Briefing Paper, February 2006

The Power of Scotland:

Cutting Carbon with Scotland's Renewable Energy

RSPB Scotland, WWF Scotland and FoE Scotland

The Power of Scotland:

Cutting Carbon with Scotland's Renewable Energy

A briefing from RSPB Scotland, WWF Scotland and FoE Scotland, February 2006

For further information contact:

Clifton Bain, RSPB Scotland
Dunedin House
25 Ravelston Terrace
Edinburgh
EH4 3TP

Richard Dixon, WWF Scotland
Little Dunkeld
Dunkeld
Perthshire
PH8 0AD

Stuart Hay – FoE Scotland
Lamb's House
Burgess Street
Edinburgh
EH6 6RD

Based on work provided by Andy Kerr, E3 International Pty Ltd, 3 The Street, Alderton, Wiltshire SN14 6NL, funded by WWF Scotland and RSPB Scotland

Design, diagrams and layout by Textlynx web and print services (www.textlynx.co.uk)

Cover photograph: Hunterston B and neighbouring wind farm by Clifton Bain, RSPB Scotland

Summary

Scotland has considerable renewable energy potential on land and at sea. Renewable electricity targets have been set by Government to help cut the greenhouse gas emissions, which cause climate change. Policies and incentives to support renewables have been successful in expanding the industry but questions have been raised over the ability of renewables to meet our energy needs and the environmental impacts of such development.

Examination of evidence from Government, industry and official inquiries demonstrates that:

- there is sufficient renewables opportunity to exceed Scotland's 2020 renewable electricity targets, without having to risk damage to sensitive environmental areas.
- Viable alternatives exist to meet necessary levels of carbon reduction, without having to build new nuclear power plants, even with planned closures of conventional power stations in Scotland
- Electricity from the national grid meets only part of our energy demands and considerable carbon reductions could be made from micro-generation
- Energy savings through reducing demand and energy efficiency are achievable and essential in combination with renewables if we are to deliver the significant cuts in carbon required to tackle climate change
- Greater emphasis on energy efficiency, demand reduction and a strategically planned approach to renewable energy will deliver urgently needed cuts in climate changing emissions, renewable electricity targets, protection of the environment and avoid the risks and long-term waste issues associated with nuclear power.

Introduction

The UK and Scottish Governments are committed to significant cuts in greenhouse gas emissions across a range of sectors to help stabilise global warming at no more than a 2˚C rise.

Reducing carbon emissions from electricity generation is a key part of the Scottish Executive's climate change programme, with an ambitious target set for 40% of electricity consumption in Scotland to come from renewable sources by 2020. Scottish Ministers have emphasised that the Executive's objective is to deliver renewables without environmental harm.

With increasing demand for electricity and the impending closures of existing fossil fuel and nuclear electricity generating plants, questions have been raised over the ability of renewable energy to meet our needs and reduce carbon emissions, without compromising environmental protection in sensitive sites.

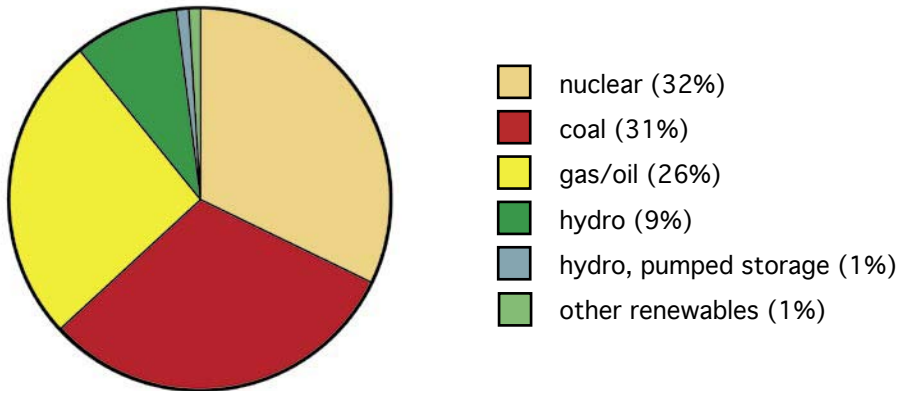
In this report, we look at the opportunities for addressing Scotland's electricity demands through renewables development and energy efficiency, taking account of planned closures in conventional generation.

Scotland's electricity requirements

Scotland has long been recognised as being in a unique position to exploit renewable sources of energy. Although energy policy is a reserved power, under the Scotland Act (1998), Scottish Ministers have devolved powers to promote renewable resources. The Scottish Executive has therefore set a target of 18% of electricity demand in Scotland to be from renewable sources by 2010 and an "aspirational" target of 40% by 2020.[1]

Between 2000–2002, Scotland's annual electricity generation was around 50TWh, with the majority from nuclear and coal power stations. Renewable generation stood at 10% (5TWh) of the total, and was made up largely of hydropower sources[2] (see figure 1). About two thirds of Scotland's generated electricity (34TWh) was consumed by electricity customers in Scotland in 2002. The remaining 16TWh (32%) was largely exported to the rest of the UK, in addition to losses from transmission and generators own use.[3]

Figure 1 Scottish Electricity Generating Output, 2002



Target for 2010

The Scottish Executive has clarified that its short-term target of 18% of electricity from renewable sources by 2010 relates to the electricity consumed in Scotland as opposed to the total amount generated. Scotland is expected to face a growing electricity demand, of about 1% per year.[4] Taking this increased demand into account the 2010 target equates to around 6.5TWh of renewable electricity generation.

To meet the 2010 target, the required increase in renewable electricity generation, above that which was already available in 2000–2002, comes to about 1.5TWh and is expected to be almost entirely from onshore wind generation.[5] The proposed output from renewable energy projects in operation together with those under construction or given planning consent in 2005 already exceeds this target[6] (see figure 2).

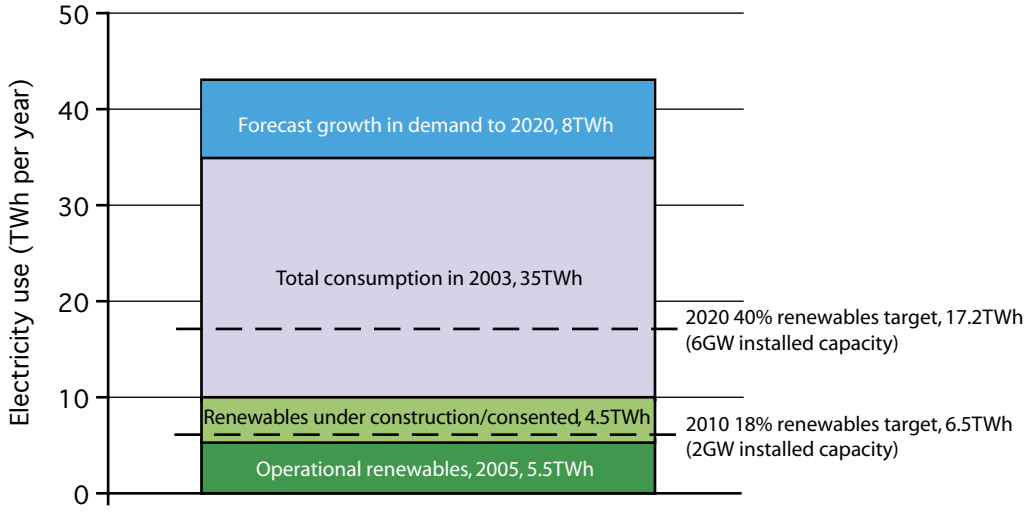
Target for 2020

By 2020, Scotland's annual electricity consumption could be around 43TWh if electricity demand continues to rise at 1% per year. The 40% renewables target for 2020 would therefore mean annual generation of 17.2TWh of renewable electricity.

It has been estimated that to deliver the 2020 renewables target of 17.2TWh will require around 6GW of installed renewables plant.[7] This is based on the expectation that renewable energy is largely going to rely on intermittent sources such as wind or marine, over the next few decades. The industry standard assumes an average of 33% of the generating plants capacity when calculating how much electricity will be produced. (6GW x 365 days x 24hrs x 0.33 load factor = 17.2TWh).

In January 2006, the installed capacity of wind farms in Scotland was 0.56GW out of a total of 1.9GW of operating renewables capacity. A further 1.4GW of wind will be available out of a total of 1.6GW of renewables which have planning consent or are under construction.[8] The total built and consented renewables (3.5GW) is well above that required to deliver the 2010 renewables target. This leaves around 3GW of renewables still required to meet the 2020 target.

Figure 2 Scotland's Renewable electricity targets in relation to renewables development[9] and overall consumption



Conventional power plant closures

Over the next two decades, Scotland will also have to deal with aging coal fired and nuclear plants. In 2003, the two nuclear plants in Scotland, Hunterston B and Torness generated 17TWh of electricity[10] while the two coal plants Longannet and Cockenzie, generated 14TWh[11] (against a total generated in Scotland of about 45.5TWh). Hunterston B is due to close in 2011, and Torness in 2021 unless a life extension is granted.[12]

A key aim for our future electricity generation is to help cut greenhouse gas emissions. The planned closure of Scotland's nuclear power plants will therefore have to be addressed without adding further carbon emissions (it should be recognised that nuclear energy is not carbon free since there are significant emissions associated with construction, mining of fuel and in decommissioning). To fill the gap in our energy supply, as a result of these closures through renewables alone could require additional annual renewable electricity generation of 8.5TWh by 2011, and a further 8.5TWh by 2021, above that already planned to deliver the 40% renewables target.

In addition, Scottish Power has indicated that they will opt out the two coal plants from the Large Combustion Plant Directive, which imposes stringent limits of sulphur dioxide and nitrogen oxides from power stations. This opt out will limit the operation of individual generating units at these plants to 20,000 hours from 1 January 2008 and would require closure of these units by the end of 2015. This would create an additional 14TWh energy gap, although there is the option of investing to reduce emissions from these plants, rather than shutting them down. A carbon reducing solution to the energy gap therefore need not rely entirely on renewable energy. It is possible for new and existing fossil fuel plant to utilise new carbon reducing technologies in the short to medium-term, while renewables technology develops.

Assuming the worst case that all the above closures do occur, it is has been claimed by some industry bodies that achieving the 40% renewables target will still leave a potential energy supply gap of around 20TWh by 2020.[13]

Can renewables deliver our energy needs?

Scotland has considerable renewable energy opportunities with around 23% of the total European wind energy resource, both on-shore and off-shore, as well as a very large part of the UK's marine energy resource, a large proportion of the UK forestry biomass resource and some untapped hydro potential.[14]

Given the planning difficulties, landscape concerns and environmental issues arising from onshore wind generation, and add the pressures to reduce coal fired generation it is perhaps no surprise that the debate has focused on: "More wind or nuclear?" Yet published evidence from the UK Government and the Scottish Executive suggests that this is a false choice. To understand why, we need to go back to the work that underpinned the imperative to reduce emissions.

In 2000, the Royal Commission on Environmental Pollution proposed that over the next 50 years the UK must reduce its carbon dioxide emissions by at least 60%.[15] In the view of the Commission, this target was feasible and essential; both to demonstrate global leadership and to minimise the potential social and environmental damage that a major change in climate would bring globally.

The views of the Commission were influential in framing the development of the UK Government's Energy White Paper[16] in 2003, which also drew on a range of detailed economic and market studies that examined the feasibility of reducing greenhouse gas emissions by such magnitude.[17,18] The White Paper concluded that the target could be met, at relatively small economic costs, but not with current energy policies. The focus had to be on improving energy efficiency and increasing the share of renewable resources, which would also go some way towards alleviating concerns over security of supplies, since the UK will become a net importer of oil and gas in the next few years. It did not set targets for the share of energy supply by different fuels.

While there are widely divergent views on the costs and potential of different renewable technologies and the barriers to improve energy efficiency, few informed people dispute:

- The practical usable renewable resource in the UK is very large.
- Energy efficiency is the most cost-effective way of meeting all four goals of UK energy policy: reducing carbon emissions, ensuring security of supply, maintaining competitiveness, and tackling fuel poverty.
- Based on current costs, new nuclear build is unattractive as a cost-effective means of reducing emissions.[19] The safe disposal of radioactive waste poses serious problems. Even the issue of dealing with 500,000 tonnes of waste from existing nuclear power stations has not yet been resolved.[20]

Renewables capacity

The Scottish Executive commissioned a study in 2001 [21] that considered areas of Scotland where wind speeds were high enough to make wind generation economically viable and then identified constraints such as sensitive wildlife and landscape areas and MOD low fly zones. Environmental and MOD constraints together covered 70% of the Scottish land area. Even with these constraints, onshore wind alone was estimated to be capable of providing around 45TWh, which is equivalent to Scotland's entire projected electricity consumption in 2020. Onshore wind in theory could therefore meet the 2020 renewables target of around 17TWh and the additional 20TWh energy gap created by planned conventional plant closures. These figures help illustrate the general point that there is considerable capacity for onshore wind but in practice high level reliance on this one technology is unlikely, both because of the need to overcome the intermittency effects of wind and the need for transmission line (grid) upgrades and new routes.

The Scottish Parliament's Enterprise and Culture Committee , when reviewing renewable energy in 2004, concluded that the Renewables Obligation (Scotland) – the mechanism by which the Executive incentivise the development of renewable sources – had been successful in a single direction, that of onshore wind, but was working against other renewable technologies. This, the Committee argued, was neither sensible nor sustainable and missed the obvious economic and environmental benefits of other renewable sources.

The 2001 Scottish Executive commissioned work on renewables demonstrates the following opportunities:

- Onshore wind resource is widespread and cost-effective, even after excluding environmental and cultural sensitive areas (60% of Scottish land area) and MoD low flying areas (26% of Scottish land area), transmission limitations from North-South bottlenecks, and the social constraint of too many wind farms in one area.
- Marine technologies, including offshore wind, wave and tidal, have very large potential resources, equating to well over the total Scottish electricity demand.
- Other resources individually offer relatively small but potentially cost-effective resources, with the opportunity of substantial benefits locally

Scotland's Resource Potential[22]		
Technology	Capacity (GW)	Energy (TWh)
Offshore wind	25.00	82
Onshore wind	11.50	45
Wave	14.00	45.7
Tidal stream	7.50	33.5
Small hydro	0.30	1
Energy Crops	0.14	1
Agricultural Wastes	0.40	3.5
Forestry residues[23]	0.4	3.1
Landfill gas	0.07	0.6
TOTAL	**59.0**	**215.1**

Transmission upgrades and new lines would be required to deliver the full potential of renewable energy[24] since unlike conventional power generation, renewable resources are often remote and widely dispersed. With no grid upgrades, the renewables potential from the 2001 Scottish Executive study is reduced to 33TWh, which is still a large proportion of Scotland's energy needs.

The energy industry is confident of addressing any technical or economic limitations arising from the intermittent nature of some renewables such as wind.[25] This can be achieved in part through ensuring a large portfolio of wind in different locations, combined with a mix of renewables technologies.[26]

With a high proportion of renewables, there are concerns about the economic implications for the remaining conventional power generators as their capital and running costs will have to be met by less generating hours. This should not be a limitation for Scotland, as new electricity trading arrangements gives generators improved access to a GB wide market (British Electricity Trading and Transmission Arrangements).[27] For the UK as a whole such concerns can be addressed by increased in connections to the European mainland or by increases in the price of electricity.

Micro-generation

Small-scale electricity generating technologies, including roof top wind turbines, solar photovoltaics, and micro-CHP could make a significant contribution to our energy demands. Micro-generation is very different to the usual way of supplying electricity from large centralised power generators in that individuals can meet their own needs. Any excess power can in principle also be linked back to the electricity grid.

The capacity for micro-renewables is potentially very significant, with mainstream estimates of up to 25% of UK electricity demand being met by 2050.[28]

Energy conservation

Reducing carbon emissions from electricity generation does not rest simply on renewable electricity but also on reducing the demand for energy, through energy efficiency and energy saving. This approach need not have a damaging effect on the economy since, over the last thirty years, our economy has doubled in size, while energy use has barely increased. The Government anticipates that around half the emissions reduction in the UK Climate Programme to 2010 will come from energy efficiency.[29]

The UK Energy White Paper projects the improvement in energy intensity[30] at 2.25% per year for the period 2000–2020.[31] If this is applied to Scotland's electricity consumption it could provide savings of 13TWh in 2020. It is important to recognise that energy efficiency alone does not necessarily cut greenhouse gas emissions as the benefits of efficiency can be undermined if demand for electricity increases. Reducing electricity demand is a key part of the Government's options for tackling climate change. A typical household in Scotland emits about 8.5t CO_2 per annum[32] and the domestic sector contributes about 14% carbon dioxide emissions in Scotland (excluding emissions from land use change).[33] Evidence suggests that the economic potential exists to reduce domestic energy use by 37% – and emissions by 41% – with net benefit to the householder.[34]

Delivering the solution

The urgent need to tackle climate change and the risks posed by new nuclear power led us to review whether renewables and energy efficiency could deliver the necessary carbon reductions and protect the environment. The evidence (summarised in Annex 1 and Annex 2) clearly shows there is considerable potential, through a combination of different technologies, to meet our renewable energy targets, even with projected closures of conventional nuclear and coal power stations. Add to this the benefits of energy efficiency and demand reduction and it is certainly possible to achieve significant reductions in greenhouse gas emissions. There is considerable public support for this approach, with a recent Mori Poll showing nearly 80% of people in Britain considering renewables and energy efficiency as better ways of tackling global warming than building new nuclear power stations.[35]

Energy strategy

All technologies to supply energy have environmental, economic and social costs and benefits. None of the available technologies are free of constraints. There are good locations for wind farms and there are poor ones. There are technical constraints to offshore wind and marine technologies. There are market barriers to uptake of energy efficiency. What is clear is that a policy framework needs to be implemented that properly values the social, economic and environmental cost of supplying energy. A strategic approach to energy policy would help ensure a mix of technologies and avoid relying on any one beyond our capacity to accommodate it, in an environmentally sustainable manner. In the absence of a strategic approach the debate has narrowed to issues such as wind or nuclear. As a result, we risk missing the very economic and environmental benefits that all informed opinion agrees exist for meeting the future energy goals of Scotland and the UK.

Strategic approach to planning renewables

Environmental bodies in Scotland, as well as the Scottish Parliament have identified the urgent need for a strategic approach to the planning of renewables.[36,37] Through careful location, design, and operation we can maximise Scotland's renewable electricity capacity and avoid environmental conflict. The renewables industry is at an early stage in understanding the impacts of their development on wildlife. Such uncertainty necessitates rigorous examination of the possible risks when developments are proposed in areas of high wildlife value. The planning system is struggling to cope with the level of applications in sensitive areas, leading to lengthy delays in the process and a drain on the resources of developers, public agencies, NGOs and local communities.

No need for new nuclear build

The findings of this report demonstrate that there are clear alternatives to building new nuclear plants in order to meet our targets for reducing carbon emissions. These alternatives can also be met without the costs, risks to health and safety, and waste disposal problems associated with nuclear power.[38,39,40]

Demand reduction, energy efficiency and micro-generation

A Bill has recently been proposed which identifies the opportunities for energy efficiency and micro-generation and suggests regulatory and fiscal measures to help deliver these benefits.[41] Calls have also been made for the Scottish Executive to produce clear energy efficiency and demand reduction targets for domestic and industrial buildings.[42,43,44]

Conclusion

This report demonstrates that there is considerable opportunity for Scotland to meet its renewable electricity targets, deliver significant savings in our carbon emissions whilst protecting sensitive areas of our environment. There are many ways in which these goals can be delivered, through combinations of different renewables technologies, grid based generation and micro-renewables, energy efficiency and demand reduction. Government has many options which would deliver emission reductions, of the scale urgently needed, from the electricity generation sector whilst avoiding the risks and problems associated with new nuclear power. This report draws on the information available at the time and more detailed statistics on energy use in Scotland are expected as part of the Scottish Executive's ongoing work on the Scottish Climate Change Programme. We will be urging the Scottish Executive to ensure that this information is presented in a way that demonstrates the wide range of opportunities available to Scotland to help cut carbon from our energy use, as described in our report, so that future decisions on energy can be made in a fully informed manner.

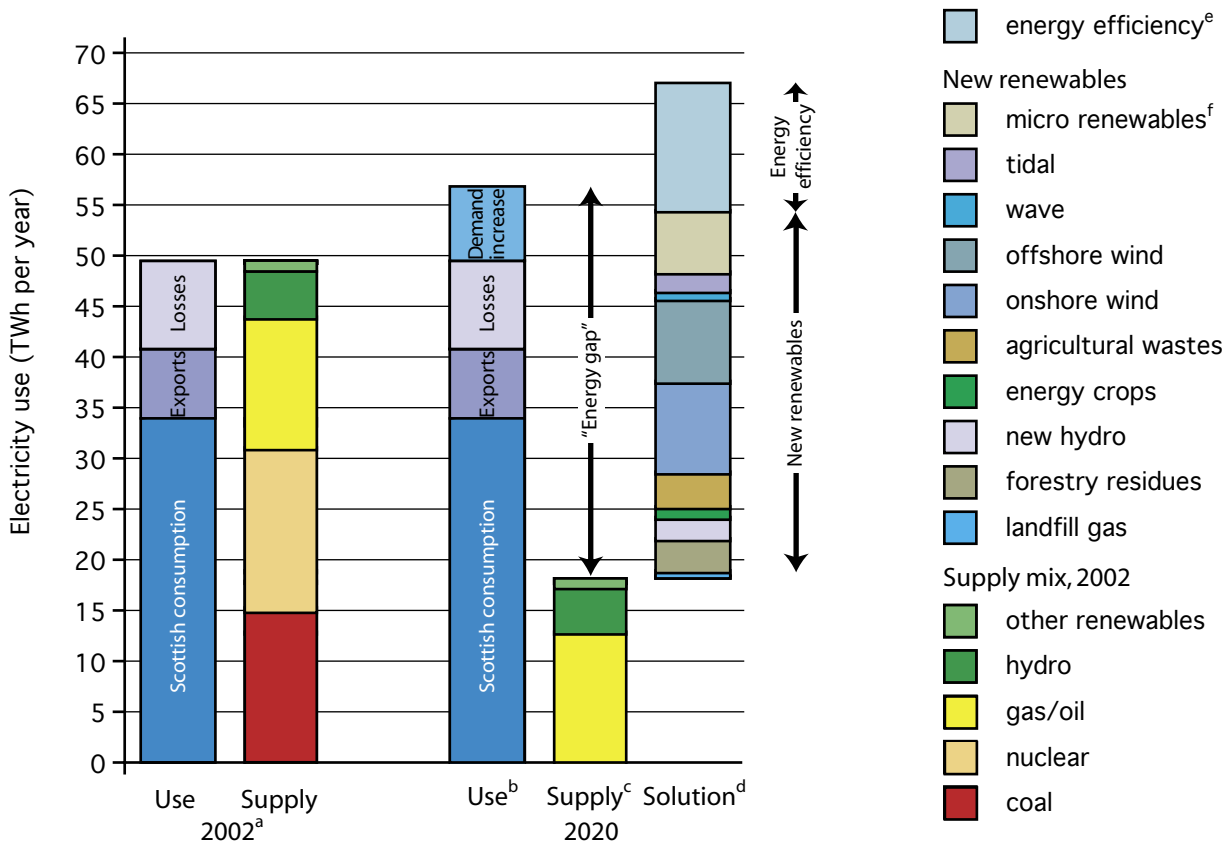
Annex 1

This figure summarises the projected electricity demands in 2020 and includes the planned closure of coal and nuclear electricity generating plants. It also takes a predicted increase on energy demand of 1% per annum as suggested by the Forum for Renewable Energy Development. This is a pessimistic view as it is possible that demand reduction measures could be put in place to help stabilise or even reduce energy demand by 2020.

The solution side of the chart presents a range of cautious renewable energy possible outputs for 2020 taking account of environmental constraints to avoid sensitive wildlife areas and assuming no transmission upgrades. This report does not suggest all these technologies will meet their capacity but illustrates that there is considerable scope for exceeding the 2020 renewables target of 17.2TWh.

Energy efficiency of 2.25% per year to 2020 is used, in line with Dti predictions.

The 2020 "Energy Gap" and a renewables solution



Notes

All renewables figures taken from: Scotland's Renewable Resource, Garrad Hassan and Partners, Scottish Executive 2001 except forestry residues which is taken from FREDs Scotland's Renewable Energy Potential report 2005.

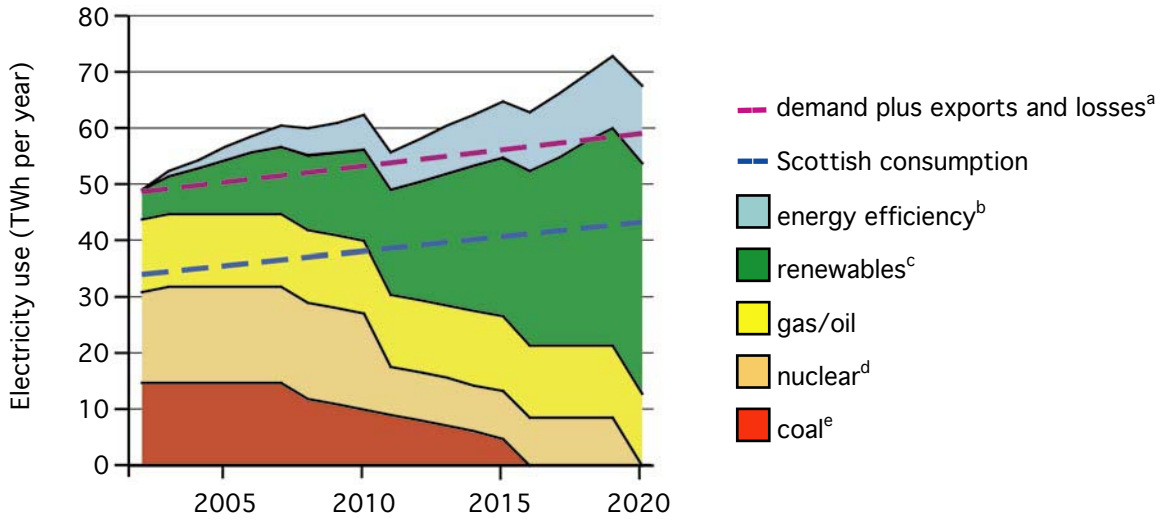
(a) Based on 2000-2002 Scottish Energy Figures (losses due to, eg, transmission losses, generators' own use)
(b) Based on demand increase forecast of increasing electricity demand of 1% per year (Scotland's Renewable Energy Potential, FREDs Future generation sub group, Scottish Executive 2005)
(c) From British Energy figures to Scottish Parliament Climate Inquiry 2005
(d) Figures given assumes no grid network upgrades – Capacity, if grid is expanded, could increase to 45TWh onshore wind, 82 TWh offshore wind, 45TWh wave and 33TWh tidal
(e) Based on Government projections of 2.25% increase in efficiency per year to 2020
(f) Derived from Potential for Micro generation Study, Dti 2005 – assumes 12% of electricity demand in 2002; could rise to 25TWh with introduction of regulation and incentives

Annex 2

This diagram gives an indication of how energy demand can be met over time with the planned growth in renewables and energy efficiency whilst taking account of closures in coal and nuclear plant.

Gas and Oil are taken as constant but gas in particular may well increase and provide extra time for the development of offshore renewables technologies.

Meeting Scottish electricity demand



Notes
(a) Total energy demand includes exports and assumes 1% increase in consumer demand per year (before efficiency savings)
(b) Energy efficiency – assumes 2.25% increase in efficiency each year
(c) Renewables – includes micro renewables and assumes introduction of tidal and wave from 2015
(d) Nuclear – planned closures of Hunterston B in 2011 and Torness in 2021
(e) Coal – reduction to 20,000 hours from 2008 and closure in 2015 of Longannet and Cockenzie

References

1 Scottish Executive News release: Future of Renewable Energy Mapped Out. 22/07/2005

2 Figure taken from Review of the Climate Change Programme: A Consultation Scottish Executive 2004

3 Key Scottish Environment Statistics. Scottish Executive 2004

4 Scotland's Renewable Energy Potential, Future Generation Group report, Scottish Executive 2005

5 Renewable Energy in Scotland: Enterprise and Culture Committee 6th Report Scottish Parliament 2004

6 Scottish Executive Press Release 18/11/2004: Scotland on target over renewable energy.

7 As 4

8 Scottish Renewables Forum Overview of Energy projects in Scotland, January 13 2006 (http://www.scottishrenewables.com/data/reports/060113_RenewablesSummary.pdf)

9 As 8

10 Figure taken from British Energy submission to the Environment and rural Development Committee Inquiry into climate Change, Scottish Parliament 2005

11 Figure taken from Scottish Power Environmental Performance Report 2003/04

12 The Scottish Executive, in their submission to the PIU UK Energy Review, anticipated that Hunterston B could well operate until around 2016

13 Using figures taken from the British Energy response to the Scottish Parliament Enterprise and Culture Committee Inquiry into renewable energy in Scotland, 2004

14 Submission by the Scottish Executive to the PIU Energy Review 2001

15 Energy: The Changing Climate: Royal Commission on Environmental Pollution 2000

16 Our Energy Future – Creating a low carbon future: Energy White Paper: DTI 2003

17 The Energy Review: Performance and Innovation Unit (PIU), Cabinet Office 2002

18 Long-term reductions in greenhouse gas emissions in the UK: IAG, UK Government 2002

19 Ibid (p12); Long-term reductions in GHGs (p56) IAG 2002, amongst others

20 The Committee on Radioactive Waste Management (CoRWM) will report with recommendations before the end of 2005 on how best to manage the existing high activity radioactive waste in the long term. The Government has stated that it will respond to these recommendations in 2006.

21 Scotland's Renewable Resource 2001 Garrad Hassan & Partners Ltd. Scottish Executive 2001

22 Ibid: Assumes that existing network constraints are managed. With no upgrade, renewable capacity is 3.1GW for onshore wind, 2.5GW for offshore wind, 0.3GW for wave, and 0.4GW for tidal stream.

23 Based on recent FREDS report Analysis of Biomass Potential in Scotland, Scottish Executive 2005

24 Renewable Energy Transmission Study, Department of Trade and Industry 2002

25 National Grid UK, 2004. Seven Year statement. www.nationalgrid.com/uk/

26 Scotland's Renewable Energy Potential. Forum for Renewable Energy Development in Scotland (FREDS) Future Generation Group Report, Scottish Executive 2005

27 Energy Act 2004, HMSO 2004

28 Potential for Micro-generation study and analysis 2005, Dti 2005

29 As 16

30 Energy intensity is a measure of energy use (usually in million tonnes of oil equivalent [mtoe]) per £billion of GDP.

31 Long-term reductions in greenhouse gas emissions in the UK: IAG, UK Government 2002

32 Sustainable Housing Design Guide for Scotland: Stevenson & Williams, Communities Scotland, 2000

33 Review of the Scottish Climate Change Programme, Dec 2004, Scottish Executive.

34 Energy efficiency: Background paper for The Energy Review, PIU, Cabinet Office 2002.

35 Poortinga W., Pidgeon, N.F. and Lorenzoni, I. (2006). Public perceptions of Nuclear Power Climate Change and Energy Options in Britain: summary findings of a survey conducted during October and November 2005. Technical Report (understanding risk working paper 06-02). Norwich: Centre for Environmental Risk

36 Link Energy Statement Scottish Environment Link, 2003

37 Enterprise and Culture Committee Renewable Energy in Scotland , Scottish Parliament 2004 also Environment and Rural Development committee report on Inquiry into Climate Change, Scottish parliament 2005

38 Small or atomic, Green Alliance, London 2005

39 Nuclear power undermines solutions to climate change, Greenpeace, London 2005

40 Tackling climate change without nuclear power, FoE, London 2002

41 The energy efficiency and micro-generation bill Proposal; Sarah Boyack MSP, December 2005

42 Scottish Environment Link submission to the Scottish Sustainable Development Strategy consultation, SEL, 2005

43 The Climate Change and Sustainable Energy Bill; Mark Lazorowicz MP, November 2005

44 Energy Efficiency Bill; Shiona Baird MSP, January 2006