rates (with attrition rates factored in). It is estimated that there will be around 5,000 MW of capacity from local authority planning submissions (currently in planning & forthcoming) that could contribute to the 2010 target, of which approximately 2,500 MW is expected to be consented and built. Forthcoming capacity to 2010 for NI and Wales is low due to long planning decision delays. Charts 1 & 2 also illustrate a 40% approval rate scenario, with the estimated built capacity from local authority applications decreasing to around 1,700 MW. Therefore, approximately 800 MW of capacity may be lost from the 2010 target if local authority approval rates were to drop to 40%.

3.6 Chart 3 shows year on year build from capacity currently approved and awaiting construction in addition to forecast consents, with 2005 build illustrated.

Chart 1: UK current local planning & appeal applications expected built capacity

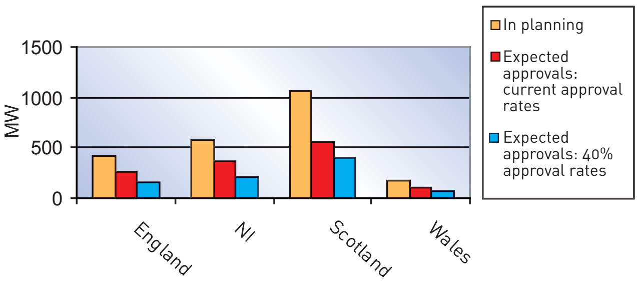


Chart 2: UK forthcoming local planning applications & appeals built capacity

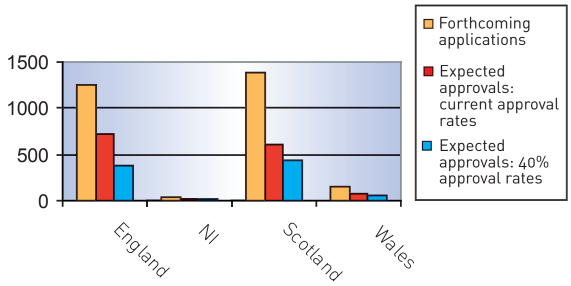


Table 3: UK current local planning & appeal applications and expected built capacity (MW)

		England	NI	Scotland	Wales
Current applications		422	578	1,065	183
Expected built capacity	(current app. rate):	267	364	562	105
Expected built capacity	(40% app. rate):	154	208	408	66

Table 4: UK forthcoming local planning applications & appeal built capacity (MW)

		England	NI	Scotland	Wales
Forthcoming applications		1,253	38	1,378	161
Expected built capacity	(current app. rate):	630	20	513	75
Expected built capacity	(40% app. rate):	337	11	437	52

Chart 3: Year on year build comprising existing LPA & Section S36 approved capacity, plus forthcoming LPA consents (current approval rates)

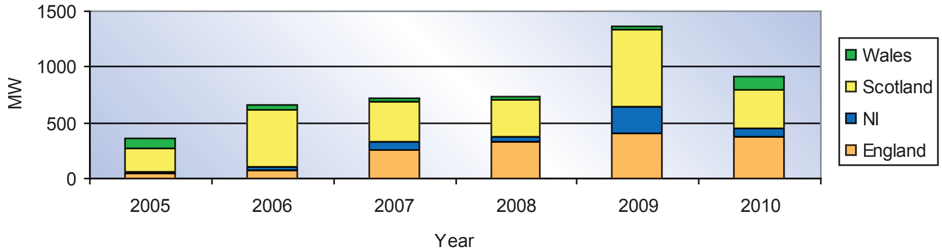


Table 5: Year on year build comprising existing LPA & Section 36 approved capacity, plus forthcoming LPA consents (MW)

	(1991-2004)	2005	2006	2007	2008	2009	2010
	(UK 767 MW)						
England:		39	81	261	336	412	368
Northern Ireland		20	17	73	35	240	87
Scotland		218	521	360	334	683	338
Wales		80	46	25	28	24	127
TOTAL:		**357**	**665**	**719**	**733**	**1,359**	**920**

Section 36 applications

3.7 There are currently over 2,468 MW of Section 36 applications that could be determined in time to be built for 2010, therefore the approval rate for Section 36 applications has the potential to make a significant impact on the delivery of onshore wind capacity. An assumption has been made for Section 36 applications that the existing 94% approval rate will not be maintained, and three different approval rate scenarios have been applied to reflect best (70%), medium (50%) and worst case (30%) approval rates. Chart 4 illustrates the Section 36 capacity currently in planning (that could be built in time for 2010). Charts 5-10 illustrate the impact three different Section 36 approval rate scenarios would have on the total delivery of onshore wind, year on year to 2010.

Chart 4: Section 36 capacity in planning and potential delivery with three different approval rate scenarios

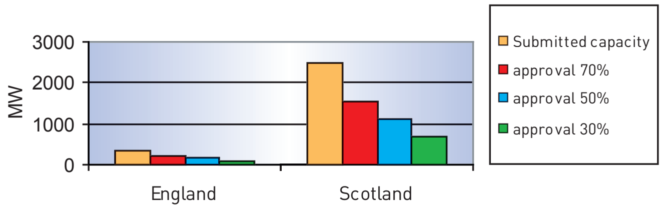


Table 6: Section 36 capacity in planning and potential delivery with three different approval rate scenarios (MW)

	England	Scotland
In planning:	343	2,468
Approval rate scenarios with 10% attrition factor included		
70% approval:	216	1,555
50% approval:	155	1,111
30% approval:	93	666

Chart 5: LPA & Section 36 year on year build by country with 30% Section 36 approval

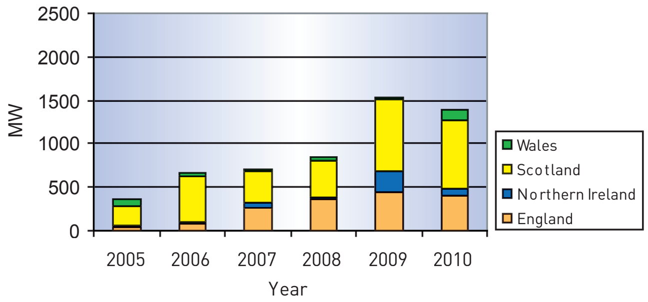


Chart 6: LPA & Section 36 cumulative year on year build with 30% Section 36 approval

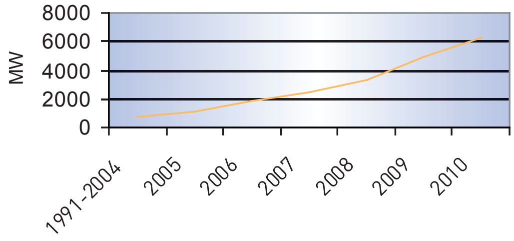


Table 7: LPA & Section 36 year on year build by country with 30% Section 36 approval

	2005	2006	2007	2008	2009	2010
England	39	81	261	358	452	399
Northern Ireland	20	17	73	35	240	87
Scotland	218	521	360	424	824	775
Wales	80	46	25	28	24	127
TOTAL:	**357**	**665**	**719**	**845**	**1,540**	**1,388**

Table 8: LPA & Section 36 cumulative year on year build with 30% Section 36 approval

(1991-2004)	2005	2006	2007	2008	2009	2010
767	1,124	1,789	2,508	3,353	4,893	6,281

Chart 7: LPA & Section 36 year on year build by country with 50% Section 36 approval

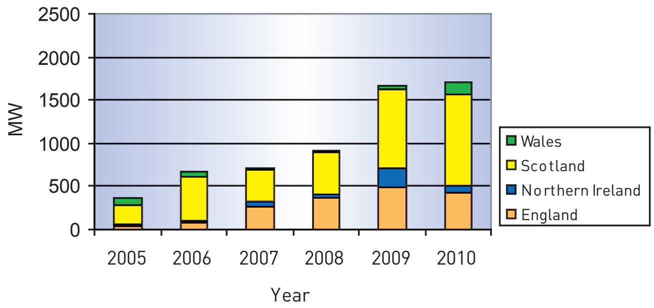


Chart 8: LPA & Section 36 cumulative year on year build with 50% Section 36 approval

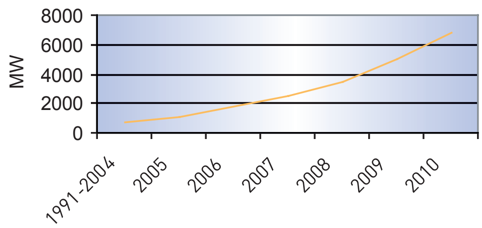


Table 9: LPA & Section 36 year on year build by country with 50% Section 36 approval	2005	2006	2007	2008	2009	2010
England	39	81	261	372	479	419
Northern Ireland	20	17	73	35	240	87
Scotland	218	521	360	483	917	1,067
Wales	80	46	25	28	24	127
TOTAL:	**357**	**665**	**719**	**918**	**1,660**	**1,700**

Table 10: LPA & Section 36 cumulative year on year build with 50% Section 36 approval

(1991-2004)	2005	2006	2007	2008	2009	2010
767	1,124	1,789	2,508	3,426	5,086	6,786

Chart 9: LPA & Section 36 year on year build by country with 70% Section 36 approval

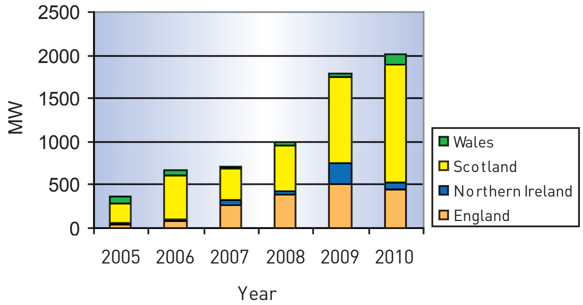


Chart 10: LPA & Section 36 cumulative year on year build with 70% Section 36 approval

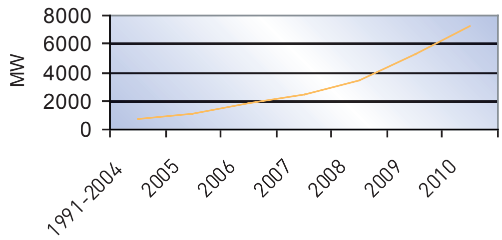


Table 11: LPA & Section 36 year on year build by country with 70% Section 36 approval	2005	2006	2007	2008	2009	2010
England	39	81	261	386	506	440
Northern Ireland	20	17	73	35	240	87
Scotland	218	521	360	543	1,010	1,358
Wales	80	46	25	28	24	127
TOTAL:	**357**	**665**	**719**	**992**	**1,780**	**2,012**

Table 12: LPA & Section 36 cumulative year on year build with 70% Section 36 approval

(1991-2004)	2005	2006	2007	2008	2009	2010
767	1,124	1,789	2,508	3,500	5,280	7,292

4. Planning decision delays

4.1 The length of time it takes to determine an application remains a key barrier to the timely delivery of onshore wind. Average decision times also vary by country and type of application (LPA, S36 or appeal). By calculating average approval rates and decision delays it is possible to have an indication of how much capacity will be approved, and when. If post-consent to build delays are then included it is possible to indicate the capacity that can actually be built each year.

4.2 In Wales and Northern Ireland it currently takes on average 27 and 28 months respectively for local authority applications to be determined. In England and Scotland it is 10 & 14 months. Approximately 2,500 MW of local authority capacity (charts 1 & 2) in planning plus forthcoming submissions is estimated to be approved in time for 2010 build. However this will not be achieved if current local authority decision times increase; part of this capacity would be pushed into the next decade.

4.3 To date, Section 36 applications have taken an average of 21 months to be determined in the UK. This does not include data for the majority of Section 36 applications that are still awaiting a decision; therefore it is likely that the average decision time will increase. An increase in Section 36 decision delays will mean many current applications will not be determined in time to be built by 2010. Chart 12 illustrates the effect that increased decision delays combined with different approval rates would have on the estimated built capacity by 2010.

Chart 11: Potential S36 capacity that could be built by 2010 with different approval rate & decision delay scenarios

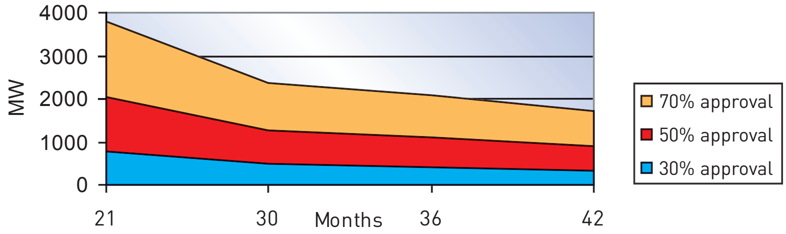


Table 13: Potential Section 36 capacity that could be built by 2010 with different approval rate & decision delay scenarios (MW)	21 months	30 months	36 months	42 months
30% approval	759	474	420	340
50% approval	1,265	790	699	566
70% approval	1,772	1,106	979	793

4.4 With relatively few Section 36 decisions made in comparison to current capacity in planning, it is not known what the average approval rate and decision delays will be in the years leading up to 2010. Therefore the most realistic assessment of decision delays based on current trends is 36 months, and 50% has been selected as a conservative and realistic estimate for approval rates. **Therefore the headline build rates and associated economic benefits contained in the executive summary and conclusions are based on this scenario.** Chart 12 and Table 14 illustrate different Section 36 decision delay and approval rate scenarios, with the assigned scenario of a 36 month delay, 50% approval rate giving an estimate of **6,221 MW** built capacity by 2010.

Chart 12: UK total built capacity (including local authority applications & appeals) by 2010 with different S36 approval rate & decision delay scenarios

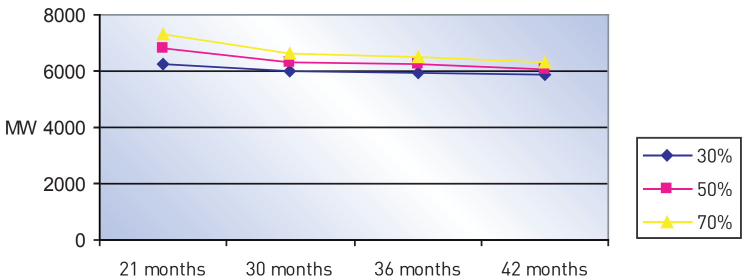


Table 14: UK total built capacity (including local authority applications & appeals) by 2010 with different S36 approval rate & decision delay scenarios (MW)

	21 months	30 months	36 months	42 months
30%	6,281	5,996	5,942	5,862
50%	6,787	6,312	6,221	6,088
70%	7,294	6,628	6,501	6,315

5. Grid Barriers

5.1 Grid infrastructure is essential to bridge the gap between the main population centres and the best sources of renewable energy. If the best sites in terms of energy resource and environmental impact are to be developed, the appropriate upgrades and extensions to the Transmission and Distribution networks must be implemented.

5.2 The grid is also critical to the amount of capacity that will be installed by 2010 and beyond, and this issue is particularly important in Scotland, Wales and Northern Ireland. Grid capacity is not considered to be a constraining factor to development in England by 2010.

5.3 There is a great deal of development interest in Scotland, and with reason. Scotland has 25% of Europe's wind resource, and is relatively unconstrained in regard to built development, with a robust national planning policy in place since the publication of NPPG6 in 2000. There is approximately 5,400 MW of capacity currently in planning in Scotland equating to 74 wind farm applications, in particular there is a great deal of developer interest in the SSE transmission area, in the north of Scotland.

5.4 There are two main barriers that arise from the grid: a) Limitations of grid capacity for new projects to connect: several upgrades are required in Scotland, Wales and Northern Ireland to allow new generators to connect to the grid, and b) The way the grid queue is managed - it is not necessary to hold an offer for connection to the grid system before a project enters the planning system, nor is it necessary for a project to have planning approval before applying for a connection offer, therefore a mismatch can occur between planning approval and grid offers, where potential capacity is wasted by projects that can't proceed though the planning system. A third barrier for some developers is this financial risk involved in accepting a grid offer for a project that may not materialise through the planning system.

Scotland

5.5 In the north of Scotland, some projects are being offered connection dates beyond 2010 that are dependent on system upgrades. However at present around 1,500 MW of projects (operational, under construction, in planning and scoping projects) in northern Scotland hold unconstrained offers for connection by 2010. The most significant upgrade with respect to the 2010 target is the proposed Beauly-Denny circuit, which would provide up to 1,000 MW of additional grid capacity.

5.6 A further 1,000 MW of projects hold offers which are contingent on the completion of the upgrade to the Beauly Denny circuit. Depending on the timing of the Beauly Denny upgrade, and again, how the queue for grid connection applications is managed, this 1,000 MW of capacity may be able to contribute to the 2010 target. Also of importance if Beauly-Denny is consented, is that offers for grid connections should be given in parallel to building Beauly-Denny; otherwise developers will not be able to proceed in time for 2010 with certainty of an offer. Approximately half the 1,000 MW Beauly-Denny contingent capacity is already submitted in the planning system, therefore 500 MW of Beauly-Denny contingent projects could be built if they receive planning permission. However if approval rates and decision delays are factored in, it is possible that none of the 500 MW in planning with a Beauly-Denny contingent connection offer could get built. The entire 1,000 MW Beauly-Denny contingent capacity could be utilised by 2010 if the grid queue is managed in a way that allows projects to be moved in the queue, depending on their planning status.

5.7 The remaining projects in northern Scotland that do not hold part of the 1,500 MW of unconstrained offers or the 1,000 MW Beauly-Denny contingent capacity, are currently being offered dates to connect of 2013 and later - dependent on a series of grid upgrades other than Beauly-Denny, including connectors from Lewis, Shetland and Orkney. These would not currently be able to contribute to the 2010 target unless their connection dates are brought forward when projects with earlier connection dates withdrew.

Wales

5.8 There is currently a shortage of available grid capacity in mid-Wales and in order for a significant proportion of the Wales 2010 onshore wind energy target to be connected, reinforcements are urgently required. There are current delays in securing the reinforcement while decisions on the necessary investment and route selection remain undetermined. This is leading to uncertainty for both the grid operators and wind farm developers in Wales.

Northern Ireland

5.9 The Northern Ireland grid infrastructure is able to accommodate approximately 400 MW of wind energy capacity without further important reinforcements. The Department of Enterprise Trade and Investment must give the strategic direction to Northern Ireland Electricity (NIE) to undertake a programme of grid reinforcements to allow Northern Ireland to meet its targets for 2012 and beyond. Grid infrastructure reinforcements require a long lead-time and must be addressed immediately to provide the appropriate transition to a low-carbon electricity industry in Northern Ireland.

5.10 Grid Recommendations

Scotland

The grid could potentially affect the delivery of a further 1,000 MW of capacity – this capacity could definitely be utilised, if the following actions are taken:

- Beauly-Denny is built in time for 2010 connections to be made, contributing 1,000 MW of connection capacity, which may or may not be fully utilised dependent on the management of the grid queuing system.
- Beauly-Denny is built and there is improved managing of the queuing system to allow more advanced projects to proceed ahead of those with a connection offer but which have fallen behind in the planning system, contributing an additional 1,000 MW to existing built, approved and under construction capacity by 2010.
- If a decision has been made to go ahead with the upgrade, individual project grid connection agreements should be administered in parallel to building Beauly-Denny, otherwise developers will not have certainty of a grid offer in time to build by 2010.
- Security measures and constraints are revised to allow greater existing grid capacity to be utilised

Northern Ireland

- In Northern Ireland the Department of Enterprise Trade and Investment must give the strategic direction to NIE to undertake a programme of grid reinforcements.

Wales

- Coordinated action by the Welsh Assembly Government, grid operators, Ofgem, local planning authorities and the wind industry must take place to ensure prompt investment, route selection and planning consent is forthcoming, to secure the necessary grid reinforcements.

6. Analysis by Country

England

6.1 For the 2010 target, the contribution that will come from England will largely depend on local authority application approval rates, given that there is currently only 343 MW of Section 36 projects in planning (some or most of which may be approved for 2010 build), compared to approximately 1,700 MW of local authority current and forthcoming applications (of which 850 MW is expected to be approved for 2010 build). Charts 13 and 14 illustrate the estimated built capacity for England up to 2010 including the three approval rate scenarios for Section 36 projects.

Chart 13: England year on year build

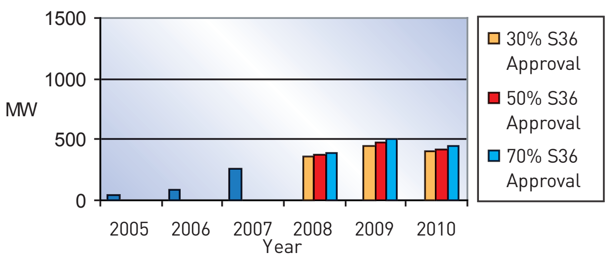


Table 15: England year on year build (MW)

1991-2004:	176
2005:	40
2006:	81
2007:	260
2008:	357 / 371 / 385
2009:	451 / 478 / 505
2010:	399 / 419 / 440
TOTAL:	1,764 / 1,825 / 1,887

Chart 14: England built capacity by 2010

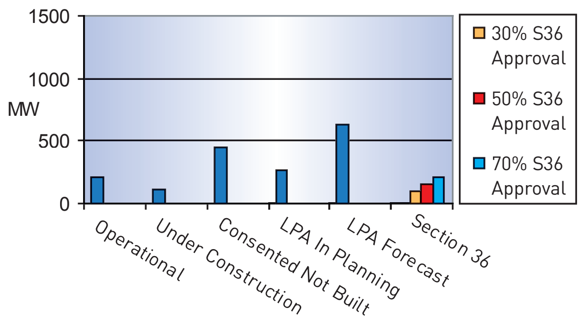
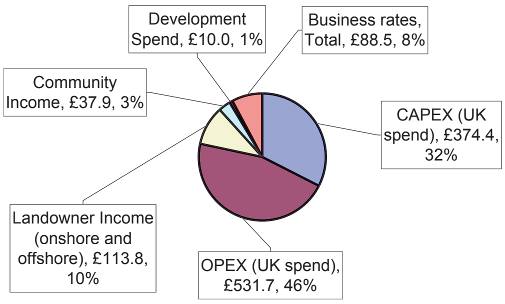


Table 16: England built capacity by 2010 (MW)

Operational:	211
Under construction:	112
Consented not built:	451
LPA in planning expected build:	267
LPA forecast submissions expected build:	630
Section 36:	93 / 154 / 216
TOTAL:	1,764 / 1,825 / 1,887

6.2 The most realistic assessment of onshore delivery based on the selected Section 36 scenario (50% approval rate with 36 month decision delay) means England will have 1,774 MW (table 27) built by 2010. This will generate at least £1,156 million (chart 15) from associated investment in development, construction and operation of wind farms and contributions to local communities and landowners, by 2020. As the average lifetime of wind farm projects is at least 20 years, this economic benefit is considered a minimum.

Chart 15: England wind energy benefits (£millions) 2006-2020, inclusive (total: £1,156.3)



Northern Ireland

6.3 There is significant capacity in planning awaiting a decision in Northern Ireland (approximately 570MW at the time of analysis), of which 384 MW will be determined in time to be built by 2010. With 159 MW already operational, under construction or consented the forecast total built capacity in Northern Ireland will total 543 MW by 2010. This will generate at least £349.5 million (chart 18) from associated investment in development, construction and operation of wind farms and contributions to local communities and landowners by 2020. As the average lifetime of wind farm projects is at least 20 years, this econmic benefit is a minimum. Due to the fact that the bulk of this capacity was submitted in late 2004 and 2005, and the long decision time in Northern Ireland, most of the build is estimated for 2009 and 2010. Charts 16 & 17 illustrate the estimated built capacity in Northern Ireland up to 2010.

Chart 16: Northern Ireland year on year build

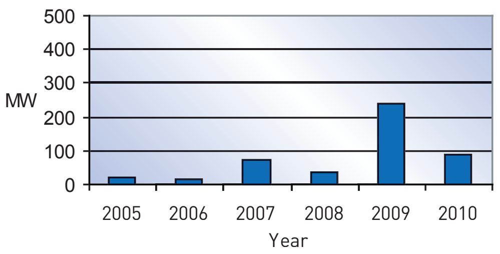


Table 17: Northern Ireland year on year build (MW)

1991-2004:	70
2005:	20
2006:	17
2007:	73
2008:	35
2009:	240
2010:	87
TOTAL:	**542**

Chart 17: Northern Ireland built capacity by 2010

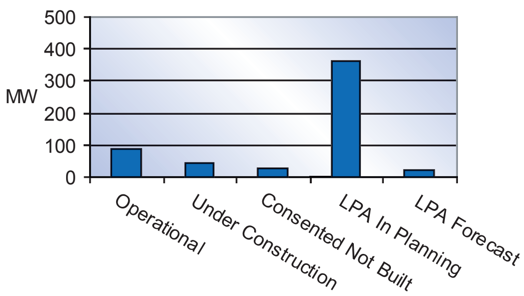
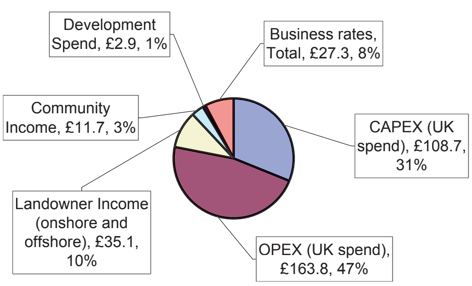


Table 18: Northern Ireland built capacity by 2010 (MW)

Operational:	90
Under construction:	41
Consented not built:	28
LPA in planning expected build:	364
LPA forecast submissions expected build:	20
TOTAL:	**543**

Chart 18: Northern Ireland wind energy benefits (£millions) 2006-2020, inclusive (total: £349.5)



Scotland

6.4 Taking account of local approval rates and decision delays, and the assigned Section 36 scenario, Scotland will deliver 3,397 MW by 2010 (table 25). This will generate at least £2,452 million (Chart 21) from associated investment in development, construction and operation of wind farms and contributions to local communities and landowners by 2020. As the average lifetime of wind farm projects is at least 20 years, this economic benefit is considered a minimum.

Chart 19: Scotland year on year build

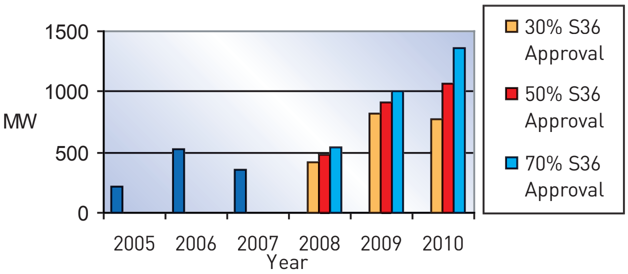


Table 19: Scotland year on year build (MW)

1991-2004:	351
2005:	218
2006:	521
2007:	353
2008:	423 / 482 / 542
2009:	824 / 917 / 1,010
2010:	775 / 1,067 / 1,358
TOTAL:	**3,465 / 3,909 / 4,353**

Chart 20: Scotland built capacity by 2010

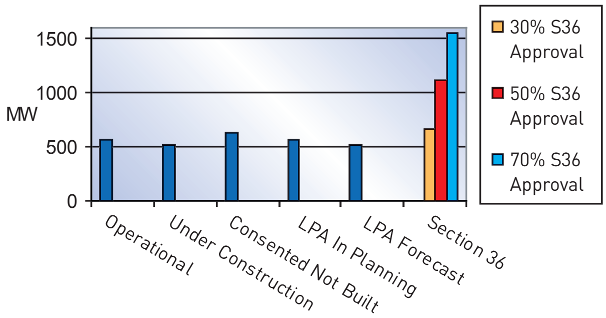
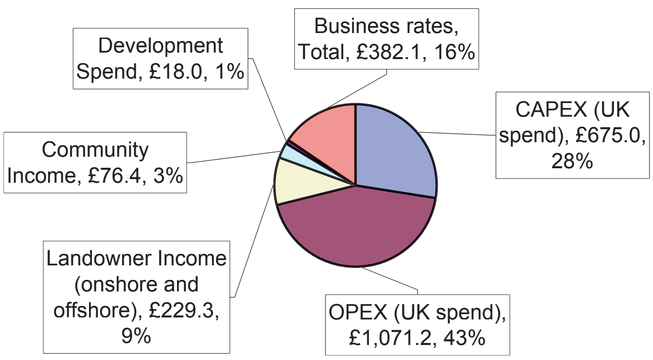


Table 20: Scotland built capacity by 2010 (MW)

Operational:	568
Under construction:	523
Consented not built:	635
LPA in planning expected build:	562
LPA forecast submissions expected build:	513
Section 36:	667 / 1,111 / 1,555
TOTAL:	**3,468 / 3,912 / 4,356**

Chart 21: Scotland wind energy benefits (£millions) 2006-2020, inclusive (total: £2,452)



Wales

6.5 505 MW is projected to be built in Wales by 2010, based on what is currently operational, under construction and consented not yet built (326 MW), plus 179 MW of capacity expected to be consented and built from projects in planning and forthcoming submissions. This will generate at least £277.8 million (Chart 24) from associated investment in development, construction and operation of wind farms and contributions to local communities and landowners, by 2020. As the average lifetime of wind farm projects is at least 20 years, this economic benefit is considered a minimum.

6.6 An additional 221 MW of capacity from the Technical Advice Note 8 (TAN8) Strategic Search Areas (SSA's) is achievable subject to timely decisions being made on projects within the SSA's. This additional capacity has been calculated by assessing the allocated capacity for each TAN8 SSA, and applying landowner and grid constraints. This comparatively low forecast will not meet the Welsh Assembly Government's 800 MW additional onshore wind target for 2010 set out in TAN8 - Wales's strategic planning policy for renewables. The reason for missing this target is the delayed publication of TAN8, combined with long local authority decision delays and reduced grid capacity. Wind industry developers are currently in the process of preparing applications for projects in the seven Welsh SSA's, but they were unable to invest in projects before the SSA's were announced in summer 2005.

6.7 In late 2005, Forestry Commission Wales (FCW) announced a programme for awarding Option Leases to wind farm development companies relating to the land they manage within the SSA's. It is unlikely that contracts will be awarded before late 2006 while developers will not commit resources to developing these projects until contracts are secured. Given the significant time period required to develop, consent and build projects this paper assumes that projects on FCW owned land will make no contribution to the TAN8 2010 targets. Despite these delays, many applications for large scale wind farm developments will be submitted in 2006, but taking into account decision times and consent to build delays, it is most unlikely that these projects will contribute to either the Welsh or UK 2010 renewable energy targets. In order to hasten the contribution that can be made in Wales by 2010, LPA resources must be urgently prioritised to secure robust local planning policy and timely decision making.

6.8 The situation in Wales could be greatly improved, and a significant portion of the 800 MW target built by 2010, if a coordinated effort is launched immediately between the wind industry, Welsh Assembly Government, local planning authorities, Ofgem and grid companies, with mutual aims to achieve timely planning decisions and ensure grid infrastructure reinforcements are in place by 2010.

Chart 22: Wales year on year build

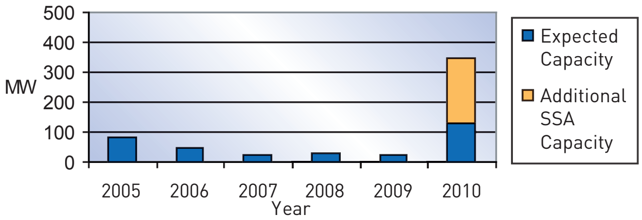


Chart 23: Wales built capacity by 2010

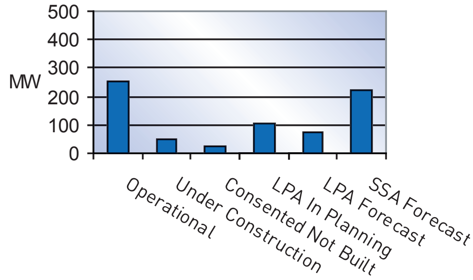


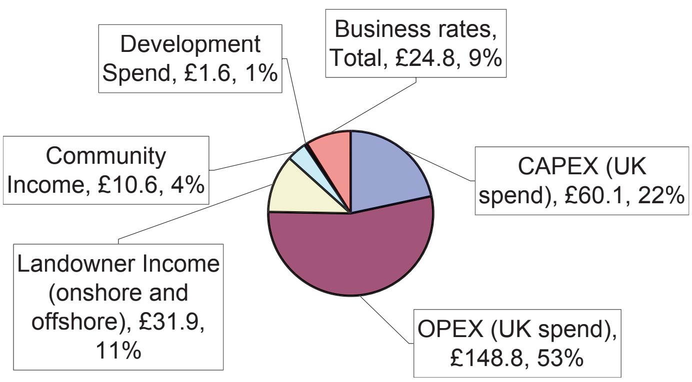
Table 21: Wales year on year build (MW)

1991-2004:	175
2005:	80
2006:	46
2007:	25
2008:	28
2009:	24
2010:	127 - 348
TOTAL:	**505 - 726**

Table 22: Wales built capacity by 2010 (MW)

Operational:	255
Under construction:	47
Consented not built:	24
LPA in planning expected build:	104
LPA forecast submissions expected build:	75
SSA Forecast	221
TOTAL:	**505 - 726**

Chart 24: Wales wind energy benefits (£millions) 2006-2020, inclusive (total: £277.8)



7. UK Total By 2010

7.1 The length of time it takes to determine an application remains a key barrier to the timely delivery of onshore wind. The development of onshore wind in Scotland by 2010 will have a significant effect on the total UK target by 2010; it has been identified in Scotland that onshore wind may contribute in the region of 2,500 MW to Scotland's target of 20% of electricity to come from renewable sources by 2010. However 3,397 MW of the UK estimated 6,200 MW forecast capacity by 2010 will need to be met in Scotland. The Scottish Executive has made clear 2,500 MW is not to be viewed as the limit to onshore wind development for 2010. Chart 25 illustrates the effect a 2,500 MW constraint might have on Scotland's contribution to the 2010 target.

7.2 Delivery of only 2,500 MW in Scotland would have a significant impact on the total UK built capacity by 2010. With no constraint, 4,999 MW to 7,515 MW of capacity could be built in the UK under 'worst case' and 'best case' planning conditions respectively. If development is constrained to 2,500 MW in Scotland, 4,681 MW to 5,654 MW of capacity would be the maximum range, thereby eliminating a capacity of between 318 MW and 1,861 MW from the UK 2010 target.

Chart 25: UK Total potential built capacity by 2010 with & without 2,500 MW constraint in Scotland

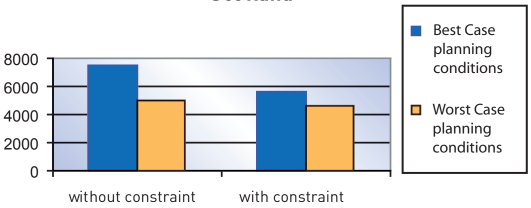


Table 23: Total UK potential built capacity with and without 2,500 MW constraint in Scotland

	Without constraint	With constraint
Best case planning conditions	7,515	5,654
Worst case planning conditions:	4,999	4,681

Chart 26: LPA & Section 36 UK total year on year build by country with 50% approval & 36 month decision delay scenario

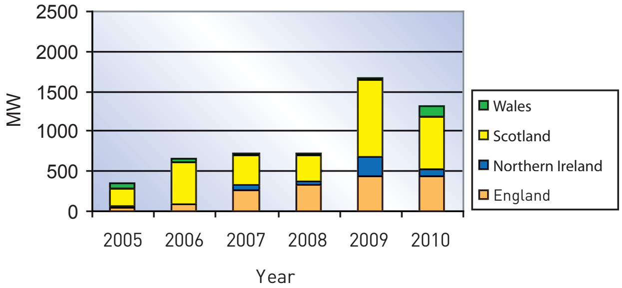


Chart 27: UK LPA & Section 36 cumulative year on year build with 50% approval & 36 month Section 36 scenario

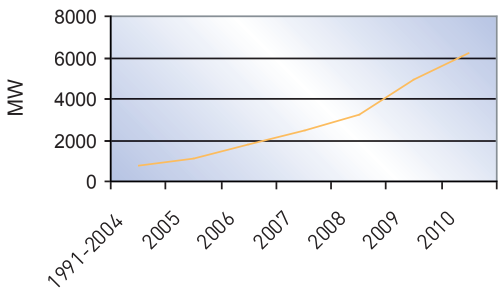


Table 24: Year on year by country with 50% approval rate and 36 month decision delay Section 36 scenario (MW)

	2005	2006	2007	2008	2009	2010
England	39	81	261	336	448	435
Northern Ireland	20	17	73	35	240	87
Scotland	218	521	360	334	951	666
Wales	80	46	25	28	24	127
TOTAL:	**357**	**665**	**719**	**733**	**1,663**	**1,315**

Table 25: UK Cumulative year on year with 50% approval rate and 36 month decision delay Section 36 scenario (MW)

(1991-2004)	2005	2006	2007	2008	2009	2010
767	1,124	1,789	2,508	3,241	4,904	6,219

UK Total Benefits to 2020

7.3 Using the selected 36 month delay, 50% approval rate Section 36 scenario which assumes an onshore wind energy capacity of 6,219 MW by 2010, a range of significant benefits will accrue, some of which have been quantified below. This range is attributable to the development, construction and operational phases of both the existing and forecast onshore wind capacity. Benefits that accrue during the operational phase have been aggregated for the period 2006-2020[7], inclusive. As such they under-estimate total benefits as wind farms have a typical life of 20-25 years and benefits from wind farms built up to 2010 will therefore accrue up to 2030-2035.

Chart 28: UK estimated 2010 build

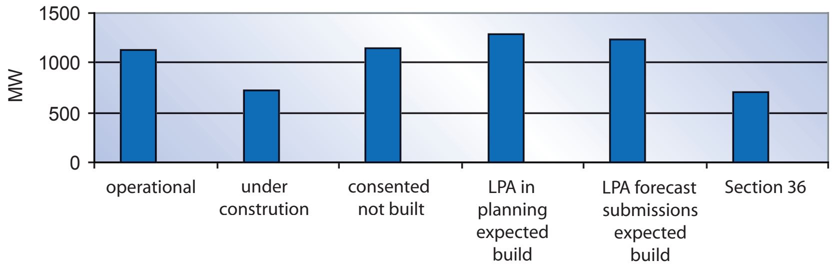


Table 26: UK estimated 2010 build (MW)

Operational:	1,124
Under construction:	723
Consented not built:	1,138
LPA in planning expected build:	1,297
LPA forecast submissions expected build:	1,238
Section 36:	699
TOTAL:	**6,219**

Chart 29: UK Estimated 2010 build by country

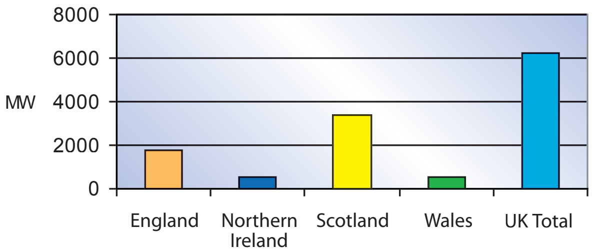


Table 27: UK estimated 2010 build by country(MW)

England:	1,774
NI:	543
Scotland:	3,397
Wales:	505
TOTAL:	**6,219**

7.4 Nonetheless, at least £4.2 billion of benefits have been identified including payments to landowners and communities in typically rural areas. Benefits to the UK relating to Capital Expenditure are also likely to be higher than the £1.2 billion assumed below. The significant build rate that is forecast would very likely lead to further UK manufacturing of wind turbines and their components, resulting in higher UK content than the 25% assumed in the calculations[7].

Chart 30: UK wind energy benefits (£millions) 2006-2020, inclusive (total: £4,235.6)

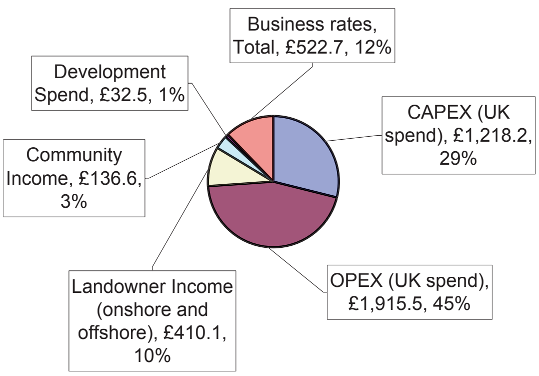


Table 28: UK economic benefits of onshore wind energy					
Benefit	**England**	**Northern Ireland**	**Scotland**	**Wales**	**Total (UK)**
Development Spend[8]	£10.0 million	£2.9 million	£18.0 million	£1.6 million	£32.5 million
Business Rates[9]	£88.5 million	£27.3 million	£382.1 million	£24.8 million	£522.7 million
Capital Expenditure (within UK)[10]	£374.4 million	£108.7 million	£675.0 million	£60.1 million	£1,218.2 million
Operational Expenditure (Within UK)[11]	£531.7 million	£163.8 million	£1,071.2 million	£148.8 million	£1915.5 million
Landowner Income[12]	£113.8 million	£35.1 million	£229.3 million	£31.9 million	£410.1 million
Community Income[13]	£37.9 million	£11.7 million	£76.4 million	£10.6 million	£136.6 million
TOTAL	**£1,156.3 million**	**£349.5 million**	**£2,452 million**	**£277.8 million**	**£4,235.6 million**

Table 29: Summary data table for onshore wind capacity by 2010 – planning scenarios

Section 36 (S36) currently in planning that will be approved, dependent on a range of scenarios:	
Current S36 capacity in planning that can be determined in 21 months & built by 2010:	2,812 MW
Current 21 month delay	
30% approval rate:	759 MW
50% approval rate:	1,265 MW
70% approval rate:	1,772 MW
30 month delay	
30% approval rate:	474 MW
50% approval rate:	790 MW
70% approval rate:	1,106 MW
36 month delay	
30% approval rate:	420 MW
50% approval rate:	699 MW
70% approval rate:	979 MW
42 month delay	
30% approval rate:	340 MW
50% approval rate:	566 MW
70% approval rate:	793 MW
S36 Range:	340 – 1,772 MW
UK local planning authority (LPA) applications	
In Planning	
LPA approvals expected existing approval rates:	1,183 MW
LPA approvals with 40% approval rate:	721 MW
Appeal Approvals Expected:	114 MW
Forthcoming Applications	
LPA approvals expected with existing approval rates:	1,148 MW
LPA approvals expected with 40% approval rate	747 MW
Appeal approvals expected:	90 MW
Wales TAN8 Strategic Search Areas (SSAs)	0 – 221 MW
UK Total confirmed	
Approved Not Constructed	1,140 MW
Under Construction	723 MW
Operational:	1,124 MW
(Total guaranteed:	2,987 MW)
UK range under existing LPA approval rates:	5,862 – 7,294 MW
UK range with 40% LPA approval rate scenario:	4,999 – 6,431 MW
UK range with 2,500 MW constraint to development in Scotland:	5,310 – 5,433 MW
UK range with 40% LPA approval & 2,500 MW constraint to development in Scotland:	4,681 – 4,804 MW
UK worst & best case range (including additional 221 MW capacity from Wales SSAs):	**4,681-7,515 MW**

8. Conclusions & Recommendations

Conclusions

8.1 Different ranges for the delivery of onshore wind in the UK by 2010 have been identified dependent on various planning scenarios; local planning authority and Section 36 approval rates, Section 36 decision delays, a 2,500 MW constraint to development in Scotland and the realisation of additional capacity in Wales through the TAN 8 Strategic Search Areas. Each of these scenarios have a significant impact on the delivery of onshore wind, however with a 'business as usual' scenario for local decision making and a pragmatic approach to Section 36 decisions and timeframes, at least 6,000 MW of onshore wind will be delivered by 2010. This assumes a 50% approval rate with decisions times of three years for Section 36 applications

8.2 The range of deliverable onshore wind capacity demonstrates that the industry is ready and able to deliver at least 6,000 MW as long as the pace of the planning system does not deteriorate beyond the current decision times and approval rates at local authority level, and three years with 50% approval rate at Section 36 level.

8.3 The TAN8 Strategic Search Areas are anticipated to contribute up to 221 MW of additional capacity relative to the 800 MW onshore target set by the Welsh Assembly Government providing that timely decisions on these applications are made.

8.4 Forthcoming planning decisions in Scotland are essential as 3,397 MW of the 2010 forecast capacity will need to be met in Scotland. Around 2,500 MW of onshore wind development in Scotland will be achieved if the existing trend of non-determination of Section 36 projects is maintained. Only 509 MW have been determined in the last two years while 3,267 MW were submitted during the same period.

8.5 Delivery of only 2,500 MW in Scotland would have a significant impact on the total UK built capacity by 2010. With no constraint, 4,999 MW to 7,515 MW of capacity could be built in the UK under 'worst case' and 'best case' planning conditions respectively. If development is constrained to 2,500 MW in Scotland, 4,681 MW to 5,654 MW of capacity would be the maximum range, thereby eliminating a capacity of between 318 MW and 1,861 MW from the UK 2010 target.

8.6 Grid capacity will not be a barrier to the installation of 6,000 MW of onshore wind by 2010 provided all the development activity is not targeted in the north of Scotland, although without upgrades it will be an increasing constraint to free access to the nominal capacity of the system at any one time. Grid capacity constraints also represent a significant barrier to maintaining the momentum of development for all renewable technologies early in the next decade.

8.7 Depending on the local planning and Section 36 decision making process, onshore wind could deliver much more than 6,000 MW – potentially as much as 7,515 MW.

Recommendations

- UK Government and devolved administrations in Scotland, Wales and Northern Ireland must maintain a positive and robust approach to national, regional and local planning policy in accordance with the Government's renewable energy and climate change targets

- Action must be taken to address local planning decision delays across the UK, in particular Wales and Northern Ireland where additional contributions to the 2010 renewable energy targets are severely constrained

- With the average decision time for Section 36 applications moving upwards, prompt action is required to ensure the necessary resources and skills are put in place to ensure quality and timeliness of decision making

- In driving forward the Welsh 800 MW onshore wind target, the Welsh Assembly Government must:

    - oversee efficient preparation of Supplementary Planning Guidance and ensure local planning authorities policy revisions are consistent with the Assembly's national policy on renewable energy as contained in TAN8
    - encourage development activity outside Forestry Commission-owned land within the Strategic Search Areas
    - oversee prompt decision making with the necessary resources being committed at the local level,

  and for Section 36 projects, the Department of Trade and Industry should also ensure timely decision making and commit to additional resources in order to reflect the increase in development activity thus ensuring a greater contribution from Wales to the 2010 target

- To contribute up to £2.5 billion to the Scottish economy by 2020; ensure that 6,000 MW of onshore wind can be met in the UK, and provide the necessary confidence for future investment in all renewable technologies in Scotland, the Scottish Executive must:
    - avoid a hiatus of onshore wind delivery towards the end of this decade and therefore bring forward the early delivery of Scotland's 2020 renewable energy target
    - accelerate its decision making process for Section 36 applications - not all decisions are expected to be favourable but they must be made in realistic timescales

- Plans to reinforce the grid infrastructure in northern Scotland, mid-Wales and Northern Ireland should move forward urgently to facilitate the full utilisation of generating capacity; provide the necessary investor confidence for all renewable technologies and to avoid a hiatus early in the next decade at a time when momentum of onshore wind delivery must be maintained.

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1 Refer to endnotes 7-14 for economic benefits calculations
2 Refer to Appendix 1 for full calculations on wind savings
3 http://www.defra.gov.uk/environment/climatechange/about/globaleffect.htm
4 http://unfccc.int/resource/docs/convkp/kpeng.html
5 http://www.rcep.org.uk/news/00-2.htm
6 http://www.dti.gov.uk/renewables/policy_pdfs/rab2005report.pdf
7 All benefits are accrued annually on the basis of Year X benefits multiplied by total installed capacity in Year X-1 with the value of benefits increasing in line with RPI (assumed to be 2.5% pa). No discount rate has been applied.
8 BWEA has estimated that average development spend in 2006, taking account of unsuccessful project spend, is £6,000 per MW installed. In the calculations, this benefit is shown during the year of first generation; in reality it would be earlier than this date.
9 Business Rates in 2006 are assumed to be £3,500 per MW installed in England, Northern Ireland and Wales and £7,500 in Scotland.
10 In consultation with its members, BWEA has assumed that the Capital Expenditure within the UK in 2006 is £225,000 per MW installed (25% of total Capital Expenditure of £900,000 per MW installed).
11 In consultation with its members, BWEA has assumed that the Operational Expenditure within the UK in 2006 is £21,024 per MW installed per year (80% of the total Operation Expenditure of £26,280 per MW installed per year, itself based on £10 per MWh generation).
12 In consultation with its members, BWEA has assumed that average, annual landowner payments in 2006 equate to £4,500 per MW installed per year.
13 In consultation with its members, BWEA has assumed that the average, annual community fund payment in 2006 equates to £1,500 per MW installed per year.

Appendix 1: Wind Energy Savings Calculations

Wind
Assumed load factor for wind of 30%
6GW will generate 15.77 TWh

Gas
Thermal efficiency of CCGT power stations is 48.6% (DTI Dukes)
So 1MWh generated requires 1/0.486 MWh energy = 2.06MWh
1m3 natural gas provides 11.06 kWh (Carbon Trust Energy Conversion Factors)
1MWh electricity requires 2.06 * 1000 / 11.06 = 186.26m3 natural gas to generate
It takes 186.26 million m3 gas to generate 1TWh
15.77 TWh wind avoids 15.77 * 186.26 million = 2.9 billion m3 natural gas

UK – Europe gas interconnector
"The UK import capacity of the Interconnector was increased from 8.5 bcm/y to 16.5 bcm/y on 8 November 2005. A second phase enhancement, due to be completed by December 2006, is progressing to schedule and will bring the UK import capacity of the system to 23.5 bcm/y."
HYPERLINK "http://www.interconnector.com/" \o "http://www.interconnector.com/" www.interconnector.com
The UK Europe interconnector can currently deliver 16.5 bcm/y
2.9 bcm is 17% current yearly import on interconnector = approx 64 days
Capacity of interconnector in 2010 is 23.5 bcm
2.9 bcm is 12% future yearly import = approx 45 days

LNG
Typical tanker holds 75,000 m3 LNG
1m3 LNG = 600m3 natural gas
1 tanker = 45million m3 natural gas
2.9bcm natural gas is equivalent to 64 LNG tankers

Coal
Calorific value of power station coal is 26.1GJ /t (dti energy staistics)
Thermal efficiency of coal fired power stations is 36.2% (Dukes table 5.10)
1MWh coal fired electricity requires 2.76MWh coal
26.1GJ = 26100MWs = 7.25MWh per tonne coal
2.76MWh coal is (2.76/7.25) = 0.38tonnes coal
1MWh coal generation requires 0.38 tonnes coal
1TWh coal generation requires 380,000 tonnes coal
15.77TWh avoids the use of 15.77 * 380,000 = 6 million tonnes coal

Electricity demand
Electricity demand in 2004 was 340TWh domestic demand was 116TWh (Dukes)
Assume 1% pa increase
2010 demand will be 360TWh and domestic will be 123TWh
15.77TWh will be 4.4% electricity demand and 12.8% of domestic demand

Household equivalents
Average Household electricity demand is 4700kWh (BWEA website)
15.77TWh is as much energy as used in 3.3million households
This is a population of approx 8m people. (assuming average 2.4 people per home – 60m people, 25m households)
8 million people is equivalent to the population of London and Glasgow
Or the 20 Biggest cities in UK combined (excluding London)
Or all of Wales and Scotland
City sizes at HYPERLINK "http://www.lovemytown.co.uk/Populations/PopulationsTable1.htm" \o "http://www.lovemytown.co.uk/Populations/PopulationsTable1.htm" http://www.lovemytown.co.uk/Populations/PopulationsTable1.htm

CO2 savings
Coal Generation
Coal produces 0.3 gCO2 for each kWh burnt (Carbon Trust Conversion factors - HYPERLINK "http://www.thecarbontrust.co.uk/energy/pages/page_64.asp" http://www.thecarbontrust.co.uk/energy/pages/page_64.asp)
Thermal efficiency of coal fired power stations is 36.2% (Dukes table 5.10)
1KWh (electrical) from a coal fired power station produces 0.3 / 0.362 = 0.83g CO2.
1TWh produces 830,000 tonnes CO2
15.77TWh wind power therefore avoids 13 million tonnes CO2

Gas generation
Gas produces 0.19 gCO2 for each kWh burnt (Carbon Trust Conversion factors - HYPERLINK "http://www.thecarbontrust.co.uk/energy/pages/page_64.asp" http://www.thecarbontrust.co.uk/energy/pages/page_64.asp)
Thermal efficiency of gas fired power stations is 48.6% (Dukes table 5.10)
1KWh (electrical) from a coal fired power station produces 0.19 / 0.468 = 0.41g CO2.
1TWh produces 410,000 tonnes CO2
15.77TWh wind power therefore avoids 6 million tonnes CO2

Appendix B: Offshore Wind: At a Crossroads, analysis of UK offshore wind industry to 2015

Assessment of UK Offshore Wind Deliverability to 2010 and Beyond

This document provides an assessment of the capability to deliver significant offshore wind capacity into the UK energy mix under two policy scenarios. The information upon which this assessment is based was obtained during detailed consultation with developers and the supply chain. Limited information on costs was also collected and will be reported later, along with suggestions for industry cooperation to improve the cost-effectiveness of the sector. This report underlines the need for new policy initiatives to unlock the potential for offshore wind in the UK.

"Credibility is the number one ingredient in our experience as a utility player. If you go to Government and ask for support you'd better be damn sure you know how to deliver. To date as a sector we have not quite achieved that." npower renewables.

1. Offshore Wind Today

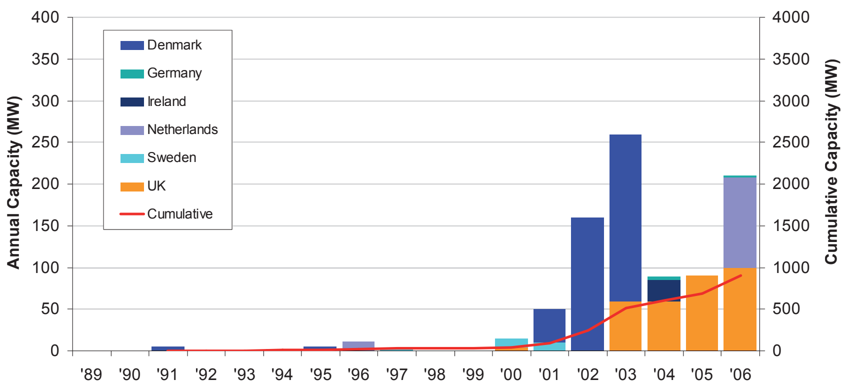
The first offshore wind project was installed in 1991 in Denmark. The first UK project in the water was the North Hoyle wind farm (60 MW), installed in 2003. Scroby Sands (60 MW) and Kentish Flats (90 MW) followed in 2004 and 2005 respectively. By the end of 2006, more than 900 MW of offshore wind will be in operation globally, all in Europe.

Today, the UK's fourth offshore Round 1 project, Barrow (90 MW), is nearing completion and work offshore at Burbo Bank (90 MW) will start before the summer of 2006. By the end of 2006, the deeper-water Beatrice demonstration project (10 MW) is also expected to be operational. The result of consenting at Redcar is imminent and the five Round 2 consents applied for to date will be supplemented by another four applications in 2006.

Outside the UK, Egmond-aan-Zee (108 MW) off Holland should be completed in 2006 and an EPC contract has just been placed for Lillgrund (110 MW), off Sweden for completion in 2007.

The global growth of offshore wind capacity to date is presented below.

Global Offshore Wind Capacity to Date



by end	1995	2000	2005	2006
GW operating	0.01	0.04	0.7	0.9 (est.)

2. At a Crossroads

Under the UK's existing Renewables Obligation and the capital grants programme for Round One, offshore projects have been built at a rate of only one per year. The near-term future remains uncertain and in the absence of a capital grant or similar support programme for Round Two, there are no clear signs of the stable pipeline of projects that the supply chain requires to drive forward investment. In short, the economic gap between capital costs, expected operational costs and revenue for most projects remains too large for substantial industry commitment.

With the Energy Review in progress, the UK offshore wind industry is at a crossroads. Two possible outcomes of the Energy Review are considered:

Scenario 1 **Continuation of current policies**. No additional support is available for offshore wind. The consequence is that the current slow evolution of improving revenue would continue, but an economic gap would remain for the foreseeable future.

or

Scenario 2 **New policy impetus in 2006**. New policies emerge which result in an improved economic environment for offshore wind, sufficient to enable 'good' projects to be developed commercially.

Sections 3 and 4, present forecasts for installation of offshore wind in the UK under each of the above scenarios together with a discussion of the implications for the industry.

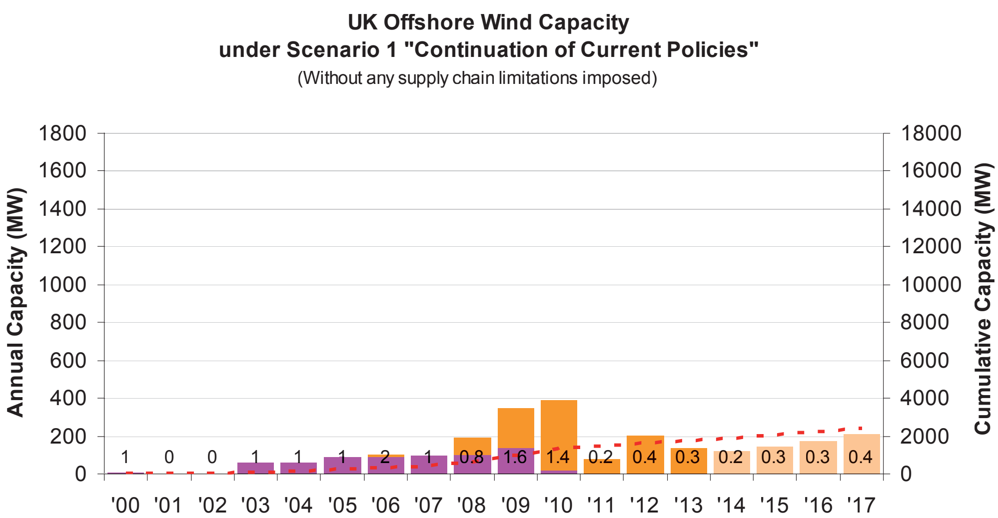
Section 5 considers supply chain capacity in the light of scenario 2.

Section 6 summarises the impact of any supply chain limitations.

3. Installation Forecast under Scenario 1 "Continuation of Current Policies

3.1 Forecast

The aggregate forecast presented below assumes no significant change in the economics until mid-way through the next decade. It does not include the possible effects of supply chain limitations other than those assumed by the developer for each project. For an explanation of methodology used to arrive at these figures refer to Section 9.



'Continuation of Current Policies'

by end	2000	2005	2010	2015
GW operating (without any supply chain limitations imposed)	0.0	0.2	1.3	2.0

Key:

Pink bars	UK offshore Round 1 projects.
Orange bars	UK offshore Round 2 and other projects.
Tan bars	UK offshore Round 3 and later projects. Total annual installed capacity (including Round 2) is assumed to be 100 MW in 2013, increasing by 20% per year, reflecting an eventual upturn in economic viability. Further discussion of post Round-2 licensing is provided in Section 4.
Broken red line	Cumulative capacity.
Values	The number of UK projects forecast to be completed per year. Note that as Round 2 and later projects come to dominate, the size of a typical project will be much greater than those installed to date.

The growth in 2008/09 is dominated by early Round 2 projects off the East Coast, coupled with installation of two further Round 1 projects.

3.2 Costs

There is a general (but not universal) consensus amongst developers that there is an economics gap equivalent to up to around 25% of installed project cost.

> "No projects will run without additional support (grant) up to £0.3m/MW." Offshore developer.

Simplistically, the economics can be split into capital expenditure, operating expenditure and revenue. Comments received regarding each of these are presented below.

Capital Expenditure:

- For onshore projects, turbine prices have risen by 10-20% in the last 2 years. These price rises have been driven by the PTC-induced activity in the US, the opening up of the Asian market and the global increased demand for wind turbines as electricity prices from wind approach those from carbon fuels.
- For offshore projects, the high cost of covering risk associated with inadequate reliability is becoming clearer, based on tough early experience from a number of (but not all) offshore wind farms. A high rate of new product introduction coupled with inadequate testing and poor build quality has lead to series-faults for some turbines.
- Raw material prices are high, due to global demand driven especially by infrastructure growth in China.
- The industry is also learning from early shortcomings in specification and offshore processes which in many cases are driving up costs to more realistic levels in the short-term.
- Grid connection costs are uncertain, especially in the North West.
- At-risk upfront development costs are also proving significant.

Operational Expenditure:

- The industry is only now starting to build up a picture of the real costs of operations and maintenance.
- Operational costs for early projects have frequently exceeded original estimates, mainly as a result of unexpected levels of component failure.

Revenue:

- Developers report that they value working in a politically stable environment, with continuity of any support mechanisms. At the same time they recognize the uncertainty in future ROC prices, especially as 2015 (latest confirmed obligation) and 2027 (latest confirmed date for ROC scheme to be operating) are now very much within project lifetimes.
- Two other potential uncertainties were stated by developers. First, if legislation was to be changed to enable a higher percentage of biomass burnt in co-fired facilities to be counted as 'ROC-able', then this would have a major effect on the ROC market. Second, the effect of the utility portfolio approach to green asset development could mean a rapid switch away from offshore wind to the development a more cost effective asset or technology available near-term. Utility staff working in offshore wind now are not dedicated solely to this sector.

3.3 Supply Chain

Under Scenario 1, all parts of the current supply chain appear to have sufficient capacity to deliver. It is unclear however, whether the UK's offshore wind-specific supply chain could be sustained with generally no more than a single UK offshore project being completed each year. In addition, the offshore wind supply chain will be further threatened by the growth of competing infrastructure and oil and gas industry opportunities.

A healthy supply chain needs a stable ongoing pipeline of projects to support volume production. Without this, offshore-wind specific investment will be extremely limited. Major effects include:

- Minimal reduction in capital costs over time.
- Little or no benefit taken from economies of scale.
- Minimal development of offshore wind processes to reduce risk and operational costs.
- Limited resources (and inclination) to invest in improving cooperation and best practice within the industry.
- The best people and facilities will be focused elsewhere (oil and gas or other ROC creation).

> "This scenario would not support supply chain sufficiently. It would be touch and go whether we would survive and certainly would not get the right investment to improve costs." UK supplier.

3.4 Conclusions

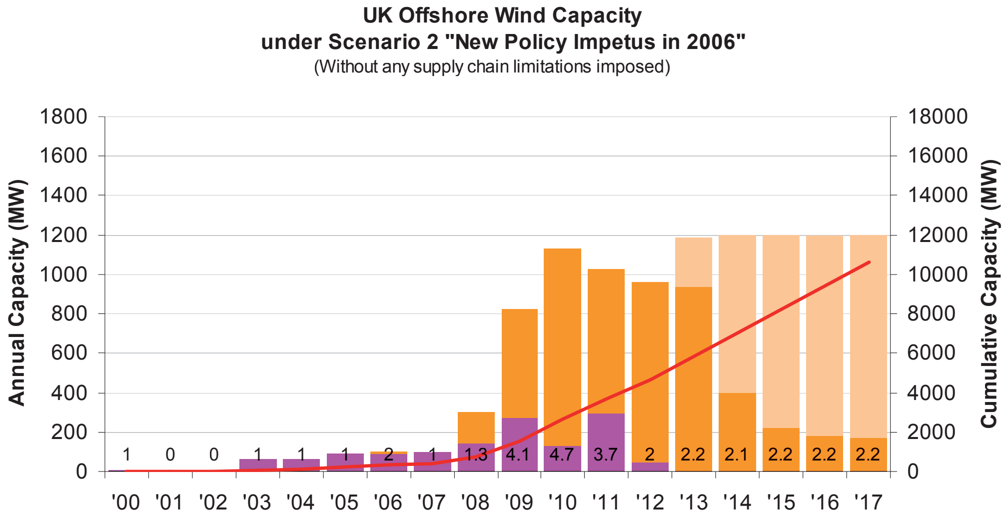
A small number of the more attractive or lower-hurdle Round 1 and Round 2 projects would be constructed. Many projects would be held post consenting until conditions improve, the value of the asset being judged higher un-built than built.

The contribution to RO targets would be low and offshore wind (and other marine renewable technologies) would not progress towards providing a significant contribution to the UK energy mix.

4. Installation Forecast under Scenario 2 "New Policy Impetus in 2006"

4.1 Forecast

The following aggregate forecast assumes that a new policy impetus in 2006 is sufficient to enable each 'good' project to be developed commercially. It does not include the possible effect of supply chain limitations other than that built into individual project plans by each developer.



"New Policy Impetus in 2006"

by end	2000	2005	2010	2015
GW operating (without any supply chain limitations imposed)	0.0	0.2	2.7	8.2

Key:

Pink bars	UK offshore Round 1 projects.
Orange bars	UK offshore Round 2 and other projects.
Tan bars	UK offshore Round 3 and later projects. Indicative of potential future installation. Annual total (including Round 2) is assumed to remain at 1200 MW from 2013 to reflect the development of Round 3 and later projects.
Red line	Cumulative capacity.
Values	The number of UK projects forecast to be completed per year. Note that as Round 2 and later projects come to dominate, the size of a typical project will be much greater than those installed to date.

This forecast is not simply an optimistic view. It is a mid-forecast based on the industry response to a new policy impetus.

Such an impetus may consist of a number of different mechanisms. Key mechanisms (generally but not universally agreed within the wind industry) include:

- Improved support for offshore wind projects.
- No significant change to environment for onshore wind.
- Encouragement of stability and long-term investment in the industry.
- Early and improved licensing procedures for offshore projects beyond Round 2.

4.2 Costs

The assumption under this Scenario is that the 'economic gap' has been closed for 'good' projects by the new policy impetus. Over time, the 'economic gap' will close, thereby requiring less and less additional support to be provided.

Opportunities for the industry to improve economics over time are considerable, but will only be realized during the implementation of a reasonable pipeline of projects.

4.3 Supply Chain

A key question is whether the wind industry supply chain can physically deliver within an improved economic environment. This is discussed in detail in Section 5.

With confidence of a gradually increasing pipeline of economically viable projects at varying stages of development, the supply chain can learn and invest, bring costs down and grow in communication with the developers.

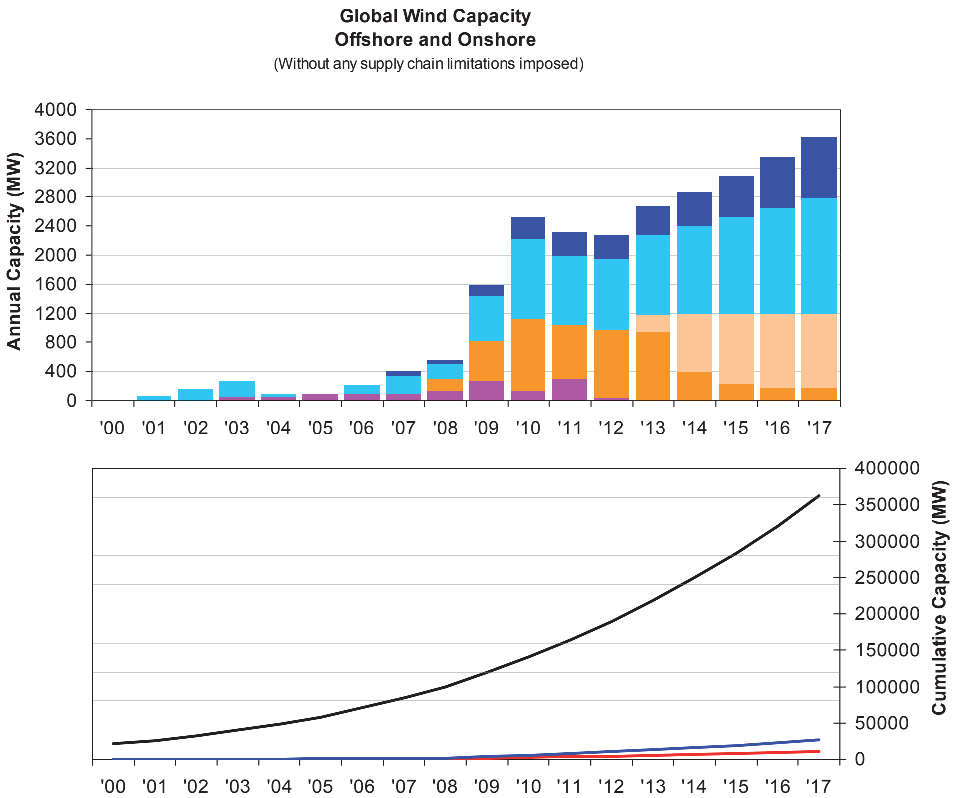
4.4 Conclusions

The result of the new policy impetus is that offshore wind:

- Provides a significant contribution towards the UK's renewable energy targets by 2015.
- Has the chance to establish as a mature industry and a cost effective part of the UK energy mix.

5. Supply Chain Capability under Scenario 2 "Policy Impetus in 2006"

The question of what the wind industry can physically deliver cannot be addressed for the UK offshore wind industry in isolation from the global wind industry. This section looks at the supply chain capacity in the context of the project time plans from developers of UK offshore projects, conservatively coupled with an optimistic forecast of the global onshore and offshore wind markets.



Key and Notes:

Pink bars	UK Round 1 projects.
Orange bars	UK offshore Round 2 and other projects.
Tan bars	UK offshore Round 3 and later projects (indicative).
Turquoise bars	EU non-UK offshore projects, planned and forecast.
Blue bars	Non-EU offshore projects, planned and forecast.
Red line	Cumulative UK offshore.
Blue line	Cumulative global offshore (inc. UK).
Black line	Cumulative global onshore and offshore (inc. UK).

Non-UK offshore data generated using similar approach to UK offshore data.

Global onshore cumulative data based on international predictions.

A number of key areas of the supply chain are considered below.

5.1 Wind Turbine Supply

Wind Turbine Supply is recognized as the most critical supply chain issue by most developers.

Global demand is high and currently, only three suppliers are both interested in- and capable of supplying to the UK offshore market. All three are stretched in delivering to the lower-risk onshore market. In this context, UK offshore wind is suffering short-term due to the extraordinary success that the wind industry is achieving globally. By 2015, there are likely to be at least 6 offshore turbine suppliers in the UK market, new entrants being a mix of upcoming and established onshore players. Balance sheet strength is likely to become even more important for turbine suppliers.

Gearbox supply is highlighted as the key bottleneck relating to turbine supply. It is also a focus area regarding reliability. Loss of independence of key suppliers Winergy and Hansen further heightens the potential for gearbox supply issues.

A number of turbine suppliers use carbon fibre in blade manufacture, a material currently in short supply globally. This had an effect on turbine sales in 2005, though further capacity is now starting to come on stream.

The rate of growth of new turbine size coming out of R&D departments is generally slower in the last two years than had been predicted, with much increased focus on testing, resolution of faults and engineering for increased reliability. The vision to use turbines rated 4.5 MW and larger for many Round 2 sites in 2009/10 may be incompatible with sales release rates for these products by wind turbine suppliers keen to manage risks carefully. Though smaller turbines (3MW class) may compromise economics, these may be the only turbines that offer rational levels of reliability in the offshore environment in the timeframe.

With optimistic average global annual installation rate for offshore wind of 2 GW between 2009 and 2012, offshore wind would still only take 10% of the global wind turbine market. In the same period, offshore UK would take less than 8% of the total wind turbine supply capacity of the players active in the UK offshore market. Physically being able to supply turbines to the UK offshore market is not likely to be a limiting factor. More important is whether turbines of the desired size are made available by wind turbine suppliers at an acceptable cost.

Turbine supply is recognised as having the greatest inertia of any element in the supply chain, with development times of over five years to series production and involving significant development commitment (man-hours and external cost). The next generation of turbines suitable for offshore applications is likely to be solely for offshore use, hence decisions regarding pace of their development are highly dependent on global offshore market expectations,

Inertia within the supply chain for some key components is also significant (for example, to accelerate the rate of manufacture of gearbox casings), whereas the timescales for establishing new turbine assembly facilities are generally short.

Following discussion with all relevant turbine suppliers in the light of global demands, it is anticipated that t**he growth of the UK offshore market between** 2009 **and** 2012 **will be limited by turbine availability** in the scenario "New Policy Impetus in 2006. It is estimated that the limit is of the order of 600 MW in 2009, rising to 1200 MW in 2012. The effect of this limitation is presented in Section 6.

As the industry moves to implementing projects that are larger and further offshore, developers advise that they will be less inclined to be the first to use latest turbine designs. There is a need for smaller, lower-risk projects to prove such turbines in the offshore environment, as these turbines are in general unlikely to 'fit' remaining Round 1 sites.

Concerns were also raised regarding the potential of the German offshore wind sector to take available turbine capacity. The German offshore wind sector will be supported via a secure feed-in tariff arrangement that has stimulated much onshore activity in Germany.

It is recognized that turbine supply is the element least within the UK sphere of influence.

5.2 Installation Vessels

Between developers, there is a wide variation in views as to whether suitable vessel supply is a major concern. In general it falls second only to the concern about turbines. Some developers are taking creative action to mitigate this risk; others seem simply to be following the industry trend in predicting problems.

There are clear indications that the lack of work in offshore wind is pushing vessels back into the oil and gas sector and limiting investment in vessels suitable for 5 MW+ turbines. The investment time to prepare suitable vessels is significant; hence a steep ramp up in capacity is unlikely to be available.

In assessing capability for turbine installation, it is assumed that the average turbine size will be 3.6 MW in 2007 then will drop to 3.4 MW 2008 before rising by 0.2 MW per year for the foreseeable future. This trend is summarized below.

	2000	2005	2010	2015
Average turbine size installed (MW)	2.0	3.0	3.8	4.8

From discussion with the supply chain, any bottleneck is likely to be around 2009-10. Sufficient availability of suitable vessels is dependent on the exact mix of turbines used (even between the different 3.6 MW turbines available), water depths and hub heights as well as whether particular vessels remain available to the sector or are contracted to the offshore oil and gas sector instead. The best estimate today based on an optimistic usage rate of 70 turbines per vessel per year is that **sufficient installation vessel capacity will only just be available.**

In time, vessels capable of installing smaller turbines will need to be used for any retrofit work required. If vessels suitable for installation of large turbines are tied up with maintenance activities, then sufficient capacity will not be available for installation.

DTI has recently commissioned a separate detailed review of this area of the supply chain. A summary of results (courtesy of ODE ltd and DTI) follows:

- Looking at UK developments alone, there is sufficient capability within the current industry installation vessel fleet.
- The potential impact on the UK market by proposed European developments (particularly offshore Germany) is significant and could cause considerable shortfall from around 2008 onwards.
- Currently, there is a potential future shortage of heavy lift vessels for the next generation of turbines (5 MW+) and deep-water operations (30m+).
- Co-operation/Co-ordination by all major stakeholders regarding project timing, development plans etc., could help control potential problems.
- Fleet reduction due to loss of vessels to other markets or through long-term contract/commitments would aggravate this situation further.

5.3 Cables

The third most common supply chain concern raised by developers is subsea cables. Two specific products make up the sector – medium voltage (MV), intra-turbine array cables (typically around 33kV) and high voltage (HV), substation to shore cables, where relevant (typically 132kV+).

> "Lots of promise from the industry but not coming through – has been frustrating to continue bidding."
> Cable supplier.

With a generous estimate of average 0.4km MV subsea cable per MW installed, peak global installation rates of 2 GW per year would require approx. 800km per year. Messages from suppliers are somewhat conflicting, partly due to the number of potential bottleneck processes involved and the wish to spread production across different sectors to minimize demand risk. Overall, global supply capacity is advised to be of the order of 3000km per year, with current offshore wind players supplying over half of this.

Supply of HV subsea cable is limited to fewer players but demand for offshore wind is lower.

Current lead times are of the order of 12 months, with pressure on supply coming from oil and gas sector and subsea interconnects. Feedback from the supply chain is that UK developers have at times not communicated early enough and asked for too short lead times – the bottleneck being lead time, not supply capacity.

> "UK developers generally open enough, though not overwhelmed by information from them. Often information passed around as rumours. Hear about ideas then silence – would be helpful if people would tell why project being postponed etc." Non-UK supplier.

Though current capacity is significantly greater than demand, expansion is likely to be required to meet optimistic EU offshore wind forecasts coupled with growth in non-wind sectors. There is a willingness to invest with the right conditions, taking 1-2 years before increased production is realized. Open communication and early commitment will be vital in ensuring sufficient supply in this scenario.

UK capability for MV subsea cable exists. JDR Cable Systems, suppliers to the Beatrice demonstration project, are keen to supply also to shallower water projects.

5.4 Structural Steelwork

Supply of steelwork is not raised as a particular concern by developers. The offshore-specific supply item is the monopile. Notwithstanding their size, the demand for offshore towers is only a small fraction of the EU total demand for wind turbine towers.

Currently, only small pool of EU players have supplied monopiles. Between them, they currently have capacity for approx. 350 4 MW monopiles per year. All have significant growth / redirection capability that could be brought on line in less than 1 year from date of investment decision. Other potential entrants exist if the market required them. UK companies could quickly cover half of the above capacity.

5.5 People

Because of the limited experience of developers/owners in managing offshore multi-contracts, there is a developing market for external project management contracting – current EPC contractors 'moving across the fence' to manage the contract on behalf of the owner.

This function and the 'in-house' teams within developers need to have a pipeline of projects in order to stay engaged and learning. It is not possible to learn 'off the job', so late, rapid acceleration may well lead to skills shortages. Related to the issue of the skills base is the evolution of contracting strategy to date which has delayed some projects but is a sign of the maturing of the sector, as seen previously in the offshore oil and gas industry. There is now significant focus in this area. Due to past experience, there is reluctance from some members of the supply chain to embark on repeat high-cost tendering exercises.

5.6 Grid

Getting a grid connection is a project specific issue. In the majority of Round 2 projects the final form, capacity and/or cost of the grid connection arrangement will be one of the last items to be resolved. This does not sit comfortably with the long-lead and final sums issues facing developers today and could lead to delays of projects forecast to be installed before the end of 2010.

Although costs and lead times are uncertain, in general policy is understood and an eventual successful outcome is assumed by developers.

5.7 Consenting Process

Generally there is high confidence that by going 'through the process' and addressing any issues arising, Round 2 projects will receive planning consent.

Some parts of the consent approval process are recognized as potential bottlenecks due to limited resource provision by key stakeholders. To date, developers awaiting consent for Round 2 projects have not received much feedback from approval authorities.

5.8 Dock Facilities

This area is not addressed in detail, though space requirements for Round 2 projects will be significant (typically 80,000 m2) and suitable locations limited.

The common expectation is that the Great Yarmouth Outer Harbour will not be available to service wind projects in 2008. It is also anticipated that East Coast projects could be serviced cost effectively from the continent even if the Great Yarmouth Outer Harbour is available.

5.9 Conclusions

The dominant supply chain limitation is wind turbines themselves. Installation vessel availability also may prove to be limiting.

The key ingredients in mitigating supply chain limitations are:

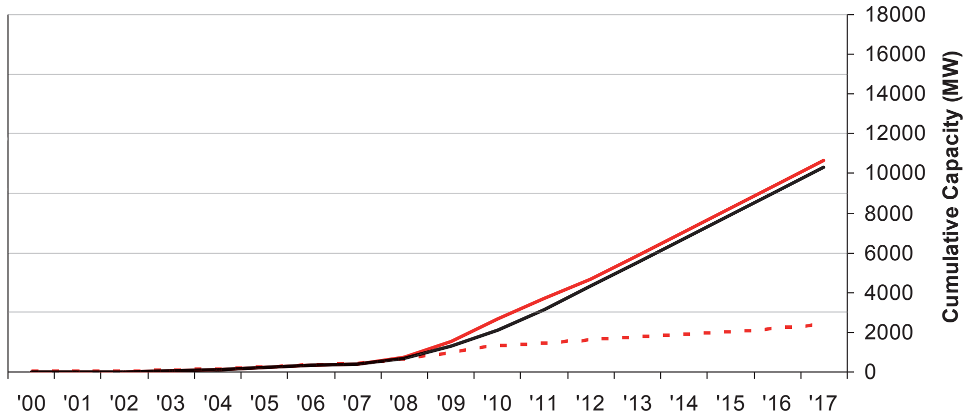
- Build confidence in long-term stable market (through early formulation of Round 3 etc.).
- Ensure active two-way communication between developers and the supply chain.
- Facilitate early involvement from- and commitment to the supply chain on any given project.
- Enable all-party cooperation on grid and consenting.

6. Effect of Supply Chain Limitations

The cumulative installation forecast for the scenario "New Policy Impetus" is shown below, along with the forecast with supply chain limits imposed, showing that the limitations have only a minor effect. Also shown for reference is the cumulative installation forecast for the scenario "Continuation of Current Policies". Installation rates for this scenario are not limited by the supply chain.

Annual installation capacity is modeled by delaying projects if sufficient supply chain capacity is not available, assuming a 30% mortality rate per year for installations delayed.

UK Offshore Wind Cumulative Capacity under Scenarios 1 "Continuation of Current Policies" and 2 "New Policy Impetus in 2006"
(Without- and with supply chain limitations imposed)



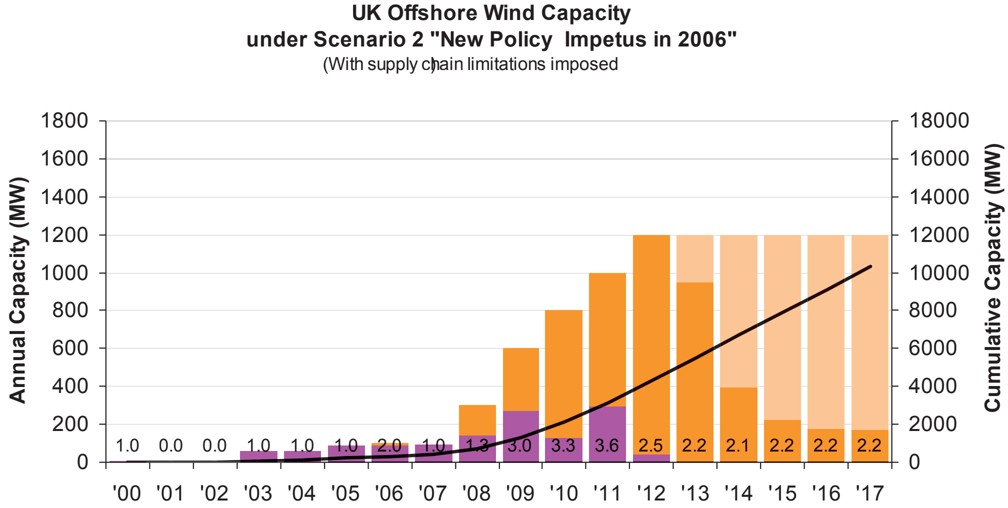
Key:

Red line	Cumulative capacity Scenario "New Policy Impetus in 2006" (without any supply chain limitations imposed).
Black line	Cumulative capacity Scenario "New Policy Impetus in 2006" (with supply chain limitations imposed).
Broken red line	Scenario "Continuation of Current Policies" (unaffected by supply chain limitations).

The only supply chain limitation that has an effect on installation is the turbines themselves. Installation is limited in the period 2009-12. Availability of installation vessels during the period 2009-10 is also marginal even taking into account the turbine supply limitations.

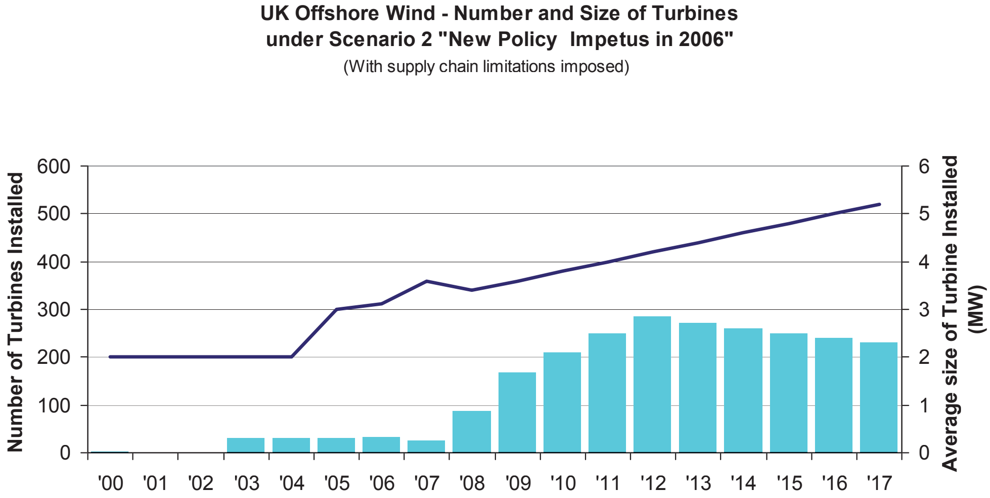
The installation forecasts under the two scenarios do not diverge significantly until after 2010, but the effect of decisions now, is far-reaching in terms of meeting the Renewables Obligation and contribution to the UK energy mix.

The annual installation rate under the scenario "New Policy Impetus in 2006" with supply chain limitations imposed is presented below, followed by an estimate of what this means in terms of number turbines per year and average size of



"New Policy Impetus in 2006"

by end	2000	2005	2010	2015
GW operating (with supply chain limitations imposed)	0.0	0.2	2.1	7.9



Key:

Turquoise bars	Number of turbines installed per year.
Blue line	Average size of turbine installed in year.

7. Conclusions

Under the UK's existing Renewables Obligation and the capital grants programme for Round One, offshore projects have been built at a rate of only one per year. The near-term future remains uncertain and in the absence of a capital grant or similar support programme for Round Two, there are no clear signs of the stable pipeline of projects that the supply chain requires to drive forward investment. In short, the economic gap between capital costs, expected operational costs and revenue for most projects remains too large for substantial industry commitment.

A new policy impetus is needed in 2006 which would result in an improved economic environment for offshore wind, sufficient to enable 'good' projects to be developed commercially.

With confidence of a gradually increasing pipeline of economically viable projects at varying stages of development, the supply chain can learn and invest, bring costs down and grow in communication with the developers. The result of this is a much earlier delivery of economic offshore wind power.

The only supply chain limitation that has an effect on installation is the turbines themselves. Installation is limited in the period 2009-12. Availability of installation vessels during the period 2009-10 is also marginal even taking into account the turbine supply limitations.

An active offshore wind sector is essential for the successful development of the nascent marine renewables sector.

The result is that offshore wind provides a significant contribution towards the RO and by 2015 is established as a mature industry and a cost effective part of the UK energy mix.

> "With extra support offshore wind can deliver significant amounts of power quickly, and with wave and tidal we have the chance to establish world-beating industries that can export to the rest of the world. As North Sea oil and gas run down, the UK's seas can again provide this country with vital home-grown energy that is carbon-free and won't run out." BWEA.

8. Feedback

Input received and the openness with which it has been given to date has been much appreciated, as has the care given by many in offering constructive feedback on the draft report.

Specific comments regarding the Energy Review and RO have been passed on to BWEA, respecting anonymity where requested.

Specific suggestions regarding cooperation within the industry and target areas for cost reduction are being turned into proposals for action, which will be published in the next stage of this work.

9. Notes on Methodology

Background:

BWEA held a one day workshop in November 2005 which was attended by key players in the industry to review current status, successes and failures and gain consensus on the key focus areas to improve rates of installation, which were identified as:

- Project economics.
- Alternative forms of contracting are needed to spread the risk more equitably.
- More communication within industry required and earlier involvement desired by the supply chain.
- Grid issues (for some projects/areas).

With the Climate Change Programme Review and Energy Review imminent, BWEA wanted to present to Government a unified industry view about what can be delivered, what cost improvements the industry can achieve and what areas of support are needed from Government in order for offshore wind to provide a significant contribution to the UK's energy mix and economy.

The purpose of the project, commissioned jointly by BWEA and Renewables East (RE) was to address two specific areas:

(1) Supply chain capability and key issues against realistic installation forecasts under two different scenarios of project economics.

(2) Wind farm costs and to explore the rational and value of setting a stretch cost target for the industry to work towards, in the context of interim support to the economics of offshore wind farms.

Accurate and objective information on these two crucial areas must be available in presenting the case for policy development to the Government as part of the Energy Review.

The principle method of collecting the information for this study was by confidential interview with all of the major offshore wind developers and supply chain companies. Factual input, company and personal views were received and mirrored back in writing to interviewees for approval.

The following companies have been interviewed as part of the study:

- ABB, Bendalls, BiFab, Bladt, Camcal, CB&I, Centrica, DONG, EDF Energy, Elsam, Energi E2, E.ON UK Renewables, Eurus Energy, Gamesa, GE Wind Energy, Isleburn Mackay & Macleod, JDR Cable Systems, KBR, Multibrid, Nexans, Nordex npower renewables, Prysmium, REpower Scira, ScottishPower, Siemens, SIF, SLP, Talisman, Total, Shell Wind Energy, Vestas Wind Systems and Warwick Energy.

Forecasts:

Forecasts were generated based on the following assumptions:

A - Economic scenarios:

Scenario 1 **Continuation of current policies**. No additional support is available for offshore wind. The consequence is that the current slow evolution of improving revenue would continue, but an economic gap would remain for the foreseeable future.

or

Scenario 2 **New policy impetus in 2006**. New policies emerge which result in an improved economic environment for offshore wind, sufficient to enable 'good' projects to be developed commercially.

For each of these economic scenarios, a probability of completion was estimated for each project. These were derived as follows:

- First, each developer was asked to provide these probabilities for each project, as well as a milestone plan for the project and summary of key issues. (In some cases the interviewee was unwilling or unable to suggest a figure.)
- Second, the probabilities were moderated based on our view of progress to date, company intent and site viability for each project.
- Finally, the probabilities were moderated by relative comparison with other projects.

Overall, for the projects where developers provided probabilities, the moderation process decreased the installation forecast by 20% in scenario 1 and 10% in scenario 2, reflecting the optimism of staff closely involved with projects.

On presentation of the aggregate forecast in Scenario 1 to developers for comment, some recognised the inconsistency between their comments regarding the economic gap and the aggregate forecast. In order to correct for this, where a developer firmly highlighted a significant economic gap the probability of installation of a project was set to 0. Where a developer confirmed the probability of installation upon challenge, the probability was unchanged. Where a developer did not express a further view, a mid value was taken.

B - Time plans for each project:

Mid time plan (set to assume 20% of wind farms installed according to realistic optimistic time plans from developers (target plan; 20% chance of meeting), 20% to pessimistic time plans from developers (fall-back plan; 20% chance of missing, but not including open-ended delays due to economics) and remaining 60% half way between these two).

It is recognised that the current model allows for open-ended delays only by low probability of completion of project, not by long delays shown in project time plan. In order to track progress of offshore wind as accurately and fairly as possible, the above process could be repeated at regular intervals. A future analysis could include a range of time plans for each economic scenario.

Aggregate UK forecasts were then combined with EU and global offshore and onshore forecasts in order to form the basis of interviews with the supply chain.

Once input had been received and aggregated, a draft summary was issued to all involved for comment. In many cases, detailed feedback was received, which was used in preparation of this final summary.

Appendix C: Marine Renewables

C1.1 Introduction

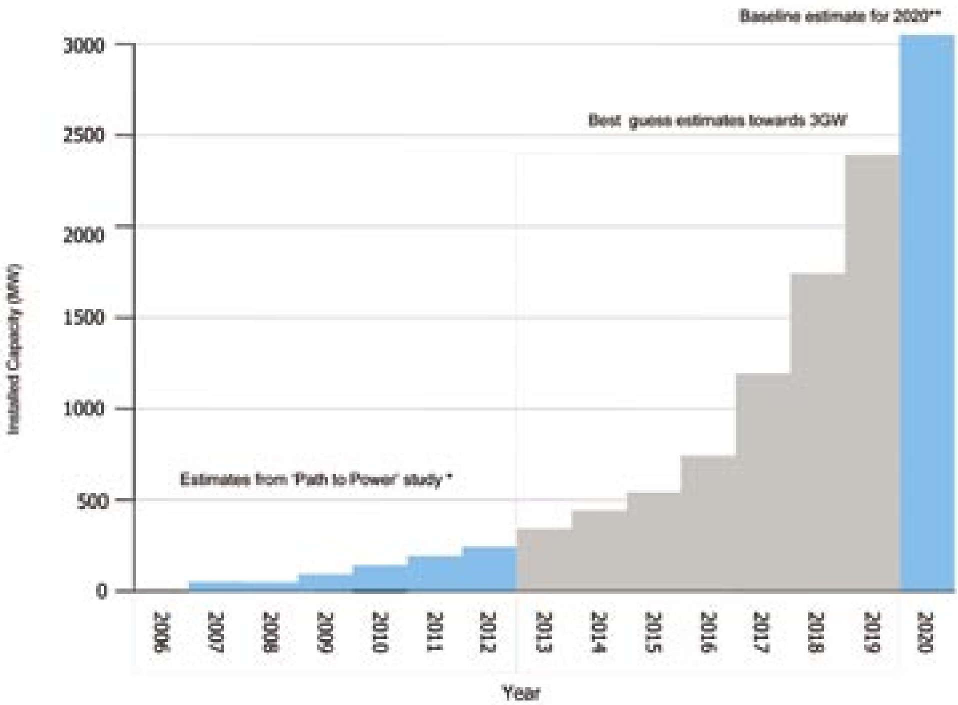
The UK is uniquely well placed to maximise the potential benefits stemming from the development of the new marine renewable energy technologies. It has the best wave and tidal stream resources in Europe and a significant skills base applicable to offshore engineering and project development. The offshore wind programme for the UK is also presently larger than any other country in the world, and this is helping to enhance the experience of UK companies involved specifically in the development of offshore renewable electricity installations. On top of this the UK is also home to the world's most advanced wave and tidal stream technology developers, who have, over the past few years, been increasingly supported, both directly and indirectly, by many bodies on a national, regional and local level.

C1.2 Potential deployment

In terms of future growth, the Carbon Trust's Marine Energy Challenge states that on present estimates between 15% and 20% of current UK electricity demand could eventually be met by wave and tidal stream energy. It also states that by 2020, up to one sixth of the UK Government's aspiration of 20% renewable electricity could be met by marine renewables (i.e. about 3% of total UK electricity supply). The Carbon Trust suggests further that between 1.0 GW and 2.5 GW of each of wave and tidal stream energy could be installed across Europe by 2020 and that a large share of this deployment could occur in the UK. On the basis of this BWEA estimates that a baseline figure of 3 GW (7.88 TWh using a conservative capacity factor of 30%) of wave and tidal stream could be installed in the UK by 2020, this represents 2.1% of UK electricity supply in 2020 based on a total supply estimate of 374 TWh in 2020 (see Figure C.1).

It is clear that the market potential is sufficiently large to merit considerable interest in its commercial development. These levels of deployment are, however, dependent on adequate, timely and suitably designed Government support mechanisms as outlined in section C3 of this submission.

Figure C.1: Potential deployment for marine renewables in the UK out to 2020



* Figures from Stage 1 of 'The npower Juice Path to Power' following interviews with industry

** Based on conservative estimate of Carbon Trust Marine Energy Challenge figures for 2020

(Sources: Stage 1 – 'The npower Juice Path to Power' (This BWEA managed project will be launched in June 2006 and will present a route-map for the development of marine renewables in the UK); The Carbon Trust – 'Future Marine Energy', www.thecarbontrust.co.uk/carbontrust/about/publications/FutureMarineEnergy.pdf)

C1.3 CO_2 reduction potential

Reducing CO_2 emissions in the electricity supply sector will involve the substantial expansion of a diversity of renewable energy generation technologies. Present support ensures the least cost (currently) renewable technologies are developed first – this means onshore renewables are the most likely to substantially contribute to CO_2 reduction targets in the short term, particularly onshore wind and landfill gas. In the medium term these technologies will begin to reach natural capacity levels and the UK will begin to rely heavily on its offshore strengths in order to maximise its supply of bulk power from the renewables sector. Without offshore renewables, the UK is unlikely to meet its aspiration of 20% renewables in the supply mix by 2020 or any further targets for bulk generation going forward. This has the potential to substantially and negatively affect CO_2 reductions in the larger general energy mix.

Taking the deployment estimates outlined in C1.2, the Carbon Trust suggests that reductions of several tens of million tonnes of CO_2 are likely from 15-20% marine renewables in the UK supply mix in the longer term. By 2020 several gigawatts of wave and tidal stream energy across Europe should lead to annual CO_2 abatements of 2-7 mt CO_2, most of which is expected to be recorded in the UK. The global potential for emission reductions stemming from the development of marine renewables is also considerable.

C1.4 Adding to security of supply

Marine renewable energies are indigenous sources of supply. They will not run out and are not exposed to political risk. For this reason their existence alone adds to energy security in the UK. To transform this to security of supply they must be suitably and responsibly harnessed for power production.

As part of the Carbon Trust's Marine Energy Challenge a study into the variability characteristics of the UK's wave and tidal current power resources and their implications for large scale development scenarios was commissioned. This was conducted by the Environmental Change Institute (ECI) at the University of Oxford. This states that a strategic approach to development between developers and industry, between planners and network operators and between financiers and market policies should allow for an ability to supply meaningful and reliable electricity at times of peak demand from wave and tidal stream energy. Understanding the resource is central to this planning and Government should look to increase support in this area in order to ensure a reduction in variability from the marine environment and an increase in renewable base load security.

For more information go to www.thecarbontrust.co.uk/ctmarine3/res/Variabilityofwaveandtidalstream.pdf

Further research by ECI highlights that a mix that includes wind, wave and tidal stream energy can markedly reduce the variability of electricity supplied even further. It states that by building a balanced portfolio of technologies with wide geographical dispersion across the UK, renewable technologies such as wind, wave and tidal stream will together deliver smoothed electrical output, high reliability and a significant reduction in the need for fossil-fueled generation. Given that high wind and wave energy periods in the UK have a significant correlation with high energy demand in the winter months the argument for the development of offshore renewables for energy security is strengthened further.

C2.1 Where are we now?

The UK Government has been supportive of technology developers through the provision of capital grant funding since 1998. This has been successful in bringing a small number of indigenous companies to the forefront of this global sector. The DTI's Renewables Innovation Review also prioritised marine renewables for further support from the 2004 Comprehensive Spending Review due to the potentially significant environmental and economic benefits they could bring to the country. This was followed by the release of £50 million in August 2004 that was to be predominately utilised as revenue-based support in addition to the Renewables Obligation. The intention was to enhance incentives for multiple-device, grid connected project development through the reduction of financial risk in the early stages of deployment. By providing support mainly for power production, it was also intended to reduce the potential burden on the public purse should any failures occur. The need for this form of support was put forward by industry through *Into the Blue*, a BWEA project conducted by Climate Change Capital in early 2004 (see www.bwea.com/pdf/intotheblue.pdf).

This work led to the DTI putting its 'Wave and Tidal Stream Demonstration Scheme' out for consultation in early 2005. The funds became available for industry to bid into in March 2006.

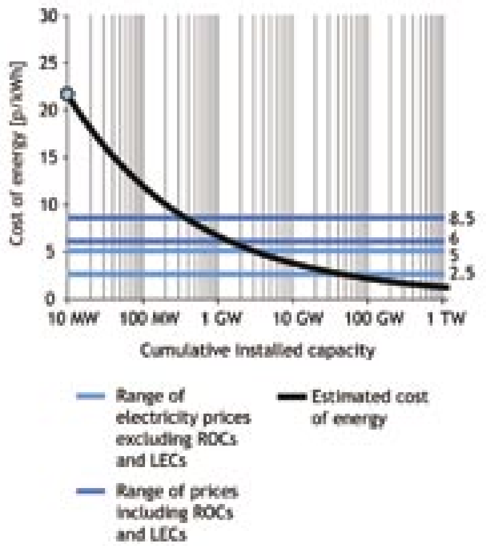
The terms of acceptance for this scheme have been regularly denounced as overly restrictive by industry since its conception, due mainly to the funding caps imposed on projects. These, it has been stated, do not provide the incentives necessary for the development of many technologies that have higher initial costs than others, regardless of their potential for significant cost reductions through larger deployment potential.

C2.2 Potential for cost reductions

The potential for cost reductions has been studied independently through the Carbon Trust over 18 months since early 2004. 'The Marine Energy Challenge' concluded that central estimates for current costs of wave energy projects were in the range 22-25p/kWh. Tidal stream projects' central current cost estimates, it states, are 12-15p/kWh. It must however be highlighted that there are a much larger range of wave energy technology types. This increases the range of current costs and has the potential to affect the central range figures. The large majority of tidal stream technologies, on the other hand, are beginning to consolidate around the horizontal axis turbine. This makes for a greater clustering of current cost potentials around the central estimates.

In relation to cost reductions for offshore wave energy, The Carbon Trust presents three scenarios based on differing starting costs and learning rates. Figure C.2 shows the central estimate scenario of starting at 21.6p/kWh with a 15% learning rate. This highlights a convergence with the high price RO market figures following the global deployment of hundreds of megawatts, which could occur reasonably quickly given the expected 2020 UK-only marine figure of 3,000 MW, much of which is expected to come from offshore wave:

Figure C.2: Offshore wave energy cost reduction scenario



21.6p/kWh starting point, 15% learning rate

(Source: The Carbon Trust, Future Marine Energy, 2006, www.thecarbontrust.co.uk/carbontrust/about/publications/FutureMarineEnergy.pdf)

The Carbon Trust states that there is potential for costs to reduce considerably in the future. Through a combination of engineering analysis and inference from other industries they have formed a view of the likely extent of these reductions for both offshore wave energy and tidal stream. Their conclusions are that:

- Marine renewable energy has the potential to become competitive with other generation forms in the future. In present market conditions it is likely to be more expensive than other renewable and conventional generation until at least hundreds of megawatts of capacity are installed
- Fast learning or a step change cost reduction is needed, and likely, to make offshore wave energy converters cost competitive for reasonable amounts of investment

- Tidal stream energy could become competitive with current base costs of electricity within the economic installed capacity for the UK of 2.8 GW.

C3.1 Support Requirements

Due to the emerging nature of the technology, marine renewables are presently high cost electricity providers operating in a relatively low cost market. For this reason, Government must support their development in order to help bring forward the private investment necessary to drive down costs as outlined above. This support must take into consideration the fact that investors will require suitable returns on their projects in order to release the investment levels necessary to bring wave and tidal stream energy costs down into the RO and beyond. Given that the potential for future growth globally is huge, support mechanisms in the early stages must allow for this investment to flow unrestrained towards the sector through the provision of adequate commercial returns. This is the only possible way to ensure the industry hits the cost reduction curves and deployment levels in the UK which, in turn, is the only way to embed the manufacturing, supply chain, project development and research skills base in this country. Given that cost reductions are expected to occur reasonably quickly, the return on the Government investment should be realised in the form of considerable economic, environmental and social benefits within a relatively short time frame.

C3.2 Targeted and timely support

At this early stage of development there are a number of risks for investors. It would therefore be prudent for Government to help minimise the most manageable ones. The problem with this lies in the fact that political risk is paramount. It would therefore be best to implement a long-term support system that works outside the process of Government spending reviews, which only assure resources for a few years with no guarantee of continuation at the next review, whilst in parallel providing funds to departments for the implementation of targeted support to specific aspects of project development. Such incentives would ensure that suitable private funds were drawn towards projects and that they could be developed with confidence and in a timely manner that ensures the momentum created in the manufacturing and project development supply chain does not decline (this would be very difficult and costly to re-create, if at all, given present global competition for this industry). By creating this momentum through a pump priming of the industry during early deployment, the UK would quickly be in a position to supply to the European market with technologies and experience which would in turn lead to greater cost reductions through economies of scale and increase the embedded nature of the industry.

Support should be targeted in the following areas, all of which will be outlined in greater detail through the release of the BWEA project 'The npower Juice Path to Power', which will be released in mid-June 2006. This project has been funded by the npower Juice fund and is intended to provide a route map to commercialisation for the marine renewables, through identifying where projects may concentrate around the UK, the consenting and grid issues they will face, and not least the means required to support the sector economically. BWEA hopes Government will pay close attention to the results of this work, and use it as a basis for putting in place the long-term policies this nascent industry requires.

C3.2.1 Market support

The DTI's demonstration support scheme is restricted, both in terms of funds and time. It does not provide the long term signals of support necessary to incentivise the necessary system outlined above. What is required immediately from Government is a statement of intent to address the long-term needs of the sector through revenue based support in a manner that does not impinge on the integrity of the RO. This must ensure a balance between the level of returns necessary for investors at this stage having to be above that for most other technologies (given the inherent risks of early stage development), and the level of deployment, so that this additional support can be reduced down to what the RO provides without adversely affecting the expected growth of renewables on the whole. Indeed the argument must be made that a net gain to UK plc will result from maintaining expected renewable growth with an expansion of marine technologies due to the benefits of industrial value creation for both an internal and external market.

This appears to be the approach being adopted by the Scottish Executive, which is looking to consult on how best to support marine in such a way. A number of suggestions are being put forward by industry as part of the preparatory work to the consultation, but the scope of the study is to look at all options available, including that of increasing ROC numbers specifically for wave and tidal stream.

Outside the necessity of a market based support mechanism for investors, more targeted support should be directed at the areas set out below.

C3.2.2 Consenting support

In November 2005 DTI released consenting guidelines to help marine renewable technologies enter English and Welsh waters as demonstration projects, without the need for Strategic Environmental Assessment. This was welcomed by industry as a positive step towards ensuring wave and tidal electricity production in the short term. DTI is also in the process of creating a research and monitoring programme that will be implemented with the support of £2 million from the original £50 million released in 2004. This should help slightly in the reduction of costs to developers and help increase the knowledge and confidence of stakeholders in what are essentially, at this stage, unknown technologies with unknown impacts on the environment.

Given the high financial risks at the demonstration level of development BWEA recommends that Government increases this pot of funds in order to ensure further monitoring and baseline assessments can be carried out as part of the consenting process for marine projects. A similar arrangement to the Collaborative Offshore Wind Research Into The Environment (COWRIE) fund for offshore wind could then be phased in; this would see developers increasingly contributing to the research funds as the industry expands. For more information on COWRIE see www.offshorewindfarms.co.uk.

At this early stage, investors require the confidence that any investment made now has the potential for increasing returns in the future. Without this confidence, capital injections will be at the high end of the risk-return spectrum. As any plan or programme for the development of marine renewables will require a Strategic Environmental Assessment (SEA), BWEA recommends that Government set in place a strategy for implementation of SEA in areas suitable for wave and tidal stream deployment at the earliest opportunity. This will send out positive signals that marine renewables are being considered in the medium to long term as potential power providers and therefore help companies in their discussions with investors. Of course such a strategy must be followed up by action in a timely manner in order to ensure that companies can hold onto their supply chain networks through their expansion from demonstration schemes to larger scale projects and beyond, without the risk of waiting for Government to put in place the required processes for deployment.

The Scottish Executive is already conducting a desk based assessment on a strategic level in order to build this confidence in the sector for the longer term. These signals are important for a high risk sector in its infancy, and could dictate how and where the industrial benefits are built. Without them, there exist constraints on development that manifest themselves in more expensive capital and therefore increased risk for projects at the earliest stages of project deployment.

It is also imperative that the Governments Marine Bill takes the UK's unique offshore renewable energy strengths into consideration. This must allow for future projects to develop in areas that combine excellent wind, wave or tidal resources with suitable onshore grid capacity. The implementation of the Marine Bill must not restrict the development of marine renewables.

To see BWEA's perspective on the Bill go to www.bwea.com/pdf/Marine-Bill.pdf

C3.2.3 Grid support

As the DTI's marine renewable energy atlas shows, the UK's wave and tidal stream resources are concentrated in certain areas around the UK. Correlation between these areas and the onshore grid capacity necessary to transfer the converted energy to centres of demand varies considerably between areas, and additional support of various kinds will be required if the UK's maximum marine potential is to be harnessed.

See www.bwea.com/marine/atlas.html

As part of 'The npower Juice Path to Power' project, Econnect has recently produced a study for BWEA that looks at these constraints and suggests what needs to be done in order to overcome them. Overall it states that grid issues for marine are the same as already identified for onshore wind. The key point is that much of the resource is in Scotland and will be competing with onshore wind for access to transmission system capacity from Scotland to the demand centres in England. It therefore joins the

Scottish queues along with the Scottish wind developments. Although some upgrades to the transmission system are planned, and allowing that some existing generation may close in the interim, capacity is already booked by wind projects.

Removing these bottlenecks will require either further reinforcement of the transmission system in Northern England and Scotland, a change to the regulatory arrangements for granting access to the network or, more likely, a combination of the two.

Grid issues are, however, unlikely to be a major barrier in the South West (Devon and Cornwall) so it may be that early marine renewable developments might focus on this area initially. The South West also has a significant wave and tidal stream resource. Nevertheless, given the expected time delays in grid reinforcement such development must be scoped early for Scotland in order to allow for penetration into the UK's best marine resources once the technologies are cost-competitive under the RO.

C4.1 Conclusions

The UK has the best wave and tidal stream resources in Europe. These hold the potential to supply up to 20% of the countries electricity supply needs in the long term. This would have substantial implications for CO_2 emission reductions from the electricity sector and security of supply concerns. There is also a large global market for technologies that can convert power from waves and tidal streams into electricity. This means early UK policy support for marine renewables could have a significant impact on global emission reductions in the long term.

Presently the UK is at the forefront of the technology market but ongoing Government support will be required in order to ensure private investment at the scale necessary to bring costs down into the RO. The potential for cost reductions is however significant and marine renewables could be cost competitive under the RO following the deployment of hundreds of megawatts. The majority of this early deployment must be in the UK if supply chain networks are to embed themselves in this country in support of a global market.

Political risk at this early stage of industrial development must be minimised and support mechanisms should be designed in reflection of this. Support must also be available for projects when required to avoid any decline in the momentum that must be created around the sector as a whole.

This support must take the form of:

- Market-based revenue support above the RO to help wave and tidal stream compete in the electricity market and allow costs to reduce via economies of scale. This must be long-term, UK-wide and ensure suitable returns for investors in order to provide incentives for further investment
- Increased support for monitoring and research at all stages of project development in order to help increase confidence with stakeholders and investors alike
- Conducting Strategic Environmental Assessment across the UK will be necessary for marine renewables to expand in the future. A clear strategy for its implementation is therefore required
- An assessment of grid reinforcement requirements and a strategy for their implementation must be conducted
- Changes to the regulatory arrangements for connecting projects to the grid will also be required to ensure the availability of onshore connection points in areas of suitable resource.

BWEA will be producing 'The npower Juice Path to Power' in mid-June 2006. This will address the above support requirements in greater detail. As this work will be based on substantial discussions with industry, stakeholders and Government departments we would recommend that Government pay close attention to the results of this work, and use it as a basis for putting in place the long-term policies this nascent industry requires.

For more information on wave and tidal stream energy go to www.bwea.com/marine

Appendix D: Delivery and economics in 2020: the contribution of wind, wave and tidal power to UK power supplies

Key points

- Wind energy and the marine renewables are capable of delivering 6% of UK electricity supplies by 2010, (4.6% from onshore wind, 1.3% from offshore wind) and 21% by 2020 (about 9% each from onshore and offshore wind, the rest from marine renewables and small wind systems), based on BWEA central estimates
- The growth of wind energy will be influenced partly by international developments and partly by UK Government actions
- Despite a current shortage of wind turbines, the international outlook is currently bright, and growth for the next few years is likely to be strong. This will lead to significant cost reductions, both onshore and offshore
- UK onshore wind is progressing well, with substantial amounts of capacity in the planning pipeline. The most likely constraint may be the implementation of transmission reinforcements and timely action is needed to initiate these
- Offshore, there is currently an international hiatus, although there are nearly 10,000 MW of European plant at various stages of planning. The UK has the second highest capacity in the world, but action is needed to maintain (or improve) this position, in particular:
  - o Place responsibility for construction of offshore transmission onto the Transmission System Operator. This will assist projects to become more viable and at the same time improve network security
  - o Ensure stable income streams accrue to developers, either from the Renewables Obligation or any alternative scheme
- The extra costs to the consumer are currently determined by the Renewables Obligation but on a level playing field with gas, onshore wind can be competitive in many locations, though potential UK sites have a considerable spread of wind speeds, and some of the most attractive ones for wind generation may not be accessible due to planning restrictions. Offshore wind may become cheaper within 10-12 years, depending on the trajectory followed by gas prices
- Fuel price risks do not exist with wind energy and making allowances for these – as suggested by several analysts – improves the competitive position of wind significantly, beyond the position suggested by simple generation cost comparisons.

D1 Introduction

As the performance of the UK renewable energy market will depend, to a certain extent, on international developments, there is a brief discussion of these first. This also shows that the UK is not attempting something which has not been achieved elsewhere: the projections we present for 2010 and 2020 can be considered conservative given the build rates and total development in other European countries. The next section deals with the resources available and the one after with likely capacity and energy contributions by 2010 and 2020, followed by longer-term assessments.

The issues associated with resource delivery are different for each of the technologies; these may be summarised below and more detailed discussions follow later:

- **Onshore wind**: the technology is well established and there is now a well-established planning framework. Steady growth is likely over the next few years and the principal constraints are likely to be the resource that is environmentally acceptable, and possible transmission constraints given the high proportion of the resource that is located in Scotland
- **Offshore wind**: there is a worldwide hiatus in offshore wind energy development, due partly to a shortage of wind turbines, partly to higher machine costs, and partly to problems with some of the early windfarms. In the UK, the principal difficulty is cost (of the installations) and price (of the electricity)

uncertainty. The UK resource is huge, and this is not an issue; transmission constraints exist, but are not critical

- **Small wind**: there is increasing interest in the potential of microgeneration (around 1kW size) and small wind turbines (10-100 kW), and there are various mechanisms that provide support for electricity consumers who wish to install such wind systems. The resource is not well characterised and uncertainty surrounds the consumer response
- **Marine renewables**: here, the principal uncertainties are associated with the technologies and how rapidly they proceed towards commercialisation. That, in turn, depends on the extent of Government support in the short and medium-term. The resources are reasonably well understood and transmission constraints are unlikely to be an issue until significant capacity is installed.

D1.1 International perspectives

There is now over 60,000 MW of wind capacity installed worldwide, of which two-thirds is in Europe. Capacity increased by nearly 12,000 MW in 2005 – the highest increase ever. Most commentators expect strong growth to continue, so that by 2020 capacity in Europe may be between 100 and 180 GW[1]. As wind energy capacity doubled every three years from 1990 to 2005, these estimates may be conservative. Germany, with over 18,000 MW, has the highest capacity, but Denmark, with over 3,000 MW, has the highest level per capita, and the highest penetration into the electricity network – around 18%. Spain comes next, with just over 8% penetration, and Portugal (5%) comes third.

Denmark

Wind production in Denmark accounts for about 18% of electricity consumed. Although western Denmark – where 80% of the capacity is installed – has connections with Germany, Norway and Sweden, the significance of these tends to be overstated. Western Danish wind capacity is effectively feeding into a larger electricity network, but the total capacity of the links is less than the capacity of the thermal plant in this part of Denmark. Taking this into account, the effective penetration level is around 12%, which is still significant.

In 2003, more than 25% of the electricity and district heating consumed was produced on the basis of renewable energy. On the basis of various scenarios, the Danish Energy Authority has prepared projections to 2025. With moderate rises in oil prices and in CO_2 allowance prices, the contribution of renewables to electricity supply will amount to more than 36%. Wind energy will account for a major part of this increase, and, allowing for the existence of the external links, the effective penetration level will be about 22%.

Denmark has 3,100 MW of wind plant, of which about 420 MW is offshore. After many years of sustained growth, onshore progress has now plateaued, but there are plans for further offshore wind farms. Most of the growth in wind is now expected to come from offshore developments.

Denmark is actively involved in the promotion of a wide range of other renewable energy sources, including biomass and wave energy.

Spain

With over 10,000 MW, Spain has the second highest wind capacity (after Germany) in the world. That capacity is expected to double by 2010, following approval of a new Renewable Energy Plan. The aim of this plan is to meet 12% of primary energy needs by renewables by 2010. The method is to create a framework of incentives to encourage private sector investment in renewable energy technologies, and the contribution of public funds to these investments is estimated to be 3% (about £470 million)[2].

Wind plant operators have a choice of trading on the power pool and being paid a production incentive, set at 50% of the average electricity tariff, or opting for a feed-in tariff, offering earnings around £41/MWh in 2005. (The production incentive delivered average earnings about 6% higher in 2005)[3].

Portugal

The development of wind energy in Portugal has accelerated rapidly since the turn of the century, and in 2005 450 MW was installed, bringing the total to around 1,000 MW. In common with many European states, there is a 'feed in' tariff. The payments step down after 2,000 hours of generation in a year, to inhibit over-development of the windiest sites, and the average remuneration is estimated to be just over £48/MWh[4].

The Portuguese Government has also established a tariff mechanism to support the first generation of wave energy projects. The tariff has been set for the first 20 MW, possibly more, of wave energy projects built and operating. The wave tariff pays about £110/MWh. Ocean Power Delivery has secured an order for a wave farm from a Portuguese consortium led by Enersis SA. The 2.25 MW scheme is being installed off northern Portugal as the first stage of a 24 MW plant.

United States

Wind energy capacity in 2005 increased by over 3,000 MW in the United States. It was (and is) encouraged by a £10/MWh 'Production Tax Credit'. This currently expires at the end of 2007 but if gas prices stay at their present high levels this could 'provide some of the certainty needed to stabilise the industry's outlook.'[5] The use of renewable technologies for electricity generation is projected to grow, stimulated by improved technology, higher fossil fuel prices, extended tax credits and State renewable energy programs. Although the Federal tax credits are currently scheduled to end after 2007, the US Department of Energy's projections suggest wind energy production will increase rapidly to 51 TWh by 2010 (the output of about 20,000 MW of wind capacity). These projections are based on a modest (about 10%) drop in installed costs. Levelised costs for 2015 are put at just under $50/MWh (around £29/MWh)[6].

Germany

Germany, with over 18,000 MW of wind, has the highest capacity in the world. Developments have been encouraged by 'feed-in tariffs', which, in the past, may have been generous, but which are now much less so, given that the average productivity of German wind plant is about half that of UK wind plant. The length of time for which the 'headline' tariffs are paid depends on the wind speed at the site. The starting rate for onshore wind is now £58/MWh, falling to £36/MWh. The starting rate falls by 2% every year. No allowances are made for inflation. The rate for offshore plant online by 2010 is £60/MWh for at least 12 years. As with onshore plant, the period for which the rate is paid depends on the wind plant's performance. It then drops to £41/MWh.

After several years of very rapid growth, capacity in 2005 increased by only 11%, although that amounted to 1,800 MW, an increase second only to the United States last year. Although there are ambitious plans for several offshore wind farms, only two near-shore machines have so far been installed.

Technical issues

The unprecedented worldwide growth rate in 2005, which is expected to continue this year, has led to supply bottlenecks and concerns that manufacturers may not be able to keep pace with the demand. A 'seller's market' has also been partly responsible for an upturn in wind turbine prices – the first for many years. This was also due to increases in the price of steel, copper and other raw materials. The strong demand has been driven partly by vigorous development in the United States, as noted above.

The rapid growth in world wind capacity has been stimulated by financial support mechanisms of various kinds, but also by a very rapid maturing of the technology. Wind's success has also been due to the growing awareness that the resources are substantial – especially offshore – and that energy costs are converging with those of the 'conventional' thermal sources of electricity generation. In some instances the price of wind-generated electricity is now lower than prices from the thermal sources.

Offshore wind energy capacity amounts to about 750 MW, of which 214 MW is in the United Kingdom. Denmark leads with over 420 MW and other countries with offshore capacity, or plans, include Germany, the Netherlands, Sweden, China, Japan and the United States. There are about 10,000 MW of offshore projects at various stages of the consenting process in Europe[7].

Offshore winds are less turbulent then onshore winds and the wind shear is lower as well, so that the dynamic loads on the machines are expected to be less severe. Although gearbox and transformer problems on Danish offshore wind farms have received much publicity, there is little evidence that any of these problems are the result of any unforeseen difficulties associated with the offshore environment. The transformer problems at Horns Rev, for example, appear to be due to insufficient insulation thicknesses – due either to an incorrect specification, or deficiencies in manufacture.

It may be noted that energy productivity from the Danish offshore wind farms – once problems have been resolved – is in line in with or in excess of expectations. The average power output of the installation at Nysted, for example, has been 40% of the rated power for two years running.

D1.1.1 Wind plant costs and electricity generation prices

Until 2005, installed costs of wind energy plant, worldwide, showed a strong downward trend and numerous analyses had suggested that the 'learning curve ratio' was between 8 and 15%. (This is the reduction in cost that is achieved with a doubling of installed capacity.) The recent upturn in prices is the first in about 15 or more years that has upset this trend. The upturn, as noted above, was due partly to increases in the costs of raw materials, partly to the need for manufacturers to increase the narrow margins on which many had been operating and partly to 'supply and demand' pressures, as demand in 2005 exceeded supply.

Nevertheless the trends that were responsible for the earlier cost reductions are still at work. Manufacturers are developing more cost-effective production techniques, so the price of machines is likely to fall from the 2005 level. Machine sizes are increasing, which means that fewer are needed for a given capacity, and so the installed costs of wind farms are decreasing. In addition, larger windfarms are being built, which spreads the costs of overheads, roads, electrical connections and financing over greater capacities. The use of larger wind turbines also means that they intercept higher wind speeds; this increases energy generation, reducing generation costs.

Electricity generation prices from wind energy depend on the institutional framework, but a good indication of current onshore levels comes from Canada, where wind contracts are being let at around £30/MWh (with a mechanism similar to the Non-Fossil Fuel Obligation). The most recent and reliable offshore data comes from the Danish Horns Rev 2 project, which will be paid €69/MWh (around £47/MWh) for about 12 years[8]. Danish developers do not have to pay for grid connection costs, and in both these cases contracts are long-term and fixed price, eliminating price risk from developments and thus reducing cost of capital and returns required.

A number of estimates of future wind costs appeared in the Sustainable Development Commission's report[9] , since when more have appeared. The most recent[10, 11], both suggest a continuing downward trend, as 'learning curve' influences are still at work – manufacturers are establishing improved production methods and reducing the (significant) labour content of wind turbines. Offshore, additional savings will be realised with larger wind farms.

A conservative estimate of future UK onshore cost trends comes from consultants Garrad Hassan[12] who suggested that onshore costs would fall to 89% of their 2003 level by 2010 and 81% by 2020. The corresponding figures for offshore costs are a drop to 73% of the 2003 figure by 2010 and to 57% by 2020. So far, however, there has been little sign of the learning curve effect operating for offshore wind; costs have been at around the same level for the last four years, despite about three doublings of capacity in that time. However, the number of projects has been small, and learning effects should kick in as that number increases.

D2 UK Wind energy resources

To establish the potential contribution that wind energy might make to UK energy supplies, knowledge of the resource is an essential starting point. What matters is the 'accessible' resource – the wind power capacity that could be installed after various constraints, such as built-up areas, Areas of Outstanding Natural Beauty, and forests are taken into account. Offshore, the constraints are different, and include areas with dredging concessions, submarine practice areas and those with unsuitable water depths or seabed conditions. The offshore resource can probably be established with greater precision, as uncertainties associated with visual effects and planning decisions are less of an issue.

D2.1 Onshore wind energy

Resource

Numerous estimates have been made of the onshore wind energy resource. Table 1 includes a limited selection and the estimates are compared with data on current developments. It must be emphasised that these estimates do not take account of transmission constraints. The early studies are, broadly speaking, still likely to be valid. Although machine sizes have increased, the necessary spacings have also increased, and so planting densities are still in the range 7-10 MW per square kilometre, although much depends on the exact configuration of a wind farm.

The table highlights the importance of the contribution from Scotland. This currently accounts for 50% of the installed capacity, and this will rise to over 70% if all the plant in planning came to fruition. The ETSU estimate suggests that the Scottish resource accounts for 60% of the total accessible resource (11,500 MW), although the more detailed study carried out by the utilities and others suggested the feasible capacity was lower (7,300 MW).

Points to note in the table overleaf are:

- The English figure of 1,600 MW (consented and planned) is about half the ETSU estimate of the accessible resource. However, it may be noted that sensitivity analyses in the ETSU study suggest that an additional 30% may easily be realised, taking the figure to around 4,000 MW
- The Scottish figure for all consented and planned plant (7,200 MW) is close to the 'accessible resource' figure from the Scottish utilities (ref 15), although ETSU and Garrad Hassan suggest a figure that is about 50% higher.

Table D1. Current activity and resource estimates for the UK. All figures in MW

	England	N.I.	Scotland	Wales	Total
Current developments					
Operating	211	90	569	255	1,125
Constructing	112	41	523	47	723
Consented, but with 10% attrition rate included	452	28	635	24	1,139
Sub-total	*775*	*159*	*1,727*	*326*	*2,987*
In planning	823	600	5,402	184	7,009
...of which – expected to build by 2010	*351*	*364*	*1,173*	*104*	*1,992*
Anticipated projects	*630*	*20*	*513*	*75*	*1,238*
Total expected by 2010	***1,756***	***543***	***3,413***	***505***	***6,217***
Resource estimates					
ETSU[13]	3,240	3,044	11,594	1,591	19,469
DTI/ETSU contracts		9,900[14]	7,300[15]		
Garrad Hassan estimate[16]			11,500		

Installation rates and energy delivery

BWEA has carried out a very detailed analysis of the way and that wind farm planning applications have progressed through the various consent mechanisms so as to provide authoritative estimates of likely future progress[17]. Key conclusions from this analysis, which are reflected in Table 1, are:

- 2,987 MW of onshore wind development is operational, under construction or approved
- 1,297 MW of capacity, currently within the local authority planning system, is expected to be approved and operational by 2010. To this, 700 MW of capacity should be added from Section 36 approvals (50% success rate assumed with a 36 month determination time) – total 2,000 MW

- 1,238 MW of capacity is expected to be submitted to the planning system, approved (taking into account current approval rates and times), and be operational by 2010.

The 'central estimate' of onshore capacity for 2010 is therefore around 6,200 MW, which would generate about 16 TWh of electricity (a little under 5% of UK supply). This represents an average increase in capacity of about 1,000 MW per year. This is about half the capacity installed in Spain and Germany in 2005, and less than the capacity installed in Germany every year from 1999 onwards.

The lower and upper bound estimates for 2010 are 4,700 and 7,500 MW, respectively. The former figure results from pessimistic assumptions on planning decisions, and takes into account the likely impact of grid constraints in Scotland.

Beyond 2010, the rate of growth will depend on the ability of the Renewables Obligation to deliver robust contracts – an ability that will become more difficult towards 2020. However, the competitive position of wind relative to gas will also be important. If gas prices have not declined from their current levels, onshore wind may be able to deliver significantly lower generation costs.

Assuming a modest growth rate of 1,000 MW per annum from 2010 onwards (still much lower than levels achieved in Germany, Spain in the United States) would result in an onshore capacity of 15,000 MW by 2020. However, this is considered to be an 'upper bound' estimate, with the lower bound around 12,000 MW. Our baseline estimate of 12,500 MW would deliver nearly 33 TWh (9% of supply). Once again, grid constraints may lower these figures, but if, as seems likely, the competitive position of wind improves, the case for building the necessary extra connections becomes much stronger, and there is time to plan and build the new infrastructure in the 2020 timescale.

D2.2 Offshore wind energy

Resource

The offshore wind energy resource is undoubtedly large. A very detailed evaluation of the UK resource[18], which took into account a very wide range of constraints, suggested that it is at least 230 TWh. Although completed over 20 years ago most of the key assumptions remain valid (shipping lanes, water depths, seabed conditions, a minimum distance from shore, nature conservation areas). In practice, some of the constraints are now regarded as unduly restrictive (e.g. minimum water depth) and developments are now taking place in some areas that were ruled out.

The resource study acknowledged the need to identify possible constraints due to military radar, and that uncertainty remains. However, the fact that developers bid 26,000 MW of plant as expressions of interest under the Round Two bidding process indicates that resource constraints are unlikely.

Offshore economics

The future of offshore wind energy in the UK is heavily dependent on movements in generation costs. These, in turn, will depend on worldwide developments. The Danish Energy Authority suggests they might fall by about 25% by 2020[a], and the Garrad Hassan study, cited earlier, suggested a 40% fall in installed costs. If, however, international development remains sluggish, these cost reductions are less likely to be realised.

Delivery

Offshore delivery may be more susceptible to international influences than onshore, given the current market conditions for wind turbines. BWEA has commissioned research on the future delivery of current UK offshore projects, which is reported in Appendix B. In this work, an 'optimistic' scenario was developed, where international development is buoyant and brings about significant reductions in installed costs, alongside additional support for offshore in the UK, making developments feasible under the Renewables Obligation. In a 'pessimistic' scenario, international development remains sluggish, and no additional UK support is forthcoming. The capacity developed in these scenarios lies between 1,300 and 2,500 MW in 2010. Constraints on turbine delivery may restrict the maximum capacity to around 2,100 MW in 2010; a figure of 1,500 MW has been taken as the baseline estimate here. This would deliver around 4.6 TWh (1.3% of supply). With offshore wind being at an early stage of its development, forecasting a figure for delivery in 2020 is not easy. If it is assumed that delivery averages 1,000 MW per year over the

[a] The future projections in the Danish report start from a lower baseline, so it is assumed that a 25% reduction is achieved from the current (higher) baseline.

decade following 2010, this would result in a total capacity of 11,500 MW. This capacity would deliver around 35 TWh – 9.4% of projected supply.

The 'optimistic' assumptions, however, assume that other possible difficulties are overcome, including wind turbine and supply chain bottlenecks (including cables and monopiles), and access to installation vessels.

Particular difficulties in the UK include:

- Uncertain income streams under the Renewables Obligation
- The cost of finance is raised to account for the perceived risks, both financial and technical. (The WACC is typically 11-12%, compared to around 8% in mature onshore markets)
- A tendency for developers to prefer turnkey contracts, which mean high risks for the contractors. There is now a move towards multi-partner contracts, with each specialist shouldering the appropriate risks[19]
- The costs of a grid connection have, up to now, pushed up the overall UK costs[b], and the removal of this requirement under the recently settled regulatory regime for offshore transmission will benefit developers. Although they will pay additional transmission charges, the change will be beneficial. (The TSO recovers these costs over 40 years at a test discount rate of 6.25%; offshore developers typically recover costs over 10-12 years at 10-12%). This arrangement might also enable the TSO to increase network security[c].

D2.3 Small wind

In recent years, there has been increasing popular interest in the potential of microgeneration, and that is now reflected in various support schemes operated by Government and local authorities. There are a few British manufacturers, hoping to harness this segment of the market. The wind turbines are typically rated at 1-2 kW, with rotor diameters around 1.5-3 metres. The market is partly domestic and partly commercial, as small wind turbines – often in conjunction with photovoltaics – provide power at various sites on the rail and road networks, for example.

Although the size of the market – in energy terms – is modest, it has popular appeal, as it enables domestic consumers to make a tangible contribution towards energy and emission savings. It is also viewed as a vehicle for promoting greater awareness of the importance of energy issues.

Assessments of the energy-saving potential are difficult to make with high accuracy, as wind speeds are uncertain and performance data from the small machines are not always well documented. However, a 3 metre diameter, 1.5 kW machine[d], operating at sites with mean wind speeds of 4-4.5 metres per second[e], may be expected to deliver about 1-1.4 MWh annually[20]. These machines cost around £2,000/kW and electricity generation costs in the 'Micro-Generation Study' were estimated to be currently in the range £150-250/MWh[21].

The manufacturers expect machine prices to come down with volume production and the Micro-Generation Study suggested breakeven prices (with domestic electricity) would be achieved between 2008 and 2013. Sales, however, will be dependent on continuing subsidies for some time to come. The Micro-Generation Study suggests a maximum contribution to UK electricity consumption of 1.3% by 2030. This would probably be a mixture of the domestic machines cited in that study, and larger (5-10 kW) machines. The study suggests that the contribution to electricity supply from micro-wind by 2020 will be very small, but may increase after that, depending on the costs of the machines, and the arrangements for purchasing surplus electricity.

In addition, there is scope for about 1,200 MW of 'small wind' (20-100 kW machines) by 2020, sited in or near commercial premises and industrial sites[22]. This study (by CCLRC and others) suggested that the total electricity generation from all small and micro-wind would lie in the range 1.7-5.0 TWh.

The two studies cited provide somewhat different estimates of the electricity generating potential and so BWEA has consulted with the manufacturers to derive a better appreciation of possible trends. It has also made its own assessments, based on the characteristics of the available machines and considering each sector of the housing market, following the approach in the CCLRC study. A cautious estimate of 0.5 TWh

[b] Danish offshore wind developers do not pay grid connection costs

[c] A new link from Ken□

[d] These parameters have been chosen to line up with the example in the Microgeneration Study

[e] The mean wind speed at Heathrow is 4 m/s. Although higher wind speeds may be found near coasts, lower speeds will prevail in many urban areas. Heathrow is a good site, relatively free of obstructions.

from the microgeneration market by 2020 has been adopted, plus 1,200 MW of small wind (2 TWh), as per the CCLRC study. The eventual resource from both these sources is difficult to judge, but may reach 5 TWh by 2030.

D2.4 Marine energy systems

The prospects for marine energy systems have been examined in some detail in a recent report from the Carbon Trust[23]. The best resources are on exposed western coasts – especially off Cornwall, south Wales, the Western Isles and the extreme north of Scotland. The tidal stream resource is estimated to be around 18 TWh/year; the near-shore wave energy resource around 8 TWh/year, and the total UK practical resource around 50 TWh/year, or more. The UK has some of the best wave energy resources in Europe.

Grid constraints may inhibit development in the north, although the picture may have changed by the time large-scale commercial developments are proposed. A 'wave hub' is planned as a connection point for experimental facilities to be tested off Cornwall. The Carbon Trust suggests generation costs for wave energy are in the region £220-240/MWh, and those for tidal stream in the range £110-140/MWh. The tidal stream resource is, however, smaller.

The contribution from both sources by 2010 is expected to be quite small. Beyond 2010, the key factor is clearly whether commercial viability is believed to be a feasible proposition. If so, and assuming appropriate support, analysis carried out for the BWEA suggests that arrays of tens of megawatts might be installed from around 2009, and larger arrays from around 2012. The 'high end' scenario suggests marine renewables might contribute about 3% (12 TWh) of UK electricity needs by 2020[24].

The Carbon Trust suggests that between 1.0 GW and 2.5 GW of each of wave and tidal stream energy could be installed across Europe by 2020 and that a large share of this deployment could occur in the UK. As a baseline figure BWEA estimates that 3 GW (7.88 TWh) of wave and tidal stream could be installed in the UK by 2020, this represents 2.1% of UK electricity supply in 2020 based on a total supply estimate of 374 TWh.

D2.5 Total wind and marine energy capability

Table 1, overleaf, and the supporting analysis shows that wind and the marine energies in 2010 are capable of delivering 23 TWh (plus or minus 5 TWh) – around 6.5% of expected electricity supply needs. For 2020, the uncertainty margins are higher, due to the difficulties of forecasting delivery in all the technologies. The central estimate is 75 TWh – 20% of supply. The 'low' estimate is about 47 TWh (around 12% of supply), and the 'high' estimate corresponds to about 104 TWh (91 TWh of wind, plus 13 TWh of marine renewables), or around 28% of supply.

Table D2. Capacity and energy estimates for wind and marine renewables

		2010		2020		Notes
		MW	TWh	MW	TWh	
Onshore	Lower	4,700		12,000		
	Upper	7,500		15,000		
	Baseline	**6,220**	**16.35**	**12,500**	**32.85**	1
	Percentage of supply		**4.7%**		**8.8%**	
Offshore	Baseline	**1,500**	**4.60**	**11,500**	**35.26**	1
	Percentage of supply		**1.3%**		**9.4%**	
Marine	Lower	70		2,000		
	Upper	70		5,000		
	Baseline	**70**	**0.21**	**3,000**	**7.88**	1
	Percentage of supply		**0.06%**		**2.1%**	
Micro & Mini	Micro				**0.5**	2
	Mini			1,200	**2.10**	3
	Percentage of supply				**0.7%**	
Total TWh			**21.16**		**78.60**	
Total supply (TWh)			350		374	4
Percent of supply			**6.06%**		**21.01%**	

Notes:

1. 30% capacity factor for onshore wind and marine renewables; 35% for offshore
2. BWEA estimate, based on EST and CCLRC reports (refs 21 and 22), and further analysis
3. CCLRC estimate of capacity; 20% capacity factor
4. Source: DTI[25]

D3 Costs to the electricity consumer

In the short to medium term, the additional costs of renewable energy to the electricity consumer fixed by the structure of the Renewables Obligation, and are not sensitive to the actual electricity generating costs of the individual technologies. Towards 2020, however, the periods over which remuneration from the Obligation will be available will gradually get shorter. It is possible that some "follow-on" mechanism may be established but that will depend on the competitive position of renewable energy technologies in the power market. It is possible that onshore wind, in particular, may be viable without further support.

When assessing the additional costs of renewable technologies at some point in the future, in the absence of the Renewables Obligation, the "reference" generation technology for assessing additional costs to the electricity consumer is usually gas-fired (CCGT). Gas prices have moved steadily upwards over the last two years and future gas prices are extremely uncertain. The indications from the futures markets are that the price will remain above 50p/therm (roughly the average 2005 beach price) until 2009, at least. However, prices in those futures markets have moved steadily upwards for most of the last 18 months or so. The availability of liquid natural gas at one time was thought to bring about a downward pressure on prices, but very strong demand from the United States may temper this effect. The United States Department of Energy's price projections have also moved steadily upwards for several years now, although they suggest falling prices from 2007 onwards. The latest prices in their futures markets do not seem to show any strong downward trend in the short term and the average for 2006 is around 45p/therm.

With gas at 45p/therm and carbon at €25/tonne of carbon dioxide (the level early in 2006), CCGT generation costs are around £49/MWh. Several onshore wind energy projects in Canada and United States have realised cheaper prices than this and several UK NFFO projects are recouping similar or lower prices. As the future price of gas is so uncertain, Table 3 illustrates the installed cost targets for a range of gas prices from 28p/therm to 48p/therm.

Table D3. Indicative breakeven prices for onshore and offshore wind

UK gas price p/therm	Onshore breakeven £/kW	Offshore breakeven £/kW
28	690	744
38	820	919
48	950	1097

Carbon dioxide at €25/tonne, 8% (real) weighted average cost of capital, 15-year depreciation, onshore capacity factors 30% and offshore 35%.

Although straightforward comparisons of generation costs enable reasonably accurate assessments of the competitive position of generation technologies, somewhat more sophisticated techniques are needed when high levels of penetration from the variable renewable sources are examined. This is because the variable sources incur additional balancing costs to cope with the variability and, in addition, the capacity credit declines with increasing penetration. To overcome this difficulty, the best way of making fair comparisons is to look at the total costs of two electricity systems: one with 10% wind (say), and an all-gas system. This reasoning led to the publication of a paper in 2003, which has been widely quoted (and misquoted)[26].

"Total cost estimates" include four elements:

- The additional generation cost of wind, compared with gas
- Extra balancing costs
- Extra costs incurred due to the fact that the capacity credit of wind (in percentage terms) declines with increasing wind energy penetration
- Extra transmission and distribution costs.

The modelling made allowances for additional transmission expenditure on the basis of capital costs per kilowatt of installed wind energy. With 20% wind energy, the additional transmission and distribution costs incurred were around £3,500 million. In practice, the additional investment does not increase smoothly with increase of capacity, but is stepped. The precise sums will also depend on exactly which additional transmission connections are authorised. The Transmission Issues Working Group suggested that expenditure of £1,500 million might be necessary to connect up to 6,000 MW of wind in Scotland, to which additional sums need to be added to allow for other reinforcement in England and Wales. However, the latest report from the Group[27] notes that proposals for new fossil generation may also introduce pressure for reinforcement and so it becomes difficult to separate the extra costs due to wind from those due to conventional generation. The allowances made for extra transmission and distribution costs in the modelling therefore seem to be realistic, and may be conservative.

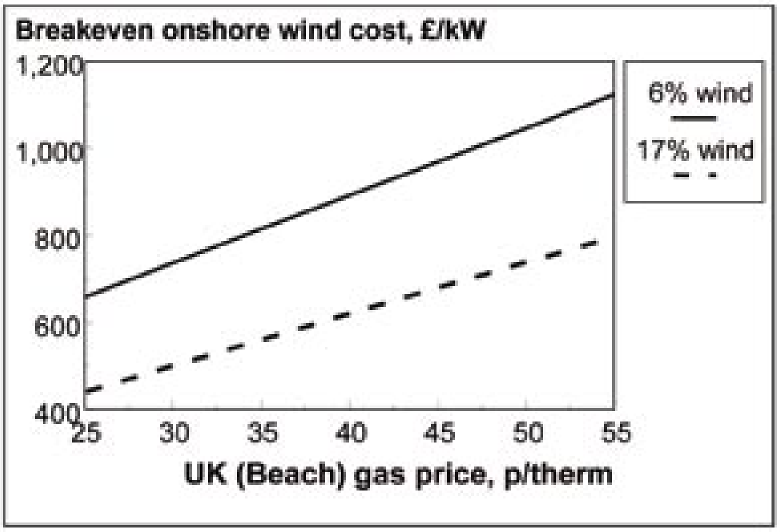
The original analysis of "Total extra costs" suggested that that extra cost of 20% wind energy would represent an additional 0.3p/kWh on consumer electricity bills. It was necessary to make projections about future trends in wind energy costs.

As the assumptions about gas prices for 2020 (19p/therm) made in the 2003 study were too low by 2005, a later analysis[28] included updated estimates for wind plant costs and showed the extra costs as a function of the "beach" price of UK gas. The Sustainable Development Commission's "Wind Energy Report"[29] took the analysis a stage further by making allowances for the "cost of carbon". With gas at 40p/therm (the highest value used), and carbon at £19/tonnes of CO_2, 20% wind would lower electricity prices to all consumers by about 0.1p/kWh.

During 2005, there was a marked upturn in the installed costs of wind plant, primarily due to increases in the price of wind turbines. This, in turn, was due to increases in the prices of steel, copper and blade materials. As a result, the estimates for installed costs used in the SDC report for 2020 may now be optimistic for 2020. To deal with this uncertainty, and avoid making any particular assumptions about gas or wind plant installed costs, breakeven costs for wind plant, as a function of UK gas prices, have now been calculated for the amounts of wind likely to be installed by 2010 and 2020, discussed earlier. This avoids the necessity of pinning the results to any particular value of installed cost.

In 2010, the central estimate is for about 6% wind (4.6% onshore, plus 1.3% offshore). In 2020, the central estimate is for 21% from wind and marine renewables; wind contributes about 18%, with roughly an equal onshore/offshore wind split. Figure 1 shows the breakeven costs for these amounts of wind.

Figure D1. Breakeven costs for wind energy



Assumptions: Transmission and distribution costs, financing costs, capacity factors and operating costs are unchanged from reference 26. The price of carbon is taken as €25/tonne. It is assumed that installed costs offshore are 50% higher than onshore costs.

With 6% wind, and gas at 45p/therm, the graph indicates that the breakeven onshore cost is £970/kW (so offshore would be £1455/kW). If wind costs were less than this – wind energy would reduce electricity prices to consumers; if they are more, electricity prices increase. The breakeven prices are lower with 17% wind, as there is a higher proportion of offshore wind.

D3.1 Quantifying fuel price risks

Recent studies have attempted to quantify the value of the "price certainty" of wind energy – once the plant is built, the generation costs are virtually fixed, and there is no danger of costs escalating due to the highly volatile nature of fossil fuel prices. By contrast, future fossil fuel prices have recently become even more uncertain. The US Department of Energy, for example, notes that its latest projection (February 2006) of the 2025 oil price is $21/barrel higher than its estimate 12 months ago[30].

Shimon Awerbuch at the University of Sussex suggests that the most logical way to deal with "fuel price risk" is to add a premium to the observed gas prices[31]. Awerbuch argues that standard, finance valuation models show that the generation cost for many renewables is less than gas-fired electricity. Adding renewables to a fossil-generating portfolio reduces overall generating cost as well as risk. This result derives from basic portfolio theory, as renewables have zero-beta "systematically riskless" costs. Properly adjusted for market risk, the cost of gas-based generation is 60-100% higher than widely believed. Adding renewables, he argues, enhances energy diversity and security.

An analysis from the Lawrence Berkeley National Laboratory at the University of California have used similar reasoning[32], linked to the differences between market prices and long-term contracts, although their latest "price premium" for gas-fired generation costs is quite modest – about £4/MWh. In other words, generation cost estimates for gas, based on current price forecasts, are likely to be optimistic by about £4/MWh.

An additional factor that may be difficult to quantify is the impact that wind may have on gas prices, by reducing the demand. Taking this into account, the Union of Concerned Scientists has estimated that increasing the generation from wind and other renewables in America from 2% to 20% by 2020 would reduce gas used by 6% and save consumers nearly $27 billion[33]. If wind energy were to supply 15% of UK electricity demand by 2020 that would reduce gas demand by about 10%, based on the current level of consumption, and assuming wind plant inhibited the construction of new gas plant.

Another angle on the "additional value" of renewables comes from consultants Oxera, who estimated the value attached to security of supply as the dependency on imported gas increases. Drawing on data from the insurance market, they estimated the possible number of supply interruptions and the implications as far as electricity generation shortfalls[34]. In order to translate these to monetary estimates, it was necessary to assume a "Value of Lost Load". This is a fairly standard concept in electricity studies, although the exact levels vary. The study used a value of £3,000/MWh. The security of supply benefit, in a system with 14,200 MW of wind (just over 10% of UK supply) was £5.1/MWh.

D4 References

1 European Wind Energy Association, 2006, *Europe's Energy Crisis – the No Fuel Solution*

2 Source: IDAE (Institute for the Diversification and Saving of Energy), quoted on Renewable Energy and Energy Efficiency Partnership web site, www.reeeep.org

3 Subsidy cut sees trading surge – Power sales switch, *Windpower Monthly News Magazin*e, February, 2005:24

4 Doing big business in Portugal at last – Red tape barriers demolished, *Windpower Monthly News Magazine*, March, 2004:66

5 American Wind Energy Association, *Wind Energy Weekly* #1161 (30 September 2005), Turbine supply constraints won't ease soon, experts say

6 Energy Information Administration, US Department of Energy, 2006, *Annual Energy Outlook 2006*, With Projections to 2030. DOE/EIA-0383(2006)

7 Lonker, O and May, H, 2005, All aboard! *New Energy*, October

8 Danish Energy Authority, 2005, *Offshore Wind Power – Danish Experiences and Solutions*

9 Sustainable Development Commission, 2005, *Wind power in the UK*

10 Coulomb, L and Neuhoff, K, 2005, *Learning curves and changing product attributes: the case of wind turbines*, Faculty of Economics, University of Cambridge, paper eprg0601

11 Ragwitz et al, 2005, *FORRES 2020: analysis of the renewable energy sources evolution up to 2020,* European Commission, Directorate General for Energy and Transport

12 Garrad Hassan and Partners, 2003, *Offshore wind: economies of scale, engineering resource and load factors*, Department of Trade and Industry/Carbon Trust

13 Brocklehurst, F, 1997, *A review of the UK onshore wind energy resource*, ETSU-R-99

14 Department of Economic Development, 1993, *Prospects for Renewable Energy in Northern Ireland*

15 Scottish Hydro-Electric Plc, Scottish Power Plc, Department Of Trade And Industry, Scottish Office, Scottish Enterprise and Highlands and Islands Enterprise, 1993, *An Assessment of the Potential Renewable Energy Resource in Scotland*

16 Garrad Hassan and Partners, 2001, *Scotland's renewable resource*, Report for Scottish Executive

17 British Wind Energy Association, 2005, *Onshore Wind Energy in the UK: Meeting the 2010 Target.* Supporting documentation

18 Milborrow, D.J., Moore, D J, Richardson and Roberts, S C, 1982, *The UK offshore windpower resource. Proc 4th International Symposium on Wind Energy Systems, Stockholm*. BHRA

19 Westwood, A, 2006. Rising costs, *ReFOCUS*, January/February 2006

20 Gipe, P, 2004, *Wind power*, James and James (Science Publishers) Ltd, London, Correlated with data from seven manufacturers of micro wind turbines

21 Energy Saving Trust, Econnect and Element Energy, 2005, *Potential for micro generation: study and analysis*

22 Dutton, A, Halliday, J and Blanch, M, 2005, *The feasibility of building-mounted/integrated wind turbines*, Part-funded Carbon Trust project

23 Carbon Trust, 2006, *Future Marine Energy*

24 Ibid

25 DTI, 2006, *UK Energy and CO_2 Emissions Projections: Updated Projections to 2020*

26 Dale, L, Milborrow, D, Slark, R and Strbac, G, 2003, A shift to wind is not unfeasible, *Power UK*, Issue 109, 17-25

27 DTI, 2005, *RETS Revisited. Connecting Renewables to the Grid – A Report by the Transmission Working Group of the Department of Trade & Industry*

28 Milborrow, D, 2005, Wind and gas – the gap narrows, *Power UK*, Issue 134, 11-14

29 Sustainable Development Commission, 2005, *Wind Power in the UK*

30 Energy Information Administration, US Department of Energy, 2006, *Annual Energy Outlook 2006, With Projections to 2030*, DOE/EIA-0383(2006)

31 Awerbuch, S and Berger, M, 2003, Applying portfolio theory to EU electricity planning and policy-making, *IEA Report EET/2003/03*

32 Bolinger, M, and Wiser, R, 2005, *Comparison of natural gas price forecast to futures prices*, Ernest Orlando Lawrence Berkeley National laboratory, (Includes references to other papers on the topic)

33 Deyette, J and Clemmer, S, 2004, Renewable energy can help ease natural gas crunch, *Global Windpower 2004 Conference, Chicago*, American Wind Energy Association

34 Oxford Economic Research Associates, 2001, *The non-market value of generation technologies*

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