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LARGE SCALE WIND POWER

TARGET AUDIENCE & OBJECTIVES:
This document is intended for non experts & is an introduction to & general overview of the issues surrounding large scale wind power development with signposting to sources of further information.

Overview
Scotland is committed to working towards an 80% reduction in CO₂ emissions by 2050⁽¹⁾. Along with Scottish government aspirations of increasing the contribution of renewables to national electricity to 50% by 2020⁽²⁾, this suggests that the development of the UK wind resource will play a crucial role.

Suggestions are that the UK is one of the windiest countries in Europe, so wind-generated power appears an attractive proposition. Furthermore, the windiest months are between December and February, when electricity demand is greatest; during this period a typical wind turbine has been shown to generate a third of its annual output.

Wind power in Scotland is an area of considerable growth, with 1550 MW of installed capacity as at October 2008⁽³⁾. Of all the renewable technologies, wind power is one of the fastest growing in Scotland and the world's largest wind turbine generator (5 MW) is currently undergoing testing in the North Sea, 15 miles off the east coast⁽⁴⁾.

There are numerous large wind farms as well as a number, both planned and operating, which are in community ownership. The siting of turbines is sometimes an issue, but surveys have shown high levels of community acceptance for wind power in Scotland. There is further potential for expansion, especially offshore, given the high average wind speeds⁽⁵⁾.

How do wind turbines work?
Wind turbines use large blades to catch the wind. When the wind blows the blades are forced round, driving a turbine which generates electricity. The stronger the wind, the more electricity produced. Most turbines produce electricity at around a quarter of their rated maximum power due to the variability of wind resources⁽⁶⁾. Scotland's wind regime has been shown to provide an average *capacity factor** of up to



58% due to more favourable wind regimes than other areas in the Europe⁽⁷⁾. *Capacity factor = Actual amount of power produced over time / Power that would have been produced if turbine operated at maximum output 100% of the time.

Public opinion
Many aspects of onshore and offshore wind have subjective view points. The Ardrossan Wind Farm on the west coast of Scotland has been "overwhelmingly accepted by local people". Instead of spoiling the landscape, they believe it has enhanced the area⁽¹²⁾. A 2003 survey of residents living around 10 of Scotland's wind farms found high levels of community acceptance and strong support for wind power, with much support from those who lived closest to the wind farms⁽¹¹⁾.

The results of this survey support those of an earlier Scottish Executive survey 'Public attitudes to the Environment in Scotland 2002', which found that the Scottish public would prefer the majority of their electricity to come from renewables, and rated wind power as the cleanest source of renewable energy⁽¹¹⁾. Some of the main public concerns are discussed below.

Aesthetics & landscape issues
Amongst those concerned about the value of natural landscapes the siting of some wind turbines has become an issue⁽⁸⁾. The John Muir Trust has stated that "the best renewable energy options around wild land are small-scale, sensitively sited and adjacent to the communities directly benefiting from them"^{(9)&(10)}, although some community-owned schemes can still prove to be controversial. Traditionally, large scale turbines are installed in non-urban areas with a strong trend for large offshore wind farms. The erection of a wind turbine, usually on prominent land may have aesthetic impacts on the landscape. Whether this impact is positive or negative is very subjective, with people varying in opinion.



Noise

Often noise is one of the primary public concerns when wind farms are proposed close to residential developments. Wind deflecting off any surface will create a noise. Noise can also be present from the gearbox and drive train of the turbine.

It is therefore inevitable that a wind turbine will generate some noise when in operation, although developments in the design of the turbine blades and improved engineering has helped reduce these noise emissions. In general noise emissions from turbines is not an issue as the majority of turbines are located in rural areas – away from people's homes.

Birds & animals

Wildlife groups and the public often raise concerns over the disruption to animals, particularly birds. However, birds are killed every year due to collisions with overhead power lines, poles and even flying into windows and in fact 300 times more birds are killed by collisions with traffic than wind turbines⁽¹⁵⁾. It is suggested that the impact of wind farms on birds is not significant, although consideration must be given to the surrounding habitat of birds and their migration paths when siting turbines

Flicker

When the turbine blades are rotating, the sun may reflect off of the blades causing a "flicker" effect. This could be an annoyance, but again careful planning can mitigate any disturbance to surrounding neighbours.

Ice

Ice throw, while it can occur under certain conditions, is of little danger. Setbacks typically used to minimize noise are sufficient to protect against danger to the public. Ice buildup slows a turbine's rotation and will be sensed by the control system, causing the turbine to shut down.

Electro-magnetic interference

In older wind turbines electro-magnetic interference due to the rotating blades and structures of the machines caused problems and interfered in the transmission of television and radio waves. This interference was due to the fact that the turbines used to be made almost completely of metal; nowadays turbines are predominately constructed using fibreglass, which creates little or no interference.

Economics

It is difficult to suggest typical costs for a wind farm. Whether a wind farm is financially viable or not depends on wind speed, cost of land used, cost and performance of the type of wind turbine used and energy prices.

Large turbines selling electricity to the national grid can be financially viable where the average wind speed is greater than around 7 m/s. They are likely to become attractive to more businesses in future, as technology continues to improve and the deregulated energy market develops⁽¹⁵⁾.

Smaller turbines may be viable with average wind speeds as low as 5 m/s, where properties are not grid connected and the only alternative is a more expensive power source such as a diesel generator.

Costs of grid-connected wind turbines

In recent years, the unit cost of wind farm projects has been falling steadily from over £1,000 per kilowatt of rated output to under £700⁽¹⁵⁾. Even so, the total project costs for a single large grid-connected wind turbine could be around £500,000⁽¹⁵⁾. Costs for connecting a wind turbine to the grid can be lower if the site is close to an 11 kV power line, but there may still be reasons that expensive alterations to the grid are needed and a careful technical study of the options can lead to substantial cost savings.

Costs of stand-alone wind turbines

For a wind turbine that is not going to be connected to the grid the costs of alternative energy sources must be compared. Installing a wind turbine involves making an initial large capital outlay that will generate an income over the next 20 years. However electricity prices could fluctuate significantly over the duration of a power purchase contract, and could influence returns for the turbine owner, possibly rising along with inflation and possibly rising faster than other prices in future⁽¹⁵⁾.

Payback period

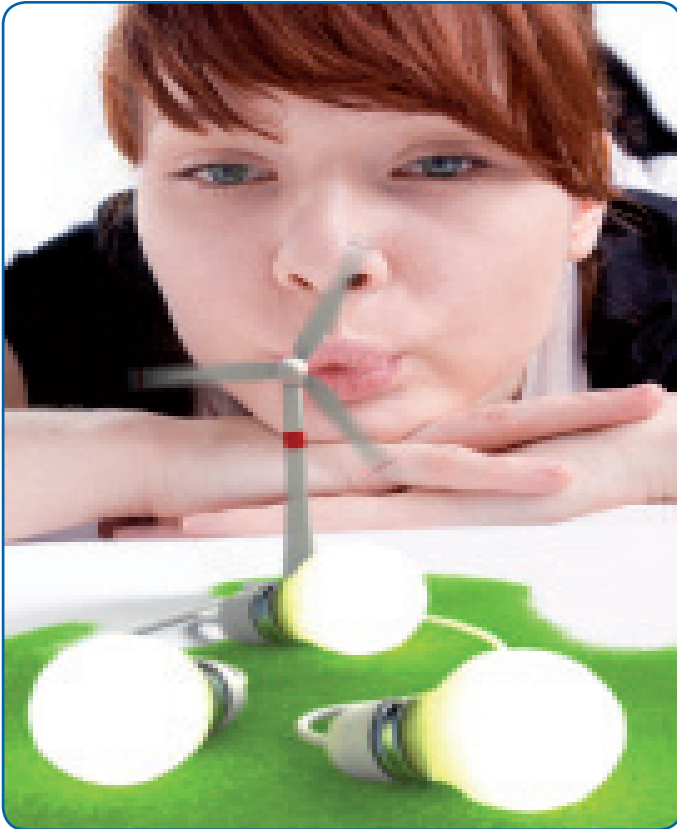
Capital outlay can vary greatly from one site to another. The price of a single turbine is irrelevant as it is the cost of the complete wind power system that is much more important.

There are likely to be significant differences in costs for obtaining a wind speed survey, seeking planning permission, carrying out site works and associated electrical installations. Equipment life is likely to be in the range 15-25 years with annual maintenance and insurance costs typically ranging between 2-3% of the capital cost. Routine maintenance and lubrication can generally be carried out by wind farm staff which helps to keep costs down⁽¹⁵⁾.

Grant aid

Numerous local and national grants are available to aid the development of wind farms in Scotland. Most are aimed to benefit purchasers of the small and medium sized wind turbines, and would have only a minor effect on profitability of the very large machines.





Summary

It has long been suggested that Scotland has the best wind energy potential in Europe although the debate about whether or not Scotland has enough potential wind to supply a considerable amount of its energy demand is still ongoing⁽¹⁵⁾. A study, commissioned by the Scottish Council for Development and Industry (SCDI), forecasts that the current 1.3GW output from working wind farms in Scotland will have to increase five-fold to 6.6GW to meet government targets of 50% contribution of renewables by 2020⁽¹⁷⁾.

It is estimated that enough onshore wind potential exists, to provide over 45 TWh of energy (compared to Scotland's total generation requirement of around 50TWh⁽¹⁶⁾). The total offshore potential is estimated at 25 GW. Here mean wind speeds are greater than on land⁽¹⁴⁾ and although more expensive to install offshore wind farms have the potential to provide almost half the total energy used in Scotland⁽¹³⁾.

The important thing to realise is there is a big gap between the potential available energy and what can reasonably be harnessed. Although the figures above suggest there is enough potential from onshore wind power to meet Scotland's peak-winter demand twice over. How much of this we can use is uncertain and at what cost is not yet known.

REFERENCES

No.	REFERENCE	LINK
1	COSLA Climate Change Issues Update – February 2009. This paper contains short updates on current issues, events and developments with regards to the Climate Change Agenda in Scotland.	www.cosla.gov.uk/attachments/execgroups/rs/rs090218climatechangeissuesupdate.doc
2	SCOTTISH PLANNING POLICY 6: Renewable Energy	http://www.scotland.gov.uk/Resource/Doc/171491/0047957.pdf
3	BBC News: Turbines Achieve Energy Landmark	http://news.bbc.co.uk/1/hi/scotland/south_of_scotland/7695508.stm
4	World's Largest Wind Turbine Generator	http://www.reuk.co.uk/Worlds-Largest-Wind-Turbine-Generator.htm
5	Economic potential of offshore renewables	http://www.scotland.gov.uk/News/Releases/2009/03/20121710
6	ECN Report on Renewables	http://www.ecn.nl/docs/library/report/2003/c03006.pdf
7	Burradale Wind Farm Shetland Islands	http://www.reuk.co.uk/Burradale-Wind-Farm-Shetland-Islands.htm
8	BBC News: Wind Power Dimema for Lewis	http://news.bbc.co.uk/1/hi/scotland/news/hi/newsid_5205000/5205430.stm
9	John Muir Trust Views on Wild Land	http://www.jmt.org/news.asp?s=2&cat=Latest%20News&nid=JMT-N10035
10	John Muir Trust Renewable Energy Policy	http://www.jmt.org/policy-renewable-energy.asp
11	BWEA/Scottish Executive: Wind farms make good neighbours.	http://www.bwea.com/media/news/goodneighbours.html
12	Guardian: Wind farms are not only beautiful, they're absolutely necessary.	http://www.guardian.co.uk/commentisfree/2008/aug/12/windpower.alternativeenergy
13	RSPB Scotland, WWF Scotland and FOE Scotland (February 2006) The Power of Scotland: Cutting Carbon with Scotland's Renewable Energy.	http://www.wwf.org.uk/filelibrary/pdf/electricity_supply_web.pdf
14	Evaluation of Global wind power	http://www.stanford.edu/group/efmh/winds/global_winds.html
15	University of Strathclyde Beginners Guide to Wind Power	http://www.esru.strath.ac.uk/EandE/Web_sites/01-02/RE_info/wind.htm
16	Scottish Energy Study Volume 5: Energy and Carbon Dioxide Projections for Scotland	http://www.scotland.gov.uk/Publications/2008/11/14093227/7tions/2008/11/14093227/7
17	Scotsman: Scotland 'will have to treble number of wind turbines' 09 December 2008	http://news.scotsman.com/wind-power/-Scotland-39will-have-to.4773213.jp

GENERAL SIGNPOSTING: LARGE SCALE WIND POWER

TITLE	DESCRIPTION	LINKS
British Wind Energy Association (BWEA)	Trade and professional body for the UK wind and marine renewables industries. Primary purpose is to promote the use of wind power in and around the UK, both onshore and offshore.	www.bwea.com
European Wind Energy Association	The European Wind Energy Association (EWEA) is the voice of the wind industry, actively promoting the utilisation of wind power in Europe and worldwide. It is ideally situated in the Renewable Energy House in Brussels ensuring close proximity to European decision-makers.	www.ewea.org
Global Wind Energy Council	The Global Wind Energy Council is the Global Forum for the wind energy sector, uniting the wind industry and its representative associations.	www.gwec.net
UK Windspeed database	The Department of Trade and Industry wind speed database contains estimates of the annual mean wind speed throughout the UK.	www.bwea.com/noabl
The Renewable Energy Centre	General Guidance on Wind Power	www.therenewableenergycentre.co.uk/wind-power
European Renewable Energy Council	The EREC acts as a forum for exchange of information and discussion on issues related to renewables as well as to represent the European RES industry & research community.	www.erec.org
Renewable Energy Association (REA)	The Renewable Energy Association is a trade association open to all companies supportive of the UK renewable energy industry.	www.r-e-a.net
Carbon Trust: Policy Frameworks for renewables.	This report examines the case for renewable energy both in the near-term and the long-term in the light of the Energy Review.	www.carbontrust.co.uk/Publications/publicationdetail.htm?productid=CTC610&metaNoCache=1

LARGE SCALE WIND (ONSHORE, OFFSHORE & COMMUNITY SCHEMES)

TITLE	DESCRIPTION	LINK
Onshore Wind	Guidance on Onshore wind	www.bwea.com/planning/index.html
Wind Power: Your Questions Answered	Sustainable Development Commission: Answers to commonly asked questions about the potential of wind power.	www.sd-commission.org.uk/publications/downloads/Wind%20Power%20-%20your%20questions%20answered%20FINAL.pdf
Wind Power in the UK	Sustainable Development Commission: A guide to the key issues surrounding onshore wind power development in the UK	www.sd-commission.org.uk/pages/wind-power-in-the-uk.html
Offshore Wind	Guidance on Offshore Wind	www.bwea.com/offshore/info.html
Wind-power sites proposed for Scotland	The Scottish Wind Assessment Project (SWAP) "Gazetteer of wind power in Scotland" 2005. maps and lists over 250 wind developments which are proposed, in the consents system or operational.	www.viewsofscotland.org/library/map.php
Wind Farms in the UK (UKWED)	The UK Wind Energy Database – UKWED - Database on wind energy projects in the UK, both onshore and offshore, tracking project progress from submission through to operation.	www.bwea.com/ukwed/index.asp
Scottish Wind Assessment Project	Gazetteer of wind power in Scotland	www.viewsofscotland.org/library/docs/SWAP_Wind_Gazetteer_v1.pdf
Centre for Alternative Technology	Community Wind Power: Case Study	www.cat.org.uk/information/catinfo.tmpl?command=search&db=catinfo.db&eqSKUdatacq=20030522111644
Offshore Wind Energy	Windfarms in Scottish Waters	www.thecrownestate.co.uk/our_portfolio/marine/offshore_wind_energy/scottish-offshore-wind.htm
Windfarms in Scottish Waters	Scottish Offshore Wind Consortia	www.thecrownestate.co.uk/our_portfolio/marine/offshore_wind_energy/scottish-offshore-wind/scottish_offshore_consortia.htm
Offshore Renewables In Scotland	Presentation by Scottish Development International on Offshore renewables in Scotland	www.uktradeinvest.gov.uk/ukti/fileDownload/ScottishDevelopmentInternational1.pdf?cid=424025
Potential of offshore wind energy	Offshore wind energy in Scottish territorial waters is to undergo strategic environmental assessment (SEA) to establish a clear and consistent approach to future development. The Scottish Government study will ensure the significant offshore wind resource is developed consistently.	www.scotland.gov.uk/News/Releases/2008/10/29112030
Scottish Power Renewables Education Pack	Created by ScottishPower Renewables (SPR) this offers an insight into renewable energy. Split into two discs, the resource has an interactive DVD detailing how renewable energy works, the process of building a windfarm, electrical safety and energy conservation.	www.scottishpowerrenewables.com/pages/education_pack.asp
Scottish and Southern Energy Merchant Wind Power	Making money out of fresh air How to capitalise on wind energy with Scottish and Southern Energy	www.scottish-southern.co.uk/SSEInternet/uploadedFiles/About_Us/Our_Businesses/Energy_Services/HowToCapitaliseOnWindEnergy.pdf
Scottish Government: Renewable Energy	Wind Power	www.scotland.gov.uk/Topics/Business-Industry/Energy/19185/17852-1
Scottish Government: Publications	Economic Research Findings: The Economic Impacts of Wind Farms on Scottish Tourism	www.scotland.gov.uk/Publications/2008/03/07113507/1
Scottish Government: Publications	Kilbraur Wind Farm Extension Scoping Opinion	www.scotland.gov.uk/Publications/2008/06/KilbraurScoping
Scottish Government: Publications	Making Scotland a leader in green energy: Draft framework for the development and deployment of renewables in Scotland	www.scotland.gov.uk/Publications/2008/11/05115324/6
Scottish Government: Publications	Review of Energy Efficiency and Microgeneration Support in Scotland	http://www.scotland.gov.uk/Publications/2008/05/30140737/0
Carbon Trust: Offshore wind power: Big challenge, big opportunity.	This study assesses the challenges to deploy UK offshore wind power to meet renewable energy and carbon emission targets and how to maximise the environmental, economic and security benefits.	http://www.carbontrust.co.uk/Publications/publicationdetail.htm?productid=CTC743&metaNoCache=1