Brexit: Energy Security

The House of Lords EU Energy and Environment Sub-Committee inquiry

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Alana Collis, IChemE Energy Centre and Technical Policy Manager, acollis@icheme.org
Deane Somerville, Head of Knowledge Service, Energy Institute, dsomerville@energyinst.org
Alan Walker, Head of Policy, Royal Academy of Engineering, alan.walker@raeng.org.uk

Executive Summary

The current discussions and lack of clarity on the terms of Britain leaving the EU have created a climate of uncertainty for the energy industry and energy sector.[1] Any progress made to provide clarity will improve confidence and have a positive impact on security of supply.

We do not expect any immediate consequence for the UK's energy security, provided agreements are reached on specific areas of collaboration. Foremost of these will be continued trading arrangements for wholesale gas and electricity that allow access to European grid networks which, if interrupted, could have serious consequences for security of energy supplies in the UK. In a post-Brexit Britain it will be important for policy- and decision-makers to work with the energy industry to identify risks and opportunities, seek assurances and make arrangements to ensure the UK's future energy security. Key aspects of the UK's energy landscape in relation to Brexit are:

Post-Brexit risks to avoid	▪ No agreement on the future energy relationship between UK and the Republic of Ireland ▪ Lack of agreement for alternative arrangements after leaving Euratom ▪ Loss of EU funding for energy research
No significant effect	▪ Short term energy security/imports of LNG ▪ Climate change legislation
Essential to negotiate	▪ Future UK trading relationship with the IEM ▪ Continued participation in ENTSO-E and ENTSO-G ▪ Replacement of EU energy related bodies/agencies after leaving
Others Post-Brexit considerations	▪ UK able to pursue separate trade agreements with other markets

The UK needs long-term planning to sustain and build trade relationships with the EU and the wider world; otherwise, there is a risk that it will become difficult to secure investments for energy infrastructure and other projects. This would make the UK more vulnerable to fluctuations in the world energy market, affecting consumer prices and jeopardising energy security.

In future, the contribution of renewable energy will increase. This will require the UK energy system to be more flexible, either through relying increasingly on interconnectors with the EU, or developing sufficient energy storage options, or a combination of both. The latter will require the deployment of gas storage infrastructure and the research, development and widespread deployment of battery or other electricity storage technology on a large scale.

1. What are the implications of the UK's withdrawal from the EU for the UK's energy security?

The impacts of leaving the EU on the UK's immediate energy security are expected to be manageable, provided agreements are reached on specific areas of collaboration and arrangements put in place to ensure the continued operation of wholesale gas and electricity markets. However, this will not be a trivial task, and failure to reach agreement could jeopardise the UK's energy security, particularly in the

[1] PwC, 2016, Brexit Monitor: The impact on the energy sector, http://pwc.to/2wDRIWJ

event of extreme winter weather requiring energy imports from the continent and potentially involving other impacts such as storms bringing down power transmission lines or industrial action.

The UK is relatively independent in terms of energy security relative to mainland Europe. But, largely as a result of declining North Sea oil and gas supplies, its dependence on energy imports has increased steadily since becoming a net importer in 2004. In terms of the EU, there are important connections between the UK and European natural gas and electricity networks. Furthermore, the intermittent nature of renewable sources and their increasing contribution to the UK's energy mix could make the UK more reliant on interconnectors to provide the flexibility to manage fluctuations in generation and demand. It is therefore essential that the UK continues to be part of the arrangements set up to oversee the wholesale trading of gas and electricity throughout Europe. To ensure near- to long-term energy security, in considering its future requirements the UK should take into account the transition to low carbon sources, acceptability of cost, future domestic production and industry needs. Security of energy supply will rely on maintaining robust domestic generation and distribution infrastructure. Consistent policies are also essential to reduce the UK's reliance on fossil fuels and to improve energy efficiency, to deliver our emissions reduction commitments to the Paris Climate Accord.

The vote to leave the EU has already increased the level of uncertainty for investors. It would be detrimental to the future security of the energy system if negotiations on the UK's future relationship with the internal energy market were to be delayed.

The UK energy market will require continued investment to maintain and enhance energy infrastructure as well as the development and deployment of new technologies. This investment relies mainly on the private sector, so the UK must remain attractive both to existing energy companies and new entrants to the UK energy market.

Access to skilled labour resources and the ability for international energy companies to easily move resources within Europe and internationally are important, in particular during the transition to a low carbon energy landscape.

UK policy on energy and climate change has surpassed the requirements set out by the EU in many relevant areas. This includes the UK's commitment, in law, to emission reductions before such targets were set out by the EU. The UK government should continue on this pathway, and continue to pursue more ambitious emissions reduction.[2,3]

During the process of leaving the EU, there is an opportunity for the UK to devise integrated policy and fiscal measures to promote the transition to the low carbon economy.[4] This involves development of new industries and improvements in the resilience of existing industry. This will be beneficial for energy security but requires a long-term commitment of policy-makers and economic investment. The government's industrial strategy will need to play a central role in future energy policy.

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[2] EEA, 2017, Annual European Union greenhouse gas inventory 1990–2015 and inventory report 2017, http://bit.ly/2vojsKl

[3] Committee on Climate Change, 2017, Meeting Carbon Budgets: Closing the policy gap, http://bit.ly/2ipXENz

[4] HM Government, 2017, Building our Industrial Strategy green paper, http://bit.ly/2vXEHGp

2. Could, or should, the UK stay in the Internal Energy Market (IEM) post-Brexit?

In its initial response to the vote to leave the EU, the engineering profession published the report *Engineering a future outside the EU: securing the best outcome for the UK*[5]. In this, it was recommended that the government should aim to continue membership of the Energy Community. However, at the time of this response being compiled, the government has signalled that it does not wish to remain part of the single market after Brexit.[6] Since membership of the IEM is part of the single market,[7] this option will not be available following announcements from the Government that the UK will leave the single market. It is important that the UK remains closely integrated with the IEM post-Brexit. One possible way to achieve this is set out in recent research published by Chatham House.[8] Alternatives will need to be found to aspects of the IEM that are favourable to the UK energy sector, such as access to the trans-European electricity and gas network through some form of continued membership of ENTSO-E and ENTSO-G (see below).

Although the IEM legislation has increased competition in the gas and electricity supply market, providing choice and driving down industrial and domestic consumer prices,[9] the UK has long been a leader in liberalising the energy market. In a post-Brexit, UK this liberal market should still be sustained through non-IEM mechanisms. One example of this is the declaration of energy cooperation between the North Seas Countries.[10]

In a post-Brexit landscape where the UK were not part of the IEM, it would not have any influence on IEM regulation and directives with which the UK industry needs to comply to continue to trade energy with the EU.

3. If not, what should be the priorities for continued cooperation with the EU?

After Brexit, the UK will need to negotiate and confirm the terms under which existing cooperation will work in the future. There are several elements of the IEM where potential for continued cooperation will need to be considered:

Governance

The current IEM rules governing the liberalisation of gas and electricity markets are complex and its interpretation has varied amongst Member States. The UK has led the way in liberalising energy markets and encouraging competition within the IEM.[11] Following Brexit, suitable trade agreements must be reached with the EU to so that the UK gas and electricity markets' trading with the EU is not

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[5] Royal Academy of Engineering, 2016, Engineering a future outside the EU securing the best outcome for the UK, http://bit.ly/2wxUM7c
[6] 2017, The government's negotiating objectives for exiting the EU: PM speech, http://bit.ly/2wxxGxE
[7] European Commission, 2014, Progress towards completing the Internal Energy Market, http://bit.ly/2vf14EP
[8] Chatham House, 2017, Staying Connected: Key Elements for UK–EU27 Energy Cooperation After Brexit, http://bit.ly/2w74VVo
[9] HM Government, 2014, Review of the Balance of Competences between the United Kingdom and the European Union Energy Report, http://bit.ly/2wnaXUo
[10] Council of the European Union, 2016, Political declaration on energy cooperation between the North Seas Countries - Establishment of the EU position in view of signature, http://bit.ly/2g7t4re
[11] Pollitt, M. G., 2017, The Economic Consequences of Brexit: Energy, http://bit.ly/2w2CBnk

unduly restricted. As noted above, failure to do so could have severe consequences for the security of energy supplies for the UK.

The EU Emissions Trading Scheme is considered to have had limited impact. In part, this is due to (i) the economic downturn, (ii) the movement of manufacturing to Asia and (iii) European manufacturers being able to buy their way out of taking action to reduce emissions.[12] Future cooperation with the EU could enable the UK to apply the principle that the 'polluter pays' and ensure that the UK continues to lead and support innovation to reduce emissions. Working in collaboration with other countries and blocs (including the EU) will provide greater resilience to the market impact of appropriate emissions targets.

Once the UK has left the EU, it will no longer have input into the EU policy- and decision-making process; however future EU decisions and policies will have both direct and indirect impacts on the UK, for example through the companies that operate in the UK. Close cooperation on issues of energy policy are important to maintain the UK's relationship with energy stakeholders that operate between the UK and the EU.

Without effective cooperation with EU Member States, the UK could find itself in a more isolated position after Brexit. Potential impacts include limited transfers through interconnectors and increasing competition from other EU countries (Germany, Belgium and Norway) which already have or are building additional LNG terminals. This could further affect the UK's position as an import and processing hub for LNG entering the EU, creating a negative impact on the UK energy sector and the economy.

Regulation

The UK is a member of The European Agency for the Cooperation of Energy Regulators (ACER), which promotes cooperation between national regulatory authorities (Ofgem in the UK). ACER can investigate market abuse and coordinate the application of appropriate penalties with the Member States; however the responsibility for applying sanctions already rests with the Member States. It is not clear that membership of ACER confers real benefit for the UK, because of the current limited energy transfer between the UK and EU27, and continued membership may not be possible. As part of the UK's Brexit negotiations, it is important to analyse the relationship between Ofgem and ACER and ensure that the regulation of EU based companies operating in the UK is clear. Ongoing cooperation on regulation would have advantages for the UK energy market, provided that they are not too restrictive.

The two European Network Transmission Systems Operators (ENTSO-G for gas and ENTSO-E for electricity) are important for the technical element of regulation. The ENTSOs govern network planning, the rules that oversee the wholesale gas and electricity markets, and the day-to-day operation of pipelines and interconnectors. UK ENTSO members already contribute to shaping EU codes and guidelines for operators. Continued participation in both ENTSOs is essential for sharing plans for the

[12] HM Government, 2014, Review of the Balance of Competences between the United Kingdom and the European Union: Environment and Climate Change, http://bit.ly/2wxLk3S

evolution of energy systems, best practice and projects of common interest. Given that some form of membership is already extended beyond EU countries for both ENTSOs, there does not appear to be any reason that the UK cannot continue to participate in these organisations. But efforts will need to be made to ensure that this happens.

Continued operation of the various UK-Europe interconnectors benefits from continued interaction with European regulatory and transmission system operator counterparts (ENTSO).[13] As part of its EU obligations, National Grid, one of the UK members of ENTSO, produces annual 10-year statements for gas and electricity. This outlines plans for the future of the transmission network including infrastructure and investment. This includes setting the parameters of the UK's capacity market.[14] Dialogue with different EU bodies plays an important role in the UK market, so cooperation must continue; for example to ensure access to appropriate operator agreements, capacity allocation mechanisms, tariffs and data exchange. Membership of ENTSO is a requirement for Transmission System Operators in order to trade in the EU. It is important that appropriate agreements for jurisdiction form part of the negotiations in order to minimise impact on the UK market.

Fuel storage

In recent years, the security of gas imports to mainland EU countries has been vulnerable to sensitivities in the relationship with Russia. The UK has been better insulated from this issue, in part owing to its more direct access to other global gas markets such as LNG shipments from Qatar and gas via undersea pipeline from Norway. It should, however, be remembered that Norway is still part of the European gas grid and, as an observer member of ENTSO-G they follow the agreed EU codes and operational arrangements. As such, they should not be viewed as being entirely independent from the EU. This situation has led to the construction of LNG processing plants and natural gas storage facilities.

The UK currently has adequate gas storage facilities to meet legal requirements.[15] As a processing hub, the UK also exports processed gas to continental Europe. If the UK's relationship with the EU led to a reduction in processed gas exports to the EU, then, in addition to the economic impact, it is likely there would be a loss in storage capacity in the longer term. Recently, it has been announced that the storage facility run by Centrica, at Rough, is set to be taken out of commission.[16] This site represents 70% of the UK's natural gas storage capacity. Its closure is attributed to safety concerns and an economically unfavourable market; the latter is due in part to the current surplus of natural gas on the global market.[17]

UK gas storage is important to UK energy security and the UK energy market. Cooperation with the EU is important to support and maintain the UK's position as an important gas processing hub for Europe.

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[13] European Parliament, 2017, Fact sheet: Internal energy market, http://bit.ly/2iorNfY
[14] National Grid, Future of Energy, http://ngrid.com/2xbSFTM, accessed 23/08/2017
[15] The Oxford Institute for Energy Studies, 2017, Brexit's impact on gas markets, http://bit.ly/2xrRdMD
[16] The Guardian, 2017, Closure of UK's largest gas storage site 'could mean volatile prices', http://bit.ly/2vo4wMr, accessed 23/08/2017
[17] Forbes, 2017, The Rapidly Expanding Global Liquefied Natural Gas Market, http://bit.ly/2wEdhpT accessed 23/08/2017

Especially given the closure of Rough, the UK will need to ensure that it has adequate storage to minimise its exposure to potential market changes in the medium- to long-term. There is potential to use depleted and decommissioned reservoirs in the North Sea for gas storage. Through successful Brexit negotiations and ongoing cooperation the UK could continue its role as a gas processing hub and potentially provide gas storage for other European countries.

Skills

The importance of engineering skills in the UK energy sector and the contribution of knowledge from EU/EEA nationals is an important consideration during Brexit negotiations.[18]

The engineering profession is facing a significant skills shortage and the energy sector is no exception.[5] Given the scale of the transformation expected in the energy system in the coming years, skilled staff, including engineers, will need to be recruited at the graduate and technical level as well as at senior management level. Currently, EU nationals make up approximately 4% of the UK energy sector's total workforce. [19] However, this is a gross number across sectors and occupations. Energy professionals and organisations have emphasised shortages in engineers.[18] This is in line with an assessment by EngineeringUK which points to a shortfall of at least 20,000 engineers annually and stresses: "*We are highly dependent on attracting and retaining international talent from the EU and beyond to help meet this shortfall: a vital part of post-Brexit policies*".[20]

Most companies in the energy sector have a presence or make sales in more than one country and routinely send people on short secondments to locations in the EU (and vice versa) to provide services and expertise and to develop staff. Lack of freedom of movement increases administrative paperwork and makes for more challenges, especially during times of commissioning, turn-around, unexpected disruption or emergency, when additional staff and expertise are needed to supplement the local skills base.

The impact of the changes to the UK's future migration policy and potential restrictions on freedom of movement should not be underestimated. If companies are unable to employ skilled individuals and easily move their staff around Europe and the UK, they will be more inclined to move hubs out of the UK.[5] The lack of necessary skills in the UK energy industry will limit the industry's ability to maintain existing infrastructure and deliver new capacity and innovation in the future.

Equipment and supplies

In addition to skills, the UK benefits from equipment and supplies from the EU. Without proper negotiation and future close collaboration, the UK may find it harder to import/export equipment. One specific area of concern is the equipment and supplies covered by the EU Dual-Use controls, including components for nuclear reactors and associated facilities (such as nuclear fuel enrichment). The Dual Use list is currently controlled by the EU although the arrangement involves all EU member states and non-EU countries such as Australia, Japan, Norway, Switzerland, New Zealand, Canada and the US.

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[18] Energy Institute, 2017, Energy Barometer (page 12), http://bit.ly/2v9vOe7

[19] ONS, 2017, International immigration and the labour market, UK: 2016 (Figure 3), http://bit.ly/2wE7HnF, accessed 23/08/2017

[20] EngineeringUK, 2017, Engineering UK: The State of Engineering, http://bit.ly/2w1H1ws, accessed 24/8/2017

Negotiation and cooperation to ensure that some form of replacement/integration is in place prior to the UK leaving the EU are essential to protect the UK's equipment supply chain including to the nuclear energy sector.

4. What will be the effect of Brexit on UK-EU energy interconnection?

Electricity

The UK only trades about 5% of its electricity with Europe through existing interconnectors with France, the Netherlands, the Republic of Ireland and Northern Ireland. These are non-synchronous, point-to-point connections that operate as independent, commercial entities with the direction of flow determined solely by market conditions, except in extreme circumstances. They are of mutual benefit to the UK and the other countries, providing resilience through increased flexibility and diversity of supply.

The rules that govern the construction and operation of interconnectors are one area that will require careful consideration. A number of new interconnectors are planned[21] and, as things stand, these are mostly subject to EU regulations.[22]

It is essential to understand the impact of Brexit on the regulation and operation of new and existing interconnections if the GB grid is to benefit from this increased diversity of supply. Some projects will continue irrespective of Brexit, provided there is sufficient economic impetus on both sides. They must be of proven value to the UK market (and the other party), rather than part of meeting an EU target.

Gas

From 2000 to 2013 there was a decline in North Sea gas production.[23] Since 2013, gas production has increased slightly, although in the same period the UK has become a net importer of gas. The trend as a net gas importer is likely to continue and, with the decommissioning of many North Sea wells, it is not clear how UK gas production will fare. It is therefore vital that the UK maintains connected to a robust global trading market in natural gas in order to ensure a diverse and resilient supply.

During the times of high oil and gas prices and falling traditional indigenous supplies, unconventional gas reserves became economically viable. Shale gas is one such solution.[24] However, with the current low gas price, it appears economically less favourable, and would take many years to build up to significant infrastructure and reserve levels. Until additional test wells are drilled and fracked, the scale of technically recoverable shale gas resource remains highly uncertain.[25,26,27] Moreover, to exploit shale

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[21] Statnett, 2017, The NSL cable to the UK, http://bit.ly/2xsclCm, accessed 23/08/2017
[22] Ofgem, Electricity Interconnectors, http://bit.ly/2vXIh3j, accessed 23/08/2017
[23] Crystol Energy, 2016, Assessing the future of North Sea oil and gas, http://bit.ly/2iqMk3o accessed 23/08/2017
[24] British Geological Society, Shale Gas, http://bit.ly/2vY8Fdr, accessed 23/08/2017
[25] British Geological Survey for Department of Energy and Climate Change, 2014, The Unconventional Hydrocarbon Resources of Britain's Onshore Basins – Shale Gas, http://bit.ly/2g3XSJr
[26] British Geological Survey for Department of Energy and Climate Change, 2013. The Carboniferous Bowland Shale gas study: geology and resource estimation, http://bit.ly/2vfh21y
[27] Smith, N.; Turner, P.; Williams, G.. 2010, In: Vining, B.A.; Pickering, S.C., (eds.) Petroleum Geology: From Mature Basins to New Frontiers: Proceedings of the 7th Petroleum Geology Conference, UK data and analysis for shale gas prospectivity. http://bit.ly/2wnJG4t

gas, the UK would need to overcome public concerns about the hydraulic fracturing process to extract gas.

5. What is EU funding used for in relation to energy infrastructure and research? Can it be effectively replaced by existing UK schemes?

The funding received from the EU for research in UK institutions was greater than the UK's contribution to the EU science research fund[28]. Having left the EU, the UK will have to significantly change its science funding policy in order for the UK to remain a globally recognised source of research excellence. Access to funding for "blue skies" research as well as commercial innovation and infrastructure is essential as it directly benefits the UK economy and provides energy security. It is important that the UK government provides sustained access to similar levels of funding post-Brexit.

There are 16 Associate Countries (including Switzerland, Israel, and Norway) that have been able to take part in the Framework and Horizon 2020 programmes for many years.[29] The UK's scientific excellence has been acknowledged by and benefited significantly from EU funding; with the UK considered a net beneficiary of EU research funding.[30] Between 2007 and 2013, UK researchers attracted the most research grants of any member country from the European Research Council and the Marie Sklodowska-Curie Fellowship programme worth €1,665m and €1,086m respectively, amounting to 22.4% and 25.5% of the programmes' total budgets.[30]

We strongly recommend that the government negotiates a relationship with the EU so that the UK can benefit from the opportunities of EU research projects. EU programmes provide access to funds, programmes and people that ensure the UK's research excellence. Some EU programmes may require the exchange of academics between institutions. Restrictions on the free movement of people as well as goods and services may make this more difficult in the future. EU negotiations offer the opportunity to align expenditure on research more closely to the UK's needs and capabilities, and the development of new bilateral schemes.

Many of these grants and awards have been for energy-related research, and it is essential for the UK's competitive position that if such funding is no longer available, it is replaced by an equally prestigious and attractive scheme. In the period 2007-2016, the value of European Investment Bank (EIB) loans to the UK energy sector was €15,593m. UK business received a total of €2,531.2m for research and development (R&D) activities.[31] Of this, €141.1m (5.6%) were specifically for the energy sector. During this period, there were no loans from the EIB to UK universities, knowledge transfer services or for the UK "knowledge economy programme" that were related to the energy sector. The reason for this is that many large-scale energy projects in the UK are often nationally funded.

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[28] Institution of Engineering and Technology, 2016, The EU Referendum – the risks to engineering, http://bit.ly/2w81oGA

[29] European Commission, International cooperation "Open to the World", http://bit.ly/2wxVEsy, accessed 23/08/2017

[30] The Royal Society, 2015, UK research and the European Union The role of the EU in funding UK research, http://bit.ly/2w2SZEa

[31] The Technopolis Group, 2017, The role of EU funding in UK research and innovation, http://bit.ly/2wDYE6d

In addition to energy research funding under general programmes, the EU provides finance to particular energy projects (such as the European Energy Programme for Recovery, European Regional Development Fund).

In 2014/15, the area of mechanical, aero and production engineering (a cost centre defined by the Higher Education Statistics Agency, HESA) received £39.29m from EU government bodies. This cost centre will include areas of research relating to energy. Similarly, general engineering, mineral, metallurgy and materials engineering and civil engineering received £28.12m, £14.55m and £11.30m respectively in the same period. The EU's €33bn plan for boosting energy, transport and digital infrastructure (the Connecting Europe Facility) supports "Projects of Common Interest" involving two or more EU countries.[32] The UK is involved in many energy projects with its neighbours including France, Belgium, Ireland and Norway (such as the interconnectors project referred to in our answer to question 4). It is important for energy security that the UK continues to form agreements with the EU for connections that affect the UK.

6. What measures would allow the continuation of the Integrated Single Energy Market on the island of Ireland after Brexit?

The island of Ireland currently imports electricity via an interconnector from Wales and gas by a pipeline from Scotland. Since the Good Friday Agreement, the energy markets of the island of Ireland have become some of the most integrated in the EU.[33] The impact of Brexit on this relationship will only become known as the UK's relationship with the EU post-Brexit takes shape. If the UK leaves the single market and the IEM without making provisions to allow the Republic of Ireland to access the IEM or the UK energy market, there will be significant pressure on the Republic of Ireland to find alternative solutions to ensure its energy security. The single Irish electricity market should remain important to the Republic of Ireland; however, due to Northern Ireland's smaller scale, it is potentially much more important to Northern Irish consumers, in relation to measures such as emergency generation flows, the maintenance of current levels of competition, the ability to absorb increasing levels of variable renewable generation including the export of excess capacity at times of maximum renewables generation, and the longer term investment decisions on new capacity needs. In this regard, it would be important to maintain common rules for trading across the North-South interconnectors.

The European Commission has already awarded €4m to pay for preparatory work on the proposed "Celtic interconnector",[34] which would provide Ireland direct access to the IEM via France. With its domestic production of gas (from the Corrib gas field) set to decrease and Ireland being totally dependent on the UK for natural gas imports,[15] serious considerations are being made into the development of alternative arrangements to allow Ireland to import gas independent of the UK.[35]

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[32] European Commission, CEF Energy, http://bit.ly/2w39rUQ, accessed 23/08/2017
[33] Business, Energy and Industrial Strategy Committee - House of Commons, 2017, Leaving the EU: negotiation priorities for energy and climate change policy, http://bit.ly/2voiHRG, accessed 23/08/2017
[34] EirGrid, Group, Celtic Interconnector project, http://bit.ly/2xskCpH, accessed 23/08/2017
[35] European Commission, 2016, Gas interconnection: North-South gas interconnectors in Western Europe, http://bit.ly/2ipQWqO

Gas and electricity interconnector projects in Ireland are still in their early stages and their feasibility/necessity will vary depending on the future relationship between the UK and the EU. Ultimately, the impact of Brexit on the energy security of the island of Ireland is complicated and ties into the wider border trade issues and political relationships that will also need to be resolved during negotiations.

7. What are the implications of the UK's withdrawal from Euratom? Will it affect the UK's security of supply?

Issues associated with the UK's withdrawal from Euratom have already been considered by the Nuclear Institute[36] which underlines the importance for the UK's nuclear industry of replacing the provisions of the Euratom treaty with alternative arrangements. This will be essential to reassure the UK public and nuclear industry, trading partners and international regulators. The UK will need to address three major issues as part of leaving Euratom.

Safeguards

These are the means by which all Special Nuclear Materials (SNMs) are monitored, tracked and properly looked after, as part of the Non-Proliferation Treaty, whereby nations agree to be transparent and allow their holdings to be inspected and verified.

Equivalent arrangements will need to be made through the UK's Office of Nuclear Regulation (ONR) to report to the International Atomic Energy Authority (IAEA) as the UK currently reports through Euratom which, has inspectors and equipment permanently based in the UK.

The UK will have to negotiate with Euratom and the IAEA to transfer sophisticated equipment, seals and means of verification used in the nuclear industry. Although the ONR is confident that the personnel can be put in place to take on this responsibility, the bigger issue will be the transfer of equipment and the making of detailed arrangements. It is highly unlikely that two years is enough for this process to be completed and therefore transitional arrangements will need to be made.

The ESA and NCAs

The treaty ensures that all member countries have ready and equitable access to nuclear materials, so all such materials are owned by Euratom. The Euratom Supply Agency (ESA) oversees the supply, exchange and transfer of nuclear materials across borders within the EU between member states and between any member states and other nations (this is part of the dual use regulations is referred to in our answer to question 3). Nuclear Cooperation Agreements (NCAs) or treaties with non EU countries presuppose Euratom cover. New NCAs/treaties will be needed with every nation with which the UK trades. Without these new arrangements, the UK will not be able to trade or move components, services, IP, equipment or medical isotopes. For engineering, the inability to acquire isotopes for non-destructive testing could have an impact on pipe welding, maintenance and inspection of refineries and tank storage. There is a list of around 15 priority countries that account for the majority of the UK's requirements in nuclear materials including the US, Japan, Australia, Kazakhstan and Uzbekistan.

[36] The Nuclear Institute, 2017, Brexit and The Euratom Treaty Issue, http://bit.ly/2xczvNG

These are countries the UK should prioritise when developing new NCAs. Achievement of the necessary NCAs in a two-year timescale will be challenging and will almost certainly require a transitional arrangement.

Research

Without new appropriate arrangements, the UK would lose access to high-cost research facilities (including those in the UK), shared knowledge and training. The UK would lose influence in the future direction of research and find it harder to leverage funding for expensive projects. The UK would also lose access to large research infrastructure contracts, such as those recently awarded to Amec Foster Wheeler by the ITER organisation.[37] Fusion research could be hampered if the UK were unable to draw down research contracts from the EU programme and could impact on the funding of the Joint European Torus (JET) at Culham by Euratom.[38]

Switzerland currently has associate status allowing it to participate in research programmes. However, with a larger nuclear industry, the UK will require more than this and will need to arrange new agreements to safeguard the necessary cross-border movement of nuclear fuel and nuclear waste.

8. What can the UK learn from other non-EU countries' experience of trading energy with the EU?

In recent decades, the UK has gone from being a net exporter of energy to a net importer of energy. Similarly the EU is a net importer of energy. There is a range of trade arrangements between the EU and non-EU countries.

Turkey imports energy from the EU; in this case it is not required to adhere to EU policy directives. Conversely, Norway exports energy to the EU; as part of the EEA it is obliged to follow EU directives and policy although it has limited influence over their formation.

The engineering profession plays a significant role in the UK energy sector. It provides skills, delivery and innovation in ensuring that the UK has sufficient energy for industrial and domestic energy security. Any future trade agreements with the EU must not compromise the availability of skills or the ability of the UK energy sector to operate effectively. This includes 'keeping the lights on' in the UK and providing a positive contribution to the UK economy.

[37] World Nuclear News, 2016, Contract to manager Iter assembly and installation, http://bit.ly/2xc0rgo, accessed 23/08/2017

[38] http://bit.ly/2voFBrY, accessed 23/08/2017