THE DAVID HUME INSTITUTE

Energy Trends: Scotland and the World

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Foreword

We at the David Hume Institute were delighted to be awarded funds, in conjunction with Professor Charlie Jeffery of the University of Edinburgh, by the Economic and Social Research Council to organise four 'conversations' on issues related to constitutional change in Scotland. Previously we have published a number of research papers related to the first two conversations; (i) macro-economic policy issues and financial sector oversight and regulation and (ii) social security and welfare under alternative constitutional settlements. We are now very pleased to be able to publish the papers for our third conversation – on a range of energy-related issues. On this topic we have also benefitted much from co-operation with the Scottish Council for Development and Industry (SCDI). The fourth will be on competition policy and regulation, for which we have the full support of the Scottish Government. All four will be completed by end May 2013.

In each of these conversations we have sought papers from a range of informed and interested parties, drafts of which were discussed at a 'Chatham House Rule' seminar before being finalised and published in advance of a full and open seminar. For the energy conversation the round table was held at the Royal Society of Edinburgh on 18th March and the seminar will take place, also at the RSE, on 7th May. We are delighted now to make these papers available.

For the round table we initially commissioned three papers. One, by Professor Mark Schaffer and colleagues at Heriot Watt University covered the evolving global; energy landscape; one by Professor Peter McGregor and colleagues at Strathclyde covered primarily energy topics; and the third by Professor John Paterson and Greg Gordon from Aberdeen University covered oil and gas issues.

However, we determined at the round table that it would be most valuable to have a separate paper on consumer matters, and we were delighted that Patricia McAuley of Consumer Focus Scotland agreed to produce such a paper, in liaison with interested parties at Which?

There is also a fifth paper of significant interest and definite relevance, produced by and separately published by SCDI. This is available at
http://www.scdi.org.uk/pi/2013/SCDIFutureScotlandApr13_Energy_web.pdf

All of the papers' authors will be with us at the seminar, where we will also benefit from an introduction from Dr Andy Kerr of the University of Edinburgh. As always with our seminars, there will also be a full question and answer session, with the authors involved.

We at DHI very much hope that these papers, along with the debate at the seminar and other elements of the conversation, will assist to inform the policy debate on an evidence-based, objective and sceptical manner. However, while commending the papers to your attention, it is as customary necessary for me to stress that the Institute itself has no views on any of the matters discussed.

Jeremy Peat
Director
David Hume Institute

Energy Trends: Scotland and the World

Julian Fennema, Mark Schaffer and Karen Turner

Introduction and overview

This paper discusses the "shifting foundations of the global energy system"[1] and the implications of these trends for policy priorities which need to be considered under any constitutional arrangements for Scotland and the UK.

Scotland is a small high-income economy that is well integrated into the regional and world economies. Facing it are energy markets that range from integrated world markets for fuels that are readily tradeable (e.g., oil and coal), to markets that are regionally integrated to varying degrees and where the degree of integration is changing (e.g., natural gas and electricity). Scotland is also an energy producer and exporter of oil and natural gas. And Scotland is also well integrated into the world's "technological frontier", so that the scope for adoption of new technologies as they become available is not limited as it would be, say, for a poor or middle income country.

The implications of constitutional change vis-à-vis developments in the world economy and world energy markets depend on various factors. We distinguish below between three types of potential impacts on Scotland. First, there is the potential impact on the demand and consumption side. Second, there is the potential impact on the supply and production side. The third aspect has to do with Scotland's international commitments.

In the case of the first two impacts – demand/consumption and supply/production – the implications of constitutional change would include changing the setting for determining policy in Scotland: energy taxation, regulation, R&D policy, etc. The main difference between the two has to do with risk and uncertainty in world and regional energy trends. The primary case is prospective developments in world oil and gas markets. Thus Scotland as a consumer of oil would face the same world oil markets, i.e., the same price for oil, as it would as part of the UK. As an oil consumer, independence would allow Scotland to follow a separate tax/pricing policy. As an oil producer, however, independence would mean Scotland would reap all the potential rewards from, but would also bear all the risk from, future movements in oil prices.

World Energy Trends: The Big Picture

We begin with a broad historical overview of world energy trends. The longer run historical perspective, and the analytical framework underlying it, draws in part on work to which two of us (Fennema and Schaffer) have contributed (Ruehl et al. 2012).

World energy demand

Growth in total energy demand is driven primarily by population growth and economic growth, but how these translate into energy consumption depend in turn on the level of economic development and on developments in technology.

The International Energy Agency, in its *World Energy Outlook 2012*, sets out three medium-run scenarios for world energy trends through 2035.

[1] International Energy Agency, World Energy Outlook, 2012

The central scenario is their "New Policies Scenario", which assumes the relatively cautious introduction of a range of currently-planned carbon-abatement policies. Under this scenario, world primary energy demand is forecast to increase by about 1.2% per year through 2035, making for an increase of about 35% over 2010 levels. The other two scenarios are a "Current Policies Scenario", under which energy demand increases by 1.5% p.a., and a "450 Scenario" – a reference to limiting CO_2 emissions consistent with limiting the long-run temperature increase to 2º C – under which energy demand increases by 0.6% p.a.

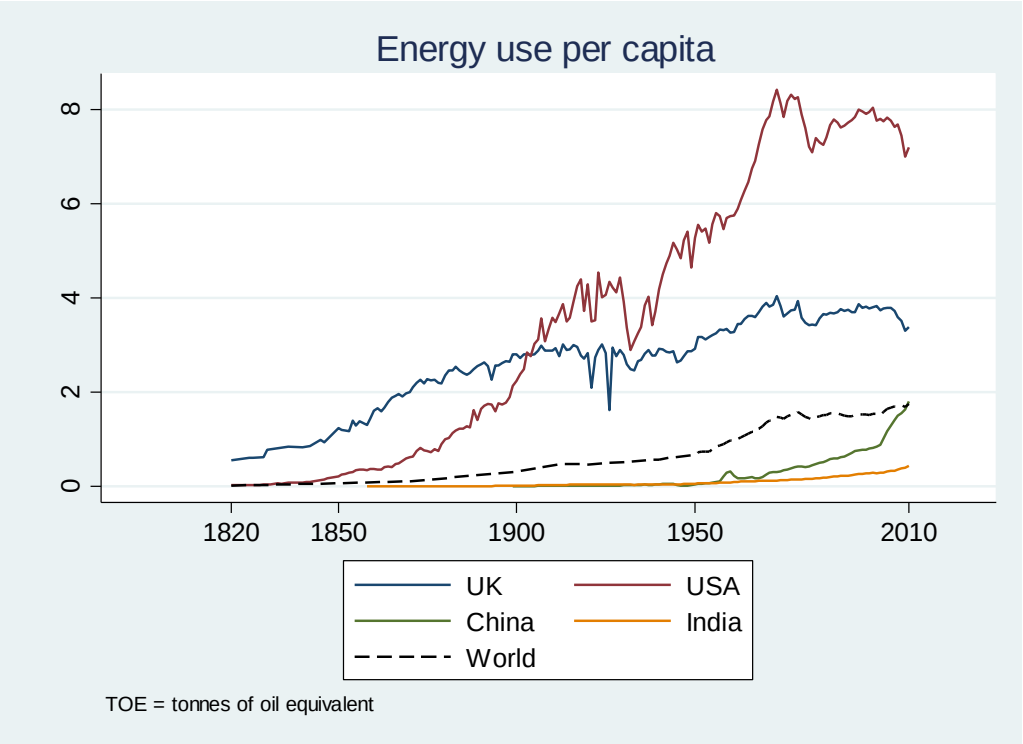
The bulk of this growth in energy demand will be driven by low- and middle-income non-OECD countries, and in particular China and India. In the IEA's "New Policies Scenario", China's energy use through 2035 grows by about 60%, and this growth accounts for 33% of the total increase in world energy demand for this period. India's energy use under this scenario more than doubles, but from a lower base than China, and hence accounts for "only" another 19% of the increase in world energy use. Developments in the OECD will be quite different: total energy consumption is likely to be approximately flat between 2010 and 2035 (IEA 2012, pp. 56, 600, 604).

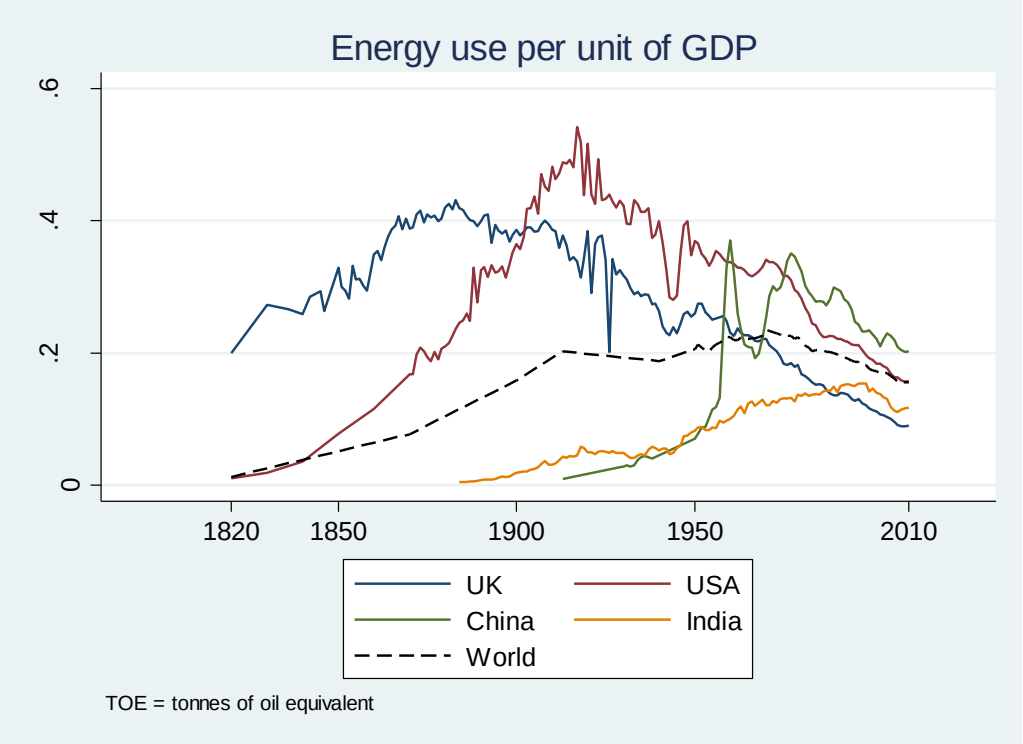
There is in fact a broad consensus about these trends. For example, in the "most likely" base case scenario presented in BP's (2013) *Energy Outlook 2030*, total world energy demand increases 36% over the next two decades. In this scenario, energy use in low- and middle-income non-OECD countries grows by about 60% and accounts for roughly 90% of the total increase in world energy demand, whereas energy consumption in the OECD hardly grows at all (6%). The main difference at this level of analysis is actually the choice of base case scenario on which to focus – the growth rate of world energy use in BP's "most likely" base case scenario is 1.6%, similar to the 1.5% in the IEA's "Current Policies Scenario".

These patterns are explained by the interplay of economic growth and technological progress. History has shown that the industrialisation seen in the early phases of rapid growth – experienced by Western countries in the 19th and early 20th centuries, and now in low- and middle-income countries – brings with it an increase in energy intensity, defined as energy from commercial fuels (coal, oil, gas, nuclear and hydroelectric power, renewables) per unit of GDP. Countering this trend is technological progress in energy efficiency. Continuous technological advances in the high-income and high-productivity areas of the world – OECD countries generally, and the already-industrialised portions of middle-income countries – means that the same amount of output can be produced with less and less energy.

The result is that historically, energy intensity follows an inverse-U shape, and energy use per capita grows and then starts to level off. Initially, countries industrialise and grow rapidly, and both energy demand per capita and energy intensity of GDP increases. Later in the industrialisation process, energy intensity starts to fall continuously because of ongoing technological progress, i.e., improvements in energy efficiency. At first the decline in energy intensity only partly offsets increases in energy demand per capita, so that growth in energy demand per capita remains positive but slows down. The rich OECD countries have now reached the stage where reductions in energy demand deriving from technological progress in energy efficiency are enough to offset increases in energy demand from economic growth. The still-industrialising non-OECD countries such as China and India are still in the phase where rapid economic and population growth drives up energy demand faster than improvements in energy efficiency reduces it.

The graphs below (see Ruehl et al. 2012) shows the historical record for the world and selected countries back to 1820 for energy intensity and energy use per capita.





Source: see Ruehl-Appleby-Fennema-Naumov-Schaffer (2012).

Thus the forecast flat total energy consumption for the OECD is the result of a forecast of continued increases in energy efficiency – declining energy intensity – that is approximately enough to offset the increase in demand driven by economic growth. For the rapidly-growing non-OECD countries, however, while energy efficiency should also continue to improve, it will not be enough to offset increased energy use resulting from economic growth.

Trends by fuel

Worldwide, fossil fuels – coal, oil and gas – together account for roughly 80% of world energy consumption. Most of the remainder is split between nuclear and hydroelectric generation. Renewables (excluding hydroelectricity generation) currently accounts only for perhaps a couple of percentage points of total world energy production.

Forecasts for the medium run of world energy consumption by fuel such as those reported by the IEA, BP and others are basically continuations of trends observed in recent years. Fossil fuels – coal, oil and gas – will together continue to account for the bulk of energy production over the next several decades, whatever the scenario. While use of renewables is expected to continue to grow rapidly, as it has in recent years, this is growth from what is a small base. In 20 years, the total contribution will be of the same order of magnitude as the current shares of hydro and nuclear.

The more disaggregated the forecasts, the more uncertain they become, but nonetheless it is still possible to highlight important trends by fuel that are expected. Developments in oil and gas are of course of particular relevance, given Scotland's role as a producer of these fuels. Several expected trends are worth noting: relatively slow growth in world oil demand, relative to other fuels; relatively rapid growth in natural gas production, driven by the "shale revolution" (a.k.a. "fracking"), in parallel with rapid growth in the international trade of gas; and the resurgence of oil and gas production in the United States.

The short-term outlook for oil and gas supply is a positive one, with burgeoning production in the United States and the expectation of reduced disruptions elsewhere. In 2012 the United States booked its largest ever recorded increase in oil production since it began in 1856, due to the switch out of unconventional gas production into liquids as a result of very low prices for natural gas. This dynamic is expected to continue into the coming years, with forecasts of an expansion of up to 1.5 million barrels per day out of the tight oil plays against modest increases in the Gulf of Mexico and a decrease in oil out of Alaska by 2015.

It is not just a story about the United States, with an expansion of supply also taking place in Canada, albeit at a lesser rate. The continued ramping up of supply out of the unconventional resource, the Athabasca oil sands, whilst slower than the most bullish forecasts of a few years ago is still expected to form the second largest non-OPEC expansion, around 500 thousand barrels per day over the next two years.

This North American arena is anticipated to provide the brunt of the non-OPEC expansion over the short term, seeing plateauing production in many of the other large producing nations due to a mixture of political and physical constraints. For example the potential contribution by a reintroduction of South Sudanese production to the non-OPEC mix is well known, but continues to be delayed by issues of border demilitarisation.

The anticipated response from OPEC to this increase of production outside of the cartel is to constrain expansion in the short-term, despite the problems that this may create for internal cohesion. It is expected that its spare capacity, effectively the difference between installed capacity and actual production, could more than double over the short term as it restricts output to counter the downwards price pressure resulting from non-OPEC production.

Over the medium-term this pressure is expected to build as further expansions arrive from outside OPEC. The lead time on projects in this capital intensive sector mean that these can be tracked a number of years ahead, for instance in the recent increased investment in the North Sea, but these are overshadowed by the scale of developments elsewhere in the world, particularly in Brazil. The large discoveries in deep water off Brazil seen over the last decade have the potential to add a further 2 million barrels of oil per day to the world energy system by 2020, adding to the expansions of elsewhere in the Americas.

This is not to say, however, that that all the production growth will stem from non-OPEC countries in the next 20 years. Two key sources of OPEC expansion are the continued return of Iraq to the world oil markets, expected to be at least as large as the Brazilian increase in production, and the expansion in supply of Natural Gas Liquids (NGLs) to the markets. These are liquid hydrocarbons, produced in conjunction with gas, that form the lighter components of a refined barrel of crude and therefore add to the available supply of oil products, predominantly as a feedstock to the petrochemical sector. Currently not covered by the OPEC agreement, production of these NGLs is expanding faster than aggregate oil production, hand in hand with the increases in gas production by some OPEC members.

The main driver of these increases in gas supply is the developments in the LNG (liquefied natural gas) trade, growing rapidly and is accounting for an increasing share of total production/consumption. This influence is reinforced by increases in interregional pipeline trade, with the result that the world market for natural gas is becoming increasingly integrated. This increased flexibility in the supply infrastructure means that price differentials in different locations generate arbitrage opportunities that can be taken monetised. The medium-run outcome is that locked-in dependence on specific suppliers (because of how pipelines run and who neighbours are) will fall, and inter-regional price differentials in natural gas – which are currently substantial, in contrast to crude oil, where there is basically a single world market price – will fall as well.

The advantage of flexibility is seen most clearly to date in one regional market, that of North America, where the price of natural gas has been driven downwards by the unconventional gas revolution. Over the longer run, US gas production may shift into export, depending on the policy stance by the administration. To date there has been a political reluctance to approve re-engineering of plants intended for LNG imports to permit the flow to go in the other direction. Certain entrenched interests, particularly heavy industry, argue against this on the basis that this means that US domestic consumption will not benefit from the very low gas price, but this clearly ignores the market effect.

World Energy Trends and the Outlook for Scotland

The future is, of course, uncertain. First of all, the above forecasts, like those produced by other agencies, are probably better thought of as "best guessed projections". At the most aggregated level of world primary energy consumption and energy efficiency in the developing and developed world, the forecasts above are unlikely to be very wrong.

The more disaggregated the projections, and the further ahead we look, the bigger the uncertainties.

Second of all, prices on world energy markets tend to be highly variable, much more so than demand/consumption. This is a consequence of inelastic short-run demand – consumers and firms cannot change their energy usage patterns very quickly in response to changes in prices – and inelastic short-run supply – producers cannot quickly adjust their production capacity and plans to match changes in prices. (Or, if they do have spare capacity, as in, e.g., some OPEC members, they may choose not to use it.) The result is world energy market prices that fluctuate dramatically.

On the world energy demand side, there are various views about short/medium/long-run trends. But the trend in the world is toward increasing integration of markets, both regionally and internationally. Scotland is well-integrated into these world markets. The difference between independence and being part of the UK is not going to be much affected by this – the domestic price structure for energy should be fairly similar either way.

Specifically, for crude oil and refined oil products, transport costs are not a big component of the final price, and there aren't any technological developments on the horizon that would change this. With respect to world/wholesale market prices, Scotland will be facing the same prices irrespective of constitutional arrangements. Where changes in constitutional arrangements can have a large impact is in the scope for local policy initiatives. In the case of oil, this means primarily taxation of petrol and diesel (though informal cross-border trade would impose some constraints here).

On the energy supply side, Scotland is distinguished mostly by having moderately large oil and gas reserves and production. Here there are important differences in the implications of Scottish independence for its role as an oil producer, and as a producer of natural gas. The differences derive from how readily these two commodities can be traded. As already noted, oil is relatively easily transported, and this is why the price of crude oil is more or less the same wherever it is purchased or delivered to – what economists call "the Law of One Price". Facilities for exporting oil from Scotland are well-developed, post-independence Scotland would be well-integrated into the world oil market, and would sell its oil and the work market price.

As an oil exporter, the big difference between being independent and being part of the UK has to do with risk and return. Being part of the UK means risk sharing; being independent means bearing all the risk and getting all the return. Short- and medium-run price variability can potentially have a significant impact on the budgetary position of an independent Scotland, at least until (or unless) an oil fund is accumulated that is sufficient in size to absorb shocks arising from short-run price fluctuations. The same point applies to the long-run uncertainties about the potential future path of world oil prices, and in the uncertainties deriving from oil and gas exploration and exploitation in Scottish territory. If world oil prices go up and stay high, or there are major new discoveries in Scotland, there will be a big payoff for an independent Scotland and a payoff for the UK as a whole if Scotland is still part of the Union; if there is a fall in oil prices, or little in the way of new discoveries, an independent Scotland absorbs the full downside, unlike the case where it is still part of the Union.

Whilst forecasting the price of oil is a process full of pitfalls, an OECD report published in March 2013[2] suggests a baseline expectation of $190/bbl (vs. the roughly $110 per barrel that we have seen for the past couple of years). This is derived from a structural model of oil demand, calibrated against the past 20 years of data, and simulated in conjunction with a process to describe the response in oil supply to price. The most important feature of the study for the purposes of this paper is the wide range of forecast prices reported by the authors for 2020 under various different plausible scenarios, from $150 to $270 dollars per barrel. Thus whilst the baseline scenario is a roughly 70% increase in the oil price by 2020, the plausible ranges from this modelling exercise range from about 25% to almost 150% - a huge range. This would of course have important fiscal implications for an independent Scotland.

The market for natural gas is quite different from that for oil, although this is changing. Natural gas can be transported from producer to consumer in one of two ways: by fixed pipeline, or via shipment in liquefied form (LNG). Export by pipeline is limited to where pipelines exist, and the investment required for additional pipeline links can be very large. LNG trade is also limited by infrastructure constraints: most LNG ports are purpose-built for supporting LNG export or import. The scale of LNG and pipeline trade is growing, but regional fragmentation is a feature of natural gas markets and will continue to be for years. For this reason, natural gas prices different widely across different markets.

Like oil prices, natural gas prices are likely to fluctuate substantially over the coming years, and the connection between fluctuating prices and independence applies here, too: being part of the UK means sharing the upside and downside risk across a large population and economy; independence implies Scotland will bear all of the risk and return. But the infrastructure constraints on natural gas trade have further implications with respect to the consequences of independence.

The aggregate UK position is that of a net gas importer, currently importing approximately 50% of its gas requirements, expected to rise to almost 80% over the next two decade as result of reduced production in UK waters. This import requirement is met through both fixed pipeline arrangements, directly with Norway and with wider continental Europe, and installed capacity for LNG imports. Both the pipeline connections to Norway and the continent, and the LNG import capacity, are located in England. Scotland currently has no LNG handling capacity for either imports or exports. There is a direct pipeline connection between Scotland and Ireland. Aside from that, an independent Scotland's primary access to international gas markets would be via pipelines to the rest of the UK, most of this connecting to England although there is also a pipeline to Northern Ireland.

Historically Scotland has produced more gas than it consumes and therefore supplied gas to the National Transmission System (NTS), subsequently consumed in the rest of the UK, and in Ireland via the interconnector located in south-west Scotland. The production that provides this input to NTS, landed at St. Fergus, is dwindling,[3] however, and currently it is not always sufficient to cover both Scottish consumption and exports to Ireland.

[2] Fournier, J. et al. (2013), "The Price of Oil – Will it Start Rising Again?", OECD Economics Department Working Papers, No. 1031, OECD Publishing. http://dx.doi.org/10.1787/5k49q186vxnp-en

[3] See National Grid, "Ten Year Statement", 2012, p.80. Note that not all gas produced in Scottish waters, according to median line definition, is brought to land at terminals in Scotland; a small proportion arrives in England at Teesside.

Continuing production decline will exacerbate this problem, with the consequence that imported gas will need to be sourced from England to provide for the Irish offtake. This shows, therefore, a different dynamic from the strong export potential of Scottish oil production.

The implications for the external position of an independent Scotland clearly depend on the agreement reached with the rest of the UK, and with Ireland, in terms of access to the gas transmission system, both for exports and transit trade to Ireland as currently, and for imports by Scotland in the future as gas production in Scotland falls. The importance of this is greater to Scotland than it is to the rest of the UK, for two reasons. First, the rest of the UK is already well integrated into gas markets and is consuming gas imported from countries other than Scotland. Second, estimates for the Scottish resource base in shale gas are small,[4] with most of the UK assessed resources located in England. Thus the likelihood of Scotland becoming the main supplier for the rest of the UK once again is minimal.

Scotland's international commitments and international cooperation

Membership of the International Energy Agency

Particularly in terms of managing risk, the UK currently benefits from membership of the International Energy Agency. The UK was a founding member of the IEA in 1974 when it was formed response to the 1973/1974 oil crisis. The IEA's initial role was to help countries co-ordinate a collective response to major disruptions in oil supply through the release of emergency oil stocks. Now it is made up of 28 member countries and has an on-going role in maintaining physical and information systems on/for energy markets and supply, assisting in development and coordination of energy and environmental policies. Its four main areas of focus are: energy security, economic development, environmental awareness, and engagement worldwide.

If an independent Scotland wanted to become a member country of the IEA, it would have demonstrate that it met the requirements of a candidate country on several criteria, including its status as a net oil importer, having a demand restraint programme for reducing national oil consumption by up to 10%, having in place the necessary legislation and organisation to operation the CERM (coordinated emergency response measures) on a national basis, and legislation and measures in place to ensure that all oil companies operating under its jurisdiction report information to the IEA as is necessary. Moreover, to become a member country of the IEA, Scotland would have to become a member of the OECD, which would require it going through an accession process that would involve reviews of Scottish policy in key areas in order to assess Scotland's position with respect to the relevant OECD legally binding and non-legally binding instruments.[5] However, even with OECD membership, IEA membership is not guaranteed and depends on the criteria noted above.

On the other hand, full IEA membership may not be appropriate and/or necessary for an independent Scotland.

[4] See House of Commons, Energy and Climate Change Committee, "Shale Gas: Fifth Report of Session 2010–12", Vol

[5] http://www.oecd.org/acts

Given growing economic interdependence, environmental issues and an increasingly global energy market, the IEA does develop relations with non-member countries (which it currently has with a number of emerging nations, including Brazil, China and India). This may be the appropriate starting point for an independent Scotland, perhaps while first OECD membership and then IEA membership are considered and/or alternative long-term options are considered if OECD and IEA membership are not possible or appropriate.

Climate change commitments: Scotland's current position within the UK

At present, international agreements and commitments on issues relating to climate change have been made and apply at the UK level. While responsibility for sustainable development has been devolved, this is in terms of contribution to UK meeting its commitments targets, and no firm targets, e.g. for reduction of GHGs, share of energy requirement from renewable sources, have been set for Scotland and/or agreed between the Scottish and UK governments. Rather Scotland has set its own targets, particularly through The Climate Change (Scotland) Act 2009, though this is linked in a number of respects preceding UK Climate Change Act of 2008.

The Climate Change (Scotland) Act 2009 set in statute the Scottish Government Economic Strategy[6] target to reduce Scotland's emissions of greenhouse gases by 80 per cent by 2050. This is set as one of Scotland's Sustainability Purpose Targets.[7] It covers the basket of six greenhouse gases recognised by the United Nations Framework Convention on Climate Change, and includes Scotland's share of emissions from international aviation and international shipping (though it should be noted that measurement of these is not clearly defined or internationally agreed). The Scottish Climate Change Act also establishes an interim target for 2020 of at least 42 per cent reductions in emissions, though Ministers may vary the reduction figure for the interim target (based on expert advice from the Climate Change Committee, which was established as an independent advisory body[8] under the preceding UK Climate Change Act of 2008). Moreover, the Scottish Climate Change Act states that progress towards the 2020 and 2050 targets is driven by a framework of annual targets that are set in 12-year batches. The first batch of annual targets, covering the period 2010-2022, were set in 2010, the second, to cover 2023-2027 in 2011. Following this, further batches are due to be set every five years thereafter, with the next batch due to be set in 2016, after the independence referendum in 2014.

Thus, one course of action, whether Scotland becomes independent or remains within the UK, will be to continue work under the framework established in the Climate Change (Scotland) Act 2009. However, if Scotland becomes independent there are issues in terms of gaining control of currently reserved policy instruments, in particular energy policy as this is likely to impact how Scotland meets targets stated under the Act, for example to reduce total final energy consumption in Scotland over the period to 2020 by 12%.

[6] http://www.scotland.gov.uk/Publications/2007/11/12115041/0
[7] http://www.scotland.gov.uk/About/scotPerforms/purposes/sustainability
[8] http://www.scotland.gov.uk/Topics/Environment/climatechange/what-is/expertadvice/advisorybody

Climate change commitments: Potential international position

Perhaps the key issue is that unless Scotland joins the EU it isn't clear what her position would be in terms of international commitments. The UK's current targets and commitments mainly relate to her membership of the EU.

For example, and in particular, the EU 20-20-20 Directive and Targets were adopted in 2009 on back of international commitments made under the 1997 Kyoto protocol (under which commitments only ran until 2012, with Copenhagen 2009 having failed to result in type of binding targets that the EU wanted). There are three headline EU 20-20-20 targets, with requirements on member states to produce action plans on how they will meet their nationally binding targets (which may be more or less than 20% in each case).

The first target is a reduction in EU greenhouse gas emissions of at least 20% below 1990 levels. This is to be achieved in part through the EU Emission Trading Scheme, ETS, which was established in 2005 and is currently applicable in Scotland as part of the UK. If an independent Scotland were to join the EU it would need to establish its own emissions allowances under ETS. In terms of targets, it should be noted that Scotland has already set herself ambitious targets to reduce greenhouse gas emissions under the Climate Change (Scotland) Act 2009, where, as noted above the 2020 target is 42%.

The second EU 20-20-20 target is that 20% of EU energy consumption should come from renewable resources. Again, Scotland has already set and begun to achieve ambitious targets, with the 2011 target of achieving 31% of electricity needs from renewable sources exceeded and a further target of 50% by 2015 set by the First Minister in 2012.

The third target focuses on achieving a 20% reduction in primary energy use compared with projected levels within the EU. This is be achieved by improving energy efficiency. Again, Scotland already has a firm target and action plan in this respect (though in this case currently less than the EU average of 20%). Under The Climate Change (Scotland) Act 2009, Scotland has committed to reducing total final energy consumption in Scotland over the period to 2020 by 12% and set an energy efficiency action plan as a statutory requirement.

Thus Scotland would seem to already be in a strong position in the context of making and achieving international commitments and targets, particularly in an EU context where the Climate Change (Scotland) Act 2009 provides a firm and internationally ambitious foundation. The key outstanding issue would again seem to be whether an independent Scotland would function within the context of international bodies to which she is currently linked through UK membership.

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Karen Turner is Professor of Economics at Heriot-Watt University. Her interests include the use of computable general equilibrium (CGE) and input-output frameworks to examine environmental externalities of economic activity.

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