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FRAMEWORK FOR THE DEVELOPMENT AND DEPLOYMENT OF RENEWABLES IN SCOTLAND: a response to the Scottish Government

Summary

In terms of security and reliability of energy supply, while the long term goal may be to have largely renewable sources of energy, it will be necessary to utilise non-renewable sources in the short and medium term. A diversity of energy sources is absolutely essential and all currently available sources and technologies will need to be considered as part of the energy "mix", including renewables, clean technologies for fossil fuels and nuclear powered generation.

- *With the need for large-scale replacement of electricity generating plant in Scotland and the UK within the next ten years and the fact that the scenarios given in the Framework rely on electricity playing a greater role (whether for heating or transport) the supply of CO_2- free electricity supply will have to increase and, as such, decisions on the viable options are urgently needed.*
- *Major research, development and demonstration in energy storage technologies will be needed to meet the needs of increasing intermittent renewables in the system and to balance supply and demand. Scotland has strong capabilities in this area, particularly in its academic and research institutions.*
- *A key strand of the overall approach to sustainable energy must be on energy efficiency and demand reduction. The RSE urges the Scottish Government to ensure the publication and implementation of an Action Plan for energy efficiency and microgeneration.*
- *Targets in energy policy should be linked to the current Scottish Climate Change Bill. In this regard the RSE strongly advocate the creation of an independent, authoritative audit body responsible for collecting and publishing reliable statistics, and determining whether target staging posts have been achieved.*
- *The RSE urges Scottish Ministers to collaborate with Scotland's significant research and industrial base in investigating and determining the opportunities that Scotland could exploit in rapidly accelerating the development and demonstration of CCS technology.*
- *The value of biomass as a contributor to our renewable obligations through the production of heat is slowly being recognised by government, although much more needs to be done to support this fledgling industry. It is important that the Renewable Heat Strategy currently being developed by the Scottish Government for the Biomass sector is implemented as quickly as possible.*

Introduction

1 The Royal Society of Edinburgh (RSE), Scotland's National Academy, welcomes the opportunity to comment on the draft *Framework for the Development and Deployment of Renewables in Scotland*. The Scottish Government will be aware of the importance that the RSE has attached to energy issues and it has been a major component of the RSE's recent work, not least its wide-ranging Inquiry into *Energy Issues for Scotland* (2006) and follow-on activities. The RSE's most recent Report of its Inquiry into the *Future of Scotland's Hills and Islands* is also relevant to the current Framework for Renewables given its implications for land use. The RSE also commented on DBERR's UK Renewable Energy Strategy which complements the Scottish Framework. Earlier this year the RSE arranged a briefing session for the Scottish Parliament's Economy, Energy and Tourism Committee to help inform its inquiry into Scotland's Energy Future as well as providing written comments to the same inquiry. The RSE has also commented on a range of energy and climate change related issues which the Scottish Government may wish to consider. References to relevant RSE responses are provided at the end of this response.

2 First, we address important contextual issues before addressing the topics set out in the Framework. As well as the focus on renewables in Scotland we have responded in the wider context of reducing CO_2 emissions. These aspects cannot be viewed in isolation. An approach that sets out targets and procedures without regard to the economic and social framework within which targets and procedures are being set is deeply flawed. In this regard, a strategy for emissions targets must be intimately related at least to an energy strategy that is realistic about the market impacts of policy and its socio-economic consequences.

Overarching issues

3 We recognise that the Scottish Government has substantial powers to determine energy strategy through its responsibility for the promotion of renewable energy, encouragement of energy efficiency, and its powers to grant consent for new electricity generation and transmission infrastructure. In these respects it is crucial that there are open lines of communication and wider connectivity at the Scottish and UK levels to ensure that there is a joined-up approach and alignment of energy policy.

4 We do not regard Scottish energy self-sufficiency as a worthwhile objective in itself. The priorities should be based on optimising between meeting emissions targets, ensuring energy security and sustainability, minimising cost and maximising the economic benefit that might arise through the exploitation of Scotland's research and development capacity. The approach should be to encourage interdependency with the UK, European and global markets. Such an approach should bring technological benefits to Scotland, stimulate enterprise and deliver social and environmental gains.

5 We are pleased that the ambitious Framework Document:

- recognises that transportation and heating account for considerably more energy use than electricity generation;
- acknowledges that greater efficiency and other means of reducing energy use have the potential to play a major part.
- highlights awareness and positive interest in research and development projects and facilities in Scotland.

6 In terms of security and reliability of energy supply, while the long term goal may be to have a largely renewable source of energy, it will be necessary to utilise non-renewable sources in the short and medium term. A diversity of energy sources is absolutely essential and all currently available sources and technologies will need to be considered as part of the energy "mix", including renewables, clean technologies for fossil fuels and nuclear powered generation. One key question is the debate about electricity supply from fossil fuels, renewables, or nuclear sources. There is no requirement that all three sources are part of a Scottish mix, but choices to ignore, or de-emphasise, nuclear power means that fossil fuels must be rapidly decarbonised in Scotland, and that a large capacity of renewable generation has to be researched, developed, demonstrated, encouraged, consented and connected at an electricity price competitive with the rest of the UK and EU. If nuclear energy is to be phased out, and if Scotland is to meet its highly challenging emissions target, the provision of secure baseload in Scotland will depend upon the hypothesis that carbon capture and storage (CCS) technology can be developed successfully and implemented in Scotland. We strongly emphasise that a diversity of supply is essential to achieve maximum security and flexibility, and suppression of greenhouse gases. To prepare for the longer term, investment in the development of alternative sources and cleaner technologies is essential.

7 With the need for large-scale replacement of electricity generating plant in Scotland and the UK within the next ten years and the fact that the scenarios given in the Framework rely on electricity playing a greater role (whether for heating or transport) the supply of CO_2 – free electricity supply will have to increase. Decisions on viable options are urgently needed. In its Energy Report, the RSE recommended that due to a lack of robust procedures for assessing energy technologies and the frequent lack of objectivity in assessments, that a common methodology should be developed to assess the relative merits of energy technologies. Factors such as state of technology, infrastructure requirements, security of supply, carbon benefit, environmental effects, cost to the consumer as well as full lifetime costs should be considered.

8 Renewable energy by its nature tends to be produced in relatively smaller quantities and from a much larger number of geographically dispersed sites compared with conventional GW-scale power stations. Specific per-unit capital costs (£/kW of capacity) are thus higher than for conventional power generation. Renewable sources tend to produce variable and intermittent supplies of electricity.

9 Hence, we recognise the crucial priority that the Scottish Government is attaching to CCS technology in Scotland. Given that the world will continue to derive energy from fossil fuels for the foreseeable future we welcome the Scottish Government's commitment to CCS technology and its decision to part fund a commercially-oriented study led by the University of Edinburgh to look at CO_2 storage and enhanced oil recovery options in and around Scotland. In addition, Scottish Power, with the SCCS at Edinburgh, is leading a large research programme to develop methods of storage site selection and appraisal for CO_2 from coal plant. There has not yet been a world demonstration of CCS technology on a power plant scale. Vattenfall have a 30MW thermal pilot project for CCS technology in Germany. The first pre-combustion coal and gas plants are expected to be demonstrated during 2012/3 in California and Abu Dhabi. Post-combustion gas plant may be demonstrated in Norway during 2013. It is vital therefore that an energy strategy for baseload electricity capacity, must recognise the risk that CCS technology will not necessarily be available in the short term to minimise emissions from carbon-based fuels. If CCS remains a critical part of Scottish electricity supply strategy, then significant additional effort will be needed to promote its demonstration, and especially deployment, in Scotland at an early date, and to encourage the required major investment so that Scotland is amongst the world's leaders in this. A back-up strategy needs to be maintained in case CCS proves unexpectedly expensive, slow to develop, publicly unacceptable or (in the worst case) fails to work at sufficient scale.

10 At the UK level the House of Commons Environmental Audit Committee recently reported on the prospects of CCS[1]. The Committee was rightly concerned about providing consent to new coal-fired power stations without CCS technology being available, and also recommended that Government needed to set a deadline for the cessation of unabated coal-fired generation. It also stated that the EU-ETS carbon price might not be enough to incentivise the development and deployment of the technology and that further Government intervention will be required during the demonstration period. The current UK strategy is focused on a competition to demonstrate CCS on just part (400MW) of one coal plant by 2014. It is certain that one of the three remaining short-listed entrants could demonstrate their plant in Scotland, but it is not guaranteed to win. A key world-class resource offered by Scotland is the proximity of well-known, high quality, and large, geological storage sites beneath the North Sea. This can offer economic growth potential to industries and additional exploitation of offshore hydrocarbon resources. A key blockage is the pricing of 'decarbonised' electricity at a long term (15 yr) to enable developers to operate the demonstration plant without making a loss. Therefore there is scope for Scotland to investigate devolved or EU incentives to capture one or more of these demonstrations within or outside the UK competition. These may be price supported by ROCs, feed-in tariff, subsidy by recycling of EU-ETS auction income to the UK, or allocation of EU-Allowances to reward CO_2 stored. Scotland has a real opportunity to be a world leader in the demonstration of CO_2 capture and storage technologies, and also in the use of subsurface resources for storage on an EU size scale, and in the adaptation of offshore engineering and offshore geological and geophysical surveying. We therefore urge the Scottish Ministers to collaborate with Scotland's significant research and industrial base in investigating and determining the opportunities that Scotland could exploit in rapidly accelerating the development and demonstration of CCS technology. It is important that strategic research and development capacity continues to increase and is well-connected between university and industry.

1 Carbon Capture and Storage; Environmental Audit Committee; Ninth Report of Session 2007-08; July 2008

11 We are concerned at the lack of recognition in the Framework of the implications of the current global economic climate in trying to derive 20% of Scotland's energy from renewable sources by 2020. The shift to alternative sources and cleaner technologies will require massive financial incentive and investment and it is questionable whether private sector investment will be limited by the uncertainties in the current economic climate. This is likely at least to slow down the rate of private investment, and may increase the onus on the public sector to provide significant investment. Similarly, the debate about the supply chain needs to be reconfigured to reflect these concerns as well as seizing on the undoubted opportunities that will arise. We return to this issue later in the response.

Energy Efficiency

12 We agree that a key strand of the overall approach to sustainable energy must include a focus on energy efficiency and demand reduction. If the focus is right these aspects can have the most immediate impact in terms of energy sustainability. In its Energy Report the RSE identified the need for an improvement in the efficient use of energy in reducing the use of fossil fuels in space and water heating, and in transport. Reductions in total energy demand, both in terms of demand reduction and improved efficiency, will produce proportional reductions in the overall energy required. Demand-side reduction is a very important but complex area and effective cross-cutting engagement and action across government departments is essential. This conclusion was also reached in a Scottish Executive Report of 2007[2]. The possibilities for energy savings are large but the primary obstacle is behavioural change. This requires a package of education, information and financial incentives. Whilst energy efficiency is important, and can be stimulated through regulation, the focus must be on demand reduction, bearing in mind that there is frequently a rebound effect in domestic usage. An example would be the driver who replaces a car with a fuel-efficient model, only to take advantage of its cheaper running costs to drive further and more often. Rebound effects in commercial usage are not inevitable if the objective is to reduce cost. Therefore, it is important that rebound effects are factored into policy assessments.

13 We note the references to building standards in the Framework and while we welcome an increase in standards the main issue is not the standards themselves but the need for their rigorous enforcement. As well as this, the Framework focuses on new buildings but it is important that retrofitting existing buildings is regarded as similarly important. Given the recent downturn in new build it could be explored whether the construction industry and its skilled workforce could have a renewed focus on improving the existing building stock. The public sector might take a leadership role in this respect.

14 The RSE's Energy Report indicated that there are many energy efficiency schemes, with low take-up, being managed by a range of organisations, and hence the need for more efficient administration and coordination. On reading the section on energy efficiency in the Framework while it appears there are a number of well intentioned initiatives, overall coordination and specific actions to improve energy efficiency are still absent. In this regard we welcome the Scottish Government's continued commitment to publish an Action Plan for energy efficiency and microgeneration and urge the Government to ensure its publication and implementation are forthcoming.

From Now to 2020

15 The Framework on renewables is highly aspirational. Many of its ambitions need a greater rationale and prioritisation. For example, the Framework states:

"20% of total Scottish energy use coming from renewable sources by 2020"; "become Europe's biggest exporter of renewable energy"; and "aspire to a higher figure for renewables than the UK as a whole"

16 *The focus* should be clearer and achievable. For example on progressive reduction in the absolute amount of carbon emissions while maintaining security of supply, all within cost limits which the consumer and public budgets will tolerate. Targets in energy policy should at least be linked to the current Scottish Climate Change Bill.

17 In this regard we strongly advocate the creation of an independent, authoritative audit body responsible for collecting and publishing reliable statistics. We suggest that the two audit functions, of energy and emissions, should be well integrated, preferably by the same body. At the moment there are considerable uncertainties and gaps in the available data that need to be resolved if public policy is to be well-informed and if progress towards agreed targets is to be monitored and adjusted. It is important that we agree about the facts and then debate what should be done, rather than arguing about the facts. The Royal Society of Edinburgh would be happy to comment further on the establishment of such a body if required.

2 Evaluation of Energy Efficiency Policies and Programmes; The Scottish Executive; March 2007

Renewables in Electricity

18 The major part of the UK's natural resource in wind, hydro, marine and biomass energy are found in the north of the UK. This is illustrated by the fact that 50% of the UK renewable energy production is sourced from Scotland[3]. Renewable sources of energy are a key contributor to energy supply needs because they reduce "whole life" CO_2 emissions from overall electricity production and also crucially, increase the diversity of fuel resources and hence security of supply. According to the DBERR UK Renewable Energy Strategy, subject to planning permission, there is an expectation that a large proportion of onshore wind development will take place in Scotland. Consequently, there are significant prospects as well as challenges for Scotland in utilising its natural resources as components of the energy mix. It must be recognised that abundance of resource does not necessarily result in its utilisation as that resource must be harnessed efficiently and at a competitive price.

19 The exploitation of renewable energy offers significant opportunities for economic growth from manufacture and export, as well as providing employment in site development, management and maintenance. However, we believe the expectations and main constraints for each technology referred to in the current Framework are not reasonable, and do not include consideration of engineering demands (e.g. the development of deep water offshore wind gear boxes), supply chain requirements, or manpower and technological availability to install, operate and maintain them.

20 The different technologies need to be divided into what could be done now and what still needs development as well as consideration of what might become available in the future. The Scottish Government should track the development of the various technologies and recognise that they will develop at significantly different rates and also have differing cost considerations. Once a technology has been proven the Government must ensure that its policy intervention is made at the right time so that the investment climate and supply chain is in place.

Financial support

21 In the case of wave technology, devices that have been developed and demonstrated are highly subsidised. The Pelamis project in Portugal, which has recently gone live, is subject to a guaranteed price for its electricity for 15 years.

22 Basic research, e.g. into wave behaviour and measuring vibrations and conditions of large wind generators at sea, needs to be stimulated, and the major costs of development and implementation need to be recognised and planned for. Uncertainty about real future costs, particularly installation, operation and maintenance costs, is a major problem. Reliability is uncertain and raw material prices are volatile. In terms of improving reliability perhaps the technology and design details of common components could be placed in the public domain. It is important that work take place to establish whether some of the above risks can be mitigated by a regime of capital grants and adjustments to economic instruments.

23 With regard to the deployment of offshore wind, wave and tidal technology, ultimately, the gap between capital costs, expected operational costs and revenue still remains too large for substantial industrial commitment without improvements in the ROC system. The ROCs regime is designed to be technology neutral and encourage diversity of electricity generation. However, undifferentiated ROCs will always lead to industry employing the lowest cost option. As a result, onshore wind turbines have become commercially viable, but this mechanism has not stimulated development of other renewable sources other than for local use. In order to bring forward emerging renewable technologies, "banding" of support levels for different technologies has been proposed. The RSE has commented on the ROCs regime and "banding" in its Report of 2006 as well as in recent responses on energy[4]. Ultimately it is important that there be a consistent and stable investment climate.

Renewables in Electricity

24 Grid access, connections and transmission infrastructure, and the technical difficulties in maintaining quality of supply in remote areas, are prominent barriers to realising Scotland's renewable potential. These barriers are likely to intensify with the significant increase in electricity from renewable sources envisaged without improvements in the grid system. Wherever and by whatever means electricity is generated, it must be delivered to the market. The greater the diversity and distribution of generating plant the greater the need for investment in grid development and increased in-grid management costs. The significant sources of renewable energy tend to be remote from major demand centres and grid access points, thus requiring heavy investment in EHV grid extensions and consequential delays to connection.

3 The Energy Technologies Partnership, Expression of Interest in Support of the UK Energy Technologies Institute; February 2007

4 Select Committee on Economic Affairs Inquiry into *The Economics of Renewable Energy*; June 2008; Scottish Government preliminary consultation on the *Introduction of Banding to the Renewables Obligation* (Scotland); July 2008

In terms of the 'GB Queue' which mainly exists in Scotland, there are approximately 9.3 GW of wind energy applications awaiting connection[5]. Ofgem and DBERR have recently completed their Transmission Access Review [6]. We hope that the measures identified by the Review result in better access to the Grid and operation arrangements in practice and provides greater certainty and incentivisation to all those involved. We also welcome the dialogue between National Grid, Ofgem and the Government on encouraging strategic investment in the Grid system in advance of need, to help stimulate and facilitate renewable deployment. It is crucial that the regulatory system provides investors with long term stability and confidence in which to make decisions. Meeting the challenging targets proposed for renewables will have major implications for the electricity networks and at this point we draw the Scottish Government's attention to the Final Report for Ofgem's LENS Project[7]. This Report is intended to help inform the development of the regulatory framework to deliver future energy networks by setting out a range of plausible electricity network scenarios for Great Britain in 2050.

25 At about 20% penetration, intermittent renewable electricity generation e.g. wind may well increase system operating costs significantly from the running of flexible and part-loaded back-up plant. Deployment of storage capacity would help to balance the Grid, which would be operating with an increased proportion of variable, intermittent renewable generation, although this also carries cost implications.

26 The scenarios and targets set out in chapter four of the Framework envisage that renewable electricity will make the dominant contribution to the 20% target. This means major research, development and demonstration in energy storage technologies will be needed to meet the needs of increasing intermittent renewables in the system and to balance supply and demand. Pumped storage hydroelectricity is the only proven large scale energy storage mechanism and has been operating for decades. Pumped storage offers a crucial back-up facility at periods of high demand due to its flexibility and could be used to store power from intermittent generators at periods of low demand. If renewable electricity from wind, wave and tidal power continues to develop, there is the possibility of large over-production at off-peak periods. This must be stored, sold or dumped. These effects do not seem to have been fully evaluated. There is scope for integration into the overall supply strategy – for example cheap off-peak electric heating for fuel-poor, or recharge of batteries for electric and hybrid vehicles to displace transport emissions.

27 Generally the draft Framework does not appreciate the most recent developments in energy storage. The USA and Japan are funding major projects on large scale storage including compressed air, chemical storage and batteries. Electrochemical technologies provide some of the most practical solutions. For larger scales, redox flow fuel cells have particular potential and are being developed by Plurion in Scotland with support from ITI Energy. For smaller stationary applications and mobile applications in particular, modern battery technology, based on either lithium or on nickel-metal-hydride is being considered. There is considerable expertise in this field in Scotland in St Andrew's University. We return to storage in regard to sustainable transport.

28 The most immediate infrastructure project with major implications for Scotland is the proposed transmission line upgrade between Beauly and Denny. A number of commentators consider this to be a prerequisite in harnessing and transmitting Scotland's renewable electricity potential. The proposed Beauly to Denny infrastructure project also highlights the long timeframe it takes to make decisions of this nature, with a final decision from Scottish Ministers still awaited. The need for further onshore reinforcements and sub sea cables is also being considered to help realise the full potential of Scotland's renewables. It is crucial that decisions for investment in the grid infrastructure are made timeously by the industry, regulators and Scottish Ministers to allow the connection of renewable generation technologies and ensure coordination of construction activities to avoid stranded assets.

29 A consequence of the GB electricity transmission charging regime is that generators in Scotland face higher connection charges compared to generators elsewhere in GB because of their distance from centres of population. This could act as a disincentive to renewable electricity generation in Scotland. Although we understand there are plans to review the system of charges.

5 *Renewable electricity – generation technologies;* Innovation, Universities, Science and Skills Committee; Fifth Report of Session 2007-08; June 2008

6 Transmission Access Review – Final Report; Ofgem & DBERR; June 2008

7 Electricity Network Scenarios for Great Britain in 2050; Final Report for Ofgem's LENS Project; November 2008; Authors: Graham Ault and Damien Frame, Institute for Energy and Environment, University of Strathclyde; Nick Hughes, King's College London.

30 One of the primary constraints is the distribution system, particularly given the increasing levels of distributed generation, which is generation connected directly to the distribution network. It is likely that small scale and distributed generation will become significant components of generating capacity. Under these circumstances, a "smart" or "intelligent" network able to accept distributed generation with multi-directional power flows, and with the flexibility to incorporate new technologies, is a priority. We return to these issues in the discussion of distributed and community energy.

Renewable Heat and Bioenergy

31 We agree that to date most focus has been on electricity supply. This is symptomatic of the history of energy policy in the UK, where the supply of heat is largely ignored. This is against the backdrop that heating comprises approximately 53% of energy consumption in Scotland. We consider that a much more detailed consideration of heat supply, and relevant innovation, is needed in Scotland. This could, for example, be 1) in the use of biofuels for heating in rural regions off the gas grid; 2) in the use of 'waste' heat to supply local industries within 30km of existing large power plants; 3) the design of integrated district heating as part of the planning process during re-developments such as in east Glasgow. All of these aspects are well established in Scandinavian countries although it should be recognised that the history of heat and electricity supply in these countries are quite different from Scotland.

32 A major new market for wood is emerging in the shape of biomass. The value of biomass as a contributor to our renewable obligations through the production of heat is slowly being recognised by government, although much more needs to be done to support this fledgling industry. The recent report from The Wood Fuel Task Force[8] highlights the increased competition for woody material in this sector and identifies numerous actions for government and private sector bodies to undertake. The key recommendations are as follows. There is a need to develop a new branch wood and brash recovery grant to help to encourage growers to bring this material to market, and to do more thinning in their forests and woodlands. A commitment to sustain a range of supply-chain capital grants, and access and timber transport grants for the next three to five years is required from the Scottish Government; this would include the continuation of the Scottish Timber Transport Fund and a variety of biomass support mechanisms, in conjunction with rural development contracts. Further, the commercial and industrial waste-producing sector should be encouraged to improve source segregation to maximise the availability of clean wood and increase awareness of opportunities to avoid landfill tax. The Task Force has identified some seven million dry tonnes of new material suitable for use by the bioenergy sector, from established forests and woodlands; short-rotation coppice and short-rotation forestry; and recycled arboriculture arisings and waste wood.

33 Analysis of those European countries, such as Austria, that have successfully adopted biomass from forestry shows the need for long-term government support, particularly in developing heating and supply distribution networks. The rise of community heating schemes in Europe presents a model that will be of increasing relevance to rural Scotland and which would bring forestry as a land use much closer to the local population. The use of biomass in heating municipal buildings, as has started in parts of Scotland, will also contribute to this. However, funding to support this new sector has been small in scale and has suffered from a stop/start approach. It is a matter of some urgency that the Biomass Support Scheme is renewed and long term funding packages put in place to encourage this market to develop and provide greater security for those taking part. To encourage development of this activity, local government could be given targets for biomass use in municipal buildings.

34 As it becomes clearer that the best use of biomass is in heating schemes, or combined heat and power, rather than in only generating electricity (claims of 90 per cent efficiency in the former are approximately three times higher than for electricity-only plants such as the Eon plant at Lockerbie), it is important that the Renewable Heat Strategy currently being developed by the Scottish Government for the Biomass sector is implemented as quickly as possible. Clear long-term goals should be set up alongside support mechanisms. These need to be combined with the development of better supply calculations based on regional analysis, both for wood fibre and for other sources of biomass. The high cost of transporting biomass products means that local production will dominate supplies and will provide strong arguments for increasing biomass availability in parts of the country with low levels of forest cover. Biomass is of particular relevance to communities remote from major gas distribution networks and could be of increasing importance on certain islands and remote rural areas. Thus a major driving force in afforestation, in at least some parts of the country, will be the need to increase biomass availability at a local level. A major issue for land use in Scotland over the next decade and more will be both the geographic location and type of land that will be afforested for biomass production.

8 Increasing the Supply of Wood for Renewable Energy Production in Scotland; The Wood Fuel Task Force; January 2008

Distributed Energy and Community Based Schemes

35 As previously referred to, there needs to be greater use of local energy sources which are capable of reducing costs, reducing environmental impact and increasing security of supply and resilience to fuel supply shortages or centralised supply and distribution outages. There is considerable opportunity for distributed energy systems in many parts of Scotland to create semi-autonomous networks. This could range from large-scale district heating or CHP in the major settlements to microgeneration facilities utilising renewable energy sources in the remoter areas of the mainland and on the islands. The statutory planning framework has not been effective in promoting the use of waste energy, or the development of district heating and CHP schemes. The utilisation of substantial waste heat from industrial processes or from power generation should be examined. We commend the innovative initiatives in Lerwick and Wick and new technologies available for obtaining energy from domestic and other waste.

36 The prospects for economic benefit to local communities from energy technology and energy production from renewable sources are substantial. The current concentration on onshore wind technology can bring community benefits, provided that the scale and location of the development is in keeping with the local environment. But it is of the greatest importance that local communities receive real financial benefits in the longer term. This has seldom been the case with such developments in the past.

37 There are emerging technologies, which are expected to come into productive use in future decades that can provide energy to local communities to reduce the reliance on imported sources, provide financial benefits, and not detract from the local environment. A bottom-up approach as envisaged can also provide significant employment and economic opportunities for local communities. Smaller scale wind, micro hydro-electric, the use of forest waste or low grade wood for biomass, the use of waste from industrial processes, as well as tidal and wave sources along the coast, are the ones most likely to emerge in the next decade or so. Although these technologies will not all develop at the same rate or have the same costs. Communities should be supported in making the best of these opportunities.

38 We applaud the activities of *Community Energy Scotland*. It can help to build community capacity to negotiate successfully with large energy companies. However, we would like to see more communities actively taking control of their energy production. The development of local electricity grids and the development of renewable energy sources for local use are all part of reducing the carbon footprint of rural areas. We consider that there is a gap in technical support between that at community level and those of the multinational companies. There are high barriers to entry and we consider that support mechanisms should be put in place to assist in bringing new schemes of medium size and complexity to fruition.

39 Formidable challenges which must be overcome include the need for significant development of the distribution network in many remote areas of Scotland. Many of the small, although extremely important, projects having to bear the cost of upgrading the distribution network in order to connect.

40 Distributed energy i.e microgrids require electricity storage to ensure security of supply. For small scale, lead-acid batteries are currently used. In future, lithium batteries are anticipated (in Japan they are already on the market for domestic dwellings). Redox flow technologies are anticipated for medium sized microgrids. In general these technologies require much greater research and development.

Sustainable Transport

41 Approximately 28% of energy demand in Scotland is from the transport sector with road and air transport dominant. Transport fuel is primarily oil based and in its Report of 2006 the RSE indicated that most commentators consider that oil-based resources will remain the main fuel source for the next 25 years, with gradual market penetration of biofuels, hybrid engines, and hydrogen (if solutions to cost effective H_2 generation and storage can be found). The transport sector also produces the largest emissions of greenhouse gases after energy supply and land use; for the UK as a whole this is about 20% of total emissions. Any energy strategy for the transport sector should, therefore, focus primarily on the reduction in carbon and other greenhouse gases, and in higher fuel efficiency; these two components should go hand-in-hand. In its Report the RSE considered that a range of incentives and restrictions are needed to stimulate the market for hybrid engines, technologies to capture energy from otherwise wasted sources such as braking, incentives for higher car occupancy, and measures to reduce speed in order to reduce consumption. In terms of public transport, there is also a need for more flexible fleets capable of adjusting to variable levels of passenger use, especially at off-peak periods. We recognise it will take time for new vehicles and new fuels to become commonplace and the need for joint working with the motor industry and other relevant stakeholders.

42 By 2020, CO_2 reductions will come from evolution of existing vehicle technologies, including more fuel efficient internal combustion engines, lighter weight materials etc. and from hybrid electric vehicles. The former alone could reduce CO_2 emissions by 30%[9]. Hybrid vehicles (which combine an internal combustion engine with a battery) are already on the market; they use conventional nickel-metal hydride batteries. New generations of hybrids using lithium battery technology are expected to be prominent in the market place well within the 2020 timescale, offering further significant reductions in CO_2 emissions.

43 Around 2020 and beyond plug-in hybrid electric vehicles (PHEV) are likely to be the major technology for decarbonising transport. They also combine an internal combustion engine with a battery and supercapacitor, but now the battery is dominant and the engine subordinate. The battery will be able to power the vehicle for the average daily commuter journey. If recharging is from low or zero CO_2 electricity this could lead to a major reduction in vehicle emissions, while maintaining flexibility for long journeys without the need to recharge from fixed charging points. During the night when the ratio of wind energy output to demand is likely to be at its highest, PHEV's could offer a major means of energy storage, balancing the intermittency of renewable supply with consumer demand. Realising the potential impact of this critical technology will depend on a step change in research and development on high energy density batteries and high power supercapacitors. Such research and development is within the category of technologies we do not have but can reasonably expect to develop. Beyond 2020 new generations of PHEV's will be required to further reduce emissions and these will depend on scientific breakthroughs in batteries and supercapacitors beyond what can be anticipated. Therefore, urgent and sustained research and development on batteries, supercapacitors, hybrid power trains, and smart electronic management are essential. Scotland has strong research in batteries and fuel cells. AGM Batteries manufacture lithium batteries in Thurso but like all lithium battery manufacturers they focus on portable electronics applications. Axion in Aberdeen and Dundee manufacture and supply lithium battery packs for electric vehicles in the UK. ITI Energy support research and development at FiFe Batteries, currently located at Culham in Oxfordshire.

44 There is potential in hydrogen as an energy vector for transport applications in the longer term provided that it is produced from low carbon emissions sources and if cost effective and efficient means of H_2 generation and storage can be found. This will require intense research as the solutions are not obvious. Widespread applications of hydrogen technology require major investment in production, transport and storage infrastructure, and stimulation of demand. More medium term use of hydrogen for transport includes using it in a normal combustion engine and this obviates the need to wait for cost effective and reliable fuel cells but does not circumvent the need for production and storage. Public transport is particularly amenable to hydrogen fuel cell implementation as there is much less need for a distribution network and storage in buses is easier to implement. The major European HyFLEET:CUTE[10] project involves the operation of hydrogen fuel cell powered buses as well as hydrogen powered internal combustion engine buses in cities around the world and also focuses on the development and testing of hydrogen refuelling infrastructure. Also, despite its relatively small scale, the PURE Energy Centre on Unst is involved in the research and development of hydrogen technologies, and has utilised wind power to extract hydrogen from sea water and use it in conjunction with a fuel cell. However, the problem of hydrogen storage is the primary issue and work on identifying hydrogen storage materials continues worldwide, including here in Scotland. The Hydrogen Energy Group established by FREDS reported[11] on opportunities for Scotland in this area. We recommend that the Framework should look to build upon current capabilities and stimulate further development in Scotland.

45 In terms of the potential from biofuel, current biofuel (biodiesel, bioethanol) production is proven technology and therefore provides a basis for production of non-fossil transport fuels. The Royal Society of London recently published a comprehensive report[12] on the science and technology prospects of delivering efficient biofuels for transport in the broader context of environmental protection and sustainability. That Report shows that biofuels are potentially an important part of the future although the existing policy frameworks and targets may not result in greenhouse gas reductions and wider environmental and social benefits. It is a very complex picture as different biofuels have widely different environmental, social and economic impacts.

9 The King Review of Low-Carbon Cars; Part I: The Potential for CO_2 Reduction; HM Treasury; October 2007

10 http://www.global-hydrogen-bus-platform.com/Home

11 Hydrogen and Fuel Cell Opportunities for Scotland; Hydrogen Energy Group (FREDS); 2006

12 Sustainable Biofuels: Prospects and Challenges; January 2008

Whole cycle analysis is required for the different biofuels to assist in determining these impacts. Future biofuels are likely to be produced from a much broader range of feedstocks, including agricultural by-products and domestic vegetable waste. Advances in the conversion process will improve the efficiency of producing biofuels. We urge the Scottish Government to consider the Royal Society of London's Report.

Consents and Planning

46 The planning system, public consultation and the democratic process generally, specifically in relation to onshore wind farms, form the greatest barriers to increased deployment of renewables. The locations of renewable energy devices, and in particular onshore wind turbine installations, are controversial because of their impact. We strongly support the recommendation of the RSE Energy Inquiry on the need for a locational strategy for renewable energy and this argument is strengthened by the proposals from DBERR in relation to onshore wind deployment in Scotland. There are signs of a shift in this direction in respect to onshore wind with the publication of supplementary guidance to Planning Advice Note 45[13]. The forthcoming National Planning Framework will have strategic importance in terms of bringing forward developments of importance to national infrastructure, including energy. To date many applications have been through a planning system which was not designed to cope with the volume of applications and has not been updated to allow effective representation by objectors or speedier decision making which is in the interests of all parties.

47 In terms of developments impinging on communities, natural heritage and the environment, perhaps some form of compensation or reparation payment could be developed to ensure that the impact is kept to a minimum and those directly affected can derive direct benefit. As examples, the Shetland Islands receive income from the North Sea oil revenues that has contributed to an improved economic state and infrastructure, and in Denmark, local attitudes to onshore wind installations softened substantially when electricity costs were reduced to hosting communities.

Research and Development

48 Research, development and demonstration of projects are paramount and these aspects should be built-in to a programme and not treated in isolation from one another. There needs to be better integration between these components. The real benefit of full scale demonstrators is their potential to provide confidence in a technology.

49 Scotland is endowed with major research and development capacity that spans the energy spectrum, particularly within its institutions. In the UK, the University of Strathclyde, judged in relation to the Engineering and Physical Sciences Research Council (EPSRC) and Carbon Trust research income it receives, is first in electricity transmission and distribution. The University of Edinburgh is first in ocean energy[14]. The Scottish Centre for Carbon Storage (SCCS) (located at the University of Edinburgh, Heriot-Watt University and the British Geological Survey) is first in geological storage of CO_2. The University of St Andrews is second in energy storage. Petroleum Engineering at Heriot-Watt University is internationally pre-eminent in hydrocarbon exploitation. Also, The Sustainable Power Generation and Supply initiative (Supergen) research consortia in marine energy, in highly distributed power systems and in energy storage are each led by Scottish universities. Crucial to the pull-through of energy technology is the need for the research and development community to be close to leading development and demonstration facilities as well as energy sources. In Scotland such facilities include the European Marine Energy Centre (EMEC), the PURE Energy Centre on Unst, the Scottish Enterprise Energy Technologies Centre, and the University of Edinburgh's curved wave tank. Doosan Babcock at Renfrew is unique in the UK as an international research and test facility for cleaner coal combustion and CO_2 capture. We also understand that Scottish Enterprise is moving forward with a power networks and demonstration facility and this will be particularly important in terms of smaller scale distributed energy sources. Furthermore, pull-through and commercialisation is being aided by the Intermediary Technology Institute (ITI) in Energy, which funds and manages early stage research and development programmes across the energy spectrum, including renewables, power networks and energy storage. The Energy Technology Partnership (ETP) is a strong pooling collaboration between all of Scotland's Universities engaged in energy research. It represents the largest and most broad based power and energy research partnership in Europe. The members of the ETP are active across the range of energy sectors and across the research, development and demonstration spheres[15]. This represents a very significant body of expertise working in Scotland.

13 PAN 45: Annex 2: Spatial Frameworks and Supplementary Planning Guidance for Wind Farms; November 2008

14 Scientific Network of Excellence in Energy; Scottish Science Advisory Committee; December 2006

15 http://www.etp-scotland.ac.uk

Supply Chain and Skills

50 A major hindrance and threat to the development and commercialisation of energy technologies in the UK is the lack of technically-skilled people. There is a deficit below requirements in those studying and graduating in engineering as they once did. This is equally true for energy engineering and other career paths relevant to the energy field such as physics, chemistry and mathematics. This must be addressed if Scotland is to deliver on its challenging targets and aspirations. As part of this, the government must investigate the skills crisis and introduce initiatives to act as a catalyst to introduce new students to energy-related discipline areas. The Innovation, Universities, Science and Skills Committee has been undertaking a wide-ranging inquiry into engineering and the findings are eagerly awaited. In Scotland, some effort has also been made by the Scottish Enterprise, High Technology Talent Strategy Board. The government's Knowledge Transfer Partnership programme is a most effective enabler for knowledge transfer and a flagship programme could usefully be established in the area of new and renewable energy systems. Such an initiative would both bridge the industry/academia gap and help with the training of new graduates.

51 The Scottish Government has a strategic objective of creating a wealthier and fairer Scotland. It is also determined to maintain and help create new employment opportunities in difficult economic circumstances. The Government and local authorities should encourage Scottish enterprises to explore the possibilities of whether they can adapt their processes in order to provide parts for the renewables industry if demand increases. Scotland already has strong capabilities within its offshore industry that could be further capitalised upon. Otherwise there is a risk that Scotland will have to rely on the import of technologies.

Additional Information and References

In responding to this consultation the Society would like to draw attention to the following Royal Society of Edinburgh responses which are of relevance to this subject:

- The Royal Society of Edinburgh's Inquiry into *Energy Issues for Scotland* (June 2006)
- The Royal Society of Edinburgh's *Energy for Scotland: A Call for Action* (May 2007)
- The Royal Society of Edinburgh's submission to the Select Committee on Science and Technology Inquiry into *Renewable Energy-Generation Technologies* (July 2007)
- The Royal Society of Edinburgh's response to the Scottish Government's *Proposals for a Scottish Climate Change Bill* (April 2008)
- The Royal Society of Edinburgh's submission to the Select Committee on Economic Affairs Inquiry into *The Economics of Renewable Energy* (June 2008)
- The Royal Society of Edinburgh's submission to the Scottish Government *Introduction of Banding to the Renewables Obligation* (Scotland) – Preliminary Consultation (July 2008)
- The Royal Society of Edinburgh's submission to the Scottish Parliament Economy, Energy and Tourism Committee Inquiry, *Determining and Delivering Scotland's Energy Future* (August 2008)
- The Royal Society of Edinburgh's Inquiry into the *Future of Scotland's Hills and Islands* (September 2008)
- The Royal Society of Edinburgh's submission to the Department for Business, Enterprise & Regulatory Reform (DBERR) *Draft Renewable Energy Strategy* (September 2008)
- The Royal Society of Edinburgh's response to the Scottish Government's consultation, *Adapting Our Ways: Managing Scotland's Climate Risk* (October 2008)

Any enquiries about this submission and others should be addressed to the RSE's Consultations Officer, Mr William Hardie (Email: evidenceadvice@royalsoced.org.uk)

Responses are published on the RSE website (**www.royalsoced.org.uk**).

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