European Parliament

DIRECTORATE-GENERAL FOR INTERNAL POLICIES

POLICY DEPARTMENT A
ECONOMIC AND SCIENTIFIC POLICY

Economic and Monetary Affairs

Employment and Social Affairs

Environment, Public Health and Food Safety

Industry, Research and Energy

Internal Market and Consumer Protection

The Impact of Brexit on the EU Energy System

STUDY for the ITRE Committee

EN

2017

The Impact of Brexit on the EU Energy System

DIRECTORATE-GENERAL FOR INTERNAL POLICIES

POLICY DEPARTMENT A: ECONOMIC AND SCIENTIFIC POLICY

The Impact of Brexit on the EU Energy System

STUDY

Abstract

This study provided by Policy Department A at the request of the European Parliament's Committee on Industry, Research and Energy (ITRE) shows that the energy-system related impact of Brexit on EU citizens and companies will be limited. The EU will be able to complete its market, achieve its climate and energy targets and maintain supply security. It appears likely (although not guaranteed) that the UK will continue to maintain sensible environmental policies and safeguard the rights of EU companies in the UK. However, special attention on the impact of Brexit on the Irish energy system is warranted.

IP/A/ITRE/2017-01
PE 614.181

November 2017
EN

This document was requested by the European Parliament's Committee on Industry, Research and Energy (ITRE).

AUTHOR(S)
BRUEGEL, BELGIUM:
Gustav FREDRIKSSON, Alexander ROTH, Simone TAGLIAPIETRA, Georg ZACHMANN[1]

RESPONSIBLE ADMINISTRATORS
Frédéric GOUARDÈRES
Dagmara STOERRING

EDITORIAL ASSISTANCE
Laurent HAMERS

LINGUISTIC VERSIONS
Original: EN

ABOUT THE EDITOR
Policy departments provide in-house and external expertise to support EP committees and other parliamentary bodies in shaping legislation and exercising democratic scrutiny over EU internal policies.

To contact Policy Department A or to subscribe to its newsletter please write to:
Policy Department A: Economic and Scientific Policy
European Parliament
B-1047 Brussels
E-mail: Poldep-Economy-Science@ep.europa.eu

Manuscript completed in November 2017

This document is available on the Internet at:
http://www.europarl.europa.eu/studies

DISCLAIMER

---

[1] The authors are thankful to J. Scott Marcus for his valuable comments on previous drafts of this report. They are also grateful for their conversations and feedback to Suman Bery, Laura Brien, Emmanuel Brutin, Miles French, Jan Haizmann, Julia Michalak, Conor Minogue, Marta Navarrete, Ingo Ramming, Klaus Röhrig, Neil Walker, Owen Wilson, Guntram Wolff, and anonymous representatives of other institutions. These acknowledgements do not imply endorsement of the content of this paper, which only represents the views of the authors.

CONTENTS

LIST OF ABBREVIATIONS

ACER	Agency for the Cooperation of Energy Regulators
bcm	Billion Cubic Metres
CCS	Carbon Capture and Storage
CEER	Council of European Energy Regulators
CEF	Connecting Europe Facility
CJEU	Court of Justice of the European Union
CRD IV	Capital Requirements Directive IV
CRR	Capital Requirements Regulation
DG	Directorate General
EEA	European Economic Area
EFTA	European Free Trade Association
ENTSO-E	European Network of Transmission System Operators for Electricity
ENTSOG	European Network of Transmission System Operators for Gas
EEPR	European Energy Programme for Recovery
EFSI	European Fund for Strategic Investments
EIB	European Investment Bank
EMIR	European Market Infrastructure Regulation
(EU) ETS	The EU Emissions Trading System
EU	European Union
Euratom	European Atomic Energy Community

FP7	Seventh Framework Programme (for Research and Technological Development)
GB	Great Britain
H2020	Horizon 2020 Programme (EU Framework Programme for Research and Innovation)
HVDC	High-Voltage Direct Current
I-SEM	Integrated Single Electricity Market
IAEA	International Atomic Energy Agency
ICE	InterContinental Exchange
ICT	Information and Communication Technologies
IEA	International Energy Agency
IED	Industrial Emissions Directive
IEM	EU internal energy market
INEA	Innovation & Networks Executive Agency
I-SEM	Integrated Single Electricity Market
ITER	International Thermonuclear Experimental Reactor
ITRE	Committee on Industry, Research and Energy
JET	Joint European Torus
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MEP	Member of the European Parliament
MFF	Multiannual Financial Framework
MiFID (II)	Markets in Financial Instruments Directive
MiFIR	Markets in Financial Instruments and Regulation

MSR	Market Stability Reserve
mtCO2e	Metric tonnes of carbon dioxide equivalent
mtoe	Million tonnes of oil equivalent
NBP	National Balancing Point
NECP	National Energy and Climate Plan
NI	Northern Ireland
NRA	National Regulatory Agency
NEMO	Nominated Electricity Market Operator
Ofgem	Office of Gas and Electricity Markets
OMP	Organised Market Places
PCI	Project of Common Interest
REMIT	Regulation on Wholesale Energy Market Integrity and Transparency
RES	Renewable Energy Sources
ROC	Regional Operation Centres
ROI	Republic of Ireland
RSC	Regional Security Coordinators
SEM	Single Electricity Market
TEU	Treaty on European Union
TFEU	Treaty on the Functioning of the European Union
TEN-E	Trans-European Energy Networks
TNP	Transitional National Plan
TSO	Transmission System Operator
TTF	Title Transfer Facility
TYNDP	Ten-Year Network Development Plans

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

The European Parliament's Committee on Industry, Research and Energy (ITRE) called for this study in light of the Brexit referendum. The study focuses on the possible effects on EU citizens and companies in order to inform the Brexit negotiations from an EU perspective.

We address eight key issues concerning the potential impact of Brexit on the EU energy system.

On aggregate, the energy system related impact of Brexit on EU citizens and companies will be limited. With or without the UK, the EU will be able to complete its market, to achieve its climate and energy targets with feasible readjustments, and to maintain supply security. In addition, we do not expect that it will be in the UK's interest to seek a competitive advantage for its companies by discriminating against EU energy companies active in the UK, or by competing with the EU's manufacturing industry through lowering energy taxes or environmental standards.

Despite our belief that the negative impact of Brexit on the EU energy system is manageable, our analysis demonstrates the immense number and sizable impact of very important details that will need to be resolved in a short period of time. Moreover, our analysis shows that special attention should be paid to the impact of Brexit on the Irish energy system.

The future of UK access to the European Energy Market

As a member of the World Trade Organization (WTO), the UK will likely be granted the right to import and export energy free of tariffs from and to other WTO members. The EU has shown flexibility with respect to the rules governing the usage of electricity and gas interconnectors with third parties. Given their mutual interest, the UK and the EU can likely find arrangements that will enable continued energy exchanges.

However, gas and electricity markets are complex service markets, not simple commodities markets, and the EU is in the process of streamlining the interface between national market designs to create a single energy market. If the UK were no longer bound by complex EU rules and institutions, it could essentially opt-out from the joint optimisation of the linked systems. This would imply substantial efficiency losses, especially in the long term. The impact would disproportionally fall on the UK (and Ireland), because the Continental market is both much larger and already better integrated than that of the UK.

Both the EU27 and the UK have an interest in an increasingly integrated energy market. But both face matters of principle that make it difficult to agree on this first-best solution. The UK seeks to repeal European rules that infringe on its sovereignty. The EU, on the other hand, does not want to allow the UK to 'cherry-pick' parts of the existing acquis in the negotiations.

Availability of EU funds for energy projects

As an EU member, the UK enjoys access to EU-based finance for energy projects from the European Investment Bank (EIB), the European Fund for Strategic Investment (EFSI), the Connecting Europe Facility (CEF), the EU Horizon 2020 programme (H2020) and the European Energy Programme for Recovery (EEPR).

After the withdrawal, the UK may have more limited access to funding from the EFSI, CEF, H2020, and EEPR.

As far as the EIB is concerned, in the absence of an agreement to the contrary, the UK would presumably cease to be a member when it ceases being an EU Member State. This suggests an urgent need to clarify these arrangements in the Brexit negotiation process.

Participation in regulatory bodies

Regulatory bodies such as the Agency for the Cooperation of Energy Regulators (ACER) and the European Networks of Transmission System Operators for Electricity and Gas (ENTSO-E and ENTSOG) play an important role in the functioning of the EU internal energy market. After Brexit, the status of any UK representatives in ACER, and the ENTSOs will change. Depending on the future arrangements, UK representatives might still remain as observers, but current rules would not allow non-EU members to vote on crucial market design issues.

Revisiting EU energy and climate targets

If the UK agrees to maintain the EU energy and climate targets (for instance as a condition of retaining access to the internal market), it might possibly be required to participate in the new Energy Union governance structure. That is, the UK might have to regularly report on renewables, energy efficiency, energy infrastructure and greenhouse gas emissions to show it is in line with the EU policy goals for 2030 and beyond. In turn, the EU would provide guidance to make sure the proposed EU-wide targets on renewables and energy efficiency are met.

If the UK does not commit to the EU energy and climate targets, a political decision in the EU will be needed on how to adjust the EU energy and climate targets after Brexit. We explore three options for readjusting the national and/or EU targets which keep constant either (1) the national ambitions, (2) the EU28 ambition in absolute terms, or (3) the EU28 ambition in percentage terms. Given that the UK targets were close to the EU average, the resulting shifts are not dramatic, but they could still be significant for individual EU countries.

A UK exit from the EU Emission Trading System (ETS) may cause a short-term surplus of allowances, because UK installations may sell off the stock of allowances they purchased for future compliance when it becomes clear that they will no longer need them. In the longer term, Brexit will most likely lead to a tightening of the system. If the UK could stay within the system until the end of its third phase in 2020, this could reduce disruption.

The Swiss model of linking a national emission trading system with the EU trading system can be a blueprint for future collaboration. A key political question would then be how the UK cap would be determined.

As the energy efficiency target is defined as a reduction compared to a baseline we suppose that each member state is essentially asked to reduce consumption compared to the baseline by exactly the same share (e.g., 30%). Hence, Brexit would not imply a change in the national contributions to meet the EU-wide energy efficiency target.

Rules for security of electricity and gas supplies

Pooling energy resources among Member States is essential for the EU to build a common and truly integrated internal energy market that is able to withstand external shocks. Given the UK's limited energy integration with the Continent, the security of electricity and gas supplies on the Continent will not be substantially affected by Brexit.

Future relation with Euratom

The UK has indicated its intention to exit Euratom as well as the EU. This requires clear arrangements on issues such as equipment safeguards and radioactive waste.

On equipment safeguards, the EU and the UK seem to agree that the Euratom Community should transfer ownership to the UK of equipment and other property located on UK territory related to the provision of safeguards. The value of the assets to be transferred will represent a key element of the negotiation.

On radioactive waste, the two parties seem to agree on the principle that responsibility should go to the state in which the spent fuel or the radioactive waste was generated. However, disagreements are likely to emerge during the negotiations.

Considering the highly technical nature of these issues, there have been calls for the UK to remain in Euratom. However, even if Euratom is legally governed by a separate treaty, its functioning depends on EU institutions. For this reason, Euratom should not be considered separately from the wider Brexit dossier.

Impact on energy markets for UK and EU companies

A large number of European companies are active on the UK gas and electricity markets and hold significant market shares there. They are subject to regulatory risks in a post-Brexit environment if the UK is no longer bound to EU rules.

London had a leading role in electricity, gas, oil and emission rights trading in Europe. For the EU it is important to make sure that UK energy traders active in the EU will have to follow at least as rigorous financial market and transparency rules as their EU counterparts.

London as a legal venue for arbitration cases will most likely not be affected. For place-of-jurisdiction clauses, companies might decide to abandon London for Continental competitors. Although enforceability is not under threat, burdensome procedures could increase the cost of enforcement of UK court rulings.

Impact of the UK withdrawal on Ireland

The energy system of the Republic of Ireland (ROI) could be significantly affected by Brexit because the ROI operates a joint electricity market with Northern Ireland (NI), trades electricity with Great Britain (GB) and buys a significant amount of gas from GB. Ensuring that the Single Energy Market (SEM) continues to function efficiently and that a level playing field is maintained in the SEM will be important following Brexit.

For the ROI, the first best solution would be for the UK were to remain inside the internal energy market; the second-best option would be for NI to remain inside the internal energy market; and the worst option would be for only the ROI to remain inside the internal energy market.

It is possible that the ROI might be exempted from certain provisions of EU energy regulation, but it seems questionable that the ROI could qualify as an 'energy island'.

The case of the ROI may offer both the EU27 and the UK an opportunity to advocate increased energy market integration after Brexit. The EU may argue that accepting full internal market membership of the UK is the price to pay for allowing the ROI to fully benefit from the EU internal energy market. The UK, on the other hand, might want to accept a certain loss of sovereignty from participating in the EU energy market framework - besides other benefits also - as the price to pay for energy security in Northern Ireland.

INTRODUCTION

This study, which Bruegel (the Brussels-based European think-tank specializing in economics) has conducted on behalf of the Committee on Industry, Research and Energy (ITRE) of the European Parliament, provides an assessment of how the UK's withdrawal from the EU (i.e. Brexit) might affect the EU energy system. The ITRE Committee called for the study in relation to the UK's Brexit referendum of 23 June 2016, in order to help Members of the European Parliament (MEPs) and the general public understand the critical aspects of Brexit from an energy and climate policy perspective.

As requested by ITRE, the main objective of this study is to offer a balanced picture of the issues concerning the impact of Brexit on the EU energy system, providing a descriptive analysis based on existing available data, studies and analysis from various sources, complemented by Bruegel's own expertise.

The study should then provide valuable insights to inform the Brexit negotiations from an EU perspective.

The UK might seek very different ways of collaborating with the EU in the energy sector after the withdrawal from the EU. While a UK membership of the European Economic Area (like Norway) would imply very limited changes in the energy sector, a model based on bi-lateral negotiations (like Switzerland) could cause substantial frictions. Somewhere in between these two options, it has been suggested that the UK might become a member of the Energy Community which would imply that the UK accepts EU energy sector rules, but entails limited joint institutions.

The role of energy and climate policy in the EU

Coordination of national coal (European Coal and Steel Community, 1952) and nuclear (Euratom, 1957) policies were foundation stones of the European integration process. The first European Commission of 1967 featured an Energy Commissioner (the Hallstein Commission, which preceded it, had no dedicated Energy Commissioner). In 1991, the European Community's Energy Commissioner, Antonio Cardoso e Cunha, proposed two Directives aimed at liberalizing the European electricity and gas markets. The Directives were enacted five and seven years later respectively. A second major energy market package followed in 2003. However, because of the lack of an energy chapter in the treaties at the time, the legal basis for these policies was competition rules.

In this context, the European leaders agreed to establish a truly common EU energy policy at the 2005 Hampton Court summit, convened by the British Prime Minister Tony Blair. Two years later, the new Treaty on the Functioning of the European Union (TFEU) added energy to the EU competences (Art. 194), even if it prevented the EU from interfering with the national fuel mixes. As most energy legislation would affect the fuel mix, the treaty provision on the energy competence is seen as being deliberately ambiguous. In 2009, a third major energy package was issued and a fourth package is currently being proposed.

As a result of a 60-year development, EU rules have profoundly changed the way in which energy sectors are organised in the Member States and how energy policies are coordinated between countries. Coordination is largely conducted through markets governed by increasingly harmonised and complex rules.

EU climate policy evolved out of EU environmental policy. The European Economic Community was already a party to the UN Framework Convention on Climate Change in 1992 and the European Community committed to joint targets in the Kyoto protocol in 1997. Accordingly, the EU started the largest greenhouse gas emissions trading system in

the world in 2005 and created a dedicated Commissioner and Directorate General (DG) for Climate Action in 2009. The TFEU gives the EU the competence for international climate negotiations (Art. 191). Given the ambitious international commitments of the EU, European climate policy will possibly become an even more important area of EU policy.

Competition and single market policies remain crucial drivers for energy and climate policies. Because energy is an important production factor and climate policies can impact the competitiveness of certain industries, distortions between countries could cascade down the value chain. Hence, state aid guidelines seek to prevent national energy or environmental policies undermining the functioning of the internal market.

Status quo of the Brexit talks

Table 1 depicts an overview of events surrounding the UK's exit from the EU. On 29 March 2017, the UK invoked Article 50 of the Treaty on European Union (TEU[2]), officially marking the beginning of the two-year negotiation period. The European Council adopted its political guidelines[3] for the negotiations with the UK at the summit on 29 April 2017. The guidelines set out a two-phase approach to the negotiations. In the first phase, the EU will provide clarity and legal certainty on the immediate effects of the UK's departure, and disentangle the UK from its commitments to the EU. On 22 May 2017, the European Council appointed the European Commission to lead the negotiations on behalf of the EU and expanded the framework for the first phase.[4] Three key issues[5] were identified as particularly pertinent to address in the first phase of the negotiations:

1. The rights of EU (UK) citizens living in the UK (EU);
2. The settlement of the UK's financial obligations; and
3. Ensuring the peace is maintained on the island of Ireland.

The negotiations commenced on 19 June 2017. Since then, EU and UK negotiators have met on a monthly basis. If the European Council ultimately decides that sufficient progress has been made on the exit deal, the negotiations will enter a second phase. In this phase, preliminary discussions will be held on the framework for the future relationship between the EU and the UK, as well as on possible transitional arrangements.[6]

[2] Treaty of Lisbon Amending the Treaty on European Union and the Treaty Establishing the European Community, 17 December 2007, 2007 O.J. (C 306) 1.

[3] European Council (2017a).

[4] European Council (2017b).

[5] The three issues were initially stipulated in the resolution of the European Parliament on 5 April 2017 (European Parliament, 2017a).

[6] European Parliament (2017b).

Table 1: Overview of events relating to Brexit

DATE	EVENT
20 February 2016	The UK Prime Minister announces the date of the referendum according to the European Union Referendum Act 2015
23 June 2016	The UK holds the referendum on EU membership.[7]
2 February 2017	The UK government publishes a White Paper outlining its vision on the Brexit negotiations.[8]
29 March 2017	UK prime minister Theresa May invokes Article 50 of the Treaty on European Union (TEU), marking the beginning of the legal process for withdrawal.[9]
29 April 2017	The European Council adopts negotiation guidelines, defining the EU's overall positions and principles, as envisioned in Article 50 of TEU at a summit.[10]
19 June 2017	First round of negotiations between the EU and UK[11]
October 2017	Fifth round of negotiations.[12]
October 2018	Negotiations conclude, ratification process begins in the EU[13]
29 March 2019	The UK leaves the EU, unless both the EU and UK agree to extend the deadline[14]

Source: Bruegel.

Since mid-2017 the UK has published several papers on its position on the energy system-related Brexit negotiations (a list of selected publications of policy papers by the government of the United Kingdom can be found in Table 2). To date (30 October 2017) it remains unclear which type of settlement the UK seeks with respect to most key questions addressed in this report.

7 BBC (2016a).
8 UK Government (2017a).
9 European Commission (2017a).
10 European Council (2017a).
11 European Commission (2017b).
12 European Commission (2017c).
13 European Commission (2017b).
14 European Commission (2017b)

Table 2: Selected UK policy papers on Brexit

TITLE OF UK POLICY PAPER	TYPE OF PAPER	DATE OF PUBLICATION
Technical note on existing contracts for the supply of nuclear material	Technical note	28 August 2017
Enforcement and dispute resolution - a future partnership paper	Future partnership paper	23 August 2017
Northern Ireland and Ireland - position paper	Position paper	16 August 2017
Nuclear materials and safeguards issues - position paper	Position paper	13 July 2017
Annex to the Council Decision authorising the opening of negotiations	Annex to Council Decisions	15 May 2017
The Repeal Bill: White Paper	White Paper	30 March 2017
The United Kingdom's exit from, and new partnership with, the European Union	White Paper	2 February 2017

Source: 'Article 50 and negotiations with the EU' (UK Government, 2017b).

Structure of this report

In Chapter 1, the future of the UK's access to the European Energy Market is discussed. An overview of EU funds for UK energy projects and their future availability is provided in Chapter 2. In Chapter 3, we review the current role of UK in European regulatory bodies, while Chapter 4 focuses on EU energy and climate targets and their future after Brexit. In Chapter 5, we assess the EU's security of supply after the withdrawal of the UK, while Chapter 6 gives an overview of the future relation with Euratom. In Chapter 7, we assess the impact of Brexit on energy markets for UK and EU companies, while Chapter 8 examines the impact of the UK's withdrawal for the energy system of Ireland. Finally, we provide an integrated summary of our findings in Chapter 9.

CHAPTER 1. THE FUTURE UK ACCESS TO THE EUROPEAN ENERGY MARKET

KEY FINDINGS

- The UK serves as a transit country for electricity and gas between the Continent and Ireland as well as (less importantly) a transit country for gas between Norway and the EU27.
- The EU27/UK electricity and gas trade was worth about EUR 6 billion in 2015 – more than 80 percent of which was in natural gas. In addition, the UK imported natural gas worth EUR 10 billion from Norway.
- Electricity markets are complex service markets, not simple commodity markets, and the EU is in the process of streamlining the interfaces between national market designs to create a single energy market.
- In the absence of an agreement in which the UK accepts to adhere to (dynamic) EU energy market rules and accepts the power of corresponding EU institutions on UK subjects, the UK might only conduct tariff-free export and import of bulk electricity, like Russia or Morocco. Hence the UK would opt-out of the joint optimisation of the linked systems, which would imply substantial efficiency losses, especially in the long term. The negative impact would disproportionally fall on the UK (and Ireland), as the Continental market is much larger and already better integrated.
- Current UK energy taxes appear not to be influenced by EU rules and hence Brexit will presumably have no direct impact on them.

1.1 Current status of EU-UK energy exchanges

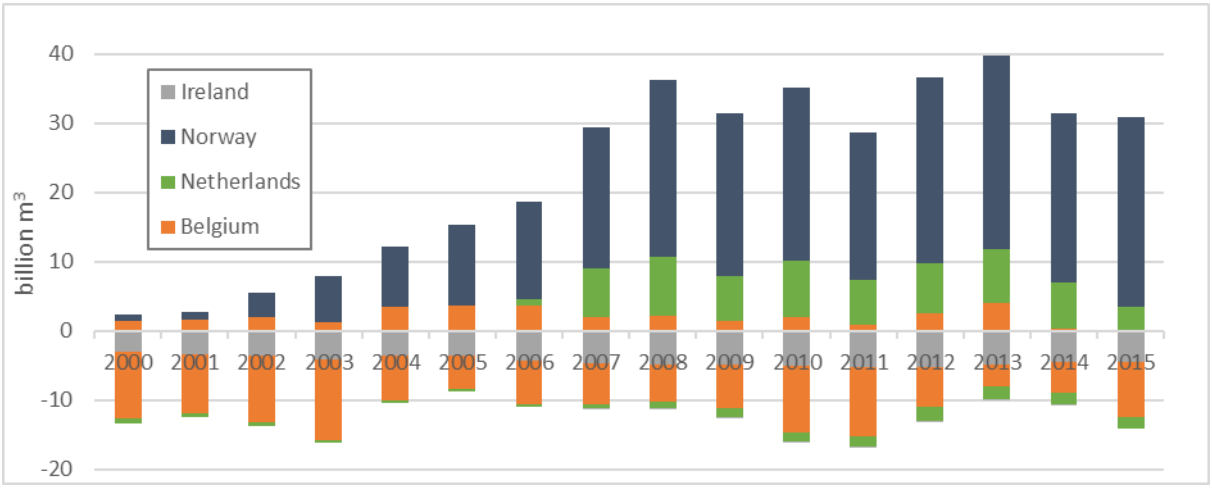
1.1.1 Natural gas (no LNG)

For a long time, the UK has been a major producer and exporter of natural gas. Since the 2000s, the UK has increasingly imported natural gas and the import dependency has risen from around 0 percent in 2000 to over 50 percent in 2013.[15] Between July 2016 and June 2017, the UK physically imported 33 billion m^3 [bcm] from Norway and 6 bcm from the EU27 according to data from the International Energy Agency (Figure 1).

On the export side, the UK has constantly exported natural gas to Ireland (4.5 bcm in 2015) as well as varying amounts to Belgium.

[15] Le Fevre (2015)

Figure 1: (Gross) UK natural gas imports and exports (gaseous state, in bcm)

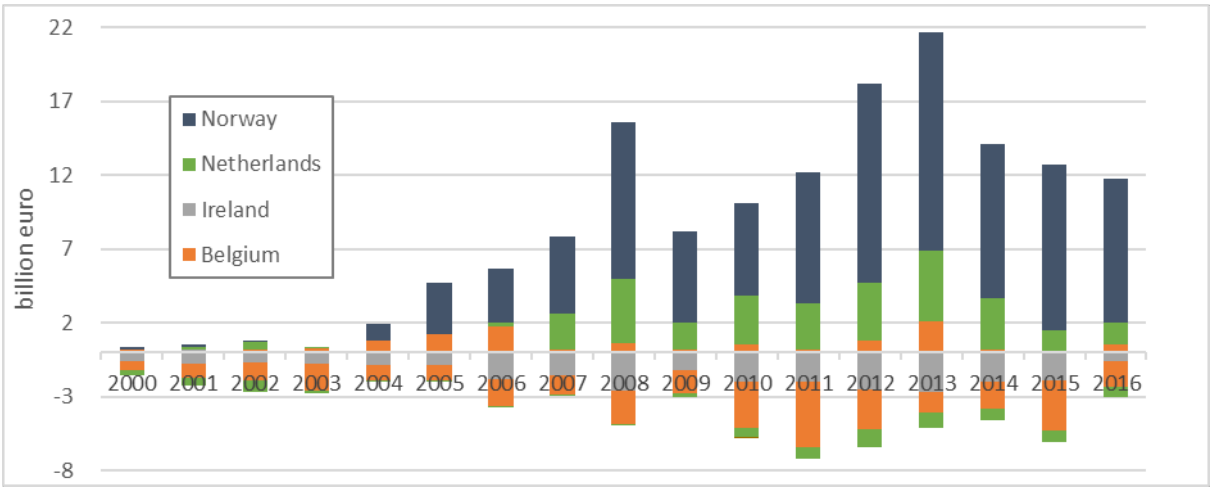


Source: Bruegel based on IEA (2017).
Note: Positive values are gross imports; negative value are gross exports.

The financial in- and outflows are similar to the physical flows. In 2015, (gross) natural gas imports had a value of over EUR 10 billion (

Figure 2). They have been decreasing markedly since their peak in 2013, when UK imported natural gas with a total value of over EUR 20 billion. Financial flows are more volatile than physical flows because of price and currency fluctuations.

Figure 2: (Gross) UK natural gas imports and exports (gaseous state, measured in billion EUR)



Source: Bruegel based on Eurostat (2017a).
Note: Positive values are gross imports; negative value are gross exports.

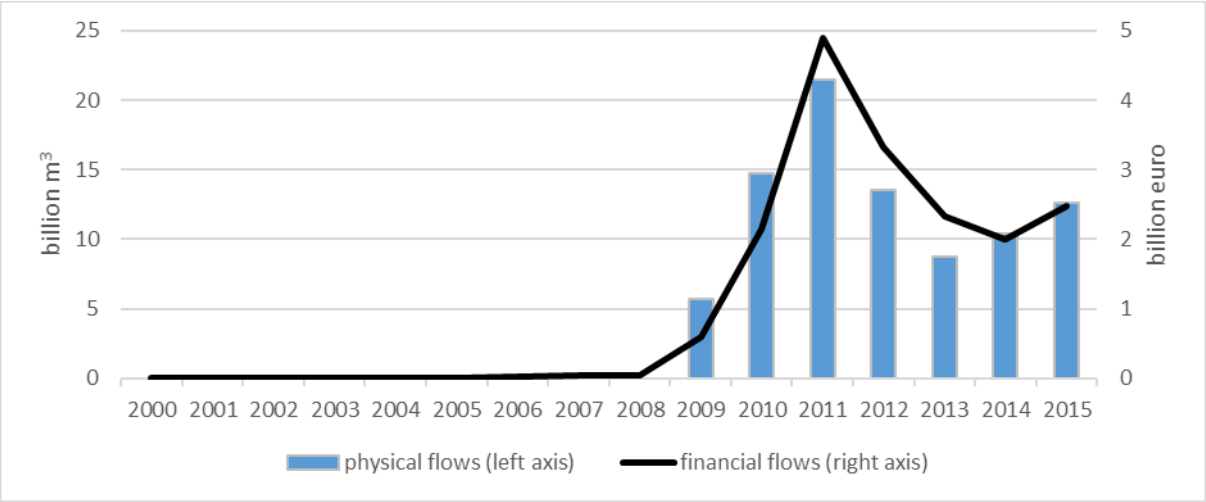
The UK is an unavoidable transit country for gas imports to Ireland (see Chapter 8), but is also used to (implicitly) bring gas from Norway (or Liquefied Natural Gas (LNG)) to Belgium. However, existing LNG and pipeline infrastructure would allow circumvention of the UK for gas transit to the Continent by increasing the usage levels.

1.1.2 LNG

LNG has become more important for the UK energy mix in the last years. Since 2009, UK has dramatically expanded its LNG imports, mainly from Qatar (Figure 3). LNG imports had a peak (in physical as well as financial terms) in 2011 with over 20 bcm worth almost EUR 5 billion. Gas exports to Belgium and Ireland are much smaller than the LNG imports of the UK, thus one could argue that on aggregate the UK is an LNG terminal for both countries. Belgium could replace pipeline imports from the UK by domestic LNG imports at its Zeebrugge terminal (which is located at the same point as the UK interconnector). Its capacity of 9 bcm/year so far has been grossly underutilised (2016: 1.1 bcm).

Ireland currently has no LNG terminal. But the proposed capacity of LNG projects in Shannon and Cork would exceed Irelands entire import demand.

Figure 3: UK LNG (gross) imports from Qatar (in billion m³ and EUR billion)



Source: Bruegel based on IEA (2017) and Eurostat (2017a).
Note: Positive values are gross imports; negative value gross exports.

1.1.3 Electricity

The UK trades electricity with three EU countries: France, Ireland and the Netherlands. As shown in Figure 4, the UK has traditionally been a net importer of electricity receiving imports mainly from France and in recent years also from the Netherlands. On the other hand, Ireland has been a net recipient of UK electricity exports. But in each interconnector, we observe flows in both directions, which suggests that in different situations electricity is cheaper on one side or the other.

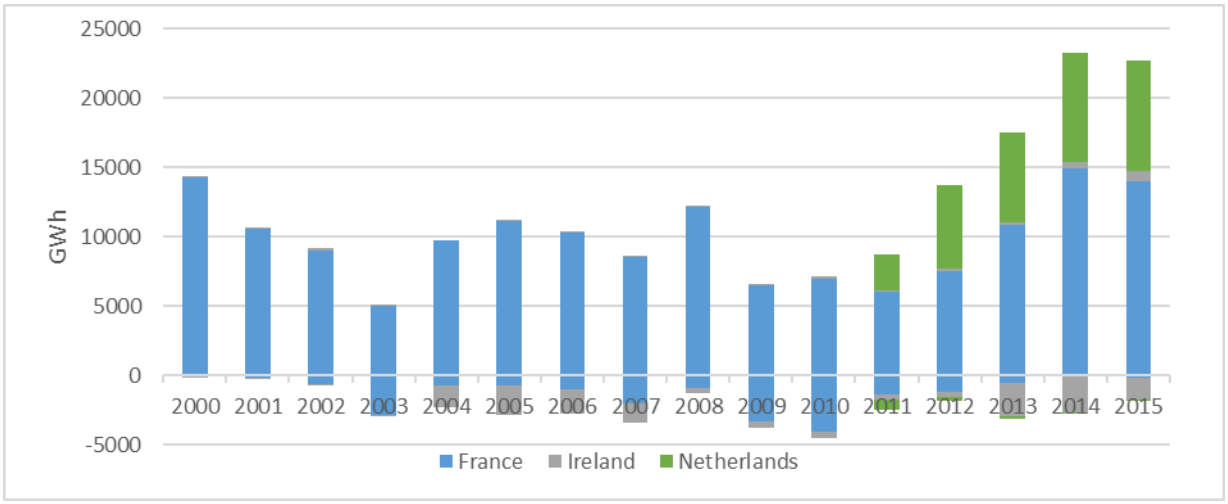
Imports from France occur mainly in peak periods (when UK prices are higher) while exports to France are more likely in situations where UK prices are lower. Trade with the Netherlands can on average not be attributed to high/low UK prices. In contrast to trade with France, the UK imports electricity from Ireland when prices in the UK are low (this might often be situations with high wind generation and low demand on the British Isles) and exports when prices are high. This nicely illustrates the complementarity of the Irish, UK and Continental systems.

Table 3: Average import and export prices for UK electricity with different trading partners

	TRADE DIRECTION FROM THE UK PERSPECTIVE	WEIGHTED AVERAGE UK PRICE (1H2017) [GBP]
French Interconnector	import	46.23
	export	41.42
Dutch Interconnector	import	43.74
	export	42.47
Irish Interconnector	import	39.82
	export	47.15
East-West Interconnector	import	41.74
	export	47.41

Source: Bruegel based on Bloomberg (2017) and Gridwatch (2017).

Figure 4: UK (gross) electricity imports and exports (in GWh)



Source: Bruegel based on IEA (2017).
Note: Positive values are gross imports; negative value gross exports.

The financial flows mirror the physical flows. Total electricity imports to the UK in 2015 had a value of over EUR 1.2 billion.

1.2 Energy trading in the internal energy market

Gas and electricity markets in principle feature the same challenges (increasing harmonisation of market designs and sophistication of EU rules) and institutional framework, but electricity markets are typically more complex. Actually, the role of electricity – and especially the more sophisticated trading-arrangements - is expected to increase in the future as decarbonisation is expected to be driven by electrification from

variable renewables. Hence, when discussing market design, we will focus on the electricity sector.

1.2.1 Electricity markets are complex service markets – not simple commodities markets

Electricity transmission and distribution networks are natural monopolies and their tariffs are hence not determined by markets, but regulated. By contrast, electricity supply is a competitive market. Given the complexity of the electricity system that requires that at any moment supply needs to equal demand, electricity supply is driven by numerous arrangements and markets for different sub-segments. Several of these sub-segments can in principle be organised as markets in which foreign players can participate – and hence there are European rules governing them. For the UK we can identify several dozen related products that can be grouped together in five categories (from most long-term to most short-term):

- *Capacity market:* The UK has a capacity market that pays power plants (and interruptible consumers) for being available some years in the future. In its latest auction for 2020/2021, the UK government awarded agreements worth GBP 1.18 billion to capacity providers.[16]
- *Renewables support:* The UK has several support mechanisms for electricity generated from low-carbon sources. For this year it planned to allocate up to GBP 760 million in terms of Contracts for Difference.
- *Wholesale market:* The most important segment remains the wholesale market in which producers, traders and consumers trade electricity from one day up to several years ahead. Assuming that all delivered electricity on average is at the day-ahead wholesale price; the total volume of the physical wholesale market is in the order of GBP 1 billion in July 2017 (in financial terms it is much larger as the same MWh of electricity might be traded multiple times between different parties). Of this total physical trade only, GBP 64 million correspond to imports and GBP 4 million to exports – which shows that overall cross-border electricity trade is small compared to countries like Germany.
- *Balancing:* Because of short-term deviations from the day-ahead schedule (e.g., because demand is lower or wind power is higher than expected the day before) electricity excess/shortage needs to be balanced by the system operator. A corresponding balancing market had a market volume of GBP 10 million in July 2017.
- Finally, there are a number of very narrow services commissioned by the system operator to make sure the system works in a stable way. These were worth another GBP 100 million in July 2017.

The above figures are neither complete nor fully consistent, but they indicate the orders of magnitude of the different segments. Overall, they sum up to a bit less than 1 percent of UK GDP, with wholesale electricity still being the largest component. The number and value of products other than bulk electricity (wholesale) increased in the past decade.[17] This has partly to do with the will to design more complex market signals to provide better

[16] National Grid (2016).

[17] For example, National Grid states: “Over time the number of balancing services procured by National Grid has grown to more than 20, ranging from Enhanced Frequency Response, to Demand Turn-Up, Reactive Power, and Black Start” (National Grid, 2017).

incentives for investment and operation and partly with the increasing share of variable renewables that require a more responsive system. Other west European markets show a similar trend towards more complex products. Because of significant interactions between the individual products, the corresponding markets cannot be treated in isolation. The efficiency of the wholesale market depends on the design of the other markets. If for example, UK companies would stop exporting to the Continent because they enter into obligations on the national capacity market, this would distort EU-UK wholesale trade. Or if EU-based power companies have a shortfall of supply for their UK customers, they need access to the balancing market.

1.2.2 The EU is in the process of streamlining the interface between national market designs

In fact, the EU embarked on a process to make national/regional electricity markets more compatible with each other to allow also more complex products to be traded across borders. This process is continuing to go ahead. Ireland is supposed to be integrated with the UK through day-ahead market coupling in 2018; and the UK is supposed to be coupled to the Continent through intraday-market coupling in 2018 (day-ahead market coupling was already established in 2014).[18]

Brexit could stall this process as the underlying rules are set by institutions of the European Union. The capacity allocation and congestion management guidelines are a Commission Regulation that is being implemented through network codes that were developed by ENTSO-E and ACER. So, when the UK is outside the EU it would not naturally be allowed to participate in these coupling exercises. This is very clear from the corresponding regulation that entails specific provisions for Switzerland and Energy Community countries:[19]

> *Article 1*
>
> *…*
>
> *4. The Union single day-ahead and intraday coupling may be opened to market operators and TSOs [Transmission System Operators] operating in Switzerland on the condition that the national law in that country implements the main provisions of Union electricity market legislation and that there is an intergovernmental agreement on electricity cooperation between the Union and Switzerland.*
>
> *5. … participation by Switzerland in day-ahead coupling and single intraday coupling shall be decided by the Commission based on an opinion given by the Agency. …*

1.2.3 Without EU rules and institutions trade partners might only export/import bulk electricity

If the UK cannot stay in the internal electricity markets (the rules of which are determined by ENTSO-E, ACER and the European Commission, and ultimately upheld by the European Court of Justice) it might have to seek an alternative arrangement for trading electricity. In fact, other electricity trading-partners such as Russia and Morocco are not bound by EU energy rules (in contrast to Ukraine, which is a member of the Energy Community) and for WTO members the EU has no tariff on electricity or gas imports.[20] For example, Russia

[18] ENTSO-E (2016).

[19] Commission Regulation (EU) 2015/1222.

[20] EU has no import tariffs on electricity (HS 2716) and natural gas (HS 2711) for WTO members as stipulated in COUNCIL REGULATION (EEC) No 2658/87 of 23 July 1987.

exports electricity to Finland which works based on an arrangement of the transmission operators in both countries. A company wanting to trade electricity has to buy electricity in Russia – which is a relatively well functioning market, book transmission capacity in Russia and transmission capacity in Finland[21]. So, there is no joint order book, i.e., the partner has to submit its sell and buy offers to the Finish market and see what would be taken up. Consequently, trading is relatively inflexible and not fully predictable. While it contributes to lowering the Finish electricity price when power is flowing, it does neither exploit short-term trade gains nor reliably increase supply security. The same is true for Morocco's electricity imports from Spain - where the Moroccan electricity company essentially acts as a large customer to the Spanish market.

In neither case does the arrangement lead to a joint optimisation of the linked systems. This implies different efficiency losses compared to the envisaged EU internal energy market:

Suboptimal dispatch: Without joint optimisation it is possible that relatively cheap plants in one country remain unused, even though their output could replace more expensive production in the other country.

Lower market liquidity: A fully integrated energy market (with implicit allocation of transmission capacities) can essentially lead to the liquidity in one market area being the sum of the liquidity in all participating market areas. In a less sophisticated system the liquidity in one market would be closer to the liquidity of this market area plus the size of the interconnector. As a result, cost and prices tend to be higher.

Less competitive pressure: As a result of the liquidity consideration above, competitive pressure is also much lower when there is no fully integrated energy market. As a result, prices tend to be higher.

Imperfect investment signals: In the long term the most important effect might be the distortion to investment signals. When each market area has to individually ensure system adequacy (of all products) we will end up with costly overinvestment.

While the impact of leaving the internal electricity market on the UK would be substantial, it will have a relatively muted impact on the Continental market (for Ireland see Chapter 8). If the UK wants to maintain a liquid, sophisticated[22] and competitive electricity market it would need to ensure continued participation in the developing internal energy markets. The rules in this market are evolving and will continue to do so. The past shows that there is no ultimate market design that will be frozen for several years, but that stakeholders will continue to tune the system to provide the right market signals in a quickly changing world (e.g., higher Renewable Energy Sources (RES) shares, increasing role of demand side and local networks, digitalisation, etc..). Hence, the UK will need to find a way to be credibly bound by the changing rules. The difficulty for the UK is that some of these rules might deeply infringe into what might be perceived as sovereign rights. For example, the proposed regional operation centres (ROCs) would oversee the system operation in a group of Member States (the Commission proposal foresaw that the UK has a ROC together with Ireland).[23] Such deeper integration will improve cross-border cooperation in terms of

[21] Buying electricity in Russia in specific hours might possibly imply paying an extra charge due to the Russian capacity mechanism.

[22] For example, with targeted products that ensure market-driven supply at minimum cost.

[23] Currently, National Grid belongs to one of the Regional Security Coordinators (RSC), Coreso which groups the German (50hertz), Belgian (Elia), French (RTE), Spanish (REE), Portuguese (REN) and Italian (Terna) TSOs. As

dispatch and investment, but imply a loss of national sovereignty as regards network operation.

1.2.4 Capacity mechanisms

The Commission proposal for an electricity market design regulation[24] currently discussed in the European Parliament contains rules on capacity mechanisms. Such mechanisms have been developed in various Member States (including the UK) to ensure that adequate generation capacities are available at all times. These mechanisms provide pay-outs to generators[25] that agree to guarantee availability in a certain timeframe. Such mechanisms typically require complex rulebooks that define how the product is defined, which are eligible and how the procurement is organised (the UK capacity market rules comprise 253 pages[26]). To avoid distortions to the internal energy market the European Commission has to approve capacity mechanisms[27] - which was done in 2014 for the UK capacity market. Furthermore, the new electricity market design regulation proposed by the European Commission[24] entails that national capacity mechanisms shall be open to participation from other Member States:

> *Article 21 Cross-border participation in capacity mechanisms*
>
> *1. Mechanisms other than strategic reserves shall be open to direct participation of capacity providers located in another Member State provided there is a network connection between that Member State and the bidding zone applying the mechanism …*

This might imply that the UK has to accept bidders from the Continent in what has become a 52 GW and EUR 1.5 billion per year market.[28] Given that capacity is short in the UK and long on the Continent that might imply payments from the UK to the Continent for capacity outside the UK (a lot will depend on how transmission capacity limitations are ultimately considered). In addition, according to the proposed EU rules the capacity need to be covered by such mechanisms would be determined on a regional (not national basis). Hence, the UK might only be allowed to have a capacity mechanism, when there is an

a principal task, they coordinate the actions of TSOs by providing close to real-time recommendations, due to a broader vision of the state of the European electricity system. The regulation on the operating of the electricity system (System Operation Guideline), adopted in comitology by the Member States in 2016 and which should enter into effect before the summer of 2017, already foresees a strengthening of the RSC's missions, particularly in terms of defining network models for coordinated capacity calculation and short and medium-term adequacy studies.

The Commission's proposal in the context of the 'Clean Energy for all Europeans' package, which intervenes even though the system will evolve in 2017, goes further by assigning new missions to ROCs and by transferring certain responsibilities to the regional level. ROCs would thus participate in the development of crisis scenarios and in the calculation of cross-border capacities relative to capacity mechanisms; they may also issue binding instructions to TSOs (e.g.: regional dimensioning of reserves).

[24] Proposal for a Regulation of the European Parliament and of The Council on the internal market for electricity (recast) (COM (2016) 861 final 2016/0379(COD)).

[25] Capacity mechanisms are often also open to providers of demand side response.

[26] It was only 151 pages in 2014.

[27] Europcan Commission Guidelines on State aid for environmental protection and energy 2014-2020, 'Article 3.9. Aid for generation adequacy' (European Commission, 2014a).

[28] Currently the UK allows the interconnectors to bid into the market which they successfully do.

aggregate capacity-shortfall in one of the regions in which the UK is a member (Region 8 [IU: Ireland and United Kingdom[29]] or Region 9 [Channel[30]]).

If the UK leaves the internal energy market it would also not participate in any cross-border exchange of capacity. This would possibly reduce corresponding income for Continental capacity providers and lead to increasing capacity investments into the UK (paid for by UK consumers). This in turn would result in increasing overcapacities – which might depress prices in regional wholesale markets.

1.3 EU energy taxation

Current EU rules for taxing energy products and electricity are laid down in the Energy Tax Directive 2003/96/EC[31], which entered into force on 1 January 2004. This Directive defined for the first time a common EU framework for the taxation of fuels, heating fuels and electricity, and also set certain minimum rates for energy products (Table 4).[32]

In 2011, the EC presented a proposal to revise the Energy Tax Directive with the aim of restructuring the taxation of energy products to support the EU's wider environmental goals.[33] The European Parliament voted on the proposal in 2012, but after unsuccessful negotiations between the EU Member States in the Council, the proposal was withdrawn by the EC in 2015.[34]

The UK's current taxation rates stand well above the Energy Tax Directive's minimum requirements for gasoline, gas oil, kerosene, heavy fuel oil, Liquefied Petroleum Gas (LPG) and natural gas (Table 4). So even when remaining a EU Member State, the UK could lower these taxes.

[29] Region 8 includes the bidding zone border between Great Britain and Single Electricity Market in Ireland and Northern Ireland attributed to the EirGrid, Moyle Interconnector (Moyle), National Grid Electricity Transmission plc (NGET) and SONI.

[30] Region 9 includes the bidding zone borders between France - Great Britain and Netherlands - Great Britain.

[31] Council Directive 2003/96/EC of 27 October 2003 restructuring the Community framework for the taxation of energy products and electricity.

[32] Prior to the entry into force of the Energy Tax Directive, the Community framework for energy taxation only covered mineral oils. The 2003 Directive widened the scope of the minimum rate system to include to all energy products, including coal and coke, natural gas and electricity.

[33] A key feature of the proposal was to tax energy in a way that reflected both its CO2 emissions and its energy content. Energy taxes would have been split into these two components to determine the overall rate at which the fuel is taxed.

[34] European Commission (n.d.-a).

Table 4: EU's minimum tax rates for energy products and the UK's current rates

PRODUCT		TAX RATE	
		Minimum EU	**Total UK (as of 01.01.2017)**
Gasoline (EUR/1000 litres)	Leaded	421	775
	Unleaded	359	664
Gas oil (EUR/1000 litres)	Propellant use	330	664
	Heating and process use	21	128
Kerosene (EUR/1000 litres)	Propellant use	330	664
	Process use	21	128
Heavy fuel oil (EUR/1000 kg)	Heating	15	123
LPG - propellant use (EUR/1000 kg)	Propellant use	125	362
	Process use	41	n.a.
	Heating	0	14
Natural gas (EUR/gigajoule)	Propellant use	2.6	6.5
	Process use and non-business heating	0.3	0.6
	Business heating	0.15	0.6
Coal (EUR/gigajoule)	Non-business heating	0.3	0
	Business heating	0.15	0.6*
Electricity (EUR/MWh)	Business	0.5	6.5*
	Non-business	1	0

Source: Bruegel based on 'Excise Duty Tables' (European Commission, 2017d) and 'Climate Change Levy: application, rates and exemptions' (UK Government, 2016a).

Note: * The values correspond to the climate change levy (CCL) rates as of 1 April 2017. The data were converted by Bruegel into EUR/gigajoule for business heating of coal and into EUR/MWh for business use of electricity; [green=UK above EU minimum rate; red=UK below EU minimum rate]

On the other hand, the UK has no excise duty on electricity and coal for non-business consumers and significantly lower excise duties on business-relevant energy products than countries like Germany or France (Table 5). Furthermore, the UK is currently applying a VAT rate to electricity and natural gas of 5 percent, far below all other EU27 countries (Figure 5).

So, it is unlikely that the UK will be able to attract manufacturing industries currently located in the EU-27 by cutting energy taxes below the EU minimum levels. However, it has

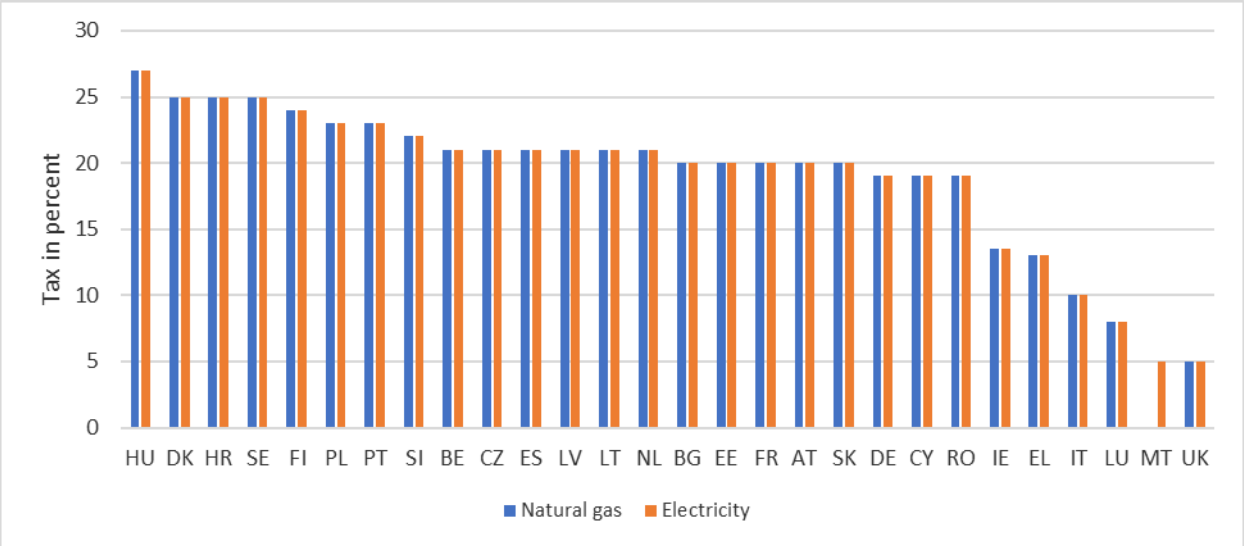
been discussed that the UK might consider adjusting its carbon price support downward post 2020 to improve competitiveness. According to a report[35] by Aurora Energy Research this could reduce energy bills by GBP 2.6 billion per year. Such a domestic policy shift would, however, also be possible if the UK stayed within the EU.

Table 5: Excise duties for business-relevant energy products in the UK, GER and FRA

	UK	FRANCE	GERMANY
Natural gas - Business heating *(EUR/gigajoule)*	0.61	1.63	4.12
Electricity - Business *(EUR/MWh)*	6.50	22.50	15.37

Source: Bruegel based on 'Excise Duty Tables' (European Commission, 2017d) and 'Climate Change Levy: application, rates and exemptions' (UK Government, 2016a).

Figure 5: VAT rates on natural gas and electricity



Source: Bruegel based on 'VAT rates' (European Commission, 2017e).

1.4 Critical issues and options

The key question is whether the UK will remain part of the internal energy market, and what arrangement will be negotiated if it does not. As the internal energy market is based on a complex and dynamic set of enforceable rules a stable set of institutions is needed to make it work. Hence, it is not conceivable that a country can participate in the internal energy market when it does not accept the powers of super-national institutions (e.g. ACER, ENTSO, ROCs, European Commission) over its own energy system.

[35] Aurora Energy Research (2017).

If the UK were to leave the internal energy market that would not imply a stop of energy trading between the EU27 and the UK, but substantially reduce the sophistication of trading arrangements. As a result, we expect that the trade gains from an internal market that jointly optimises the electricity systems (both in terms of dispatch and investments) in the UK and the EU27 will vanish. The effects will be asymmetrical. The UK will require costly domestic overcapacities to ensure system adequacy, if it cannot rely on the Continent for compensating domestic shortfalls. In addition, wholesale prices will increase and become more volatile due to decreasing competition and falling liquidity. On the Continent (for Ireland see Chapter 8) we in principle expect the same effect - but at a much smaller magnitude. In this case the EU should make sure that UK-overcapacities (that are supported through mechanisms that are unavailable for market participants in the EU27) do not undermine investment or dispatch decisions in the EU27.

Table 6: Which arrangements allow a country to enjoy tariff-free energy exchanges and/or joint optimisation of dispatch with the EU?

	Tariff-free energy exchanges	Joint optimisation of dispatch
EU Member State (e.g. France)	Yes	Yes
EEA (e.g. Norway)	Yes	Yes
Energy Community (e.g. Ukraine)	Yes	Case-by-case
Bilateral Treaty (e.g. Switzerland)	Yes	Case-by-case
WTO (e.g. Morocco)	Yes	No

Source: Bruegel.

CHAPTER 2. AVAILABILITY OF EU FUNDS FOR ENERGY PROJECTS

KEY FINDINGS

- Between 2012 and 2017, the European Investment Bank (EIB) provided about EUR 9 billion for energy projects in which the UK participates.
- Since 2015, the European Fund for Strategic Investment (EFSI) has signed financing worth EUR 1.4 billion for energy projects related to the UK, and approved another EUR 410 million.
- Of the current EU projects of common interest (PCIs), 16 are UK-related. These projects received funding of EUR 125.6 million from the Connecting Europe Facility, and additional funding of EUR 90 million is in the pipeline.
- The EU Horizon 2020 programme currently funds more than 90 energy-related research and innovation projects in which the UK participates, for a total commitment of EUR 160 million.
- The European Energy Programme for Recovery (EEPR) has provided grants to UK-related energy projects for a total of EUR 330 million.
- After the withdrawal, the UK might have more limited access to funding from the EFSI, CEF, H2020, and EEPR.
- The details of the UK's withdrawal from the EIB should be part of a single financial settlement between the EU27 and the UK, and should not be treated separately.

The aim of this chapter is to assess the current status of and potential way forward for the availability of EU funds for energy projects in the UK, and most notably for UK-related EU Projects of Common Interest (PCIs).

To do so, the chapter will review the most important EU financing institutions and mechanisms: the European Investment Bank (EIB), the European Fund for Strategic Investments (EFSI) and the Connecting Europe Facility (CEF), the Horizon 2020 programme (H2020) and the European Energy Programme for Recovery (EEPR).

For each of these entities, three levels of analysis will be provided:

1. An outline of the entity's mandate and activities;
2. An outline of the entity's past, current and planned financing for UK-related energy projects; and
3. An outline of the (eventual) conditions under which non-EU countries can participate in the entity.

2.1 European investment bank

Founded in 1958 under the Treaty of Rome, the EIB is the EU's long-term lending institution. The shareholders of the EIB are the EU Member States.[36] The capital of the Bank, EUR 233 billion, is provided by Member States on the basis of their economic weight within the EU at the time of their accession. The UK is one of the largest four shareholders of the Bank (together with Germany, France and Italy), with a capital subscription of almost EUR 39 billion.[37] Since 1959, the EIB has provided around EUR 117 billion in financial support -i.e. mainly lending- to UK projects, of which about EUR 30 billion has been provided for energy projects.[38] The Bank's mandate is to borrow money on capital markets and to lend it on favourable terms to projects that support EU objectives.[39] The EIB provides three main types of products and services: lending, blending and advising. Lending represents around 90 percent of the Bank's total financial commitment, and around 90 percent of this activity is made within the EU.[40]

Energy has traditionally represented an important sector for EIB financing. As the Bank's activities in the field are primarily guided by EU energy and climate policy priorities, EIB's typical focus is on energy efficiency, renewable energy, energy networks, as well as related research and innovation.

Between 1959 and 2011, the EIB provided EUR 19.5 billion of financing support to the UK's energy sector.[41] This support scaled up in the recent past, as nearly half of this amount (EUR 9 billion) was provided between 2012 and 2017 (Table 7).

Table 7: EIB financing support to UK energy projects (2012-2017) – in billion EUR

Electricity projects	Gas projects	Other projects	Total
6.86	1.77	0.40	**9.04**

Source: Bruegel based on 'EIB project list' (EIB, n.d.-b).
Note: These amounts do not include EFSI-funded projects.

The Treaty on the Functioning of the European Union (TFEU) states, in its Article 308, that 'The members of the European Investment Bank shall be the Member States.'[42] Neither the TFEU nor the EIB's Statute have provisions concerning a withdrawal from the EIB or provisions concerning the participation of non-EU Member States into the Bank's activities and governance. In the absence of an agreement to the contrary, the UK may cease to be a member of the EIB when it ceases to be an EU Member State. This suggests an urgent

[36] EIB (2017).
[37] EIB (n.d.-a).
[38] The full list of funded projects can be found here: http://www.eib.org/efsi/efsi-projects/index.htm?c=GB&se=3.
[39] Consolidated Version of the Treaty on the Functioning of the European Union art. 309 (ex. Article 267 TEC), 2012 O.J. C 326/47 [hereinafter called TFEU].
[40] EU (n.d.).
[41] The list of energy projects financed by the EIB can be found here: http://www.eib.org/projects/loan/list/index.htm?from=1959&region=1&sector=1000&to=2011&country=GB.
[42] TFEU Art. 308 (ex Article 266 TEC), 2012 O.J. C 326/47.

need to clarify these arrangements going forward through the Brexit negotiation process so as to avoid uncertainties or ambiguities.[43] This is consistent with the European Council's call for the EU and UK to "*respect the obligations resulting from the whole period of the UK membership in the Union [so as to] cover all commitments as well as liabilities, including contingent liabilities*".[44] The Council called for these issues to be addressed through an integrated approach not only for the EIB, but also for the MFF, the European Development Fund (EDF) and the European Central Bank (ECB).

2.2 European fund for strategic investment

The European Fund for Strategic Investment (EFSI) was launched in 2015 as a joint initiative by the EIB Group and the European Commission, with the aim of reversing the negative investment trend in the EU. The EFSI is managed by the EIB, and is not a 'fund' *per se*. Instead, it is a guarantee instrument allowing the EIB Group to increase its risk bearing capacity by lending to commercially viable, yet higher risk, projects.[45] The EFSI's mandate is to finance such projects in strategically important sectors for the EU, including:

- Strategic infrastructure, such as digital, transport and energy;
- Education, research, development and innovation;
- Renewable energy and resource efficiency; and
- Support for small and mid-sized businesses.[46]

The EIB Group and the EU have contributed EUR 5 billion and EUR 16 billion respectively to the EFSI, implying that a total budget of EUR 21 billion is available. By mid-2018, the EFSI aims to have supported investments in its target sectors by at least EUR 315 billion. The European Commission has proposed increasing this goal to EUR 500 billion for 2020, though this proposal has not been implemented yet.[47]

A number of energy projects in the UK are supported by the EFSI. As shown in Table 8, the EFSI has signed financing for energy projects that are (at least partly) in the UK worth EUR 1.4 billion and approved another EUR 410 million of financing.

The EFSI's financial support is available to only EU Member States and to cross-border investments with EU Member States' neighbouring countries.[48] Hence, after a complete withdrawal from the EU, the UK will presumably have no direct access to EFSI funding for internal UK projects, but may still receive funding for cross-border projects with EU Member States. The status of internal UK projects that have already received a commitment of funding will most likely be subject to the Brexit negotiations.

[43] The EIB recently announced that Brexit may impair the ability of UK infrastructure projects to access finance from the EIB. (Financial Times, 2017a).

[44] European Council (2017a).

[45] EU (2016).

[46] EIB (n.d.-c).

[47] EU (2016).

[48] European Commission (2016a).

Table 8: EFSI financing support to UK-related energy projects

NAME OF PROJECT	COUNTRIES	EFSI FINANCING AMOUNT (MILLION EUR)
Signed energy projects		
Copenhagen Infrastructure Fund II	DE, PL, SE, UK	75
UK Energy Efficiency Investments Fund II	UK	56
Smart meters - Project Spark	UK	478
Galloper Offshore Wind	UK	314
Beatrice Offshore	UK	292
QUAERO European Infrastructure Fund	BE, DE, ES, FI, FR, LT, UK	40 (of which 10 percent energy-related)
Infracapital Greenfield Infrastructure Fund	BE, DE, FI, FR, IT, PO, SK, SE, UK	118
Calvin Smartmeter Roll-out	UK	48
CUBE Infrastructure Fund II	CZ, FR, IE, IT, SE, UK	100 (of which 28 percent energy-related)
Total:		**1,413**
Approved (but unsigned) projects		
London Energy Efficiency Cofinancing Facility	UK	136
IMPAX Climate Property Fund II	UK	36
Odewald Renewable Energy Infrastructure Fund	DE, ES, FI, FR, IE, IT, UK	80
Offshore Transmission Network Round 4	UK	58
Fonds Infragreen III	DE, DK, EL, ES, FR, HR, IT, PL, UK	50
Amundi Energy Transition Alba I	FR, UK	50
Total:		**410**

Source: Bruegel based on 'EFSI project list' (EIB, n.d.-d).

2.3 Connecting Europe facility

The Connecting Europe Facility (CEF) was established in 2013 as an EU funding instrument developed specifically to direct investment into Trans-European Transport Networks (TEN-T), Trans-European Energy Networks (TEN-E), and Broadband and Information and Communication Technologies (ICT).[49]

The agreed budget for CEF amounts to EUR 30.5 billion for the period 2014-2020, the major share of which is allocated to transport projects (EUR 24.1 billion). The budget allocated to the energy sector amounts to EUR 5.35 billion, whereas telecom projects have been allocated about EUR 1.04 billion.[50]

Of the EUR 5.35 billion allocated to energy projects, EUR 4.7 billion is available in the form of grants.[51] These grants are notably aimed at supporting the development of EU Projects of Common Interest (PCIs). These projects have been identified by the European Commission as essential for completing the EU internal market, and must:

- Have a significant impact on two or more EU countries;
- Improve market integration and the integration of EU countries' networks;
- Strengthen competition in energy markets by providing alternatives to consumers;
- Improve security of supply; and
- Contribute to the EU's energy and climate goals by facilitating the integration of energy from variable renewable sources.[52]

Table 10 describes the current UK-related PCIs. These projects already received funding for EUR 125.6 million from the CEF, while additional funding for EUR 90 million is in the pipeline (Table 9).

Table 9: CEF's funding for UK-related Projects of Common Interest

STATUS	ELECTRICITY PROJECTS	GAS PROJECTS	TOTAL
Ongoing	85.6	36.7	122.3
Completed	0.8	2.5	3.3
Not yet started	90.0	0	90.0

Source: Bruegel based on 'Funding for Projects of Common Interest' (European Commission, n.d.-e), 'CEF-Energy projects: United Kingdom' (European Commission, n.d.-f), 'Projects of common interest – Interactive map' (European Commission, n.d.-g), 'Technical information on Projects of Common Interest' (European Commission, n.d.-h).

[49] European Commission (2017h).
[50] European Commission (2017f).
[51] European Commission (2017f).
[52] European Commission (n.d.-i).

Table 10: UK-related Projects of Common Interest

NUMBER	NAME	ACTION TYPE	COUNTRIES	MAXIMUM CEF FUNDING (MILLION EUR)	TOTAL COST (MILLION EUR)	STATUS
Electricity: Priority Corridor Northern Seas Offshore Grid ('NSOG')						
1.1.1	Interconnection between Zeebrugge (BE) and the vicinity of Richborough (UK)	Work	BE, UK	N/A	N/A	Ongoing
1.1.2	Internal line between the vicinity of Richborough and Canterbury (UK)	N/A	UK	N/A	N/A	Ongoing*
1.7.1	France - United Kingdom interconnection between Cotentin (FR) and the vicinity of Exeter (UK) ['FAB' project]	Study	FR, UK	7.24	14.47	Ongoing
1.7.2	France - United Kingdom interconnection between Tourbe (FR) and Chilling (UK) ['IFA2' project]	Study	FR, UK	5.96	11.91	Ongoing
1.7.3	France - United Kingdom interconnection between Coquelles (FR) and Folkestone (UK) ['ElecLink' project]	Studies	FR, UK	0.60	1.20	Completed
1.7.3	France - United Kingdom interconnection between Coquelles (FR) and Folkestone (UK) ['ElecLink' project]	Studies	FR, UK	0.20	0.40	Completed
1.9.1	Ireland - United Kingdom interconnection between Co. Offaly (IE), Pembroke and Pentir (UK) ['Greenlink']	Study	IE, UK	0.81	1.62	Ongoing
1.9.2	Ireland — United Kingdom interconnection between Coolkeeragh — Coleraine hubs (IE) and Hunterston station, Islay, Argyll and Location C Offshore Wind Farms (UK) ['ISLES' project]	Two studies have been completed. Under construction	IE, UK	N/A	N/A	Ongoing
1.10	Norway - United Kingdom interconnection	Studies	NO, UK	31.30	62.60	Ongoing
1.10 B	Norway - United Kingdom interconnection ['NorthConnect' project]	Studies	UK	10.76	21.51	Ongoing
1.12	Compressed air energy storage in United Kingdom - Larne	Study	UK	8.28	16.56	Ongoing
1.12	Compressed air energy storage in United Kingdom - Larne	Study	UK	6.47	12.31	Ongoing
1.12	Compressed air energy storage in United Kingdom - Larne	Work	UK	90.00	418.41	Not yet started
1.13	Interconnection between Iceland and United Kingdom ['Ice Link' project]	Study	IC, UK	N/A	N/A	Ongoing
1.14	Interconnection between Revsing (DK) and Bicker Fen	Study	DK, UK	14.82	29.65	Ongoing

	(UK) ['Viking Link' project]					
Electricity: Priority Corridor North-South Electricity Interconnections in Western Europe ('NSI West Electricity')						
2.13.1	Ireland — United Kingdom interconnection between Woodland (IE) and Turleenan (UK)	N/A	IE, UK	N/A	N/A	Ongoing*
2.13.2	Ireland — United Kingdom Interconnection between Srananagh (IE) and Turleenan (UK)	N/A	IE, UK	N/A	N/A	Ongoing**
Gas: Priority Corridor North-South Gas Interconnections in Western Europe ('NSI West Gas')						
5.1.1	Physical reverse flow at Moffat interconnection point (IE/UK)	Study	IE, UK	0.93	1.85	Ongoing
5.1.2	Upgrade of the SNIP (Scotland to Northern Ireland) pipeline to accommodate physical reverse flow between Ballylumford and Twynholm	Studies	UK	N/A	N/A	Ongoing***
5.1.3	Development of the Islandmagee Underground Gas Storage (UGS) facility at Larne (Northern Ireland)	Study	UK	4.02	8.05	Ongoing
5.1.3	Development of the Islandmagee Underground Gas Storage (UGS) facility at Larne (Northern Ireland)	Study	UK	2.50	5.00	Completed
Gas: Priority thematic area Smart Grids Deployment						
10.1	North Atlantic Green Zone Project (Ireland, United Kingdom/Northern Ireland) aims at lowering wind curtailment by implementing communication infrastructure, enhanced grid control and interconnection and establishing (cross-border) protocols for Demand Side Management	Specification and planning & interaction with regulatory authorities	IE, UK	31.74	N/A	Ongoing

Source: Bruegel based on 'Funding for Projects of Common Interest' (European Commission, n.d.-e), 'CEF-Energy projects: United Kingdom' (European Commission, n.d.-f), 'Projects of common interest – Interactive map' (European Commission, n.d.-g), 'Technical information on Projects of Common Interest' (European Commission, n.d.-h).
Note: N/A implies that the information was not available in the sources listed above.
*The project status is 'Permitting' and therefore assumed to be ongoing.
** The project status is 'Planned, but not yet in permitting' and therefore assumed to be ongoing.
*** The project status is 'Under consideration' and therefore assumed to be ongoing.

If an infrastructure project is considered as strategic for the interests of the EU, non-EU countries can also host PCIs.[53] For instance, among the current 195 PCIs, there are also

[53] European Commission (2017g)

projects concerning Norway, Switzerland, Ukraine, Israel and Algeria.[54] On this basis, PCIs concerning the UK could continue to advance with EU support even after the withdrawal, should this be considered by the European Commission to be in the EU interest.

2.4 Horizon 2020

Horizon 2020 plays an important role in the EU 2020 strategy aimed at improving Europe's global competitiveness. The programme was launched by the European Commission in 2014 as a follow-up to the previous Seventh Framework Programme (FP7), with the mandate to provide grants to research projects that support economic growth and employment creation in Europe.[55] Horizon 2020 runs between 2014 and 2020, and has a budget of almost EUR 80 billion.

The programme focuses on funding research and innovation projects in three main research areas. The first, called 'Excellent Science', targets research in science, while the second, 'Industrial Leadership', seeks to accelerate the development of technologies and innovations that can enable enterprise growth. The third research area, 'Societal challenges', aims to identify solutions to social and economic problems.[56]

Energy projects fall under the domain of 'Societal challenges'. The funding to these projects is managed by the Innovation and Networks Executive Agency (INEA). The funding allocation is structured as follows:[57]

- Smart, green and integrated transport (EUR 2.9 billion in 2014-2020);
- Secure, clean and efficient energy (EUR 3.8 billion in 2014-2020);
- Food security, sustainable agriculture and forestry, marine, maritime and inland water research and the bio-economy (EUR 17 million in 2016-2017);
- Cross-cutting activities (EUR 131.5 million in 2016-2017).

More than 90 energy-related research and innovation projects in the UK are currently benefiting from Horizon 2020 funding.[58] As illustrated in Table 11, projects focused on renewable energy are the largest recipient, while CCS and grid projects also obtain relatively large amounts.

[54] See the following for a full list of PCIs: http://ec.europa.eu/energy/en/topics/infrastructure/projects-common-interest

[55] European Commission (2016b).

[56] European Commission (2014b).

[57] European Commission (n.d.-b).

[58] The full list of projects funded by Horizon 2020 can be found here: https://ec.europa.eu/inea/en/horizon-2020/projects/funded-projects

Table 11: H2020's funding to UK research parties in the field of energy

TYPE OF PROJECT	FUNDING (TO THE UK PARTY INVOLVED) (MILLION EUR)
Renewable energy sources	60.16
Carbon capture storage	27.38
Grid	21.29
Shale gas	3.25
Other	48.38
Total	**160.45**

Source: Bruegel based on 'funded projects' https://ec.europa.eu/inea/en/horizon-2020/projects/funded-projects. (European Commission, n.d.-c).

Project applicants from non-EU countries are allowed to participate in Horizon 2020 programmes, but only those that have entered an Association Agreement with Horizon 2020 are automatically eligible for H2020 funding.[59] But applicants from other non-EU countries may exceptionally be granted funding provided that certain conditions[60] are satisfied. Thus, certain projects based in the UK might remain eligible for funding after the withdrawal, even in the absence of an Association Agreement.[61]

Whether the UK is able to fulfil these conditions is largely discretionary on the part of the EU. The conditions are (1) the existence of a bilateral scientific/technological agreement between the EU and the third country; (2) a statement in the call for proposals stating that their participation is permitted; or (3) a determination that the third country's participation is valuable to a bidder consortium due to outstanding competence/expertise; access to research infrastructure, access to particular geographical environments; or access to data. The first of these requires a determination on the part of the EU that is not very different from the determination of eligibility for an Association Agreement. The second involves similar considerations, but is specific to a particular call for proposals. The third implies a case by case evaluation.[62]

[59] European Commission (2017i).

[60] European Commission (2017i).

[61] Association to Horizon 2020 is governed by Regulation (EU) No 1291/2013 of the European Parliament and of the Council.

[62] European Commission (2017i).

2.5 European energy programme for recovery

The European Energy Programme for Recovery (EEPR) is a funding mechanism of the European Commission. Established in 2009, EEPR provides financial assistance in the form of grants to EU energy projects that contribute to stronger economic growth, greater security of supply and reduced greenhouse gas emissions. The programme has allocated nearly EUR 4 billion to help co-finance projects in three sectors. These include electricity and gas interconnection (44 projects), offshore wind energy (9), and carbon capture and storage (6).[63] By mid-2016, 37 out of the 59 projects had been completed, and around EUR 2.12 billion had been paid to recipients.[64]

A total of EUR 330 million has been assigned to co-finance UK energy projects. All of the activities for which the EEPR funds were assigned have already been completed.[65] Thus, all of the current funding will have been completed by the time of a potential UK exit from the EU.

Table 12: EEPR's finance support to UK energy projects

TYPE OF PROJECT	FUNDING (MILLION EUR)	STATUS
Carbon capture storage	180	Completed
Electricity interconnection	110	Completed
Wind	40	Completed
Total	**330**	

Source: Bruegel based on European Commission (n.d.-o).
Note: A project is denoted 'completed' if the activities for which EEPR funding was received are completed (according to the source for the table).

Some projects that have been co-financed under the EEFR have involved non-EU Member States.[66] Thus, it is possible for non-EU Member States to receive funding indirectly, if they are one of the states involved in the project. After the withdrawal, the UK could therefore theoretically receive funding indirectly from the EEFR.

2.6 Critical issues and options

The future availability of EU funds for UK energy projects is heavily dependent on whatever settlement is ultimately negotiated (if any) between the EU27 and the UK. This is

[63] European Commission (n.d.-e).

[64] Report from the Commission to the European Parliament and the Council On the implementation of the European Energy Programme for Recovery and the European Energy Efficiency Fund (COM (2016) 743 final).

[65] Though one wind power project to which EUR 40 million was assigned is not completed, all the activities for which EEPR funding was received have been completed. (European Commission, n.d.-o) The project itself is expected to be completed in 2018 (Vattenfall, 2016).

[66] For instance, the gas bridge between Asia and Europe ('Nabucco') involved Turkey (European Commission, n.d.-d).

particularly the case for the EIB, given the Bank's financial and political peculiarities, and given the UK's substantial involvement on its capital. After the withdrawal, the UK may presumably have more limited access to funding from the EFSI, CEF (should projects be considered strategic by the European Commission), H2020 (should the UK sign a corresponding Association Agreement), and EEPR.

The running programs do not entail extraordinary benefits to EU27 citizens and companies that the EU unconditionally needs to protect. The EU should nonetheless seek to keep a window open for projects that are to the benefit of EU27 citizens and companies, as it does for other third countries.

Table 13: Which arrangements allow a country access to EU funding mechanisms?

	EIB	EFSI	CEF	H2020	EEPR
EU Member State (e.g. France)	Access	Access	Access	Access	Access
EEA (e.g. Norway)	Possible access	Possible access	Possible access	Possible access	Possible access
Energy Community (e.g. Ukraine)	Possible access	Possible access	Possible access	Possible access	Possible access
Bilateral Treaty (e.g. Switzerland)	Possible access	Possible access	Possible access	Possible access	Possible access
WTO (e.g. Morocco)	Possible access	Possible access	Possible access	Possible access	Possible access

Source: Bruegel.

CHAPTER 3. PARTICIPATION IN REGULATORY BODIES

KEY FINDINGS

- Regulatory bodies such as ACER, CEER, ENTSO-E and ENTSOG, play an important role in the functioning of the EU internal energy market (IEM).
- The UK withdrawal will have no substantive impact on the voting shares and the functioning of these bodies.
- However, in this field the withdrawal is likely to have a negative impact on the UK. Should the UK seek to continue its participation in the IEM, it will have to comply with decisions taken by these regulatory bodies, while having little or no influence over them.

The EU internal energy market (IEM) is shaped by major legislative packages, such as the 'Third Energy Package' which was adopted in 2009 by the European Institutions. However, an important role in the implementation of this legislation is played by the following regulatory bodies:

- The Agency for the Cooperation of Energy Regulators (ACER);
- The Council of European Energy Regulators (CEER);
- The European Network of Transmission System Operators for Electricity (ENTSO-E);
- The European Network of Transmission System Operators for Gas (ENTSOG).

The aim of this chapter is to assess the eventual implications of the UK withdrawal on these regulatory bodies. To this end, two levels of analysis are presented for each institution: i) a review of its mandate, key activities and membership composition; ii) an insight on the role played by the UK in it.

3.1 The Agency for the Cooperation of Energy Regulators (ACER)

ACER was established in 2009 in the framework of the 'Third Energy Package', with the mandate of complementing and coordinating the work of national energy regulators at EU level, and to work towards the completion of the IEM. In particular, ACER is responsible for the coordination of regional and cross-regional actives that promote European market integration. ACER also oversees the monitoring of the European transmission system operators and of their network plans.[67]

In 2016, ACER completed the implementation of the Regulation on Wholesale Energy Market Integrity and Transparency (REMIT). Since then, it has a full picture on the trading in wholesale energy products across the EU. This information allows ACER to monitor wholesale energy markets to detect and deter market abusive behaviour.[68]

ACER's membership is composed of the national energy regulatory authorities of EU Member States. Participation of a third country in ACER is possible, but only if that country has concluded agreements with the EU and if it has adopted, and is applying, EU law in the field of energy and, if relevant, in the fields of environment and competition. This participation would not, however, involve any voting rights. Voting rights are attributed

[67] ACER (n.d.).
[68] ACER (2016).

only to the members. When creating an individual cooperation agreement with a third country, ACER must specify the nature, scope and procedural aspects of the involvement of the country in the work of the Agency, including provisions relating to financial contributions and to staff.[69]

Articles 13 and 14 of the ACER Regulation limit membership to ACER's formal bodies, i.e. the Board of Regulators (BoR) and the Administrative Board (AB), to representatives from EU Member States. Article 31, however, also opens the possibility for participation of third countries in ACER, provided that:

1. The third country has concluded an agreement with the Union (Article 31(1));
2. The third country has adopted and is applying Union law in the field of energy and, if relevant, in the fields of environment and competition (Article 31(1)); and
3. An institutional framework has been set up in the agreement referred to under (1) to specify, in particular, the nature, scope and procedural aspects of the involvement of the third country including provisions relating to financial contribution and to staff (Article 31(2)).

The Commission by letter of 25 March 2015 clarified that the Energy Community Treaty is to be considered an 'agreement' as referred to in Article 31(1); and that the assessment of a third country's compliance with the second requirement of Article 31(1) is to be carried out by the Commission with the support of the Secretariat being welcomed.

The Commission, however, in the same communication also underlined that the above requirements are only relevant for a third country's participation in the BoR and AB, whereas the criteria for and acceptance of their involvement in ACER Working Groups remain at the discretion of the Director of ACER. The Director of ACER, by letters of 26 November 2014[70] and 24 July 2015[71], expressed his intention to allow participation of National Regulatory Authorities (NRAs) from third countries "*as long as their countries are assessed as being on track in meeting the requirements of Article 31 and there being an expectation that this will be achieved within a reasonable period of time (6 to 12 months)*".

An outline of ACER's governance is presented in Table 14.

[69] Regulation (EC) No 713/2009.

[70] Ref. ACER-AP-FG-ss-2014-647.

[71] Ref. ACER-AP-FG-ss-2015-390.

Table 14: Outline of ACER's governance

	FULL MEMBER	ASSOCIATE MEMBER	OBSERVER MEMBER
Admission criteria:	Energy NRAs from all EU countries.	In general, not open to non-EU members; cooperation possible via individual contracts	
Attendance and Voting:	1 vote per member	No voting rights foreseen.	
Members:	28 NRAs from EU28	-	
	Decision Rule	**Voting power of UK**	
Voting system:	2/3 majority	1 vote out of 28, or 3.6 percent	

Source: Bruegel based on Regulation (EC) No 713/2009.

As UK is an EU Member State, UK's energy regulator Ofgem (Office of Gas and Electricity Markets) is currently a full member of ACER. Therefore, it participates as a member to ACER's Board of Regulators, the body which determines the regulatory policy of ACER and which has a substantial influence on the decisions, opinions and recommendations of the Agency. In terms of voting system, each member of the Board has one vote, and decisions are taken by a 2/3 majority. Hence, each member has a voting power corresponding to 1/28, or 3.6 percent of the total.

Furthermore, considering the structure of this governance, a UK withdrawal is not likely to have a noteworthy negative impact on ACER (except to the extent that the UK's contributions to dialogue will be missed). On the contrary, should the UK seek to continue its participation in the IEM, it would have to comply with decisions taken by ACER, despite having no influence over them. Indeed, even if the UK were to remain associated with ACER as a third country, it would presumably have no voting rights. Since ACER has not yet signed any association agreement with a third country, it is highly uncertain how a possible future relation between ACER and the UK might look like.

3.2 The Council of European Energy Regulators

In contrast to ACER, which is an EU body with a legal mandate, CEER is a private association of European regulators. As such, it strives to promote the interests of the national regulatory agencies (which, for example, includes highlighting issues of subsidiarity against the desire of the European Commission to harmonise rules). CEER currently consists of 36 national regulatory authorities (NRAs) having two different statuses: Members and Observers.[72]

All NRAs of the EU and of the European Economic Area (EEA) are eligible to become Members of CEER if they comply with the EU directives and regulations relevant to the IEM.

National regulatory authorities of members of the European Free Trade Association (EFTA)[73] and of EU accession countries are eligible to participate in CEER's work as Observers. As such, they are required to strive to comply with the EU directives and regulations relevant to the IEM.[74]

Currently, CEER has 29 members (EU-28 minus Slovakia, plus Norway and Iceland) and 7 Observers (Bosnia And Herzegovina, FYROM, Georgia, Kosovo, Moldova, Montenegro, and Switzerland).[75] Observers can participate in the meetings of the General Assembly but do not have any voting rights. The General Assembly decides about accession to CEER (members and observers).[76]

An outline of CEER's governance is presented in Table 15.

[72] CEER (2015).
[73] With the exception of Switzerland, they are already voting members by virtue of their membership in the EEA.
[74] CEER (2015).
[75] CEER (n.d.).
[76] CEER (2015).

Table 15: Outline of CEER's governance

	FULL MEMBER	ASSOCIATE MEMBER	OBSERVER MEMBER
Admission criteria:	Energy NRAs of EU and European Economic Area (EEA) countries	Energy NRAs from EFTA and EU accession countries	
Attendance and Voting:	Weighted votes*	Participation in meetings allowed; no voting rights	
Members:	NRAs from EU-28 minus Slovakia plus Norway, Iceland, and Liechtenstein	NRAs from Bosnia and Herzegovina, FYROM, Georgia, Kosovo, Moldova, Montenegro, Switzerland	
	Decision Rule	**Voting power of the UK**	
Voting system:	2/3 majority	29 votes out of 360, or 8.1 percent	

Source: Bruegel based on CEER (2015).
Note: * Members' votes will be weighted in accordance with the voting principles of the Council of the European Union as foreseen in Article 205 (2) EC-Treaty.

In case the UK will leave the EU without a treaty and is unable to join the EEA, UK's NRA (Ofgem) will not be allowed to be member of CEER, even if UK complies with the rules of the IEM. It could remain as a member, if UK joins the EEA and remains compliant with the rules of the IEM. UK's Ofgem could join CEER as Observer, if the UK joins EFTA or if the UK would be an accession candidate for the EU (which is currently very unlikely).

In any case, the UK withdrawal is likely to have no major adverse impact on CEER and its activities.

3.3 ENTSO-E and ENTSOG

ENTSO-E and ENTSOG play an important role in the functioning of the IEM. The EU gave to these institutions the mandate to organise the operation of the EU electricity and gas infrastructure and market.[77]

On infrastructure, the two institutions organise the work on the Ten-Year Network Development Plans (TYNDP) for electricity and gas, which serve not only as the basis for determining the European Commission's PCIs, but also for the coordination of networks and generation planning across borders.[78]

On market functioning, the two institutions are responsible for the development of network codes, i.e. the rules that govern all cross-border electricity and gas market transactions

[77] For details, see Regulation (EC) 714/2009 (for ENTSO-E) and Regulation (EC) 715/2009 (for ENTSOG).
[78] ENTSO-E (n.d.-a).

and system operations. Based on framework guidelines developed by ACER, ENTSO-E and ENTSOG draft a series of complex network codes which become (after a policy process involving ACER, the European Commission and the Member States) directly applicable legislation across the EU. Hence, these network codes deeply influence the organisation of national energy systems.[79]

The governance of both ENTSO-E and ENTSOG is composed of a General Assembly and committees and legal and regulatory working groups. Decisions are taken by the General Assembly, whereas the proposals are prepared in the committees as well as in the working groups.

Although ENTSO-E's and ENTSOG's governance structures are different, they share some common features. The governance of ENTSO-E and ENTSOG foresees three different kinds of members: i) Members; ii) Associate members; iii) Observers.

Members have the right to attend and vote in all bodies (General Assembly, committees, groups). In ENTSO-E, both EU and non-EU TSOs can become members. 43 TSOs from 36 countries are indeed currently members of ENTSO-E, including TSOs from Albania, Bosnia and Herzegovina, Iceland, Switzerland, Montenegro, FYR of Macedonia, Norway and Serbia.[80] However, a non-EU TSO can be member only if its country has entered into an agreement with the EU governing its relationship with the IEM.[81] ENTSOG currently has 45 TSOs as members, from 24 EU countries. TSOs from non-EU countries can only participate in ENTSOG as Observers.[82]

Associate members can attend all bodies, but do not have a right to vote. In ENTSO-E to become an associate member, the candidate TSO should show its concrete intention to comply with the relevant technical and market rules for the IEM. In ENTSOG, associate members are TSOs from EU Member States that derogate from the IEM rules.[83]

Observers have very limited rights. Neither in ENTSO-E nor ENTSOG observer member can vote and even attendance rights are very limited. In ENTSOG, observer members can only attend the general assembly. In ENTSO-E, an observer member cannot attend any meeting by default but they may be provided with information and publications of working groups to which it was invited to name a representative.

Both ENTSO-E and ENTSOG have a voting system in which the vote of each member is split in two parts. For the first part, every country has one vote ('one country, one vote' principle). For the second part, the size of the country (based on the population) matters how many votes the corresponding member has.[84] [85] To adopt a decision, members have a voting power based both on their relative size within the country (due to the 'one country, one vote' principle broken down among several TSOs) and on the relative size of their country (based on the population of the country).

---

[79] ENTSO-E (n.d.-b).

[80] ENTSO-E (n.d.-c).

[81] Article 7 of ENTSO-E's Articles of Association (ENTSO-E, 2014).

[82] ENTSOG (2014).

[83] ENTSOG has created the Associate Member statues so that the TSOs of Estonia and Latvia can work with ENTSOG although the country is derogating from the Third Energy Package (ENTSOG, n.d.).

[84] If a country is represented by more than one TSO, the first and the second part of the vote is split between the TSOs based on their relative size in that country.

[85] The voting system is inspired by the voting system of the European Council.

In the case of ENTSO-E, if the UK continues to be a member, the UK might keep its voting rights unchanged, as the internal regulations clarify that '[f]or countries that are not EU Member States, the voting power shall be defined according to the same mechanism (as if these countries were EU Member States)'[86].

A detailed outline of ENTSO-E and ENTSOG governance is presented in Table 16.

Table 16: Outline of ENTSO-E and ENTSOG governance

	FULL MEMBER	ASSOCIATE MEMBER	OBSERVER MEMBER
ENTSO-E			
Admission criteria:	Full compliance with IEM rules necessary	Intention to comply with IEM rules. Full unbundling required.	Full unbundling; physical link to EU country.
	EU Member State or from a country that has entered into an agreement with EU governing its relationship with the IEM	Physical link to the IEM and relevant to IEM	Physical link to the IEM
Attendance and Voting	Weighted votes*	Full attendance rights; no voting.	No attendance rights; no voting.
Members:	43 TSOs (EU28 except Malta plus 8 third countries) **	-	TEIAS (Turkey)
ENTSOG			
Admission criteria:	Full compliance with IEM rules.	TSOs from a EU Member State that derogates from the IEM rules.	
	EU Membership not required	EU Membership not required	EU accession country, Energy community, EFTA
Voting and attendance:	Weighted votes*	Can attend the General Assembly and Working Groups to the extend granted by the Board; no voting rights.	Can attend General Assembly; no voting rights.
Members:	45 TSOs (EU28 except Estonia and Latvia)	Elering AS (Estonia) Conexus Baltic Grid (Latvia)	GA-MA AD (FYROM) Gassco AS (Norway) Swissgas AS

[86] Article 15.6 of ENTSO-E Articles of Association (ENTSO-E, 2014).

			(Switzerland) Ukrtransgaz (Ukraine) Modlovatransgaz (Moldova)
	Decision Rule	**Voting power of the UK**	
ENTSO-E		*1. Part*	*2. Part*
Voting system:	Depending on the vote; at least 55 /65 percent majority	12 votes out of 432, or 2.77 percent	~10.5 percent *Population based; maximum of 35 percent*
ENTSOG		*1. Part*	*2. Part*
Voting system:	Depending on the vote; at least 60/60 percent majority	1 vote of 26, or 3.85 percent	Not entirely disclosed *Population based, maximum of 10 percent; remaining votes distributed based on cross-border significance*

Source: Bruegel based on ENTSO-E (2014) and ENTSOG (2014).
Note: * Voting power is (roughly) proportionate to the number of votes that that country has as a EU Member State in the Council of the European Union under the voting mechanism defined by the Lisbon Treaty.
** Albania, Bosnia and Herzegovina, FYR of Macedonia, Iceland, Montenegro, Norway, Serbia, Switzerland.

The UK's electricity TSOs (i.e. National Grid Electricity Transmission plc, SONI, SHETL SP, Transmission Ltd) are currently members of ENTSO-E, just as the UK's gas TSOs (i.e. GNI, Interconnector Limited, National Grid, Premier Transmission Limited) are members of ENTSOG.

After the withdrawal, the UK's electricity TSOs could remain members of ENTSO-E, but only if the UK enters into an agreement with the EU governing its relationship with the IEM. Given the important role of ENTSO-E for the functioning of the EU electricity market, the UK's electricity TSOs have a strong interest in maintaining their membership. Likewise, UK's gas TSOs have an interest in remaining part of ENTSOG even if only as Observers. Currently, only EU Member States are members/associates of ENTSOG which would imply that UK's TSOs will no longer be able to have an important role in ENTSOG. However, the Articles of Association of ENTSOG do not state that only TSOs from EU countries can become members or associated members. Hence, it has to be seen if UK can strike a deal so that its gas TSOs can stay as members. Another option would be the observer status if UK decides to remain in the Energy Community or join EFTA.

In case UK's TSO continue to participate to the IEM without being part of ENTSO-E and ENTSOG, they will have to comply with decisions taken by these institutions, albeit having no influence over them.

From an EU27 perspective, the UK withdrawal is not likely to have a noteworthy negative impact on ENTSO-E and ENTSOG as these institutions could simply continue their activities on a business-as-usual basis without the participation of UK's TSOs. Yet internally, the departure of UK's TSOs will change the voting shares of the remaining TSOs. TSOs of the already population-rich member states would gain more voting shares in absolute terms.

3.4 Critical issues and options

From an EU27 perspective, there seem to be no critical issues emerging from the UK withdrawal as far as these regulatory bodies are concerned. By contrast, the UK is likely to face a series of critical issues if it withdraws from these regulatory bodies (or is otherwise unable to continue to participate). In fact, any non-EU Member States that is part of the EU IEM must, by default, accept the decisions of ACER, ENTSO-E and ENTSOG, but holds very limited powers to influence them. However, the high level of expertise of UK representatives in those bodies will be missed, if they have to leave.

Table 17: How can countries participate in EU regulatory bodies under different arrangements?

	ACER	CEER	ENTSO-E	ENTSOG
EU Member State (e.g. France)	Membership possible	Membership possible	Membership possible	Membership possible
EEA (e.g. Norway)	Associate member theoretically possible, but agreement with EU necessary*	Membership possible	Membership possible, but agreement with EU necessary	Membership possible, but agreement with EU necessary*
Energy Community (e.g. Ukraine)	Associate member theoretically possible, but agreement with EU necessary*	Associate membership possible**	Membership possible, but agreement with EU necessary	Membership possible, but agreement with EU necessary*
Bilateral Treaty (e.g. Switzerland)	Associate member theoretically possible, but agreement with EU necessary*	Associate membership possible**	Membership possible, but agreement with EU necessary	Membership possible, but agreement with EU necessary*
WTO (e.g. Morocco)	Associate member theoretically possible, but agreement with EU necessary*	Associate membership possible**	Membership possible, but agreement with EU necessary	Membership possible, but agreement with EU necessary*

Source: Bruegel.
Note: * No such agreement has ever been adopted by the EU with any country; ** Under current rules, this would appear to be realistically possible only if the UK were to re-join the EFTA.

CHAPTER 4. REVISITING EU ENERGY AND CLIMATE TARGETS

KEY FINDINGS

- If the UK accepts that it will continue to adhere to EU energy and climate targets (so as to retain access to the internal market), it could possibly be required to participate in the new Energy Union governance structure.
- If the UK cannot commit to EU energy and climate targets, a political decision in the EU is needed on how to adjust the EU energy and climate targets after Brexit.
- We explore three options for readjusting the national and/or EU targets which either keep (1) the national ambitions, (2) the EU28 ambition in absolute terms, or (3) the EU28 ambition in percentage terms constant. Given that the UK targets were close to the EU average, the resulting shifts are not dramatic – but can be still significant for individual Member States.
- If the UK exits the EU Emissions Trading System (ETS) it might cause a short-term surplus of allowances, but most likely Brexit will tighten the system in the longer term.

4.1 The EU energy and climate targets after Brexit

Over the past decades, the EU has developed a comprehensive framework to reduce the environmental impact of the energy system by regulating the emission of greenhouse gases and pollutants, as well as by promoting energy efficiency and the roll-out of renewable energy sources. The UK has been a front-runner on some of these aspects, but the UK withdrawal might allow policy-makers in Westminster to withdraw from some commitments in the hope that this would improve the competitiveness of UK businesses.

Under EU law, the UK is bound by the so-called 2020-targets that require the UK to achieve a 15 percent share of renewables in the energy mix and a 16 percent reduction of those greenhouse gas emissions not covered by the EU emissions trading system (ETS) compared to 2005 levels. Furthermore, 2030 targets were agreed upon by the European Council in October 2014, and they were the basis for the EU's Nationally Determined Contribution for the Paris Agreement. To ensure the EU27 meets its targets, the EU27 would either have to adapt its own ambition (by taking out the contribution of the UK) or readjust the individual Member States' targets. Hence, Brexit may have important consequences for the EU's climate targets. This section explores various scenarios regarding the impact of the UK's exit on the targets for renewable energy and non-ETS emissions.

4.1.1. Impact on the Renewable Energy Share targets

The Renewable Energy Directive[87] stipulates the EU's target of deriving 20 percent of its gross final energy consumption from renewable energy sources (RES) by 2020. The target is broken down to specific targets for individual Member States. The national targets range

[87] Directive (EU) 2009/28 of the European Parliament and of the Council.

from 10 percent for Malta to 49 percent for Sweden.[88] The UK has agreed to increase its share from 1.3 percent in 2005 to 15 percent in 2020. Furthermore, the EU recently proposed a target of deriving 27 percent of its energy from renewable sources by 2030 in a revised Renewable Energy Directive.[89] The revised Directive does not break down the RES shares to individual Member States targets.

Brexit may impact the overall and national RES targets. The following explores three possible scenarios for the 2020 targets if the UK left the EU. The scenario analysis applies the methodology used in an Impact Assessment[90] Report by the European Commission. The report calculates similar targets to those stipulated in the Renewable Energy Directive, which suggests that its methodology is suitable to replicate. For a detailed overview of the methodology and calculations used to conduct the scenario analysis, please see the appendix. The change in the overall EU and national targets for each scenario are shown in Table 18.

Scenario 1 – Same national targets.

In this scenario, the national targets (of the individual Member States) remain unchanged. This would increase the EU's overall RES target by 0.63 percentage points (i.e. from 20 percent to 20.63 percent). The increase in the overall EU target reflects the relatively low RES target of the UK. Omitting the UK thus increases the EU average.

Scenario 2 - Same overall EU target in absolute terms.

The existing EU target of achieving a RES of 20 percent implies that the amount of renewable energy in the EU would be expected to equal 256.2 million tonnes of oil equivalent (mtoe)[91] in 2020. If the UK left the EU, the EU27 may want to achieve the same level of renewable energy in absolute terms (i.e. 256.2 mtoe in 2020). With the UK departure, 11.73 mtoe[92] of renewable energy would thus need to be distributed[93] across the remaining Member States. The national targets would consequently increase for most Member States. Furthermore, the overall target for the EU would increase to 22 percent.

Scenario 3 - Same overall EU target in percentage terms.

As a third scenario, the EU may want to achieve the same RES target in percentage terms (20 percent) without the UK. If the current national targets are retained, the share of renewable energy in 2020 of the EU27 would exceed the target of 20 percent. Thus, the targets could consequently decrease for some Member States to reflect an EU average of 20 percent.[94]

---

88 The national targets are listed in Directive (EU) 2009/28 of the European Parliament and of the Council.

89 Proposal for a Directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources (recast) (COM/2016/0767 final).

90 European Commission (2008).

91 This figure includes Croatia. See the appendix for an explanation of how the targeted volume of Croatia's renewable energy in 2020 was calculated.

92 This corresponds to the amount of renewable energy the UK still has to add as of 2015 until 2020 in order to meet its target.

93 See the appendix for a detailed explanation of how the distribution was carried out.

94 See the appendix for a more detailed explanation of how the targets were calculated.

Table 18: The change in the current RES targets for 2020 in various scenarios following a UK departure from the EU

COUNTRY	Scenario 1 – Same national targets	Scenario 2 - Same overall EU target in absolute terms	Scenario 3 - Same overall EU target in percentage terms
	Change in percentage points relative to the current targets		
Belgium	0	1	0
Bulgaria	0	0	0
Czech Republic	0	0	-1
Denmark	0	2	-1
Germany	0	2	0
Estonia	0	0	-1
Ireland	0	2	-1
Greece	0	1	0
Spain	0	0	-1
France	0	1	-1
Croatia	0	0	0
Italy	0	1	-1
Cyprus	0	2	0
Latvia	0	0	0
Lithuania	0	1	0
Luxembourg	0	1	-1
Hungary	0	0	-1
Malta	0	1	-1
Netherlands	0	2	0
Austria	0	2	0
Poland	0	1	0
Portugal	0	0	-1
Romania	0	0	-1
Slovenia	0	0	-1
Slovakia	0	1	0
Finland	0	1	0
Sweden	0	2	0
EU27	0.63	2	0

Source: Bruegel based on data from European Commission (2008a), Eurostat (2017b) and EEA (2017a).
Note: In line with the methodology in the Impact Assessment which was used to conduct the scenario analysis for the RES targets, the new targets (i.e. ex-post Brexit) were rounded at the end. Subtracting the original targets (which are integers) from the new targets therefore gave integers, as shown in the table. Please see the annex for a more detailed explanation of the methodology used to calculate the targets.

4.1.2 Impact on non-ETS emissions targets

By 2020, the EU aims to reduce the emissions not covered by the EU Emissions Trading System (ETS)[95] by 10 percent relative to the 2005 levels.[96] By 2030, the reduction target is set to 30 percent compared to 2005 levels.[97] The EU overall targets (for 2020 and 2030) are broken down to national targets. The UK plans to reduce its non-ETS emissions by 16 percent by 2020 and by 37 percent by 2030, compared to its baseline emissions level of 414.71 million tonnes of CO2 equivalent (mtCO2e) in 2005.[98] The emissions level in 2015 of the UK was 328.65 mtCO2e, implying that the UK has already achieved its 2020 target.[99] The following scenario analysis will focus on the impact of the UK's departure on the 2030 national and overall EU27 targets.

The same three scenarios as in the previous RES section are used to conduct the analysis. The methodology differs, however, and is described in the appendix. The change in the emissions reduction targets in each scenario are depicted in Table 19.

Scenario 1 – Same national targets.

If the individual targets of the Member States are preserved, the departure of the UK implies that the EU's overall level of ambition will decrease. This is because the UK aimed to reduce greenhouse gas emissions by more than the EU28 average.

Scenario 2 - Same overall EU target in absolute terms.

If the EU wants to reduce its overall emissions by the same amount in absolute terms, the reduction targets for all the Member States (besides Bulgaria[100]) would increase. The EU28 currently aims to reduce emissions from 2,848 mtCO2e in 2005 to 1,994 mtCO2e[101] by 2030. Arriving at the same level of emissions in 2030 (1,994 mtCO2e) would imply an increase in the majority of national targets, as the UK reduction amount[102] would have to be distributed[103]. The overall target for the EU would increase to 31.66 percent.

Scenario 3 - Same overall EU target in percentage terms.

The EU may seek to retain its 2030 target of reducing overall emissions by 30 percent. In this case, the EU will have to increase its overall reduction amount by 27.02 mtCO2e.[104] This would imply an increase in all of the national reduction targets apart from Bulgaria's.

---

[95] See section 4.3 for a discussion of the impact of Brexit on the EU ETS.

[96] European Commission (n.d.-j).

[97] European Commission (n.d.-k).

[98] Eurostat (2017b).

[99] As the UK's 2020 target is to reduce emissions by 16 percent compared to 2005 level, the targeted 2020 level of emissions is 348.36 mtCO2e.

[100] Bulgaria's 2030 target is to reduce emissions by zero percent compared to 2005, which explains why its target does not change.

[101] This amount was calculated by multiplying the 30 percent reduction target with the baseline emissions of 2,848 mtCO2e.

[102] The UK's reduction amount corresponds to the difference between the level of emissions in 2015 (328.65 mtCO2e) and the targeted level in 2030 (261.27 mtCO2e), which corresponds to 67.38 mtCO2e.

[103] See the appendix for a detailed explanation of how the distribution was carried out.

[104] See the appendix for a detailed explanation of how this amount was calculated.

Table 19: The change in the current 2030 non-ETS emissions reduction targets in various scenarios following a UK departure from the EU

COUNTRY	Scenario 1 – Same national targets	Scenario 2 - Same overall EU target in absolute terms	Scenario 3 - Same overall EU target in percentage terms
	Change in percentage points relative to the current targets		
Belgium	0	3.35	1.34
Bulgaria	0	0.00	0.00
Czech Republic	0	1.34	0.54
Denmark	0	3.74	1.50
Germany	0	3.64	1.46
Estonia	0	1.25	0.50
Ireland	0	2.88	1.15
Greece	0	1.53	0.61
Spain	0	2.49	1.00
France	0	3.55	1.42
Croatia	0	0.67	0.27
Italy	0	3.16	1.27
Cyprus	0	2.30	0.92
Latvia	0	0.58	0.23
Lithuania	0	0.86	0.35
Luxembourg	0	3.83	1.54
Hungary	0	0.67	0.27
Malta	0	1.82	0.73
Netherlands	0	3.45	1.38
Austria	0	3.45	1.38
Poland	0	0.67	0.27
Portugal	0	1.63	0.65
Romania	0	0.19	0.08
Slovenia	0	1.44	0.58
Slovakia	0	1.15	0.46
Finland	0	3.74	1.50
Sweden	0	3.83	1.54
EU27	-1.19	1.66	0.00

Source: Bruegel based on Eurostat (2017c) and European Commission (n.d.-p).

Whether a readjustment of the 2020 RES and 2030 non-ETS targets to take account of Brexit will tighten or loosen EU policy will depend on the chosen approach. To protect the

confidence of all actors on what has been agreed it might be most straightforward to keep the national RES and non-ETS targets (i.e., scenario 1) as they are, and try to convince the UK to do the same.

4.2 Non-EU Members in the new energy union governance structure

On 30 November 2016, the Commission published a proposal[105] that integrates and replaces the existing Monitoring Mechanism Regulation. It requires Member States to adopt National Energy and Climate Plans (NECPs). NECPs will replace existing separate plans for renewables and efficiency and help streamline related obligations for planning and reporting. Monitoring progress will take place under a new annual cycle in the framework of the Energy Union, which is similar to the European Semester. The proposal puts forward requirements for the content of the plans, including a detailed and binding template for Member States to use. Importantly, it also contains the process for adopting and monitoring national energy objectives on renewable energy deployment and energy efficiency, as Member State contributions to EU level binding targets in these areas.[106] To date it is not clear how associate countries (such as EEA or Energy Community), that also have energy efficiency and RES targets for 2030, would have to participate in the NECPs, but it seems straightforward to assume that they might have to follow a similar procedure. If the UK were to seek some sort of an associate status, it is very conceivable that it will have to commit to energy efficiency and RES targets for 2030 as well.

The proposed governance structure would oblige Member States to enter into some form of regional co-operation - specifically consulting the draft NECPs with neighbouring Member States, but also in terms of implementation. According to the Commission's proposal, this cooperation-requirement only extends to Member States and is largely facultative. But especially on RES policy both the neighbouring Member States and the UK might benefit from a coordinated approach – especially if the UK choses to maintain targets that are in line with EU objectives.

4.3 Impact of the UK leaving the EU emission trading system

The UK is a member of the EU Emission Trading System (ETS) that establishes a common carbon price in the EU. An exit of the UK from this system would have substantial repercussions on the demand and supply of allowances in this system. The implications could be significant, as there is a substantial overhang of two billion emission allowances (currently worth some EUR 10 billion) owned by different entities.

Established in 2005, the EU ETS is the EU's carbon market. The ETS covers around 11,000 industrial installations and power plants in the 28 EU Member States as well as Iceland, Lichtenstein and Norway.[107, 108] The participants in the system are required to surrender an allowance for every tonne of carbon dioxide or an equivalent amount of other greenhouse gases emitted. Allowances are distributed in auctions and in certain cases are provided free. A 'cap', or limit, is placed on the total number of allowances issued each year. The cap is reduced each year. The ETS is currently in its third trading phase (2013-2020), and is

[105] Proposal for a Regulation of the European Parliament and of the Council on the Governance of the Energy Union (COM (2016) 759).

[106] Introduction borrowed from Duwe et al. (2017).

[107] European Commission (2016c).

[108] A separate ETS exists also for the aviation sector in these countries.

larger in scope compared to the first phase (2005-2007) and second phase (2008-2012). A fourth phase is scheduled for 2021-2030.

On 29 March 2019, the UK may potentially leave the EU emissions trading system (ETS). This section explores the implications of such a departure on the overall ETS market. Three possible impacts are discussed. *Firstly*, the departure may lead to an adjustment of the overall level of the ETS cap. This may affect the supply and price of allowances particularly in the fourth phase. *Secondly*, we consider the impact of a UK exit on the short-term supply and price of allowances. *Finally*, the distribution of allowances may change. These potential impacts are elaborated on below.

4.3.1 The potential impact on the emissions cap

The EU has established two emissions reduction targets. The first, set during the second phase of the ETS, is to reduce the emissions covered by the ETS by 21 percent by 2020 compared to 2005.[109] Because the reduction in emissions will exceed the target, the emissions cap for 2020 was revised during the third phase of the ETS.[110] Throughout the third phase, emissions will be reduced annually by 1.74 percent of the average total quantity of allowances issued between 2008 and 2012.[111] The cap was set at around 1,816 mtCO2e for 2020.[112] This corresponds to a 2020 reduction target of around 23.5 percent[113] relative to 2005 levels. The second target is to reduce overall emissions by 43 percent by 2030 compared to 2005.[114]

In the event of a UK departure, the EU would likely change the level of the ETS cap. Though the EU is technically not obliged to do so, leaving the cap unchanged would imply an increase in the surplus of allowances and a decrease in the price. A reasonable assumption is that the cap would be adjusted such that the emissions reduction targets for 2020 and 2030 are retained. In order to model the impact of a potential UK departure on the cap, we borrow the following methodology from a recent report by Sandbag[115].

- The 2005 baseline emissions[116] for the EU28[117], EEA and the UK are first adjusted to reflect the current scope of the ETS[118].
- The 2005 baseline emissions for the EU27 are thereafter calculated by subtracting the 2005 baseline emissions (according to the current scope) for the UK from the EU28.

[109] European Union (2015a).

[110] Sandbag (2017).

[111] Report from the Commission to the European Parliament and the Council - Report on the functioning of the European Carbon Market (COM (2017) 48 Final).

[112] Report from the Commission to the European Parliament and the Council - Report on the functioning of the European Carbon Market (COM (2017) 48 Final).

[113] The original 2020 reduction target was 21 percent and was set under the second phase scope of the ETS. The scope was extended in Phase 3 though. The actual 2020 cap is 1,816 mtCO2e which would translate into a reduction target of around 23.46 percent, which can be rounded to 23.5 percent, compared to the 2005 baseline.

[114] European Commission (n.d.-l).

[115] Sandbag (2017).

[116] The emissions data are acquired from EEA (2017b).

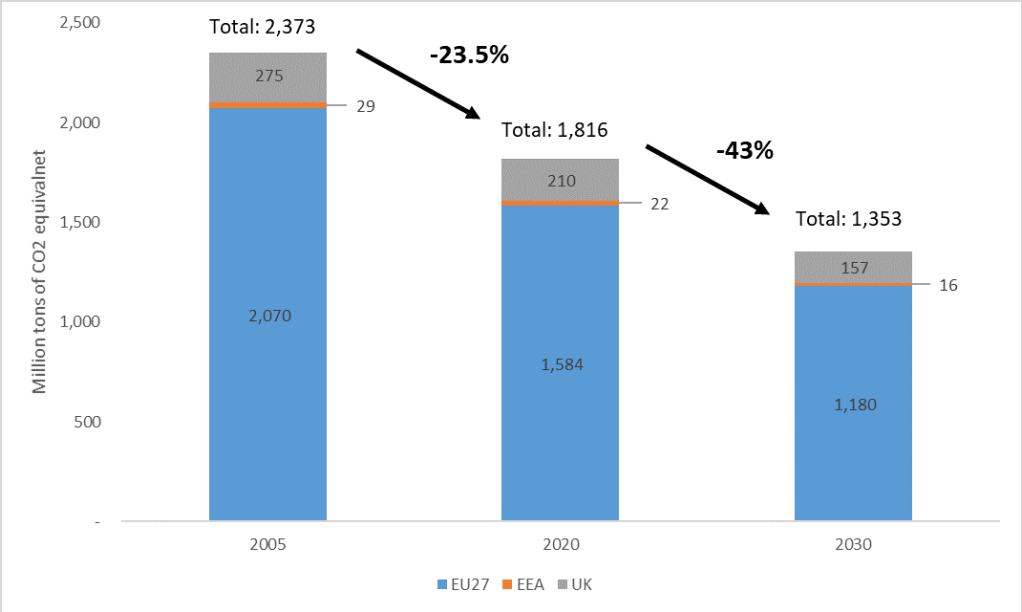
[117] Including Croatia.

[118] The current scope covers more emissions, and is therefore larger than in 2005.

- The caps for the EU27 in 2020 and 2030 are finally calculated by multiplying the 2005 baseline emissions for the EU27 with the current 2020 and 2030 percentage emissions reduction targets (23.5 and 43 percent respectively).

Figure 6 illustrates the results. The emissions in 2005 equalled 2,070 mtCO2e for the EU27. The cap for the EU27 would therefore be 1,584 mtCO2e in 2020 and 1,180 mtCO2e in 2030. By definition, the caps for 2020 and 2030 represent the same percentage reductions as for the EU28.

Figure 6: The cap with and without the UK if the overall emissions reduction targets are maintained



Source: Figure replicated and updated by Bruegel from Sandbag (2017). Data obtained from EEA (2017b).
Note: The scope of the ETS in 2005 is adjusted to reflect the scope in the third phase.
The numbers in the figure have been rounded, and may therefore not always sum up perfectly.

Whether the cap tightens due to the UK's departure depends on the change in the cumulative allowances relative to cumulative emissions. The reduction in allowances is determined by the cap. As Figure 6 shows, the cap in 2020 would have to decrease by 210 mtCO2e until 2020 and by an additional 157 mtCO2e until 2030 if the UK left the ETS and the overall emissions reduction targets were retained.[119] Emissions, however, are expected to decrease by *less*. This is because the UK is expected to feature an above-proportionate reduction in emissions compared to other EU Member States, i.e., it was expected to shoulder a larger reduction burden. Hence, without the UK, the overall cap would tighten by an estimated 745 mtCO2e between 2021 and 2030 according to the Sandbag report. However, due to the Market Stability Reserve (MSR) - that only absorbs excess allowances

[119] These amounts correspond to the reduction in the cap required to maintain the overall 2020 and 2030 emissions reduction targets. They are different from the number of allowances actually allocated to the UK which is much smaller. Indeed, the UK has been allocated fewer allowances than what it would have received if the number of allocated allowances had been proportional to the country's share of baseline emissions in 2005.

if the system is not too tight – the actual tightening may be significantly less.[120] The Sandbag report estimates the net tightening (after the MSR) due to Brexit to equal only around 230 mtCO2e by the end of the fourth phase. According to the report, a modest price increase of ten percent on average across the fourth phase is anticipated, relative to the scenario in which the UK remains in the ETS.

4.3.2 The potential impact of a UK departure in the short-term

In the period leading up to a UK departure, UK companies may attempt to offload allowances that they might not need after Brexit (and which might potentially even be cancelled). When these allowances enter the market[121] the price may decrease in the short term. A recent report by ICIS[122] suggests the price reduction may be larger the later the exit date is announced by the UK government and the earlier the exit takes place. If the exit date is announced late, a large share of allowances of UK utility companies, originally bought to hedge against future price risk, may expire when the UK leaves the ETS. These companies may thus be forced to offload these allowances in a short period of time. The ICIS report highlights the benefits of a long lead time (e.g. slightly more than two years) between the announcement date and the exit date, as this would give UK utilities sufficient horizon to avoid hedging their positions beyond the exit date. Moreover, a long lead time would allow UK industrials to spread the sale of any surplus allowances over a long-time period, which may help to avoid a large and sudden price decrease.

Interestingly, in spite of the anticipated initial price decrease, the ICIS report forecasts an overall increase in the price of allowances between mid-2017 and the beginning of 2019, regardless of the length of lead time between the announcement and exit date. The price increase is attributed to the MSR. Though not discussed in the ICIS report, the surplus of allowances in the ETS market may be further reduced by a proposal of the European Parliament, which seeks to nullify allowances issued by the UK after 1 January 2018.[123] The proposal was accepted in October 2017 and could help mitigate a short run increase in the supply of allowances.[124] Moreover, it could prevent allowances issued in the UK in February 2019 to be used in the EU27, as they will not be needed in the UK as of April 2019, when all installations hand in their allowances for compliance.

4.3.3 The potential impact of a UK departure on the distribution of allowances

The UK has achieved a significant reduction in its emissions covered under the ETS (see Figure 7 for the reduction to date in the third phase). This is largely due to carbon price support policies, which have increased the cost of emissions. The majority of the UK's decarbonisation has been in coal-intensive sectors, where the cost of reducing emissions is relatively low.[125] In spite of the reduction in emissions, the UK is currently a net buyer of allowances. As shown in Figure 7, the UK's emissions have exceeded allowances in all years

[120] The MSR will enter into force on 1 January 2019 and will decrease the number of allowances in the ETS if the surplus in the previous year exceeds 833m (SWD (2015) 135 final). In contrast, if the market surplus in the preceding year is below 400 million allowances, the MSR will release 100 million allowances into the ETS (Decision (EU) 2015/1814 of the European Parliament and of the Council). The annual reduction rate is expected to equal 24 percent between 2019 and 2023, and thereafter 12 percent (ICIS, 2017).

[121] Some allowances may also be placed in the MSR in order to soften the downward pressure on the price.

[122] ICIS (2017).

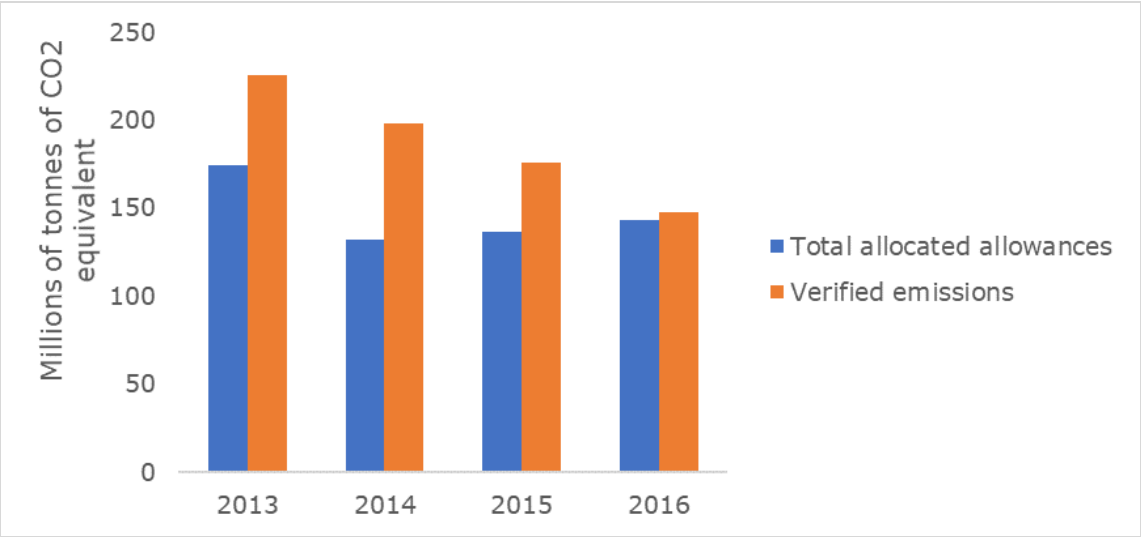
[123] IETA (2017).

[124] Reuters (2017)

[125] Sandbag (2017).

of the third trading phase. Though the gap is narrowing, the short position of the UK reflects the historically low allocation of allowances to this country. As mentioned in section 4.3.1, the UK's actual allocation is lower than the number of allowances it would have received if the allocation was based on the share of baseline emissions in 2005.

Figure 7: Total allocated allowances and verified emissions in the UK during the third phase of the EU ETS



Source: Bruegel based on data from EEA (2017b).

The short position of the UK may partly stem from a low share of auctioned allowances. Auctioning is the default method of allocating allowances, as 57 percent of allowances will be auctioned during the third phase.[126] The allocation rules for auctioned allowances are stipulated in Box 1. 88 percent of auctioned allowances are allocated based on the share of baseline emissions. The remainder, however, is distributed to less wealthy Member States. The UK therefore receives a lower amount of allowances than if the allocation were solely based on the share of baseline emissions.

However, according to the Sandbag report, UK emissions have been falling faster than the number of allowances allocated to the UK. Hence, the UK may become a net seller of allowances at some point between 2017 and 2020. This further suggests that a UK departure from the ETS may tighten the system.

[126] The remaining allowances are distributed for free. This method is primarily used for sectors characterised by carbon leaking (i.e. industries with high costs related to climate policies that would transfer production elsewhere if subjected to emission constraints). The departure of the UK from the ETS will likely have a minimal impact on the distribution of free allowances. This is because the free allowances are allocated to installations, and are therefore not based on relative proportions of Member States.

Box 1: An overview of the rules governing the auctioning of ETS allowances

EU ETS AUCTIONING RULES

During the third trading phase, the following rules determine the allocation of auctioned allowances across Member States:

- 88 percent of allowances are distributed according to the Member States' share of verified emissions from EU ETS installations in 2005 or the average in 2005-2007, whichever one is the highest;
- 10 percent is allocated to the least wealthy Member States; and
- 2 percent is allocated as a bonus to nine Member States* that by 2005 had reduced their emissions by at least 20 percent of their base year levels.

The allocation rules for the fourth trading phase are expected to be:

- 90 percent of allowances are distributed according to the Member States' share of verified emissions; and
- 10 percent is allocated to the Member States which GDP per capita did not exceed 90 percent of the EU average in 2013.

Source: Bruegel based on European Commission (n.d.-m).
Note: *These countries are Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania and Slovakia.

Box 2: The relationship between Switzerland and the EU ETS

SWITZERLAND AND THE EU ETS

Switzerland is not a member of the EU ETS, and operates its own ETS instead. The Swiss ETS covers around 10 percent of the country's GHG emissions and is considerably smaller than its EU counterpart. Moreover, prices have historically been higher in the Swiss ETS. The Swiss system has a similar design to the EU ETS. They cover the same gases and sectors, and decrease the annual amount of allocated allowances by the same rate. The methodologies of allocating free and auctioned allowances are also consistent.

In January 2016, Switzerland and the EU concluded their negotiations on linking the two systems. The agreement will enter into force once it has been ratified and signed by both parties.* Linking both systems will result in mutual recognition of EU and Swiss allowances.[127] Furthermore, Switzerland expects the linkage to result in lower costs of reducing emissions, enhanced liquidity and greater price stability. Disputes in the linked system will be referred to a Joint Committee for resolution. If the Committee is unable to settle the dispute within six months, the dispute can be referred to the Permanent Court of Arbitration. The European Court of Justice will therefore not be used as a dispute resolution mechanism.

If the UK leaves the EU ETS and implements an independent system, a similar linkage arrangement is theoretically possible. However, such a linkage may take a long time to enact and may be less efficient than if the UK remained in the EU ETS.

Given the size of the UK, a similar arrangement would imply a political question on who decides on the cap of the UK system. If the cap is restrictive, the UK would be an importer of allowances from the EU27, while a too lose cap would make the UK an exporter.

Source: Bruegel based on EEA (2017b) and ICAP (2017) and COM (2017) 427 final[128].
Note: *The agreement may be signed by the end of 2017, though it is not expected to enter into force before 2019.[129, 130]

4.4 Industrial emission rules post-Brexit

The Industrial Emissions Directive (Directive 2010/75/EU) obliges Member States to control and reduce the impact of industrial emissions on the environment. Installations are only allowed to operate with a permit that specifies the conditions for operation, and they are obliged to use the best available techniques. The permit for an installation has to take into account the entire environmental performance of the plant (i.e. an 'integrated approach'). This legislation places restrictions on the number of running hours for fossil fuel power generation plants with regard to the harmful waste gases that they emit (unless investments are made to reduce this impact), and will affect decisions on whether to invest in new plants or maintain existing facilities. Hence, a number of (coal-fired) power stations

[127] European Commission (n.d.-n).

[128] Proposal for a Council Decision on the conclusion, on behalf of the European Union, of an Agreement between the European Union and the Swiss Confederation on the Linking of their Greenhouse Gas Emissions Trading Systems (COM(2017) 427 final).

[129] European Commission (2017j).

[130] BusinessGreen (2017).

will have to close by 2023 or when they have exhausted their allocated 17,500 running hours.

The plants covered by the IED had three options:[131]

1. Opt-in to the IED and satisfy the emissions requirements as of 1 January 2016.
2. Opt-in via the Transitional National Plan (TNP) and thereby gradually adjust to the new emissions requirements. Plants will be subjected to an emissions allocation during the transitional period (between 1 January 2016 and 30 June 2020).[132] At the end of the period, plans could either opt in to the IED or limit their operating hours to 1,500 per year.
3. Opt-out from the IED, and thereby limit the running hours to 17,500 between 2016 and 2023. These plants will be forced to close when the hours are exhausted or by the end of 2023, whichever is reached first.

The UK's withdrawal could in principle allow the UK government (which expects a capacity shortfall in the coming years) to loosen the regulation on industrial emissions, making it easier for coal plants to stay online without being modernised. However, the phase-out of coal in the UK is largely driven by domestic policies and might hence not be altered by the option to renege on the IED-commitments after Brexit.

4.5 Energy efficiency

The EU energy efficiency policy prescribes on the one hand a Union-wide energy consumption reduction of 20 percent (compared to prior projections) by 2020 that is not broken down to binding targets for the individual Member States. On the other hand, it entails detailed regulation on a number of specific measures such as obliging energy distributors to reduce consumption, renovations of public buildings to make them more energy efficient, and improving access to consumption data for customers. For 2030, an energy-efficiency target of at least 27 percent has been endorsed by the European Council. As the energy efficiency target is defined as a reduction compared to a baseline we suppose that each member state is essentially asked to reduce consumption compared to the baseline by exactly the same share (e.g., 30%). Hence, Brexit would not imply a change in the national contributions to meet the EU-wide energy efficiency target.

If the UK would seek a "soft" Brexit which allows it to stay inside the internal energy market, the EU would likely require the UK to commit to contribute to the EUs energy efficiency target, in order to avoid a different treatment of UK companies. Hence, it is conceivable that the UK will have to report on its energy efficiency policies to the European Commission, which might provide guidance to the UK when it deems the UK efforts inappropriate.

By contrast, a "hard" Brexit could allow the UK government to alter its energy efficiency ambitions. Given that most energy efficiency measures have relatively limited cross-border consequences, the biggest impact of the UK withdrawal on energy efficiency could arise if the UK choses to opt out of EU wide energy efficiency standards (namely Ecodesign and Energy Labeling), as this could hamper EU-UK trade in these goods.

[131] UK Government (2015).
[132] European Commission (2016d).

4.6 Critical issues and options

Brexit will require the EU to reassess its energy and climate targets. The first option would be to consider the UK like a Member State and continue to integrate it in the Energy Union governance framework. For the EU this would avoid recalculating the targets while the UK would not need to explore new ways of committing to energy and climate policies that the EU deems compatible (in order to maintain full access to the internal market).

If the UK and the EU cannot agree on a 'business as usual' approach, the EU will have to revisit its targets. For the 2020 RES and 2030 non-ETS emissions targets, we see three options:

1. Member States keep their national targets unchanged leading to deviations of the resulting EU27 targets from the initially planned EU targets. It would imply that the EU total 2020 RES target becomes more ambitious while the EU 2030 non-ETS target becomes less ambitious.
2. Member States adjust their targets so that the EU27 achieves the EU28 targets in absolute terms, even if the UK does not deliver. This would imply that the Member States 2020 RES targets and 2030 non-ETS targets generally become more ambitious.
3. Member States adjust their targets so that the EU27 targets are the same in percentage terms as the initially planned EU28 targets. This will mean that the Member States need to do less or the same with respect to increasing the share of renewable energy, but more with respect to reducing non-ETS emissions.

The last two options will also affect the relative burden of the Member States.

Moreover, Brexit can be expected to lead to an initial increase in the surplus of allowances in the EU ETS, as installations attempt to offload their UK allowances before the exit date. In the longer term, however, the system is expected to tighten.

For the EU wide targets that are not broken down to the Member States level (i.e. the energy efficiency target and the 2030 RES target), it can be envisaged that the current targets are maintained. This would be the easiest solution from a political perspective, and likely have little impact on the energy efficiency and RES levels in the EU27.

Overall, as the UK targets are not too different from the EU average targets, the distortions will be limited.

Table 20: Possible means to coordinate a countries energy and climate targets and emission trading system with the EU's under different arrangements

	RES target	Non-ETS target	ETS membership	EE target
EU Member State (e.g. France)	Joint EU target under EU governance	National targets under EU law	Membership possible	Joint EU target under EU governance
EEA (e.g. Norway)	Joint EU target, possibly under EU governance	National target agreed with EU	Membership possible	National target possible
Energy Community (e.g. Ukraine)	National target agreed with EU	National target agreed with EU	Linking possible	National target possible
Bilateral Treaty (e.g. Switzerland)	National target, possibly coordinated with EU	National target, possibly coordinated with EU	Linking possible	National target possible
WTO (e.g. Morocco)	National target not coordinated with EU	National target not coordinated with EU	Linking possible	National target possible

Source: Bruegel.

CHAPTER 5. RULES FOR SECURITY OF ELECTRICITY AND GAS SUPPLIES

KEY FINDINGS

- Pooling energy resources among Member States is essential for the EU to build a common and truly integrated internal energy market that is able to withstand external shocks.
- Physical interconnections represent a fundamental prerequisite to enable solidarity in both electricity and gas markets.
- For electricity, the UK benefits considerably from its trade with the EU27. Imported electricity (7.5 percent of the total UK's consumption) helps the UK to keep prices down. On its side, the EU27 does not receive any substantive benefit, because its electricity exchanges with the UK remain well below 1 percent of its total consumption.
- For gas, the EU27-UK trade volume is generally rather limited. From a EU27-wide perspective, gas trade with the UK is not a relevant issue, also because, given the capacity and the underutilisation of its LNG terminals, the EU27 could manage its LNG markets even without the UK's infrastructure. However, gas trade is an important issue for Ireland, which imports 56 percent of its consumption from the UK.
- The EU27's security of electricity and gas supplies will not be affected by the UK withdrawal. It is reasonable to expect the UK's and neighbouring countries' transmission system operators to continue their long-lasting cooperation on the basis of their respective regulatory frameworks. For a discussion of the specific case of Ireland, refer to Chapter 8.

Both the Lisbon Treaty and the Energy Union strategy[133] emphasise that pooling energy resources among Member States is essential for the EU to build a common, integrated, and functional internal energy market that can withstand external shocks. With the UK withdrawal, the UK will no longer be obliged to comply with this EU solidarity principle.

To make this solidarity principle work (which to date has never been tested), the EU Security of Gas Supply Regulation[134] has recently been updated. This legislation introduces a solidarity principle (in the event of a severe gas crisis, neighbouring Member States will help out to ensure gas supply to households and essential social services), closer regional cooperation and greater transparency. As far as electricity is concerned, in 2014 the European Council called for all Member States to achieve interconnection of at least 10 percent of their installed electricity production capacity by 2020 in order to improve electricity security of supply.[135]

[133] European Commission (2016e).
[134] Regulation (EU) No 994/2010.
[135] European Council (2014).

Physical interconnections thus represent a fundamental prerequisite to enable solidarity in both electricity and gas markets. Assessing the impact of the UK withdrawal on the EU electricity and gas security thus appears to be necessary. To do so, this chapter will:

- Carry out a background analysis of the current state of interconnection capacity, gas and electricity flows between the UK and EU Member States;
- Assess the potential impact of the UK withdrawal on these interconnections and related markets; and
- Based on the above, identify the issues arising from Brexit that affect EU citizens and companies the most, and discuss options on how to address them.

5.1 Existing electricity interconnectors

Electricity interconnectors are transmission wires which allow electricity to flow between countries, enabling countries to import power at times of shortage and export at times of surplus. The UK currently has four of them, linking it to France, Ireland, The Netherlands and Northern Ireland, totalling 4 Gigawatts (GW) of capacity (Table 21 - A). This capacity is relatively small, as it represents around 5 percent of UK's total installed electricity generating capacity.

As an island, the UK is connected only through asynchronous interconnectors with the rest of the EU. Consequently, in contrast to Continental countries that have developed a joint system for allocating cross-border capacities (where flows on the German-French border affect flows on the German-Dutch border in a synchronised system), the UK interconnectors with France and the Netherlands are individually managed. As merchant interconnectors, they also do not fall under the EU regulatory regime.

Electricity interconnectors generate considerable economic benefit to the UK and its citizens. Given that electricity prices are higher in the UK than in neighbouring countries, importing lower cost electricity from other parts of Europe enables the UK's prices to be reduced. On this basis, over the last years two new interconnectors projects (to France and Belgium) have been advanced, and are currently under construction (Table 21 – B). After their completion in 2019, these interconnectors will add 2GW of new capacity. Furthermore, six additional new interconnectors have been contracted (Table 21 – C).

Table 21: UK-EU electricity interconnectors

A – EXISTING INTERCONNECTORS (4 GW TOTAL CAPACITY)				
Project Name	**Developers**	**Connecting Country**	**Capacity [MW]**	**Starting Year**
Interconnexion France-Angleterre	National Grid Interconnector Holdings (NGIH) and RTE	France	2000	1986
Moyle	Mutual Energy	Northern Ireland	500*	2002
BritNed	NGIH and TenneT	Netherlands	1000	2011
East-West Interconnector	EirGrid	Ireland	500	2012
B – NEW INTERCONNECTORS UNDER CONSTRUCTION				
Project Name	**Developers**	**Connecting Country**	**Capacity [MV]**	**Estimated Starting Year**
ElecLink	Star Capital Partners Limited and Groupe Eurotunnel	France	1000	2019
NEMO	NGIH and Elia	Belgium	1000	2019
NSN	NGIH and Statnett	Norway	1400	2020
IFA2	NGIH and RTE	France	1000	2020
C – PERSPECTIVE INTERCONNECTORS (CONTRACTED, NOT YET UNDER CONSTRUCTION)				
FAB Link	Transmission Investment and RTE	France	1400	2022
Viking	NGIH and Energinet.dk	Denmark	1000	2022
Greenlink	Element Power	Ireland	500	2021

Source: Bruegel based on Ofgem (2017a) and Froggatt et al. (2017).
Note: *Moyle has been operating at around half of its normal 500 MW capacity due to subsea cable faults since 2012.

Should all of these projects advance, the UK's total electricity interconnection capacity would rise to more than 11GW by 2022. Together, these capacity expansions would not only allow the UK to have more access to cheaper sources of electricity and to rely on non-UK supplies in times of domestic generation scarcity, but it would also make the UK a hub for electricity exchanges between the Continent, the Republic of Ireland, and Scandinavia.

5.2 Existing gas interconnectors

Around 45 percent of UK's gas supplies still come from domestic gas fields located in the North Sea. But, due to resource depletion, domestic gas production is rapidly falling (i.e. from 80 billion cubic metres (bcm) in 2006 to 41 bcm in 2016), making the UK more reliant on gas imports. The country currently imports gas from Norway (i.e. via pipelines directly connecting the UK with Norway's gas fields), and from other European and international producers either via pipelines or LNG.

As far as pipelines are concerned, the UK has 3 links to Norway's gas fields and 3 interconnectors linking it to Belgium, the Netherlands and Ireland (Table 22).

Table 22: UK's gas interconnectors

PROJECT NAME	CONNECTING COUNTRY	CAPACITY [BCM]	MAIN DIRECTION (UK perspective)	BI-DIRECTIONAL
Vesterled pipeline link	Norway	14.2	Import	no
Langeled pipeline	Norway	26.3	Import	no
Tampen Link	Norway	9	Import	no
UK-Belgium interconnector	Belgium	25.5	Import	yes
UK-Netherlands pipeline	Netherlands	14.2	Import	no
Interconnector 1 and Interconnector 2	Ireland	12	Export	no

Source: Bruegel based on Energy UK (2017) and IEA (2012).

The respective national regulatory authorities (Ofgem in the UK, CREG in Belgium, ACM in the Netherlands and CER in Ireland) are currently charged with regulating and supervising these pipelines under the EU Third Energy Package.

The UK also has a substantial 52 bcm per year LNG import capacity, based on 3 onshore terminals and 1 offshore terminal (Table 23).

Table 23: UK's LNG terminals

LOCATION	CAPACITY (BCM/Y)
Dragon at Milford Haven, Pembrokeshire	7.6
Isle of Grain, Kent	19.5
South Hook, Pembrokeshire	21
Teesside GasPort (offshore)	4.2
Total	***52***

Source: Bruegel based on GIIGNL (2017).

The UK has a gas storage capacity of 4.4 bcm (Table 24). Albeit limited, this storage capacity is important for the country, as it provides a margin of flexibility particularly useful when considering the falling domestic production.

Table 24: UK's gas storage facilities

FACILITY	WORKING CAPACITY (BCM)	WITHDRAWAL RATE (MCM PER DAY)	COMPANY
Rough	3.3	45	Centrica Storage
Aldbrough	0.2	12	SSE/Statoil
Hatfield Moor	0.1	2	Scottish Power
Holehouse Farm	0.06	7	Energy Merchants Gas Storage (EDF)
Hornsea	0.3	17	SSE Hornsea
Humbley Grove	0.3	7	Star Energy
LNG storage	0.08	3	National Grid LNGS

Source: Bruegel based on IEA (2012).

Covering 70 percent of the country's total storage capacity, and being able to supply up to 10 percent of the UK's daily gas needs, the Rough facility represents an important element in the UK's gas architecture. Following repeated outages, the facility has been permanently shut in June 2017, and it will remain so at least up to May 2018.[136] This disruption highlighted the UK's rising gas vulnerability, and led to a quick increase in gas prices in the order of 5-7 percent.

5.3 Potential impact of Brexit on interconnections and markets

The potential impact of Brexit on gas and electricity interconnections and markets seems to be rather limited for at least three reasons:

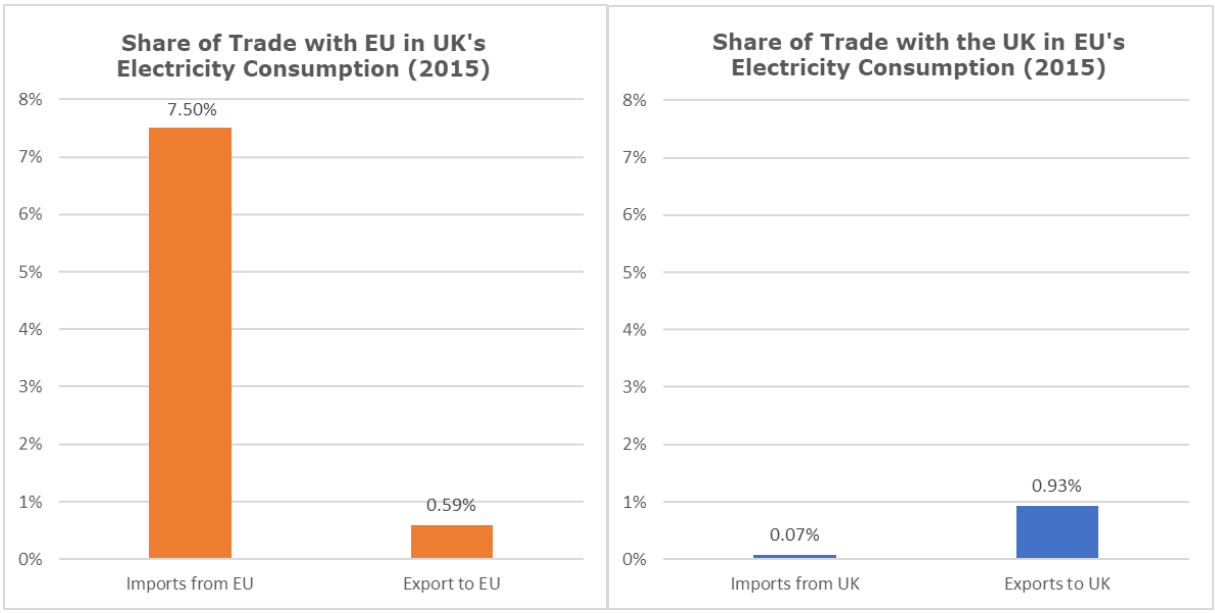
i) Limited volume of EU-UK electricity and gas trade;
ii) Specificity of UK's interconnector regime;
iii) Limited role of UK's LNG for the EU gas security of supply.

i) Limited volume of EU-UK electricity and gas trade

From a general perspective, the EU27-UK electricity and gas trade is rather limited. On electricity, the UK certainly depends more on the EU27 than vice-versa, as it imports from the EU 7.5 percent of its consumption, while the EU imports from the UK 0.07 percent of its consumption (Figure 8). Especially UK imports might increase, when the planned additional transmission capacities are commissioned, and hence physical bottlenecks removed.

[136] Financial Times (2017b).

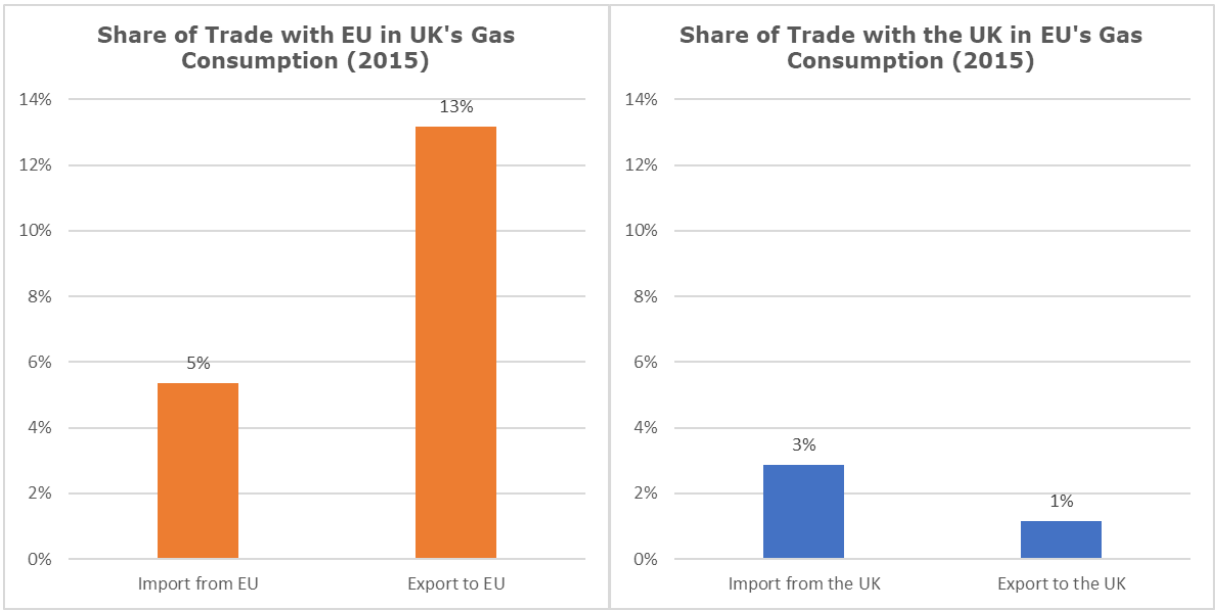
Figure 8: EU27-UK electricity trade (2015)



Source: Bruegel based on IEA (2017).

For gas, the UK imports from the EU27 5 percent of its consumption, while the EU27 imports from the UK 3 percent of its consumption (Figure 9). However, it is necessary to stress that, even if negligible from a EU27-wide perspective, gas trade with the UK does represent an important issue for the Republic of Ireland. That country currently imports 56 percent of its gas consumption from the UK. Given its special position, the case of Ireland is separately discussed in Chapter 8.

Figure 9: EU27-UK gas trade (2015)



Source: Bruegel based on IEA (2017).

ii) Specificity of UK's interconnector regime

While other EU Member States have tended to look to incumbent transmission system operators (TSOs) for the development of interconnectors, the UK interconnector regime is unique in that it specifically allows for and encourages merchant interconnectors to be developed by private investors. For currently planned interconnectors, the investment model on the UK side may not change after Brexit, as it is currently set by UK regulatory structures. However, national regulators in EU Member States (and Norway) are also involved in negotiating arrangements for their side of the interconnectors. Brexit may then result in additional examination of these frameworks, but it is well possible to expect TSOs to continue to speak with one another even after Brexit (see Chapter 3). Furthermore, as illustrated in Chapter 3, National Grid could even remain a member of the ENTSO-E and ENTSOG, which have some non-EU members. So, Brexit does not seem likely to have any noteworthy negative impact on either UK or EU electricity energy security.

iii) Limited role of UK's LNG for the EU gas security of supply

In 2016, the UK imported 11.84 bcm of LNG, *vis-à-vis* a total LNG import capacity of 52.3 bcm. As illustrated in Table 25, this low utilisation rate of LNG terminals does not affect only the UK, but all European countries.

Table 25: European LNG utilisation rates

COUNTRY	CAPACITY IN 2016 (BCM/Y)	IMPORTS IN 2016 (BCM/Y)	UTILISATION RATE (percent)
Spain	69.00	16.10	23
UK	52.30	11.84	23
France	34.30	8.79	26
Italy	15.10	7.27	48
Netherlands	12.00	0.59	5
Belgium	9.00	1.25	14
Portugal	7.60	2.07	27
Greece	5.00	0.84	17
Poland	5.00	1.30	26
Lithuania	4.00	1.58	40
Sweden	0.60	0.38	63
Finland	0.10	0.03	32

Source: Bruegel based on GIIGNL (2017).

In this context, it is difficult to see UK's LNG infrastructure playing any relevant role in the EU's gas security of supply architecture. That is, having a sizeable and considerably underutilised LNG infrastructure, the EU27 could well manage its LNG imports even without the UK's contribution.

5.4 Critical Issues and options

Continued cooperation and coordination on security of energy supply would benefit both sides. Given the limited volume of EU27-UK electricity and gas trade, Brexit is not likely to cause any critical issues for the EU27's security of electricity and gas supplies.

On electricity, the EU27 only gets very limited benefit in terms of security, as its electricity exchanges with the UK remain well below 1 percent of its total consumption.

On gas, the EU27-UK trade volume generally remains rather limited and from a EU27-wide perspective it does not represent a relevant issue (for a discussion of the specific case of Ireland, refer to Chapter 8), as the UK does not provide access to storages or suppliers to which the EU27 would not have access on its own.

Furthermore, given the capacity and the underutilisation of its LNG terminals, the EU27 could well manage LNG markets even without the UK's infrastructure.

It is also possible to expect the UK's and neighbouring countries' transmission system operators to continue their long-lasting cooperation, on the basis of their respective regulatory frameworks.

Table 26: A countries participation in the EU's energy solidarity under different arrangements

	Participate in EU solidarity
EU Member State (e.g. France)	Yes
EEA (e.g. Norway)	Under discussion
Energy Community (e.g. Ukraine)	Under discussion
Bilateral Treaty (e.g. Switzerland)	Not formally, but cooperation of TSOs
WTO (e.g. Morocco)	Not formally, but cooperation of TSOs

Source: Bruegel.

CHAPTER 6. FUTURE RELATION WITH EURATOM

KEY FINDINGS

- The UK Government has signalled its intention with its Brexit White Paper that when invoking Article 50, it "*will be leaving Euratom as well as the EU*".
- From the withdrawal date, the UK will have sole responsibility for ensuring its compliance with international treaties and conventions on nuclear energy.
- Both the EU and the UK recognise the need for setting-out in the Withdrawal Agreement clear arrangements on issues like nuclear safety and radioactive waste.
- On safety, the two parties seem to agree that the Euratom Community should transfer ownership to the UK of equipment and other property on its territory related to the provision of safeguards. However, the two parties will most likely disagree on the value of this property, which might thus be subject to negotiation.
- On radioactive waste, the two parties seem to agree on the principle that the state in which the spent fuel or the radioactive waste was generated should be responsible. However, disagreements could well emerge during the negotiations.

6.1 Future relation with Euratom

The UK Government signalled its intention with its Brexit White Paper that when invoking Article 50, it 'will be leaving Euratom as well as the EU'.[137] The need to distinguish between exiting Euratom and exiting the EU arises because Euratom is legally distinct from the EU. The UK decided to leave Euratom because, albeit independent, the institution relies for its functioning on EU bodies (e.g. the Commission, the Council of Ministers and the Court of Justice), staff and budget.

According to the White Paper, the UK Government considers the nuclear industry of strategic importance for the country, and for this reason it 'will seek alternative arrangements' to continue civil nuclear cooperation, safeguards, safety and trade with Europe in the framework of Brexit's negotiations.

In this section, we examine the functions of Euratom, its relevance for the UK, the potential implications of 'brexiting' Euratom for both the UK and for Euratom itself, the positions apparently assumed by the EU and the UK on the issue, and the potential way forward.

6.2 Euratom: what it is and what it does?

The European Atomic Energy Community (Euratom) was founded by the Treaties of Rome of 1957 with the aim of creating a European market for nuclear power. Euratom is legally distinct from the EU, while it is governed by EU's institutions. Its membership is composed of EU Member States. Euratom also has cooperation agreements with Switzerland since 2014, and with eight 'Third Countries': US, Japan, Canada, Australia, Kazakhstan, Ukraine, Uzbekistan and South Africa.

[137] UK Government (2017a)

The key functions of Euratom are to:

- Promote research on nuclear energy, and particularly on nuclear fusion – a technology that has the potential to provide a sustainable solution for the world's energy needs and could thus be considered to be a global common good;
- Establish uniform safety standards and ensure that they are applied;
- Ensure the regular supply of ores and nuclear fuels;
- Ensure that nuclear materials are not diverted to purposes other than those for which they are intended;
- Ensure free movement of capital for investment in nuclear energy and free movement of employment for specialists in the sector.

Euratom carries out these functions using three key instruments:

- The Euratom Supplies Agency, which owns and controls the supply of all fissile materials in Euratom's Member States;
- The European Commission, which develops research programmes to foster research on nuclear energy;
- The Euratom Safeguards Directorate, which ensures that nuclear materials are not diverted from their intended uses (non-proliferation). This institution is a part of the European Commission (DG Energy).

6.3 The UK links to Euratom

Reflecting the key functions of Euratom, the UK's links with the organisation are fourfold.

6.3.1 Nuclear fusion research

Euratom's flagship project is called 'International Thermonuclear Experimental Reactor' (ITER)[138], the world's largest planned nuclear fusion experiment. Located in the south of France, ITER is designed to produce 500 MW of fusion power from 50 MW of input power, i.e. a ten-fold return on energy. It is funded and run by a seven-party consortium composed of the EU, India, Japan, China, Russia, South Korea and the US.[139] The UK has an important role in this project, as it hosts the Joint European Torus (JET)[140], the world's largest operational nuclear fusion device. This project is also known as 'Little ITER', since its experimental design and results serve mainly as a contribution to the ITER's design. The JET project - carried out by a team of 350 scientists - is formally a joint venture used by more than 40 EU laboratories.

6.3.2 Budget for nuclear fusion

The EU covers the largest share of ITER's construction costs (45 percent), amounting to EUR 2.7 billion over the 2014-2020 period. This is financed through a specific budget line within the Multiannual Financial Framework (MFF) of the EU budget. During the forthcoming negotiations, the European Commission is expected to claim the UK's share of this amount as a liability towards the EU. In addition, ITER-related research costs are covered through

[138] ITER (n.d.).

[139] Part of this structure is a European Joint Undertaking (Euratom Chapter 5) of which Switzerland is also a member (Fusion for Energy, n.d.).

[140] EUROfusion (n.d.-a).

the EU Framework Programme for Research and Innovation (Horizon2020, formerly FP7), administered by Euratom. The UK stands to lose these funds. To put it into perspective, over the 2014-18 period Euratom has a total research budget of EUR 1.6 billion drawn from the H2020 budget, of which EUR 700 million will be distributed to carry out research specifically on nuclear fusion.[141] EUR 424 million will go to EUROfusion, a Consortium of university groups and national labs, mostly for research related to the ITER project. The remaining EUR 283 million have been budgeted solely for the Culham Centre, the JET's hosting institute in the UK, operating as a common facility for researchers across Europe. JET alone receives around EUR 69 million per year of funding[142], 87.5 percent of which is provided by the European Commission and the remaining 12.5 percent is funded by the UK.

6.3.3 Safety, non-proliferation and free movement of capital and labour

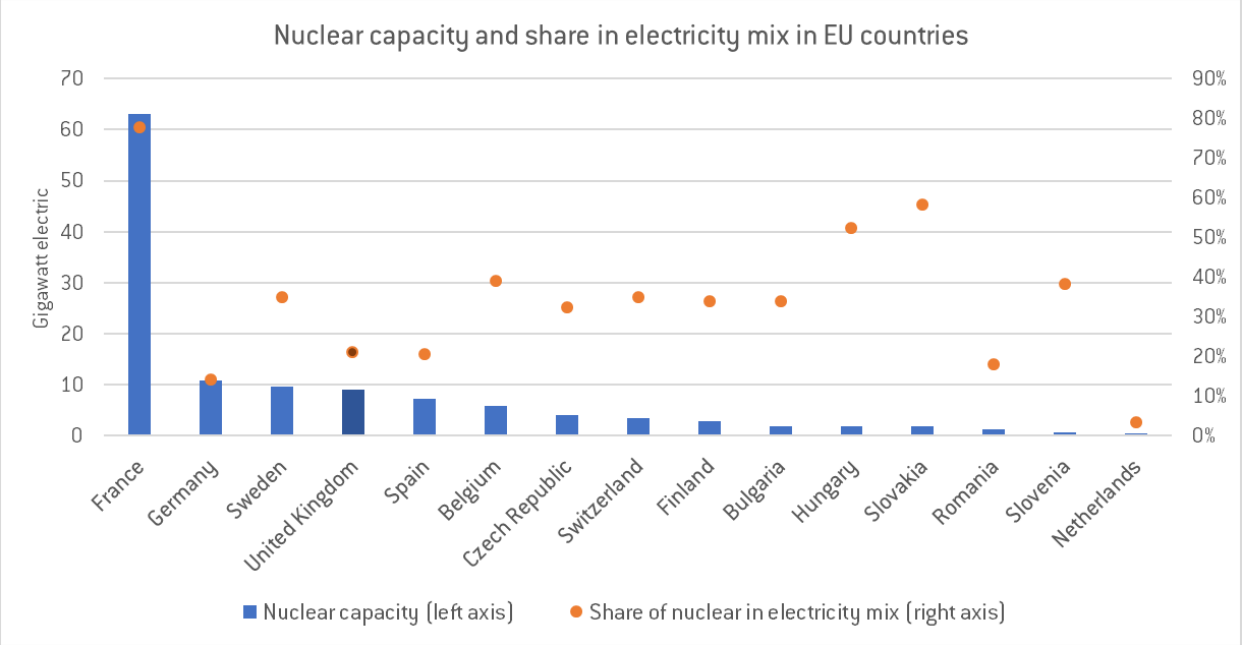
Euratom is not only relevant to the UK for its research component, but also for its operational functions. The UK is historically highly dependent on nuclear energy. As of 2016, nuclear covers around 21 percent of the UK's electricity generation mix. With its 15 nuclear reactors in operation, the UK ranks 2nd in the EU by number of nuclear power plants (after France) and 4th by nuclear power capacity (after France, Germany and Sweden)[143]. Being a nuclear country, the UK thus relies on Euratom for activities related to safety at nuclear power plants, supply of nuclear fuels and non-proliferation. Being part of Euratom, the UK is part of an established legislative framework ranging from nuclear safety issues to free movement of capital for nuclear investments and free movement of employment for nuclear specialists, that facilitate investments in the sector and reduce costs associated with nuclear power generation. By 'brexiting' Euratom, the UK would then lose this package of advantages. All these elements might impact the UK's operating nuclear power plants, as well as the new projects under development, such as the controversial Hinkley Point mega-project, which was finally approved by the UK Government in September 2016.

6.3.4 Supply of nuclear fuel

Under the Euratom Treaty, the Euratom Supplies Agency is endowed with a right of option on ores, source materials and special fissile materials produced in the territories of Member States and has an exclusive right to conclude contracts relating to the supply of ores, source materials and special fissile materials coming from inside the Community or from outside. This common purchasing scheme allows the Euratom Community to have more bargaining power while negotiating contracts with external suppliers of nuclear fuels, thus contributing to the reduction of nuclear power generation costs. By 'brexiting' Euratom, the UK would also lose this economic advantage.

[141] EUROfusion (n.d.-b).
[142] EUROfusion (2017).
[143] European Nuclear Society (n.d.)

Figure 10: Nuclear capacity and share in electricity mix in EU countries



Source: Bruegel based on Eurostat (2017d).

6.4 'Brexiting' Euratom: potential impacts on the UK's nuclear sector

The decision to leave Euratom could, therefore, impact the UK's nuclear industry under several perspectives.

6.4.1 Nuclear fusion research

Although the JET program is not likely to be affected before the end of 2018, its subsequent status is currently in a legal limbo.[144] JET's experiments may be halted or seriously delayed and, as a result, the ITER project could also be slowed down, being highly dependent on the JET's outcomes.

6.4.2 Safety and non-proliferation

The UK Government would have to budget additional costs to run an autonomous system to guarantee the appropriate safety standards, in particular for nuclear safety inspections. By leaving Euratom, the UK would also need to set up the proper framework to comply with its nuclear non-proliferation safeguards commitment and to decommission radioactive waste. The JET facilities alone, for instance, have produced some 3,000 cubic meters of radioactive waste, which will cost about EUR 336 million to decommission, currently done through an EU-wide cost-sharing arrangement.[145]

[144] Nature (2017).
[145] Financial Times (2016).

6.4.3 Free movement of capital and labour

The Brexit announcement caught the scientific community unprepared and caused large disquiet, with researchers now considering leaving the UK. According to Prof. Steve Cowley, former CEO of the UK Atomic Energy Authority, the perspective of losing EU funding puts at risk more than 1,000 clean-energy exploration jobs, and loss of expertise well beyond that at the Culham Centre, related to the research and tertiary education sector at large.[146] Labour movement and trade restrictions may also have implications for the construction costs and schedule of new projects. Long negotiations could impose severe delays to the advancement of new facilities, such as Hinkley Point C, increase general nuclear costs and also the risk of not fulfilling the UK's targets for reducing greenhouse gas emissions.

6.4.4 Supply of nuclear fuels

Currently the Euratom Supply Agency guarantees equal access to nuclear raw materials between Member States.[147] By pulling out of Euratom, the UK will have to re-negotiate commercial contracts to ensure the provision of nuclear fuel, ores and fissile materials. Once it is outside of the EU, it is debatable whether the UK will have similar bargaining capacity to negotiate with others, a fact that may lead to higher costs for nuclear power generation in the UK.

6.4.5 Other legal issues

Euratom currently has about 20 nuclear cooperation agreements with third countries around the world, which the UK will have to re-negotiate. Of crucial importance are those with the International Atomic Energy Agency (IAEA), the world's intergovernmental body for co-operation in the nuclear field, and with the US, from which the UK is a substantial importer of technology and fuel for its nuclear reactors.

6.5 Future relation with Euratom: the options on the table

Looking into the future, this section outlines the possible scenarios for the post-Brexit UK-Euratom relationship that could be taken into consideration during the forthcoming negotiations.

6.5.1 UK out of Euratom

In this scenario, the UK Government would have neither obligations nor rights towards Euratom. As a result, the UK might ultimately see increasing costs for its nuclear power generation, due to the additional operational costs and supply costs deriving from being outside the established framework of Euratom.

Furthermore, new projects such as Hinkley Point might be delayed, not only as a direct consequence but also due to the volatile investment climate that this scenario could generate. As far as the EU is concerned, this scenario would not necessarily imply any noteworthy additional costs, but only a potential delay in the nuclear fusion research at ITER due to the potential end of the JET project.

[146] BBC (2016b).
[147] European Commission (2014c).

6.5.2 UK collaborating with Euratom on specific areas as Third Country

According to Article 101 of the Euratom Treaty[148], 'The Community may, within the limits of its powers and jurisdiction, enter into obligations by concluding agreements or contracts with a third State, an international organisation or a national of a third State'.

By acquiring the status of Third Country, the UK might join countries such as China and Russia, with which Euratom has established a 'structured dialogue to identify a common set of research topics of mutual interest in which cooperation can take place on a shared-cost basis'.

6.5.3 UK collaborating with Euratom on specific areas through an association agreement

According to Article 206 of the Euratom Treaty, 'The Community may conclude with one or more States or international organisations agreements establishing an association involving reciprocal rights and obligations, common action and special procedures'.

This article does not imply the possibility of an associated membership to Euratom. It only implies the possibility of establishing association agreements to cooperate on specific activities with Euratom.

As Johnston (2017) outlines, most commonly such agreements involve Chapter 1 research programmes. Such collaborations are not the same as membership or associate membership and do not usually include in their scope activities under other chapters such as safety (Chapter 3), supplies (Chapter 6) and safeguards (Chapter 7).[149]

The typical example of a country linked to Euratom with an association agreement is Switzerland. The country participates with in several Euratom-focused research programmes under the Horizon 2020 programme. However, these kinds of cooperative arrangements do not represent a full-fledged associate membership in Euratom.

6.6 The EU position

With the 'Position paper on nuclear materials and safeguard equipment (Euratom)'[150] published on July 13, 2017, the European Commission outlined the EU position on the issue – focusing on four points:

6.6.1 Safeguards obligations

On the date of the withdrawal, the UK will have to ensure that all nuclear materials present on UK territory will be handled in accordance with applicable international treaties and conventions on nuclear safety, safeguards, non-proliferation and physical protection of nuclear materials. The UK will have to have in place safeguards agreements with the IAEA, and will have to operate a domestic nuclear safeguards system.

6.6.2 Equipment used to provide safeguards

On the date of the withdrawal, the (Euratom) Community should transfer ownership to the UK of equipment and other property related to the provision of safeguards located on UK

[148] Consolidated version of the Treaty establishing the European Atomic Energy Community (2010/C 84/01).
[149] Johnston (2017).
[150] European Commission (2017l).

territory. The UK should reimburse the Community for this transfer, on the basis of the value assigned to this property in the consolidated accounts of the Union.

6.6.3 Special fissile material

On the date of the withdrawal, the Community should be able to require that special fissile material present on UK territory, and the right of use of which is with an EU27 Member State or with persons or undertakings established in the EU27, be deposited with the Euratom Supply Agency or in other stores which are or can be supervised by the Commission.

Likewise, on the date of the withdrawal, the Community should transfer to the UK any special fissile material present on EU27 territory, and the right of use of which is with a natural or legal person established in the UK.

6.6.4 Spent fuel and radioactive waste

Spent fuel and radioactive waste generated in the UK, and present on EU27 territory on the date of withdrawal, should remain the responsibility of the UK.

6.7 The UK position

With the 'Position paper on nuclear materials and safeguards issues'[151] published on July 13, 2017, the UK Government outlined its position on the issue – focusing on five points.

6.7.1 Safeguards arrangements

The UK commits to take responsibility for meeting safeguards obligations, as agreed with the IAEA.

6.7.2 Safeguards equipment

The UK commits to ensure that all necessary safeguards equipment is in place to comply with its IAEA obligations. It remains open on the possibility of taking ownership of existing Euratom-owned equipment, if rooted in a common understanding of fair value and liabilities.

6.7.3 Special fissile material

According to the UK Government, ownership of special fissile material that is currently with the Euratom Community and which is present on UK territory on the date of withdrawal should transfer to the persons or undertakings with the right of use, whether these are established in the UK, EU or non-EU states. Vice-versa, the ownership of special fissile material that is currently with the Community, which is present on Euratom territory on the date of withdrawal, and which belongs to a natural or legal person in the UK, should be transferred to the UK.

[151] UK Government (2017c).

6.7.4 Existing contracts for the supply of nuclear material

According to the UK Government, contracts for the supply of nuclear material between operators in the UK and Euratom, which have been approved by the Euratom Supply Agency and EC, should remain valid and not require any further approvals.

6.7.5 Spent fuel and radioactive waste

According to the UK Government, it should be ensured that spent fuel and radioactive waste remain the responsibility of the state in which it was generated. This should apply to spent fuel and radioactive waste generated in both the UK and Euratom Community.

6.8 Critical issues and options

From the two Euratom position papers, it clearly emerges that the EU and the UK do have similar views on some issues, while they have different views on others. In sum:

Both the EU and the UK recognise that from the withdrawal date, the UK will have sole responsibility for ensuring its compliance with international treaties and conventions.

Both the EU and the UK recognise the need for setting-out in the Withdrawal Agreement clear arrangements on issues like special fissile materials, safeguards equipment and radioactive waste.

On safeguards obligations, the two parties agree that on the date of the withdrawal the UK will have to have in place safeguards agreements with the IAEA.

On safeguards equipment, the two parties seem to agree that the Euratom Community should transfer ownership to the UK of equipment and other property related to the provision of safeguards located on UK territory. However, the two parties will most likely disagree on the value, as the EC assumes the value assigned to this property in the consolidated accounts of the Union, while the UK claims the need to negotiate a 'fair value'. This point can thus be expected to be a subject of intense negotiation.

On the issue of ownership of special fissile material, the two parties seem to be aligned.

On the issue of spent fuel and radioactive waste, the two parties agree on the principle that responsibility should go to the state in which the spent fuel or the radioactive waste was generated. However, disagreements could well emerge during the negotiations. This could particularly be the case of the UK's Sellafield nuclear reprocessing site, the world's largest civilian stockpile, which stores around 130 tonnes of plutonium, about a fifth of which stems from imported nuclear waste.[152] Any disagreement on this issue will presumably be subject to negotiation.

Considering the highly technical nature of these issues, there have been calls for the UK to remain with Euratom. However, even if Euratom is legally governed by a separate treaty, its functioning is based on EU institutions. For this reason, Euratom could not be considered separately from the wider Brexit dossier.

[152] Financial Times (2017c).

Table 27: Possibility of UK membership in Euratom and the IAEA under various scenarios

	Euratom-member	IAEA
EU Member State (e.g. France)	Membership possible	Membership possible
EEA (e.g. Norway)	Membership possible	Membership possible
Energy Community (e.g. Ukraine)	Association membership possible	Membership possible
Bilateral Treaty (e.g. Switzerland)	Association membership possible	Membership possible
WTO (e.g. Morocco)	Association membership possible	Membership possible

Source: Bruegel.

CHAPTER 7 IMPACT ON ENERGY MARKETS FOR UK AND EU COMPANIES

KEY FINDINGS

- Many European companies are active on the UK gas and electricity markets and hold significant market shares. They would be subject to regulatory risks in a post-Brexit environment if the UK is no longer bound by EU rules.
- The UK has traditionally been a leader in market liberalisation and its gas trading hub remains one of the largest and most important in Europe, only overtaken by the Dutch Title Transfer Facility (TTF). Unless this approach is reversed by protectionist policies, we believe the UK gas trading NBP can retain its status. However, Continental trading hubs could gain market shares because of the uniform regulatory environment, safeguarded by the EU combined with no currency risks.
- London as a venue for arbitration cases will most likely not be affected. This is a consequence of the New York Convention on the recognition and enforcement of foreign arbitral awards. For place-of-jurisdiction clauses, EU27 companies might decide to abandon London in favour of Continental competitors. Enforceability currently enshrined in the Brussels Convention will no longer be automatic, but it is not under threat. However, burdensome recognition procedures could increase the costs of enforcement of UK court rulings.

The subsequent chapter focuses on the impact of Brexit on the EU and UK energy markets and companies. Firstly, we assess the risk for European companies that are active in the UK energy market and evaluate what is at stake for them. Secondly, we analyse which consequences for energy markets could arise if UK is no longer bound to EU financial regulations. Thirdly, we identify the impact on the European energy trading hubs and finally, we address the future of the UK as legal venue for arbitration and contracts.

7.1 Member State electricity and gas companies in the UK market

European energy markets are typically characterised by a strong dominance of national energy utilities; the presence of foreign companies is limited. The UK energy market is an exception as companies from the Continent are very active on the UK electricity and gas market, both in the retail and wholesale sectors.

In case the UK would leave the EU without any agreement ruling the future relations, the UK would no longer be bound by EU rules, thus imposing a regulatory risk on Continental European energy companies doing business in the UK. Thus, the level of activity of EU27 energy companies in the UK market is highly relevant in the upcoming Brexit negotiations.

7.1.1 EU electricity and gas companies and the UK energy market

In contrast to most European energy markets, the British Energy market is highly penetrated by non-UK companies. Table 28 gives an overview of the market shares of EU27 energy companies in the UK market. As shown, Continental European energy companies are very active on the UK market both in electricity and gas, in wholesale as well as retail. EU27 companies hold market shares of 50 percent in the electricity retail market and 56

percent in the electricity wholesale market. The gas and electricity networks (transmission and distribution) are mainly not owned by EU27 companies.[153]

Table 28: EU 27 electricity and gas companies active in the UK market

MARKET SEGMENT	ELECTRICITY	GAS
Wholesale Market *(market shares in brackets, 2016)*	EDF (24 percent), RWE (16 percent), Uniper (6 percent), ScottishPower* (4 percent)	No data
Retail Market *(market shares in brackets, Q1 2017)*	EDF (12 percent), E.ON (14 percent), RWE npower (9 percent), ScottishPower* (11 percent)	EDF (8 percent), E.ON (10 percent), RWE npower (8 percent), ScottishPower* (9 percent)
Transmission Networks	No activity	No activity
Distribution Networks	No activity	No activity

Source: Bruegel based on Ofgem (n.d.) and Le Fevre (2015).
Note: *Scottish Power is part of Iberdrola; market shares are calculated based on the number of meter points.

7.1.2 State aid after Brexit

Competition policy is crucial in oligopolistic and strategic sectors such as energy. Currently, UK must comply to EU state aid rules which limit measures of states to distort competition in the EU market. Competition issues (namely antitrust, cartels, mergers, and state aid) involving parties of multiple Member States are ultimately settled at the European Court of Justice. After the UK withdrawal, the competitive environment in UK might be shaped by possible arrangements between UK and EU and by English competition law.

Without being in the European Union and bound to EU legislation, the UK would have extended (even discriminating) possibilities to enact regulation that impacts the competitive structure and the revenues of the energy sector.[154,155]

- *Retail market:* For instance, the energy retail price freeze discussed during the 2017 general election campaign[156] would not face effective opposition from European institutions. Such a freeze would impact the revenues of energy retail companies.
- *Wholesale market*: The UK could also have more flexibility to incentivise investments in new generation facilities. The 'Contract for Difference' remuneration

[153] Several networks in the UK are owned by foreign investors. For example, the electricity networks in London and other parts of England are owned by Cheung Kong Group and NationalGrid (whose major shareholders are investment funds) plans to sell its gas distribution business to another group of Asian investors.

[154] For a more general discussion see Petropoulos (2016) and Craig (2016).

[155] It is estimated that 're-regulation' will cost energy suppliers operating in the UK £2.6 billion. The cost for EU companies operating in the UK would be almost £1.3 billion. (Mammadov, 2017)

[156] Telegraph (2017).

scheme for the Hinkley Point C nuclear plant had to be designed in such a way as to comply with EU state aid rules.[157] Follow-up projects could receive more direct state support, thus creating artificial competition and thereby reduce the revenues of existing plants of which many are owned by companies from the EU27.

Post-Brexit, the UK would not be bound to EU state aid rules (unless for instance the UK joins the EEA), and UK courts will presumably interpret British rules on state aid. Hence, EU companies would have to challenge aid given by the UK government to UK competitors in a UK court. The same presumably holds for merger decisions. Anecdotal[158] and empirical[159] evidence suggests some (strategic) 'home bias' of competition authorities. Hence, after Brexit, EU companies might need some safeguards against an uneven playing field.

Even without an explicit EU27-UK treaty defining future state aid rules, the UK would remain bound by WTO rules.[160] Yet, the EU state aid rules exhibit a wider scope than WTO subsidy rules and are applied differently. In contrast to the EU state aid framework, the WTO framework works in an ex-post manner. The Dispute Settlement Body of the WTO can declare certain subsidies to be unlawful under WTO agreements. By contrast, state aid measures in the European Union must be notified and approved beforehand by the European Commission.[161]

In addition, the UK will remain a signatory of the Energy Charter – an investment protection treaty. This treaty has in the past been used to shield foreign investors against detrimental policy change. But again, the limited number of past cases and the ex post nature of related settlements do not establish legal certainty equivalent to the current institutional system.

7.2 Future of the UK as a place of energy trading hub

The UK has historically been one of the major global energy trading points. According to Public Eye (2017) about a quarter of global oil trading is conducted in London. Besides oil and coal trading, the UK hosts one of the most liquid gas and electricity markets in the EU.

The UK thereby not only offers physical trading, but the most liquid market of energy-derivatives trading in the EU as well as clearing services. The London based InterContinental Exchange (ICE) is one of the leading global energy exchanges and a main trading place for European energy futures.[162] Consequently, essential reference prices such as 'Brent oil' and 'NBP gas' are determined in the UK.[163] With the UK potentially dropping out of EU financial market regulations, the conditions under which the UK might still be able to maintain its leading role in energy trading will depend on the Brexit negotiations and on

[157] For more information see European Commission (2014d) and UK (2014).

[158] For example, when Germany granted an exemption for the E.ON-Ruhrgas merger in 2002, or when Spain blocked E.ON from buying Endesa in July 2006.

[159] For example, Schinkel et al. (2010) find that the chance of success for appeal against competition decisions of the European Commission is significantly higher in cases with non-European companies than it is in purely European cases.

[160] Nctm (2016). Note however that while the UK is a WTO member, many post-Brexit aspects of the UK's WTO arrangements are not yet clear.

[161] Oxera (2016).

[162] The ICE Holding is based in London, but main subsidiaries are US-based. ICE Futures Europe and ICE Clear Europe, Ltd. Are based in the United Kingdom, while the European Climate Exchange Limited is based in Dublin. Job announcements suggest that the Dublin office is growing.

[163] Platts (n.d.).

the willingness of the UK to implement EU-compatible regulations. For energy trading there are at least four most relevant regulations:

MiFID II (Regulation (EU) No 2014/65/EU) will enter into force from January 2018 thus before the expected date of the UK's exit. In conjunction with EMIR and MIFIR, MIFID II implies that for specific transactions traders need to comply with detailed rules on position limits, capital requirements, market surveillance, and so on.

Commodities and energy trading firms will be impacted by MiFID II if their trading volume exceeds the thresholds, qualifying for an exemption for example, as provided by MIFID II. If the UK will not join the EEA (or alternatively that a specific EU-UK regime cannot be negotiated), companies that only have a UK regulated entity will not be able to offer their services throughout the EU, as they will lose the MiFID II passport. However, the EU has introduced a specific regime for non-EU investment firms which provide cross-border services to clients in the EU. Obviously, companies could also decide to open a new company branch in the EU27 and thus be regulated under MiFID II.[164] In case the UK decides to transpose MiFID II into UK law, the EU could recognise UK laws as 'equivalent' which would extend the scope of MiFID II to UK.[165] As the MiFID equivalence regime has not been used up to now, the outcome is highly unclear and a possible transition deal is crucial.[166]

REMIT (Regulation (EU) No 1227/2011/EU) is the *Regulation on Wholesale Energy Market Integrity and Transparency* and has the objective to identify and prevent the use of insider information and other forms of market abuse. Monitoring under this EU regulation is undertaken by the Agency for the Cooperation of Energy Regulators (ACER) together with national regulatory authority. In practise, any contract related to the supply of gas and power in the EU must be reported to ACER. Anyone entering into any transaction on EU wholesale energy markets in wholesale energy products, whether EU or non-EU domiciled, is bound by this regulation. After the UK's withdrawal, any power or gas delivered by a UK-based supplier will no longer be in the EU and reporting to ACER will not be needed. This is already the case for transactions at Swiss delivery points which are not reported to ACER.

Broadly speaking, two main parties will likely be affected:

- *Market Participants:* Any (legal) person including transmission system operators that enters into transactions, including the placing of orders to trade, in one or more wholesale energy markets;
- *Organised Market Places (OMPs):* ACER has published a list of OMPs which includes energy exchanges and other trading venues as defined under the Markets in Financial Instruments and Regulation (MiFIR).

We can expect that the UK government will preserve essential parts of REMIT, as UK has been one of the first countries to implement REMIT and is currently strengthening its framework.[167] A British version of REMIT is also expected to be introduced within the 'Great Repeal Bill' which will transpose existing EU laws into British laws. Of course, after Brexit the UK is free to change these formerly EU based laws and can create its own legal framework.

[164] Maycock (2016).
[165] Bean, Croxon, & Stone (2016).
[166] Stafford (2017).
[167] Galbraith, Davies, & Wright (2016)

After a complete dropout of the UK out of the EU (without agreement), UK-based market participants will still be bound to REMIT when operating in the EU. Even if UK would comply with REMIT, it would be regarded as a third country and carve-out rules would not be applicable any more. This means that electricity and gas trading settled in the UK would be treated as financial instruments implying higher capital requirements and hence a disincentive to trade in UK-settled production. In addition, data exchange between UK and EU will not be possible after Brexit unless EU and UK decide on a new regime of data exchange.[168] However, the UK government could decide to lower administrative burden for solely UK-based market participants compared to the current regime creating a less regulated competitive environment.[169]

EMIR (Regulation (EU) No 648/2012) was designed to regulate the trade of over-the-counter derivative transactions. Although EMIR is based on EU legislation, it is expected that the UK government will adopt a legislation like EMIR into British law.[170] The question is however how the guidance of ESMA on the application of EMIR be respected by the UK.

CRR/CRD IV (Regulation (EU) No 575/2013) defines minimal standards for capital requirements as well as minimum regulatory capital. It is expected that CRR will be preserved even in a post-Brexit environment since its source is the *Basel 3 Accord*. Regarding CRD IV, future UK legislation might depart from certain regulations that stem from EU policies (and not from Basel 3).[171]

In any case, given the uncertainties around the future of cross-border regulatory issues, it can be assumed that the UK withdrawal will accelerate the rise of Continental trading places as we have experienced for gas with the rise of Title Transfer Facility (TTF).

For the EU it is important to make sure that after Brexit UK energy trading is subject to rigorous financial market and transparency rules to preclude any loopholes that could enable market manipulation and tax evasion.

7.3 Energy trading hubs and the role of the UK in the European gas market

For the European gas market, trading hubs constitute places where demand and supply are balanced, and where regular trades are processed. Liberalised markets and predictable rules are required for trading hubs so that wholesale traders and energy suppliers join the trading at the hub for portfolio and risk management.[172]

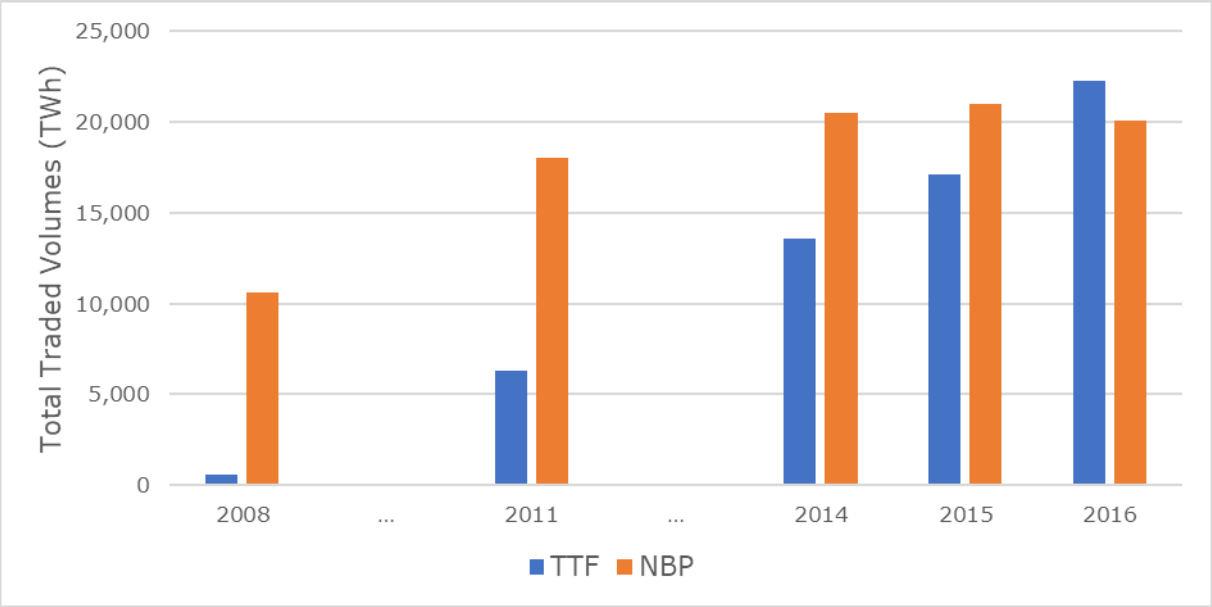
Trading hubs are associated with certain market areas. In the UK, the energy trading hub for gas is the NBP (National Balancing Point) which was created in 1996, one year after the liberalisation of the British gas sector.[173] The NBP quickly became the largest trading point and was used by traders from all over Europe to balance their systems on a daily basis. Other trading points, such as the Italian PSV, the German Gaspool and NCG, and the biggest hub TTF, were modelled after the NBP.[174] The largest gas hubs in the EU, TTF and NBP, are virtual trading hubs and the prices of contracts traded at NBP and TTF are mainly

[168] Willis (2017).
[169] Galbraith, Davies, & Wright (2016).
[170] Stretch, Bielkowicz, & Parker (2016).
[171] Gray (2016).
[172] Heather (2015).
[173] Avis (2016).
[174] Heather (2015).

determined in over-the-counter transactions.[175] Some trading volume occurs at the InterContinental Exchange (ICE).[176]

For most of the time in the last 20 years, NBP has been the largest and most liquid trading hub in Europe. Yet, TTF has recently accomplished to overtake NBP in terms of volume traded (Figure 11).

Figure 11: Traded volumes at the TTF and NBP



Source: Bruegel based on Heather & Petrovich (2017).

As long as the UK keeps a liberalised and open market (which guarantees liquidity), NBP will most probably remain one of the major energy trading hubs in Europe. However, the exit of the UK could further strengthen the importance of TTF and other Continental trading hubs at the expense of NBP. This is underpinned by an exchange rate risk and a reduced liquidity at the NBP which could lead to higher volatility compared to the TTF reducing the overall attractiveness of NBP.[177]

[175] ACER (2015).
[176] Avis (2016).
[177] Bros (2017b).

7.4 Future of the UK as a legal venue for the EU

7.4.1 Arbitration

London is chosen in many energy contracts as the seat of arbitration, which is particularly true for contracts concluded between parties from weak legal systems. The UK withdrawal is unlikely to affect the good reputation of English courts and law. The UK Arbitration Act of 1996 will continue to be regarded as accessible, user-friendly and modern as before, and the immense body of English law especially in the commercial field will ensure predictability.[178]

As the UK and all EU Member States are parties to the *Convention on the Recognition and Enforcement of Foreign Arbitral Awards* (also known as the *New York Convention*) of 1958[179], arbitration awards issued by tribunals are enforceable in any of the 158 states that are party to the New York Convention and awards issued by an arbitration tribunal seated in any of the other EU Member States will still be enforceable in the UK. Thus, the withdrawal of the UK from the EU is unlikely to affect London's position as seat of arbitration.

7.4.2 Place of Jurisdiction

Beyond arbitration, English courts are often chosen as place of jurisdiction (combined with a choice of English law) in commercial contracts.[180] The *Brussels Regime*[181] generally allows jurisdiction clauses in contracts, which preserves the right of parties to reach agreement at the time of contracting as to which court should be (exclusively) competent to decide should govern any dispute. It also ensures the automatic recognition and easy enforceability of UK court rulings in all EU Member States. Regarding judgments by courts from third countries (such as the UK after Brexit), the national law of each member state will govern the recognition and enforceability of English judgments which will, in principle, lead to somewhat more procedures and a more restricted enforceability depending on the relevant state law in which enforcement is sought.[182]

In case the UK decides to join EFTA, it would gain the possibility to accede the *Lugano Convention*[183] of 2007 which governs issues of jurisdiction and enforcement of judgments between the EU Member States and the EFTA members.

The UK may also decide to join the *Hague Convention*[184] on (exclusive) Choice-of-Court Agreements of 2005 to which the EU, but not the Member States, is a party. This would lead to a far-reaching (but nor automatic) recognition of judgments of English courts, based on an exclusive choice-of-court agreement, in the Member States of the EU. These judgments would also be enforceable. However, national (perhaps burdensome) procedures on the recognition of judgments would still be applicable. To this extent, London may somewhat suffer as a place of jurisdiction at the expense of other EU jurisdictions.

---

[178] Ambrose & Naish (2016).
[179] New York Convention (n.d.).
[180] Batsaikhan & Schoenmaker (2017).
[181] Regulation (EU) No 1215/2012.
[182] The applicability of the *Brussels Convention* of 1968 to guarantee enforceability is disputed.
[183] Official Journal of the European Union, L 339, 21 December 2007
[184] Hague Conference on Private International Law (2005)

7.4.3 Applicable Law

The so-called *Rome I Regulation*[185], deals with the applicable law concerning international contracts. Under Rome I the contracting parties have the freedom to decide the law under which contracts are governed. All courts in the EU apply Rome I, and, therefore, respect a choice-of-law clause by the parties.

After Brexit, EU Member State courts will continue to respect choice-of-law clauses in contracts to which UK companies and persons are partners. English law may be chosen, and, if chosen, courts of the Member States will apply English law in the same manner as they do at present. In contrast, UK courts will no longer be able to apply the Rome I Regulation where the choice-of-law is to an EU Member State. However, although the Rome I Regulation is exclusive to EU Member States, the Parliament of England may 'incorporate' Rome I as English law (on a 1:1 basis), thereby acknowledging the freedom of the parties to choose the applicable law. If this does not happen (in the foreseeable future), it can be expected with near certainty that English courts will turn back to traditional rules of English private international law, thereby accepting choice-of-law clauses just in the same way as under Rome I.

In the end, parties will be able to choose English law for their contracts, and this choice will be respected by courts in England and in the Member States of the EU.

7.4.4 Conclusion

The UK could decide to join the Hague Convention to achieve mutual recognition of court decisions. Yet, it is argued that joining this agreement might not be sufficient to calm businesses' concerns, as timing as well as details are uncertain. However, the same problems would arise in case the UK decides to negotiate a bilateral treaty with the EU to clarify mutual recognition of court decisions. In consequence, the UK (and hence London) could suffer as place of jurisdiction in expense of other European countries as enforceability of UK court rulings will to some extent more burdensome after the UK has left the EU. Several Continental EU countries (and cities) have already started to build up legal capacities and adopted English speaking procedures to increase their chance to be chosen as a place of jurisdiction. However, the UK withdrawal could also lead to an increased use of arbitration clauses in private contracts strengthening London as legal venue in the end.

7.5 Critical issues and options

Several European energy companies are severely exposed to regulatory changes in the UK energy market. As future UK legislation is not bound to EU state aid regulations (and WTO rules are less strict), future revenues could be impacted by special UK state aid rules. Potential home bias of UK regulatory decisions and competition policy could pose another threat to EU companies. They should also consider that enforcement of prospective UK court rulings might be more burdensome.

Regarding energy trading, we expect that Continental trading hubs might gain an advantage from Brexit as liquidity might shift. Even if UK decides to retain the status quo, (short-term) legal uncertainty could increase trading business on the Continent.

The same holds true for UK as a legal venue. Continental venues could benefit when companies decide to move place of jurisdiction to Continental sites.

[185] Regulation (EC) No 593/2008.

Table 29: Rules applicable to energy companies in countries under different arrangements

	Market rules	Financial regulation of energy trading	Legal jurisdiction and enforceability
EU Member State (e.g. France)	EU IEM legislation + EU state aid rules	EU legislation	Full enforceability (*Brussels Regime*) Full choice of law (*Rome I*)
EEA (e.g. Norway)	EU IEM legislation + EU equivalent state aid/competition rules	'Passport' clauses for certain regulations 'Equivalence' clauses for certain regulations (+ International rules)	Enforceability possible (*Lugano Convention*)
Energy Community (e.g. Ukraine)	EU IEM legislation + UK state aid rules + WTO subsidy rules	'Equivalence' clauses for certain regulations (+ International rules)	Bilateral and international treaties (*The Hague Convention* possible)
Bilateral Treaty (e.g. Switzerland)	national state aid rules + WTO subsidy rules	'Equivalence' clauses for certain regulations (+ international rules)	Enforceability possible* (*Lugano Convention*)
WTO (e.g. Morocco)	national state aid rules + WTO subsidy rules	'Equivalence' clauses for certain regulations (+international rules)	Bilateral and international treaties (*The Hague Convention* possible)

Source: Bruegel.
Note: * If the UK joins the EFTA and chooses to join the Lugano Convention.

CHAPTER 8. IMPACT OF THE UK WITHDRAWAL FOR IRELAND

KEY FINDINGS

- The energy system of the Republic of Ireland (ROI) could be significantly affected by Brexit because the ROI operates a joint electricity market with Northern Ireland (NI), trades electricity with Great Britain (GB) and buys a significant amount of gas from GB.
- For the ROI, the first best solution is if the UK remains inside the internal energy market; the second-best option is if NI remains inside the internal energy market; and the worst option is if only the ROI remains inside the internal energy market.
- Ensuring that the SEM continues to function efficiently and that a level playing field is maintained in the SEM will be important following Brexit.
- It is uncertain whether the ROI may be exempted from certain provisions of EU energy regulation. It seems questionable though that the ROI would qualify as an 'energy island'.
- The case of the ROI may offer both the EU27 and the UK an opportunity to advocate increased energy market integration after Brexit. The EU may argue that accepting full internal market membership of the UK is the price to pay for allowing the ROI to fully benefit from the EU internal energy market. The UK, on the other hand, may argue that accepting a certain loss of sovereignty from participating in the EU energy market framework is the price to pay for Northern Ireland.

The following chapter evaluates the potential impact of Brexit on the energy system of the Republic of Ireland (ROI). The first part focusses on the electricity sector of the ROI. In particular, the impact of Brexit on the island of Ireland's joint electricity market and future integration with the rest of Europe is discussed. The second part deals with possible efficiency and security of supply issues in the gas sector of the ROI. A discussion on whether the ROI may become exempted from certain provisions of EU energy law is furthermore included.

8.1 Electricity market

8.1.1 Current situation

The Single Electricity Market (SEM), founded on 1 November 2007, comprises the wholesale electricity markets of the ROI and Northern Ireland (NI). The SEM is a gross mandatory pool market into which all electricity produced on and imported to the island of Ireland must be sold, and from which all wholesale electricity for consumption on or export from the island must be purchased.[186] The SEM is underpinned by national legislation in ROI and NI and a legally non-binding Memorandum of Understanding between the UK and the ROI. The rules governing the SEM can therefore remain after Brexit. Based on legislation in NI and the ROI, the Single Electricity Market Committee has been established

[186] SEM Committee (n.d.).

as the decision-making authority, and comprises members from the Commission for Regulation of Utilities (CUR) (formerly the Commission for Energy Regulation), Utility Regulator of Northern Ireland (UR), an independent member, and a deputy independent member. The decisions of the committee are binding for the regulatory authorities in NI and the ROI.

The SEM is currently being redesigned to comply with the EU's vision of the EU Target Model.[187] The new wholesale market, called the Integrated Single Electricity Market (I-SEM), will replace the SEM by May 2018.[188] The I-SEM is considered a key step to further integrate the electricity market of the ROI and NI, improve its efficiency and make it compatible with the other EU electricity markets in order to complete the internal energy market. It will, *inter alia*, entail the creation of cross-zonal day-ahead and intraday markets. This may imply that an increase in intermittent wind generation on the island of Ireland might be used to reduce fossil generation in Germany – if sufficient transmission capacity is available. With a 'hard' Brexit, the EU's vision of a deeply integrated internal energy market will still be feasible on the Continent, but more difficult to achieve for the ROI (see Chapter 1).

The level of interconnectivity of the SEM (and ultimately also of the I-SEM) with the rest of Europe is limited. Two interconnectors to GB exist: (1) the 500 MW Moyle Interconnector between Scotland and NI, and (2) the 500 MW East–West Interconnector between the ROI and North Wales. In case of a separation of the SEM, the ROI would still have the East-West Interconnector to Wales and three interconnectors[189] between the ROI and NI (although only one of these three allows for mass flow of electricity).[190]

Several Projects of Common Interest (PCIs),[191] intended to increase the transmission capacity with other European electricity markets, are ongoing.[192] The most important is the second North-South interconnector for which planning approval has been achieved in the ROI and is awaited in NI. Delivery of this project will remove the current restriction on flows across the existing interconnector (limited to 300 MW for system security purposes) which amounts to approximately 30 percent of the effective economic flow that would occur were this limit not in place. Another notable PCI is the construction of a 700 MW high-voltage direct current (HVDC) cable (known as the 'Celtic Interconnector') between the SEM and France. A preliminary feasibility study was completed in August 2016 and the project is now undergoing a two-year design phase. An additional PCI seeks to add a 500-700 MW interconnector (known as the Greenwire Interconnector, or 'Greenlink') between the SEM and Wales.[193]

---

[187] The EU Target Model was introduced in the 2009 Third Energy Package and essentially promotes an integrated energy market in the EU.

[188] SEM Committee (2016).

[189] There are three electricity interconnectors between the ROI and NI: (1) Tandragee-Louth, (2) Strabane/Tyrone – Letterkenny/Donegal, and (3) Enniskillen/Fermanagh-Corraclassy/Cavan. Only (1) is used for electricity trading while (2) and (3) are standby interconnectors used for technical assistance and facilitating local networks stability.

[190] Department for the Economy (n.d.).

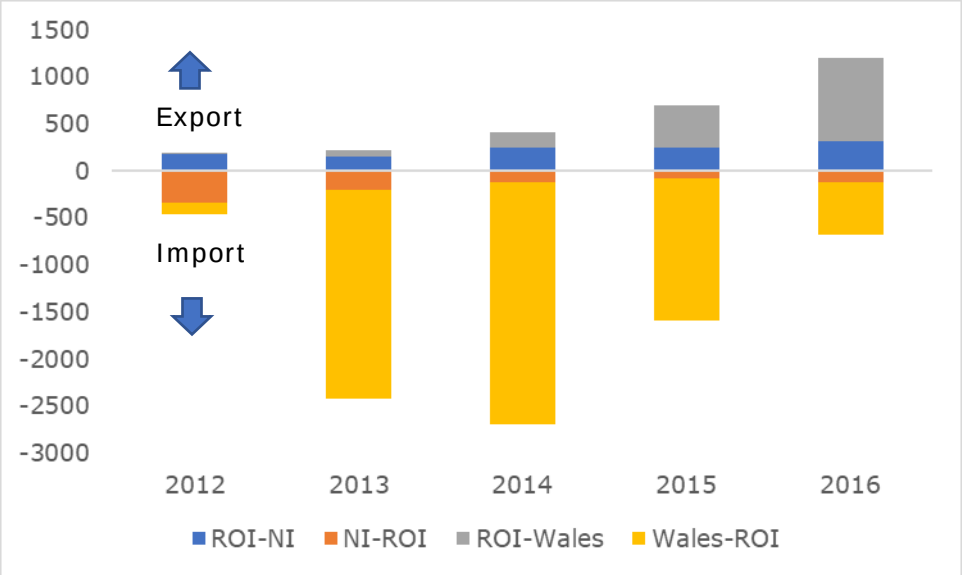
[191] See Chapter two for more on PCIs.

[192] The full list of PCIs relating to the ROI and NI can be found here: https://ec.europa.eu/inea/en/connecting-europe-facility/cef-energy/projects-by-country/ (European Commission, 2017k).

[193] Two studies have also been completed on the 'ISLES' interconnection between the SEM and Scotland. The project is currently under consideration. (European Commission, 2016f)

Most electricity on the island of Ireland is produced domestically. More recently, the SEM area has become a net exporter of electricity to GB (see Figure 12). The net export trend has continued in 2017.

Figure 12: Electricity imports to and exports from the Republic of Ireland 2012 – 2016



Source: Bruegel based on UK Government (2017d).

Electricity trading between the SEM and GB (the only market to which the SEM is connected) is important for the SEM to balance its system more efficiently and economically. In windy hours the island of Ireland can produce up to 4,000 MWh of electricity from wind, while in windless hours this drops to virtually zero. The 1,000 MW of electricity interconnectors to GB serve as a crucial buffer for wind production and demand fluctuations that will become more important as the share of wind power increases in the Irish fuel mix.

Electricity flows between the Continent and the ROI via GB. The flows are largely determined by the price differentials between the Continent and GB as well as between the SEM and GB. In the first half of 2017, in 37.3 percent of the hours, GB imported electricity from the Continent and at the same time exported to the island of Ireland (Table 30). In 7.5 percent of the hours, GB served as a transit country in the other direction.

Table 30: Electricity transit through GB - Number of hours (January to June 2017)

	IMPORTS FROM IRELAND	EXPORTS TO IRELAND
IMPORTS FROM THE CONTINENT	2,225	1,622
EXPORTS TO THE CONTINENT	325	172

Source: Bruegel based on Gridwatch (2017).
Note: The total number of trading hours in the first half of 2017 were 4344.

Overall, in the first half of 2017, 160 GWh flowed from the SEM to the Continent and 2,490 GWh flowed from the Continent to the island of Ireland via GB. The island of Ireland's electricity supply is currently also dependent on natural gas imports from GB (see section 8.2 for more on the gas sector in the ROI).

The departure of the UK from the EU might have major implications for the functional operability of the SEM. In addition, it might become more advantageous for the ROI to establish interconnectivity with other electricity markets. The following will discuss these issues further.

8.1.2 Implications for the SEM/I-SEM

Brexit could, at least in theory, constrain the development of the I-SEM. When the UK leaves the EU, it will no longer be obliged to comply with the EU Target Model.[194] If the UK decides not to comply, agreeing on a common set of rules underpinning the I-SEM may become more difficult. Alternative market arrangements, such as integrating NI with the electricity market of GB, may then be necessary.[195] Although this scenario is theoretically possible, the withdrawal of NI from the SEM (and in the future, the I-SEM) would be irrational. Both NI and the ROI derive great benefits from the market integration, and both sides remain committed to maintaining the integrated market structure. As significant volumes of electricity also flow between (mainly from) the ROI and (to) NI, NI may be negatively affected by a less integrated market.[196]

The efficiency of the SEM may worsen due to Brexit. The impact will likely be limited if the current regulatory environment is preserved. If, however, changes occur, the costs for market operators and regulatory authorities may increase. Whether the legal framework is disrupted may depend on NI and GB remaining in the EU internal energy market (IEM). The three key scenarios, from the most to the least desirable from an ROI perspective, which might unfold following Brexit are:

1. The UK remaining in the IEM.
2. NI remaining in and GB leaving the IEM.
3. Both GB and NI leaving the IEM.

In the first scenario, in which both GB and NI remain in the IEM, the impact of Brexit might be limited. The EU network codes and guidelines would likely continue to apply, implying that the efficiency of the SEM may be largely unaffected.

In the second scenario, there would be more uncertainty about the extent to which the efficiency of the SEM may be impacted. In particular, it is unclear whether the existing network codes and guidelines would continue to apply to the cross-border trade between the island of Ireland and GB. Whether NI can remain in the IEM without GB may depend on both the participation requirements in the IEM set by the EU and on the willingness of GB to devolve some authority to NI.

The third scenario would be the worst outcome for the ROI, especially if it leads to a change to or termination of the SEM arrangement. A withdrawal of the UK from the EU and the IEM means NI will no longer be obliged to accept the European Court of Justice (ECJ) as a final court of appeal in the event of disputes. Should NI reject the ECJ, there will be a

[194] Higgins & Costello (2016).
[195] Higgins & Costello (2016).
[196] Higgins & Costello (2016).

need for an alternate dispute resolution mechanism.[197] If the regulatory structures diverge between the NI and ROI jurisdictions, it may furthermore be more difficult to ensure that all participants in the SEM are exposed to a common set of rules and a level playing field.

However, it is uncertain whether the regulation underpinning the SEM would change due to Brexit. The development of the I-SEM demonstrates the ROI's and NI's efforts to harmonise the regulation of the joint market with EU network codes and guidelines. Moreover, as both NI and the ROI derive great benefits from the joint market structure, it is in their dual interest to ensure that the functional operability of the SEM is not worsened by Brexit.

8.1.3 Implications for electricity market integration

Brexit could have significant implications for the integration of the SEM with the broader EU electricity market. A higher level of integration would enable the ROI to better manage the increasing domestic supply of intermittent power sources (most notably wind). One option is to increase the transmission capacity with GB. As discussed in section 8.1.1, several PCIs aimed at doing this are ongoing. The progress of these projects may be slowed down, however, by Brexit. Specifically, Brexit has resulted in increased market uncertainty and investor insecurity, which may deter investment in infrastructure projects in GB.[198] It is also unclear to what degree the UK will be eligible to access EU funds for cross-border energy infrastructure projects (see Chapter 2) after leaving the EU. This may expose future interconnection projects between GB and the SEM to financial obstacles.

Instead of increasing integration with GB, the ROI may seek closer ties with Continental Europe. Currently, all of the Irish island's imported electricity is either directly bought from or transited through GB. This renders the island vulnerable to disruptions in the GB system. Increased integration with Continental Europe would diversify risk and reduce dependence on a third country like the UK. More transmission capacity to the Continent would thus enhance security of supply. From an efficiency point of view, however, the picture is less clear. It might be costlier to link the SEM to Continental Europe than to GB. Moreover, the value of building an interconnection to the Continent would depend on the future level of interconnectivity between GB and the Continent.[199] Electricity prices in GB remain relatively decoupled from Continental prices because of transmission constraints. However, if GB adds interconnection capacity with Europe as planned, prices on the GB market would increasingly align with those on European markets.[200, 201] The value for the ROI of directly linking to the EU would thereby diminish.

In essence, increased integration with the electricity markets of Continental Europe would enhance security of supply and might increase the efficiency of the SEM. The outcome of the latter would depend on GB's efforts to integrate its own market with the Continent.

---

[197] Higgins & Costello (2016).

[198] The value of all infrastructure contracts in the UK in July 2016 (the first full month following the Brexit referendum) and September 2016 were 20 percent and 44.5 percent lower respectively compared to the same months in 2015 (Higgins & Costello, 2016).

[199] Barrett et al. (2015).

[200] Barrett et al. (2015).

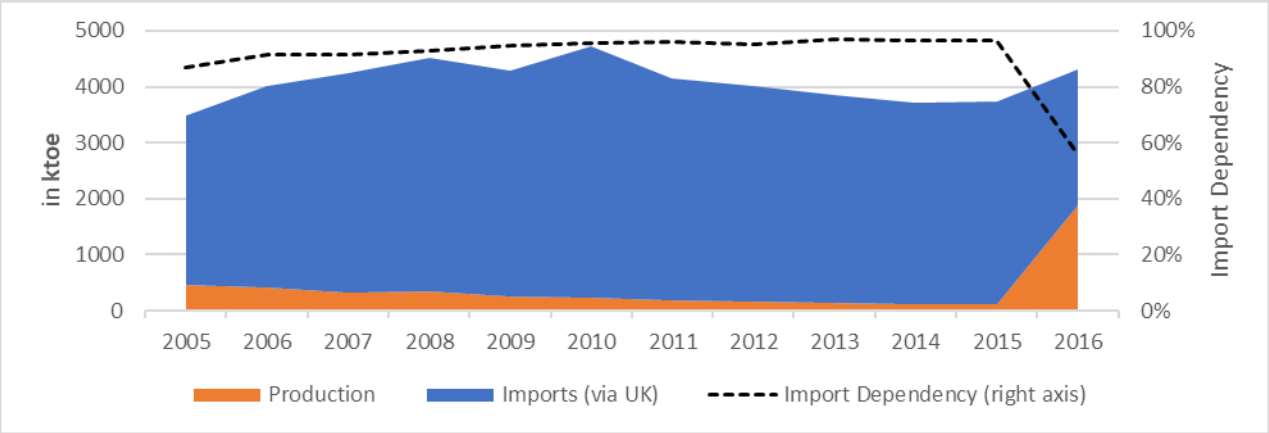
[201] The UK is currently building an interconnector to Norway, a country which is integrated with the Nordic and Baltic countries through the Nord Pool market.

8.2 Gas market

8.2.1 Current situation

In contrast to the electricity sector, the gas markets of the ROI and NI are separate. Gas plays a crucial role in the energy sector in the ROI. More than 46 percent of the electricity was generated from natural gas in the ROI in 2014. All of the imported gas is either supplied from or transited through the UK. The ROI is heavily reliant on these imports, as illustrated in Figure 13. Until 2015, almost the entire gas supply consisted of imports. At the end of 2015, however, a domestic gas field (the Corrib Gas Field) became operational. This led to a large increase in domestic production and a decrease in imports. The ROI currently imports around 40 percent of its gas from the UK. However, the supply of domestic gas is only expected to last for at most twenty more years, after which the ROI may become increasingly dependent on UK imports again.[202]

Figure 13: The ROI's gas production and imports



Source: Bruegel based on Irish Central Statistics Office and BP Statistical Review 2017.

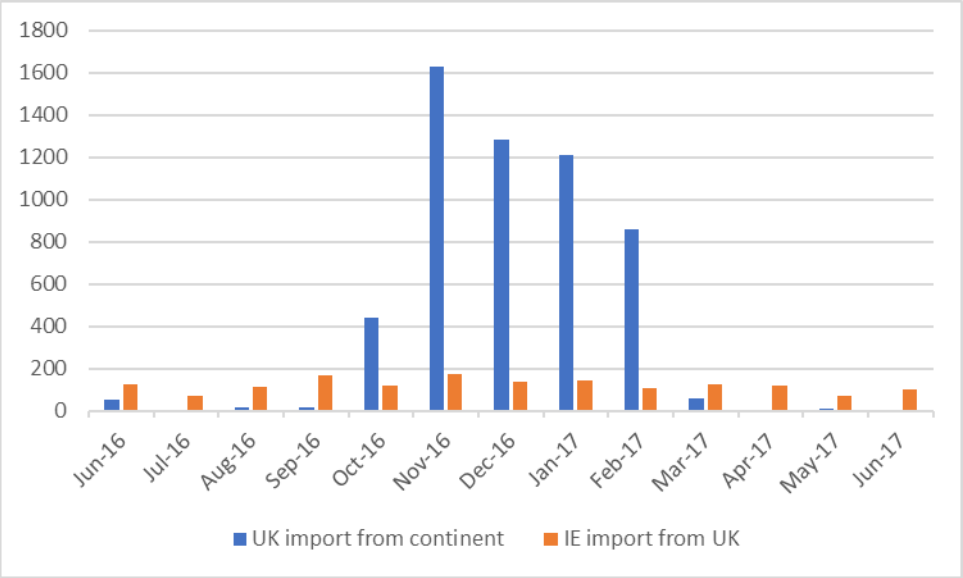
The ROI currently does not possess a liquefied natural gas (LNG) terminal. However, the ROI's 2016 imports of two bcm through the Moffat Interconnector could be replaced by currently-discussed LNG projects (i.e. the Shannon and Cork LNG projects would exceed the ROI's entire import demand.[203] However, it is unclear whether the Shannon project will be completed.[204]

[202] Higgins & Costello (2016).

[203] See Platts (2017) and Business Irish (2017) for more on these projects.

[204] The Shannon project has been designated PCI status and could therefore be eligible for funding from the Connecting Europe Facility, but it is unclear if the project is commercially viable, as it may require a premium above the price of natural gas imported from the UK in order to be profitable.

Figure 14: The ROI's gas imports from the UK and UK imports from the EU27 (June 2016 - June 2017)



Source: Bruegel based on IEA (2017).

Brexit can be expected to raise two primary concerns for the gas sector of the ROI. Firstly, the departure of the UK might, in theory, increase the price of the gas traded on the UK's gas exchange. Thus, it is possible that imports from the UK become costlier in the future. Secondly, the ROI will be dependent on a third country (the UK) for its gas imports after Brexit which may raise security of supply concerns. Both the possible efficiency and security of supply issues are evaluated in the following sections.

8.2.2 Implications for future gas exchange

A report by the Oxford Institute for Energy Studies[205] suggests that the spread between the NBP and TTF may rise after the UK's departure from the EU. This could happen if the NBP becomes a smaller hub, with a lower volume of trades, because of financial services moving away from the UK. Moreover, the price of UK gas might also increase if European countries impose stricter regulations on pipelines to the UK, in order to make the EU more competitive. This would increase the cost of importing gas for the UK, which in turn could spill-over to the ROI's gas market. The base case, however, is that the NBP-TTF spread might not significantly increase because the UK market remains well connected to Norway and the Continent.

The efficiency of importing gas from the UK could, in theory, also be affected by changes in the regulation of gas pipelines between the UK and the ROI. Current rules are based on bilateral agreements. It is possible that the EU could impose a single legal framework for all pipelines[206] linked to the UK.[207] The single EU-UK framework could replace the current bilateral agreement between the ROI and the UK. It is currently unclear whether the rules

[205] Bros (2017a).

[206] The UK has three international gas pipelines: Moffat with the ROI, Interconnector UK with Belgium and the Balgzand Bacton Line with the Netherlands (Bros, 2017).

[207] Bros (2017a).

governing these pipelines will change. However, this might be of limited concern, since the current bilateral regulations are largely based on EU principles. The legal framework might therefore not change much after Brexit.

8.2.3 Implications for the security of gas supply

Because the ROI derives a significant share of its gas from the UK, the ROI is vulnerable to supply disruptions in the UK market, even if the UK remained in the EU. Moreover, as the UK itself is a net importer of gas, the ROI is indirectly exposed to potential gas system problems in the countries exporting to the UK.

The impact of Brexit on the security of supply for the ROI is ambiguous. On the one hand, the ROI could no longer rely on the EU's Solidarity Principle in the event of a major domestic gas disruption, since it would lack direct access to EU gas markets.[208] Prior to Brexit, the UK, as a Member State, would be obliged to help the ROI in the event of a gas crisis by providing gas to essential social services and households.[209] Brexit would remove this EU obligation, which could potentially leave the ROI more vulnerable to energy crises. On the other hand, Gas Networks Ireland (GNI)[210] noted the following in a statement in June 2017: "*within the framework of existing intergovernmental agreements in place since 1993 between Ireland and the UK concerning Ireland's two gas interconnectors, Gas Networks Ireland and National Grid have agreed a voluntary protocol for dealing with gas emergencies affecting GB and Ireland. We see no reason for these arrangements to change post Brexit.*"[211]

This suggests that Brexit might ultimately have a limited effect on the issue of security of gas supply for the ROI.

[208] Barrett et al. (2015).

[209] European Commission (2017m).

[210] Gas Networks Ireland (GNI) is the state-owned entity that owns and operates the natural gas network in the ROI.

[211] Houses of the Oireachtas (2017).

Box 3: Irish eligibility for derogations from EU energy legislation

IRISH ELIGIBILITY FOR DEROGATIONS FROM EU ENERGY LEGISLATION

After Brexit, the ROI's energy market might become more isolated from the rest of the EU. The ROI could therefore, in theory, be more likely to qualify for certain derogations from EU energy law. It is theoretically possible that the ROI becomes increasingly compared to 'energy islands'. These are isolated and/or emergent energy systems that enjoy a privileged status in EU legislation.[212] They can derogate from the requirements on energy market design and on the regulatory framework stipulated in EU energy law.[213] A country can obtain derogations for either its electricity or gas sector, or both. The ROI will likely not qualify as an 'electricity island' as it is too large to meet the threshold.[214] With respect to the ROI's gas sector, the legal text is somewhat more ambiguous and it is therefore less clear whether the ROI could qualify as a 'gas island'. However, as the ROI's gas market is sufficiently competitive, we deem it unlikely to meet the criteria to become exempted from EU gas market rules.[215]

A UK departure from the EU may imply that the ROI would, at least temporarily, no longer be directly physically connected to the electricity systems of other Member States. It is unclear whether this may theoretically exempt the ROI from some EU network codes and guidelines. In particular, certain provisions state that they only apply to Member States which are connected with other transmission systems. For instance, Article 1(2) of the Guideline on Capacity Allocation and Congestion Management (CACM) says:

"This Regulation shall apply to all transmission systems and interconnections in the Union except the transmission systems on islands which are not connected with other transmission systems via interconnections." [216]

It is unclear though whether the ROI can obtain derogations from only some of the provisions of EU network codes and guidelines. Moreover, there is some ambiguity as to whether "*connected with other transmission systems*" refers to transmission systems of other Member States, or also to those outside the EU. Whether the ROI can derogate from some provisions of EU energy law without becoming an energy island is furthermore not evident.

Source: Bruegel.

[212] De Hauteclocque & Ahner (2012).

[213] More specifically, the Third Energy Package allows EU energy islands to be derogated from the common rules governing the Member States' energy systems for electricity and gas contained in Directive 2009/72/EC and Directive 2009/73/EC respectively.

[214] Derogations in electricity are possible for 'small isolated systems', which are defined as having a consumption of less than 3,000 GWh in the reference year 1996, where less than five percent of the annual consumption is obtained through interconnections with other systems. The electricity consumption in the ROI in 1996 was 15,847 GWh (based on Eurostat (2017b)) which is much higher than the consumption threshold.

[215] The ROI can obtain derogations as a so-called 'isolated gas market' if its gas system is not connected to the system of another Member State and if it has only one main external supplier. A 'main supplier' is defined as a supplier with a market share of more than 75 percent. (Directive 2009/73/EC) As the market share of the largest retail gas supplier in the ROI is only around 50 percent in the first quarter of 2017 (in terms of both customer numbers and GWhs supplied), it seems unlikely that the ROI would qualify as a 'gas island' (CRU, 2017).

[216] Commission Regulation (EU) 2015/1222.

8.3 Critical issues and options

Both the EU27 and the UK have an interest in an increasingly integrated energy market. But both face matters of principle that make it difficult to agree on this first-best solution. The UK seeks to repeal European rules that infringe on its sovereignty. The EU, on the other hand, does not want to allow the UK to 'cherry-pick' parts of the existing acquis in the negotiations.

The complex case of the Republic of Ireland might offer both sides an opportunity to achieve a first-best solution. The EU might argue that accepting full internal market membership of the UK is the price to pay for allowing the Republic of Ireland to fully benefit from the EU internal energy market. At the same time, the UK – which anyway benefits from the internal energy market – can argue that accepting a certain loss of sovereignty from participating in the EU energy market framework (possibly without being able to play a full role in the institutions) is the price to pay for Northern Ireland. This mutual dependency can be a credibility device for both sides (and it might also help convince investors of the stability of the arrangement).

Ultimately, ensuring that the SEM (and in future the I-SEM) continues to function efficiently is key for the ROI (and NI). The regulatory framework of the SEM should furthermore facilitate a level playing field on the island of Ireland.

CHAPTER 9. FINDINGS

A tacit assumption in all of our findings is that the UK will in fact withdraw from the EU.

9.1 The future of UK access to the European energy market

The UK imports electricity and gas from the EU27 and the EEA. It also serves as a transit country for electricity and gas between Ireland and the EU26 (EU 27 minus Ireland), as well as a transit country for gas between Norway (an EEA country that is not an EU Member State) and the EU27.

More than 80 percent of the value in EU27/UK electricity and gas trade in 2015 (some EUR 6 billion) was for natural gas. The UK imported natural gas worth an additional EUR 10 billion from Norway.

The EU is in the process of creating a single energy market for electricity. For the UK to fully participate, it would need to adhere to changing EU energy market rules and to accept the authority of the relevant EU institutions to enforce those rules. In the absence of an agreement to do so, the UK would be limited to conducting tariff-free export and import of bulk electricity, as do Russia and Morocco. If the UK were to take this route, it would sacrifice the long term efficiencies that come with the joint optimisation of the linked systems. The negative impact would disproportionally fall on the UK (and Ireland), as the Continental market is much larger and already better integrated.

In principle, the same also holds for the internal gas market. But as natural gas is storable the benefits of a jointly optimised system are slightly less prevalent and hence the relative impact of Brexit might be somewhat less significant than for the electricity exchanges between the EU27 and the UK.

Brexit is unlikely to have any direct impact on UK energy taxes.

9.2 Availability of EU funds for energy projects

After Brexit, the UK might have more limited access to funding from the European Investment Bank (EIB), the European Fund for Strategic Investment (EFSI), the European Energy Programme for Recovery (EEPR), the Connecting Europe Facility (CEF) and Horizon 2020 (H2020). The impact on the UK could be substantial in light of the level of funding currently committed for energy projects in which the UK participates.

- The EIB provided about EUR 9 billion between 2012 and 2017.
- The EFSI has signed financing worth EUR 1.4 billion since 2015, and approved another EUR 410 million.
- The EEPR has provided grants for a total of EUR 330 million.
- The CEF has funded EUR 125.6 million, and additional funding of EUR 90 million is in the pipeline. Of the current EU projects of common interest (PCIs), 16 are UK-related.
- The H2020 programme currently funds more than 90 projects, for a total commitment of EUR 160 million.

The details of the UK's withdrawal from the EIB should be part of a single financial settlement between the EU27 and the UK, and should not be treated separately.

9.3 PARTICIPATION IN REGULATORY BODIES

The UK withdrawal will have no substantive impact on the voting shares and the functioning of the EU regulatory bodies that oversee the functioning of the EU internal energy market,

such as ACER, ENTSO-E and ENTSOG. Should the UK seek however to continue its participation in the internal energy market, it will have to comply with decisions taken by these regulatory bodies while having little or no influence over them.

9.4 Revisiting EU energy and climate targets

If the UK accepts that it will continue to adhere to EU energy and climate targets (so as to retain access to the internal market), it could possibly be required to report on its corresponding policies to the European Commission and receive guidance on its corresponding policies in order to allow the EU to achieve its union-wide targets.

If the UK does not adhere to its current commitments regarding EU energy and climate targets, a political decision in the EU will be needed on how to adjust the EU27 energy and climate targets after Brexit. We explore three options for readjusting the national and/or EU targets which keep constant either (1) the national ambitions, (2) the EU28 ambition in absolute terms, or (3) the EU28 ambition in percentage terms. Given that the UK targets were close to the EU average, the resulting shifts are not dramatic, but they might still be significant for individual Member States.

If the UK were to exit the EU Emissions Trading System (ETS), it might cause a short-term surplus of allowances, but most likely Brexit will tighten the system in the longer term.

9.5 Rules for security of electricity and gas supplies

Pooling energy resources among Member States is essential for the EU to build a common and truly integrated internal energy market that is able to withstand external shocks.

Physical interconnections represent a fundamental prerequisite to enable solidarity and stability in both electricity and gas markets. Pooling benefits both the EU27 and the UK.

For electricity, the UK benefits considerably from its trade with the EU27. Imported electricity (7.5 percent of the total UK's consumption) helps the UK to keep prices down. The EU27 receives relatively little substantive benefit, however, because its electricity exchanges with the UK remain well below 1 percent of its total consumption.

For gas, the trade volume between the EU26 (EU27 minus Ireland) and the UK is generally rather limited. From an EU26-wide perspective, gas trade with the UK plays a minimal role. Further, given the capacity and the underutilisation of its LNG terminals, the EU26 could manage its LNG markets even without the UK's infrastructure. However, gas trade is an important issue for Ireland, which imports 56 percent of its consumption from the UK.

The security of the EU26's electricity and gas supplies is not likely to be affected by the UK withdrawal. It is reasonable to expect the UK's and neighbouring countries' transmission system operators to continue their long-lasting cooperation on the basis of their respective regulatory frameworks. For a discussion of the specific case of Ireland, refer to Section 9.8.

9.6 Future relation with Euratom

The UK Government has signalled its intention to leave not only the EU, but also Euratom. If it does so, the UK will have sole responsibility for ensuring its compliance with international treaties and conventions on nuclear energy from the withdrawal date.

Both the EU and the UK recognise the need for setting out clear arrangements on issues like nuclear safety and radioactive waste in the Withdrawal Agreement.

On safety, the two parties seem to agree that the Euratom Community should transfer ownership to the UK of equipment and other property on its territory related to the

provision of safeguards. However, the two parties will most likely disagree on the value of this property, which might thus be subject to negotiation.

On radioactive waste, the two parties seem to agree on the principle that the state in which the spent fuel or the radioactive waste was generated should be responsible. However, disagreements could well emerge during the negotiations.

9.7 Impact on energy markets for UK and EU companies

Many European companies are active on the UK gas and electricity markets and hold significant market shares. They would be subject to regulatory risks in a post-Brexit environment if the UK is no longer bound by EU rules.

The UK has traditionally been a leader in market liberalisation and its gas trading hub remains one of the largest and most important in Europe. However, Continental trading hubs could gain market shares because of the uniform regulatory environment, safeguarded by the EU combined with the absence of currency risks. London is one of the most important trading hubs for electricity, gas, oil and emission rights in the world. For the EU it is important to make sure that UK energy traders active in the EU will have to follow at least as rigorous financial market and transparency rules as their EU counterparts.

London as a venue for arbitration cases will most likely not be affected. This is a consequence of the New York Convention on the recognition and enforcement of foreign arbitral awards. For place-of-jurisdiction clauses, EU27 companies might decide to abandon London in favour of Continental competitors. Enforceability currently enshrined in the Brussels Convention will no longer be automatic, but it is not under threat. However, burdensome recognition procedures could increase the costs of enforcement of UK court rulings.

9.8 Impact of the UK withdrawal for Ireland

The energy system of the Republic of Ireland (ROI) could be significantly affected by Brexit because the ROI operates a joint electricity market with Northern Ireland (NI), trades electricity with Great Britain (GB) and buys a significant amount of gas from GB. Ensuring that the Irish Single Energy Market (SEM) continues to function efficiently and that a level playing field is maintained in the SEM will be important following Brexit.

For the ROI, the first best solution is if the UK remains inside the internal energy market; the second-best option is if NI remains inside the internal energy market; and the worst option is if only the ROI remains inside the internal energy market.

It is uncertain whether the ROI might be exempted from certain provisions of EU energy regulation. It seems questionable, however, that the ROI would qualify as an ‘energy island’.

The case of the ROI may offer both the EU27 and the UK an opportunity to advocate increased energy market integration after Brexit. The EU might perhaps argue that accepting full internal market membership of the UK is the price to pay for allowing the ROI to fully benefit from the EU internal energy market. The UK, might want to accept a certain loss of sovereignty from participating in the EU energy market framework, also, as the price to pay for energy security in Northern Ireland.

REFERENCES

- ACER. (2015). *ACER/CEER Annual Report on the Results of Monitoring the Internal Electricity and Natural Gas Markets in 2014.* ACER/CEER. Retrieved September 01, 2017, from http://www.acer.europa.eu/official_documents/acts_of_the_agency/publication/acer_market_monitoring_report_2015.pdf
- ACER. (2016). *Annual Activity Report .* ACER.
- ACER. (n.d.). *Mission & Objectives*. Retrieved October 01, 2017, from ACER: http://www.acer.europa.eu/en/The_agency/Mission_and_Objectives/Pages/default.aspx
- Ambrose, H., & Naish, V. (2016). *Brexit: Implications for London as a seat of arbitration?* Retrieved October 01, 2017, from Thomsen Reuters Practical Law Arbitration Blog: http://arbitrationblog.practicallaw.com/brexit-implications-for-london-as-a-seat-of-arbitration/
- Aurora Energy Research. (2017). *The carbon price thaw.* Aurora Energy Research. Retrieved October 01, 2017, from https://www.auroraer.com/wp-content/uploads/2017/10/GM-CPS-final_publication_Nonsubscribers.pdf
- Avis, P. (2016). *Hedging European Gas, retrieved September 2017*. Retrieved October 01, 2017, from http://energyanalyst.co.uk/hedging-european-gas/
- Barrett, A., Bergin, A., FitzGerald, J., Lambert, D., McCoy, D., Morgenroth, E., Studnicka, Z. (2015). *Scoping the Possible Economic Implications of Brexit on Ireland.* Dublin: The Economic and Social Research Institute.
- Batsaikhan, U., & Schoenmaker, D. (2017). *Can EU actors keep using common law after Brexit?* Retrieved October 01, 2017, from Bruegel: http://bruegel.org/2017/06/can-eu-actors-keep-using-common-law-after-brexit/
- BBC. (2016a). *EU Referendum - Results*. Retrieved October 01, 2017, from BBC: http://www.bbc.com/news/politics/eu_referendum/results
- BBC. (2016b). *Brexit will risk UK nuclear research jobs, says UKAEA boss*. Retrieved October 01, 2017, from BBC: http://www.bbc.com/news/uk-england-oxfordshire-36288657
- Bean, N., Croxon, M., & Stone, G. (2016). *MiFID still happens with "Brexit"*. Retrieved October 01, 2017, from Bloomberg Professional Services: https://www.bloomberg.com/professional/blog/mifid-still-happens-with-brexit-2/
- Bloomberg. (2017). *APX UK Power Day-Ahead Auction Price*. Retrieved October 01, 2017, from Bloomberg Terminal.
- Bros, T. (2017a). *Brexit's impact on gas markets - Brexit and security of supply for UK and Ireland.* Oxford Institute for Energy Studies. Retrieved October 01, 2017, from https://www.oxfordenergy.org/wpcms/wp-content/uploads/2017/01/Brexits-impact-on-gas-markets-OIES-Energy-Insight.pdf
- Bros, T. (2017b). *Brexit's impact on gas markets - Irish options: IBP, NBP or TTF?* Oxford Institute for Energy Studies. Retrieved October 1, 2017, from

https://www.oxfordenergy.org/wpcms/wp-content/uploads/2017/03/Brexits-Impact-on-Gas-Markets-Irish-Options-IBP-NBP-or-TTF.pdf

- Business Irish. (2017). *US company wants to build LNG terminal in Cork*. Retrieved October 01, 2017, from Business Irish: https://www.independent.ie/business/irish/us-company-wants-to-build-lng-terminal-in-cork-35952148.html
- BusinessGreen. (2017). *EU and Switzerland make breakthrough on emissions trading linkup*. Retrieved October 01, 2017, from BusinessGreen: https://www.businessgreen.com/bg/news/3015803/eu-and-switzerland-make-breakthrough-on-emissions-trading-linkup
- CEER. (2015). *Articles of Association of the Council of European Electricity Regulators ASBL – Consolidated on 15 September 2015.* CEER.
- CEER. (n.d.). *Members*. Retrieved October 01, 2017, from CEER: https://www.ceer.eu/eer_about/members
- Craig, R. (2016). *The potential impact of Brexit on UK competition law*. Retrieved October 01, 2017, from TaylorWessing: https://united-kingdom.taylorwessing.com/download/article-brexit-competition-law.html
- CRU. (2017). *Retail Market Reports*. Retrieved October 15, 2017, from Commission for Regulation of Utilities: https://www.cru.ie/document_group/retail-market-reports/646/
- De Hauteclocque, A., & Ahner, N. (2012). *'Opt-out' clauses for EU energy islands in the third liberalization package: Striking balances?* Robert Schuman Centre for Advanced Studies.
- Department for the Economy. (n.d.). *Cross-border interconnection*. Retrieved October 01, 2017, from Department for the Economy Northern Ireland: https://www.economy-ni.gov.uk/articles/cross-border-interconnection
- Duwe, Matthias; Meyer-Ohlendorf, Nils; Umpfenbach, Katharina. (2017). *Governance of the Energy Union - Assessment of the Commission Proposal for a Governance Regulation.* Berlin: Ecologic Institute.
- EEA. (2017a). *Final energy consumption in Croatia per sector, 1990–2020*. Retrieved October 01, 2017, from European Environment Agency: https://www.eea.europa.eu/data-and-maps/figures/final-energy-consumption-in-croatia
- EEA. (2017b). *EU Emissions Trading System (ETS) data viewer*. Retrieved October 01, 2017, from European Environment Agency: https://www.eea.europa.eu/data-and-maps/dashboards/emissions-trading-viewer-1
- EIB. (2017). *The European Investment Bank (EIB): Financing for Sustainable Economic Growth in the Caribbean.* European Investment Bank. Retrieved October 15, 2017, https://eeas.europa.eu/sites/eeas/files/eib_lending-activities_may17_trinidad_eurochamtt.pdf
- EIB. (n.d.-a). *Shareholders*. Retrieved October 01, 2017, from European Investment Bank: http://www.eib.org/about/governance-and-structure/shareholders/index.htm
- EIB. (n.d.-b). *Projects financed - Multi-criteria list*. Retrieved October 01, 2017, from European Investment Bank: http://www.eib.org/projects/loan/list/index.htm

- EIB. (n.d.-c). *What is the European Fund for Strategic Investments (EFSI)?* Retrieved October 15, 2017, from European Investment Bank: http://www.eib.org/efsi/what-is-efsi/index.htm
- EIB. (n.d.-d). *EFSI project list*. Retrieved October 01, 2017, from European Investement Bank: http://www.eib.org/efsi/efsi-projects/index.htm?c=GB&se=3
- Energy UK. (2017). *Gas Supplies*. Retrieved October 01, 2017, from Energy UK: http://www.energy-uk.org.uk/energy-industry/gas-generation/gas-supplies.html
- ENTSO-E. (2014). *Articles of Association.* ENTSO-E. Retrieved October 01, 2017, from https://www.entsoe.eu/Documents/General%20ENTSO-E%20documents/General%20ENTSO-E%20documents/140930_Articles_of_Association.pdf
- ENTSO-E. (2016). *Report on the progress and potential problems with the implementation of Single Day-Ahead and Intraday Coupling.* ENTSO-E.
- ENTSO-E. (n.d.-a). *Ten year Network Development Plans 2018*. Retrieved October 01, 2017, from ENTSO-E: http://tyndp.entsoe.eu/
- ENTSO-E. (n.d.-b). *What are Network Codes?* Retrieved October 02, 2017, from ENTSO-E: https://electricity.network-codes.eu/network_codes/
- ENTSO-E. (n.d.-c). *ENTSO-E Member Companies*. Retrieved October 01, 2017, from ENTSO-E: https://www.entsoe.eu/about-entso-e/inside-entso-e/member-companies/Pages/default.aspx
- ENTSOG. (2014). *Articles of Association.* Retrieved September 30, 2017, from https://www.entsog.eu/public/uploads/files/publications/Balancing/2010/LGT0207_141 0207_Amendments%20to%20ENTSOG's%20AoA_EN_GA221014_clean.pdf
- ENTSOG. (n.d.). *Members*. Retrieved October 01, 2017, from ENTSOG: https://www.entsog.eu/members
- EU. (2016). *The role of EFSI in financing urban and regional projects.* European Union. Retrieved from http://www.eib.org/attachments/documents/mooc_factsheet_the_role_of_efsi_en.pdf
- EU. (n.d.). *European Investment Bank (EIB)*. Retrieved October 01, 2017, from European Union: https://europa.eu/european-union/about-eu/institutions-bodies/european-investment-bank_en
- EUROfusion. (2017). *EUROfusion statement on Brexatom*. Retrieved October 01, 2017, from EUROfusion: https://www.euro-fusion.org/2017/01/eurofusion-statement-on-brexatom/
- EUROfusion. (n.d.-a). *JET*. Retrieved October 01, 2017, from EUROfusion: https://www.euro-fusion.org/jet/
- EUROfusion. (n.d.-b). *Budget*. Retrieved October 01, 2017, from EUROfusion: https://www.euro-fusion.org/eurofusion/budget/
- European Commission. (2008). *Impact Assessment - Document accompanying the Package of Implementation measures for the EU's objectives on climate.* Retrieved from http://ec.europa.eu/transparency/regdoc/rep/2/2008/EN/2-2008-85-EN-1-0.Pdf

- European Commission. (2014a). *Guidelines on State aid for environmental protection and energy 2014-2020.* European Commission. Retrieved from http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014XC0628(01)&from=EN
- European Commission. (2014b). *HORIZON 2020 in brief. The EU Framework Programme for Research & Innovation.* Brussels.
- European Commission. (2014c). *Euratom - Mission Statement*. Retrieved October 01, 2017, from European Commission: http://ec.europa.eu/euratom/mission.html
- European Commission. (2014d). *Commission Decision of 08.10.2014 on one aid measure Sa.34947 (2013/C) (Ex 2013/N) which the United Kingdom is planning to implement for support to the Hinkley Point C Nuclear Power Station.* European Commission. Retrieved from http://ec.europa.eu/competition/state_/cases/251157/251157_1615983_2292_4.pdf
- European Commission. (2016a). *Investment Plan for Europe: One year of the European Fund for Strategic Investments (EFSI) – Frequently Asked Questions*. Retrieved October 01, 2017, from European Commission: http://europa.eu/rapid/press-release_MEMO-16-1967_en.htm
- European Commission. (2016b). *19 January 2016 – the Commission adopts ex-post evaluation of FP7*. Retrieved October 01, 2017, from European Commission: https://ec.europa.eu/research/fp7/index_en.cfm
- European Commission. (2016c). *EU ETS Factsheet.*
- European Commission. (2016d). *IED - Chapter III - Special provisions for Large Combustion Plants*. Retrieved October 01, 2017, from European Commission: http://ec.europa.eu/environment/industry/stationary/lcp/chapter3.htm
- European Commission. (2016e). *Commission proposes new rules on gas and a heating and cooling strategy*. Retrieved October 01, 2017, from European Commission: https://ec.europa.eu/energy/en/news/commission-proposes-new-rules-gas-and-heating-and-cooling-strategy
- European Commission. (2016f). *Technical information on Projects of Common Interes.* Retrieved from https://ec.europa.eu/energy/sites/ener/files/documents/technical_document_8_march_2016for_publication_-_change_05102016_1.pdf
- European Commission. (2017). *Report from the European Commission to the European Parliament and Council (COM(2017) 48 final).* Brussels.
- European Commission. (2017a). *Article 50 of the Treaty on European Union – Q&A*. Retrieved October 01, 2017, from European Commission: http://europa.eu/rapid/press-release_MEMO-17-648_en.htm
- European Commission. (2017b). *State of play of Article 50 negotiations with the United Kingdom*. Retrieved October 01, 2017, from European Commission: http://europa.eu/rapid/press-release_MEMO-17-2001_en.htm
- European Commission. (2017c). *Press statement by Michel Barnier following the fifth round of Article 50 negotiations with the United Kingdom*. Retrieved October 15, 2017, from European Commission: http://europa.eu/rapid/press-release_STATEMENT-17-3921_en.htm

- European Commission. (2017d). *Excise Duty Tables.* European Commission. Retrieved from https://ec.europa.eu/taxation_customs/sites/taxation/files/resources/documents/taxation/excise_duties/energy_products/rates/excise_duties-part_ii_energy_products_en.pdf
- European Commission. (2017e). *VAT rates.* European Commission. Retrieved from European Commission: https://ec.europa.eu/taxation_customs/sites/taxation/files/resources/documents/taxation/vat/how_vat_works/rates/vat_rates_en.pdf
- European Commission. (2017f). *The Connecting Europe Facility: Mid-term results.* European Commission. Retrieved from https://ec.europa.eu/inea/sites/inea/files/cef_implementation_brochure_web_final.pdf
- European Commission. (2017g). *2017 CEF Energy Call for Proposals.* European Commission.
- European Commission. (2017h). *Connecting Europe Facility*. Retrieved October 18, 2017, from European Commission: https://ec.europa.eu/transport/themes/infrastructure/ten-t-guidelines/project-funding/cef_en
- European Commission. (2017i, August 22). *Guidance note - Funding of applicants from non-EU countries & international organisations.* European Commission. Retrieved from European Commission.
- European Commission. (2017j). *EU and Switzerland join forces on emissions trading*. Retrieved October 01, 2017, from European Commission: https://ec.europa.eu/clima/news/eu-and-switzerland-join-forces-emissions-trading_en
- European Commission. (2017k). *CEF-E Actions by Country*. Retrieved October 25, 2017, from European Commission: https://ec.europa.eu/inea/en/connecting-europe-facility/cef-energy/projects-by-country/
- European Commission. (2017l). *Position paper on nuclear materials and safeguard equipment.*
- European Commission. (2017m). *Agreement reached on new Security of Gas Supply Regulation*. Retrieved from European Commission: https://ec.europa.eu/energy/en/news/agreement-reached-new-security-gas-supply-regulation-0
- European Commission. (n.d.-a). *Excise Duties: Energy Tax Proposal*. Retrieved October 01, 2017, from European Commission: https://ec.europa.eu/taxation_customs/business/excise-duties-alcohol-tobacco-energy/excise-duties-energy/excise-duties-energy-tax-proposal_en
- European Commission. (n.d.-b). *Horizon 2020*. Retrieved October 01, 2017, from European Commission: https://ec.europa.eu/inea/en/horizon-2020
- European Commission. (n.d.-c). *Funded projects*. Retrieved October 01, 2017, from European Commission: https://ec.europa.eu/inea/en/horizon-2020/projects/funded-projects
- European Commission. (n.d.-d). *EEPR Factsheet Interactive Map*. Retrieved October 01, 2017, from European Commission: http://ec.europa.eu/energy/eepr/projects/

- European Commission. (n.d.-e). *Funding for Projects of Common Interest*. Retrieved October 01, 2017, from European Commission: https://ec.europa.eu/energy/en/topics/infrastructure/projects-common-interest/funding-projects-common-interest
- European Commission. (n.d.-f). *CEF-Energy projects: United Kingdom*. Retrieved October 01, 2017, from European Commission: https://ec.europa.eu/inea/en/connecting-europe-facility/cef-energy/projects-by-country/united-kingdom
- European Commission. (n.d.-g). *Projects of common interest – Interactive map*. Retrieved October 01, 2017, from European Commission: http://ec.europa.eu/energy/infrastructure/transparency_platform/map-viewer/main.html
- European Commission. (n.d.-h). *Technical information on Projects of Common Interest*. Retrieved October 19, 2017, from European Commission: https://ec.europa.eu/energy/sites/ener/files/technical_docu.pdf
- European Commission. (n.d.-i). *Projects of common interest*. Retrieved October 01, 2017, from European Commission: https://ec.europa.eu/energy/en/topics/infrastructure/projects-common-interest
- European Commission. (n.d.-j). *Effort Sharing Decision.* European Commission. Retrieved September 2017, from https://ec.europa.eu/clima/policies/effort_en#tab-0-0
- European Commission. (n.d.-k). *2030 climate & energy framework*. Retrieved October 01, 2017, from European Commission: https://ec.europa.eu/clima/policies/strategies/2030_en#tab-0-0
- European Commission. (n.d.-l). *Revision for phase 4 (2021-2030)*. Retrieved October 01, 2017, from European Commission: https://ec.europa.eu/clima/policies/ets/revision_en
- European Commission. (n.d.-m). *Auctioning*. Retrieved October 01, 2017, from European Commission: https://ec.europa.eu/clima/policies/ets/auctioning_en#tab-0-0
- European Commission. (n.d.-n). *International carbon market*. Retrieved October 01, 2017, from European Commission: https://ec.europa.eu/clima/policies/ets/markets_en
- European Commission. (n.d.-o). *European Energy Programme for Recovery*. Retrieved October 01, 2017, from European Commission: http://ec.europa.eu/energy/eepr/projects/#!/
- European Council. (2014). *2030 climate and energy policy framework.*
- European Council. (2017a). *European Council (Art. 50) guidelines following the United Kingdom's notification under Article 50 TEU*. Retrieved October 01, 2017, from European Council: http://www.consilium.europa.eu/en/press/press-releases/2017/04/29-euco-brexit-guidelines/
- European Council. (2017b). *Directives for the negotiation of an agreement with the United Kingdom of Great Britain and Northern Ireland setting out the arrangements for its withdrawal from the European Union.* European Council. Retrieved from http://www.consilium.europa.eu/en/meetings/gac/2017/05/directives-for-the-negotiation-xt21016-ad01re02_en17_pdf/

- European Nuclear Society. (n.d.). *Nuclear power plants in Europe*. Retrieved October 01, 2017, from European Nuclear Society: https://www.euronuclear.org/info/encyclopedia/n/nuclear-power-plant-europe.htm
- European Parliament. (2017a). *Negotiations with the United Kingdom following its notification that it intends to withdraw from the European Union.* European Parliament. Retrieved from http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//NONSGML+TA+P8-TA-2017-0102+0+DOC+PDF+V0//EN
- European Parliament. (2017b). *The Brexit negotiations: Issues for the first phase.* European Parliament. Retrieved from http://www.europarl.europa.eu/RegData/etudes/IDAN/2017/607267/EPRS_IDA(2017)607267_EN.pdf
- European Union. (2012). Consolidated Version of the Treaty on the Functioning of European Union. *O.J. C 326/47*.
- European Union. (2015a). *EU ETS Handbook.* European Union.
- Eurostat. (2017a). *International trade database access (ComExt)*. Retrieved October 01, 2017, from Eurostat: http://epp.eurostat.ec.europa.eu/newxtweb/
- Eurostat. (2017b). *Eurostat Database*. Retrieved October 01, 2017, from Eurostat: http://ec.europa.eu/eurostat/data/database
- Eurostat. (2017c). *Greenhouse gas emissions in ESD sectors (t2020_35)*. Retrieved October 01, 2017, from Eurostat: http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=t2020_35&plugin=1
- Eurostat. (2017d). *Nuclear energy statistics*. Retrieved October 01, 2017, from Eurostat: http://ec.europa.eu/eurostat/statistics-explained/index.php/Nuclear_energy_statistics
- Financial Times. (2016). *Brexit's nuclear fallout: 3,000 cubic metres of Oxfordshire waste*. Retrieved October 01, 2017, from Financial Times: https://www.ft.com/content/6ee1ba76-b324-11e6-a37c-f4a01f1b0fa1
- Financial Times. (2017a). *EU infrastructure bank warns of Brexit hit to UK*. Retrieved October 16, 2017, from Financial Times: https://www.ft.com/content/aaaaa9cc-b1b2-11e7-aa26-bb002965bce8?mhq5j=e5
- Financial Times. (2017b). *Largest UK gas storage base shut to new supplies for a year*. Retrieved October 01, 2017, from Financial Times: https://www.ft.com/content/ca377e3c-1f9f-11e7-a454-ab04428977f9
- Financial Times. (2017c). *Brussels plans to saddle UK with EU nuclear waste*. Retrieved October 01, 2017, from Financial Times: https://www.ft.com/content/4cd8a146-3039-11e7-9555-23ef563ecf9a?mhq5j=e1
- Froggatt, A., Wright, G., & Lockwood, M. (2017). *Staying Connected - Key Elements for UK–EU27 Energy Cooperation After Brexit.* Chatam House.
- Fusion for Energy. (n.d.). *Objectives*. Retrieved October 01, 2017, from Fusion for Energy: http://fusionforenergy.europa.eu/aboutfusion/

- Galbraith, S., Davies, H., & Wright, C. (2016). *Brexit: potential impacts on energy markets and regulation.* Slaughter and May. Retrieved from https://www.slaughterandmay.com/media/2536193/brexit-and-energy-markets.pdf
- GIIGNL. (2017). *GIIGNL ANNUAL REPORT 2017.* GIIGNL.
- Government of the United Kingdom. (2017). *The United Kingdom's exit from and new partnership with the European Union.*
- Government of the United Kingdom. (2017b). *Position Paper by the United Kingdom: Nuclear materials and safeguards issues.*
- Gray, K. (2016). *EU-derived laws after Brexit: Focusing on the CRR and CRD IV*. Retrieved October 01, 2017, from Norton Rose Fulbright: http://www.insidebrexitlaw.com/blog/eu-derived-laws-after-brexit-focusing-on-the-crr-and-crd-iv
- Gridwatch. (2017). *G.B. National Grid Status*. Retrieved October 01, 2017, from Gridwatch: http://www.gridwatch.templar.co.uk/
- Hague Conference on Private International Law. (2005). *Convention on Choice of Court Agreements.* The Hague: Hague Conference on Private International Law. Retrieved from https://assets.hcch.net/docs/510bc238-7318-47ed-9ed5-e0972510d98b.pdf
- Heather, P. (2015). *The evolution of European traded gas hubs.* Oxford Institute for Energy Studies. Retrieved from https://www.oxfordenergy.org/wpcms/wp-content/uploads/2016/02/NG-104.pdf
- Heather, P., & Petrovich, B. (2017). *European traded gas hubs: an updated analysis on liquidity, maturity and barries to market integration.* Oxford Institute for Energy Studies.
- Higgins, P., & Costello, R. (2016). *IIEA Policy Brief: What does Brexit Mean for the Energy Sector in Ireland?* Dublin: Institute of International and European Affairs.
- Houses of the Oireachtas. (2017). *Gas Networks Ireland's Statement to the Seanad Special Select Committee on .* Houses of the Oireachtas. Retrieved from http://www.oireachtas.ie/parliament/media/committees/seanadspecialselectctteeonbrexit/reports/Opening-Statement-June-1-2017_Gas-Networks-Ireland.pdf
- ICAP. (2017). *Swiss ETS.*
- ICIS. (2017). *EU ETS White Paper – Brexit risks for the European carbon market .*
- IEA. (2012). *Energy Policies of IEA Countries - The United Kingdom 2012 Review.* Paris: OECD/IEA.
- IEA. (2017). *World energy statistics*. Retrieved October 01, 2017, from IEA World Energy Statistics and Balances (database): http://www.oecd-ilibrary.org/energy/data/iea-world-energy-statistics-and-balances/world-energy-statistics_data-00510-en?isPartOf=/content/datacollection/enestats-data-en
- IETA. (2017). *Measures to protect EU ETS from Brexit impacts must ensure market stability, urges IETA*. Retrieved October 01, 2017, from IETA: http://www.ieta.org/page-18192/5081199
- ITER. (n.d.). *What is ITER?* Retrieved October 01, 2017, from ITER: http://www.iter.org/proj/inafewlines

- Johnston, M. (2017). *Euratom myth-buster*. Retrieved October 2017, 2017, from markjohnston.org: https://markjohnston.org/2017/07/23/euratom-fact-check/
- Le Fevre, C. (2015). *The Role of Gas in UK Energy Policy.* Oxford Institute for Energy Studies. Retrieved from https://www.oxfordenergy.org/wpcms/wp-content/uploads/2015/07/NG-100.pdf
- Mammadov, E. (2017). *Re-regulation spells £2.6bn loss for U.K. energy suppliers*. Retrieved October 10, 2017, from Bloomberg Terminal: https://twitter.com/elchinmamedov/status/917682100446400512
- Maycock, J. (2016). *Brexit: Energy and commodities trading.* KPMG. Retrieved from https://assets.kpmg.com/content/dam/kpmg/uk/pdf/2016/11/Brexit-energy-commodities-trading.pdf
- National Grid. (2016). *Final Auction Results - T-4 Capacity Market Auction for 2020/21.* National Grid. Retrieved from https://www.emrdeliverybody.com/Capacity%20Markets%20Document%20Library/Final%20Results%20Report%20-%20T-4%202016.pdf
- National Grid. (2017). *New consultation launched*. Retrieved October 01, 2017, from National Grid: http://nationalgridconnecting.com/system-needs-product-strategy-launched/
- Nature. (2017). *Researchers shocked at UK's plan to exit EU nuclear agency*. Retrieved October 01, 2017, from Nature: http://www.nature.com/news/researchers-shocked-at-uk-s-plan-to-exit-eu-nuclear-agency-1.21388
- Nctm. (2016). *The Impact of Brexit on the European Energy market: some issues*. Retrieved October 01, 2017, from Nctm Law Firm: http://www.nctm.it/en/news/articles/the-impact-of-brexit-on-the-european-energy-market-some-issues#_ftnref1
- New York Convention. (n.d.). *Contracting States - List of Contracting States, retrieved September 2017*. Retrieved October 01, 2017, from New York Convention: http://www.newyorkconvention.org/list+of+contracting+states
- Ofgem. (2017a). *Electricity interconnectors*. Retrieved October 01, 2017, from Ofgem: https://www.ofgem.gov.uk/electricity/transmission-networks/electricity-interconnectors
- Ofgem. (2017b). *Dataportal*. Retrieved October 01, 2017, from Ofgem: https://www.ofgem.gov.uk/data-portal/overview
- Oxera. (2016). *Brexit: implications for state aid rules.* Oxera. Retrieved from https://www.oxera.com/getmedia/ca754e24-5bb2-4a68-a923-067bc716427a/Brexit-implications-for-state-aid-rules-new.pdf.aspx?ext=.pdf
- Petropoulos, G. (2016). *Brexit and competition policy in Europe*. Retrieved October 01, 2017, from Bruegel: http://bruegel.org/2016/07/brexit-and-competition-policy-in-europe/#_ftn1
- Platts. (2017). *Ireland backs revival of Shannon LNG facility on Brexit concerns*. Retrieved October 01, 2017, from Platts: https://www.platts.com/latest-news/natural-gas/london/ireland-backs-revival-of-shannon-lng-facility-26729600

- Platts. (n.d.). *UK NBP Gas Price Assessment: Natural Gas Price Assessments*. Retrieved October 01, 2017, from Platts: https://www.platts.com/price-assessments/natural-gas/uk-nbp
- Public Eye: *Trading in corruption: Evidence and mitigation measures for corruption in the trading of oil and minerals* Retrieved November 01, 2017, from https://www.publiceye.ch/fileadmin/files/documents/Rohstoffe/U4-Issue-2017-06-v4-full.pdf
- Reuters. (2017). *EU agrees measure to safeguard carbon market from Brexit*. Retrieved October 17, 2017, from Reuters: http://www.reuters.com/article/us-eu-carbon/eu-agrees-measure-to-safeguard-carbon-market-from-brexit-idUSKBN1CN33A
- Sandbag. (2017). *Brexit & the EU ETS: Greater as the sum or in parts?* London.
- Schinkel, P. M., Caree, M., & Günster, A. (2010). European Antitrust Policy 1957–2004: An Analysis of Commission Decisions. *Review of Industrial Organization, 36*(2).
- SEM Committee. (2016). *I-SEM Project Update Stocktake Report*. Retrieved October 01, 2017, from SEM Committee: https://www.semcommittee.com/news-centre/i-sem-project-update-stocktake-report
- SEM Committee. (n.d.). *SEM*. Retrieved October 01, 2017, from SEM Committee: https://www.semcommittee.com/sem
- Stafford, P. (2017). *Mifid vies with Brexit as City traders' main problem*. Retrieved October 01, 2017, from Financial Times: https://www.ft.com/content/f18bd4a4-7b4a-11e7-ab01-a13271d1ee9c?mhq5j=e5
- Stretch, K., Bielkowicz, K., & Parker, C. (2016). *European Derivatives Regulation in a Post Brexit World.* Paul Hastings. Retrieved from Paul Hastings: https://www.paulhastings.com/docs/default-source/PDFs/stay-current-emir-and-eu-derivatives-regulatory-reform---european-deriva.pdf
- Telegraph. (2017). *What is the energy price cap - and what does it mean for bills?* Retrieved October 01, 2017, from The Telegraph: http://www.telegraph.co.uk/business/2017/05/09/energy-price-cap-does-mean-bills/
- UK. (2014). *State aid approval for Hinkley Point C nuclear power plant*. Retrieved October 01, 2017, from UK Department of Energy & Climate Change: https://www.gov.uk/government/news/state-aid-approval-for-hinkley-point-c-nuclear-power-plant
- UK Government. (2015). *Large combustion plant directive (LCPD): Running hours during winter 2014/15 and capacity for 2015/16.*
- UK Government. (2016a). *Climate Change Levy: application, rates and exemptions*. Retrieved October 01, 2017, from UK Government: https://www.gov.uk/guidance/climate-change-levy-application-rates-and-exemptions#overview
- UK Government. (2016b). *Industrial emissions: list of limited lifetime combustion plants in the UK*. Retrieved October 01, 2017, from UK Government: https://www.gov.uk/government/publications/industrial-emissions-list-of-limited-lifetime-combustion-plants-in-the-uk

- UK Government. (2017a). *The United Kingdom's exit from and new partnership with the European Union.* UK Government. Retrieved from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/589191/The_United_Kingdoms_exit_from_and_partnership_with_the_EU_Web.pdf
- UK Government. (2017b). *Article 50 and negotiations with the EU*. Retrieved October 01, 2017, from UK Government: https://www.gov.uk/government/collections/article-50-and-negotiations-with-the-eu
- UK Government. (2017c). *Nuclear materials and safeguard issues - Position Paper.* UK Government. Retrieved from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/627909/FINAL_OFF_SEN_Position_Paper_HMG_Nuclear_materials_and_safeguards_issues_Position_Paper_FINAL_120717__3_.pdf
- UK Government. (2017d). *Energy Trends: Imports, exports and transfers of electricity (ET 5.6)*. Retrieved October 01, 2017, from Department for Business, Energy & Industrial Strategy: https://www.gov.uk/government/statistics/electricity-section-5-energy-trends
- Vattenfall. (2016). *Aberdeen Offshore Wind Farm*. Retrieved October 01, 2017, from Vattenfall: https://corporate.vattenfall.co.uk/globalassets/uk/projects/aberdeen-bay/vattenfall_aowf_suppliers_information_pack.pdf
- Willis, P. (2017). *Brexit: Energy market liberalisation implications*. Retrieved October 01, 2017, from Bird & Bird: https://www.twobirds.com/en/news/articles/2016/uk/brexit-eu-electricity-liberalisation

APPENDIX

Detailed calculations of renewable energy share targets

The following details the methodology underpinning the analysis of how the RES targets may change due to Brexit in scenarios two and three.[217]

The analysis is conducted on the basis of the methodology stipulated in an Impact Assessment report from the European Commission.[218] The targets derived in the Impact Assessment yields the current RES targets that are stipulated in the Renewable Energy Directive (except for Latvia[219]) (see column A in Table 31 for the official targets per Member State). This methodology is therefore considered suitable for calculating the new targets.

Scenario 2 – Same overall EU target in absolute terms

If the EU27 wants to attain the same overall volume of RES in 2020 (256.2 mtoe)[220], the remaining RES of the UK as of 2015 (11.73 mtoe)[221] would be distributed across the EU27 Member States. Applying the methodology of the Impact Assessment[222], the distribution is calculated as follows:

1.) The GDP/capita of each Member State in 2016 is divided by the EU27 average in 2016.[223] The resulting index is shown in column B in Table 31.

2.) The index is multiplied by a 'residual effort per citizen' value which is defined as follows:

---

[217] For scenario one, the individual national targets remain unchanged. This changes the EU-wide target. This change is calculated by subtracting the UK's forecasted gross final energy consumption in 2020 and renewable energy volume in 2020 (assuming it meets its RES target) from the EU totals, and thereby calculating the EU27's share of renewable energy in forecasted gross final energy consumption in 2020.

[218] European Commission (2008a).

[219] The RES target derived in the Impact Assessment (42 percent) is slightly different from that stipulated in the Renewable Energy Directive (40 percent) for Latvia. This is taken into account in the scenario analysis, as explained later.

[220] According to the Impact Assessment, meeting the 2020 RES targets implies that the volume of renewable energy in the EU28 minus Croatia (Croatia was not a Member State at the time when the Impact Assessment was written) would be 254.1 mtoe by 2020. The anticipated amount of renewable energy in Croatia by 2020 was calculated manually by multiplying its forecasted final energy consumption in 2020 (10.6 mtoe - obtained from EEA (2017b)) with its RES target of 20 percent. The resulting 2.1 mtoe was added to the 254.1 mtoe to give the amount of renewable energy which the EU28 is expected to attain by 2020 (256.2 mtoe).

It should be noted that data were only available for the forecasted final energy consumption for Croatia, and not for forecasted *gross* final energy consumption. The difference between the two is likely small though.

[221] The 11.73 mtoe was calculated as follows. First, the amount of renewable energy already attained by the UK was derived by multiplying the share of renewable energy in 2015 (8.2 percent - obtained from Eurostat (2017b)) with the final energy consumption in this year (131,370 mtoe - obtained from Eurostat (2017b)). This gives a renewable energy amount of 10.77 mtoe in 2015. Subtracting this from the amount of renewable energy the UK is expected to add by 2020 in order to meet its 15 percent target (i.e. 22.5 mtoe – obtained from the Impact Assessment report) gives the volume of renewable energy which the UK still needs to add by 2020 (equal to 11.73 mtoe).

Unfortunately, data on *gross* final energy consumption in 2015 were unavailable. This should not change the results signficiantly though.

[222] It should be noted that the 2020 targets are calculated in two main steps in the Impact Assessment. Firstly, the RES share of each Member States in 2005 is increased by 5.5 percentage points. Secondly, an index is calculated in order to assign the remaining renewable energy needed to attain the 20 percent EU-wide RES target by 2020. We ignore the first step in this report and only replicate the second step. This is primarily done in order to simplify the analysis.

[223] The GDP and population data were acquired from Eurostat (2017b).

$$Residual\ effort\ per\ citizen = \frac{UK\ RES}{Pop\ EU27}$$

Where *UK RES* is the remaining amount of renewable energy the UK would have to add from 2015 onward to meet its current 2020 target, and *Pop EU27* is the EU27 population in 2016. The 'residual effort per citizen' value, equal to 0.026 in this scenario, indicates the additional renewable energy (in toe) required per citizen in the EU27 due to the UK's departure. Multiplying this value with the index in column B gives an updated index (column C)

3.) In order to obtain the total amount of additional renewable energy per Member State, the index in column C is multiplied by the population of the respective Member State in 2016, and then converted from toe to mtoe by dividing by one million. This gives the additional amount of renewable energy (in mtoe) that each Member State has to add due to the UK's departure (column D).

4.) The additional amount of renewable energy is added to the current targeted volumes of renewable energy for 2020 for each Member State.[224] This gives the new overall quantity of renewable energy which each Member State seeks to attain by 2020. (column E)

5.) Dividing the new RES targeted volumes with the forecasted gross final energy consumption in 2020 (acquired from the Impact Assessment) gives the new RES targets in percentage terms (column F).

6.) The RES targets are rounded and thereafter further adjusted for Sweden and Latvia. Specifically, the target for Sweden is adjusted downward by one percentage point in line with the methodology in the Impact Assessment.[225] The Latvian target is adjusted downward by two percentage points in order to account for the discrepancy between the current targets stipulated in the Impact Assessment and the Renewable Energy Directive.[226]

7.) The current targets are subtracted from the new targets (column G) to give the difference between the new and old targets (column H).

Table 31: Calculating the new RES targets for scenario 2

	(A) Original targets (in Renewable Energy Directive) (percent)	(B) GDP/capita index	(C) GDP/capita index multiplied by a 'residual effort per citizen'	(D) Residual effort per MS (mtoe)	(E) RES needed in 2020 (mtoe)	(F) New 2020 target (percent)	(G) New 2020 RES target (rounded and adjusted) (percent)	(H) New vs old target (percentage points)

[224] The current targeted volumes of renewable energy for 2020 for each Member State are stipulated in the Impact Assessment.

[225] This was done in the Impact Assessment in order to ensure that Sweden's RES target is below 50 percent (i.e. it was adjusted down from 50 percent to 49 percent). Though Sweden's target will exceed 50 percent in this scenario, we maintain some consistency with the methodology in the Impact Assessment by adjusting this country's target by the same number of percentage points.

[226] The Latvian RES target was 42 percent in the Impact Assessment and 40 percent in the Renewable Energy Directive. As the latter target is the official one, we account for the discrepancy by reducing the new target by two percentage points.

Belgium	13	1.33	0.04	0.40	5.35	14.29	14	1
Bulgaria	16	0.24	0.01	0.04	2.02	16.46	16	0
Czech Republic	13	0.60	0.02	0.17	4.01	13.26	13	0
Denmark	30	1.73	0.05	0.26	4.96	31.80	32	2
Germany	18	1.36	0.04	2.95	43.28	19.67	20	2
Estonia	25	0.57	0.01	0.02	0.93	25.13	25	0
Ireland	16	2.08	0.05	0.26	2.56	18.28	18	2
Greece	18	0.58	0.02	0.17	4.56	18.67	19	1
Spain	20	0.85	0.02	1.05	23.68	20.45	20	0
France	23	1.19	0.03	2.09	39.88	24.23	24	1
Croatia	20	0.39	0.01	0.04	2.16	20.41	20	0
Italy	17	0.98	0.03	1.57	27.88	18.06	18	1
Cyprus	13	0.75	0.02	0.02	0.28	14.57	15	2
Latvia	40	0.45	0.01	0.02	2.50	42.43	40	0
Lithuania	23	0.48	0.01	0.04	1.44	23.55	24	1
Luxembourg	11	3.35	0.09	0.05	0.55	11.72	12	1
Hungary	13	0.41	0.01	0.11	2.75	13.26	13	0
Malta	10	0.81	0.02	0.01	0.08	11.33	11	1
Netherlands	14	1.47	0.04	0.66	8.37	15.73	16	2
Austria	34	1.43	0.04	0.33	10.51	35.62	36	2
Poland	15	0.40	0.01	0.40	11.17	15.60	16	1
Portugal	31	0.64	0.02	0.17	6.80	31.50	31	0
Romania	24	0.31	0.01	0.16	8.40	24.07	24	0
Slovenia	25	0.69	0.02	0.04	1.59	25.20	25	0
Slovakia	14	0.53	0.01	0.08	1.90	14.81	15	1
Finland	38	1.40	0.04	0.20	10.02	39.00	39	1
Sweden	49	1.67	0.04	0.43	17.78	51.55	51	2
EU27	20	N/A	N/A	11.73	245.40*	21.66	22	2

Source: Bruegel based on data from European Commission (2008a), Eurostat (2017b) and EEA (2017a).
Note: *The sum of this figure (245.40 mtoe) and the renewable energy already added by the UK by 2015 (10.77 mtoe) equals the EU28 total (256.2 mtoe).

Scenario 3 - Same overall EU target in percentage terms.

In this scenario, the forecasted gross final energy consumption of the EU27 in 2020 is first derived. This is calculated by subtracting the forecasted consumption for the UK from that of the EU28.[227] 20 percent of this amount corresponds to the new target volume of

[227] Both consumption figures are obtained from the Impact Assessment.

renewable energy for the EU27 for 2020. The new target equals 226.6 mtoe of renewable energy.

If the individual Member State RES targets were not adjusted from the current ones, the EU27 would be expected to produce a total of 233.7 mtoe by 2020. This amount exceeds the new target volume of 226.6 mtoe. Thus, if the EU wants to retain its 20 percent target (and thereby produce 226.6 mtoe), the EU27 will have to reduce its current production level. Specifically, the EU27 will have to reduce RES production by 7.1 mtoe (i.e. 233.7-226.6). This reflects the fact that the UK has a relatively large share of the EU28's total energy consumption, while its RES percentage target (15 percent) is relatively low.

The reduction in the national targets is distributed according to the same methodology explained in the previous scenario. The only difference is that the 'effort per citizen value' has changed from 0.026 toe to -0.016 toe (as an overall *reduction* of 7.1 mtoe across the EU27 occurs in the third scenario). Applying the same methodology as in the previous scenario[228] gives the results in Table 32:

[228] Including the downward adjustment for Sweden and Latvia by one and two percentage points respectively.

Table 32: Calculating the new RES targets for scenario 3

	(A) Original targets (in Renewable Energy Directive) (percent)	(B) GDP/capita index	(C) GDP/capita index multiplied by a 'residual effort per citizen'	(D) Residual effort per MS (mtoe)	(E) RES needed in 2020 (mtoe)	(F) New 2020 target (percent)	(G) New 2020 RES target (rounded and adjusted) (percent)	(H) New vs old target (percentage points)
Belgium	13	1.33	0.02	0.24	4.71	12.59	13	0
Bulgaria	16	0.24	0.00	0.03	1.95	15.88	16	0
Czech Republic	13	0.60	0.01	0.10	3.74	12.38	12	-1
Denmark	30	1.73	0.03	0.16	4.54	29.12	29	-1
Germany	18	1.36	0.02	1.79	38.54	17.52	18	0
Estonia	25	0.57	0.01	0.01	0.90	24.27	24	-1
Ireland	16	2.08	0.03	0.16	2.14	15.31	15	-1
Greece	18	0.58	0.01	0.10	4.29	17.58	18	0
Spain	20	0.85	0.01	0.63	22.00	19.00	19	-1
France	23	1.19	0.02	1.27	36.52	22.19	22	-1
Croatia	20	0.39	0.01	0.03	2.09	19.75	20	0
Italy	17	0.98	0.02	0.95	25.36	16.42	16	-1
Cyprus	13	0.75	0.01	0.01	0.25	13.15	13	0
Latvia	40	0.45	0.01	0.01	2.47	41.79	40	0
Lithuania	23	0.48	0.01	0.02	1.38	22.59	23	0
Luxembourg	11	3.35	0.05	0.03	0.47	9.98	10	-1
Hungary	13	0.41	0.01	0.06	2.58	12.44	12	-1
Malta	10	0.81	0.01	0.01	0.06	9.20	9	-1
Netherlands	14	1.47	0.02	0.40	7.31	13.74	14	0
Austria	34	1.43	0.02	0.20	9.98	33.84	34	0
Poland	15	0.40	0.01	0.24	10.53	14.70	15	0
Portugal	31	0.64	0.01	0.11	6.52	30.21	30	-1
Romania	24	0.31	0.00	0.10	8.14	23.33	23	-1
Slovenia	25	0.69	0.01	0.02	1.53	24.24	24	-1
Slovakia	14	0.53	0.01	0.05	1.77	13.86	14	0
Finland	38	1.40	0.02	0.12	9.70	37.73	38	0
Sweden	49	1.67	0.03	0.26	17.09	49.53	49	0
EU27	20	N/A	N/A	7.10	226.57*	20.00	20	0

Source: Bruegel based on data from European Commission (2008a), Eurostat (2017b) and EEA (2017a).
Note: * This amount excludes both the UK's actual and planned increase in renewable energy as of 2015.

Detailed calculations of non-ETS emissions reduction targets

The following details the methodology underpinning the analysis in scenario two and three of how the non-ETS emissions reduction targets may change due to Brexit.[229]

Scenario 2 - Same overall EU target in absolute terms.

If the EU27 wants to reduce its overall emissions by the same amount in absolute terms, the EU27 would have to take into account the UK's remaining emissions reduction. Between 2005 and 2030, the UK seeks to reduce emissions by 153.44 mtCO2e[230]. By 2015, the UK had reduced emissions by 86.06 mtCO2e.[231] The remaining emissions (67.38 mtCO2e) would have to be reduced by the remaining EU27 Member States in this scenario.

The 67.38 mtCO2e was distributed according to an index of the Member States' reduction targets in *absolute* terms. Countries that aim to reduce their emissions by a large amount will thus be allocated a larger share of the UK's emissions. This methodology was deemed more suitable than weighting based on the reduction amounts in *percentage* terms since the latter would have led to some small countries with high percentage reduction targets (e.g. Luxembourg) being allocated a large share of the UK's emissions.

Table 33 breaks down the methodology. Applying the current emissions reduction targets (column A) to the 2005 baseline emissions (column B) yields the current reduction volumes between 2005 and 2030 (column C). An index is calculated on the basis of the reduction volumes in column C. Specifically, each Member State is assigned a weight equal to the percentage of its reduction volume relative to the EU27 amount. These weights are shown in column D. Multiplying the weights with the residual emissions reduction amount of the UK as of 2015 (i.e. 67.38 mtCO2e) gives the new reduction amounts in mtCO2e between 2005 and 2030 (column E). The new percentage reduction targets, relative to the 2005 baseline emissions, are calculated (column F) and the difference between the new and old targets is shown in column G.

[229] For scenario one, the individual targets are assumed to remain unchanged. The only change is in the EU-wide target. This change is calculated by firstly subtracting the UK's baseline emissions in 2005 from those of the EU28. The level of emissions in the EU27 by 2030 is thereafter calculated by subtracting the UK's targeted volume of emissions in 2030 from that of the EU28. The EU27's targeted 2030 emissions level is thereafter divided by the EU27 baseline. Subtracting one from this amount gives the new overall EU27 emissions reduction target.

[230] This amount was calculated by multiplying the UK's 37 percent reduction target with the baseline emissions of 414.71 mtCO2e.

[231] Using data from Eurostat (2017c), the 86.06 mtCO2e was calculated by subtracting the UK's emissions in 2015 from those in 2005.

Table 33: Calculating the new non-ETS emissions reduction targets for scenario 2

	(A) Original 2030 reduction targets (percent)	(B) 2005 GHG level (mtCO2e)	(C) Current reduction 2005-2030 (mtCO2e)	(D) Index of weights	(E) New reduction amount (mtCO2e)	(F) New targets (percent)	(G) New vs old target (percentage points)
Austria	36	56.67	20.40	0.03	22.35	39.45	3.45
Belgium	35	78.20	27.37	0.04	29.99	38.35	3.35
Bulgaria	0	24.57	0.00	0.00	0.00	0.00	0.00
Croatia	7	16.82	1.18	0.00	1.29	7.67	0.67
Cyprus	24	4.18	1.00	0.00	1.10	26.30	2.30
Czech Republic	14	62.55	8.76	0.01	9.60	15.34	1.34
Denmark	39	40.08	15.63	0.02	17.13	42.74	3.74
Estonia	13	5.43	0.71	0.00	0.77	14.25	1.25
Finland	39	33.60	13.11	0.02	14.36	42.74	3.74
France	37	395.59	146.37	0.21	160.40	40.55	3.55
Germany	38	468.44	178.01	0.25	195.06	41.64	3.64
Greece	16	61.78	9.88	0.01	10.83	17.53	1.53
Hungary	7	46.38	3.25	0.00	3.56	7.67	0.67
Ireland	30	47.52	14.26	0.02	15.62	32.88	2.88
Italy	33	329.14	108.62	0.15	119.02	36.16	3.16
Latvia	6	8.52	0.51	0.00	0.56	6.58	0.58
Lithuania	9	10.78	0.97	0.00	1.06	9.86	0.86
Luxembourg	40	10.13	4.05	0.01	4.44	43.83	3.83
Malta	19	1.03	0.19	0.00	0.21	20.82	1.82
Netherlands	36	122.88	44.24	0.06	48.48	39.45	3.45
Poland	7	176.01	12.32	0.02	13.50	7.67	0.67
Portugal	17	49.53	8.42	0.01	9.23	18.63	1.63
Romania	2	73.03	1.46	0.00	1.60	2.19	0.19
Slovakia	12	22.30	2.68	0.00	2.93	13.15	1.15
Slovenia	15	11.85	1.78	0.00	1.95	16.44	1.44
Spain	26	233.84	60.80	0.09	66.62	28.49	2.49
Sweden	40	42.90	17.16	0.02	18.80	43.83	3.83
EU27	30	2,433.72	856.54*	N/A	770.48**	31.66***	1.66

Source: Bruegel based on Eurostat (2017c) and European Commission (n.d.-p).
Note: *This is the combined amount of reduced emissions of the EU27 and the UK (the latter is 153.44 mtCO2e).
**This amount does not include the emissions already reduced by the UK by 2015. Adding the latter (86 mtCO2e) to the 770.48 mtCO2e gives the EU27 reduction amount in column C though.
***Using the EU27 emissions in 2005 as a baseline.

Scenario 3 - Same overall EU target in percentage terms.

If the EU27 seeks to retain its overall 30 percent reduction target, the EU27 baseline emissions in 2005 are first calculated by subtracting the UK's 2005 emissions from those of the EU28. The EU27 emissions in 2005 thus equal 2,433.72 mtCO2e. 30 percent of this amount is 730.12 mtoCO2e, which is the new target reduction quantity. If the Member States achieve their current reduction targets, the cumulative EU27 reduction amount is 703.10 mtCO2e. The difference (730.12-703.10=27.02) would need to be distributed across the EU27 Member States. The positive difference reflects the ambitious emissions reduction target of the UK.

The distribution of the 27.02 mtCO2e was carried out using the same methodology as in the second scenario. The results are shown in Table 34. Columns A-B are the same as in the second scenario. In column C, the national amounts are the same as in second scenario, though the EU27's overall amount differs. The latter reflects the fact that the emissions already reduced by the UK (up until 2015) are excluded from this scenario. As the UK's emissions in 2005 was removed from the baseline to calculate the new absolute reduction targets in this scenario, it makes sense to also remove all of the UK's planned emissions reduction volume between 2005 and 2030 from the EU28 total when calculating what the EU27 will achieve if it maintains its current national targets. Column D contains the same weights as in the second scenario, while column E illustrates the new reduction amounts after the 27.02 mtCO2e have been distributed. The new targets are shown in column F and column G depicts the change in the targets.

Table 34: Calculating the new non-ETS emissions reduction targets for scenario 3

	(A) Original 2030 reduction targets (percent)	(B) 2005 GHG level (mtCO2e)	(C) Current reduction 2005-2030 (mtCO2e)	(D) Index of weights	(E) New reduction amount (mtCO2e)	(F) New targets (percent)	(G) New vs old target (percentage points)
Austria	36	56.67	20.40	0.03	21.18	37.38	1.38
Belgium	35	78.20	27.37	0.04	28.42	36.34	1.34
Bulgaria	0	24.57	0.00	0.00	0.00	0.00	0.00
Croatia	7	16.82	1.18	0.00	1.22	7.27	0.27
Cyprus	24	4.18	1.00	0.00	1.04	24.92	0.92
Czech Republic	14	62.55	8.76	0.01	9.09	14.54	0.54
Denmark	39	40.08	15.63	0.02	16.23	40.50	1.50
Estonia	13	5.43	0.71	0.00	0.73	13.50	0.50
Finland	39	33.60	13.11	0.02	13.61	40.50	1.50
France	37	395.59	146.37	0.21	151.99	38.42	1.42
Germany	38	468.44	178.01	0.25	184.85	39.46	1.46
Greece	16	61.78	9.88	0.01	10.26	16.61	0.61
Hungary	7	46.38	3.25	0.00	3.37	7.27	0.27
Ireland	30	47.52	14.26	0.02	14.80	31.15	1.15
Italy	33	329.14	108.62	0.15	112.79	34.27	1.27
Latvia	6	8.52	0.51	0.00	0.53	6.23	0.23
Lithuania	9	10.78	0.97	0.00	1.01	9.35	0.35
Luxembourg	40	10.13	4.05	0.01	4.21	41.54	1.54
Malta	19	1.03	0.19	0.00	0.20	19.73	0.73
Netherlands	36	122.88	44.24	0.06	45.94	37.38	1.38
Poland	7	176.01	12.32	0.02	12.79	7.27	0.27
Portugal	17	49.53	8.42	0.01	8.74	17.65	0.65
Romania	2	73.03	1.46	0.00	1.52	2.08	0.08
Slovakia	12	22.30	2.68	0.00	2.78	12.46	0.46
Slovenia	15	11.85	1.78	0.00	1.85	15.58	0.58
Spain	26	233.84	60.80	0.09	63.13	27.00	1.00
Sweden	40	42.90	17.16	0.02	17.82	41.54	1.54
EU27	30	2,433.72	703.10*	N/A	730.12*	30.00	0.00

Source: Bruegel based on Eurostat (2017c) and European Commission (n.d.-p).
Note: *This amount excludes all of the planned and already achieved emission abatement of the UK.

CAT: QA-06-17-273-EN-C (paper)
CAT: QA-06-17-273-EN-N (pdf)

DIRECTORATE-GENERAL FOR INTERNAL POLICIES

POLICY DEPARTMENT A
ECONOMIC AND SCIENTIFIC POLICY

Role

Policy departments are research units that provide specialised advice to committees, inter-parliamentary delegations and other parliamentary bodies.

Policy Areas

- Economic and Monetary Affairs
- Employment and Social Affairs
- Environment, Public Health and Food Safety
- Industry, Research and Energy
- Internal Market and Consumer Protection

Documents

Visit the European Parliament website:
http://www.europarl.europa.eu/supporting-analyses

PHOTO CREDIT:
iStockphoto.com; Shutterstock/beboy

ISBN 978-92-846-2237-5 (paper)
ISBN 978-92-846-2238-2 (pdf)

doi: 10.2861/33984 (paper)
doi: 10.2861/024 (pdf)

Publications Office

The Impact of Brexit on the EU Energy System