The Royal Society of Edinburgh's call for evidence: Scotland Energy Future

To whom it concerns,
Please find below Dunelm Energy's response to The Royal Society of Edinburgh's call for evidence regarding Scotland's Energy Future.

Ian Marchant set up Dunelm Energy after he left SSE (CEO 2002-2013). The company provides assistance and connections to companies and individuals involved in the disruptive changes in the energy industry (http://dunelmenergy.co.uk/home.html).

1. What are the most significant challenges to, and influences on, the energy landscape that any future energy strategy needs to take into account?

The physical nature of our energy system is changing, rapidly. As we decarbonise our economy, we will drastically reduce the flexibility and resilience within both the heat and transport sectors (as existing energy storage in the form of fossil stocks in our car tanks and gas from the North Sea declines). This will require new sources of flexibility and reliability in heat and transport, part of which may switch to electricity where we will simultaneously reduce that systems own storage as old coal stations which their piles of fuel start to close.

Demand for energy varies constantly throughout the days, weeks, months and the future energy system of Scotland needs to be flexible and deliver electricity and heat at the right times. The transition to low-carbon and renewable generation in conjunction with energy storage technologies can help to tackle climate change, decrease our resilience on fossil fuels and maintain energy security. We need both innovative and long-standing storage technologies to provide greater flexibility and to maximise our use of renewable generation by storing it at time of low demand and making sure it is available when we need it most. The level to which storage is deployed is also important. We believe positioning storage at the smaller distributed end, at the household and community level is most important, rather than relying on fewer centralised schemes at grid level.

Decarbonising heat in Scotland is also an important task and will require a set of solutions involving the development of new infrastructure to support all three-heat vectors; gas, district heat and electrification. For decarbonisation of heat in Scotland, difference solutions will have to be found to address a whole diversity of end users needs and local circumstances. Hydrogen appears to be convincing pathway to decarbonisation and is already entering the energy system in stand-alone applications. Hydrogen has the potential to play a valuable and integrated role, helping to manage the electricity grid, fuel the vehicle fleet and provide heat for homes and industry. These applications could use hydrogen from natural gas or from surplus renewable energy, and will benefit from removing regulatory and market barriers to help them become commercially viable.

One of the biggest challenges facing the energy system is the issue of urban heat. Urban areas play a key role in climate change mitigation and some estimate that the cities share of energy demand and carbon emissions will approach 80% over the next 20-25 years. The main issue with urban heat is the loss of carbon from the system. Infrastructure and technologies should be focused on a transition through a combination of more electrification, decarbonised fossil fuel heat and conversion to hydrogen.

2. What will energy demand in Scotland look like in 2030, 2040, and 2050?

Demand for energy varies constantly throughout the days, weeks, months and the future energy system of Scotland needs to be flexible and deliver electricity and heat at the right times. The transition to low-carbon and renewable generation in conjunction with energy storage technologies can help to tackle climate change, decrease our resilience on fossil fuels and maintain energy security. We need both innovative and long-standing storage technologies to provide greater flexibility and to maximise our use of renewable generation by storing it at time of low demand and making sure it is available when we need it most. The level to which storage is deployed is also important. We believe positioning storage at the smaller distributed end, at the household and community level is most important, rather than relying on fewer centralised schemes at grid level.

Looking forward to 2030, 2040 and 2050 we envisage energy demand to look very different. We would hope to envisage that the demand for energy is substantially lower with emerging technologies and increased energy efficiency in domestic, industry and transport sectors. We would foresee energy demand decreasing on a downward slope towards 2050 and levelling off. For example in the domestic sector heating demand would follow this pattern as emerging technologies, building standards and smart appliances make homes more efficient and changes the pattern of energy demand. In other sectors the electrification of heat and transport should occur by 2050, therefore changing the energy demand in Scotland.

3. What are the biggest barriers faced to meeting the demand we will have for energy by 2030, 2040, and 2050?

So far Government policies and targets have been focused on the supply side of the energy industry, this is natural enough, as historically the industry as revolved around generation. Missing is an appreciation of the individual needs and choices that form the *demand* side of the energy problem. We believe that the biggest shift that is required in policy and strategies is to incorporate the demand side that balances flexibility, meeting needs and affordability. Policies and strategies also need incorporate support mechanisms for emerging technologies and realise the interdependence of heat, transport and power. For example by 2050 we would hope to see electric vehicles being also used as storage devices or the gas infrastructure being capable of supplying green gases, both hydrogen and biogas.

4. Given the international nature of energy market, how should acceptable quantities and origins of energy imports, and their associated energy security risks, be assessed?

Scotland will face the same security and continuity of supply issues as the rest of the UK, especially increasing dependence on imported fossil fuels, particularly gas and oil from the Middle East and from Russia. Scotland is in a good place in which there is the potential to produce more energy from its own natural resources and at the same time reduce its' greenhouse gas emissions. However, energy security risks are likely to increase and stricter environmental restrictions on fossil fuel consumption could be imposed. A move to renewable-energy and low carbon systems can therefore contribute to the security of energy supply and protection of the environment.

With assessment of quantities and origins of energy imports and their associated energy security risk technical assessment should be undertaken. There are several risk factors to be evaluated of the intended State to be importing energy resources from, including:

- Geological risk: possible exhaustion of an energy source
- Technical failure: owning to weather, lack of capital investment or the generally poor conditions of the energy system
- Economic risk: erratic fluctuations in the price of energy products on the markets
- Geopolitical risks: potential government decisions to suspend deliveries because of deliberate policies, war, civil strife and terrorism
- Environmental risks: potential damage from accidents (oil spills or nuclear accidents), or emissions such as greenhouse gas emissions).

Generally any source of danger to the continuity of the provisions and/or consumption of energy and energy services is conceived as a risk to energy security and should therefore be evaluated.

5. What overall role should be played by various elements of the energy landscape, for example:

- **Different sources of renewable energy;**
- **Offshore oil and gas;**
- **Unconventional oil and gas;**
- **Nuclear power**
- **Energy Storage**
- **Others**

For the future energy landscape in Scotland different sources of renewable energy and are imperative to the longer-term improvement in energy efficiency, demand reduction and the transition to a low carbon economy as well as increasing energy security. From developing the role of hydrogen in the energy mix to marine renewables, hydro power, offshore and onshore wind and solar PV, a diverse range of

renewable energy sources will be needed to generate Scotland's energy demand. Renewable technologies and emerging innovative supply side technologies can offer significant economic opportunities and improve supply security by reducing future energy supply demands and any associated greenhouse gas emissions.

Nuclear power, which was notably absent in the Scottish Government's Energy Strategy, is a certain risk in the energy landscape, given the move to a more decentralised energy supply. We believe nuclear power is an issue of scale, for example Hinkley Point C is far to big, but there has been a revival of interest in small and simpler units for generating electricity from nuclear power and for processing heat. The technologies are numerous and diverse and Small Modular Reactors (SMRs) could potentially have a key role in delivering low carbon energy at lower upfront capital cost compared to larger conventional nuclear reactors and should at least be investigated for their role in a future energy landscape in Scotland.

The physical nature of our energy system is changing, rapidly. Instead of continuing to see the system and energy landscape as supply driven, we need to appreciate the importance of demand side and energy storage, particularly at the distributed, residential scale. The debate about energy storage tends to be dominated, right from the start, about technology be it batteries, phase change materials or pumped hydro storage. First and foremost, we need to separately assess our current and future needs for resilience and flexibility, *then* decide at what level in the system can most effectively by met and only then determine the choice of technology. We must put needs before technology. We see four levels at which energy storage can be deployed; household, community/local substation, generator and grid level. We believe that there is too much focus on large scale (third or fourth levels). It is increasingly possible to position energy storage at the smaller distributed energy, rather than relying on fewer centralised schemes. Of course the need for aggregation is introduced here, but it need not be as daunting as some clearly find it. We also need to consider whether we *care* about the level at which energy storage is located- whether we want energy storage to provide additional services/address ancillary issues such as fuel poverty for example.

Lastly for future energy landscapes innovative and emerging technologies need a platform. From technologies dealing with digital or smart systems to even smart metering they need a platform and space to emerge, be supported and be able to fully research, design and test their technologies and therefore improve before being commercially viable. Linked to this is the large issue of funding, who is going to fund the transition to a decentralised and decarbonised energy landscape? At the moment, we would suggest the market mechanisms (including research and development) are not in place to support this transition. Investors need long-term security and cannot just rely on short-term support mechanisms. Companies with emerging innovative technologies need to have long-term support from the Government through grants, to ensure that the technologies are supported through their entire life cycle. We would also suggest that the large energy companies ('The Big 6') are to be viewed as part of the solution, and some restrictions and policies that are in place should be removed. If the space were available to the large energy companies to allow for innovative funding of technology or allow for energy efficiency to be funded through the energy bill, it would ensure momentum and more security for the renewables sector.

6. What action needs to be taken to ensure that Scotland fulfils its climate change obligations while also meeting demand; and what are the main obstacles to achieving this?

Setting clear measureable targets, and having effective monitoring procedures in place is essential to meet the 80% reduction of greenhouse gas emissions by 2050, the 2030 'all energy' renewables targets and to ensure continuation into the future.

We would suggest that key performance indicators (KPI) be developed for each sector, domestic, industry and transport. Further KPI's could further be implemented for each renewable technology sector, thermal storage, district heating and so on. The S3C[1] highlighted that performance indicators should be accompanied with energy targeting, especially when wanting to incorporate consumer feedback with a change in behaviour and particularly relating to determining the effect of a smart grid environment on energy consumption. Key performance indicators should be considered on a large scale, as they are useful in performance monitoring, they identify areas in need of improvement, increase motivation and communication and also strengthen accountability[2]. Characteristics that KPIs need to encompass include, according to Neely *et al.* [3] include:

- Aligned with goals

- Embedded in strategic management
- Adjusted/flexible
- Timely
- Purposeful/relevant
- Clearly defined/simple
- Normative as best as possible
- Comparable/relative to competitors achievements
- Form part of the control-loop
- Detailed and accurate

We would advise that monitoring and reporting should follow that same structure as financial reporting. Whereby publishing and reporting of KPI's should be conducted on a timely basis, so the most update figures and results are presented, we would envisage this being done on a yearly basis. For example with performance for the year to March reported in June. Accurate data and figures are essential for policy emissions, standards and benchmarks. Out of date figures, will not provide useful in order to meet the 2050 visions of the Scottish Government's Energy Strategy. All reports should also be independently verified to ensure accurate reporting.

7. What are the factors and risks which may impact upon the Scottish Government meeting the targets it has proposed on sustainable and renewable energy?

One the biggest risks which may impact the Scottish Government is unstable governments and their associated policies. Climate change policies and a transition to a low carbon society require clear political and societal long-term commitment towards renewable energy to ensure key targets are met. This cannot be done if new Governments continually change policies. Therefore cross party agreement, acknowledgement of key targets, and a clear road map for meeting targets must be upheld between the parties.

The Scottish Government, should also aim to help, through policy, those that are most vulnerable and most "at risk" to the changing energy systems by including the social implications of transitioning to a decarbonised energy system. It will be those already struggling at the moment, for example those in fuel poverty, which have the biggest constraints and need the most help transitioning to more energy efficiency methods.

8. What are the environmental impacts of individual elements of any future energy mix, to what extent can these be mitigated, and how can any remaining waste products be dealt with?

Renewable energy sources have been shown to have very little contribution to the anthropogenic carbon dioxide emissions when compared to the use of fossil fuels, Table 1[4]. Nevertheless, all forms of electricity generation have their impacts whether it be the air and water emissions, waste generations, noise generation, land use, greenhouse gas emission or hazardous materials. All of these various aspects of impacts of renewable energy can be analysed and any technology or device in the future energy mix should undergo a complete environmental and economic impact assessment to ensure any mitigation measures can be put in place. There is a strong environmental science base within Scotland and effort should be made to use various institutions in a collaborative approach across many different disciplines to make educated assessments of any environmental impacts of devices or technologies for the future energy mix.

Table 1. Life cycle emissions from various energy sources[4]

Energy Sources	Green-house gas emission		
	CO_2	SO_2	NO_x
	g/kWh	g/kWh	g/kWh
Coal (best practice)	955	11.8	4.3
Coal (NO_x) and FGD	987	1.5	2.9
Oil (best practice)	818	14.2	4.0
Natural gas (CCGT)	430	–	0.5
Diesel	772	1.6	12.3
Small hydro	9	0.03	0.07
Large hydro	3.6–11.6	0.009–0.024	0.003–0.006
Wind	7–9	0.02–0.09	0.02–0.06
Solar photovoltaic	98–167	0.2–0.34	0.18–0.30
Solar thermal electric	26–38	0.13–0.27	0.06–0.13
Energy crops – current practice	17–27	0.07–0.16	1.1–2.5
(likely to improve to)	(15–18)	(0.06–0.08)	(0.35–0.51)
Geothermal	7–9	0.02	0.28

An issue, which is not necessarily thought of with regards to implementing renewable devices, is what happens to devices when they come to their end their life and the associated waste management. Waste management of renewables and end-of-life management offers opportunities relating to the "three R's" of sustainable waste management can could spawn new industries, support considerable economic value, yield employment in the public and private sector and is consistent with the global shift to sustainable long-term development. For example Solar PV waste management systems could generate additional employment especially in the repair/reuse and recycling/treatment industries, while also encouraging overall PV waste management practices.

In Scotland with the implementation of Zero Waste Scotland under the Scottish Government's circular economy strategy, provides plenty of examples of novel and creative ways of dealing with waste:

- **Argent Energy**- uses waste fats and oils to convert into high-grade biodiesel used by vehicles and in heating and/or power generation.
- **CelluComp**- turns nano fibres from root vegetables into an environmentally friendly thickener for paint.
- **Ogilvy Spirits**- Scotland's first Potato Vodka producer, making vodka from potatoes not suitable for retail.
- **Celtic Renewables**- is an innovative start up company formed to commercialise a process for producing a superior next generation biofuel (and other high value sustainable products) from the by-products of biological industries.

The same ideas should be considered for renewable technologies and how their end-of-life and decommissioning has a role in the circular economy within Scotland. For this to be implemented, sustainable end-of-life management policies for renewables, through a regulatory framework, needs to be established. Collaboration is also needed, between the intended institutions, universities and the energy and waste sectors in supporting the management, research and development and the data and analyses need to support the regulatory and investment conditions. In the coming years, although exhaustive effort is being made into installing renewable devices and technologies, policy makers and stakeholders must prepare for the rise of waste and design systems to capitalise on the resulting opportunities.

9. What account should be taken of the environmental and social impacts on those living elsewhere in the world, of the international energy supply chains on which we may choose to rely?

We should definitely take account of the environmental and social impacts of those living elsewhere in the world, especially with regards to issues such as climate justice. Climate change is one of the principles threats to quality- and equality- of life on earth. Beyond environmental problems, climate change threatens food security, water availability, health and housing, however these burdens are not equally distributed. Impacted the most and hardest hit are those who are generally the least responsible for causing it, and have the least capacity to adapt. Scotland's unique geography creates both resilience and vulnerabilities to the impacts of extreme weather and climate change, however there is a responsibility to help combat the effects of climate change further along the international energy supply chains. It is therefore imperative that then topic of Climate Justice continues to receive funding and support in the Climate Change Plan. Additionally there also has to be recognition from Governments and economies of best practices to deal with environmental and social impacts, but not seen to be outsourcing our problems to other countries.

10. What actions can be taken, and by whom, to ensure that energy is accessible to all at an affordable cost for those on low incomes; and that any changes in energy provisions and associated tariffs are understandable and acceptable?

Public awareness is essential for transforming energy use, and should be included in long-term priorities. Consumers and the general public need a greater understanding of why changing their behaviours is necessary for transforming energy use within Scotland. Without this understanding the reasons behind schemes such as smart metering, they will simply not have the long term benefits envisaged, as people will not see the financial benefits of changing their behaviours and will therefore not continue to implement the necessary changes to their daily lives.

The Scottish Government, should aim to help, through policy, those that are most vulnerable and most "at risk" to the changing energy systems by including the social implications of transitioning to a decarbonised energy system. It will be those already struggling at the moment, for example those in fuel poverty, which have the biggest constraints and need the most help transitioning to more energy efficiency methods. The standard measures to help those in fuel poverty, such as making the house more energy efficient by replacing light bulbs, draught proofing windows and door and improving insulation should be offered to those in need. Further opportunities such as providing granularity in energy bills and in technologies, such as enhancing the role of energy displays. Granularity in energy bills and technology such as smart meters and apps and payment schemes, which allow shifts in payment patterns, for example quarterly payments to be made instead. It should also be a cumulative effort from governments and energy companies to support those who often have low disposable incomes, high fuel costs and poor energy efficient homes.

11. What are the particular advantages enjoyed, and challenges faced, regarding energy; and what lessons can be learned on a national scale from community energy schemes undertaken by:

a. Rural and remote communities

b. Urban communities.

Community energy schemes and projects can encompass a wide range of initiatives such as locally owned renewable energy generation, community hall refurbishments, collective behaviour-change programmes and aim to bring additional public engagement benefits to top-down policy initiatives[5]. Community energy schemes and projects can have several advantages as they help tackle climate change, develop community energy and transport projects, help minimise waste, improve the quality of the local environment, and promote fair trade and sustainable consumption and production. They are also seen as suitable avenues for raising awareness of sustainable energy issues, improving public receptivity to renewable energy installations, increasing engagement in behaviour-change initiatives and reducing carbon emissions. However there are key differences between rural and urban communities with regards to basic conditions and social framework that should be considered when implementing sustainable energy generation and energy saving projects and schemes.

Scotland has a considerable renewable energy potential, and expansion of a commercial renewable energy sector holds the promise for a better economic future in many rural areas, where challenges such as long-term decline of agriculture is an issue. However it has been shown that rural and urban households are shown to have different welfare gains, which are dependant on the type of renewable energy technology and the scale of project under construction. Wind energy, for example, are unlikely to provide a large number of permanent jobs, but the jobs created will be based near where the projects are built. Construction jobs will obviously be created during the construction phase, but are short lived, whereas biomass projects may lead to a higher long-term levels of rural job creation.

Nearly all of the activity in community renewable generally, and community ownership in particular has taken place in rural areas, where a sense of community is more pronounced than urban areas. While urban communities are typically less clearly defined and arguably, less collectively organised and cohesive than rural ones, there may be models of collective ownership that are better suited to urban environments. Wind, biomass and hydro are generally less viable in an urban setting, but building mounted solar, combined heat and power (CHP) and district heating networks are potentially more viable[6]. It has been suggested that in urban communities that renewable energy generation should become part of urban regeneration initiatives, with community ownership providing economic and social returns and objectives should be linked to reducing fuel poverty, such as the Castlemilk urban wind farm in Glasgow for example[6].

Pressure to engage society more widely in carbon reduction and the likelihood for future instability in energy markets, are important drivers for more locally controlled and owned models of energy generation, and for shifts towards more concerted policies of support. Communities, both rural and urban, are seen as critical players in sustainable energy generation and energy saving efforts.

12. To ensure that energy is successfully sourced for, and delivered to, the people living in Scotland, how can different levels of government best cooperate:

a. With one another;
b. Internationally;
c. With existing energy generators, network operators and retailers?

To ensure that energy is successfully sourced and delivered to the people living in Scotland we would suggest at all levels of government needs to undoubtedly have multi-sector collaborations from communities, stakeholders, private and public entities as well local councils to governmental level. Multi-sectorial collaboration has the greatest potential for communities to become empowered and for them to become equal players with business and government in making decisions that affect them. For collaboration at different levels and between organisations to be successful there needs to be a common purpose, strong insistence of a whole systems approach, shared power and use the user's perspective to stimulate change.

To ensure a proper 'energy transition', in line with the Scottish Government's 2050 vision, governments need to collaborate with private sector organisation, like those listed in the energy strategy:

- Scottish Energy Advisory Board (SEAB)
- Local Authorities
- Enterprise and Skills agencies
- Research and Innovation Centres (Universities)
- Scottish Funding Council

We would also highlight that the opportunities offered by business-led community development or social investment programmes should not be overlooked, especially when companies can use their core business skills and competencies to enhance energy access. We would also suggest that the large energy companies ('The Big 6') are to be viewed as part of the solution, and some restrictions and policies that are in place should be removed. If the space were available to the large energy companies to allow for innovative funding of technology or allow for energy efficiency to be funded through the energy bill, it would ensure momentum and more security for the renewables sector.

13. How can we best encourage objective, evidence-informed debate around energy while also acknowledging the differing perspectives and priorities held by businesses, civil society and government?

For objective, evidence-informed debates around energy an inclusive atmosphere needs to be created. Where a range of agencies, stakeholders, public and private sectors and businesses, local and national government representatives need to be included at the debate. It should also be recognised that NGOs and other civil society groups are not only stakeholders in governance, but also a driving force behind greater international cooperation through the active mobilisation of public support for national agreements. The evidence presented should also not be the reason for the debate, hence, there should be cross party agreement of acceptance of the evidence and should be presented by external, independently verified parties. Lastly, acceptance that there will be different perspectives and priorities of business, civil society and government has to be accepted and is often the reason for the debate.

14. How can Scotland ensure that it retains, and develops, the necessary workforce of skilled professionals needed to meet its energy needs?

Ensuring that Scotland retains a skilled workforce of professions to meet its energy needs is essential. Firstly investing and maintaining the provision of high-level skills in science and engineering and then secondly create a supportive collaborative business environment to allow research and innovation to occur and a job market to match the level of the workforce.

The transition to a resource efficient, low carbon and circular economy represents a massive opportunity for businesses and for jobs. To truly grasp the opportunities of the future more must be done to promote entrepreneurial skills and culture within Scotland and to attract, nurture and retain the most innovative companies and individuals in Scotland. Support should be given to the supply chain to capitalise on new and emerging opportunities and help should be given to reduce the cost base for energy supply sector technologies.

15. What issues arise regarding innovation for Scotland's energy future; how might this interact with an industrial strategy for Scotland?

Depending on the new UK Industrial Strategy and Emission Reduction Plan, this could potentially be an issue for innovation in Scotland's Energy future. If the UK Government doesn't choose a progressive enough approach, then this could delay the opportunity to invest in the low carbon economy.

Generally on of the most cited barriers to innovation is cost. New technologies and products require investment and companies considering environmental innovation this is a key issue. Although renewable energy technologies are efficient, this does not always make them the most suitable choice for commercialisation. There therefore has to be a platform within Scotland for companies and universities to be able to test, develop and trial their technology and to learn from the outcomes. Essentially, investing in innovation is needed in Scotland, as good resources and technologies will give the Scottish energy industry the space and edge to be competitive in future energy markets.

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