forum for
RENEWABLE ENERGY
development In Scotland

SCOTLAND'S RENEWABLE ENERGY POTENTIAL:
realising the 2020 target

2020

Future Generation
Group Report
2005

SCOTTISH EXECUTIVE

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realising the 2020 target

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FORUM FOR RENEWABLE ENERGY DEVELOPMENT IN SCOTLAND (FREDS)

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We believe that Scotland is well placed to meet its renewable electricity targets, thereby contributing to tackling global warming and in so doing creating a viable new industry with particular benefits for remoter areas and communities. We suggest, however, that the Scottish Executive's targets are more helpfully expressed in terms of installed capacity, so providing greater clarity and allowing progress to be more easily monitored. The target should be based on estimated electricity demand in Scotland. On this basis, a total of around 6GW renewable installed capacity is required. The target should not be regarded as a cap.

It is technically feasible for the amount of renewable generation that we recommend to be contained on the electricity system without threat to security of supply.

Onshore wind developments may provide the economic justification required to ensure that Scotland's grid infrastructure is sufficiently established such that it can also economically accommodate the emerging marine technologies. Continuing support for onshore wind is also essential if investor confidence in the renewables market generally is to be maintained. Implementation of the recommendations of the FREDS marine, biomass and hydrogen energy groups is essential if these technologies are to make a contribution and Scotland is to achieve its ambition of a mix of renewables technologies. The UK Government and the Scottish Executive should accelerate their support for marine and biomass technologies to ensure that they are capable of contributing to the target as soon as possible.

Rationing infrastructure for use by individual technologies, or the setting of specific targets for these, is unnecessary and would be detrimental to the overall growth of the renewables industry in Scotland.

Background

1. The UK Government has set itself on a course to create a low carbon economy. It has set a target to cut the UK's carbon dioxide emissions – the main contributor to global warming – by 60% by about 2050, with real progress by 2020. The UK Government's Energy White Paper, published in February 2003, concludes that if the UK is to achieve a reduction in carbon emissions of that order, then renewables will need to contribute at least 30-40% of our electricity generation and possibly more. The UK Government has therefore set a target of supplying 10% of UK electricity from renewables by 2010, subject to the cost to consumers being acceptable, and aspires to double that amount by 2020.

2. In order to help deliver the Programme for Government commitment to make an equitable contribution to the UK effort, the Scottish Executive set targets that 18% of electricity generated in Scotland should come from renewable sources by 2010 rising to 40% by 2020. It seems likely that the renewable energy capacity already installed, plus capacity that has been consented but not yet built, will be sufficient to meet the 2010 target. FREDS believes, therefore, that this would be an opportune time to take stock of progress, and to consider in particular how the 2020 target might be met, both in terms of technologies and the installed capacity that might be necessary. In doing so, FREDS believes that issues such as security of electricity supply, transmission infrastructure and Scotland's contribution to the UK renewable electricity targets, should be taken into account.

Terms of Reference

3. FREDS has therefore established a sub group with the following terms of reference:

"To consider how best Scotland's renewable energy potential might be realised having regard to the 2020 targets set by the UK Government and the Scottish Executive and to advise on how individual renewable technologies might contribute to these targets, taking into account the Executive's economic development priorities.

In particular, the sub group will:

- advise on the issues and priorities necessary to ensure that a range of renewable technologies across Scotland can be accommodated on the grid to meet 2020 targets;
- advise on whether it is appropriate to develop targets for particular renewable technologies to ensure that a diverse mix of generation is achieved and, if so, what these targets might be;
- in reaching a view on these issues, consider the current and potential economic and employment benefits offered by individual technologies;
- advise on the proportion of intermittent to base load generation that is appropriate in Scotland given security of supply considerations;
- advise on the implications for renewable generation of the likely reduction in the amount of base load generation located in Scotland brought about by the closure of 'life-expired' non-renewable plant and the introduction of locational transmission charges;
- advise on Scotland's role in meeting UK targets for new renewable generation; and
- take account of the impact on securing ongoing investor confidence in the renewables sector."

The 2020 Target

4. The Scottish Executive's policy is set out in *Securing a Renewable Future: Scotland's Renewable Energy*, published in March 2003. This states that "Scotland should aspire to generate 40% of its electricity from renewable sources by 2020." This commitment is included in *A Partnership for a Better Scotland*, which confirms that, during the lifetime of the current Parliament, Scottish Ministers "will work towards our target for 40% of Scottish electricity generation to be from renewable sources by 2020 as part of our commitment to addressing climate change."

The current position

5. As at end April 2005, the installed capacity of renewables developments either operating or consented* was:

Technology	***Installed capacity (GW)***
Existing hydro **	1.3
Existing wind	0.4
Consented (on and off shore wind, hydro, biomass)***	1.1
Total	**2.8**

* It should be noted that consented projects will not all necessarily be built, as developers may be unable to meet all of the terms of their consent.

** Hydro pumped storage schemes are not included as renewable sources of electricity because it is non-renewable energy that is used to pump the water.

*** If a demand forecast is used to calculate required installed capacity then this figure reduces by 200MW- see Annex A.

Meeting the target

6. Different scenarios can be used to calculate the amount of renewables installed capacity that is likely to be required in order to meet the 2020 target. Renewable output generated in Scotland relative to assumed projected Scottish electricity generation could be used; alternatively, renewable output generated in Scotland as a proportion of projected Scottish demand could be the determining factor. None will produce a precise figure as assumptions have to be made, for example, of likely trends in electricity usage and total installed capacity in the period to 2020.

7. We believe that using projected demand is the best way of determining the target. This is described in Annex A. On this basis, we believe that Scotland needs to develop a total of around 6GW of renewable installed capacity in order to be certain to achieve the Executive's target of 40%. This means that, taking into account the amount of capacity already operating and consented, around a further 3.4GW installed capacity needs to be built. It is important to note, however, that the Scottish Executive has confirmed that the target of 40% should not be regarded as a cap.

8. This is a challenging but achievable target which reflects as closely as possible the 40% originally announced by Scottish Ministers. However, it needs to be reviewed on a regular basis in the light of further research and information and if it appears that further renewables build is possible and desirable, then that should be encouraged.

9. The Scottish Executive's policy is to encourage the development of renewable energy both as a response to Scotland's own climate change commitments and as a measure to promote the Scottish economy. The targets that the Executive has set for Scotland reflect this ambition, and in pursuing this policy, Scotland will make a substantial contribution to the UK's renewables targets. Given the amount of wind and hydro capacity already consented and in the planning system, it is clear that Scotland should be well placed to meet the target that the Executive has set and perhaps before 2020.

The GB Market under the British Electricity Trading and Transmission Arrangements (BETTA)

10. Questions around how much generation might be accommodated in Scotland must be considered in the context of the GB electricity market, the interconnected GB transmission system and the associated access and charging rules. A key factor in this consideration relates to when an application for connection in Scotland was received.

11. A generator who applied or applies for a grid connection after 31st December 2004 can only be accommodated subject to all necessary grid reinforcements, including upgrades to the interconnector and in the North of England, having been achieved. A generator who applied prior to that date is dependent only on transmission upgrades within Scotland having been undertaken. Approximately 16 GW of generation applications fall into the latter category. However, this is not an indication of what a renewables industry in Scotland will look like. The huge escalation in applications in the last months of 2004 was the direct result of the new connections rules, as developers sought to ensure that their proposal – however speculative – would not be subject to interconnector and upgrades in England. FREDS made clear in January 2005 its view that the majority of these connection applications will either not make it to the planning application stage or if they do, will not all secure the necessary planning consents. Many of these speculative applications are already dropping out of the system – around 2GW in total during the last couple of months - as developers are required to make up front connection payments. We expect the figure to continue to reduce over the next year.

12. Although any level of generation can theoretically be connected under the existing market rules, constraint costs would increase significantly due to the need to 'constrain off' generation to avoid exceeding the physical capability of the interconnector between Scotland and England. If levels of constraint costs were unacceptably high, then further interconnector upgrades and associated upgrades in the North of England would need to be considered as a means of reducing these costs.

13. As part of the introduction of BETTA, new use of system charging methodology has been introduced across GB. This was developed by National Grid Company plc (NGC) in its role as the GB transmission system operator and approved by the regulator, Ofgem, who has however asked NGC to review the charging methodology in order to potentially better meet the relevant objectives in NGC's licence in relation to reflecting costs and facilitating effective competition. FREDS recognises the importance of this work now being undertaken by NGC.

14. Following close consultation with the Scottish Executive, the UK Government took a power in the Energy Act 2004 to enable Ministers to limit transmission charges for renewable generators in a specified area of GB, if those charges would otherwise deter renewable development in that area. UK Ministers have recently indicated that they are minded to exercise that power to limit transmission charges for renewable generators on the Western Isles and Orkney and Shetland, and to consult on whether to exercise it for renewables on the mainland of the North of Scotland.

This demonstrates the importance Government attaches to exploiting the renewables potential where it is located (subject, of course, to planning controls) and will go some way to ensure that remote location does not stand in the way of attracting the necessary investment for renewable development in the North of Scotland.

The Transmission system

15. Substantial upgrades will be required to Scotland's electricity transmission system depending on the level of renewable development to be accommodated. A report (Renewable Energy Transmission Study – RETS) produced by the transmission companies in 2002 for the Department of Trade and Industry (DTI) considered a number of options for accommodating significant increases in renewable generation in Scotland. It discussed three scenarios, an increase in installed renewables capacity of 2GW, 4GW and 6GW over the level pertaining at the time (mostly the large hydro capacity) and identified various infrastructure reinforcements that might be required. These scenarios were developed on the basis of estimated demand and in response to applications for renewable energy schemes received at that time and resulted in proposals for transmission capacity in appropriate locations. The options are currently being revisited by the DTI's Transmission Issues Working Group in the light of current development activity.

Transmission upgrades currently approved by Ofgem

16. Ofgem responded to the RETS report in December 2004 by proposing a mechanism to fund a number of key upgrades:

    - Beauly - Denny (involving works in SHETL and SPTL areas - primarily upgrade along existing route)
    - Sloy (involving works in SHETL and SPTL - primarily upgrades to the substation)
    - South-West Scotland (involving works in SPTL - primarily new network)
    - The Scotland- England interconnector (involving works in SPTL and NGC - upgrade of infrastructure)

17. These key upgrades, along with further local reinforcements, could allow the connection of up to 6.3GW of the current generation applications, depending on the locations of consented generation schemes. The capacity would be created across the two transmission areas as follows:

    - up to 2.3GW in the SHETL area; and
    - up to 4.0GW in the SPTL area.

    1.5GW of this has already been consented and installed (refer to table at paragraph 5).

18. The timetable for completion of these upgrades is heavily dependent on the planning process. Construction timescales for the various projects are 1-3 years from the granting of planning consent, depending on the scale of the project. It is essential, therefore to ensure that these developments move through the planning process to determination as efficiently as possible to avoid unnecessary delays in the progress towards achieving Scotland's renewables target.

Transmission upgrades that would require Ofgem approval

19. The location of renewables projects is dependent on several factors, including resource, environmental impact, visual impact and grid capacity. Due to the number of important factors

involved in the location of any project it is not possible to site projects on the basis of transmission capacity alone. Therefore, further transmission upgrades, additional to those noted in paragraph 16 above, may have to be considered depending on the locations of consented generation schemes or if additional generation capacity is required. Work is ongoing to review the potential further upgrades that may be required based on the original RETS work and on the generation applications that have been received. These could include:

- Beauly-Blackhillock, accommodating up to 500MW in SHETL (primarily upgrade to existing infrastructure);
- Beauly – Keith, accommodating up to 400MW in SHETL (primarily upgrade along existing route);
- SSE 400kV ring accommodating up to 1,200MW in SHETL (primarily upgrade to existing infrastructure);
- South West Scotland 400kV extension accommodating up to 1,200 MW in SPTL (primarily new network); and
- SP upgrades in North Ayrshire to accommodate up to 550 MW of generation connected in the SHETL areas of Kintyre and Cowal (combination of upgrade and new network).

20. In addition, upgrade of the existing infrastructure between Beauly and Dounreay will allow developments in that area to utilise the additional capacity created by the infrastructure improvements mentioned above. Up to 700MW of additional generation could be for connections in North Highland as well as potentially the Northern and Western Isles.

21. If all of these upgrades went ahead consideration would need to be given to further upgrading of the Scotland-England interconnector circuits.

22. Construction timescales would again be 1-3 years from the granting of planning consent, depending on the scale of the project.

Providing information about transmission capacity

23. General information on the availability of transmission capacity is publicly available in the Seven Year Statement published by NGC. Specific information about the availability of capacity for a particular generator would be discussed in detail between the Transmission System Operator (NGC), the relevant Transmission Owner (SHETL or SPTL) and the generator once an application was made for connection to the transmission system. A formal offer of connection would then be made to the generator specifying the terms for connection. These terms would include a connection date derived from the identified system reinforcements that must be completed prior to connection.

24. We consider that the planning process would benefit from information relating to the availability and timing of transmission connections being made available to the planning authorities. Where possible, this information will be made available to the relevant planning and consenting authorities; however, the transmission licensees are bound by confidentiality provisions and when they cannot release this information, prospective generators are free to share this information with the planning authorities. We therefore recommend that planning authorities should be advised to request this information from generators for consideration during the planning process.

25. We conclude that up to 4.8GW of installed renewable capacity, over and above what has already been installed and consented, could be achieved from the transmission upgrades

for which Ofgem has already proposed a funding mechanism. However, further upgrades may be required depending on the locations where generation is consented or to accommodate additional generation and/or to reduce constraint costs.

Infrastructure requirements for the newer technologies

26. While emerging technologies, particularly marine, are likely to require transmission network upgrades if they are to be developed in Scotland, these upgrades cannot be justified on the grounds that, for example, wave and tidal stream developments might come forward at some time in the future. They can only be progressed once firm generation requirements are known.

27. However, transmission infrastructure constructed in the short term as a consequence of a demand by new onshore wind, biomass, and hydro projects will, wherever possible and efficient, be designed in such a way as to minimise the cost of accommodating further generation capacity. Examples of how further capacity could be accommodated from the transmission upgrades identified in this paper are set out below.

    - Replacing overhead line conductors to increase the rating of the line. This could be implemented, for example, in SHETL's Beauly - Blackhillock scheme.
    - Increasing the operating voltage of some 275kV circuits to 400kV, thereby increasing the capacity, while retaining the existing towers. This would be similar to SHETL's proposed 400kV ring development.
    - Extending the overhead lines currently proposed. For example, the 275kV overhead line proposed by SPTL in South West Scotland could be upgraded to 400kV and extended into the North of England enabling the connection of additional generation and increasing the export capability.

28. **Transmission capacity can only be built on the basis of firm development proposals; it cannot be built in anticipation that the newer or less established technologies will come through at some future date.**

Intermittency

29. No generation technology is 100% reliable and reserves are always required to cover unexpected outages on all plants. Often the need to shut down plant to repair it can be foreseen so that replacement generation can be made ready to take its place. However, from time to time particular generation units will also fail in-service causing a sudden and unexpected generation deficit. Demand is also variable and, because not all variations can be accurately forecast, it is also uncertain to some extent. In order to keep generation and demand in balance it is necessary to maintain reserves of either extra generation or controllable demand to meet the imbalances that will arise. The transmission system is operated in a manner that does just this so that it can cope with the sudden loss of a major transmission line or loss of a large power station, as well as sudden increases in demand.

30. Individual wind turbines, like all other generators, will break down and require repairs from time to time, but they are also subject to the availability of the wind itself. While there is some diversity in wind levels in different locations, there is also a strong common mode characteristic arising because weather systems may cover a significant area of the country – causing simultaneously high or low output from the national wind generation portfolio. This effect is commonly referred to

as the intermittency of wind generation. It will be in addition to the imbalances that arise from generation breakdowns and demand forecast errors, and so require additional reserves to be held.

31. The need to establish additional reserves to cover wind intermittency in the short-term (i.e. the few hours up to real-time) is mitigated to some extent by the convenient statistical characteristics of wind which, due to wind persistence, make generation levels somewhat more predictable. Wind conditions may not be easily predicted over the course of days or weeks, but forecasting for a few hours in advance has become quite accurate (and as further wind is developed is likely to become increasingly accurate). The total output of all wind capacity will be less variable as it will be made up of a number of wind farms spread across GB. In addition, the GB market operates on a one hour 'gate closure' meaning that contracts to supply electricity have to be agreed only one hour in advance by which time the likely contribution of wind generation will be reasonably well known and other plant can be scheduled accordingly. Any shortfall in predicted wind output can then be met by the routine use of balancing services.

32. As the output of an intermittent generation portfolio can be expected to be more variable than existing conventional generation, the implications for security of supply must be considered. NGC has stated that it believes adequate short-term reserves and other balancing services are likely to be available to address the additional statistical variability resulting with 10% wind (i.e. 8GW and sufficient to meet the 10% GB target for 2010). Subject to there being no wind generation technology related issues that would give rise to a common mode failure of wind generators, NGC has also stated that it does not believe there will be a technical ceiling on the amount of variability arising from wind that can be accommodated. A report on this issue by the DTI and Carbon Trust (Renewables Networks Impacts, 2004) also came to this conclusion, as did the Sustainable Development Commission's recent report entitled 'Wind Power in the UK – a guide to the Key issues surrounding onshore wind power development in the UK'. In fact, this is an economic/market constraint based on the cost of providing additional balancing services, which will become increasingly important and in the longer term will determine the amount of wind that can be accommodated. GB studies for 2020 assuming up to 25GW of wind have been examined on this basis.

33. The Electrical System Technical Issues Steering Group was established to consider the dynamic performance of the GB electricity system given the predicted high levels of wind generation and CCGT plant likely to exist in the next decade. The Group, which includes representatives from NGC, Ofgem and the Electricity Networks Association in addition to a number of technical experts, has commissioned work on generation scenarios and intermittency and has now agreed a work programme of GB-wide studies which will shed light on future network dynamic performance. This work is expected to extend over a period of some 10 months. However, initial results from a generic study undertaken by the University of Manchester using a much-simplified system model suggests that, unlike "conventional" wind generators, current technology appears to have the potential to improve the overall electricity network dynamic performance. This conclusion needs to be confirmed by the detailed GB-wide studies referred to above.

34. To ensure security of supply for consumers in Scotland, there must be adequate generation available to meet the demand, with sufficient flexibility in the portfolio such that it can respond in the time that fluctuations to demand or the availability of wind might occur. This flexibility may be located in the wider GB market at times when the network capacity between Scotland and England is adequate but must be located within Scotland at times when the link capacity could be exceeded.

35. For the generation/demand balance in Scotland in particular, the availability of network import and export capacity and the availability of flexible generation within Scotland are key to accommodating the future Scottish renewable generation portfolio. At present, and for the immediate future reflected in existing use of system contracts, the availability of a significant tranche of existing thermal and renewable generation in Scotland means that expansion of network export capacity to take power out of Scotland is the priority. Such capacity will reduce the need to constrain the operation of generation in Scotland that wishes to participate in the GB market. Plans are progressing to upgrade the capacity of the Scotland-England interconnector from the current capacity of 2.2GW to 2.8GW (refer to paragraph 16). However, Ofgem has specified that funding of this upgrade is dependent on the Beauly to Denny upgrade receiving planning consent. Discussions between SPTL and Ofgem are continuing on this issue. Subsequent phases of reinforcement could further increase the capacity. On the basis of these identified reinforcements, and those that will be needed to establish connections and reinforce infrastructure within Scotland, NGC, with the assistance of the Scottish Transmission Licensees, is currently preparing use of system offers for the large number of new generators seeking to connect within Scotland.

36. In the longer-term, retirement of existing generation within Scotland may change the network priorities. Retirement of some existing Scottish generation will reduce export levels and so make available capacity for new generation. However, if a significant proportion of existing generation should retire then, even with a significant renewables portfolio, it may be necessary to reinforce the import capacity of the network so that when generation output is low balancing supplies can be obtained from the remainder of the GB market.

37. Support to the system required to respond to variations in the outputs from 6GW of renewable generation in Scotland, or in the availability of conventional plant, can be supplied from the GB electricity market without difficulty. NGC believe that, provided network rules are satisfied, there is unlikely to be a technical ceiling due to the variability of wind on the amount of renewable generation that can be installed in Scotland. Any constraints are likely to be for economic/market reasons rather than technical.

Changes to the mix of generation in Scotland

38. As intimated above, there may be significant changes to the mix of generation plant in Scotland by 2020. Changes that could occur include closure of the existing plant at Hunterston (its Nuclear Site Licence runs until 2011) and at Cockenzie and Longannet (existing plant currently opted out of LCPD and therefore scheduled for closure by 2015).

39. Any systems issues arising from a change in generation mix in Scotland will be considered and resolved by NGC as Transmission System Operator and the Scottish Transmission Owners (SHETL and SPTL) in line with their various licence obligations. There are various factors that could effect the position:

- In the case of Cockenzie and Longannet it is possible that the life of the existing plant could be extended by the installation of flue gas desulphurisation equipment (FGD) to enable compliance with the EU Large Combustion Plant Directive (LCPD).
- Reviews of transmission charges could influence the economics of generation plant in Scotland and encourage new conventional generation to locate in Scotland.
- It is also possible that new conventional generation will locate in Scotland between now and 2020.

- It is possible that new plant could be installed on the existing generation sites, the reduced infrastructure costs may help to create an economic case for the investment.
- Further upgrades can be made to the interconnector to allow greater import of generation capacity.

40. The development of increased levels of renewable generation will also help to offset any loss of conventional thermal generation plant on the transmission system, even though this generation might be intermittent in nature. It would therefore not be prudent to restrict the amount of renewable generation in the face of potential reductions in conventional generation.

41. We conclude that changes to the generation mix in Scotland by 2020, including the potential closure of the large conventional generation plants, do not present a barrier to the achievement of renewables installed capacity of around 6 GW. This is because, even if Scotland only has renewable generation in the future, the system can still be managed by virtue of transmission reinforcements and also being operated on a GB wide basis. In fact, renewable generation in Scotland will delay the need for alternative solutions (e.g. further interconnector strengthening) that would be required to allow the import of electricity into Scotland.

Employment and Wider Economic Impacts

42. The main driver for the development of renewable means of generating electricity is the Executive's determination to tackle the causes of climate change. However, the Executive's 2003 strategy pointed also to the possibility of developing a viable renewables industry in Scotland. We were keen to explore the economic benefits, particularly in terms of potential employment, of the development of renewable energy in Scotland, taking into account the impacts of different technologies. A number of studies have previously been undertaken and it is clear from these that, given uncertainties about the extent and nature of the various technologies involved, this is very difficult to forecast with any degree of accuracy.

43. Some tentative conclusions emerge, however. For instance, it appears that most jobs are generated in the construction phase of development. The key point about employment impacts, though, is that much depends on the extent of domestically produced inputs. Technology sourced locally would have a considerably higher domestic employment impact than imported technology. Employment generated would also be higher to the extent that Scottish-based firms were able to export their technology. Any rigorous analysis would, therefore, need to consider which types of renewable energy production Scotland may have a comparative advantage in producing the inputs for, including estimating the future export potential of each, and how policy can appropriately support domestic production. This would be a substantial task that has not been possible in the timeframe within which the subgroup has been operating.

44. It is clear that other forms of renewable energy offer the possibility of greater employment impacts than onshore wind where the technology is largely imported from abroad and where other countries have established a market lead. However, that few of the other forms are yet economically viable on a large-scale (the exception is biomass) is a point of crucial importance. Supply chain activity associated with onshore wind development is already supporting employment across Scotland, and the importance of this in more remote areas with fragile economies should not be under-estimated. Indeed, consideration of the geographical distribution of economic impacts of renewable energy generation is a key question. For example, the Vestas Celtic tower manufacturing and turbine assembly plant in Argyll employs around 200 people in what was an economic blackspot. There

are also impacts associated with rents paid to communities, which could also have a significant economic effect at the local level.

45. We believe that there is a need for a better understanding of these potential economic impacts and recommend that the Scottish Executive looks into the feasibility of commissioning further work to look at how Scotland can maximise economic benefits from all of the technologies, taking account of existing work and the recommendations of the other FREDS groups.

The Renewables Technologies

46. A range of renewable technologies could be deployed to meet the Scottish and UK targets for 2020. Clearly onshore wind will play the greatest short term role, but, assuming a range of technical and economic issues can be overcome, other technologies should also be capable of playing an important part by 2020. Annex B, an excerpt from the DTI's Innovation Review, provides a summary of the comparative costs of these technologies.

Onshore Wind

47. At present, onshore wind presents by far the greatest opportunity for Scotland to develop a renewables industry and most developments that are proposed intend to use that particular technology. As mentioned earlier in the report, SHETL and SPT are currently dealing with circa 16GW of connection applications but as also noted, it is the view of FREDS that the majority of these applications will not be built.

48. Given the constraints on the other technologies, discussed below, there can be little doubt however that onshore wind projects will provide the economic justification for development of Scotland's grid which in turn could also substantially benefit other renewable technologies which will come on stream over the longer time frame. Onshore wind, therefore, has an important part to play in terms of technology pull through and supporting the development of the wider market.

Offshore Wind

49. There has been very little interest among developers in shallow water offshore wind developments off the Scottish coast. The seabed shelves away too quickly in most areas to make such projects viable. Deepwater offshore wind offers a potential opportunity however. Talisman Energy and SSE propose to construct demonstrator turbines at the former Beatrice oil field on the 12-mile limit. If the technology proves successful, a 1GW wind farm could follow. However, this is a number of years away, and the technology has not yet been tested in that difficult environment. A project of this scale will, like the Northern and Western Isles, require grid upgrade additional to those currently being considered.

Hydro

50. The scope for new hydro-electric schemes in Scotland is limited (unlikely to be more than 200MW). This is a tribute to the work done in the 1940s, 1950s and 1960s, which was almost totally successful in fulfilling the potential for hydro-electricity in Scotland. In addition, the environmental constraints on new developments are much greater than was the case in the post-war decades. Nevertheless, new hydro has an important part to play in helping to realise Scotland's renewable energy ambitions. A series of small-scale hydro-electric schemes have been developed in recent

years, and others are under development. An application has also been submitted to Scottish Ministers for consent to build a large-scale hydro-electric scheme at Glendoe, near Loch Ness. In addition, the potential of existing hydro-electric schemes to contribute more to the achievement of renewable energy targets should not be overlooked. The refurbishment of the hydro power stations improves their efficiency by around 5% and enables them to produce more electricity.

Biomass

51. The FREDS biomass energy group (BEG) estimated that up to 450MW of electricity could be generated using Scotland's wood fuel resource. There is also some potential to increase this amount of electrical output through the use of specially grown energy crops. The Group's report noted that biomass plant could act like conventional plant to balance the system. Biomass is a proven technology and BEG believes that significant capacity could be developed within the next 5 years.

52. The BEG report made a number of recommendations for supporting the development of biomass in Scotland. These included reviewing existing funding support while also considering the need for further assistance, supporting the development of a supply chain, provision of updated planning guidance, supporting development of a positive regulation and policy signals, and greater levels of advice and information for both developers and the public. While the report did not specifically consider the potential of the biomass heat market, it did underline the importance of the development of the biomass heat sector in further reducing electricity demand.

Marine Energy (wave and tidal)

53. The FREDS marine energy sub group (MEG) estimated the potential practicable marine resource to be around 1,300MW installed capacity, mainly off the northern and western seaboards of Scotland. Wave and tidal technologies are at a very early stage of development world-wide with significant development and financial risks remaining to be overcome. Accessing this particular resource on a commercial basis is likely to be longer term than either onshore and offshore wind and biomass.

54. To increase the likelihood of Scotland successfully developing a strong marine energy sector, the FREDS marine sub group set out an action plan that would: accelerate the commercial deployment of marine energy devices in Scotland; maximise the contribution from marine energy to Scotland's energy mix by 2020; and develop a sustainable manufacturing base for marine energy technologies in Scotland.

55. The Marine sub group recognised that the key areas of support needed to bring marine to a stage when it could be commercially deployed and therefore make a meaningful contribution to the targets were: (a) creating market pull through additional government financial support; (b) supporting the work of the European Marine Energy Centre (EMEC); (c) ensure Scotland led work in marine energy certification; (d) develop a clear planning and regulatory framework; (e) take action on grid infrastructure investment; (f) develop Scotland's academic capacity; and, (f) ensure enterprise agencies and business groups work together to support skills and manufacturing development.

Hydrogen and Other Technologies

56. A FREDS sub-group is also examining the development of a hydrogen sector in Scotland, and is due to publish its report this summer. Unlike other renewable energy technologies FREDS is involved with, hydrogen is not a source of energy; it is a carrier of energy similar to electricity. One of its benefits is that it can be produced from a diverse range of sources, from nuclear energy to wind power. Hydrogen created from renewable sources is an environmentally friendly, non-polluting source of energy. The favoured method to store hydrogen is fuel cells, a device similar to a continuously recharged battery, which generates electricity by combining hydrogen with oxygen from the air.

57. Hydrogen fuel cell technology, although at the early stages of development, offers Scotland many opportunities, most notably, perhaps, in the ability to capture and store energy from renewable resources. This has significance for remote and off grid communities who could use fuel cells to ensure a steady supply of energy from a wind turbine. The PURE Project in Unst demonstrates much of this technology, using two 15 kW wind turbines to create hydrogen which is stored in a fuel cell during periods of excess generation. The stored hydrogen is used when energy demand cannot be met from the wind turbines.

58. There is limited development of still further renewable technologies in Scotland, mainly at the micro end of the spectrum. The Executive's Scottish Community and Householder Renewables Initiative (SCHRI) funds the installation of renewable technologies in homes, schools, hospitals and other public buildings. The SCHRI has supported the development of several technologies, from micro wind and biomass CHP systems through to solar water and space heating, micro hydro, geothermal, air and water source heat pump solutions. The scheme was recently extended for a further three years, and is currently undergoing a review to ensure that it remains properly funded and appropriately targeted.

Conclusion on Technology Targets

59. The Scottish Executive's policy is that its 2020 target should be met by a range of renewable technologies. Both hydro and onshore wind are already making a contribution and these technologies will continue to contribute substantially in the period up to 2020. Biomass is a proven technology which is used extensively in other parts of Europe and, provided that the recommendations of the FREDS Biomass Energy Group are implemented, could be making a substantial contribution to the Scottish target by as early as 2010. Similarly, marine technologies, once proven to be technically and economically viable, could play an important part in the overall generation mix.

60. The group's remit was to consider whether it would be appropriate to develop targets for individual technologies within the overall 2020 target for the newer and less well developed technologies.

61. We believe that a strong resolve to support onshore wind now would ensure continued investor confidence in the renewables market which over time will be to the benefit of the wider renewables sector. To hold back the development of individual renewable technologies within the overall 6GW target to a certain level or to ration consents or the pace of build would have adverse consequences. In particular, it would send confusing and discouraging signals to investors with the likely result of diminished confidence in the UK renewables market. Once development momentum was lost, it would be very difficult to regain because of the fear of a "stop/start" approach.

62. Equally, it would be damaging to set individual targets for particular technologies. The Renewables Obligation is a market-led mechanism that rewards the lower cost renewable technologies and, in doing so, limits the costs to consumers. Individual technology targets would mean higher prices to consumers. And while Government wishes to see a wider range of renewable sources developed, this would not be achieved by holding back wind developments. Companies developing other technologies would in fact be discouraged by such a move as it would be seen as signifying a loss of confidence in renewables as a whole.

63. Other FREDS sub groups have considered the support that is required to bring forward the currently less economic technologies and have set estimates of what they might contribute given appropriate support to help them reach commercial viability. We urge Government to ensure that this support is delivered in order that all technologies can contribute to the target by 2020.

64. We conclude that there is ample scope for all technologies to play their part in helping to meet both the Scottish and UK targets and to support economic development. The sub-group recommends that it would be both inappropriate and inadvisable to set targets for particular technologies. Constraining some technologies will not open up opportunities or support the commercialisation of others. The focus should be on the removal of barriers faced by emerging technologies as recommended by the other FREDS sub-groups including appropriate support by Government.

Reservation of Transmission Capacity

65. Similarly, we believe that Scotland's renewable industry will succeed only on the back of further onshore wind developments. These will also be the key that unlocks the improvements in grid infrastructure necessary to bring on stream the other technologies that are either not yet commercially viable or are less well developed in Scotland.

66. There is a concern that not to reserve capacity would result in everything that is available being fully utilised by onshore wind leaving no room for other technologies. If this were to be the case, then the newer technologies could be squeezed out of the market before they have had the opportunity to demonstrate their effectiveness and as a result Scotland could lose its existing market lead and opportunity to secure meaningful economic benefit from their commercial development.

67. Under the terms of the licence, NGC is obliged not to discriminate between any persons or classes of persons as to the provision of use of system or the carrying out of works for the purpose of connection to the transmission system. NGC is also obliged to offer terms for connection to any person who makes the requisite application. These obligations would preclude NGC from reserving capacity on the network for the purpose of ensuring that capacity was available at a future date so as to allow certain generators to make an application for connection.

68. As mentioned earlier, grid infrastructure upgrade required to facilitate onshore wind development now will, wherever possible, be designed in such a way as to minimise works required in the future to accommodate generation from new technologies.

69. **Capacity reservation would not be an efficient use of transmission assets and could constrain the development of commercially viable renewable technologies, potentially jeopardising the achievement of the renewables target**.

Conclusions and Recommendations

70. The sub-group believes that Scotland is well placed to meet its targets and to play an important part in contributing to the achievement of UK targets. While it recommends translating the percentage target into a MW target, it does not believe that this should be considered a ceiling and recommends that the Scottish Executive keeps it under regular review. The sub-group believes that sustained onshore wind development will continue to play a leading role in achieving targets but that the importance of developing emerging technologies for future generation should not be underestimated. Early implementation of the FREDS marine and biomass sub-group recommendations for these technologies will be crucial to ensure they are brought forward. Rationing of infrastructure availability for individual technology targets will not provide the stimulus needed by these technologies and indeed will serve only to damage investor confidence and the ability to meet renewable generation targets.

    The following recommendations address the sub-group's terms of reference noted in paragraph 3:-

- **Scotland is well placed to meet its renewables target, perhaps before 2020, and could aspire to a greater renewables capacity if that was considered desirable.**
- **Achievement of the Scottish target will result in Scotland making an equitable and substantial contribution to meeting the UK target.**
- **The current 40% target should be redefined to provide a MW target based on electricity demand. This equates to installed renewables capacity of around 6GW. This must not be regarded as a cap.**
- **The future mix of conventional generation in Scotland is unknown although closure of plant is likely. Resolution of this issue is a matter for the Transmission System Operator, Owners and the Regulator and should not delay or restrict renewables development in Scotland.**
- **There are no technical constraints to the achievement of the target.**
- **Onshore wind should not be constrained within the 6GW target. Capacity should not be reserved nor targets set for any renewable technologies, such as offshore wind, biomass and wave & tidal. Such measures would damage both the industry and investor confidence in the UK renewables market and, consequently, the potential for a market for the emerging technologies in the UK, once commercial.**
- **Intermittency characteristics of renewables can be managed in the UK context but require adequate interconnector capacity between Scotland and England as well as Scotland and Ireland.**
- **We believe that there is a need for a better understanding of potential economic impacts and recommend that the Scottish Executive looks into the feasibility of commissioning further work to look at how Scotland can maximise economic benefits from all of the technologies, taking account of existing work of the other FREDS groups.**
- **All concerned should urgently implement the recommendations of the FREDS biomass, marine and hydrogen sub-groups in order that these technologies can be developed to a stage where they become commercially viable and can contribute to the achievement of the target and to the Executive's aim of achieving a diverse renewable energy generation portfolio. The key issues are those already identified in the FREDS marine and biomass reports, and the hydrogen report which will be published shortly (see Annex C for summary of marine and biomass group recommendations).**
- **FREDS should, on a regular basis, monitor the implementation of the recommendations contained in this report together with progress towards achievement of the Executive's target.**

Annex A

Meeting the Target

In reaching its conclusion that a total of around 6GW installed capacity is required to meet the 2020 target of 40%, the group has considered the following scenarios:

a. renewable output relative to total projected output

Using this method, it is necessary to make an assumption about what total Scottish electricity output will be in 2020. We acknowledge that annual output will change due to a number of factors including closure of conventional plant (which may or may not be replaced). Although current estimates suggest that these cuts could be substantial, issues arising from a change in generation mix will be managed by the Transmission System Operator and Owners. As described in our report, we do not believe that closure of conventional plant will act as a barrier to renewables.

Therefore, in working up this scenario we have proceeded on the assumption that output in 2020 will be at the level that it was in 2003, the last year for which information is available. This was 45.5 TWh[1]. A 40% share of this equates to 18.2 TWh, which would require an installed net capacity of 2.1 GW. Current average load factor of renewable developments in Scotland – hydro and wind – is of the order of 33%. Although load factor will change over time as less intermittent forms of generation, for example biomass, are accommodated on the transmission system, we believe that such change is unlikely to substantially alter the installed capacity order of magnitude required to meet the Executive's target. Assuming a load factor of 33%, this would require a total renewables installed capacity of around 6.3 GW.

b. renewable output as a proportion of Scottish consumption

This method allows us to model the amount of output/capacity that would be required by 2020 using existing demand and a forecast of how that demand is likely to change. The advantage of this approach is that demand projections can be modelled with a greater degree of confidence than output. Scottish demand in 2003 was 35TWh (the last year for which information is available) and is increasing by around 1% per annum. If this pattern were to continue (an outcome which is supported by a separate study being carried out for the Executive by the University of Edinburgh.) then output of c.43 TWh would be required in 2020 in order to meet demand.

The Department of Trade and Industry's Electricity Systems Technical Issues Steering Group was established to consider the specific issue of dynamic network performance, given the predicted growth in renewables and the growth in gas fired plant. To this end, the group commissioned consultants ILEX to develop a number of demand and generation scenarios and associated interconnector power transfers to test the dynamic performance of the network and identify possible constraints. The ILEX

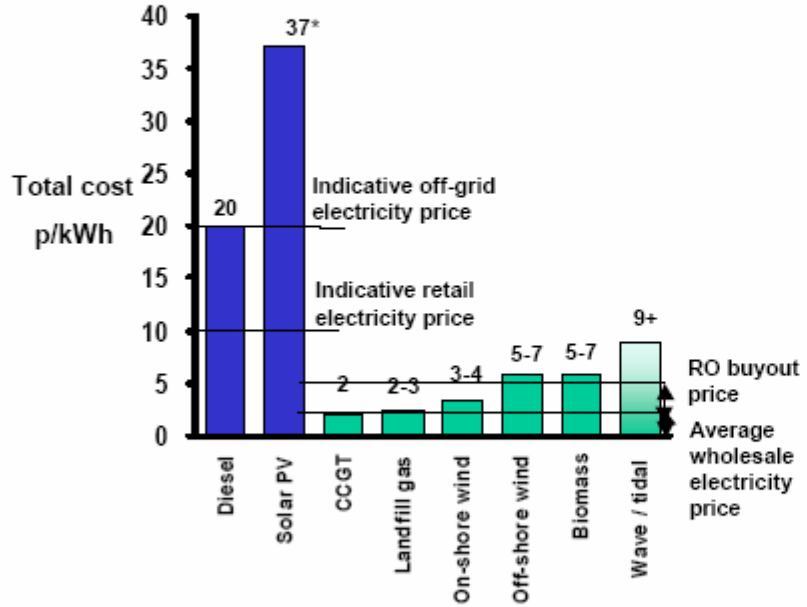
[1] Since this report was published, it has been drawn to our attention that the figure used to calculate a target based on projected generation output by 2020 was incorrect. An unfortunate error in transcription has meant that the calculation in this section was carried out using the figure 45.5 TWh for electricity generation in 2003, instead of the correct figure - 49.5 TWh. The effect of this error has been to make the estimated figure for renewables capacity required to meet the 40% target based on projected generation 0.6 GW lower than it should have been (using the same assumptions).
The error is unfortunate, but it does NOT change the report's conclusion on how the Executive's 40% renewable target might be translated into capacity terms - this figure (6 GW) is based on projected output as a proportion of demand, and is produced from the calculation for scenario (b). It should also be borne in mind that the installed capacity target is illustrative - it provides a representation of what Scotland should aspire to achieve from renewables, given our huge resource and the clear economic and environmental benefits. Ministers have already said that they do not regard the capacity figure produced by the FREDS report as a cap.

scenarios were based on total energy supply and were consistent with the above projections although work is not yet complete on this report.

Using an average load factor of 33%, this would require a total renewables installed capacity of around 6GW. It should be noted however that the Robin Rigg offshore wind development in the Solway Firth, although consented by the Scottish Executive, will be connected to the Cumbrian transmission system and that the electricity produced will not therefore count towards Scottish targets. The installed capacity of Robin Rigg should not therefore be included under this scenario.

Wind, both on- and off-shore dominates near-term forecast renewables growth as the only scaleable, economically viable technology under the RO

Cost competitiveness of renewable versus conventional technologies in 2003



Off-grid costs On-grid costs (low uncertainty) On-grid costs (high uncertainty)

* Under UK conditions for integrated systems

Sources : Carbon Trust (2003); Oxera; and internal review modelling

Scaleability

- On-shore wind has large demonstrable capacity that can be developed
- Off-shore wind is expected to have similar characteristics
- Biomass has similar economics to offshore wind but fuel supply chains are currently not sufficiently established

11

Annex C

Key Conclusions of the FREDS Marine Energy and Biomass Energy Groups

Marine Energy Group

- There is a clear case for additional public sector support for marine energy and Government should give a clear and early commitment to determine the most efficient method and level of financial support that can be provided.
- The European Marine Energy Centre must be supported in the work it has already begun to establish Scotland as the internationally recognised centre for marine energy technical, operating and safety standards.
- The regulator and the grid operator should prioritise action on transmission investment with particular regard to connecting those remote mainland and island locations that can provide the greatest renewable generation capacity.
- Economic development strategies and policies should be reviewed to ensure that they can adequately support a vibrant Scottish manufacturing and supply chain for marine energy.

Biomass Energy Group

- Appropriate means to support supply chain infrastructure innovation and development should be considered.
- The regulatory agencies, in particular SEPA and Ofgem, must recognise the opportunities that exist to develop biomass power sources and adopt a proactive approach to overcoming problems.
- There is a funding gap to be overcome if Scotland is to make the most of its biomass opportunity. Government should commit to determine at an early date how that support should be provided.
- The Forestry Commission should keep under regular review the level of support that it provides to the growers of energy crops in Scotland.
- The Executive should consider amending the Renewables Obligation Scotland to ensure the greater use of co-firing using wood fuel.

Annex D

Membership of Future Generation Sub-Group

Keith Anderson	ScottishPower
Archie K Campbell	CoSLA
Sandy Cumming	Highlands and Islands Enterprise (Chairman)
Lewis Dale	National Grid Company
Charles Gallacher	Ofgem
Elaine Hanton	Highlands and Islands Enterprise (co-secretary)
Karl Johnston	The Scottish Executive
Sarah Kydd	Department of Trade and Industry
Keith MacLean	Scottish & Southern Energy
Graham McKee	Scottish Enterprise (Deputy Chair)
Wilson Malone	The Scottish Executive
Maf Smith	Scottish Renewables Forum
Neil Stewart	The Scottish Executive (co-secretary)

Annex E

Glossary of Terms

BEG	Biomass Energy Group (sub-group of FREDS)
BETTA	British Electricity Trading & Transmission Arrangements
CCGT	Combined Cycle Gas Turbine
CHP	Combined Heat and Power
DTI	Department of Trade and Industry
EMEC	European Marine Energy Centre
FGD	Flue Gas Desulphurisation
FREDS	Forum for Renewable Development in Scotland
LCPD	Large Combustion Plants Directive
MEG	Marine Energy Group (sub-group of FREDS)
NGC	National Grid Company
OFGEM	Office for Gas &Electricity Markets
PURE	Promoting Unst Renewable Energy
RETS	Renewable Energy Transmission Study
SCHRI	Scottish Community & Households Renewables Initiative
SHETL	Scottish Hydro-Electric Transmission Ltd
SPT	ScottishPower Transmission
TNUoS	Transmission Network Use of System Arrangements

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