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Scotland, Nuclear Energy Policy and Independence

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Keywords: Scotland; Scottish Independence; Nuclear Energy Policy; Nuclear Waste.

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Scotland, Nuclear Energy Policy and Independence

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Abstract

This paper examines the role of nuclear energy in Scotland, and the concerns for Scotland as it votes for independence. The aim is to focus directly on current Scottish energy policy and its relationship to nuclear energy. The paper does not purport to advise on a vote for or against Scottish independence but aims to further the debate in an underexplored area of energy policy that will be of value whether Scotland secures independence or further devolution. There are four central parts to this paper: (1) consideration of the Scottish electricity mix; (2) an analysis of a statement about nuclear energy made by the Scottish energy minister; (3) examination of nuclear energy issues as presented in the Scottish Independence White Paper; and (4) the issue of nuclear waste is assessed. A recurrent theme in the analysis is that whether one is for, against, or indifferent to new nuclear energy development, it highlights a major gap in Scotland's energy and environmental policy goals. Too often, the energy policy debate from the Scottish Government perspective has been reduced to a low-carbon energy development debate between nuclear energy and renewable energy. There is little reflection on how to reduce Scottish dependency on fossil fuels. For Scotland to aspire to being a low-carbon economy, to decarbonising its electricity market, and to being a leader within the climate change community, it needs to tackle the issue of how to stop the continuation of burning fossil fuels.

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1. Introduction

In 2010, UK government policy on energy provision reached a state of tension. One point of tension was that the parties comprising the new UK coalition government (the Conservatives and the Liberal Democrats) had expressed different manifesto commitments on energy. Second, in Scotland and Wales, the devolved governments each expressed the importance of developing large-scale renewable projects in their jurisdiction. Indeed, Scotland had moved further down its own path than Wales and in 2008 the Scottish Parliament produced its own energy policy document for Scotland that included an expressed opposition to new nuclear power stations.[1]

As the vote on the 18 September 2014 for Scottish Independence looms, a debate on energy policy in Scotland is due and could play a crucial role in determining the outcome. Ever since the statement in 2008 in the earlier mentioned energy policy document where the Scottish Government said no to future nuclear new build in Scotland, it seems that debate on nuclear energy as part of the Scottish energy mix has ceased.[2] However, herein lies a significant problem. Nuclear energy provides *ca.* a third of Scottish electricity supply. Replacing this will be a significant problem, and one that has not been addressed in any discussions yet.

If Scotland were to choose to go down the route to independence in 2014 the process that would follow will take some time. Alex Salmond leader of the Scottish National Party is reported to be keen to declare Scottish Independence in March 2016 just before the next Scottish Parliamentary elections scheduled to occur in May of that year[3]. From that election process a new Scottish government will emerge. It is that government that would oversee the policies of a newly independent Scotland. It seems highly probable that the SNP would lead the first government of a newly independent Scotland and hence one might expect a continued ambitious plan for Scotland to be a low-carbon economy. Within that framework the SNP is generally averse to nuclear new build, but the full range of issues shaping the future role of nuclear energy has not been explored. As things stand today (early 2014) the debate has centred on promoting the development of more wind farms and the ownership of the oil and gas resources in the North Sea. The continued focus on the extraction of oil and gas in the North Sea cannot contribute to Scotland developing itself into a low-carbon nation.

In a strict constitutional sense energy policy is not devolved from London to Edinburgh. The UK Department of Energy and Climate Change (DECC) formally has authority over policy in the whole of the UK, but the reality is that Scotland has much policy power in practice and the Scottish Government has an energy minister, Fergus Ewing. The strongest aspect of DECC policy power concerns electricity market arrangements on the island of Great Britain[4]. The British electricity market has included Scotland since April 2005 and the formation of the British Electricity Trading Transmission Arrangements which essentially brought Scotland into the

[1] Scottish Government, 2008. *Scottish Energy Policy: An Overview* (2008). [Last accessed 08 January 2014, available at http://www.scotland.gov.uk/Resource/Doc/237670/0065265.pdf].
[2] Fn.1, *Ibid*.
[3] BBC News Website, 2013. *Q&A: Scottish independence referendum.* [Last accessed 27 February 2014, available at http://www.bbc.co.uk/news/uk-scotland-13326310].
[4] Northern Ireland is part of a single electricity market with the Republic of Ireland [see: last accessed 27 February 2014 http://www.sem-o.com/Pages/default.aspx].

market arrangements established in England and Wales. The (UK) Energy Act 2013 implements Electricity Market Reform (EMR) and further adjusts market arrangements especially relating to new build low-carbon generation. Despite the formal power of Westminster and Whitehall over Scottish energy policy, the reality, especially as relates to new infrastructure investment, is that the Scottish Government has power over all decision making relating to environmental permission and as such it has a veto over all proposed investments. That reality ensures that while EMR will apply in Scotland, its powerful arrangements intended to make possible new nuclear build will have no direct impact in Scotland.

The current academic literature is somewhat divided on the issue of the effect of Scottish devolution on UK energy policy. The Scotland Act 1998 which created the new Scottish Parliament appears to have given Scotland extensive powers regarding the formulation of its own environmental policy (Little, 2000) [5]. However, as Little (2000) determined, there are limiting factors such as the need to adhere to international and EU environmental law as well as the provisions for judicial review and political review by the UK Government. In this context, Keating (2010)[6] argued that while Scottish devolution may be limited by intergovernmental relations with both the UK and the EU in many policy areas, there are nevertheless opportunities for policy innovation. Hence, while developing its own environmental policy maybe a limited exercise, Scotland has in effect the capability to pursue its own energy policy. It remains to be seen how far Scotland may diverge in its approach to its energy policy from that of the residual UK, and as of yet the only distinctive difference with the rest of the UK has been the decision not to build new nuclear reactors. It is arguable therefore that energy policy has fragmented to a degree within the UK and though this is a topic to consider in more depth in future, it can be stated that the Scottish move in 2008 to have its own energy policy has added to the uncertainty in the development of a long-term UK energy policy.

This paper examines the role of nuclear energy in Scotland, and the resulting concerns for Scotland as it votes for independence. The aim is not to provide an overview of the UK nuclear energy industry[7] nor engage in a discussion about a possible nuclear renaissance [8] but to focus directly on current Scottish energy policy and its relationship to nuclear energy. There are four central parts to this paper: (1) the Scottish electricity mix is detailed; (2) a statement about nuclear energy by the Scottish energy minister is analysed; (3) nuclear energy as stated within the Scottish Independence White Paper is examined [9]; and (4) the issue of nuclear waste is assessed. The paper does not purport to advise on a vote for or against Scottish

[5] Little, G. 2000. Scottish Devolution and Environmental Law. Journal of Environmental Law, 12 (2) 55-174.
[6] Keating, M. 2010. (2nd Ed.). The Government of Scotland: Public Policy Making After Devolution. EUP: Edinburgh, UK.
[7] Please see the following for analysis of history of the UK nuclear energy sector: Taylor, S. 2007. Privatization and financial collapse in the nuclear industry – the origins and cause of the British Energy crisis of 2002. Routledge: London, UK.
[8] Please see the following for more detail on the nuclear renaissance: Nuttall, W. J. 2005. Nuclear Renaissance: Technologies and Policies for the Future of Nuclear Power. Taylor and Francis: Oxon, UK.
[9] Scottish Government. (2013). Scotland's Future: Your Guide to an Independent Scotland. The Scottish Government: St. Andrew's House, Edinburgh, UK.

independence but aims to further the debate in an underexplored area of energy policy that will be of value whether Scotland secures independence or further devolution.

In this paper we also do not explore the interesting and contentious issues relating to nuclear weapons policy and an independent Scotland. The United Kingdom submarine-based nuclear deterrent is based at Her Majesty's Naval Base Clyde at Faslane with supporting infrastructures, such as the Royal Naval Armaments Depot Coulport nearby. In the event that Scotland were to become independent of the United Kingdom a key infrastructure of the UK nuclear deterrent would be outside the UK. In October 2012 Scottish First Minister Alex Salmond spoke out against any connection between an independent Scotland and support for UK nuclear weapons. He is reported to have said: "The UK government has two choices – they either relocate Trident to another part of the rest of the UK or alternatively they could use nuclear facilities in America or France."[10]

The civil nuclear power debate has parallels with the defence nuclear debate in discussions of Scottish independence. There are also the possibilities of some linkages, such as that a slow erosion of Scottish civil nuclear expertise could have implications for the governance and even maintenance of the nuclear defence capabilities on Scottish territory. Notwithstanding such synergies this paper will focus entirely on civil energy policy issues.

2. The Scottish Electricity Mix

In 2008 Scottish National Party (SNP) Leader and First Minister Alex Salmond asserted that Scotland had achieved electricity self-sufficiency even without the substantial nuclear power generation in the country[11]. It would appear however that he was relying on annual averaging of just a number of years to justify his claim and periods of renewable power surplus (and export) were being allowed to offset periods of shortfall. At that time, on average, 20 *per cent* of Scottish power was exported to England. In terms of the electricity market structure, despite potentially no currency union there would not be a significant impact in terms of investment or market withdrawal by energy companies.[12]

Data from 2002-2012 for the Scottish Electricity Mix is stated in Figure 1. Notable is the reliance on fossil fuels that are 48.7 *per cent* of the total electricity generation.

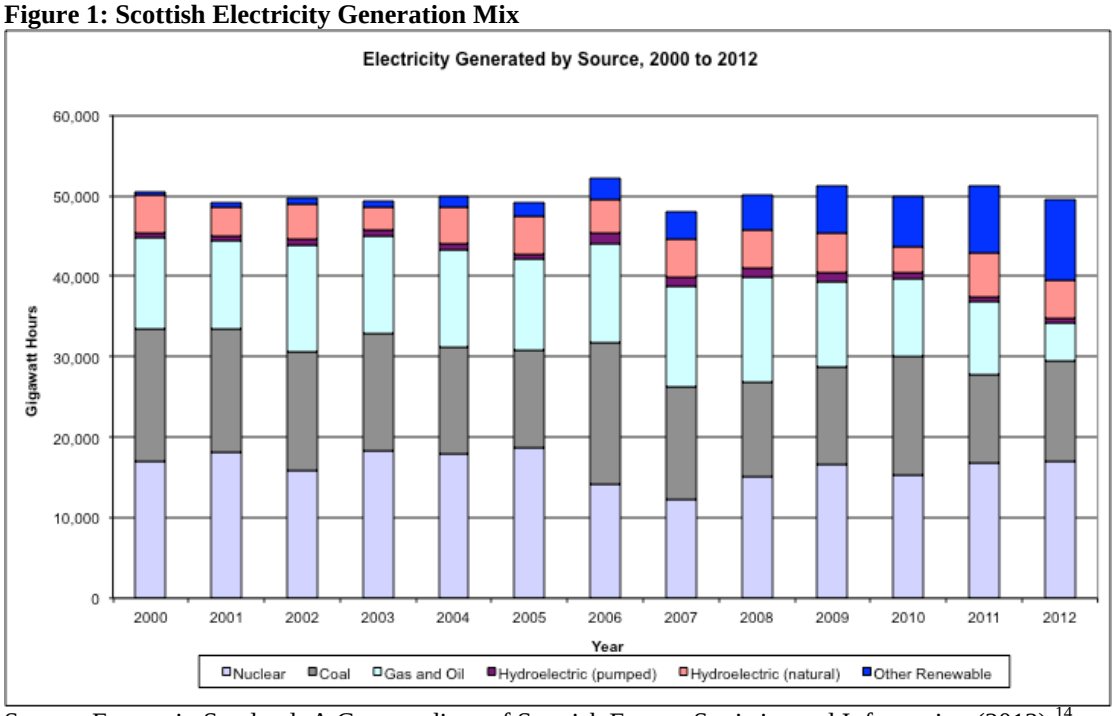
[10] BBC, 2012. Nuclear weapons 'outlawed' in an independent Scotland, says Salmond [Last accessed 18 April 2014, available at: http://www.bbc.co.uk/news/uk-scotland-scotland-politics-20020839].

[11] The Scotsman, *Salmond: nuclear redundant in self-sufficient Scotland*, 10 January 2008. [Last accessed 27 February 2014, available at: http://www.scotsman.com/news/salmond-nuclear-redundant-in-self-sufficient-scotland-1-1073316].

[12] This is because expectation would be for minimal change due to EU policy being for further integration of electricity markets. In this context Scotland could sell electricity to other markets just as the rest of the UK could buy electricity from other markets. Therefore keeping a common electricity market would be reasonable for both sides despite no currency union. For more on this see: UK Parliament Energy and Climate Change Committee, June 2012. [Last accessed 29 March 2014, available at: [http://www.publications.parliament.uk/pa/cm201213/cmselect/cmenergy/writev/scottish/m01.htm]. This includes data on current investments by a number of energy companies and their investment indicates that the prospect of the break-up of the UK currency union post Scottish Independence is not such an issue for energy investment.

There is also a heavy reliance on nuclear energy, which provides 30.6 *per cent*[13]; a high proportion considering that Scotland has a 'no to new nuclear energy' policy.

Figure 1: Scottish Electricity Generation Mix



Source: Energy in Scotland: A Compendium of Scottish Energy Statistics and Information (2012).[14]

Scottish energy policy faces a challenge seen elsewhere in Europe (e.g. Germany). The stated goal of policy is to move towards a low-carbon economy. Alongside that ambition is a policy aversion to nuclear power - the policy of 'no to new nuclear energy'. In this constrained way Scotland is aiming to change 79.3 *per cent*[15] of its electricity generation. It is the Scottish Energy Policy of 2008 that dictated that all efforts would be made to embark on a path towards a carbon-free Scotland.[16] More recently, this 'carbon-free Scotland' is also supported by the new Scotland 2020 Climate Group[17] and the new *2020 Routemap for Renewable Energy in Scotland*.[18]

With the expected closure of the nuclear reactors and the replacement of fossil fuel energy sources in the push for a low-carbon economy, it is clear that new energy infrastructure is needed; and therefore the earlier mentioned 79.3 *per cent* of Scotland's electricity generation (kWh supplied) will have to be replaced. Factoring in the abundance of wind farms already in place and planned, it remains to be seen

[13] Based on 2010 data.
[14] The Scottish Government. 2012. Energy in Scotland: A Compendium of Scottish Energy Statistics and Information. [Last accessed 08 January 2014, available at http://www.scotland.gov.uk/Resource/0038/00389297.pdf and also the Energy Statistics available at: http://www.scotland.gov.uk/Topics/Statistics/Browse/Business/TrendData].
[15] This comprises of the 48.7 *per cent* of the total electricity generation by fossil fuels and the 30.6 *per cent* from nuclear energy.
[16] Scottish Energy Policy of 2008, See FN. 1.
[17] For more on the Scotland 2020 Climate Group, see the link: [Last accessed 08 January 2014, available at http://www.2020climategroup.org.uk/].
[18] See the 2020 Routemap For Renewable Energy In Scotland: [Last accessed 08 January 2014, available at http://www.scotland.gov.uk/Resource/0044/00441628.pdf].

what form this new technology will take. With nuclear energy not an option, one idea mooted is to fit future (or even existing) gas and coal plants with Carbon Capture and Storage (CCS) technology. However, whether Scottish CCS is viable and sufficient (noting residual emissions and thermodynamic efficiency penalties) to meet the targets of Scotland's low-carbon policy is still to be demonstrated. In this context, a transitional approach of switching to gas first and then to other lower-carbon sources may be adopted. Scotland could see therefore see a 'dash for gas' however, will new gas energy infrastructure have to be fitted with CCS technology or even be capture-ready'?

One of the main reasons for the Scottish 'no to new nuclear energy' is its failure to have a solution for its long-term waste. However, CCS technology has some similar waste issues to nuclear power.[19] Further, it is not presently commercially viable nor does it actually reduce the carbon emissions on a gas or coal power plant to zero. For example, gas produces just less than 400 kilograms per megawatt hour (kg/MWh) of CO_2 and through the use of CCS technology these emissions will be reduced by *ca.* 85 *percent* – however, it will increase the cost of the of construction up to 60 *per cent* and reduce the efficiency of the power station.[20] Moves to fit CCS technology to Longannet power station in Fife, Scotland, stalled and were eventually scrapped in 2011.[21] Given these realities, and with an abundance of hydroelectric power plants (150 schemes currently) already in place, it remains for other renewable energy sources to help fill the looming supply gap in Scottish electricity supply. The strong presence of despatchable hydro-power in Scotland favours high levels of penetration by intermittent renewables especially if there is a reduced obligation to address issues of grid instability in England.

The crux of the problem is the replacement issue of old energy infrastructure. There are challenges between the old and new energy infrastructure in Scotland. The legacy of environmental impact is not considered in sufficient detail when planning for new energy infrastructure. Simply, because one technology choice is cheaper than another does not mean it actually is when viewed over its lifetime. Nuclear power stations have the longest lifespan (up to 60 years), while gas and coal plants have a shorter lifespan (up to 40 years) and wind turbines having in many cases just a 25-year life span.

There are also fuel and waste costs. In particular, the costs for waste (radioactive waste and carbon dioxide emissions) across the energy sector are an unresolved issue. The cost of waste for long-term storage for nuclear energy or CCS are difficult to quantify while carbon emissions from coal, gas and oil fired plants continue unabated and untaxed across the world. Wind projects suffer from reliability problems along with the interfering with wildlife and scenery. It is clear that whatever policy a

[19] Reiner, D. M. and Nuttall, W. J. Geological Disposal of Carbon Dioxide and Radioactive Waste: Similarities and Differences, in Toth, F. L. 2011. (Editor) Geological Disposal of Carbon Dioxide and Radioactive Waste: A Comparative Assessment, Springer: New York.
[20] International Energy Agency, 2013. Technology Roadmap: Carbon capture and storage. OECD/IEA: Paris, France.
[21] BBC. 2011. Longannet carbon capture scheme scrapped. [Last accessed 08 January 2014, available at http://www.bbc.co.uk/news/uk-scotland-north-east-orkney-shetland-15371258].

government follows regarding energy infrastructure there will be both positives and negatives.

Due to the financial climate across the world, it seems more sensible to make decisions that can have a short to medium term impact. A low-carbon economy is highly desirable, and a government also needs to ensure the development of energy infrastructure that will not leave or create harmful environmental legacies for the next generation. However, at the same time it needs to ensure that a low-carbon Scotland does not come at too high a price for its current population. A transitional approach that may involve a Scottish 'dash for gas' might be one such strategy to achieve this. Overall, more modest goals that place climate change at the forefront of the triumvirate of policies - economic, environmental and energy - and decision-making will make for a more sustainable low-carbon economy in the long run.

3. Nuclear Energy in Scotland

Scotland has been home to nuclear power plants since their introduction in the UK and there have always been issues with their location.[22] Currently, there are two nuclear power plants with two reactors each in operation in Scotland – see Table 1 below. Nuclear power plants face significant environmental challenges when decommissioned. A need exists however to maintain and develop new expertise in this area with the final four operational reactors in Scotland due to be closed by 2023 though Hunterston B was originally scheduled for closure in 2016.

Table 1: Nuclear Energy Plants in Scotland, UK.

Name	Capacity	Technology	Began Operation	Scheduled for Closure	Status
Hunterston B	960 MW (current)	AGR	1976	2023	
Hunterston A	2 x 160MW	Magnox	1964		Closed - 1989
Torness	1185MW (current)	AGR	1988	2023	
Chapelcross	4 x 49 MWe	Magnox	1959		Closed - 2004
Dounreay	Research Reactors	DMTR, DFR, PFR	1955		Closed 1994

Source: Compiled by Authors and EDF (2013).[23]

A nuclear power plant generally can take four to six years to build but it can also take the same amount of time to actually begin the construction on the project. Reactor design approval, project finance, and planning permission all take years to prepare and obtain. While the UK is in the process of making and ensuring significant gains in these areas, a nuclear new build project is still one with a long-term planning and development phase. Hence, a government decision on developing nuclear new build should be taken sooner rather than later. One important consideration in this context will be life extensions. Life extensions are extremely cost-efficient investments for

[22] The siting of UK nuclear installations has recently been reviewed by Grimston *et al.* (2014), see: Grimston, M., Nuttall, W.J. and Vaughan, G. 2014. The siting of UK nuclear reactors. Journal of Radioological Protection, 34 (2), R1-R24.

[23] EDF. 2013. EDF Energy's nuclear power stations. [Last accessed 08 January 2014, available at http://www.edfenergy.com/energyfuture/edf-energys-approach-why-we-choose-new-nuclear/current-nuclear-sites].

the operating company. The economic attractiveness of a nuclear reactor life extension far exceeds that of new power station construction of any type and especially nuclear new build.

The energy company, EDF, now owns and operates the nuclear power plants in Scotland. Recently, they began to push for an extension of the operating lifespan of the nuclear reactors in Scotland. The Scottish government has publicly stated that they will not object to these potential life extension requests.[24] In December 2012, Hunsterson B received a life extension until 2023.[25] In addition, the AGR twin reactors at Torness (the other nuclear power plant location in Scotland) are among the most modern of the UK fleet of AGR plants. The presumption is that EDF will follow a strategy beyond 2023 of securing life extensions of seven years duration.[26] EDF is currently developing this programme of securing life extensions for these aging plants from beyond 2023, however, it may only be able to secure one to two more life extensions. Therfore, based on seven-year life extension, 2030 or 2037 may see both nuclear power plant closures in Scotland and a need for this energy supply to be replaced. Hence, the importance of the government decision on developing nuclear new build is highlighted again.

The mutual importance between Scotland and the UK nuclear industry is revealed by the fact that, *ca.* 2013, the UK had roughly 63,000 people employed in the nuclear sector including the direct supply chain, of whom 8.3 *per cent* were based in Scotland.[27] While the Scottish government is somewhat hostile to nuclear weapons, civil nuclear power and nuclear research these various capabilities represent an important part of the Scottish economy especially in some regions, such as the remote Caithness coast (Highlands and Islands – see Table 2) where the Dounreay laboratories are located. In Table 2 below, it is evident that the majority of the nuclear workforce are in relatively vulnerable employment regions and post independence this may put some of these jobs under threat especially when the 'no new nuclear energy' policy of the Scottish Government is factored in.

Table 2: Nuclear Workforce by Scottish Region 2013

Scottish Region	2013 Percentage
Central Scotland	5.4%
Glasgow	13.4%
Highlands and Islands	27.5%
Lothian	1.3%
Mid Scotland and Fife	2.5%
North East Scotland	0.1%
South Scotland	24%
West Scotland	25.7%

[24] BBC. 2012. Scotland's nuclear stations could stay open. [Last accessed 08 January 2014, available at http://www.bbc.co.uk/news/uk-scotland-scotland-business-17266084].
[25] BBC. 2012. Hunterston B nuclear power plant will run until 2023. [Last accessed 08 January 2014, available at http://www.bbc.co.uk/news/uk-scotland-glasgow-west-20590915].
[26] EDF, 2012. Regulatory Story: Life Extensions. [Last accessed 18 April 2014, available at: http://www.edfenergy.com/about-us/shareholder-information/documents/Life_Extensions,_HPB_and_HNB_-_04.12.12.pdf].
[27] Nuclear Industry Association. 2013. Nuclear Industry Association – Industry Jobs Map. [Last accessed 29 March 2014, available at: http://issuu.com/nuclear_industry_association/docs/jobsmap_scot13].

Source: Nuclear Industry Association, 2013.[28]

4. The Scottish Government and Nuclear Energy

Despite the current Scottish Government's anti new nuclear build stance, nuclear energy is destined to play a role in its electricity sector until at least 2023 (see earlier comment on planned life-extensions). It is not clear what will happen then and if at a later date there will be a review of the stance of the Scottish Government on nuclear energy. The nuclear energy option in the future in Scotland is an issue for further examination and to-date it has received little attention. A brief look by the reasonably interested reader of available publications from the Scottish government, NGOs, and academic literature, point towards an area that is under-analysed and researched. Further, and equally significant, the contribution of nuclear energy to the overall energy policy debate seems misunderstood.

This paper will next examine two recent (2013) communications by the Scottish Government in relation to nuclear energy. The first is a statement by the Scottish Energy Minister specifically on nuclear energy. The second analyses the references to nuclear energy in the Scottish Government independence document.

On the 23 October 2013, the Scottish Energy Minister Mr. Fergus Ewing (Scottish Nationalist Party and Minister for Energy, Enterprise and Tourism) stated the following in response to the UK Government's ambition in its announcement to support the development of a new nuclear plant:

> "Today's announcement confirms that consumers across the UK will be paying for nuclear generation until after the middle of this century. The single nuclear station at Hinkley could be eligible for consumer funded payments totalling around £1 billion per year, depending on wholesale prices. These payments will apply for the length of the contract being awarded – which, at 35 years, dwarfs the 15 years being offered to renewable energy technologies.
> The cost of this single station alone is comparable to the £43 billion which the UK Government's budget is assigned for all energy technologies between 2013/14 and 2020/21 and risks squeezing out home grown developments for imported nuclear technology.
> This UK Government's misguided enthusiasm for nuclear comes at a time when other countries, such as Germany and EDF's home nation France, are either eliminating or scaling back their dependence on nuclear generation and when we should be putting the support to our renewables energy industry and the jobs it will support across the country.
> The guarantee of support and subsidy under this contract until after the middle of this century also sits in sharp contrast with the lack of a UK Government commitment to support our offshore renewables sector and its potential beyond 2020.
> The Scottish Government has an ambitious but achievable target to generate the equivalent of 100% of electricity from renewable sources by 2020, alongside generation from thermal sources fitted with carbon capture and storage.
> Nuclear energy cannot be relied on for our energy needs. The output from Scottish nuclear generation fell to historic lows in 2006 and 2007 due to unplanned outages. Although output has increased since then, nuclear generation has not yet recovered to its pre 2006 levels.
> This underlines the susceptibility of nuclear to sudden interruptions, and supports the Scottish Government's drive towards a balanced energy portfolio, based on cleaner thermal generation and the advantages which our huge renewables potential offers to Scotland."
>
> *Statement by Mr. Fergus Ewing, MSP, Minister for Energy, Entreprise and Tourism. October 23rd 2013.*[29]

[28] Nuclear Industry Association. 2013. *Ibid*.

This statement has been chosen for analysis as it is one of the few communications verbal or written from the Scottish Government specifically on nuclear energy. The statement expresses a rather biased view against nuclear energy, at first in relation to the benefit of nuclear energy and second, in its discussion of the alternatives to nuclear energy. In addition, the statement demonstrates a disconnect between Scottish energy policy and Scottish economic policy of moving towards a low-carbon economy.

A major oversight in the statement is that thermal generation power plants will have carbon capture and storage technology fitted to it. This is despite the withdrawal of funding to the Longannet project mentioned earlier. Back in 2011 £1 billion was promised to the carbon capture storage project by the UK government but this proved insufficient to ensure project success.[30] There were also parallel EU initiatives to support CCS but unfortunately the UK and EU competition criteria were poorly aligned. There is also the question of the commercial viability of carbon capture storage. Such commercial viability is not expected until 2030 at the earliest.[31] Lowe *et al.* (2010) state that the lack of commercial viability for CCS relates to: the high cost of adding the CO_2 capture plant; transport infrastructure and storage operations; the impact of CO_2 capture on plant performance in output and efficiency; and the market structure of the electricity sector which does not cost CO_2 emissions properly.[32] Even so, CCS technology does not decrease carbon emissions to zero but only by a percentage and it uses energy from the fossil fuel plant itself to drive the process reducing overall power plant (fuel use) efficiency. . A recent 2013 International Energy Agency report entitled *Technology Roadmap: Carbon capture and storage* confirms this finding as stated earlier.

The statement shows a further misunderstanding of energy policy in that it cites both the change in France and Germany regarding nuclear energy as support for criticising the decision of the UK government. This demonstrates a lack of understanding energy policy holistically. The energy policy of Germany is a contradiction. The movement against nuclear energy is largely determined by internal political opinion, and not on more technical climate policy, or arguably even energy policy, considerations. Fundamentally German energy policy and the "Energiewende" may be characterised as a firm move away from nuclear power and in favour of renewables, smart grids and energy efficiency. Any low-carbon benefits are purported to emerge from this system transformation, but thus far they are not being seen. At this stage one sees a collapse of German wholesale power prices and an erosion of the market value of power companies while retail electricity prices are some of the highest in Europe because of a socialised component of the domestic consumer bill sitting atop the wholesale

[29] Ewing, F. 2013. Scotland's response on nuclear energy. [Last accessed 08 January 2014, available at http://news.scotland.gov.uk/News/Scotland-s-response-on-nuclear-power-553.aspx ; and for a profile specific to Mr. Fergus Ewing see: http://www.scotland.gov.uk/About/People/14944/Scottish-Cabinet/fergusewing].

[30] BBC. 2011. Longannet carbon capture scheme scrapped. [Last accessed 08 January 2014, available at http://www.bbc.co.uk/news/uk-scotland-north-east-orkney-shetland-15371258].

[31] It is unclear when CCS will be commercially viable due in part due to the fact that it is not yet known which is the best technology for CCS.

[32] p. 97. Lowe, A., Beasley, B. and Berly, T. 2010. Carbon Capture and Storage (CCS) in Australia. In Hester, E. E. and Harrison, E. M. 2010. Carbon Capture: Sequestration and Storage. The Royal Society of Chemistry: Cambridge, UK.

power component. Struggling power companies note the collapse of the EU Emissions Trading Scheme and the very low price on carbon emissions and hence direct investment to highly CO_2 polluting lignite and hard coal based generation capacity. New coal fired power stations are being built in Germany and German power sector emissions are not yet falling[33]. In addition, early reports suggest that emissions of carbon dioxide have increased over the last few years.[34] Is this what a low-carbon Scotland is aiming for?

France, is not necessarily scaling down its nuclear energy ambitions. Despite the statement by President Hollande that the intention of energy policy in France is to reduce nuclear energy to 50 *per cent*, there are a variety of other factors at play. There was political motivation by the French President Francois Hollande to provide increased support for renewable energy and increase his political support from the Green Party.[35] Hollande's government wants to reduce French reliance on nuclear energy while also aiming to increase significantly renewable energy sources, remaining averse to domestic "fracking" and slowly removing its small reliance on fossil fuels. The French nuclear energy industry is also in transition, with a clear move to develop it globally rather than limit it to just France. The international nuclear energy industry is gathering pace, and EDF needs to use a significant amount of its resources abroad. There is also the advantage that licence renewals (life extensions) continue to be successful and France continues to be a net exporter of electricity. Nevertheless, France aims to keep half its electricity supply from nuclear energy and its actions do not represent comparison with a 'no-nuclear policy'.

For Scotland, the answer to the question of how to achieve a low-carbon economy should focus on reducing and replacing its reliance on fossil fuels – which account for 47.8 *per cent* of its electricity mix (see Figure 1 earlier). The current focus on developing wind farms at a very large scale is not viable. Offshore wind farm development cannot be the sole solution as it is sometimes currently perceived., with recent cancellations of two projects in the UK.[36] The continued development of onshore wind farms is limited and Heffron (2013) refers to a *wind energy tipping point* where the public will demand no more onshore wind projects are built.[37] This would imply that the replacement of operating nuclear power plants by wind turbines is not a realistic option; *ca.* 10,000 wind turbines would be needed to replace the

[33] The Economist, *European utilities How to lose half a trillion euros*, Oct 12th 2013. [Last accessed 27 February 2014, available at: http://www.economist.com/news/briefing/21587782-europes-electricity-providers-face-existential-threat-how-lose-half-trillion-euros].
[34] Physics Org. 2013. German greenhouse gas emissions rose in 2012. [Last accessed 08 January 2014, available at http://phys.org/news/2013-02-german-greenhouse-gas-emissions-rose.html].
[35] BBC 2014. France struggles to cut down on nuclear power. [Last accessed 29 March 2014, available at http://www.bbc.co.uk/news/magazine-25674581].
[36] See recent media reports on two wind farm projects and one nuclear energy project: 'Plans for £5.4bn Argyll Array offshore wind farm near Tiree dropped' (BBC 13 December 2013), [Last accessed 08 January 2014, available at http://www.bbc.co.uk/news/uk-scotland-scotland-business-25364699; 'Wind energy faces adverse conditions as RWE axes project' (Financial Times, 26 November 2013), [Last accessed 08 January 2014, available at http://www.ft.com/cms/s/0/08fc5494-5686-11e3-ab12-00144feabdc0.html?siteedition=uk#axzz2lmSbh6tF].
[37] Heffron, R. J. 2013. Accommodating Energy Law within Environmental Law: An Irish Exploration. *Irish Planning and Environmental Law*, 20 (2), 56-64.

contribution of nuclear energy according to the data from Energy Research Systems Unit at the University of Strathclyde.[38]

An examination of public preferences in Scotland in Table 3 below reveals that a significant proportion (32 *per cent*) of the public would be in favour of nuclear energy being built in their area. All energy projects built near the public are reasonable high suggesting that people see economic benefits to any such energy project. More significantly is the 13 *per cent* who would choose nuclear energy as the majority source for their electricity. This is quite high when in comparison to wind (at just 18%) and the total combined of fossil fuels (including shale gas) which is just 7 in *per cent* in total. This suggests a clear preference for low-carbon energy sources by the Scottish public - with 86 *per cent* favouring the majority of their electricity supply from lo-carbon energy sources.

Table 3: Public Preferences in Scotland in the UK

Energy Source	Percentage in Support
A. Support for Energy Generation projects in their area?	
Hydro	80%
Large Scale Wind Projects	62%
Solar	78%
Nuclear Energy	32%
Bioenergy	59%
Shale Gas	24%
Black Oil	37%
Gas (excluding shale gas)	42%
Coal	34%
B. From what source should the majority of electricity come from?	
Hydro	27%
Large Scale Wind Projects	18%
Solar	15%
Nuclear Energy	13%
Bioenergy	3%
Shale gas	1%
Black Oil	0%
Gas (excluding shale gas)	3%
Coal	3%

Source: YouGov, February 2013.[39]

The final paragraphs of the statement by Mr. Fergus Ewing, MSP, Minister for Energy, Entreprise and Tourism, reveals a policy bias against nuclear energy. Nuclear energy is apparently unreliable, there can be sudden interruptions and that Scottish energy policy should consist of a "balanced energy portfolio, based on cleaner thermal generation and the advantages which our huge renewables potential offers to Scotland." Nuclear energy's reported poor reliability stems from low levels of generation arising from minor outages at both plants in 2005 and 2006. The

[38] Energy Systems Research Unit. 2013. University of Strathclyde, Scotland UK. [Last accessed 08 January 2014, available at http://www.esru.strath.ac.uk/EandE/Web_sites/01-02/RE_info/interesting.htm].

[39] YouGov, 2013. Scottish Renewable Surevey Results, February 25th - 26th Results. [Last accessed 29 March 2014, available at http://d25d2506sfb94s.cloudfront.net/cumulus_uploads/document/vj66wakgzm/YG-Scottish-Renewables-Archive-results-260213-renewable-energy.pdf].

Minister's statement fails to mention the contribution of nuclear energy to base-load electricity provision and intermittency of renewable energy.

In addition, there is the repeated assertion at the end of the statement that Scotland will benefit from cleaner thermal energy production. As stated earlier, it is highly suspect to base an energy policy on this as stated earlier because of the lack of CCS technology development. It emerges from this final part of the statement that Scotland plans to move towards a low-carbon economy with a continued ambition to use thermal/fossil fuel power plants; this is repeated in the White Paper on Scottish Independence.

The fossil fuel industry plays a significant role in the Scottish economy. Indeed, there can be no doubt that they play an influential role in the political lobbying of various kinds in Scotland and down in Westminister. A recent study in the US, demonstrated the scale of the fossil fuel lobby groups and calculated that they spend close to $900 million per year.[40] It would be *naïve* to think that similar sums (in proportion to size of the industry and population) were not spent in the UK; indeed, recently, Hutton (2014) expressed an opinion that lobbyists remain a problem in the UK.[41]

5. Nuclear Energy in an Independent Scotland

An examination of material from the Scottish Government demonstrates similar contradictions.[42] The document entitled *Scotland's Future: Your Guide to an Independent Scotland* (hereafter referred to as the *White Paper on Scottish Independence*) published in November 2013 makes for interesting reading regarding nuclear energy and its overall contribution to energy policy.

It is a stated aim within the *White Paper on Scottish Independence* that an independent Scotland aims to decarbonise its electricity supply (p. 18). It is not clear however, despite the rhetoric in the document how Scotland aims to achieve this. The document highlights that one of three central aims is for Scotland to be a leader on climate change (p. 293) and that there will be an accelerated delivery of its commitments on reducing CO_2 emissions (p. 292). Yet however, moving to discuss energy specifically, the *White Paper on Scottish Independence* repeats that the decarbonisation of the electricity sector is a priority and the continuation of its non-new nuclear stance (p. 299). The document states that renewable energy and its development are a safer and more cost-effective method of achieving this than investing in nuclear energy. The reader is not told however, what will happen the 47.8 *per cent* of electricity supply from fossil fuels. The implication is that an expansion of renewable energy and energy efficiency gains will render nuclear energy unnecessary.

[40] Brulle, R. J. 2013. Institutionalizing Delay: foundation funding and the creation of US climate change counter-movement organisations. Climatic Change, (Advance Access) DOI 10.1007/s10584-013-1018-7.

[41] Hutton, W. 2014. Power Lobbyists and Fawning Ministers are Corroding Society. The Observer, 11 January 2014. [Last accessed 12 January 2014, available at http://www.theguardian.com/commentisfree/2014/jan/11/corrosive-influence-big-business-lobbyists].

[42] Scottish Government. (2013). Scotland's Future: Your Guide to an Independent Scotland. The Scottish Government: St. Andrew's House, Edinburgh, UK.

The discussion on oil and gas (p. 301 onwards) makes for more revealing reading. The oil and gas reserves of Scotland will continue to be developed. Further, an independent Scotland would support further exploration and as a result will continue with policies to support this. These policies include having tax-relief schemes and other incentives for oil and gas exploration (p. 303-305). The oil and gas industry it highlights face large up-front costs, and methods for lowering these and other costs such as decommissioning will be sought by the new Scottish administration.

The document specifies clear support for the export-oriented fossil fuel industry while in contrast criticises the UK government for supporting low-carbon nuclear energy. The global climate impacts of Scottish carbon making its way to the atmosphere are rather over-looked and assisted by the fact that international climate policy focuses on the geographical location of fossil fuel combustion not resource extraction. The *White Paper on Scottish Independence* holds nuclear energy as too expensive, in need of long-term contracts and being unsafe. These three latter issues will be examined in turn. The development of new nuclear energy is expensive mainly due to large upfront costs. It does not benefit from tax relief schemes which apply to the oil and gas sector. A brief examination of the tax reliefs that oil and gas production companies receive is revealing. Tax reliefs are given for nearly every expense related to production, and exploration, for both planned, successful and unsuccessful projects. An overview is outlined in a document from the *HM Revenue and Customs titled A Guide to UK and UK Continental Shelf Life: Oil and Gas Taxation 2008.*[43] In addition, UK taxpayers will also pay for decommissioning in the oil and gas sector which will now receive tax incentives on decommissioning costs, estimated at £30 billion over the next 15 years; this tax relief was granted in 2012.[44] The offering of tax relief for development and decommission represent similar long-term contracts to those being given to nuclear energy in the UK. Part of the purpose of tax legislation for fossil fuels is stated as to "allow a project to rapidly recover its costs".[45] Why are low-carbon energy sources not treated the same way and allowed to recover costs of a project rapidly? Fundamentally energy policy and oil and gas extraction policies occupy different worlds – and there is little joined up decision making. An independent Scotland is likely to do nothing to alter that reality as there are political benefits in preserving it.

Finally, in terms of safety, it is not specified in the *White Paper on Scottish Independence* why nuclear energy is unsafe. Safety is a key concern across the energy sector, and low safety standards in the energy sector are a subsidy as it reduces the cost of providing safe operations. If safety is seen in terms of fatalities a recent study has showed that between 1971 and 2009 the use of nuclear power in comparison to

[43] UK HM Revenue and Customs. 2008. A Guide to UK and UK Continental Shelf Life: Oil and Gas Taxation 2008. [Last Accessed November 30th, available from: http://www.hmrc.gov.uk/international/ns-fiscal3.htm].

[44] Burges Salmon. 2013. Guaranteeing Tax Relief for Decommissioning. Oil and Gas Connect. Issue 9, August 2013. [Last Accessed November 30th, available from: http://www.burges-salmon.com/Sectors/energy_and_utilities/Oil%20and%20Gas/Publications/Guaranteeing_tax_relief_for_decommissioning_what_will_it_mean.pdf].

[45] UK HM Revenue and Customs. 2013. Guide to the North Sea Fiscal Regime. [Last Accessed November 30th, available from: http://www.hmrc.gov.uk/oilandgas/guide/prt.htm].

fossil fuels has saved 1.8 million lives.[46] Fossil fuels in general have high fatality rates for example in the US and China where there are *ca.* 30 and 2000 fatalities *per annum* respectively.[47] The UK has suffered its own major accidents with Piper Alfa causing 167 deaths in 1985. The question arises, has the safety culture improved, or do lower safety standards contribute to the lower cost of fossil fuels?

Douglas (2002: xix) makes an interesting connection in this regard, and links big industry and government together, alongside the influence of political affiliation – in many ways the fossil fuel issue and not nuclear energy in Scotland mirrors this quote:

> "Dangers are manifold and omnipresent. Action would be paralysed if individuals attended to them all; anxiety has to be selective. We drew on the idea that risk is like a taboo. Arguments about risk are highly charged, morally and politically. Naming a risk amounts to an accusation. The selection of which dangers are terrifying and which can be ignored depends on what kind of behavior the risk-accusers want to stop. Not risky sports, not sunbathing nor crossing the road; it was to do with nuclear or chemical hazards – in short, big industry and government. Subsequent survey research showed that political affiliation was the best indicator of the distribution of attitudes to risk."
> *Purity and Danger: An Analysis of Concepts of Pollution and Taboo.*[48]
> *Professor Mary Douglas, xix preface to the Routledge Classics 2002 edition.*

6. Nuclear Waste in an Independent Scotland

This issue of nuclear waste is a problem in many countries worldwide. Perhaps the most forward-thinking countries on this issue are Sweden and Finland. Both these countries have had long-term nuclear waste storage plans and both are in the process of receiving final approval to begin construction.[49]

Scotland currently has two nuclear power stations with two reactors on each site. An independent Scotland might be expected to have to deal with the problem of Scottish nuclear waste, and perhaps also the nuclear wastes arising from its plants that are currently being stored at Sellafield in England. The problem arises because under EU law it is the responsibility of member states to manage spent fuel and radioactive waste. However, it is possible that two or more member states can agree to use a common disposal facility under strict conditions.[50] So Scotland could avail of the latter upon becoming an EU member State, assuming the residual UK were to agree.

[46] Pushker A. Kharecha and James E. Hansen, 'Prevented Mortality and Greenhouse Gas Emissions from Historical and Projected Nuclear Power' (2013) 47 (9) Environmental Science Technology, 4489-4895.
[47] This is an average taken from across multiple sources from the US Labour Department to OECD statistics and is a conservative estimate. For a full list of sources please contact the author.
[48] Douglas, M. 2002. Purity and Danger: An Analysis of Concepts of Pollution and Taboo (Routledge Classics Edition). Routledge: London, UK.
[49] For more on this see: Heffron, R. J. 2013. Nuclear Energy, Year in Review. In Fauchald, O. D., Hunter, D. and Wang, X. 2012. Yearbook of International Environmental Law, Vol. 23, 269-273. Oxford University Press: Oxford, UK.
[50] Council Directive 2011/70/Euratom OJ L199/48. Establishing a Community Framework for the Responsible and Safe Management of Spent Fuel and Radioactive Waste. For a brief summary see: last accessed 27 February 2014 *http://europa.eu/rapid/press-release_IP-11-906_en.htm*.

In addition, EU law[51] now obliges member states to develop national programmes for nuclear waste disposal and to notify them to the European Commission by 2015 at the latest. These national programmes must include a timetable for the construction of disposal facilities, as well as a description of the activities needed to implement disposal solutions, costs assessments and a description of the financing schemes.[52]

There is conflict here in that Scotland has rejected the idea of a deep geological disposal facility ("GDF")[53] (and also new nuclear build).[54] Heffron *et al.* (2013)[55] comment that:

> "Jamie Reed MP *(Labour)* voiced concerns in parliament in 2012 as to whether the government will commit itself to an analysis of the volumes of Scottish higher activity radioactive waste which is stored in England, the costs to remove them, where they will be located in Scotland, and who will be responsible for them in the long term.[56] A Scottish government statement in reply suggested that proposals for nuclear decommissioning in an independent Scotland would be covered in a white paper to be published in November 2013."[57]

However, the storage of nuclear waste and nuclear decommissioning has received little attention in the *White Paper on Scottish Independence*. It is addressed very briefly (p. 520-521) and no solutions are given, just an expression that nuclear waste will be managed safely and effectively. The promised answers have not yet (April 2014) materialised.

7. Conclusion: The Nuclear Future in Scotland

Whether one is for, against, or indifferent to new nuclear energy development, the topic highlights a major gap in Scotland's energy and environmental policy goals. The energy policy debate from the Scottish Government perspective has been reduced to a low-carbon energy development debate between nuclear energy and renewable energy. The challenge should be how to reduce the 47.8 *per cent* of the electricity supply sector that comes from fossil fuels, noting Scotland's continuing enthusiasm for fossil fuel extraction and processing.

This continuation of the use of fossil fuels will continue the emission of carbon dioxide. This prompts the question, were an independent Scotland to join the EU, would their accession agreement require them to close their fossil fuel power plants?

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[51] Fn 34, *Ibid*.
[52] Fn 34, *Ibid*, Chapter 2 Obligations, Article 5 National Framework (a) – (h).
[53] Scottish Government, 2011. Scotland's Higher Activity Radioactive Waste Policy. DPPAS11098 (01/11), 4-5.
[54] Scottish Government. 2008. *Scottish Energy Policy: An Overview* (p.7) [Last accessed 08 January 2014, available at http://www.scotland.gov.uk/Resource/Doc/237670/0065265.pdf].
[55] Heffron, R. J., Allen, M. and McCauley, D. 2013. The Forgotten Law and Policy Issue: Nuclear Waste Management in Scotland. *Edinburgh Law Review*, 17 (3), 325-332.
[56] Scottish Express. 20012. Nuclear waste Bill threat to Scotland, 22 January 2012. [Last accessed 08 January 2014, available at *http://www.express.co.uk/news/uk/297168/Nuclear-waste-bill-threat-to-Scotland*].
[57] News & Star. 2012. Cumbrian MP says Scotland must take waste back under independence, 18 October 2012 [Last accessed 08 January 2014, available at *http://www.newsandstar.co.uk/news/business/cumbrian-mp-says-scotland-must-take-waste-back-under-independence-1.1005981?referrerPath=home*].

For many new EU Member States since 2005, the closure of fossil fuel plants has been a key part of meeting their accession agreements.[58] In addition, the European Industrial Emissions Directive (Directive 2010/75/EU - to have been implemented by 2013) places limits on the emissions of and fossil fuel power plants (in particular, SO_2 and NO_x)

For Scotland to aspire to being a low-carbon economy, to decarbonising its electricity market, and to being a leader within the climate change community, it needs to tackle the issue of how to stop the continuation of burning fossil fuels. This is not something the Scottish Government has yet achieved. Until this happens these policy aspirations of the Scottish Government must be seen as consisting of simultaneous enthusiasm for a renewables-led energy policy and an oil and gas extraction industrial policy. Between these two odd components sits nuclear energy – an important Scottish industry destined for neglect and decline almost irrespective of Scottish independence.

[58] New entrants to the EU had to reduce state aid to the fossil fuel sector and also reduce emissions such as those from fossil fuel plants, for example: SO_2, No_x, VOC and NH_3 . For more detail please see the EU Accession Articles on Energy and the Environment respectively: [Last accessed 18 April 2014, available at: http://www.europarl.europa.eu/enlargement_new/treaty/default_en.htm].