OpenAIR@RGU

The Open Access Institutional Repository at Robert Gordon University

http://openair.rgu.ac.uk

Citation Details

Citation for the version of the work held in 'OpenAIR@RGU':

TOKE, D., STRACHAN, P., COWELL, R., ELLIS, G. and SHERRY-BRENNAN, F., 2013. Is an independent Scottish electricity system good for renewable energy and Scotland?: The DREUD Report on implications of the UK Government's decisions on new nuclear power and Electricity Market Reform for the prospects of renewable energy in Scotland. Available from *OpenAIR@RGU*. [online]. Available from: http://openair.rgu.ac.uk

Citation for the publisher's version:

TOKE, D., STRACHAN, P., COWELL, R., ELLIS, G. and SHERRY-BRENNAN, F., 2013. Is an independent Scottish electricity system good for renewable energy and Scotland?: The DREUD Report on implications of the UK Government's decisions on new nuclear power and Electricity Market Reform for the prospects of renewable energy in Scotland. Aberdeen: Robert Gordon University.

Copyright

Items in 'OpenAIR@RGU', Robert Gordon University Open Access Institutional Repository, are protected by copyright and intellectual property law. If you believe that any material held in 'OpenAIR@RGU' infringes copyright, please contact openair-help@rgu.ac.uk with details. The item will be removed from the repository while the claim is investigated.

Is an independent Scottish electricity system good for renewable energy and Scotland?

The DREUD Report on implications of the UK Government's decisions on new nuclear power and Electricity Market Reform for the prospects of renewable energy in Scotland.

By David Toke, Peter Strachan, Richard Cowell, Geraint Ellis, and Fionnguala Sherry-Brennan.

Delivering Renewable Energy Under Devolution (DREUD) is a project funded by the ESRC in the 2011-2013 period conducted by Cardiff University, University of Birmingham, Queens University Belfast and Robert Gordon University. This report extends the work of this project.

Note: Dr Toke who worked on the project based at the University of Birmingham is now based at the University of Aberdeen.

EXECUTIVE SUMMARY

At the beginning of 2013 five academics from different UK universities published a paper on the prospects for renewable energy in the context of the debate about Scottish independence (Toke et al 2013). The conclusion was that it would likely be rather more expensive to reach the Scottish Government's renewable energy targets in the case of an independent Scotland as opposed to Scotland remaining within the Union. Since the paper was published, there have been significant developments in UK electricity policy, and as a result we now wish to adjust our conclusions with respect to the prospects for renewables in the case of Scottish independence, or 'devo plus' circumstances, where Scotland has an independently managed and financed electricity system. In short, we now suggest that with a UK nuclear new build programme going ahead, an independent Scottish electricity system could deliver the Scottish renewable electricity target at lower electricity prices for the consumer than if this was achieved as part of the continued union of the electricity system between Scotland and the rest of the UK.

Since the paper was published, there have been significant developments in UK electricity policy, and as a result we now wish to adjust our conclusions with respect to the prospects for renewables in the case of Scottish independence

Two new factors are radically changing the context of our earlier analysis. On October 21st the UK Government announced a 'deal' for a new twin nuclear reactor at Hinkley C, and possibly a second twin reactor at Sizewell C. Further nuclear plant are also planned. This will significantly increase prices for UK electricity consumers that would not have to be paid by consumers in an independent Scottish electricity system. Second, in June 2013 the UK Government announced incentive levels and terms for renewable energy from 2017/18 as part of Electricity Market Reform (EMR) (DECC 2013). These incentive levels seem unlikely to support major deployment of Scottish offshore renewable resources. The incentives for offshore wind and also tidal stream and wave power payable from 2018 under Electricity Market Reform (EMR) have been significantly reduced compared to the incentives available under the Renewables Obligation (RO), something that is critical for offshore wind schemes in deeper waters. Unlike nuclear power, loan guarantees are not available for innovative marine renewable technologies like tidal stream and wave power. The EMR settlement means that there is now unlikely to be major offshore Scottish renewable development after 2017. This reduces the argument in favour of Scotland remaining in a UK-wide electricity system. An (offshore renewable) programme which does not exist cannot be cheaper for Scottish consumers in a UK wide electricity system as opposed to a Scottish system.

We have used this changing context to look again at the costs of achieving Scottish renewable electricity targets under an independent Scottish system compared to a UK-wide electricity system. We believe that given the progress that is already being made towards meeting the Scottish renewable energy target (of 100 per cent of Scottish electricity consumption derived from renewable energy by 2020), achievement of the target can be extensively based on further development of onshore wind and other sources including hydro, solar pv and sustainable biomass. Increases in Scottish energy prices to fund this will be less than remaining in a UK-wide electricity system in which Scottish consumers would have to fund both renewable energy and the

Our calculations include the assumption that under an independent system the Scottish Government could reduce the annual charge to electricity consumers of delivering renewable energy

UK Government's projected nuclear power construction programme. In an independent Scottish system the Scottish Government could use its discretion to fund some offshore renewable whilst restricting price increases to less than may be the case in a UK-wide system.

For the purposes of this analysis we assume current technology costs of renewable energy in the shape of onshore wind and nuclear power in the form of Hinkley C nuclear power station. The prices are based on the levels set by the Government, with the proviso that renewables receive equivalent terms to that of nuclear power, as explained below. We calculate that, in the case of continued union of Scottish and electricity systems in England and Wales, the combined increase of prices to domestic electricity consumers of new nuclear build and that of reaching the Scottish Government's renewable electricity target would range from 5.6 per cent in the case of just the Hinkley C construction, 8.0 per cent if both Hinkley C and Sizewell C is built, and 10.4 per cent in the case of construction of a third twin reactor set.

By contrast we calculate that achievement of the Scottish Government's renewable energy target, in the context of an independent Scottish electricity system, would increase Scottish electricity consumer bills by 7.2 per cent. However, such a (Scottish) price increase would last for a much shorter period (than in England and Wales) as 35 year premium price contracts are being awarded for nuclear power and, in our analysis, 20 years for renewables. In this case it is very possible that further steep declines in the cost of technologies such as solar pv could reduce prices before the end of the period in which consumers were paying off the incentives for nuclear power.

Our calculations include the assumption that under an independent system the Scottish Government could reduce the annual charge to electricity consumers of delivering renewable energy by a) offering 20 year contracts to renewable energy generators rather than ones lasting just 15 years under EMR, b) by offering the renewable energy schemes loan guarantees (as is being done with Hinkley C), and also c) by extending 'feed-in tariff' contracts to independent generators, not just major electricity companies as is the case under EMR. Under an independent Scottish electricity system a Scottish Government could also offer increased incentives and loan guarantees to promote significant development of Scottish offshore renewables, something that seems unlikely to occur under EMR. This would either involve price increases over 7.2 per cent or restricting the Scottish renewable target to, say, 90 per cent of Scottish electricity consumption. An independent Scottish electricity system could also be designed to suit renewable electricity rather than conventional centralised power generation, such as ending the priority to Feed-in Tariffs given to the big energy companies over independent generators. This would also help the growing community renewable energy sector.

We therefore conclude that we need to heavily qualify our previous conclusion that it would necessarily be much more expensive to reach the Scottish Government's renewable energy targets under the establishment of an independent Scottish electricity system. Indeed in the context of EMR and the possibility of extending the nuclear programme beyond Hinkley C, from the mid-2020s onwards, it is likely to be cheaper for Scotland's renewable energy target to be met in the context of an independent electricity supply system.

INTRODUCTION

The announcement, on October 21st, that the UK Government had concluded a deal with EDF and partner companies[1] (hereafter referred to as 'EDF etc') has a number of implications for UK energy policy, some of which are hotly debated. The 'deal', which still requires consent of the EU Commission under EU state-aid rules, involves EDF etc being given the option of developing Hinkley C nuclear power scheme with premium prices lasting 35 years from the point of plant commissioning. The premium price will be £92.50 MWh. In recent times wholesale electricity prices have been in the region of £50 per MWh. The Government also hopes that more nuclear power will be built by 2030. If a further two sets of reactors are built this there will be a total of 9.6 GWe of 'new build' nuclear power in operation by 2030.

Much of the debate about the 'Hinkley C' Government decision has been either about the price agreed, the length of the contract, the offer of loan guarantees, or the involvement of Chinese companies in owning the plant. However, there has been much less discussion of the implications of this decision for Scottish electricity and renewable energy policy in the context of the Independence Referendum in September 2014.

This lack of discussion is strange, if you consider the recent controversies around increases in domestic energy bills and the centrality of energy issues to debates over Scottish Independence. Indeed the Scottish Government has been explicit in its opposition to granting planning permission for nuclear power plant on Scottish soil, and it has also adopted ambitious targets to supply the equivalent of 100 per cent of electricity consumption in Scotland from renewable energy by 2020.

Two factors perhaps explain the lack of debate. First, energy is a very complex business, with the ramifications of policies poorly understood by the general public, especially in this case with the added complication of the relationship between electricity in Scotland to renewable energy programmes organised through Westminster. A second factor is that the Westminster Government has recently focussed public attention on the impact of support for renewable on energy prices, rather than impact of the new nuclear power programme, which will not start operating before 2023. The new nuclear programme is also likely to increase consumer electricity prices, although this would not be the case in Scotland if its electricity system was independent from the rest of Britain.

energy is a very complex business, with the ramifications of policies poorly understood by the general public, especially in this case with the added complication of the relationship between electricity in Scotland to renewable energy programmes organised through Westminster

[1] HM Government (2013) Initial agreement reached on new nuclear power station at Hinkley Press Release, 21/10/13, https://www.gov.uk/government/news/initial-agreement-reached-on-new-nuclear-power-station-at-hinkley

We, the authors of a study on 'Delivering Renewable Energy Under Devolution' (DREUD), have already commented on the potential impact of Scottish independence on renewable energy ambitions (Toke et al 2013). However, this study was completed prior to the recent deal over nuclear power stations. Indeed, we assumed that agreements such as that announced for Hinkley C would be economically implausible. Moreover, since we published our original research, the Government has also announced its incentives for renewable energy under Electricity Market Reform (EMR) which appear to be significantly less supportive of renewable energy compared to the arrangements associated with the Renewables Obligation (RO) (DECC 2013). These developments substantially impact on our previous conclusions, so we now feel an imperative to highlight its implications for the future management of the Scottish renewable programme and indeed, for the wider debate on Scottish Independence.

We previously argued that, relative to remaining with the Union, Scottish Independence could substantially increase the cost to Scottish consumers of achieving its renewable energy targets. However, having reviewed the impact of the Government's recent decisions on nuclear power and incentives for renewables, we believe that this is no longer the case. Moreover, the notion of Scotland having its own renewable energy support mechanism (and indeed its own electricity market arrangements) is no longer necessarily detrimental to the prospect of renewable energy in the long term. On the contrary, on the basis of the evidence considered here, we believe that Scotland's renewable energy programme would now benefit from having an independent electricity system and support arrangements for supporting non-fossil electricity sources.

OUR MODEL

Our model compares the costs to the consumer of meeting the Scottish Government's renewable electricity target under four different scenarios. Our projections are conservative in the sense that we assume current technology costs for nuclear power and renewables, as evidenced in the price and terms of the Hinkley C 'deal' and incentives offered by the Government for onshore wind. We note that the Government has assumed that the price of successive nuclear power plant will fall (with the price being reduced from £92.50 MWh to £89.50 if Sizewell C is built), which we regard as being at least, if not more, speculative than assuming the cost of renewables will also fall. Indeed there are good arguments that the costs of wind and solar energy are more likely to fall than nuclear power. Nevertheless we use the headline premium prices announced by the Government for onshore wind power from 2017 and for Hinkley C as the bases of our analysis for all future nuclear and onshore wind plant. The only caveat to this is the assumption that onshore wind power projects will receive equivalent terms and conditions to nuclear power through access to loan guarantees and longer premium price contracts, and the 'headline' prices are re-calculated to give effect to this reasoning.

We fully appreciate that other very viable renewable energy technologies exist, but for the sake of clarity we have focussed on comparing just two technologies; wind and nuclear. We discuss this issue in some further detail later. We also simplify the calculation by assuming that wholesale electricity prices will remain at the same level as in recent times, £50 per MWh. Government projections indicate a big increase in real wholesale electricity prices over the coming years, a speculation that is open to question. However, even though wholesale electricity prices may well change (upwards or downwards), the relative costs of the renewable and nuclear programmes under the different scenarios are likely to remain the same and the conclusions about comparative costs of delivering renewable programmes under different scenarios will not be fundamentally altered. Calculations that are based on the assumptions made here are reproduced in the Appendix of this report.

To illustrate our argument we have developed four scenarios, based on the following;

- Scenario 1: construction of just two reactors at Hinkley C, by around 2023, and continued investment in renewable energy in the UK;
- Scenario 2: 4 nuclear reactors by 2030, and continued investment in renewable energy in the UK;
- Scenario 3: Six nuclear reactors by 2030. It should be noted that the projection of six nuclear reactors by 2030 is still less than the HM Government project to be built by 2030 (HM Government 2013). Again, continued investment in renewable energy in the UK is achieved;
- Scenario 4: an independent Scottish electricity system. Under this scenario Scottish consumers would not pay any premiums for new nuclear power stations but they would pay premiums necessary to fulfil Scotland's 100 per cent renewable target after 2017. It is assumed that the Scottish renewable energy target of 100 per cent of electricity consumption from renewable energy would be achieved by around 2023.

The price increases apply to all of British electricity consumers under scenarios 1, 2 and 3, but in Scenario 4 has its own electricity trading arrangements. This would apply in the circumstance that Scotland developed its own electricity market and renewable energy support system. Such an arrangement would still allow electricity to be traded between Scotland and the UK, but Scotland and England/Wales could have separate support mechanisms for non-fossil energy sources and a separate regulatory system. Such arrangements could apply under both Scottish Independence or in the case of any 'devo-plus' settlement which included indigenous control over Scottish electricity market arrangements. A Scottish Ofgem would need to exist and agreements over cross border energy trading would have to be developed under 'devo plus'. In some ways full independence would require fewer new decisions to be made as cross border electricity trading would simply be regulated by EU network codes, as discussed below.

Under Scenario 4:

- Scottish electricity consumers would be responsible for paying the full cost of premium price contracts for renewable energy installed after an agreed post-referendum 'market separation' date. The date would have to be negotiated according to the practicalities of achieving market separation, which may be in the context of either independence or a new 'devo-plus' arrangement. If, following a public consultation, legislation was brought forward in 2016, then new market arrangements could at least begin to take effect in 2018.

- Renewable energy installations commissioned (and also those subject to contract) prior to the agreed date for market separation would continue to be funded by 'pooled' arrangements under the Renewables Obligation (RO) and a transitional arrangement to cover the introduction of Electricity Market Reform (due to be phased in from 2014-2017).

- Under conditions of market separation the Scottish Government would be free to create conditions to underpin, and terms that suit, the development of a Scottish electricity system based on renewable energy. Currently the British system is underpinned by arrangements that do not suit funding and management of renewable energy.

- The Scottish electricity system would be managed separately to that of England and Wales. This was the case until 2005, whereafter the British Electricity Transmission and Trading Arrangement (BETTA) was established. A system could be established similar to the NORDPOOL system covering Scandinavia. Under this system there is a common electricity trading network whereby electricity is traded at the prevailing wholesale prices between the different networks. However the different countries maintain differing regulatory regimes within their national zones, in particular relating to premium prices paid to different renewable energy technologies (i.e. payments that differ from the wholesale electricity price). Such premium prices are payable only to schemes installed within the different countries, although renewable energy support schemes can be common between countries by agreement (in particular between Norway and Sweden). It should be noted that under EU internal market rules the rest of the UK would have to trade equitably with

Scottish generators and suppliers on the basis of wholesale electricity prices. There are precise rules, and indeed an agreed price, governing inter-state electricity trading, the agreed transmission price for traded electricity being pegged at a low level so that inter-state trading can be encouraged (ENTSO-E 2013). An independent Scottish system would be responsible for regulating transmission upgrades. However, a lot of planned transmission upgrades will be completed or under construction by 2018, and the costs of future interconnectors between Scotland and the South may be shared between Scotland and (the rest of) the UK.

- Scottish electricity consumers would not be liable to pay premium prices to support new nuclear power. On the other hand it would mean that Scottish electricity consumers would have to bear the sole burden of paying premiums necessary to support Scottish renewable energy installed after the market separation date. However, as mentioned earlier (and discussed more later), the fact that this would be offset by avoiding having to pay for new nuclear power could allow a substantial expansion of Scottish renewable energy to continue without paying extra costs.

- Separate regulation of the renewable energy support mechanism would allow a feed-in tariff system to be established that allows independent and community based renewable energy schemes to have direct access to the feed-in tariff. This is the case under the German feed-in tariff system. Under the current EMR arrangements only very large electricity companies have access to the feed-in tariff contracts ('contracts for difference' – CfDs). This would allow higher income for, and more projects from, the independent generators and less unearned income for the major electricity companies that ought to go directly to the renewable energy generators (Toke 2012).

- Regulations more suited to managing a system based on renewable energy could be introduced compared to the regulations under BETTA. Since the 'New Electricity Trading Arrangement' (NETA) was introduced in 2001 trading on wholesale electricity markets has been effectively limited to major electricity companies owing to regulations demanding high levels of guaranteed liquidity to pay 'imbalance charges' - potentially high penalties for failing to deliver electricity promised by generators. However this system was introduced to ensure that conventional 'centralised despatch' power plant delivered expected outputs, in the context of issues associated with the operation of conventional fossil fuel power stations. Such a regulation is unnecessary and counterproductive for variable, decentralised, generation. A separate system regulated by Scotland could end the need for renewable energy generators to face penalties for failure to supply. This could enable even small renewable energy generators to trade on wholesale electricity markets. There are different options for managing balancing of renewables. The task can be assigned to the System Operator. The renewable generators could also be incentivised to contract for their own balancing arrangements, as is being done in Germany.

- We assume that under market separation (ie. under independence, or by agreement under 'devo plus' market separation) the Scottish Government would have at its disposal the ability to give loan guarantees for non-fossil energy purposes similar to that being offered to Hinkley C to renewable energy. Indeed, we suggest that around £4.9 billion[2] would be required to give around 65 per cent loan guarantees to the renewables programme, discussed in this document for Scotland, which would be necessary to complete the Scottish Government's 100 per cent renewable energy target. We estimate that this will reduce the required internal rate of return (IRR) for onshore wind power schemes by around 2 per cent and lead to significant reductions in the premium price necessary to deliver a given capacity of wind power. We base this on analyses such as that conducted by Earthtrack (1995) on impacts of government underwriting in general on required rates of return and on the discussion of how investment conditions affect onshore wind power financing in Mazar (2013). See the Appendix for a cost breakdown. It should be noted that £10 billion worth of loan guarantees are being offered for development of Hinkley C. This implies that something of the order of £30 billion of loan guarantees would have to be offered by the UK Government to finance three twin reactors.

- We assume that under market separation the Scottish Government would be able to issue 'feed-in tariff' contracts with longer contract lengths than is the case under EMR, for example 20 years as opposed to 15 under EMR. This produces a reduced level of premium prices payable to renewable energy schemes. See Appendix for a cost breakdown.

- Based on data concerning renewable energy that is in operation, is under construction or has been consented and is likely to be built (RenewableUK 2013 - UKWED, UK Government 2013, plus media reports on specific project consents), we calculate that by 2018, sufficient renewable energy generation will be installed to achieve around 67 per cent of the Scottish renewable electricity target . We calculate that around 25.3 TWh is likely to be generated in 2018 compared to Scottish electricity consumption (in 2011) of 37.9 TWh (Scottish Government 2013a, 25). See the Appendix for further discussion.

---

2 Assuming capital costs of £1400 per KW (Milborrow 2013)

MODEL OUTPUTS

Our projections indicate that:

1. The price increase for the Scottish consumer of having Hinkley C and achieving the Scottish Government's renewable energy target in the context of a unified UK electricity market (under EMR) would be 5.6 per cent in the case of Hinkley C being built, but this would rise to 8.0 per cent if Sizewell C was also built and 10.4 per cent if a third twin reactor was built. Indeed these price increases would apply to all UK electricity consumers outside of Northern Ireland. The bulk of these price rises would persist for 35 years after 2023.

2. Under an independent Scottish electricity system, a consumer price increase of 7.2 per cent would be required to meet the Scottish Government's renewable electricity target, with price increases lasting for 20 years from around 2020-23.

DISCUSSION

One objection to Scenario 4 might be the amount of extra onshore wind required to meet the Scottish renewable target – some 5.4 GWe. Yet we argue that our analysis is still plausible considering that:

- Currently there is around 7.6 GWe of onshore wind power in Scotland that is either operational, under construction or which has been given planning consent. There is already a considerable quantity of onshore wind power awaiting planning decisions to increase this capacity. In the summer of 2013 (the most recent data available to us) this amounted to almost 4 GWe of onshore wind projects (Scottish Government 2013b).

- The quantities of sites that could be used for wind power could be considerably enhanced if solutions that are now available to solve radar interference are applied in areas currently ruled out for wind development by aviation objections

- The 5.4 GWe figure is at the top end of requirements for onshore wind power to meet the target since other forms of renewable energy can be deployed to help meet the Scottish renewable energy targets. These include solar, hydro and sustainable biomass sources. Despite impressions that exist to the contrary, solar resources (per square metre) in Scotland are little different to the rest of the UK and solar pv prices have declined dramatically in recent years meaning that installation rates are likely to pick up in the years ahead.

It is a matter of debate about what the most suitable premium price contract length for renewable energy schemes may be. Differing technologies may have a need for different lengths; certainly offshore renewables (especially tidal stream and wave) could do with longer rather than shorter contract lengths. However the granting of such a long term contract for nuclear power (35 years), as recently announced by the UK Government, distorts the price comparison with renewables if such comparisons are made solely by comparing the 'headline cost' rather than taking into account the impact on consumer costs of a longer contract (as well as loan guarantees) for nuclear compared to renewables. Certainly, from this point of view, our decision to use 20 years as the contract length basis for renewables is justified in order to give a more realistic assessment of the comparisons of costs to the consumer between nuclear and renewable energy programmes. Claims by the Government that nuclear power deserves such longer contracts compared to onshore wind (allegedly because nuclear stations will last 60 years whilst onshore wind cannot generate for longer than 25 years) may be challenged on the basis of the historical record. The oldest nuclear power plant still operating is no more than 45 years old whereas there are commercial wind turbines in California still operating after 30 years.

Although Scotland gives a high priority to development of marine renewable resources, we have chosen not to include the costs of this in our analysis. It has been noted that Scotland could not afford to develop large quantities of marine resources if it was outside the UK. Indeed in our previous paper (Toke et al 2013), this point formed an important part of our argument about the relative affordability of an offshore programme being funded by the UK rather than Scottish consumers on their own. However, recent announcements on the funding of new nuclear power plants using controversial terms and the EMR incentives and terms, are not encouraging for offshore renewables after 2018. Therefore the argument that Scotland will depend on the wider UK to support its offshore programme does not apply if there is little possibility of more than very small quantities of marine renewable emerging through EMR. The headline price for offshore wind from 2018 was set at £135 per MWh (in June 2013) which sounds comparable to that on offer under the Renewables Obligation (RO), except that the length of the contract for all renewable schemes was cut by 25 per cent and there is less allowance for inflation adjustment of price. In addition no loan guarantees will be available for the capital costs of the offshore renewable projects themselves. There is unlikely to be much offshore wind built on such terms after 2018, especially in Scotland where the proposed schemes tend to be in the deeper, more expensive, waters and sites. The Scottish Government has keenly supported tidal steam and wave developments in the Pentland Firth. Yet despite the apparently high strike prices offered to wave and tidal under the EMR settlement, very little of this capacity is likely to be developed with just 15 year contracts and also without loan guarantees being offered for the projects themselves. These innovative technologies may be regarded by banks as involving uncertainties. Loan guarantees, it seems, are being reserved for nuclear power rather than marine renewables.

Under EMR the Scottish Government loses all control over consumer financed renewable energy incentives after 2017. However, a Scottish Government that does control financial incentives for energy may choose to trade-off support for onshore renewable with additional funding for offshore renewable projects. Of course, the more offshore renewables capacity is funded then either the price for Scottish electricity consumers will rise above the level indicated here, or the Scottish renewable energy target may not be achieved by 2023.

Another issue is the impact of the ability of an independent Scottish electricity system to meet electricity demands without increased danger of blackouts for consumers, which is one of the key justifications for investing in nuclear. We can see no persuasive argument that an independent Scottish system would have greater insecurity. As is the case with the UK system, increased use of renewable energy implies the usefulness of having some sort of 'capacity mechanism' whereby the System Operator ensures, through regular auctions for capacity in different conditions, that there is sufficient power station capacity available to meet demand. The adoption of such a system is a key part of EMR.

One study suggested that an independent electricity system in Scotland would have a peak demand of 7.3 GWe (University of Edinburgh 2006). Even if we discount completely the value of variable renewable energy supplies towards meeting peak demand (although on probability grounds this variable generation will still have some 'firm demand' value), Scotland should need no more than around 5 GWe of new fossil fuel reserve capacity. This assumes the retirement of Torness and Hunterston B nuclear power stations by 2030 and other existing fossil fuel power plant (unless converted to CCS or to run on biomass). Assuming a modest growth in hydro and biomass renewable capacity around 3 GWe of firm capacity should be available from these sources. In addition to this 'demand shifting' techniques are being developed that will reduce the level of peak electricity demand. The remaining balance of fossil fuel reserve would most likely be combined cycle gas power stations (CCGTs) such as the planned 1000 MW plant at Cockenzie, or CCS power plant such as the 400 MWe plant planned for Grangemouth. However, given the existence of the EU's internal electricity market, which has strict rules which defend the rights of all market actors to engage in competitive electricity trading, such CCGTs would not need to be sited in Scotland itself. A Scottish capacity mechanism could contract with CCGTs in England and Wales, and also the UK capacity mechanism could contract with Scottish based power plant to supply capacity for the UK electricity system. A capacity mechanism will add to the costs of the system (much as there were capacity payments in the system in the 1990s), but there is no clear reason to suggest that capacity charges will be significantly higher in Scotland compared to England. It may be argued that the greater reliance on variable renewable energy supplies may make the Scottish system more expensive to manage, but set against this is the fact that the UK will be reliant on inflexible nuclear generation which restricts the efficiency of the system to respond to demand variations. It is beyond the scope of this study to model different combinations of non-renewable power plant capacity and operation. What is apparent, however, is that Scotland will continue to be a net electricity exporter to the South.

We have assumed current electricity consumption and recent wholesale electricity prices when making the calculations in this report. Although it is the case that electricity consumption may rise in the next few years, it is also the case that electricity consumption in the UK has actually fallen by 7 per cent in the period 2007-2012. We do not speculate about future wholesale electricity prices. We note Government projections of massive price increases over the next 15-20 years. As we commented in our introduction, such scenarios are treated with scepticism by many, and anyway under such circumstances, an independent Scottish electricity system would still deliver a cheaper outcome for Scottish consumers compared to a continued UK-wide electricity system.

CONCLUSION

The conclusion of this report therefore qualifies our previous conclusion that it would necessarily be much more expensive to reach the Scottish Government's renewable energy targets under the establishment (or, to be precise, re-establishment) of an independent Scottish electricity system. Indeed, if the UK's new nuclear build does extend beyond Hinkley C, from the mid-2020s onwards it will be clearly cheaper for Scotland's renewable energy targets to be met in the context of an independent electricity supply system rather than in a 'socialised' UK system. This change in our analysis is driven by two new factors. First, because of the combined impact of the increased cost to consumers that will occur because of the proposed deal over Hinkley C, Sizewell C and possibly other reactors which Scottish consumers would not have to bear in the case of an independent Scottish electricity system. Second this is because of the Electricity Market Reform incentives levels announced in June 2013, which are unlikely to support significant deployment of offshore renewable resources in Scotland. A key point of our earlier argument was that the Scottish consumers were unlikely, in political terms, to bear the costs of nearly as much deployment of offshore renewable energy capacity compared to what could be afforded on a united UK-wide basis. However, the point about the EMR settlement is that there is unlikely to be much Scottish offshore renewable development anyway after 2017. In short, a programme which does not exist cannot be cheaper than another programme which may not exist! Certainly, an independently run Scottish system could decide to pay higher charges in order to support at least some offshore renewable development in Scottish waters, acknowledging that doing so may constrain the amount that may be deployable at acceptable cost. Such discretionary power is part of the attraction of having an independent Scottish electricity system. However, it flows from the foregoing analysis that if the UK as a whole is willing to entertain over a 10 per cent increase in prices in the context of a new nuclear capacity, then it would clearly be feasible, at the same cost, for Scotland to both fulfil its 100 per cent renewable energy electricity target and also deploy some offshore renewable schemes as a contribution to this target.

The policy mechanisms that could be deployed by an independent Scottish action seem to us to allow a rather more cost-effective mode of delivery of renewable energy compared to that ensconced within EMR. An independent Scottish programme could issue longer term contracts for renewable energy schemes compared to what will be the case under EMR, it could offer loan guarantees to renewable energy projects comparable to those being offered to new nuclear build, and it could also issue feed-in tariff contracts that could be accessed by independent generators, including an expanding community renewables sector. Indeed the very architecture of the trading rules governing an independent Scottish electricity system could be fashioned to reflect a system based on renewable energy, as opposed to the architecture of the UK system which makes trading on electricity markets well nigh impossible for independent energy generators.

APPENDIX - ASSUMPTIONS AND CALCULATIONS

All costs based on 2013 prices. We assume that the 'strike prices' paid to generators for technologies such as nuclear power and onshore wind remain constant at the levels announced by the Government to take effect from 2017/8 onwards.

UK and Scottish electricity generation and consumption

Consumption was 326 TWh in 2011 for UK, 32.1 TWh for Scotland. Generation figures are higher to reflect losses in activities such as electricity distribution, and also, in the case of Scotland, there are electricity exports to the South. In the UK electricity generation was 368 TWh and Scotland generated 52TWh (UK Government 2012, p 54-56). The figure for Scottish electricity consumption used to calculate the Scottish renewable target is 37.9 TWh, this being a 'gross' consumption figure (Scottish Government 2013a, 25).

Assuming average GB domestic electricity bills of £500 per year and average electricity consumption of 4200 KWh per year, as calculated by a November 2013 House of Commons Report (Bolton 2013, 6-7), the average electricity price was around 12p/KWh in 2012.

A capacity factor of 26.7 per cent was assumed for wind power in Scotland (UK Government, 2013, 57).

Scottish renewable energy generation was 14.8 TWh in 2012 (UK Government 2013, 51). Based on analysis of the data for wind power capacity that is installed, under construction and consented according to the UKWED database (RenewableUK 2013), we estimate that (using a conservative estimate) an additional 9.2 TWh of annual Scottish wind production will be in place by 2018. This increase includes generation from capacity installed during 2013. In addition to this there will be additions of generation from biomass, hydro and solar pv which may add a further 1.3 TWh of generation, leading to Scottish renewable energy production of around 25.3 TWh in 2018. This is around 67 per cent of the Scottish renewable energy target for 2020.

Nuclear power

Building nuclear power at Hinkley C and Sizewell C would comprise a total generating capacity of 6.4 GWe operating at 90 per cent generating capacity producing 50 TWh a year, around 14 per cent of UK electricity generation. We assume that a third set of a twin reactor would cost a similar amount as the previous sets, meaning total new nuclear capacity of 9.6 GWe, 76 TWh a year or around 21 per cent of UK electricity generation.

Cost to UK consumers of nuclear power

Assumptions: wholesale electricity price £50 per MWh (approximate average for 2010-2013 period), the Government's announced 'strike price' of £92.50 for Hinkley C and £92.50 per MWh for both Hinkley C and Sizewell C, all for 35 year contracts with 65 per cent investment covered by Treasury loan guarantees. We assume that the price for an additional two reactors would also be £92.50 with similar other terms. The price increase for 2 reactors (Hinkley C) would be 2.4 per cent, or £10 a year for the average Scottish consumer. This increase would last for 35 years. The price increase for 4 reactors would be 4.8 per cent for domestic electricity consumers by 2030, with price increases lasting for 35 years. In the case of six reactors there would be a price increase of 7.2 per cent for Scottish electricity consumers.

Renewable energy costs under EMR

The declared incentive for onshore wind power to be paid under EMR from 2017 is £95 per MWh for a 15 year contract, no loan guarantees, with the feed-in tariff contracts only made directly available to major electricity companies. In order to try to the UK's EU target for renewable energy deployment (and whatever target replaces the target after 2020), the UK would have to fund renewables both north and south of the Scottish border. Moreover this would be funded using, as discussed, a much more expensive system compared to our projected system of Scottish feed-in tariffs with loan guarantees and 20 year contracts and direct access for contracts for independent generators.

If we assume, on the basis of recent past experience, that around 40 per cent of the renewables funded under EMR were deployed in Scotland, and 60 per cent in the rest of the UK then we need to calculate the cost to the consumer of installing the 5.4 GWe of renewable energy (in terms of capacity outputs equivalent to onshore wind) to be installed in Scotland to meet their target (as discussed in the next section) and around 8.1 GWe installed in the rest of the UK. Thus keeping the 40:60 ration of deployment discussed. This would take the UK towards (although still short) of the 30 per cent of electricity sourced from renewable energy often associated with achieving the EU target of 15 per cent of all UK energy being derived from renewable by 2020. At £95 per MWh this works out at an increase of around 3.2 per cent in UK consumer electricity prices. In other words, the cost to Scottish electricity consumers as well as consumers in the rest of the UK in order to meet the Scottish renewable electricity target would be 3.2 per cent. As we argue elsewhere in this paper, an additional 5.4 GWe of onshore wind (or at least its equivalent in other renewable technologies) is not implausible in Scotland, at least by around 2023. In the case of the UK, a large proportion of the projected 8.1 GWe of onshore wind (or equivalent capacity in other renewable technologies) would certainly have to come from technologies other than onshore wind. Resources of onshore wind will still exist, perhaps more in Northern Ireland and Wales and the Republic of Ireland rather than England. However other renewable energy resources maybe mobilised for the much the same costs as onshore wind in the future. This includes dedicated biomass plants, more biomass conversion of existing power plant and, again, as mentioned earlier, the possibility that solar pv will achieve increasing penetrations at costs no more than £100 per MWh, or for less as the 2020s roll on.

Increases in electricity prices for Scottish consumer of meeting renewable target and nuclear power under a united UK electricity system.

As indicated earlier the consumer price increase for two reactors would be 2.4 per cent, 4.8 per cent for 4 reactors and the cost of six reactors would thus be 7.2 per cent. Adding together the costs of paying for both nuclear power and the UK renewable energy programme, the minimum price increases for consumers in both Scotland and the rest of the UK in a unified UK electricity market that would be associated with achieving the Scottish renewable electricity target together with the nuclear programme would be 5.6 per cent in the case of Hinkley C being built, but this would rise to 8.0 per cent if Sizewell C was also built and 10.4 per cent if a third twin reactor was built.

Renewable Energy costs under an independent Scottish electricity system

5.4 GW of wind power operating at 26.7 per cent capacity factor will generate around 12.6 TWh of electricity which is around 33 per cent of Scottish electricity consumption calculated for the purposes of the Scottish Government's 100 per cent renewable electricity target. As can be seen in a recent analysis of investment costs of onshore wind in the UK longer loan repayment schedules, lower lending margins and higher debt to equity ratios would significantly increase the economic viability of windfarms. Loan guarantees offered by the Scottish Government could help achieve these objectives. It is assumed that loan guarantees offered by the Scottish Government will reduce the required internal rate of return by around 2 per cent than would otherwise be the case. An additional factor reducing wind power costs under a Scottish feed-in tariff would be if they can be awarded, as in Germany, directly to independent renewable energy generators rather than just major electricity companies as is an effect of EMR. This will improve the opportunities for independent generators to make economically viable projects. Below is an estimated comparison of economically viable payments to windfarms under different terms.

With 15 year contract and no loan guarantees: £95 per MWh to be paid by UK Government under EMR from 2017. We calculate, using discounted cashflow analysis that this will give equivalent returns to equity under the following terms:

With 20 year contract and no loan guarantees: £87 per MWh

With 20 year contract and loan guarantees to cover 65 per cent of capital costs (a similar proportion to that being offered to Hinkley C): £76 per MWh

We use this £76 per MWh as our assumed cost of onshore wind when we calculate the costs of meeting the Scottish Government's renewable energy target in the context of an independent Scottish electricity system.

Increases in Price for Scottish consumer under an independent Scottish electricity system

Under an independent Scottish electricity system costs to consumer of wind power at £76 per MWh would be 7.2 per cent price increase with price increases lasting for 20 years from around 2020-2023

REFERENCES

Bolton, P., (2013) Energy Prices, House of Commons Library, www.parliament.uk/briefing-papers/sn04153.pdf

Department of Energy and Climate Change (2013) Electricity Market Reform: Capacity Market – Detailed Design Proposals, DECC, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/209280/15398_TSO_Cm_8637_DECC_Electricity_Market_Reform_web_optimised.pdf

Earthtrack (1995) Quantifying the Value of Government Loans: The Price of Risk in the Oil Industry, http://www.earthtrack.net/files/legacy_library/Value%20of%20Intermediation,%20Oil%20Example.pdf '

Edinburgh University (2006) Matching Renewable Electricity Generation with Demand , http://www.scotland.gov.uk/Resource/Doc/1086/0022200.pdf

ENTSO-E (2013) Inter TSO Compensation, https://www.entsoe.eu/about-entso-e/market/inter-tso-compensation/

HM Government (2013) Long Term Nuclear Energy Strategy, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/168047/bis-13-630-long-term-nuclear-energy-strategy.pdf, p4

Mazars Consultancy (2012) UK Onshore Wind Investment, http://cdn.mazars.mediacitizens.com/assets/file/user_6/27958%20Onshore%20wind%20investment%20report-web.pdf

Milborrow, D., (2010) Cutting costs by preventing failure instead of running wind turbines until they break lies at the heart of a new approach to operations and maintenance, Wind Power Monthly June 15th 2010, http://www.windpowermonthly.com/article/1010136/breaking-down-cost-wind-turbine-maintenance

Milborrow, D., (2013) Wind energy costs bring more projects into profitability, Wind Power Monthly, February 1st, 2013, http://www.windpowermonthly.com/article/1168162/wind-energy-costs-bring-projects-profitability

RenewableUK (2013) UKWED, http://www.renewableuk.com/en/renewable-energy/wind-energy/uk-wind-energy-database/ http://www.renewableuk.com/en/renewable-energy/wind-energy/uk-wind-energy-database/

Scottish Government (2013a) Energy in Scotland, http://www.scotland.gov.uk/Resource/0041/00415880.pdf

Scottish Government (2013b) Energy Statistics http://www.scotland.gov.uk/Topics/Statistics/Browse/Business/Energy

Toke, D., (2012) 'A Proven Solution - How to Grow Renewables with a Fixed Feed-in Tariff' , London: Friends of the Earth, http://www.foe.co.uk/sites/default/files/downloads/david_toke_fits.pdf

Toke, D., Sherry-Brennan, F., Cowell, R., Ellis, G. & Strachan, P. (2013). 'Scotland, Renewable Energy and the Independence Debate: Will Head or Heart Rule the Roost?'. Political Quarterly, vol 84, no. 1-3, pp. 61-70.

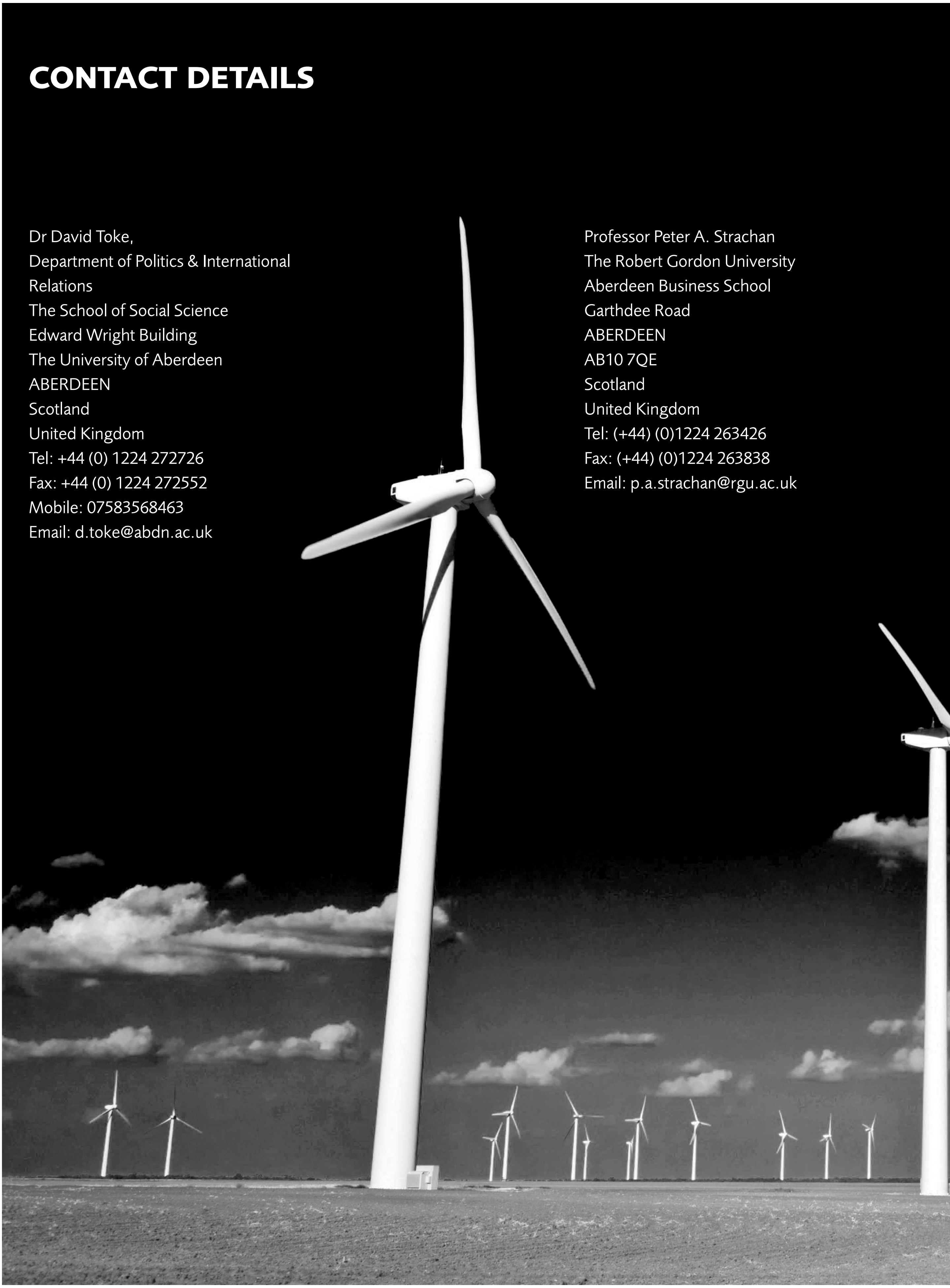
UK Government (2012) Electricity generation and supply figures for Scotland, Wales, Northern Ireland and England, 2008 to 2011 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/65841/7345-elec-gen-2008-2011-et-article.pdf

UK Government (2013) 'Special feature – Sub national renewable electricity figures Renewable electricity in Scotland, Wales, Northern Ireland and the regions of England in 2012', https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/244732/1_regional_renewables_2012.pdf

CONTACT DETAILS

Dr David Toke,
Department of Politics & International Relations
The School of Social Science
Edward Wright Building
The University of Aberdeen
ABERDEEN
Scotland
United Kingdom
Tel: +44 (0) 1224 272726
Fax: +44 (0) 1224 272552
Mobile: 07583568463
Email: d.toke@abdn.ac.uk

Professor Peter A. Strachan
The Robert Gordon University
Aberdeen Business School
Garthdee Road
ABERDEEN
AB10 7QE
Scotland
United Kingdom
Tel: (+44) (0)1224 263426
Fax: (+44) (0)1224 263838
Email: p.a.strachan@rgu.ac.uk



Dr Richard Cowell
School of Planning and Geography
Cardiff University
Glamorgan Building
King Edward VII Avenue
Cardiff CF10 3WA
Wales
United Kingdom
Tel: +44(0)29 20876684
Email: cowellrj@cardiff.ac.uk

Professor Geraint Ellis,
School of Planning, Architecture and Civil Engineering
Queen's University, Belfast
David Kier Building,
Stranmillis Rd
Belfast
BT9 5AG
United Kingdom
Tel: (+44) 02890974370
Email: g.ellis@qub.ac.uk

Dr Fionnguala Sherry-Brennan
Low Carbon Research Institute
Welsh School of Architecture
Bute Building
Cardiff University
King Edward VII Avenue
Cardiff
CF10 3NB
United Kingdom
Tel: +44 (0)29 20879314
Email: sherry-brennanf@cardiff.ac.uk

Cardiff University
Prifysgol Caerdydd

1495
University of Aberdeen

Queen's University Belfast

RGU
Robert Gordon University Aberdeen

Designed and printed By The Gatehouse-Design & Print Consultancy at RGU