SUBMISSION FROM PROFESSOR STUART HASZELDINE AND DR VIVIAN SCOTT

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1 Context

1) We write in a personal capacity, not representing the views of SCCS, or of the University of Edinburgh. Stuart Haszeldine is Professor of Carbon Capture and Storage at the University of Edinburgh. Dr Vivian Scott is senior policy researcher at the University of Edinburgh. Both are part of SCCS, a pan-university research alliance within Scotland.

2) Scottish Government's current electricity generation policy is shaped by the twin targets for meeting the equivalent of 100% of Scotland's electricity demand from renewables, and achieving a 42% reduction in greenhouse gas emissions relative to 1990, both by 2020. Scotland is broadly on track to achieving the first of these, but has repeatedly missed interim targets for the second. Beyond 2020, Scotland does not yet have domestic targets but is subject to those of the UK and EU for 2030 and 2050. Additionally, Scotland does not support new nuclear build – Hunterston B and Torness are expected to decommission within the next decade.

3) Continued unabated coal power generation (Longannet) has always been incompatible with achieving the 2020 greenhouse gas target making Longannet's closure a necessity. However, there is little evidence of a coherent strategy to replace thermal generation's role in delivering security of supply in Scotland.

4) The impact of the likely closure of Longannet, due not to its emissions, but to failure to secure contracts arising in part from the UK transmission charging system, should be considered in two contexts:

1. Short-term (to 2020) consequence of Longannet's expected closure in 2016.

2. Longer-term (2020 onwards) strategy for electricity generation and climate action in Scotland.

5) We will briefly reflect on the short term, but concentrate primarily on the longer term context which we suggest the committee should take this opportunity to explore beyond 2020 in detail.

1.1 Short term considerations

6) The closure of Longannet can be expected to impact negatively upon Scotland's security of supply, both in the context of addressing the intermittency of renewable generation, and in capability to respond and recover from a widespread generation failure – black start.

7) With respect to the former, current interconnection to rest of UK (rUK) appears inadequate to fully provide appropriate backup until completion of the western link interconnector (2017). Interim mitigation strategies appear to be calculated on a UK basis such that Scotland's security of supply could be reliant on dropping voltages and interrupting supply in rUK. Even following completion of the interconnector it is not sufficiently clear how Scotland would maintain security of supply in the event of a sustained (3+ day) period of still weather during winter (these invariably coincide with very low temperatures and resulting high energy demand). Present arrangements for periods of hours to a few days of low wind, rely on use of pumped storage, which is then replenished overnight. However during a prolonged period on low wind, it is not clear that method is adequate. Additionally, with the demise of Lonagnnet, the pumped storage can be drawn down less, as it forms a proximal component to the "black start" plan. These are low risks (hours to days per year of vulnerability), but could have high impact. Mitigation relies on building more and more interconnection, on the assumption that power will be available for export from an unknown location(s) "somewhere else".

8) With respect to black start, it is expected that closure of Longannet will noticeably lengthen the time from system shutdown to full recovery (e.g. from less than 24 hours to perhaps 36 hours or more depending on the cause and degree of shutdown).

9) While responsibility for security of supply formally resides with UK Secretary of State, the delivery of that security lies with commercial contracts through National Grid. No performance standards are known to exist. Scottish Government should request additional assessment of the possible impact on Scotland's security of supply and identify measures necessary to mitigate these risks.

10) It is worth noting that intermittency of wind power generation is well known, but its effects have been mitigated by local thermal generation in Scotland. If wind power continues to grow its percentage of UK power, then the impact across the UK of low wind events, particularly multi-day, could become more apparent. There are clear records in weather of the past 5 years, where minimal wind generation has occurred across all of NW Europe. It is not possible to import wind surplus from "somewhere else" if there is none. For example 19 Jan 2015, produced just tens of MW from wind in Scotland, rather than several thousands. On 8 Feb 2013, there was very low output from 9 EU countries around the UK. How secure is the backup generation?

1.2 Longer-term considerations

11) The expected closure of Longannet should alert Scottish Government to its lack of coherent strategy for electricity generation, energy supply and climate ambition delivery in the period post 2020.

12) The 2020 onwards generation system with a large renewable (intermittent wind) share will require increasing amounts of backup. This could be provided

by (combination of) energy storage, concentrated generation (thermal or nuclear), or interconnection to generation outwith Scotland.

13) Conventional energy storage (pumped hydro) has limited options for substantial increase, and a long delivery period of construction. Alternative storage (e.g. grid batteries) are not yet developed at scale. Scottish government does not support new nuclear build, and existing nuclear plant do not operate sufficiently flexibly. Thermal generation can be sourced from coal, gas or biomass, but the former require carbon capture and storage (CCS) to be low carbon, and the sustainability of substantial biomass usage is questioned. Interconnection should be encouraged to maximise best use of macro-regional (European) resources, but with caveat that the source of supply brought in is outwith UK Government oversight and planning control – the import of electricity generated by unabated coal and gas undermines a domestic focus on low-carbon generation.

14) Of these options, CCS provides the most deliverable option, and one with wide additional benefits – utilising Scotland's world class CO2 storage potential and subsurface industries, delivering secure low-carbon generation, and providing a decarbonisation pathway for Scotland's industrial emissions.

15) Currently, Scotland hosts two CCS project proposals: Peterhead (gas), presently undertaking detailed design as one of two projects in the UK government's CCS commercialisation programme, and Caledonia (coal), recently awarded funding from Scottish and UK government for feasibility assessment. We note that Peterhead decarbonises existing generation capacity (400 MW), while Caledonia adds new low-carbon generation capacity (570 MW). The sum of new generation from both of these is substantially less than the lost capacity from Longannet (2,000 MW). Neither project is guaranteed to succeed.

16) It is envisaged that early CCS projects will be financed through a contract for difference (CfD), though it remains to be seen how much funding will be available for CCS under both the current, and next levy cap framework given expected allocation to renewables and programme of new nuclear build in England. Scottish Government should seek to secure an allocation of CfDs to CCS in line with envisioned CCS generation capacity.

1.2.1 Transmission charging

17) As with renewable generation, investment in concentrated generation in Scotland will continue to be disadvantaged unless transmission charging is re-evaluated in a manner that appropriately assesses the full low-carbon generation system. For CCS, transmission calculations should not just assess the electricity grid connection distance and congestion, but also account for the transportation (pipeline) distance to CO2 storage. Such calculation would more strongly favour locating generation to optimise access to CO2 storage. This trade-off requires further investigation and should form a component of any transmission charge reform. The time for action on this is now, because thermal power plant built now has a lifetime of 30 to 40 years, so that

decisions made without accounting for future carbon prices and penalties may become stranded or devalued. By contrast including a wider suite of actors means more resilient siting.

1.2.2 Industrial emissions

18) Appropriately supported, CCS can not only deliver secure, cost-competitive low carbon generation by or before 2020 (subject to funding confirmation), but also create CO2 transport and storage infrastructure essential to decarbonise industrial emissions. To achieve longer-term emissions reduction goals industrial emissions will either have to be addressed through CCS, or these facilities will have to close. Following this logic we recommend that Scotland's future electricity generation strategy should be integrated with the steps needed to achieve cost-effective and timely economy wide decarbonisation. CCS generation located in the central belt and eastern Scotland could initiate a low carbon industrial zone, supplying low-carbon power and products and securing the regional economy. Types of industries affected by this are the entire Grangemouth petrochemical complex, paper, cement, glass. It is also possible that creation of low carbon zones will be able to attract future inward investment, because of low costs of carbon emissions removal to storage. Work undertaken by SCCS shows that some 70-80% of these high carbon industries lie within 10-20km of the Feeder 10 east coast pipeline from Longannet/Falkirk to St Fergus. That makes decarbonisation of Scotland extremely feasible in terms of low cost connection to a spine pipe for CO2 removal to storage. The Caledonia Clean Energy project at Grangemouth is currently vital to that pipeline. A strategic plan needs to be created, to combine electricity, industry and offshore benefits of employment protection and low carbon growth into the future..

19) Here, we note that the Longannet site is unique in possessing solid fuel (coal or biomass) import by rail from deep water port, natural gas supply connection, large grid connection and proximity to the Feeder No 10 pipeline assessed for CO2 transport to St Fergus and subsequent North Sea subsurface storage. As such, the Longannet site should not be re-developed ad-hoc, but Longannet should be retained as identified in NPF3 as a strategic asset for thermal power generation with CCS.

1.3 Future planning : electricity, heat, and hydrocarbons

20) It is clear that the closure of Longannet is as a consequence of UK wide policy, rather than Scottish policy. The future of Peterhead as a gas generation plant remains unclear and dependent for the moment on guaranteed running time as part of the CC S development project, and an interim contract to provide capacity into the UK grid. Peterhead is running at much less than optimal capacity, and remains vulnerable to losing the National Grid contract. It is a plausible scenario that Peterhead will also close within 15 years. It is clear that Hunterston B is entering poorly known territory, with accumulated damage to the core graphite insulation of the reactor core.

Even though robust safety inspections may prolong its life span, it to is very likely to close within 10 years. Durability of Torness is unclear, but an extension of life could be anticipated, although poorly quantified.

21) All of the above point to the inevitable closure of large-scale generation sites within Scottish territory, whether as part of the UK, or as an independent region. Will the remedy for that continue to be increased numbers of inter-connectors built from south to north? That prospect would require to treble or more the present interconnection. There will inevitably be technical problems related to frequency stability at 50 Hz, and to maintaining equable voltage dependent on peaks and troughs of wind output. Scenario planning, and replacement of powerplant generation within the Scottish region, is at present, left to the wholesale generation market reading signals from Ofgem and National Grid pricing. It is of course possible that market could provide connection of adequate generation in Scotland. However the priorities of companies are to make profit for shareholders, rather than to deliver optimal cost electricity to the dispersed populations of Scotland. If transmission charging remains as it is now, then construction of any new generation plant is unlikely.

22) A different route into the future is, therefore, for Scottish government to undertake scenario design and detailed planning, and shape policy, which enables and indeed encourages the construction of powerplant which delivers decarbonised electricity together with optimal reduced prices for Scottish consumers businesses

23) The benefits flowing from construction and operation of power plant need not be restricted to electricity generation. It is clear that substantial heat can be harvested from powerplant, and as the Caledonia project shows substantial decarbonisation of the high-value chemical industry can result enabling attractive inward investment from energy intensive or high carbon industries. This provides an opportunity to develop the east of Scotland in a low carbon manner

24) Onshore generation by fossil fuel with CCS also interacts with the offshore industries. Transport and storage of CO2 arising and captured from powerplant can be transported by pipeline to the coast and thence by shipping or pipe to storage destinations offshore. Several of these can be developed as CO2 improved oil recovery, where a waste product from onshore can be transformed into a commercially valuable operating chemical offshore, to raise oil production from an average of 45% up towards 60%. This can extend North Sea life for 15-30 years, without additional carbon emissions. The connected benefits across the Scottish and UK economy need to be assessed, not just silos of electricity or hydrocarbon industry.

25) Elsewhere, SCCS has researched the benefits of CO2 EOR (Enhanced Oil Recovery) in rapidly accelerating the development of offshore pipeline networks and improving storage capacity in the Scottish sector of the North Sea. The mid-term to long-term effects of this accelerates development so that Scotland can offer secure CO2 storage to other European member states

many years before that becomes available within their own borders. Correctly managed, this can be the commencement of a new chapter in utilisation of North Sea resources, where CO2 storage could provide rental service income into Scotland of £5 billion per year for the next 100 years. Using the CO2 derived from carbon capture power plant and industry is an essential first step

CO2 storage ownership from power plant is devolved - now

26) Scotland also has unique potential under the terms of the Smith commission and devolution of the Crown Estates, to gain competent authority status and operation and licensing over CO2 storage and offshore porespace in Scottish territorial waters to the 200 mile nautical mile limit. This power to license pore space for CO2 storage is unique amongst European regions and means that Scotland could provide a unique climate mitigation business. In principle, it is possible that Scotland could own, license, regulate, and negotiate vital ownership of CO2 imported from England, Netherlands, Denmark, Germany, or Poland. As with any developments of an offshore resource, those who can construct the infrastructure reliably and at suitable cost, early in the development phase, will set the geography and access for development of the whole basin. The early bird catches the worm.

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