

ENVIRONMENT, ENERGY AND CLIMATE

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Summary

The environment, energy and climate are transboundary issues that require cooperative action to sustainably address. To meet our energy requirements, both the UK and Europe are heavily reliant on energy imports.

As international concerns rise over the impacts of climate change and over increasing levels of geopolitical unrest, UK government energy policy must balance the need for competitive energy prices, with the requirements to ensure security of supply and to achieve environmental sustainability.

Much of the UK's environmental policy and legislation derives from European Union (EU) Directives. Some sectors of industry may argue that this imposes a burden on their business, whilst others may argue that it leads to stability of government policies and that it enables long-term decision-making and investment. Environmental groups do contend that European Directives provide a much-needed safety net, to protect the environment over timescales longer than a UK electoral cycle. This safety net is particularly effective because the successful implementation of EU Directives must be evidenced, protecting the progress of these policies, particularly during periods of financial stress.

As part of a larger grouping of countries, negotiations on the world stage (such as climate negotiations) can be conducted with more authority than would be possible as an individual country, since the countries represented by the EU collectively represent a larger proportion of the global population, and account for a larger proportion of consumption and emissions.

Cross-European research and development (R&D) projects have a wider geographical scope, cover a broader range of environments and draw upon a larger pool of skills and researchers than would be possible if projects were centred within a single country. Such projects are facilitated by a number of EU mechanisms – though it is possible that non-EU countries can gain access to EU research activities, e.g. through associate country status.

The implications for energy, environment and climate, of a move to leave the EU are not clear. It is clear, however, that environmental policy in the UK has historically been driven by European legislation, that the UK is deeply embedded within the European energy market, and that the UK (and European) economies are heavily reliant on energy imports. Whatever the UK decides, it is critical that improved energy security remains a government priority, and that we adopt a move towards a fully integrated energy, environmental and climate policy.

Introduction

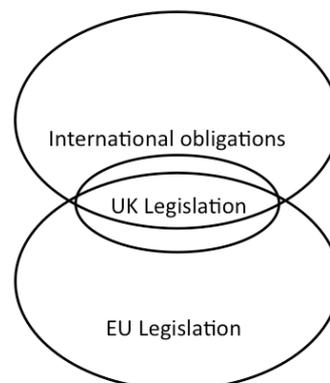


Figure 1 Schematic representation of how UK environmental, energy and climate policy is shaped by EU legislation and by international agreements and conventions.

Although the UK makes environmental, energy and climate policy within the UK Parliament in Westminster, and within the devolved administrations, domestic laws have been increasingly shaped by EU legislation, and to a lesser extent wider international conventions and agreements (UKELA, 2016). Figure 1 depicts schematically the overlap between UK, EU and international legislation, demonstrating that UK environmental, energy and climate policy are always informed by international obligations to which the UK is party, and that a large proportion of this legislation is shaped by EU legislation. Some domestic legislation arises from EU legislation in the absence of international conventions and agreements. The UK must evidence the successful implementation – or progress towards implementation – of EU legislation, and likewise for international obligations.

Environment

Environmental Policy, Legislation & Implementation

In the UK, 'the environment' is generally defined to mean air, water and land. The regulatory bodies with responsibility for protection of the environment in the UK are, principally: Environment Agency, Natural Resources Wales, Scottish Environmental Protection Agency, the Department of the Environment in Northern Ireland, and Local Authorities (UKELA, 2016).

Since joining the European Community (as it was then) in 1972, European environmental legislation has increasingly shaped domestic environmental laws (UKELA, 2016). A series of single issue Directives were made within the EU (e.g. the Nitrates Directive to limit nitrogen pollution of water course and water bodies), but these single issue Directives have increasingly been replaced by "framework" Directives (e.g. the Waste Framework Directive, the Water Framework Directive) and "daughter" Directives (e.g. the daughter End of Life Vehicles Directive). The framework Directives attempt to deliver an integrated approach to environmental protection (UKELA, 2016).

To show how EU legislation has evolved and how this has influenced environmental law in the UK, take policy on Nitrate pollutants as an example. The EC Nitrates Directive (91/676/EC) was a single issue directive that aimed to "protect water quality across Europe by preventing nitrates from agricultural sources polluting ground and surface waters and by promoting the use of good farming practices" (EU, 2016a), and supported drinking water quality as outlined under the earlier EC Drinking Water Directive of 1980. Specific management strategies to reduce the levels of nitrates had to be drawn up by 1995 and implemented by 1999. The Nitrate Directive shaped law in the UK, and Scotland in particular, as follows:

1991: In response to the Nitrates Directive, the UK established Nitrate Sensitive Areas (NSAs), where nitrate concentrations in drinking water sources exceeded, or was at risk of exceeding, the limit of 50 mg/l set by the 1980 EC Drinking Water Directive (Defra, 2016a). Voluntary agricultural measures were introduced by UK MAFF (now Defra) in England and Wales, and payments were made to farmers in the NSAs who complied. The measures aimed to reduce nitrate levels where they were too high, and provide information about the most effective agricultural management actions to reduce these concentrations (Defra, 2016). The scheme was piloted in ten areas in 1990, later expanded to 32 areas, and closed to further new entrants in 1998 (although existing agreements continued for their full five-year term) (Defra, 2016).

1996: NSAs were broadened into Nitrate Vulnerable Zones (NVZs), defined as catchments where nitrate levels exceeded 50mg/l or were likely to in the future. Sixty eight NVZs were identified, representing an area of 650,000 ha (mostly in East Anglia and the Midlands; Defra, 2016b) and all NSAs occurred within NVZ boundaries (Defra, 2016a). Additional NVZs were designated under new rules in 2002. Within NVZs, agricultural measures to reduce nitrate pollution are considered good practice and so are not compensated, and farmers are obliged to follow certain approaches.

2000: The EU Water Framework Directive (WFD) entered into force in December 2000 (EU, 2016b) and has shaped UK policy since. The WFD largely superseded the Nitrates Directive in terms of protecting water bodies from nitrate pollution, but was broader in its aims, including ambition to deliver cleaner rivers and lakes, groundwater and coastal beaches (EU, 2016b), and was integrated across a range of pollutants rather than solely nitrate. Responsibility for reporting WFD compliance lies with the environmental regulatory body for each of the UK Devolved Administrations (Defra/Welsh Government, 2014, SEPA, 2016).

2003: In response to the WFD, Scotland developed the Water Environment and Water Services (Scotland) Act (WEWS Act) of 2003. In 2011, this was backed up by The Water Environment (Controlled Activities) (Scotland) Regulations which apply regulatory controls over activities which may affect Scotland's water environment (SEPA, 2016).

EU legislation has shaped domestic environmental law, and holds to account Member States who do not implement them. In December 2000, the European Court of Justice ruled that the UK had failed to fully implement the Nitrates Directive, because the UK had only protected drinking water resources. The UK was obliged to either implement the Directive fully, or pay non-compliance fees (Defra, 2016b). In 2012, the European Commission evaluated the implementation of the WFD and, though proving challenging for all Member States, the aspiration to meet the demands of the Directive had delivered substantial improvement in the management of water resources across the UK and EU (European Commission, 2012).

Many environments and environmental issues are transboundary, and EU-wide participation in environmental protection and sustainable management practices are therefore advantageous.

Implementing EU legislation has presented both opportunities and challenges for UK environmental law practitioners. A report by UKELA (2012) identified several problematic issues, including a lack of integration and coherence of environmental legislation at EU level, and increasing fragmentation of environmental law across the devolved administrations. The report suggested that more coherent and cohesive environmental law, applicable over larger geographical areas (such as the EU), may help address these challenges.

Energy

UK Energy Consumption and Supply

In 2014, the UK consumed 198.7 million tonnes of oil equivalent energy (DECC, 2015). The vast majority of this energy consumption, 86%, was derived from hydrocarbons in the form of coal, oil and gas (Figure 2). Of the remaining 14% of energy consumed, around one third was produced from burning of biomass and waste, and approximately two thirds was primary electricity, mainly nuclear. In total, 7% of the 2014 UK energy consumption was derived from renewable sources (DECC, 2015). UK energy consumption is dominated by three sectors; transport (37.9%), domestic (26.7%), and industry (16.8%). Only the domestic sector has shown some decline in demand in recent years, as a result of energy efficiency measures (DECC, 2015a).

UK INLAND ENERGY CONSUMPTION 2014

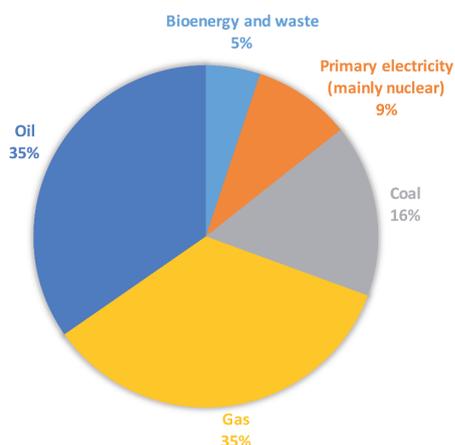


Figure 2 UK Inland Energy consumption 2014.

Energy markets are important for the UK's trade operations. The UK imports and exports energy, but has been a net importer of energy (i.e. importing more than it produces) since 2004. Over the last five years, imports of energy have increased dramatically with 46% of the energy consumed in 2014 being imported. The UK imports energy from a wide range of countries, depending on fuel type. Key imports are from Russia (coal and petroleum products), Norway (crude oil and

gas), Qatar (Liquefied Natural Gas, LNG) and OPEC countries (crude oil). The UK's largest supplier of transport fuels is Russia, particularly diesel, with aviation fuel being sourced mainly from Asia. In 2014 net imports accounted for around 45% of gas demand, and this value is expected to increase (Kopp, 2015) particularly as the role of natural gas in meeting future UK energy demand is strengthened (c.f. speech by Amber Rudd MP, on 18th November 2015). Norway accounted for over 50% of gas imports in 2014, a further 25% was imported as LNG from Qatar.

EU Energy Consumption and Supply

The EU had a total energy inland consumption in 2013 of 1661 million tonnes of oil equivalent (European Commission, 2015a), around 5% of which was consumed in the UK. Currently, 15% of EU energy consumption is generated from renewable sources, and under the Renewable Energy Directive (RED) this should increase to 20% by 2020 (Directive 2009/28/EC). EU Energy consumption is dominated by the same three sectors as the UK, with transport accounting for just under a third of demand, and domestic and industry accounting for approximately a quarter of demand (European Commission, 2015a).

The EU is a significant net importer of energy. The percentage of energy imports in the EU has risen steadily from 43% in 1990 to 53% of energy consumed in 2013. The most significant energy imports, as a percentage of consumption, are solid fuel (44%), petroleum and petroleum products (87%) and natural gas (65%). Of the European nations, the UK imported the 4th highest amount (million tonnes of oil equivalent) of energy, behind Germany, France and Italy (European Commission, 2015a).

By far the largest supplier of energy to the EU is Russia, which supplies 39% of natural gas, 34% of crude oil, and 33.5% of solid fuels. Natural gas and crude oil are also imported in significant quantities from Norway, the remainder of imports are sourced from a variety of nations including Algeria, Qatar, Saudi Arabia, Nigeria, and Kazakhstan (European Commission, 2015a).

The Energy Trilemma and Energy Governance

The 'Energy Trilemma' is recognised as the need to balance competitiveness, security of supply and environmental sustainability on a national and international basis. Governance of this trilemma is increasingly important due to rising concern over the impacts of climate change, global geopolitical unrest and the need to address fuel poverty; in 2013, 10.4% of households in England were estimated to be in fuel poverty (DECC, 2015c), in Scotland this figure was 35.8%, mainly as a consequence of higher winter fuel consumption (Scottish Government Statistics).

Energy Union is a strategic priority for the Commission (European Commission, 2014). Energy Union policy seeks to address the challenges posed by the Energy Trilemma, identifying five target areas: energy security; a single internal EU energy market; energy efficiency; emissions reductions; and research and innovation. In November 2015, The European Energy Council agreed to the introduction of a European Energy Governance system including the introduction of National Energy and Climate Plans that “will serve as the reference points for monitoring the achievement of all EU energy policy objectives and targets” (EU Energy Council, 2015). Energy Governance will take into account “EU-binding or indicative 2030 climate and energy targets”, and will be “reviewing and developing legislation related to emissions reduction, energy efficiency and renewables to underpin the agreed 2030 targets” (EU Energy Council, 2015). The House of Lords (HoL) Report on EU Energy Governance, December 2015, welcomed the introduction of National Energy and Climate Plans including “the move to longer-term planning and the assessment of progress against EU level targets” calling on the UK Government to meet the Commission’s deadline for development of national plans by 2018. The HoL urged the UK Government to “do more to report against its own progress on its energy and climate goals” and noted the critical importance of long term policy signals to energy investors. They also recommended that the “UK Government should go to greater lengths to explain to consumers the financial and security benefits of a more integrated EU energy market”.

Energy security is the UK Government’s number one priority (DECC Minister of State, HOL EU Energy Governance, 2015). The Government’s response to energy security has tended to focus on risk (Ekins *et al.*, 2011), whereas the EU Energy Union response is much broader. Key tools in increasing energy security are: *demand side response* in which consumers sign up to schemes which reward them for changing how and when they use their electricity and energy storage. For electrical power, energy storage takes the form of batteries or hydropower. For gas, energy storage is defined by the time taken to withdraw it: medium-range and long-range storage are in the form of injection into on-shore and off-shore underground reservoirs (respectively); for short-range storage, gas is converted to LNG. Over 50% of total gas storage capacity in Europe is contained within three countries: Germany, Italy and France. Europe’s gas storage capacity is around 98 billion cubic metres (European Commission, 2015c); which equates to approximately 85 days of average gas consumption (based on data from European Commission 2015a). The UK has a relatively low capacity for gas

storage, equivalent to 21.5 days’ worth of supply at average UK consumption rates, or 10% of total demand for gas in winter (European Commission, 2015b). Security of supply of gas is therefore high priority to the UK Government. A pipeline interconnector between the UK and Belgium enables the UK to access Europe’s gas supply (and stored gas), and these imports have met a significant proportion of gas demand during times of low UK gas storage levels (DECC, 2014). To-date, the majority of disruptions to UK gas supply have been technical in nature rather than geopolitical (Le Fevre, 2013), for example, in March 2013, a combination of technical difficulties and cold conditions left the UK with less than one days’ worth of gas supply in storage (DECC, 2014).

The transport sector consumes the most energy in the UK and the EU, and these fuels have the greatest import dependency; imported crude accounted for 54% of total processing in 2013 (UKPIA, 2015). UK refineries are configured to meet historically higher demand for petrol and fuel oil, leading to a modern day deficit of, for example, diesel and jet fuel, and changing refinery production to meet demand will require major investment. The UK already relies on Russia for over one third of total diesel imports in 2014 (IEA, 2016). There are few refineries still operating in the UK, which presents a risk to supply reliability. For example, while Grangemouth refinery provides Scotland with a robust supply of petroleum products, its dependency on a single refinery, is high risk (Purvin & Gertz, 2013). The EU refining sector is also struggling due to changes in demand and market forces. Without state aid, further closures of EU refineries are expected, which would leave the EU more dependent on the international refined product markets.

Climate

Climate Policy, Legislation and Implementation

As noted above, while some UK laws are derived from EU legislation, some UK environmental laws arise from international Conventions and Agreements. An example of UK Laws arising from International Treaty is legislation surrounding climate change. The United Nations Framework Convention on Climate Change (UNFCCC) was signed at the Rio summit in 1992, and it is the Convention which led to the development of the Climate Change Act (2008) at UK level (UK Government, 2008) and the Climate Change (Scotland) Act in 2009 (Scottish Government, 2009). Both of these Acts are world leading in their ambition for greenhouse gas (GHG) emission reduction (with a commitment to an 80% cut in emissions relative to 1990 levels by 2050), and are more ambitious than the collective ambition of the EU, at least for 2020 targets (EU, 2016d).

Within the UNFCCC climate negotiations, the EU negotiates as a block (UNFCCC, 2016). As noted by the UNFCCC (2016): “The 28 members of the European Union meet in private to agree on common negotiating positions. The country that holds the EU Presidency – a position that rotates every six months – then speaks for the European Union and its 28 member states. As a regional economic integration organisation, the European Union itself can be, and is, a Party to the Convention. However, it does not have a separate vote from its members.”

Given that the EU accounted for 10.3% of total global greenhouse gas emissions in 2010 (the third largest greenhouse gas emitter after China and the USA), compared to the UK’s 1.4% of total global emissions (WRI, 2016; Figure 3), the importance of the EU grouping as a global emitter and, thereby, as part of the potential solution, is clear.

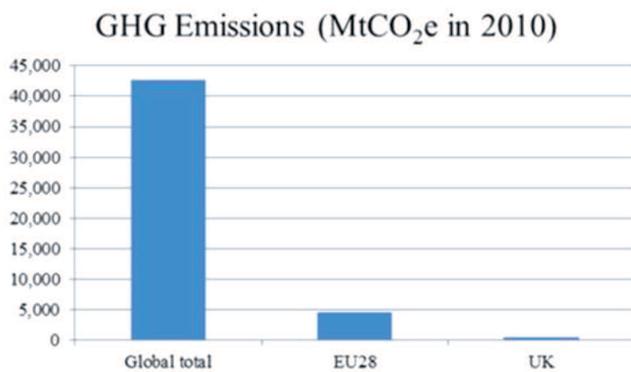


Figure 3: GHG emissions in 2010 (Mt CO₂e) for the world, EU28 and the UK (data from WRI, 2016).

The EU has played a strong role in bringing ambitious climate targets to the UNFCCC negotiations, and has been instrumental in helping to deliver the first truly global climate deal at the 21st Conference of Parties to the UNFCCC in Paris in December 2015.

In 2015, Norway entered into an agreement with the EU about a joint fulfillment of the EU climate targets, implying that non-EU countries can, through associate country status, adopt these policies. Furthermore, the 31 countries of the European Economic Area (EEA) participate in the EU Emissions Trading System (ETS). Thus, a UK departure from the EU would not negate UK inclusion in these legislations if it remained in the EEA.

Environment, Energy and Climate Research & Development

The climate is a global commons (i.e. all countries share the global climate system; Hansen et al., 2013), the small countries of the EU (e.g. the UK) by themselves

have a relatively small global climate footprint, but collectively the EU has the third largest climate footprint in the world (WRI, 2016). Since climate impacts vary between regions, it is reasonable to conduct climate impact research at any scale (e.g. within a country), but being able to assess impacts across a wider geographical region allows trends to be more easily detected and causes attributed.

The EU has encouraged close collaboration among environmental researchers across Member States. The projects arising from the EU’s Framework Programmes, and the more recent Horizon-2020 programme, have brought together researchers from across Europe (EU, 2016c). Cross-European research projects have a wider geographical scope, cover a broader range of environments and draw upon a larger pool of skills and researchers than would be possible if projects were centred within individual countries. From the authors’ experience, this is generally regarded to have been a positive influence on the quality, scope and societal and policy impact of the research undertaken.

R&D in the UK has benefited greatly from EU funding mechanisms, as evidenced by the results of the 2014 Research Excellence Framework; the EU Government is the only source of research funding that has increased since 2004, and the UK is one of the largest beneficiaries of the Horizon2020 funds. EU funding for R&D is unlikely to decline. For example, one of the five principal aims for the European Commission’s Energy Union policy, proposed in 2014, is research and innovation.

The beneficial nature of the EU for research and development outcomes is supported by the fact that non-EU countries such as Switzerland participate in EU projects from Swiss contributions (SERI, 2016). This also demonstrates that the pan-European benefits of EU could, in-theory, be accessed from a UK outside the EU through associate country status.

Discussion

A key contention for UK membership of the European Union is being subject to European Commission Policy Directives. Whilst membership reduces the ability of the UK to create individual policies tailored to national need, it also has significant advantages. Chief amongst these is that European policy is less changeable and more long-lasting than UK policy, as it is less subject to the vagaries of four year government cycles. A failure to commit to long-term planning can lead to weak policy signals and business uncertainty, which in turn can result in underinvestment in infrastructure and technology.

A recent Institute for European Environmental Policy (IEEP) report identified that many of the key environmental challenges in the UK are those that require an enhanced degree of cooperation and coherence; “governments working together as much as businesses in a supply chain”, and the EU serves to facilitate cooperative action and the exchange of ideas towards sustainable practices. The report concludes that “a potential UK departure from the EU would leave the British environment in a more vulnerable and uncertain position than if it were to remain as a member of the EU”, but these effects may be lessened if the UK remains in the EEA following departure from the EU (Baldock *et al.*, 2016a).

Energy does not recognise national boundaries and the interconnected nature of energy in Europe means that Member States are affected by the policy and development decisions of their neighbours. New infrastructure and technology developments are required to complete the internal energy market, increase European interconnection, diversify supply, meet carbon emissions targets and, importantly, ensure energy security (Godzimirski *et al.*, 2015; HoL EU Energy Governance report, 2015). Many of these are transboundary, longer term developments, which EU governance will facilitate.

Longer-term European policies allow for more strategic research and development. Examples include longer-term climate solutions, such as negative emission technologies (Smith *et al.*, 2016), carbon capture and storage technologies, and investment in digital smart metering. The latter has the potential both to reduce total energy consumption and to reduce peak energy use, by applying price incentives for energy use when demand is low. One downside of the longer term European policy cycle, however, is that policy change is slower, and as a consequence, institutions may be less nimble in responding to changing drivers than those within independent countries with national policies. Member States, however, are not prevented from implementing more ambitious domestic environmental legislation, as for example, the UK Climate Change Act (2008).

Another benefit of longer-term policies throughout the EU is the potential for collaboration and collective learning between Member States. Member States must evidence the successful implementation – or progress towards implementation – of EU Directives. Management and implementation plans for each Member State must be approved, as must the monitoring approach, bringing independent quality assurance. Information about the quality of performance gives scope to compare progress, identify common issues, serving to strengthen and streamline the policies and the management

strategies implemented. Further, governments are more willing and able to address challenging environmental issues working together rather than independently (Baldock *et al.*, 2016b).

Non-EU countries can, through associate country status, adopt EU policy. For example, in 2015 Norway entered into an agreement with the EU about a joint fulfillment of the EU climate targets. Norway is also implanting the WFD and the Environmental Impact Assessment Directive, though the implementation of these policies lags significantly behind EU Member States (European Commission, 2016e; EFTA, 2014) thereby supporting the notion that EU membership may serve to enhance – rather than retard – adoption of environmental policy). There is concern that, should the UK leave the EU, future UK governments might relax EU environmental standards, particularly if concerns about market competitiveness become more acute in a liberalised trading environment (Baldock *et al.*, 2016b).

The energy supply sector is the largest single source of the UK’s greenhouse gas emissions in 2013, accounting for 33% (DECC, 2015b). The low carbon agenda contributes to several energy security objectives (lower energy demand; diversity of supply) but could leave the UK much more import dependent (Ekins *et al.*, 2011). This might strengthen the argument for the single energy markets envisaged by the EU Energy Union. The supply of refined products, such as diesel and aviation fuel in the UK (and EU) is notably dependent on imports from outside the EU (e.g. Russia), and this will increase should further EU refineries close.

One issue of current debate is that, by comparison to the UK, the EU has a high reliance on Russian gas imports. This is largely a consequence of geography and the existing gas pipeline infrastructure; the UK imports over 50% of its gas through the subsea Langeled pipeline that runs directly from Norway to England (DECC, 2015b). Investment in additional infrastructure to improve connectivity within Europe can reduce the dependency of some EU nations on Russia as a single gas supplier. The EU has identified the need for investment in such infrastructures (EU Energy Council, 2015). Improved connectivity would also serve to improve UK energy security; there is uncertainty over the future of Norwegian gas production beyond 2020, due to a lack of certainty on the extent of known resources (DECC, 2014).

It is worth noting that issues of non-financial constraints to energy challenges, and behavioural aspects of energy diversity and energy demand reduction are important and should not be underestimated. However, little is known about how these are affected by EU association.

The introduction of National Energy and Climate Plans in the EU by 2018 could form an important step towards an integrated international energy and climate agreement. Given that EU policy tends to be longer term and less changeable than UK policy, negotiations on the world stage, including energy and climate negotiations, can be conducted with more authority than would be possible as an individual country, since the larger collection of countries represented by the EU represents a larger proportion of the global population, and accounts for a larger proportion of consumption and emissions.

Among researchers, collaboration at an EU level is generally regarded to have been a positive influence on the quality, scope and societal and policy impact of climate research. Models exist to access these benefits from outside the EU but these could require government funding.

Conclusions

Much of the UK's environmental policy and legislation derives from EU Directives. Some sectors of industry may argue that this imposes a burden on their business, whilst others may argue that it leads to stability of government policies and that it enables long-term decision-making and investment. Environmental groups do contend that European Directives provide a much-needed safety net, to protect the environment over timescales longer than a UK electoral cycle, particularly during periods of financial stress.

The implications on energy, environment and climate, of a move to leave the European Union are not clear. However, what is clear, is that the UK is deeply embedded within the European energy market, that environmental policy in the UK has historically been driven by European legislation, and that the UK (and European) economies are heavily reliant on energy imports. Whatever the UK decides, it is critical that improved energy security remains a Government priority, and that we adopt a move towards a fully integrated energy, environmental and climate policy.

References

- Baldock, D., Buckwell, A., Colsa-Perez, A., Farmer, A., Nesbit, M., Pantzar, M., (2016a) The potential policy and environmental consequences for the UK of a departure from the European Union. Prepared by the Institute for European Environmental Policy (IEEP).
- Baldock, D., Farmer A., Nesbit, M. (2016b) "Brexit – the Implications for UK Environmental Policy and Regulation". A special independent report commissioned by the all-party parliamentary environment group.
- Defra (2016a)
<http://adlib.everysite.co.uk/adlib/defra/content.aspx?id=000IL3890W.16NTBX2QC4I100> [Accessed 22nd February 2016].
- Defra (2016b)
<http://adlib.everysite.co.uk/adlib/defra/content.aspx?id=000IL3890W.16NTBX2TOOS101> [Accessed 22nd February 2016].
- Defra/Welsh Government (2014).
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/307788/river-basin-planning-standards.pdf [Accessed 22nd February 2016].
- DECC (2014) UK Risk Assessment on Security of Gas Supply. Report URN 14D/189 completed for EU Regulation 994/2010. Available at:
<https://www.gov.uk/government/publications/uk-risk-assessment-on-security-of-gas-supply>
- DECC (2015a), Digest of United Kingdom Energy Statistics.
 Available at: <https://www.gov.uk/government/collections/digest-of-uk-energy-statistics-dukes#2015>
- DECC (2015b), UK Energy in Brief.
 Available at: <https://www.gov.uk/government/collections/uk-energy-in-brief>
- DECC (2015c) Annual Fuel Poverty Statistics Report
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/468011/Fuel_Poverty_Report_2015.pdf
- Directive 2009/28/EC (Renewable Energy Directive):
<http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32009L0028>
- Directive 91/676/EC (Nitrates Directive):
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A31991L0676>
- EFTA Surveillance Authority, (2014) Press Release (Internal Market)
<http://www.eftasur.int/press--publications/press-releases/internal-market/nr/2312>
- Ekins, P., Wang, X., Skea, J., Shakoob, A., Ramachandran K., Strbac, G., Chaudry, M., Whitaker, J., (2011) Building a Resilient UK Energy System: Research Report. UKERC report: UKERC/RR/HQ/2011/001.
- European Commission (2012), Fitness Check of EU Freshwater Policy.
 Available at: http://ec.europa.eu/environment/water/blueprint/fitness_en.htm

- European Commission (2014): http://ec.europa.eu/priorities/energy-union-and-climate_en [accessed March 2016].
- European Commission (2015a) EU Energy in Figures, Statistical Pocket Book. Available at: <https://ec.europa.eu/energy/en/statistics/energy-statistical-pocketbook>
- European Commission (2015b) The role of gas storage in internal market and in ensuring security of supply. Report EUR 2015.1391 EN.
- European Commission (2016a) http://ec.europa.eu/environment/water/water-nitrates/index_en.html [accessed: 22nd February 2016].
- European Commission (2016b) http://ec.europa.eu/environment/water/water-framework/index_en.html [accessed: 22nd February 2016].
- European Commission (2016c) <http://ec.europa.eu/research/index.cfm> [accessed: 22nd February 2016].
- European Commission (2016d) http://ec.europa.eu/clima/policies/international/negotiations/initiatives/index_en.htm [accessed: 22nd February 2016].
- European Commission (2014e): http://ec.europa.eu/environment/water/participation/map_mc/countries/norway_en.htm [Accessed March 2016].
- European Commission (2015c). The role of gas storage in internal market and in ensuring security of supply. Directorate-General for Energy Internal Energy Market. Available at: <https://ec.europa.eu/energy/sites/ener/files/documents/REPORT-Gas%20Storage-20150728.pdf> [Accessed March 2016].
- EU Energy Council (2015) Conclusions on the governance system of the Energy Union: <http://www.consilium.europa.eu/en/press/press-releases/2015/11/26-conclusions-energy-union-governance/> [Accessed March 2016].
- Godzimirski, J.M. (Ed) (2015) EU Leadership in Energy and Environmental Governance: Global and Local Challenges and Responses. International Political Economy Series (Palgrave Macmillan, UK).
- Hansen, J., Kharecha, P., Sato, M., Masson-Delmotte, V., Ackerman, F., Beerling, D., Hearty, P.J., Hoegh-Guldberg, O., Hsu, S.L., Parmesan, C., Rockstrom, J., Rohling, E.J., Sachs, J., Smith, P., Steffen, K., Susteren, L.V., von Schuckmann, K. & Zachos, J.C. 2013. Assessing “dangerous climate change”: required reduction of carbon emissions to protect young people, future generations and nature. *PLoS ONE* 8(12), e81648. doi:10.1371/journal.pone.0081648.
- House of Lords European Union Committee (2016) EU Energy Governance. Report from the inquiry [HL Paper 71]: <http://www.publications.parliament.uk/pa/ld201516/ldselect/ldeucom/71/7102.htm> [Accessed March 2016].
- International Energy Agency (IEA) (2016) <https://www.eia.gov/beta/international/analysis.cfm?iso=GBR> [accessed March 2016].
- Kopp, S D. (2015) Politics, Markets and EU Gas Supply Security: Case Studies of the UK and Germany. (Springer).
- Le Fevre (2013), Gas storage in Great Britain. The Oxford Institute of Energy Studies.
- Purvin & Gertz (2013) The role and future of the UK refining sector in the supply of petroleum products and its value to the UK economy, commissioned by the UK Petroleum Industry Association (UKPIA). Available at: <http://www.ukpia.com/files/pdf/therolefutureoftheukrefiningsector.pdf>
- Rudd, Amber. MP, Secretary of State for Energy and Climate Change (2015). New Direction for UK Energy Policy: <https://decc.blog.gov.uk/2015/11/18/new-direction-for-uk-energy-policy/> [accessed March 2016].
- Scottish Government (2009). Climate Change (Scotland) Act 2009. Available at: <http://www.legislation.gov.uk/asp/2009/12/content> [Accessed: 22nd February 2016].
- Scottish Government Statistics: Fuel Poverty. <http://www.gov.scot/Topics/Statistics/Browse/Housing-Regeneration/TrendFuelPoverty> [accessed March 2016].
- SEPA (2016) <http://www.sepa.org.uk/regulations/water/> [Accessed: 22nd February 2016].
- SERI (2016) <http://www.sbf.admin.ch/themen/01370/01683/index.html?lang=en> [Accessed: 22nd February 2016].
- Smith, P., Davis, S.J., Creutzig, F., Fuss, S., Minx, J., Gabrielle, B., Kato, E., Jackson, R.B., Cowie, A., Kriegler, E., van Vuuren, D.P., Rogelj, J., Ciais, P., Milne, J., Canadell, J.G., McCollum, D., Peters, G., Andrew, R., Krey, V., Shrestha, G., Friedlingstein, P., Gasser, T., Grübler, A., Heidug, W.K., Jonas, M., Jones, C.D., Kraxner, F., Littleton, E., Lowe, J., Moreira, J.R., Nakicenovic, N., Obersteiner, M., Patwardhan, A., Rogner, M., Rubin, E., Sharifi, A., Torvanger, A., Yamagata, Y., Edmonds, J. & Yongsung, C. 2016. Biophysical and economic limits to negative CO₂ emissions. *Nature Climate Change* 6, 42-50. doi: 10.1038/nclimate2870.
- UNFCCC (2016) http://unfccc.int/parties_and_observers/parties/negotiating_groups/items/2714.php [Accessed: 22nd February 2016].
- UK Government (2008) Climate Change Act. Available at: <http://www.legislation.gov.uk/ukpga/2008/27/contents> [Accessed: 22nd February 2016].
- UKELA (2012) The State of UK Environmental Law in 2011-2012. Is there a case for legislative reform? Available at: <http://www.ukela.org/rte.asp?id=143> [Accessed: 22nd February 2016].
- UKELA (2016) <http://www.ukela.org/rte.asp?id=14> [Accessed: 22nd February 2016].
- UKPIA Statistical Review (2015). Available at: http://www.ukpia.com/industry_information/industry-data.aspx
- WRI (2016) Climate Data Explorer. Washington, DC: World Resources Institute. Available at: <http://cait.wri.org/> [Accessed: 22nd February 2016].

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