ICE report T1.1.2 Policy Issues

An overview of renewable energy policy and regulatory considerations in Ouessant and the UEA campus

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About ICE

Supported by Interreg VA France (Channel) England, the Intelligent Community Energy (ICE) project, aims to design and implement innovative smart energy solutions for isolated territories in the Channel area. Islands and isolated communities face unique energy challenges. Many islands have no connection to wider electricity distribution systems and are dependent on imported energy supplies, typically fossil fuel driven. The energy systems that isolated communities depend on tend to be less reliable, more expensive and have more associated greenhouse gas (GHG) emissions than mainland grid systems. In response to these problems, the ICE project considers the entire energy cycle, from production to consumption, and integrates new and established technologies in order to deliver innovative energy system solutions. These solutions will be implemented and tested at our unique pilot demonstration sites (Ushant island and the University of East Anglia's campus), to demonstrate their feasibility and to develop a general model for isolated smart energy systems elsewhere. The ICE consortium brings together researcher and business support organisations in France and the UK, and engagement with SMEs will support project rollout and promote European cooperation.

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1. Introduction

This document provides a methodology for undertaking resource assessment of renewable technologies for remote communities and sets out to identify and describe the key policy and regulatory factors in expected to be relevant to the aims of the ICE project. These factors include policies and regulations that affect the production, distribution and consumption of energy in two locations. Together the two parts fulfil task T1.1 of the ICE project.

The two sites selected as the foci of the ICE project are Ushant (Ouessant), an electrically isolated island community of a few hundred people off the coast of North Western France, and the main campus of the University of East Anglia (UEA), a large teaching, research and residential facility serving more than 15,000 students in Eastern England.

At first glance, these sites' energy systems appear quite different. Ushant is electrically isolated, having no physical connection to mainland France, while the UEA campus is connected to its local gas and electricity distribution systems with ample capacity for its energy requirements now and in the future. Ushant is a publicly administered *commune*, meaning that potentially controversial changes to its energy system are a matter for cooperative decision-making, while the UEA campus operates as a privately-owned site offering greater autonomy to energy decision makers.

However, there are two shared qualities that can help categorise the two sites and to identify commonalities. Firstly, both sites occupy relatively small geographical areas. The UEA campus is built on 130 hectares, while Ushant has an area of around 1,500 hectares. Importantly, both sites have clearly defined electrical boundaries: Ushant due to its isolation and UEA due to its status as a managed campus. Secondly, both locations have strong incentives to make changes to their energy systems that require the use of innovative energy supply and/or energy management technologies. On Ushant, the current energy system is entirely reliant on fossil fuels shipped from mainland France for electricity, heat and transport, and its electricity system depends heavily on a single generation plant. The cost, security and environmental impacts of this arrangement are unsustainable. While the UEA campus is linked to the wider Great Britain (GB) electricity and gas networks, there is a strong incentive as a research University to lead on environmental issues, including through cleaner, more efficient energy systems as well as minimizing the cost of providing energy services to staff and students. All UK universities have government-mandated targets for carbon emission reduction and plans in place for achieving them.

An electrically isolated island energy system faces some unique challenges. The difficulties of meeting residents' energy needs without the benefit that comes with interconnection to larger electricity networks is compounded by the need to do so in way that protects against unnecessary economic or environmental cost. Fortunately, recent years have seen advances in both energy supply technologies – primarily renewable energy conversion technologies – and demand-side technologies such as demand management and information technologies and energy storage. There is growing consensus about the merit of such 'smart grids' that can:

> "*…intelligently integrate the behaviour and actions of all users connected to it – generators, consumers and those that do both – in order to efficiently deliver sustainable, economic and secure electricity supplies*" (European Technology Platform, 2010; Connor *et al.*, 2014).

This report considers the broad policy and regulatory factors relevant to the ICE project. The transition from a conventional fossil fuel based energy systems to a smart, renewable energy-based system requires significant changes to all aspects of the energy system and may involve:

- Installation of new renewable electricity generation, storage, and management equipment including;
- Changes to the physical and operational characteristics of the electricity distribution network;
- Changes to the energy practices of domestic and business energy consumers

This document is intended as a companion to ICE deliverable T1.4, detailing the community specific assessment of local energy conditions, specifically the quantification of the available local energy resource for a number of different renewable energy technologies. Information is drawn from documentary sources, informal discussion with stakeholders and project partners including fact-funding visits to the UEA campus 19th of October, 2017 and Ushant on the 9th and 10th of November, 2017.

After the introduction, this report provides an overview of the key features of these implications proceeding in 5 main sections:

- Section 2 sets down the approach to the analysing the policy and regulatory arrangements. It outlines the key policy and regulatory elements that are *prima facie* relevant to the aims and objectives of the ICE project. It considers the tasks that a functional system of regulation and governance is required to perform;
- Sections 3, 4 & 5 present a multi-levelled policy and regulatory review which considers the relevant local, national and supra-national arenas of policymaking;
- Section 6 concludes

2. Analytical approach

This section sets out the policy and regulatory elements that will be considered by the review. It is broken into several sub-sections covering relevant elements of electricity supply policy – especially renewable energy policy, as well as factors pertinent to energy demand and 'smart' energy systems.

2.1 Electricity supply policy

For any renewable electricity generation project to proceed, there are several important interactions with local, regional, national and European legal and regulatory processes. This assessment surveys the policy and regulatory landscape relevant to RE generation projects in both Ushant and at the UEA campus. As well as the overall policy context, it will consider, for the range of supply technologies identified as potentially viable, factors vital to the success of renewable energy projects. This report will describe for each jurisdiction:

- Political, policy and institutional context
- Routes to market: RE production offtake and remuneration
- Network access and grid connection
- Permits, licenses and land-use planning

2.1.1 Political, policy and institutional context

The supply potential from any renewable energy source is impacted by the political, policy and institutional context in which it is to take place. It is well established that the political and policy context is an important determinant of divergences in renewable energy supply portfolios between countries of similar development status (Aklin and Urpelainen, 2013; Ćetković and Buzogány, 2016). Alongside existing policies for renewable energy deployment and system integration which will be covered below, the historical roots of renewable energy deployment, attitudes to renewable and other energy issues as well as the current status and trajectory of the supply-mix. Since renewable energy policy in the EU is simultaneously conducted at the European and national levels (Boasson and Wettestad, 2013), the analysis considers both the EU and national policy and regulatory contexts. Finally, since the means and rate of deployment and integration of renewable electricity projects is strongly influenced by electricity market structure and progress made towards market liberalisation (Meyer, 2003; Fouquet and Johansson, 2008a), the analysis will consider these issues.

2.1.2 Routes to market: RE production offtake and remuneration

For renewable energy project to be viable, the policy framework needs to consider how the output makes its way to the market and how the producer is remunerated. This requires a financial settlement and arrangements for power offtake.

A complete financial settlement

As discussed earlier, despite some signs of reductions in the cost of renewable energy in the last few years, most European markets have some form of revenue support in place of or in addition to wholesale electricity market revenues to support investments. Policy-makers have numerous design options open to them when selecting how to support renewable energy investment and there is a copious literature produced over the last two decades discussing the merits of and problems with a wide range of models (see Mitchell *et al.*, 2006; del Río and Gual, 2004; Fouquet and Johansson, 2008b; Fagiani *et al.*, 2013 etc.). The literature focuses largely on the impact of remuneration model, risk allocation and the functioning of the financial mechanism. To allow comparison of revenue support models, a typology which enables comparison of approaches to revenue support is developed below. There are three elements, which, from the perspective of a renewable energy project developer, define a complete financial support settlement for renewable electricity projects (Fitch-Roy, 2016). Although the choice of particular policy formulation will often determine more than one element, the merit of the framework is in the fact that it takes the developer's perspective and effectively asks three questions vital to the investment decision. These are[1]:

- **Allocation** - how is the support accessed?
- **Remuneration model**[2] - on what basis does the plant owner receive support?
- **Deciding the level** - how is the level of the remuneration determined?

Each has a finite number of conceptual options. We now look at each in turn and explore the options for each as well as some of the interrelationships.

Allocation

There are two alternative options for managing access to a RES support system in the short run. In one, a project owner automatically qualifies for the revenue support by dint of successfully completing the development process (possibly including an accreditation stage) and commissioning their plant. This type of approach is often referred to as a 'first-come-first-served' (FCFS) allocation. Any plant that meets the requirements and is able to generate electricity receives the support.

The alternative is to restrict access to particular projects in some way. This approach strictly limits the volume (number of projects, installed capacity) to be supported or the budgetary commitment to be made. Projects seeking support are ranked based on criteria guided by the policy aims of the government and 'best' projects are selected until the desired volume or budget has been reached. The allocation is often but not always decided based on production cost in an auction or tender format.

Remuneration model

Any RES financial settlement must specify the basis on which payments will be calculated. There are a number of conceptual alternatives that are discussed at length in the literature (del Río and Gual, 2004 provides a good overview). The most commonly discussed and compared models in the literature are the tradable green certificate[3] (TGC) and the feed-in-tariff (FIT). A TGC system enables a producer to sell renewable energy certificates (REC) as proof of qualified renewable generation into a specialist market to realise revenues in addition to electricity sales. While certificate prices may vary, they tend to do so independently from the price of electricity (Fouquet and Johansson, 2008b). A FIT most commonly guarantees a generator a fixed price per unit of production for the duration of the support although several FIT arrangements are possible (Kitzing *et al.*, 2012). A common alternative to the fixed price approach is one in which the support is a fixed premium in addition to revenues from electricity sales. In Europe, the feed-in-tariff, until recently, tended to

[1] While other policy decisions and design options must be considered, these are the main dimensions on which renewable energy revenues support models vary.

[2] As highlighted by Couture and Gagnon (2010)

[3] Also known as a Renewable Portfolio Standard (RPS) or Renewable Energy Certificate (REC) or quota schemes

dominate implementations of RES support (Kitzing *et al.*, 2012).

A third and increasingly common variant is the sliding premium tariff, also known as contracts for difference (CfD). In this arrangement, a producer's support is usually calculated as the difference between the support level and some market reference price and provided in addition to market revenues. These models are sometimes described as contracts for difference (CfD), sliding or 'target-price' feed-in tariffs (Kitzing *et al.*, 2012). The options therefore are:

- **fixed payments** per unit of production;
- **sliding payments** to meet a target price; and
- **wholesale+**: A payment in addition to the wholesale revenue, either from a fixed premium or the sale of a certificate.

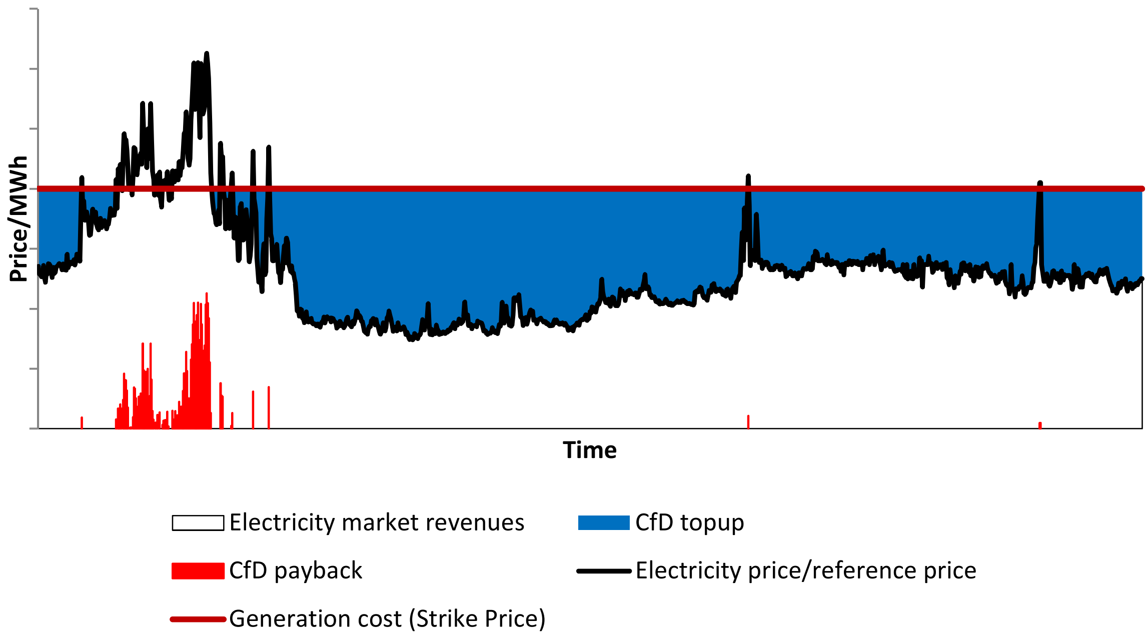


Figure 2.1: Sliding premium (or contracts for difference) remuneration model

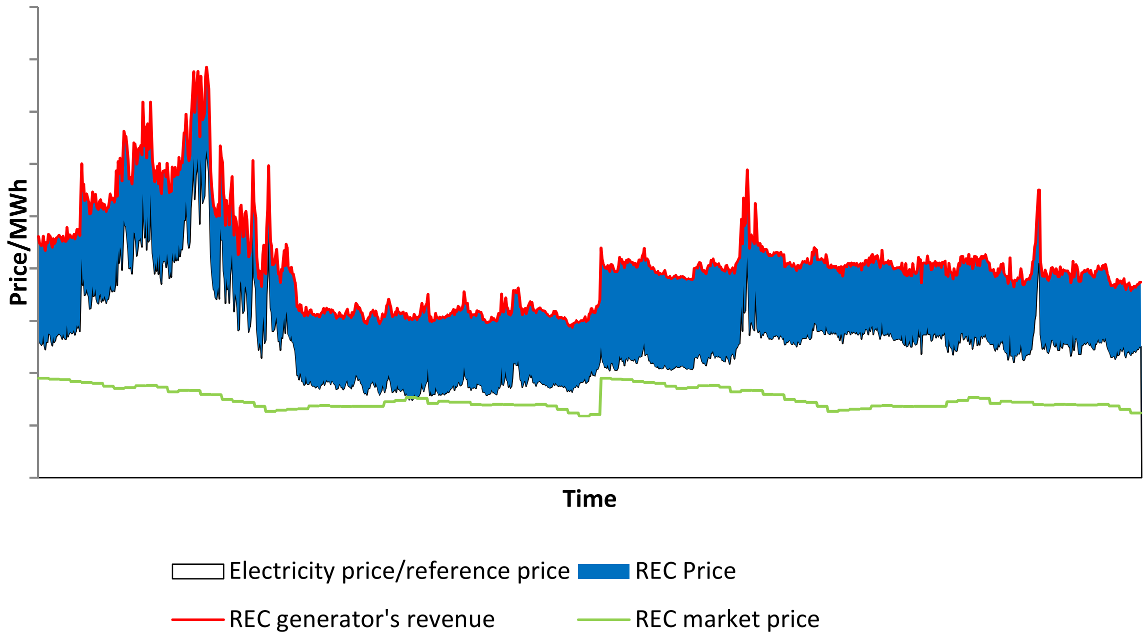


Figure 2.2: Quota system remuneration model

Deciding the level of remuneration

In addition to, but not necessarily independent of, the revenue structure and allocation method, a coherent financial settlement must consider how the level of payments is determined. A common approach is for policy makers to calculate the level of remuneration based on bottom-up estimates of technology costs and the intended rate of return for projects or other criteria. Alternatively, a competitive process can be used to 'reveal' the lowest support level at which a producer is able to proceed. Thirdly, a volume-setting system which makes use of a secondary market (such as for TGCs) to determine the level of support can be used. A TGC market aims to reflect in its price the balance of supply (volume of certificates offered by producers) and demand (from suppliers seeking to obtain sufficient certificates to fulfil a mandated obligation to source a particular proportion of its sales from RES sources or present certificates). A high certificate price (high remuneration for RES producers) indicates an under supply and a low price indicating an oversupply. In addition, several certificate systems include features such as 'banding' in which the number of certificates a producer may present for sale for each unit of production varies according to the RES technology used to produce (Kitzing et al, 2012).

Overview of financial settlement options

The finite number of options for each element of a financial settlement is shown in the table below[4]:

Allocating access	**Remuneration mode**	**Deciding the level**
Automatic	Fixed	Administratively set
Constrained by rounds	Sliding	Specialist market

[4] It is very unlikely that all of the 18 theoretical permutations (2*3^2) of policy formulations will or can be implemented.

	Wholesale+	Competitive process

Table 2.1: Options for a renewable electricity financial settlement

Other financial elements

In many countries, renewable energy projects are eligible for additional financial support associated with capital investment or production such as tax credits.

Typical offtake arrangements and contractual options

Electricity generators have various options for contracting to sell their product with the decision depending on the type of technology, market, support policy and finance arrangements. The type of option selected will determine the revenue stream and risk profile for project – and, in turn, the ability of projects to raise finance based on the support scheme (Klessmann *et al.*, 2013). The most basic offtake arrangement is to sell directly into wholesale electricity markets as a merchant, which will require sophisticated risk management and hedging that is most likely a possibility for a large company, possibly with a broad electricity generation portfolio. It also requires liquid wholesale markets. Alternatively, and far more common for renewable energy projects, is the negotiation of a long-term power purchase agreement (PPA) with a counterparty better able to manage the risks of wholesale market participation. Typical offtake counterparties include large energy utilities, state-owned energy companies, major energy users, corporations and financial institutions.

Network access and grid connection

Renewable energy project may connect to the wider electricity system in one of three ways. i) by connecting directly to the high-voltage, long-distance transmission system. This is most applicable for large projects. ii) by connecting to the lower voltage, local distribution system. This is the most common for medium-sized and small capacity commercial projects. iii) by connecting 'behind-the-meter' at the point of demand with the consumption used on-site in a domestic or commercial. Behind-the-meter connections are most common for small domestic installations or for commercial entities seeking lower costs (where generation costs are lower than grid-supplied energy).

While the application process for transmission or distribution grid connections can be lengthy and costly, often with waiting periods or moratoria in areas with high demand for connections or insufficient network capacity, behind-the-meter applications tend to rely on the existing import connection. Different rules concerning connection may apply for each of these three arrangements, and for any charging relating to their use of networks for their power.

Connecting offshore renewables

Connecting offshore electricity generation plant, such as offshore wind, and wave and tidal energy conversion devices, poses some unique challenges. Since Ushant has access to rich marine energy resources such as the Fromveur tidal current, the implication of connecting such devices to the local electricity system is discussed here. Unlike onshore renewable electricity generation projects, offshore projects tend to be sited outside the scope of the onshore transmission and destitution systems. There are, however, several conceivable ways in which the transmission system can be extended to connect offshore renewables projects. Some of the differences are a function of whether the transmission system is expanded in an ad-hoc, radial fashion in which projects are connected one at a time or whether meshed or coordinated approaches are taken - at least some of which is related to international interconnection plans for offshore wind (European Commission, 2014c). However, to aid comparison of Member States' approaches to project development, it is more useful to examine the roles and responsibilities of the main actors involved in connecting offshore projects to the onshore grid. There are three prime candidates for involvement - the onshore transmission system operator (TSO), the owner of the station to be connected, and a third party.

In general, there are four possible boundaries for connection responsibility: i) an onshore substation which marks the extremity of the onshore system, ii) an offshore hub or 'socket at sea' provided by the TSO to which one or more projects may connect and a projects own substation (the point at which all of the units in an array's individual connection cables meet) (SKM, 2012).

Meeus (2014) usefully identifies three distinct models for connecting offshore renewable energy projects to the grid:

1. A 'TSO model' in which responsibility for extending the transmission grid to accommodate offshore connections is performed by the TSO but responsibility to connect to the offshore transmission system remains with the project owner;
2. A 'generator model' in which responsibility to connect to the onshore system lies with the project owner; and
3. A 'third party model' in which a (regulated) third party is responsible for the connection between the generator and the TSO

A fourth model may be added in which the transmission system is extended to accommodate offshore connections and the connection from the wind farm to the offshore transmission system is handled by the TSO.

Social and environmental permits, licenses, seabed tenure and land-use planning

Building any structure or facility for generating electricity likely requires permits from local or national public authorities, including for any additional infrastructure required for transmission or distribution. The range of permits required, the issuing authority and process for application can vary between countries, regions and between technologies and scales of project. The objective of building permits is generally to demonstrate compliance with social and environmental law and to conform to land use planning policy.

Offshore development rights

In general, national governments[5] play a much greater role in permitting offshore renewables than their onshore cousins, with specialist central agencies often taking the lead in issuing permission to proceed (Toke, 2011). Without policy action designed to facilitate marine renewable energy, projects can often appear 'maze-like', with prospective developers faced with a range of '*ill-fitting legal instruments'* before targeted reform is implemented (Wright, 2014). Much of this complexity arises from the number of public agencies from which permits must be obtained or to which legal compliance must be demonstrated (Snyder and Kaiser, 2009). The other area of complexity is the requirement to consult with various statutory and other stakeholders as part of the conditions of many offshore permits (Gray *et al.*, 2005).

[5] As opposed to local or regional authorities

Consequently, there are two main ways in which this targeted reform may be implemented: i) by limiting the number of public agents from which permits must be obtained (with an idealised end point often typified as a 'one-stop-shop' (Vantoch-Wood, 2013)) and ii) by simplifying or limiting the process of consultation. This provides two indicators of whether the permitting process has been reformed to enable renewable energy development. A country that has reduced the number of public agencies a developer must interact with *or* simplified the consultation process(es) can be said to have implemented targeted reform of the development rights issuing process.

2.2 Smart grids and energy demand policy

The creation of electricity systems reliant on large volumes of variable, distributed, renewable generation is likely to require more dynamic operation of electricity networks, more demand management and the integration and dynamic use of new demand-side technologies such as smart meters, heat-pumps and electric vehicles. These changes mean that electricity grids need to – and are – becoming 'smarter', as outlined in the introduction and elsewhere (Connor *et al.*, 2014).

In addition to the development and installation of new electricity generating plant, the creation of a smart electricity system requires interactions with policy and regulatory processes that affect the use and management of energy. Policy-factors perceived by experts and policy makers to be driving the necessity for smart grids include increasing renewable energy integration, electric mobility and heat pumps. Meanwhile, the same experts see customer engagement, industry resistance and costs as contra-indicators for increased smart grid adoption (Xenias *et al.*, 2015). Therefore, this review will also consider recent and ongoing changes to policy and regulatory environment relevant to the establishment of smarter electricity systems.

The following section reviews the relevant EU, national and local policy and regulatory situation applicable to the two sites. It first reviews EU-level policy setting out important information about electricity supply, energy efficiency and climate & energy policy. The section then covers the two national settings, the UK and France, by reviewing governance and policymaking, national and local energy context, renewable energy policy and policy relevant to smart grids.

3. European Union policy

Both sites are currently in European Union (EU) countries and therefore affected by decisions taken at the EU level. In October 2009 the heads of state and government of the EU set an objective for the EU to reduce greenhouse gas emissions by 80 to 95% by 2050 - a political goal that has played a major role in defining the terms of climate and energy policymaking since (European Council, 2009). This review covers three distinct areas: electricity supply, energy efficiency and climate and energy policy.

3.1 Electricity supply policies at the EU level

3.1.1 The European Internal Energy Market

Since the 1980s a central thrust of EU action on energy has been the creation and completion of the so-called internal energy market (IEM) (Eikeland, 2008). The ultimate objective of creating EU-wide liberalised markets in electricity and gas holds particular significance since it is seen as an important part of the broader European project by which closer economic ties between member states is sought as a means of tightening the Union. It is also argued by the European Commission that an integrated European energy market is the "*only realistic tool*" to maintain a cost-efficient, decarbonised and secure energy system (European Commission, 2014b).

Between 1996 and 2009, the EU adopted three legislative packages aimed at the internal market. Progress includes liberalisation of the sector, in particular the separation of supply and production, the creation of a European-level regulatory coordination body, the European Agency for the Cooperation of Energy Regulators (ACER), and support for infrastructure projects that connect isolated territories to greater European energy networks.

3.1.2 The 2009 Renewable Energy Directive

One of the most visible manifestations of renewable energy policy at the European level is the 2020 climate and energy package agreed in 2007. Designed to meet part of the EU's three-fold energy goals of clean, secure and competitive energy, the package consisted of what became known as the 20/20/20 targets. The targets included a commitment to a 20% reduction in emissions (30% in the event of a global deal on climate change), an increase of EU energy consumption from renewable sources to 20%, and a 20% improvement in energy efficiency, all by 2020.

In 2009 the renewable energy target was implemented in the form of a European Directive (2009/28/EC), legally binding the Member States to produce a specified proportion of their energy consumption from renewables (European Commission, 2009). Energy efficiency legislation has been implemented through a non-binding Directive issued in 2012 (see below). Member States are required to produce and maintain National Renewable Energy Action Plans (NREAPs) stating the national target, the means by which it will be reached and ongoing progress. While all Member States have a single overall national target, they may choose to break this down across different sector as they see fit. Progress towards both overall renewable targets and energy efficiency targets appears to be more or less on track if somewhat aided by reduced energy demand resulting from poor economic performance exerting a dampening effect on energy demand (European Environment Agency, 2014; Bergamaschi *et al.*, 2014).

Progress towards the targets

Progress across the Union towards the 20% renewable energy target is largely on track with 16% of gross final energy consumption reached in 2014 (European Commission, 2014b). The figure below shows progress against both the trajectory used to calculate the renewable energy directive target and the trajectory represented by the member states' collective NREAPs. It can be seen that progress across the Union is ahead of target.

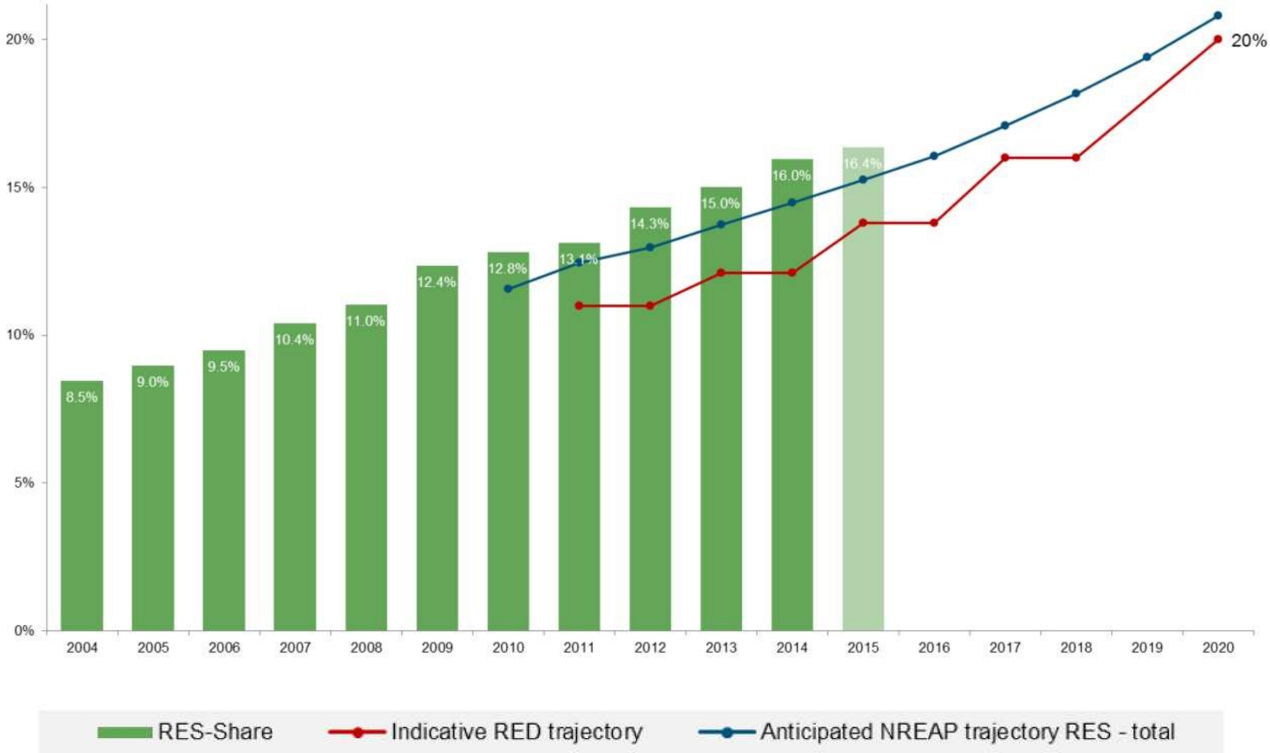


Figure 3.1: EU renewable energy progress against the 2020 target (source: European Commission, 2017b)

Progress against the target, however, differs between sources and member states. Renewable heating and cooling, while accounting for more than half of the 16% renewably sourced heating has shown slower growth than in renewable electricity production. In 2015 18.1% of energy for heating and cooling was sourced from renewables while in the electricity sector the comparable figure is 28.3%.

While most member states are on track to meet the 20% target, as is the Union as a whole, some member states will need to significantly increase their rate of deployment to meet their target; Ireland, Luxembourg, the Netherlands and the United Kingdom face a real risk of missing their target. In this eventuality, the renewable energy directive allows for bilateral arrangements such as statistical transfers between member states. The UK's situation may be impacted by ongoing Brexit negotiations.

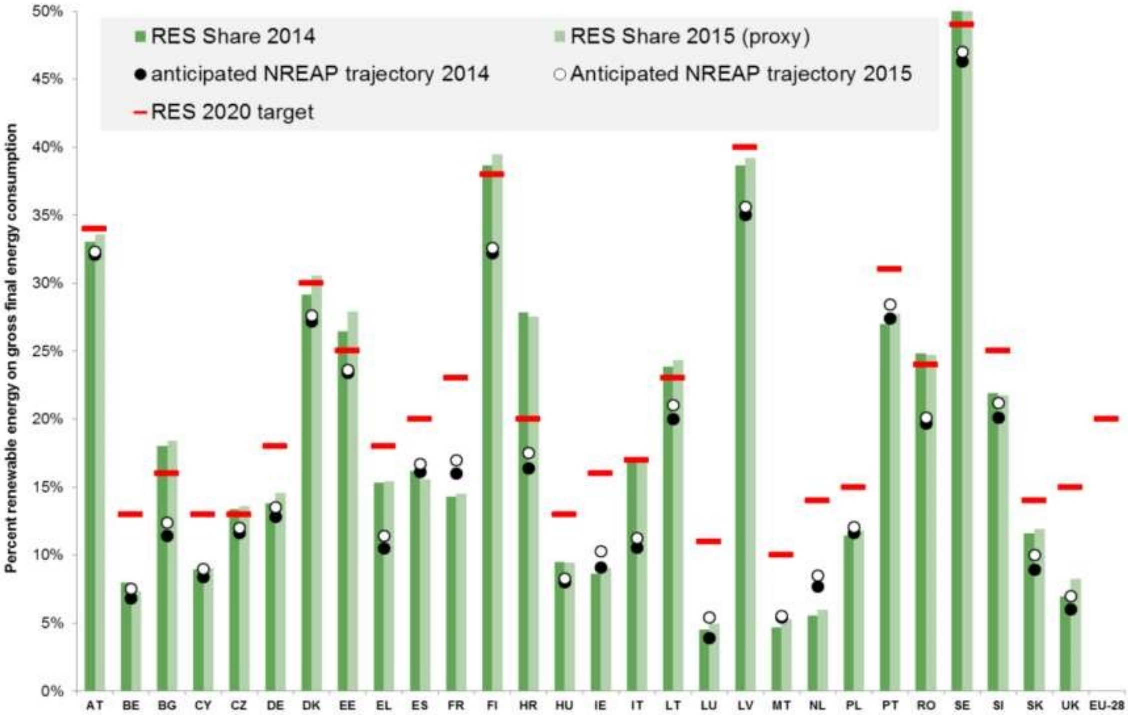


Figure 3.2: Renewable energy target progress by member state (source: European Commission, 2014b)

3.1.3 The Energy and Environment State Aid Guidelines 2014

As part of the European Commission's role as guardian of the European single market, it produces guidelines on what might or might not constitute illegal 'state-aid' or "an advantage in any form whatsoever conferred on a selective basis to undertakings by national public authorities" (European Commission, 2016). While this definition covers many areas of potential activity in the energy system by Member States, until 2014 renewable energy subsidies and other financial support were largely exempted, following notification of the European Commission by the Member State and Member States were able to select policy instruments more or less freely.

The European Commission's Guidelines on State Aid for environmental protection and energy 2014-2020 (EEAG) (European Commission, 2014a), however, requires member states wishing to offer support to renewable energy electricity generators from the 1st January 2017 to use "instruments, such as auctioning or competitive bidding process[es]" (para 109) to ensure that the cost of support is minimized. The use of such instruments is presumed by the Commission to deliver RES support in way that "is proportionate and does not distort competition to an extent contrary to the internal market". This rule has resulted in the almost complete replacement of financial support policies such as feed-in tariffs and tradable green certificate systems with auction type instruments that allocate support based on valued bids, lowest cost first.

However, the EEAG (para. 126) also allows for exceptions. In cases where member states can demonstrate that a) "*only one or a very limited number of projects or sites could be eligible*", b) "*competitive bidding process would lead to higher support levels (for example to avoid strategic bidding)*" or c) "*competitive bidding process would result in low project realisation rates (avoid underbidding)*" an application may be made to the Commission for approval to use alternative support instruments. Member States may also provide support on a non-competitive basis for installations less than 1MW capacity or for (non-wind) technology demonstration projects up to 6MW or with up to six generation units (para. 127). For an exemption to be granted, the Member State must demonstrate that the support does not over-compensate the producer – i.e. the support is no more than the levelised cost of energy (LCOE) (including a return on capital and adjusted to reflect any investment aid) and the realizable market price for the energy produced.

3.1.4 Environmental Impact Assessment (EIA) Directive

European law has implications for the siting and development of potential renewable energy generation projects. In particular, the Environmental Impact Assessment (EIA) Directive 2014/52/EU requires member states to implement planning laws which follow a harmonised assessment procedure for the potential impact on the environment of projects including some renewable energy projects.

3.2 Energy Efficiency Directive

As part of the same package of measures agreed in 2007 that includes the renewable energy target for 2020, the EU also has a 20% target for reduction in energy consumption over the same period. The energy efficiency directive of 2012 (2012/27/EU) requires Member States to ensure energy demand reduction, energy auditing private enterprises, renovation of public buildings, procurement of energy efficient buildings, products and services by public bodies and an obligation on energy companies to realise energy savings. There are also provisions to assist with the development of 'smarter' energy networks and energy use (European Commission, 2012).

Ten of the Directive's articles require Member State implementations. These are:

- Article 5: Exemplary role of public bodies' buildings
- Article 6: Purchasing by public bodies
- Article 7: Energy efficiency obligation schemes
- Article 8: Energy audits and energy management systems
- Articles 9-11: Metering; billing information; cost of access to metering and billing information
- Article 14: Promotion of efficiency in heating and cooling
- Article 15: Energy transformation, transmission and distribution

3.3 2030 package and the future

In addition to the legally binding renewables and energy efficiency targets set for 2020, the EU is currently defining its goals and policies for the period between 2020 and 2030. On 23rd October 2014, the heads of state and governments of the twenty-eight Member States met at the European Council to decide the content of the 2030 climate and energy policy goals, based on policy proposals from the European Commission. As a result, they agreed a framework within which the EU aims to:

- emit 40% less greenhouse gas in 2030 than it did in 1990;
- produce 27% of the energy consumed in the Union from renewable sources; and
- reduce energy consumption by 27% compared to a projection derived from a 2007 reference case (European Council, 2014).

Some action on increasing electrical interconnection to integrate the EU's 'energy islands' was also agreed (European Council, 2014; Oliver, 2014). Following up on this commitment and as part of the 'Energy Union' initiative launched by the European Commission in 2015, a series of new legislative and other actions are anticipated. A recast Renewable Energy Directive (RED II) was proposed by the European Commission in early 2017 for consideration by the Council of the European Union and the European Parliament, the legislative bodies of the EU (European Commission, 2017a).

4. France

4.1 French governance and policymaking institutions

There are four basic nested levels of French government: national, regions (13 metropolitan, 5 overseas), departments (102) and communes (>30,000). All levels are involved in energy policy. The allocation of responsibilities of various bodies relevant to the energy sector are set out in the French Energy Code (Code de l'Energie) which bundles a wide range of legislative ordinances (Legifrance, 2017). The government body ultimately responsible for energy and renewables in France is the newly created *Ministry for the Ecological and Inclusive Transition.* Within the Ministry, the *General Directorate for Energy and Climate (DGEC)* designs, plans and implements policies in this area (de Balorre *et al.*, 2016).

The Commission for Energy Regulation (CRE) is responsible for the economic regulation of gas and electricity markets. It administers some renewable energy policies, such as the competitive auctions that are now the predominant tool for promoting the expansion of renewables in many countries (IRENA, 2017; del Río, 2017). The CRE is also responsible for the regulation of gas and electricity networks including ensuring that the networks are developed appropriately and that access to the networks is available. Under the French Energy Code, the CRE is responsible for proposing changes to regulated consumer energy prices although the relevant government minster reserves the right to reject the proposals (Legifrance, 2011).

4.1.1 Regions

The French regions are required to reflect the goals of the energy transition when drafting their Regional Plan for Climate, Air and Energy (SRCAE). These coordination documents set out goals and the measures for meeting them at a regional level. The current plan for the region of Brittany, covering the period from 2013 to 2018, includes, *inter alia,* renewable energy goals and policies (Region of Brittany, 2013).

4.1.2 Ushant decision making

The island of Ushant is part of the French region of Brittany (Bretagne) for general governance purposes. It is administered as a commune of the department of Finistère and as such has a Mayor and a municipal council, which play an important role in scrutinising and approving proposed infrastructure projects such as renewable energy developments.

The electricity network and present generation equipment supplying homes and businesses on Ushant is entirely owned and operated by EDF and its distribution subsidiary, Enedis. The state-owned firm is therefore a major stakeholder in any changes to the system but under French law it is possible for independent generators and prosumers to connect to and provide energy through the existing network. The degree to which this is technically feasible, however, can only be assessed through a thorough review of the physical properties of the system.

4.2 National and local energy context

In 2015, renewable sources accounted for almost 20% of electricity generation. Figure 4.1 shows the recent evolution of the fuel mix in France between 2012 and 2016.

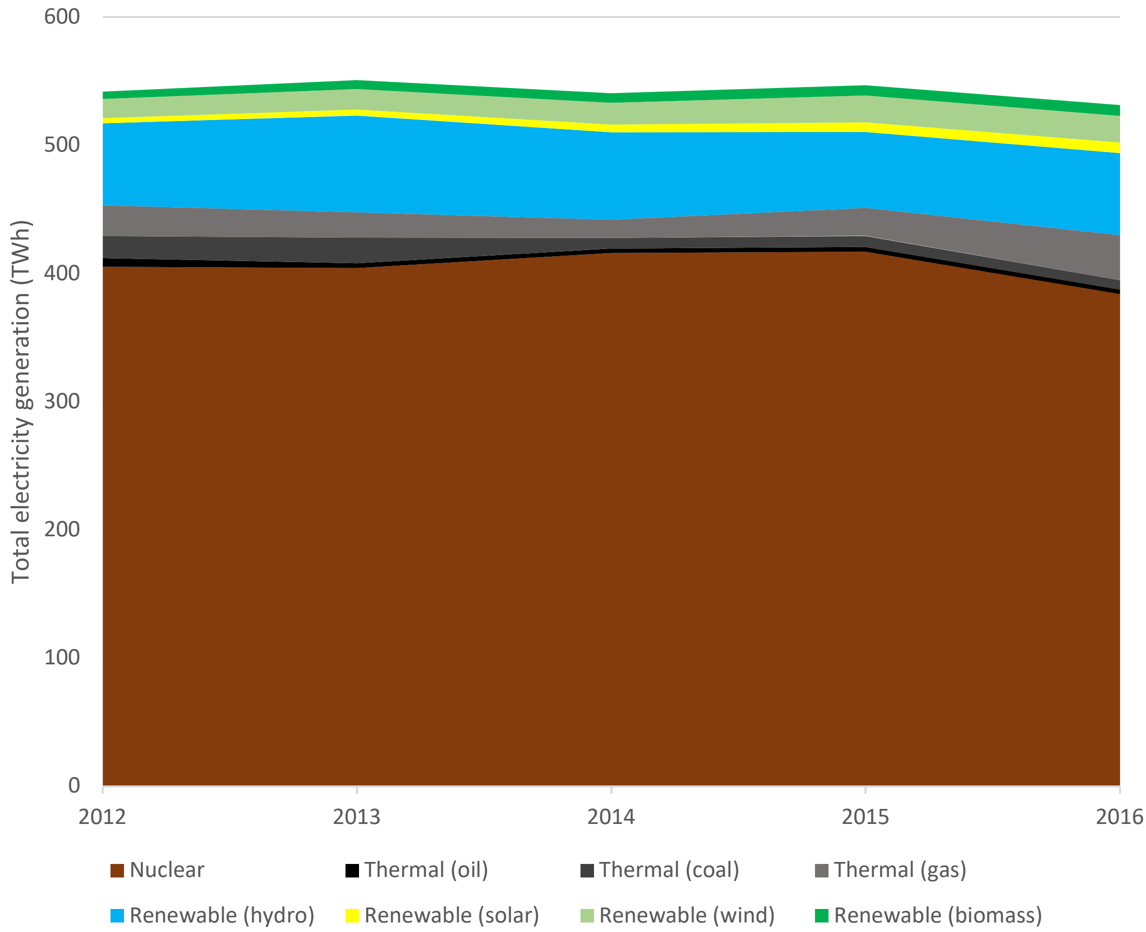


Figure 4.1: Electricity generation in France by source, 2012-2016 (source: opendata.rte-france.com)

The historical incumbent, state-owned utility company, Electricite de France (EDF), owns all of the country's nuclear power plants and dominates the French electricity generation market; the nuclear fleet alone accounted for 72% of total generation in 2016. In 2017, total installed capacity of installations larger than 1MW was 104 GW and total electricity generation was 531 TWh. Electricity generation was 2.8% higher in 2016 than in 2015 (RTE, 2017a; RTE, 2017b).

In 2009 and 2010, two laws were passed which created a legal framework for environmental protection and reforms in area important to the energy sector. The *Grenelle* laws, as they were known, created carbon accounting, placing an onus on the French regions to produce and report performance against energy plans and implications for permitting for wind energy installations (de Balorre *et al.*, 2016).

While the law requiring strict adherence to wind development zones determined at the local level (Zone de Développement Eolien - ZDEs) was relaxed in 2013, there remains a strong requirement for local involvement in planning renewable energy developments, especially wind energy and strict regional rules for planning siting equipment (DREAL Bretagne, 2012).

In August 2015, France passed a legislative act that sets the strategic direction for French energy policy for the following decades. The 'Energy Transition for Green Growth Law' or 'Energy Transition Law' includes six goals for energy in France:

1. Cut greenhouse gas emissions to contribute to the target of a 40% decrease in EU emissions by 2030 (compared with 1990 levels);
2. Cut France's consumption of fossil fuels by 30% by 2030;
3. Reduce the share of nuclear energy to 50% of electricity production by 2025;
4. Increase the share of renewables to 32% of final energy consumption by 2030 and to 40% of electricity production;
5. Halve France's final energy consumption by 2050 (compared with 2012);
6. Cut waste going into landfills by 50% by 2050.

Implementing the goals of the act is a 'multi-annual energy programme' that sets out national targets for the installed capacity of certain renewable energy technologies in 2023.

In 2016, France also began to push for a more ambitious EU-level carbon price, with plans to increase it to €56/tonne by 2020 and €100/tonne by 2023. While the plan is seeing some resistance in Brussels, current President Macron is still pursuing it in France (Gouvernement.fr, 2017).

4.2.1 Market liberalisation status

Historically, France has been seen as somewhat slower than many other EU countries in its progress towards electricity market liberalisation. Nevertheless, all electricity consumers in France have been able to choose between a market offering and a regulated tariff since 2007 and industrial consumers have only been able to access market-determined prices since 2015. While EDF still dominates all areas of the electricity market, competition is developing and there are currently more than ten companies offering energy supply contracts in France (de Balorre *et al.*, 2016). The proportion of volumes sold through regulated tariffs is changing, with market tariffs now accounting for more than half of all volumes.

Transmission and distribution are unbundled from generation in line with the requirements of the EU liberalisation agenda. However, the transmission system operator, RTE, and the largest distribution operator, Enedis (formerly ERdF), are 100% owned by EDF, consistent with the independent transmission operator (ITO) model allowed for in the EU's third liberalisation package (de Balorre *et al.*, 2016).

Municipal bodies known as *Autorité Organisatrice de la Distribution d'Energie* (AODE) own the distribution network in a particular territory and are legally responsible for the provision of energy services such as street lighting and, in particular, electricity distribution with a concession for the management of the network let to a provider of such services. EDF subsidiary, Enedis, currently holds approximately 95% of all distribution network concessions, although 82% of these are due to expire by 2028 (the Ushant concession expiring in 2023[6]) (IEA, 2016). The Departmental AODE, which in Ushant is *Syndicat Départemental d'Energie et d'Equipement du Finistère* (SDEF), is responsible for ensuring the quality of services provided by the concessionaire and mediating disputes with services users.

In common with many other European Countries, domestic energy prices have been trending upwards in the last several years.

[6] http://www.sdef.fr/Presentation-/79.html

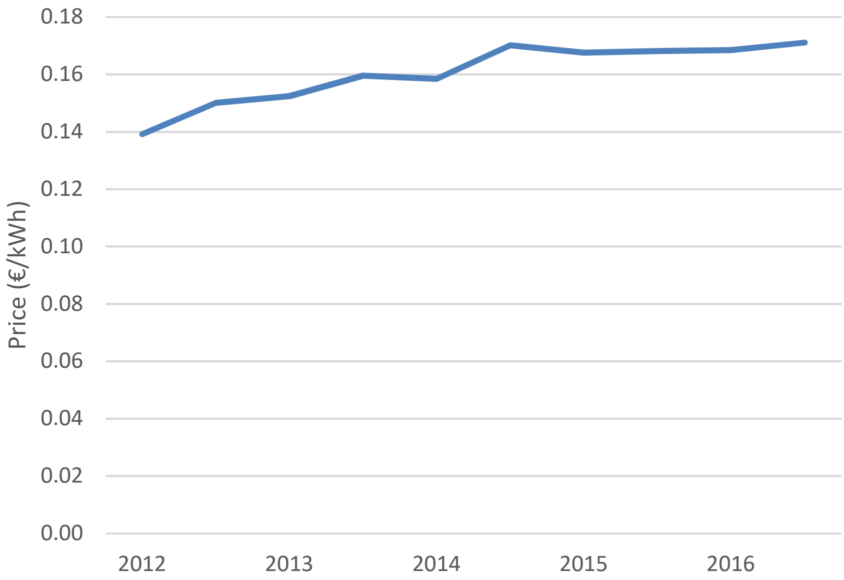
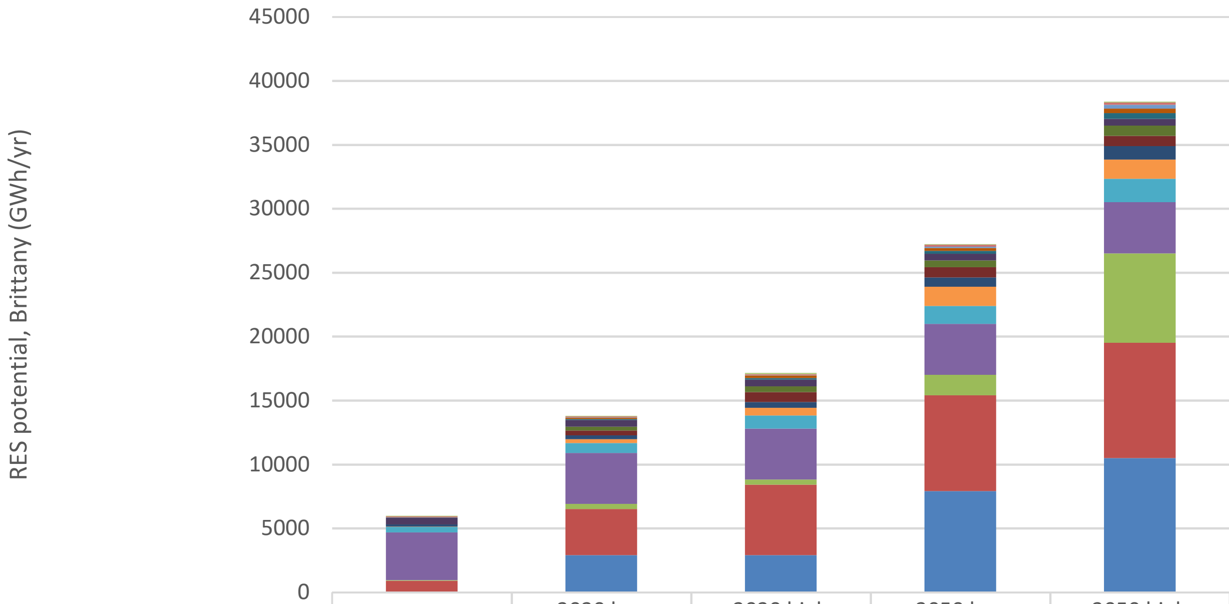


Figure 4.2: Domestic energy prices in France, 2012-2016 (source: Eurostat)

4.2.2 Brittany

As outlined above, the regions for France are required to set out their plans for participation in the national energy transition. Brittany's current Regional Plan for Climate, Air and Energy (SRCAE) describes the potential for renewable energy production in the region as well as the potential for benefits from a more flexible, decentralised approach to energy production.



	2010 actual	2020 low scenario	2020 high scenario	2050 low scenario	2050 high scenario
Hydro	66	50	80	50	80
Household waste (electricity)	79	80	80	160	160
Tidal Stream	0	10	30	100	300
Biomass cogeneration	0	120	195	216	350
Solar thermal	12	73	140	234	448
Tidal barrage (Rance)	523	523	523	523	523
Biomass cogeneration (heat)	0	293	450	530	810
Methanisation (electricity)	4	380	760	810	810
Household waste (heat)	176	300	460	720	1040
Biogas methanisation (heat)	30	300	600	1500	1500
Biomass district heating	410	770	1025	1390	1850
Biomass logs (heat)	3755	4000	4000	4000	4000
Solar PV	29	400	400	1600	7000
Onshore wind	905	3600	5500	7500	9000
Offshore wind	0	2900	2900	7900	10500

Figure 4.3: Comparison of the potential of renewable energy sources in Brittany, 2010, 2020 and 2050, low and high scenarios. GWh/yr (source: Region of Brittany, 2013)

4.2.3 Ushant

The island of Ushant is electrically as well as geographically isolated from the European continent (Pleijel, 2015). The French energy regulator deems such zones to be 'non-interconnected zones' (ZNI) (CRE, 2016). The population of Ushant is highly variable through the year, fluctuating between 888 and 1,546 in 2011 and as many as 3,000 during a busy summer (Sogreah, 2009; Pleijel, 2015). The island receives an estimated 120,000 tourist visits per year, almost all from mainland France.

Despite some experimentation with wind energy in the 1980s, with no electrical connection to the transmission system of mainland France, all electricity demand on the island was met, until recently, from a single EDF-owned, diesel fuel generation plant. This plant consists of four units, two of which are used to meet demand and two of which represent 100% redundancy in case of failure (particularly important due to the presence of important navigational aids on the island) (Zhou *et al.*, 2017). While the total capacity of the system is as high as 5,300kVA (~4,200kW) (Boughriet, 2009), a typical annual peak is more likely to be slightly greater than 1MW (Zhou *et al.*, 2017) although peaks of up to 2.2MW have been reported. The diesel plants provide almost all of the roughly 6,000MWh of electrical energy consumed on the island in 2014, consuming nearly 1.9 million litres of fuel in the process (Boughriet, 2009; Pleijel, 2015).

Electricity *costs* in Ushant are high and forecast to increase further. The marginal cost of electricity production is expected to be €243/MWh in 2022 and €252/MWh by 2032 (CRE, 2017b) with overall cost of supply believed to be as high a €400/MWh. However, electricity *prices* faced by consumers remain the same as those experienced by mainland consumers with standard domestic tariffs set at around €150/MWh depending on consumption[7]. The difference is made up by a general levy or surcharge on energy suppliers that covers this *geographic tariff equalisation* as well as renewable energy subsidies called Contribution au Service Public de l'Electricité (CSPE) or the Contribution to Public Electricity Service. In 2015, the cost of covering tariff equalisation across all of France's non-interconnected zones (including overseas territories) came to €1.5bn (Crampes and Léautier, 2015). It is our current understanding that EDF have installed a 1MW/0.5MWh capacity electrical storage device on the island, although the precise role that the device plays on the electricity system is not clear ('Ouessant veut se Décarboner', 2017).

Beginning in 2009, the Regional Council of Brittany initiated a series of actions designed to reduce the dependence of Ushant and nearby Molène on diesel for electricity generation by moderating energy demand and expanding the use of renewable energy technologies. The current ambition is for 70% of the island's electricity consumption to be sourced from renewables by 2020, rising to 100% by 2030.

In 2015, two kilometres from Ushant, a prototype 1MW tidal stream energy conversion device manufactured by Breton company Sabella was installed in 55m of water in the Fromveur Passage. By the end of 2015, the device was able to contribute up to 50kW of power to the Ushant electricity system, producing a total of 50MWh by the end of the testing campaign, a little over a year later (Sabella, 2015; 2016b). The device was removed to shore in Brest in July 2016 and a second testing campaign is planned (Sabella, 2016a). A 54kWp solar PV array was recently installed on the roof of a municipally owned sports centre by SDEF although the utilisation and its impact on the island's grid system is not clear. Some efforts are being made to install a wind energy generator on Ushant, although planning constraints mean that large-scale wind energy exploitation is unlikely. At the time of writing, erection of a meteorological tower for resource assessment is planned. Energy efficiency in Ushant has improved in recent years with actions such as the replacement of incandescent light bulbs with LEDs and replacement refrigerators saving approximately 300MWh/yr.

[7] Eurostat table nrg_pc_204

4.3 France (renewable) electricity supply policy

4.3.1 Routes to market: RE production, offtake and remuneration

Offtake and RES obligation

As discussed above, the French electricity system, including the development and integration of renewable energy technologies, has been traditionally dominated by the state-owned utilities company, Electricité de France (EDF), which either owned or acted as offtaker and counter-party[8] for nearly all independent renewable energy projects. Although EDF (or one of its local subsidiaries) remains the primary route to market for independent generators, recent changes make the participation of other offtakers more likely. However, in the event that renewable energy projects are unable to access an offtake contract on commercial terms, EDF will act as an 'offtaker of last resort', letting a contact for a maximum of 80% of the electricity's market value.

Output remuneration policies

France has two primary output-based support mechanisms for renewable energy: a premium sliding tariff for large-scale installations, allocated through competitive auctions, and a feed-in tariff for smaller projects.

Premium tariff (Complément de rémunération par guichet ouvert)

The feed-in tariff has been the main instrument for encouraging deployment of renewables in France to-date. However, the European State aid guidelines (see section 3.1.3) require a major re-design of RES support systems in France.

To this end, the Act on Energy Transition for Green Growth in August 2015 introduced a sliding premium tariff known as the "compensation mechanism" (mécanisme de compensation). This instrument consists in allocating a premium tariff to renewable electricity producers on top of the price they are able to achieve in the electricity market, in order to cover the costs of their installations and ensure their profitability (art. 104, loi n°2015-992). Depending on the technology, location and size of the installation, the premium tariff is allocated to generators either administratively through first-come-first-served 'open' contracts ("guichet ouvert") or through a competitive auction process. The value of the premium is calculated by the French electricity market regulator, CRE, using a formula that considers the market price, estimated administrative costs, the cost profile of a reference installation and revenues from capacity guarantees. The tariff payable reduces (towards the wholesale market price) once a threshold volume has been generated by the generating plant.

Importantly for Ushant, the move to the sliding premium system is only applicable in the continental French electricity system where there is a liquid wholesale electricity market to provide a reference price for these contracts. In electrically isolated territories, a fixed-price contract will remain the primary revenue support structure. Whether the tariff is sliding or fixed, the contract duration is twenty years.

[8] EDF contracted with generators to both fulfil the physical and financial elements of taking production

Renewable energy auctions (tenders)

As discussed above, in common with all other EU members, France has moved to a tendering or auction system for allocating all renewable energy support with some exemptions such as installation with less than 1MW installed capacity or fewer than six wind turbines. For mature technologies such as onshore and offshore wind and solar PV, France has been experimenting with the use of tenders for some years. Recently, the government launched a series of tenders for a wide range of types of renewable energy support.

In 2016, the government launched a programme of six tenders to be held between 2016 and 2019 to support a total of 3GW of solar PV. At the time of writing, one of these tenders saw 79 projects take contracts for support at an average price of €62.5/MWh. In parallel, a similar series of six tenders will be held between 2017 and 2020 for all onshore wind installations with more than six turbines, also letting contracts for up to 3GW[9]. A tender is also open for 50MW of self-consumption installations, with qualified bidders required to consume at least half of the project's output on-site. Auctions for tidal and/or wave energy projects are expected before the end of 2017.

Solar plus storage tenders

In 2015, the French government launched a tender specifically targeting the country's island territories. The 'solar-plus-storage' tender for 25MW of ground mount and 25MW of rooftop solar PV systems over 100kW requires the integration of electrical energy storage. Altogether, the first round of this type of tender fulfilled its 50MW goal with 33 projects on islands in France and her overseas territories in June 2016 (Ministère de l'Environnement de l'Énergie et de la Mer, 2016). In March 2017, the government announced that it would launch a tender for tidal energy projects between 50 and 100MW in designated zones in Normandy and Brittany (OEE, 2017). France has run two successful tenders for offshore wind in 2012 and 2013 and plans to contract up to 3GW by 2023. The figure below illustrates planned auctions for renewable energy in France including tender volumes by date and technology as well as cumulative capacity target for all tenders.

[9] http://www.cre.fr/documents/appels-d-offres

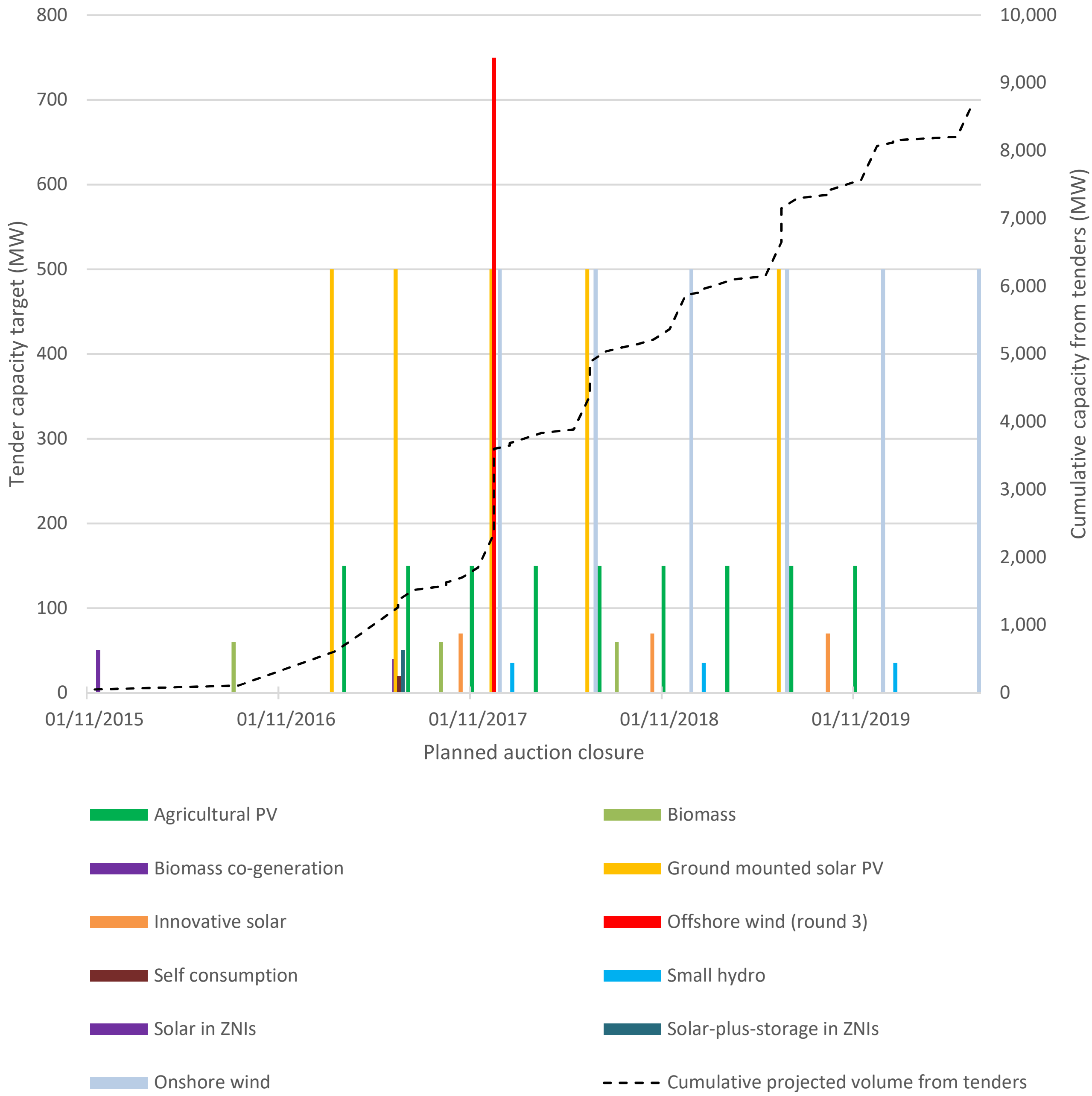


Figure 4.4: Planned renewable energy auctions by technology and volume, France. Does not include expected marine energy tenders. (source: authors' own elaboration. Data: CRE.fr)

In addition to the regular tenders, the scale of which may not lend themselves to projects on ZNIs, CRE also allows renewable capacity to be procured on an ad-hoc basis in these territories. These 'over the counter contracts' are "*subject to analysis by CRE and allow the determination of a level of support tailored to the specificities of the project and the territory it is connected to*" (CRE, 2016, p.29).

Feed-in tariff (Tarif d´achat)

Although the sliding premium is being expanded progressively, a role remains in France for the 'classic' fixed-price feed-in tariff as a support instrument for smaller installations and less mature renewable energy technologies including solar PV plants of up to 100kW capacity.

Other financial elements

Homeowners in France are able to benefit from a tax credit (crédit d´impôt pour la transition énergétique, CITE) aimed at encouraging energy saving and renewable energy production. The tax credit can be claimed for 30% of qualified works up to a limit of €8,000. There are also value added tax (VAT) concessions for building renovation work that improves energy performance (IEA, 2016).

4.3.2 Network access and grid connection

Renewable energy installations in France must meet the same obligations as any other form of generation when connecting to electricity networks and while they are not given priority, neither can they be discriminated against. Plant owners seeking electricity export to the public distribution system applies directly to transmission system owner, Réseau de Transport d'Electricité (RTE) or the local distribution company, almost invariably Enedis.

Agreements must be held for access to the grid (*Contrat d'accès au réseau public*), connection to the grid (*Contrat de raccordement*) and use of grid connection equipment (*Contrat d'exploitation des ouvrages de raccordement*) (Boekhoudt and Behrendt, 2014). Recent changes introduce strict deadlines for connection. From the point at which a signed contract is accepted, connections of more than 3kVA must be made available within 18 months. As before, smaller connections must be prepared in two months or less.

4.3.3 Social and environmental permits, licences and land-use planning

Formerly complex, onerous and seen as a drag on development, the planning permits required to build renewable energy projects in France have recently been significantly simplified. Until 2017, a large number of permits were required and gaining permission to build a 12MW wind farm took an average of 7-8 years (Lazerges *et al.*, 2016). A single environmental permit issued by the departmental prefect, and covering all requirements was introduced in June 2017. The key elements of the new system are:

- Special authorization for national nature reserves and nature reserves that are Government-listed in Corsica;
- Special authorization for registered sites or those pending registration;
- Exemption from measures protecting wild fauna and flora;
- Non-opposition procedure for Natura 2000 sites;
- Authorization to operate an electricity production installation;
- Approval of private electricity structures using public land;
- Land clearance authorization; and
- For onshore wind turbines, various authorizations under defence national heritage

(Fornacciari and Verrier, 2017; Martor and Harada, 2017)

Electricity generating plants in France are required to obtain an electricity generation license. Smaller renewable energy generation stations are exempt, however. The exemption threshold was raised in 2017 from 12MW for solar and 30MW for wind farms to 50MW for both, as well as for ocean renewables.

4.4 'Smart grids' policy

A number of actions have been taken in France in order to enable the creation of a smarter electricity system that can better monitor and manage distribution networks as the volume of generation connected to low-voltage networks increases, and to allow more effective charging of electric vehicles (Leiva *et al.*, 2016). In response to growing ambition in France for its 'Energy Transition for Green Growth', a consortium of public and private bodies known as 'Think Smart Grids' was established in 2015 to coordinate the French smart grid sector (Enedis, 2017).

Consumer supply contracts tend to have some price variation across the hours or days that have the highest demand. The transmission and distribution networks calculate that rapidly expanded use of battery storage technologies, residential demand response through smart meters, industrial demand response and 'wind energy controllability' can all play a major role in reducing the cost and improving the performance of the French electricity systems by 2030 (RTE, 2017c; Enedis, 2017).

Enedis began a smart meter roll out in 2016, later than many other EU countries, and with a view to providing new meters to all consumers by 2021 (IEA, 2016). While some observers are concerned about EDF's ability to innovate in areas such as responsiveness to electric mobility and in maximising systemic benefits relating to smart meters, the ability of new actors and business models to play a role as EDF's concessions expire over the coming decade may offer new opportunity in this area (IEA, 2016).

The regulator, CRE, is currently considering how best to design network usage tariffs that place appropriate incentives on market actors to pursue innovation in smarter technology and practices and is engaging with stakeholders on issues such as self-consumption (CRE, 2017c). Aside from the smart meter roll out, the bulk of activity in this area has been focussed on establishing a series of demonstration and pilot projects. In 2016, the French Government agreed to fund three projects in Provence-Alpes-Côte-dAzur, Bretagne et Pays-de-la-Loire and Métropole Européenne de Lille et Nord-Pas-de-Calais with €665 million. The projects intend to create industrial consortia that can develop and test new technologies (Think Smartgrids, 2016). In total, France and its territories has 147 smaller projects underway (CRE, 2017a).

5. United Kingdom

5.1 UK governance and policymaking institutions

The nature of jurisdiction in the United Kingdom (UK), which comprises the countries of England, Wales, Scotland and Northern Ireland, creates a marked degree of complexity in the governance of energy. Certain legislative responsibilities have, in recent years, been granted by central government to the national authorities (except England) in a process known as devolution. The nature and extent of devolution varies between the constituent countries, leading to a situation in which there is no stratum of administrative unit common to the whole of the UK (United Kingdom Permanent Committee on Geographical Names, 2009). The Scottish Executive, the Welsh Assembly and the Northern Ireland Executive have varying roles in energy governance. In simple terms, devolution has progressed further in Scotland than in either Wales or Northern Ireland but each country has a unique arrangement for the governance of energy projects with responsibilities divided between central government and devolved administrations.

The electricity system of the UK is split geographically and regulated on this basis. Electricity and gas in Great Britain (i.e., England, Scotland and Wales) is regulated by Ofgem while Northern Ireland's Utility Regulator oversees electricity, gas and water. This section is primarily concerned with the situation relating to GB energy.

The primary national level decision and policy making body for energy in the UK is the relevant department of the civil service which sets the objectives and terms of policy. Since 2016, this has been the Department for Business, Energy and Industrial Strategy (BEIS). However, the UK's finance ministry, HM Treasury, plays an important constraining role in setting the budgetary limitations of BEIS. Since the UK's pioneering privatisation and liberalisation of its energy industries and networks in the 1980s and 1990s, the UK's markets and networks (except those in Northern Ireland) - and therefore much of the day-to-day decision-making about energy - has been overseen by a regulator, currently known as the Office for Gas and Electricity Markets (Ofgem). Electricity transmission is owned by National Grid Plc in England and Wales and by two regional companies, Scottish and Southern Energy and Scottish Power, in Scotland[10], which also own the Scottish distribution system. There are 14 licensed distribution systems, owned by six companies as a result of mergers and acquisitions since the original privatisation. The current model sees these operate as largely passive 'distribution network operators' (DNO). The incentives have been shown to be broadly incompatible with the active role required by a smart electricity system (Lockwood, 2013) and the government is planning for a "*smarter, more flexible*" future including a shift from the DNO model to a 'distribution system operator' (DSO) model (BEIS, 2017b).

Since 2011, a process of electricity market reform (EMR) has been underway, requiring the creation of new responsibilities and institutions. As 'EMR delivery body', the GB TSO, National Grid Plc, has been granted responsibility for key elements of energy policy delivery including design and implementation of both renewable energy and capacity auctions. Two new statutory corporations, the Low-carbon Contracts Company (LCCC) and Electricity Settlements Company (ESC) were

[10] National Grid Plc is responsible for the operation of transmission system of all GB, including Scotland where it is owned by the Scottish utilities

constituted in 2013 to act as counterparty to contracts such as low-carbon CfDs and capacity market contracts.

5.2 National and local energy context

Coal has historically dominated the UK electricity generation sector but increasing gas generation in the 1990s and more recent increases in renewable generation have steadily reduced coal's share of the fuel mix. Over the last decade there has been an accompanying trend for lower overall generation. In 2017, the GB electricity system functioned for 24 consecutive hours without the burning of coal for the first time since commercial electricity generation began in the 19th century. Figure 5.1 shows the development of the GB electricity fuel mix between 2006 and 2016.

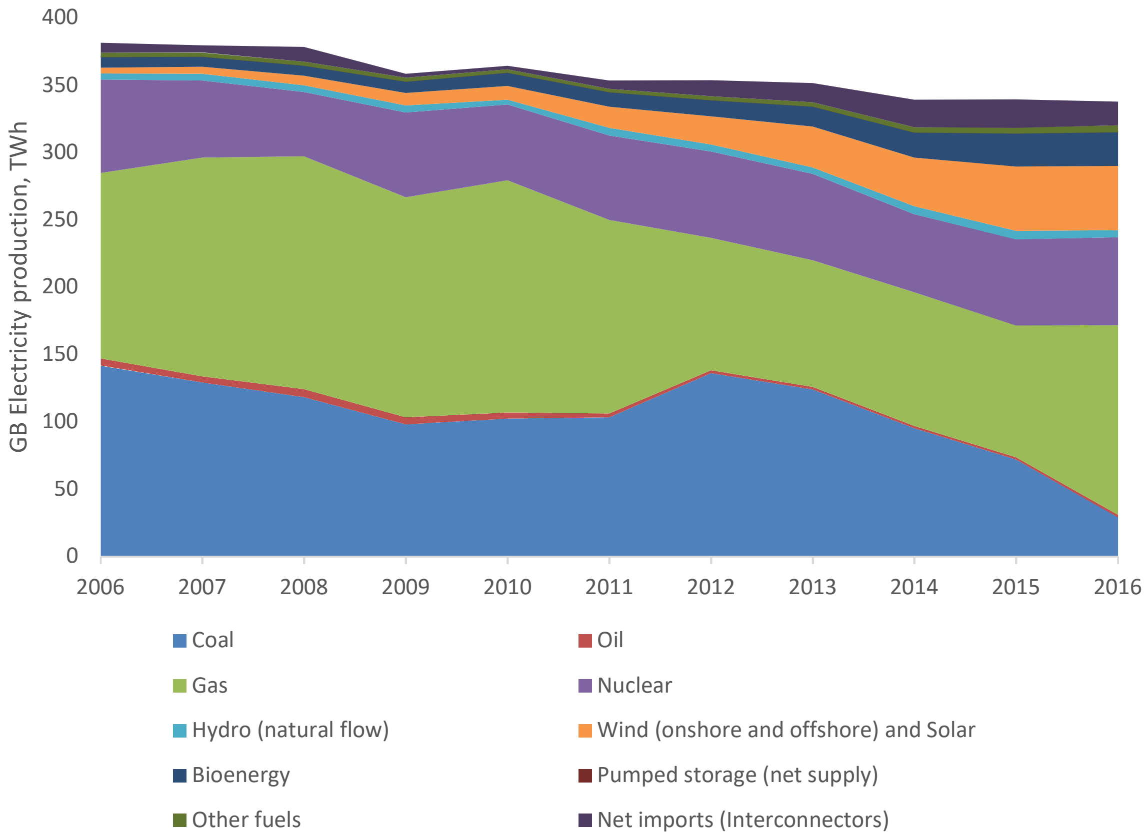


Figure 5.1: GB fuel mix 2006-2016. Source: Digest of UK Energy Statistics

The Climate Change Act (2008) (UK Government, 2008) passed into UK law a legally binding target of greenhouse gas (GHG) emissions in 2050 that are 80% lower than in 1990. This, along with obligations stemming from the Renewable Energy Directive (see section 3.1.2) means that electricity policy in the UK for the last decade has focussed largely on reducing emissions from the electricity industry while at the same time maintaining secure electricity supplies. This has resulted in a series of policies which promote renewable and other low-carbon generation options and, more recently, a 'capacity mechanism' that seeks to ensure sufficient reliable capacity is available (DECC, 2011).

Policies for encouraging the expansion of renewable generation have been in place in the UK since 1990. In 2002, a quota obligation known as the renewables obligation (RO) was implemented which rewarded large-scale renewable energy projects with supplemental revenues to those earned in wholesale markets with saleable certificates.

In 2011, a process of electricity market reform (EMR) was begun, which introduced a number of emissions reduction and energy security measures including replacement of the RO with a new sliding premium mechanism known as Contracts for Difference (CfD) which are allocated through competitive auction processes administered by the GB TSO. For small-scale electricity generation, a feed-in tariff has been available since 2010 and supports a range of technologies including solar PV, onshore wind energy, hydro-electricity and anaerobic digestion projects smaller than 5MW installed capacity. This scheme has been dominated by PV, helping to drive an increase from 26MW of installed capacity in 2010, to 12.3GW in 2017 (HM Government, 2017).

5.2.1 Market liberalisation status

The UK was one of the first countries in the world to liberalise its national energy monopolies, privatising all key functions of gas provision in 1986 and electricity provision in 1990, creating markets in both generation and supply and privately owned, regulated monopoly network companies. Since the early 2000s, the market structure has been quite concentrated, with six former regional monopolies (the 'big six[11]') accounting for 99% of all electricity sales as recently as 2012. More recently, however, there has been growth in the number of suppliers and the volumes of supply accounted for by them. By 2017 the big six accounted for 83% of sales and there were more than 100 entities holding supply licences (Ofgem, 2017b). The figure below illustrates the point.

[11] British Gas, EDF, E.ON, RWE Npower, Scottish Power, SSE

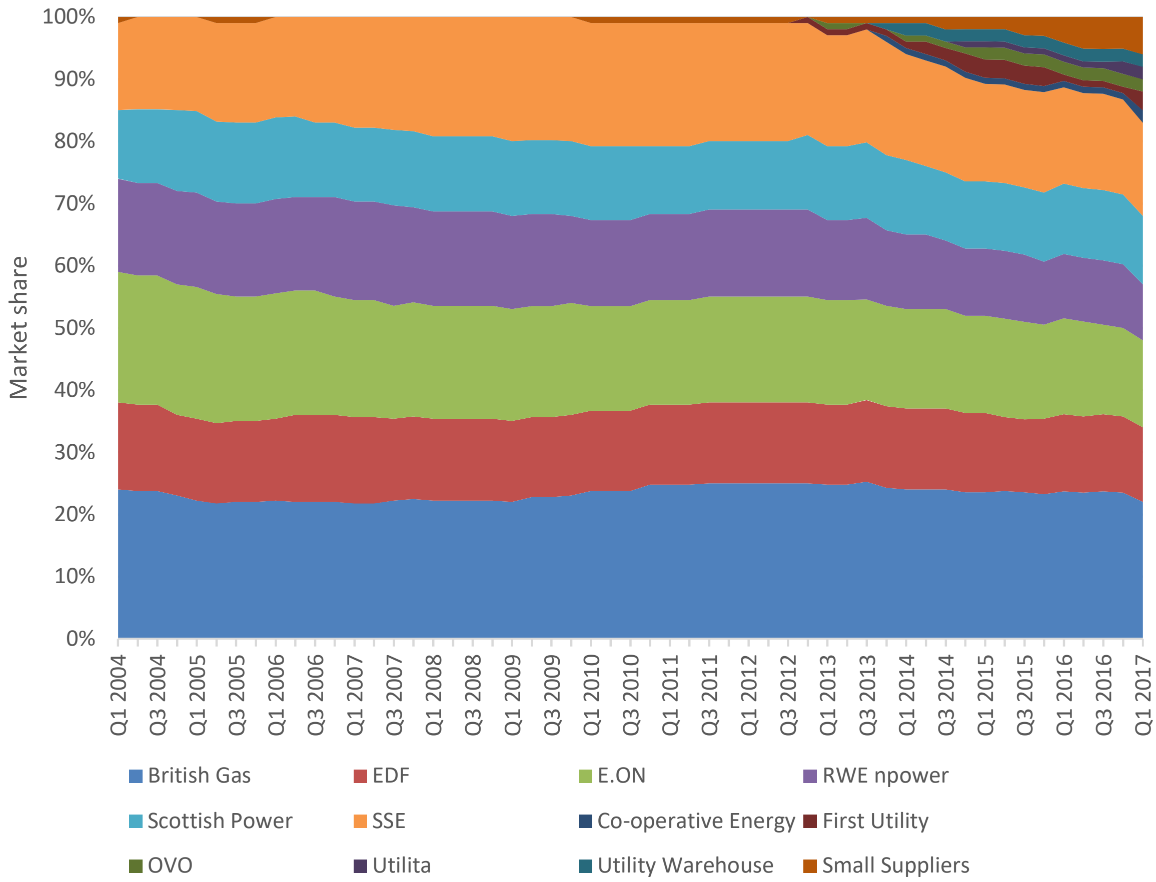


Figure 5.2: Market share by electricity sales, GB 2004-2017

5.2.2 Energy situation on UEA campus

The main campus of the University of East Anglia (UEA) is found to the west of the city of Norwich in Norfolk, UK and accounts for 95% of the university's energy consumption. Electricity usage on the main campus is approximately 34,500MWh and heat around 40,000MWh per year. Natural gas demand from the national network is around 75,000MWh. Peak electricity demand is 5.8MW in winter and 4.4MW in summer. There is a single electrical grid connection with 8MW capacity. On-site accommodation accounts for approximately 20% of overall energy consumption. All energy is supplied under a single contract with a supplier of gas and electricity.

The university meets some of the campus energy demand with on-site generation. There is 5.7MW of CHP and 300kW of solar PV generation currently installed. In total there are 22MW of natural gas fired boilers for heat provision and a 200m^3 thermal store used in conjunction with CHP thermal production. There are plans in train for 1MW of additional thermal provision from biomass boilers and up to 1MW of solar PV.

There are also plans to reduce energy consumption overall with a target of a 25% reduction compared to 2013/14 by 2021 and to reduce emissions by 35% compared to 1990 baseline by 2020 (UEA, 2015). Greater use of electricity generation from the CHP units during times of anticipated high electricity distribution costs and the potential for temporal electrical load shifting with battery storage is also being actively considered. A third party provider of flexibility services (Open Energi) provides firm frequency response services (FFR) on behalf of the University from the UEA campus. The figure below provides an overview of energy flows into and through the UEA campus.

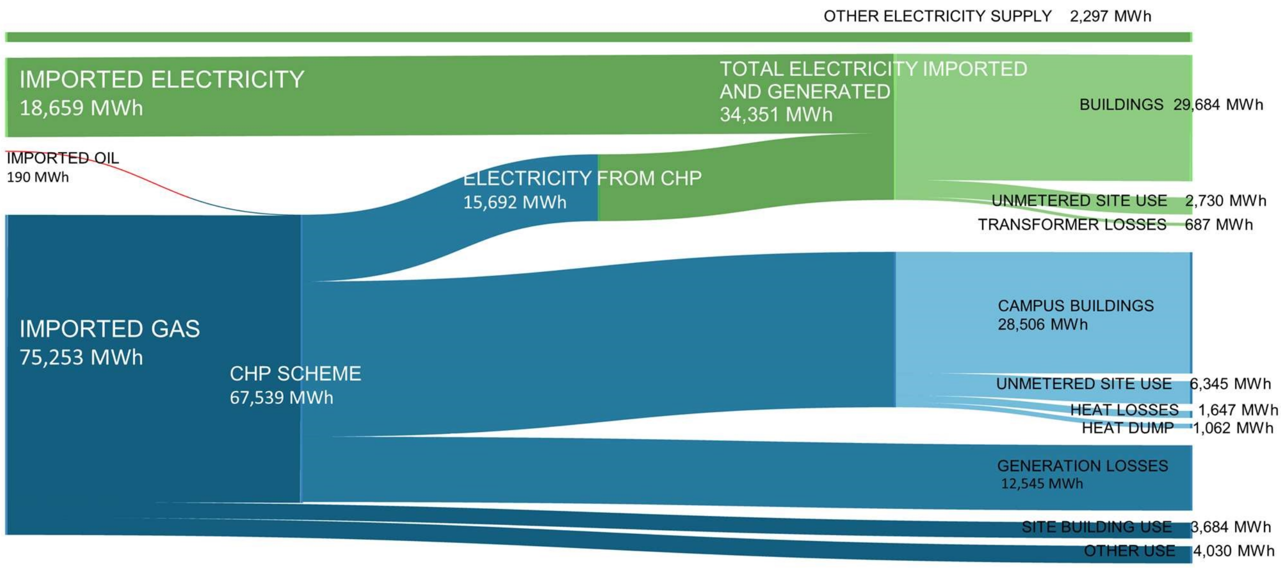


Figure 5.3: UEA Energy Flows (Source: UEA)

5.3 UK electricity supply policy

5.3.1 Routes to market: RE production, offtake and remuneration

Renewable energy output remuneration policies

Following the staged closure to new projects of the renewables obligation (RO) quota system in March 2017, there are two principle financial support mechanisms for renewable electricity in the UK. These are a feed-in tariff for projects smaller than 5MW capacity and a type of sliding premium known as contracts for difference, allocated on a competitive basis for larger projects.

Feed-in Tariff

Since 2010, a feed-in tariff (FIT) system has been available for renewable energy projects smaller than 5MW in Great Britain[12]. The FIT covers solar PV, onshore wind, micro-CHP (<2kW), hydroelectricity and anaerobic digestion. Licenced energy supply companies with eligible technologies receive fixed payments per unit of production. While the processing of financial transactions and application processing for small projects is performed by licensed supply companies, Ofgem, in its role as energy networks and markets regulator, manages some aspects of the accreditation process for larger projects (>50kW) and maintains a register of all accredited installations. Ofgem also calculates and publishes the rates payable based on guidance from the UK energy department, BEIS. Qualifying small-scale generators receive a basic tariff per unit of energy generated, and in addition to the benefits gained from self-supply, generators also receive a fixed rate export tariff for an assumed 50% of generation. In order to constrain budgetary commitment, deployment is strictly managed. Capacity caps are set for each quarter and a 'queue' established. As an indication of the policy's popularity, on the 1st August 2017 there were 353 stand-alone solar PV

[12] The UK, excluding Northern Ireland

projects awaiting accreditation[13]. Substantive reductions in the tariffs have led to a slowing down of the installation rates for small-scale PV in 2017 (HM Government, 2017).

Contracts for Difference

Conceived in 2011 as an element of electricity market reform (EMR), the contracts for difference (CfD) mechanism is the UK's main financial support instrument for large-scale 'low carbon' generation, including renewable energy (DECC, 2011). The instrument is a form of sliding premium, designed to offer a payment in addition to wholesale electricity market revenues up to a fixed 'strike price'. The strike price is set through competitive tenders[14], of which one has been held in 2014/15 and a second in 2017 (Fitch-Roy and Woodman, 2016). The CfD auctions held to date have allowed participation of a range of renewable energy technologies divided into two categories of more and less mature technologies. Onshore wind was excluded from the second auction due to a political commitment from the governing political party. The auctions have resulted in the contracting of a large volume of renewable energy, mostly offshore wind (DECC, 2015; BEIS, 2017a).

5.3.2 Network access and grid connection

Generators gain access to the GB electricity networks through contracts with either the TSO, in the case of large, transmission-connected plant or one of 14 distribution network owners (DNOs). Concerning these small generators in particular, the cost, time involved, transparency and difficulty of obtaining a grid connection offer – and then securing a functioning connection – from DNOs has posed some challenges for some generators, especially small renewable generators. Efforts have been made by the regulator, however, to make the process more efficient, which to-date have proved largely unsuccessful, leading the regulator to explore punitive measures (Ofgem, 2014; 2017a).

5.3.3 Social and environmental permits, licences and land-use planning

Under the Town and Country Planning Act (1990), local planning authorities are responsible for issuing permits to developments with installed capacity of less than 50MW. The level of local engagement required to gain permission to build new renewable installations means that planning policy in the UK tends to favour projects that are either wholly or partly owned by community initiatives. Since 2015, the necessity of local involvement in approving areas for wind energy in particular, has been explicit, making wind energy development very challenging in many areas, setting a clear division between onshore wind energy and other renewable energy technologies (DCLG, 2015a; Smith, 2016). However, some opportunities for very small installations on existing buildings remain under what are known as 'permitted development rights' (Smith, 2016).

For projects larger than 50MW, the Planning Act (2008) allows decisions to be taken by the responsible minister with local planning authorities contributing through formal consultation (DCLG, 2015b).

[13] https://www.ofgem.gov.uk/environmental-programmes/fit/contacts-guidance-and-resources/public-reports-and-data-fit/feed-tariffs-deployment-caps-reports

[14] A series of bilaterally negotiated contracts were let in 2013 and 2014 in what was known as the Final Investment Decision Enabling for Renewables (FiDER) process

5.4 'Smart grids' policy

The UK has implemented or is in the process of implementing a number of policy and regulatory changes with the goal of fostering a 'smart and flexible' energy system (BEIS, 2017b). Enabling smarter grids is seen by government, regulators and other stakeholders as essential to facilitating increasing volumes of intermittent and distributed low carbon technologies by allowing system wide adoption of new 'smart' technologies, more active network management and opening markets to services and technologies that will increasingly include demand side action (Jenkins *et al.*, 2015). The UK Government has taken a number of actions already to facilitate change in the UK's regulation of markets and networks to meet the needs of the low carbon transition and many of these will have implications for opportunities for increased network smartness. The Government, in partnership with energy markets regulator, Ofgem, established the Smart Grid Forum (SGF) in 2014. The SGF has worked closely with electricity sector stakeholders to devise actions to identify all areas requiring action to facilitate smart grid evolution.

5.4.1 Policy for Future Smart Networks

Significant actions already undertaken include a change in incentive structures for the transmission and distribution companies, to try to drive greater network innovation and to allow greater flexibility in terms of investment and return on smart network management approaches rather than simply expanding physical networks. Ofgem also permits network companies to commit additional spending to network innovation through various programmes, including the Low Carbon Network Fund, the Electricity Network Innovation Competition (ENIC) and the Network Innovation Allowance (NIA). Essentially, their aim is to allow the network companies to explore smarter solutions to integrating large volumes of low carbon technology, while minimising cost and maintaining reliability (Connor *et al.*, 2014; Jenkins *et al.*, 2015).

The Government has recently announced changes that will have significant further implications for distribution networks. with the announcement that the current, largely passive, distribution network owner (DNO) model will switch to a more active 'distribution system operator' (DSO) model (BEIS, 2017b). The Open Networks Project is an initiative of the energy sector aiming to determine what changes are needed, including the changing interaction between transmission and distribution, impact on consumers, and charging issues, as well as the DNO to DSO transition (ENA, 2017). The DSO model is common across Europe and the changing role of the DNOs is seem as essential to enabling many of the features likely to be essential to smart grids in the UK (Xenias *et al.*, 2014; BEIS, 2017b). Essentially, the shift would see DNOs maintain their current responsibilities but have access to a wider range of active network management approaches and be expected to work more closely with the System Operator and Transmission Owners.

The UK is engaged in a nationwide effort to replace *all* domestic and small business electricity and gas meters with smart meters by 2020. The goal is to bring down systemic costs by reducing supplier costs, driving energy efficiency and by enabling new and innovative approaches to network management such as aggregation, time-of-use tariffs. There are substantive hurdles to maximising benefits however, since some rely on behaviour change and some on access to smart meter generated data by companies which do not currently enjoy access. The rollout of smart meters has also been subject to delays and there is thus some way to go to enabling some key smart energy initiatives deriving from smart meters. There are additional barriers to the coming to fruition of some of the potential smart grid services. Further planned actions include (BEIS, 2017b):

- Increasing the participation of large non-domestic consumers in demand side response (DSR);
- Promoting innovation in DSR;
- Making legal provision for integrating electricity storage into networks and regulatory systems;
- Continuing the roll-out of smart energy meters in homes and small businesses and removing barriers to the provision of 'smart tariffs' by energy suppliers;
- Developing new standards for smart electrical appliances and electric vehicle charging infrastructure;
- Working to remove barriers to the provision of DSR storage services from electric vehicles;
- Updated cyber security and data protection measures;
- Levelling the playing field for storage and DSR providers in the GB capacity market which currently favours new generation;
- Updated, streamlined regulatory regime for 'ancillary services' provision, including frequency response;
- Possible plans for more cost-reflective network charging;
- Possible review of the security of supply standard (introduced in the 1950s) which governs demand connections on distribution networks.

It is likely that the need for additional actions beyond this list will emerge as experience with improving systemic smartness grows and as some options prove themselves or are rejected by the various stakeholder groups. This wide selection of overarching policy and regulatory changes are relevant in the case of sites such as the UEA campus since their role as a major consumer offers the future potential for demand side initiatives, to act as a producer, establishing its own generation or via a 'private wires' agreement, to use storage systems for internal and potentially external use, to become a mini-grid operator or to manage its own consumption more cost-effectively. Decisions regarding all of these actions will be impacted by the options that the market allows, and this will depend on wider regulatory architecture, licensing costs, the availability of new market opportunities and the emergence of new actors or divergence of established actors in exploiting them.

Perhaps of particular interest to the UEA example is the potential to offer DSR. The scale of the UEA campus and its role as a generator, large-scale consumer and potential site for storage or even to develop as a mini-grid offers the potential to act

5.4.2 Smarter Energy Markets

Ofgem announced a new programme – Smarter Energy Markets (SEM) – in 2013, with the goal of delivering reform in the wider electricity market and enabling smart approaches that would improve competition and enhance consumer protection (Ofgem, 2013). Enhanced DSR and new products and services fall into this category. Much of the eventual wider-scale application of this will be aimed at smaller consumers but it is likely that the broadening of DSR as a market service will begin with larger energy users, including institutions like the UEA campus.

DSR is already a substantial market, with1.4GW of contracts awarded under the December 2016 Capacity Market auction (BEIS, 2017b), though it can be argued that some of this is less desirable, most notably small-scale diesel generation. UEA may have the potential to improve its demand side management to take advantage of improved tariffs or even to go as far as to act as a deliverer of DSR and access the DSR market, possibly in partnership with a third party. The Government and Ofgem is currently exploring aggregation (BEIS, 2017b; Ofgem, 2017c). The UEA campus may have potential to aggregate across its own use, acting either on its own behalf or in partnership with a third party. However, currently aggregators are limited in their scope since they cannot access the balancing market (BEIS, 2107b) and there are other substantial barriers to their growth in the market which may impede the use of these techniques in the ICE project (Ofgem, 2016).

Augmented frequency response policies

In addition to participation in the GB capacity market, in which storage and demand-side response is largely over shadowed by new generation plant, new revenue streams are becoming available for non-generation grid services. As part of a trend towards enabling wider participation in so-called 'ancillary-services' markets and observing increasing volatility of transmission system voltage as conventional, inertia providing plant is run less often, the GB TSO, National Grid is expanding its range of frequency response providers. The first enhanced frequency response (EFR) tender ran in autumn 2016 and adds sub one-second response to primary (10s) and secondary (30s) frequency response. In the 2016 auction, eight battery storage systems were awarded contracts (Virley *et al.*, 2016).

6. Conclusions

This report sets out what we expect to be the main policy and regulatory factors relevant to the aims and scope of the ICE project. It provides information about electricity supply policy, renewable energy support, routes to market for electricity producers, permitting and spatial planning, grid connection, and smart grids policy.

It cannot, however, be expected to be exhaustive and new policy or regulatory issues may be encountered as the project progresses. It shows that the policy and regulatory environment at the EU, national and local levels is broadly supportive of renewable energy deployment, and, while there is common acceptance that a more flexible electricity system is necessary in the future, smart grid and demand response policies are less well developed in both the UK and France.

The unique geographical and legal statuses of the two sites mean that generalisations about smart grids, renewable energy deployment and the future demands on the energy system are impossible. Instead, this report provides a baseline for consideration by future work in the ICE project.

EU policy, as a fundamental driver of national policy, is important, even at local scales. Policies in both France and UK to promote renewable energy over the last decade or so have been shaped by decisions in Brussels. In particular, the renewable energy directive of 2009 and the energy efficiency directive of 2012 have led to national policy changes. More recently, the 2014 update to the European Commission's state-aid guidelines has been instrumental in the introduction of competitive bidding processes in renewable energy support in France (although the UK was planning an auctions system before prompting from the EU).

In France, the predominance of the national electricity utility, EDF, is a challenge and an opportunity for creating a smart energy island on Ushant. Its scope to act on energy supply as well as on demand side innovation is considerable, especially in a self-contained island context where many of the constraints experienced in mainland France are less pronounced (cost for example). To fulfil this potential, however, may require many small actions by a wide range of actors which will pose a management and collaboration challenge for EDF and the relevant public institutions.

The UK's highly liberalised energy markets are being challenged by the demands of creating a smart, flexible and low carbon system. The UK ICE pilot site on the campus of UEA has detailed plans for decarbonisation and is already experimenting with innovative technologies to better manage demand. The focus of the ICE roll out here is more likely to involved innovations that target the energy behaviours of the staff and students that live and work on the site.

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References

Aklin, M., Urpelainen, J. (2013) Political competition, path dependence, and the strategy of sustainable energy transitions. *American Journal of Political Science*. **57**(3), 643–658.

de Balorre, A., Barbier, C., Gasne, S. (2016) *Electricity regulation in France: overview*.

BEIS (2017a) *Contracts for Difference Second Allocation Round Results*.

BEIS (2017b) *Upgrading Our Energy System: Smart Systems and Flexibiliy Plan*. London.

Bergamaschi, L., Holmes, I., Lawson, R. (2014) *Making Sense of the Numbers : What does the Commission's 30% energy efficiency target by 2030 mean and is it enough?* London.

Boasson, E.L., Wettestad, J. (2013) *EU Climate Policy: Industry, Policy Interaction and External Environment*. Ashgate Publishing, Ltd.

Boekhoudt, A., Behrendt, L. (2014) *Taxes and incentives for renewable energy*.

Boughriet, R. (2009) 1ère phase du programme de maîtrise de l'énergie et de production d'EnR sur les îles d'Ouessant et Molène. *ACTU Environment*. [online]. Available from: https://www.actu-environnement.com/ae/news/plan_eco_energie_bretagne_ile_ouessant_molene_7769.php4 [Accessed June 16, 2017].

Ćetković, S., Buzogány, A. (2016) Varieties of capitalism and clean energy transitions in the European Union: When renewable energy hits different economic logics. *Climate Policy*. **16**(5), 642–657.

Connor, P.M., Baker, P.E., Xenias, D., Balta-Ozkan, N., Axon, C.J., Cipcigan, L. (2014) Policy and regulation for smart grids in the United Kingdom. *Renewable and Sustainable Energy Reviews*. **40**, 269–286.

Couture, T., Gagnon, Y. (2010) An analysis of feed-in tariff remuneration models: Implications for renewable energy investment. *Energy Policy*. **38**(2), 955–965.

Crampes, C., Léautier, T.-O. (2015) Electric islands. *Florence School of Regulation*. [online]. Available from: http://fsr.eui.eu/electric-islands/ [Accessed June 20, 2017].

CRE (2016) *15 Years of regulation: Activity report 2015*.

CRE (2017a) Annuaire des projets en France. [online]. Available from: http://www.smartgrids-cre.fr/index.php?p=france [Accessed October 17, 2017].

CRE (2017b) *Délibération de la commission de régulation de l ' énergie du 9 mai 2017 portant communication relative à la publication des coûts marginaux prévisionnels de production d'électricité dans les zones non interconnectées aux horiz*.

CRE (2017c) Régulation et financement. [online]. Available from: http://www.smartgrids-cre.fr/index.php?p=regulation-financement [Accessed October 17, 2017].

DCLG (2015a) *House of Commons: Written Statement: Local planning, 18 June, 2015*.

DCLG (2015b) *Planning practice guidance for renewable and low carbon energy*.

DECC (2015) *CFD Auction Allocation Round One - a breakdown of the outcome by technology, year and clearing price*.

DECC (2011) *Planning our electric future: a White Paper for secure, affordable and low-carbon* *electricity*.

DREAL Bretagne (2012) *Schéma éolien terrestre en Bretagne*.

Eikeland, P.O. (2008) *EU Internal Energy Market Policy : New Dynamics in the Brussels Policy Game?*

ENA (2017) *Open Networks Project Factosheet*.

Enedis (2017) Economic assessment of smart grids solutions: analysis carried out by the distribution network operators.

European Commission (2009) *DIRECTIVE 2009/72/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC*. European Union.

European Commission (2012) *Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency*.

European Commission (2014a) *Guidelines on State aid for environmental protection and energy 2014-2020*. European Comission.

European Commission (2014b) *Progress towards completing the Internal Energy Market*.

European Commission (2017a) *Proposal for a Recast Renewable Energy Directive*.

European Commission (2017b) *Renewable Energy Progress Report*.

European Commission (2014c) Study of the Benefits of a Meshed Offshore Grid in Northern Seas Region.

European Commission (2016) What is state aid? [online]. Available from: http://ec.europa.eu/competition/state_aid/overview/index_en.html [Accessed June 13, 2017].

European Council (2009) *29/30 October 2009: Conclusions*.

European Council (2014) *European Council (23 and 24 October 2014) Conclusions on 2030 Climate and Energy Policy Framework*.

European Environment Agency (2014) *Trends and projections in Europe 2014: Tracking progress towards Europe's climate and energy targets for 2020*.

European Technology Platform (2010) *Smart grids: strategic deployment document for Europe's electricity networks of the future*.

Fagiani, R., Barqu??n, J., Hakvoort, R. (2013) Risk-based assessment of the cost-efficiency and the effectivity of renewable energy support schemes: Certificate markets versus feed-in tariffs. *Energy Policy*. **55**, 648–661.

Fitch-Roy, O.W. (2016) An offshore wind union? Diversity and convergence in European offshore wind governance. *Climate Policy*. **16**(5), 586–605.

Fitch-Roy, O.W., Woodman, B. (2016) *Auctions for Renewable Energy Support in the United Kingdom: Instruments and lessons learnt*.

Fornacciari, M., Verrier, J. (2017) *Renewable Energy: The new regulatory landscape*.

Fouquet, D., Johansson, T.B. (2008a) European renewable energy policy at crossroads—Focus on electricity support mechanisms. *Energy Policy*. **36**(11), 4079–4092.

Fouquet, D., Johansson, T.B. (2008b) European renewable energy policy at crossroads—Focus on electricity support mechanisms. *Energy Policy*. **36**(11), 4079–4092.

Gouvernement.fr (2017) Energy transition. *Gouvernement.fr*. [online]. Available from: http://www.gouvernement.fr/en/energy-transition [Accessed October 17, 2017].

Gray, T., Haggett, C., Bell, D. (2005) Ethics , Place & Environment : A Journal of Philosophy & Geography Offshore wind farms and commercial fisheries in the UK : A study in Stakeholder Consultation. *Ethics, Place and Environment*. **8**(June 2005), 127–140.

HM Government (2017) Solar photovoltaics deployment - GOV.UK. [online]. Available from: https://www.gov.uk/government/statistics/solar-photovoltaics-deployment.

IEA (2016) *France 2016 review*.

IRENA (2017) *Renewable Energy Auctions: Analysing 2016*. Abu Dhabi: IRENA.

Jenkins, N., Long, C., Wu, J. (2015) An Overview of the Smart Grid in Great Britain. *Engineering*. **1**(4), 413–421.

Kitzing, L., Mitchell, C., Morthorst, P.E. (2012) Renewable energy policies in Europe: Converging or diverging? *Energy Policy*. **51**, 192–201.

Klessmann, C., Rathmann, M., de Jager, D., Gazzo, A., Resch, G., Busch, S., Ragwitz, M. (2013) Policy options for reducing the costs of reaching the European renewables target. *Renewable Energy*. **57**, 390–403.

Lazerges, R., Gölz, J., Sauzay, A. (2016) *French on-shore wind farm market in 2017: New tariffs structure and other important updates*.

Legifrance (2017) Code de l'énergie. [online]. Available from: https://www.legifrance.gouv.fr/affichCode.do?cidTexte=LEGITEXT000023983208&dateTexte=20110816 [Accessed June 21, 2017].

Legifrance (2011) Ordonnance n° 2011-504 du 9 mai 2011 portant codification de la partie législative du code de l'énergie. [online]. Available from: https://www.legifrance.gouv.fr/affichTexteArticle.do;jsessionid=6F149067985A7FC710B81A3CFB2E3113.tpdila14v_2?cidTexte=JORFTEXT000023974937&idArticle=LEGIARTI000023977706&dateTexte=20110510 [Accessed June 21, 2017].

Leiva, J., Palacios, A., Aguado, J.A. (2016) Smart metering trends, implications and necessities: A policy review. *Renewable and Sustainable Energy Reviews*. **55**, 227–233.

Lockwood, M. (2013) System change in a regulatory state paradigm: the 'smart' grid in the UK. In *Exploring New Modes of Energy Governance, European Consortium for Political Research General Conference 2013*. ECPR, pp. 1–37.

Martor, B., Harada, L.-N. (2017) New environmental single permit will simplify economic activities in France. [online]. Available from: http://www.lexology.com/library/detail.aspx?g=124e3f2e?4463?4d94?a694?6a3caa0ca5b3 [Accessed May 12, 2017].

Meeus, L. (2014) *Offshore grids for renewables: do we need a particular regulatory framework?*

Meyer, N.I. (2003) European schemes for promoting renewables in liberalised markets. *Energy Policy*. **31**(7), 665–676.

Ministère de l'Environnement de l'Énergie et de la Mer (2016) *Lauréats de l'appel d'offres «PV + stockage» dans les zones non-interconnectées*.

Mitchell, C., Bauknecht, D., Connor, P.M. (2006) Effectiveness through risk reduction: A comparison of the renewable obligation in England and Wales and the feed-in system in Germany. *Energy Policy*. **34**(3), 297–305.

OEE (2017) France announces tidal tender plans. [online]. Available from: https://www.oceanenergy-europe.eu/oee-statement-france-announces-tidal-tender-plans-2/ [Accessed October 17, 2017].

Ofgem (2014) *A guide to electricity distribution connections policy*.

Ofgem (2016) *Aggregators -Barriers and External Impacts*.

Ofgem (2017a) *Consultation on penalties for the distribution network operators under the Incentive on Connections Engagement*.

Ofgem (2013) *Creating the right environment for demand-side response: Next steps*.

Ofgem (2017b) List of all electricity licensees with registered or service addresses | Ofgem. [online]. Available from: https://www.ofgem.gov.uk/publications-and-updates/list-all-electricity-licensees-registered-or-service-addresses [Accessed August 8, 2017].

Ofgem (2017c) *Ofgem's views on the design of arrangements to accommodate independent aggregators in energy markets*.

Oliver, C. (2014) Franco-Spanish energy spat tests EU. *FT.com*. [online]. Available from: http://www.ft.com/cms/s/0/8e94079c-585f-11e4-b331-00144feab7de.html#axzz3JiQ4BOei [Accessed November 21, 2014].

'Ouessant veut se Décarboner' (2017) Ouessant veut se Décarboner à l'Horizon 2030. *Le Journal des Iles du Ponant*, 5.

Pleijel, C. (2015) *Energy audit on Ouessant*.

Region of Brittany (2013) *Schéma Régional Climat Air Énergie de Bretagne*.

del Río, P. (2017) Designing auctions for renewable electricity support. Best practices from around the world. *Energy for Sustainable Development*. **41**, 1–13.

del Río, P., Gual, M. (2004) The promotion of green electricity in Europe: Present and future. *European Environment*. **14**(4), 219–234.

RTE (2017a) Open Data RTE. [online]. Available from: https://opendata.rte-france.com/pages/accueil/ [Accessed June 15, 2017].

RTE (2017b) Production installed capacity. [online]. Available from: http://clients.rte-france.com/lang/an/visiteurs/vie/prod/parc_reference.jsp [Accessed June 15, 2017].

RTE (2017c) *Smart Grids: Socioeconomic value and optimal flexibility portfolios*.

Sabella (2016a) End of the Sabella D10 first campaign of tests. *sabella.fr*. [online]. Available from:

http://www.sabella.fr/fiche.php?id=257 [Accessed September 12, 2017].

Sabella (2015) Sabella D10, first tidal turbine to export electricity on French power grid. *sabella.fr*. [online]. Available from: http://www.sabella.fr/fiche.php?id=252&lg=gb [Accessed September 12, 2017].

Sabella (2016b) Sabella D10 has generated more than 50 MWh from tides. *sabella.fr*. [online]. Available from: http://www.sabella.fr/fiche.php?id=254 [Accessed September 12, 2017].

SKM (2012) *Research into GB offshore electricity transmission development . A comparative assessment with key countries.*

Smith, L. (2016) *Planning for onshore wind farms*.

Snyder, B., Kaiser, M.J. (2009) Offshore wind power in the US: Regulatory issues and models for regulation. *Energy Policy*. **37**(11), 4442–4453.

Sogreah (2009) *Etude de Faisabilite d'une Operation de Maitrise de L'Energie et de Development des Energies Renouvables sur les Iles de Molene et Ouessant*.

Think Smartgrids (2016) The French Smart Grids industry moves to industrial scale deployment with three projects | Think Smartgrids. [online]. Available from: https://www.thinksmartgrids.fr/en/actualites/filiere-smart-grids-francaise-passe-deploiement-industriel-trois-projets/ [Accessed October 17, 2017].

Toke, D. (2011) The UK offshore wind power programme: A sea-change in UK energy policy? *Energy Policy*. **39**(2), 526–534.

UEA (2015) *UEA Energy and Carbon Reduction Programme: 2015 – 2020*. Norwich.

UK Government (2008) *Climate Change Act 2008*. London.

United Kingdom Permanent Committee on Geographical Names (2009) *Toponymic Guidelines for Map and Other Editors: United Kingdom of Great Britain and Northern Ireland*.

Vantoch-Wood, A. (2013) *Comparative Report from the Respondents of Two Regional Studies Task D4.2.4 of WP4 from the EU MERiFIC Project*.

Virley, S., Scholtz, A., Gupta, A., Wafa, J. (2016) *EFR tender results*.

Wright, G. (2014) Regulating marine renewable energy development: a preliminary assessment of UK permitting processes. *Underwater Technology: International Journal of the Society for Underwater Technology*. **32**(1), 39–50.

Xenias, D., Axon, C., Balta-ozkan, N., Connor, P.M., Davidson, R., Taylor, G., Whitmarsh, L. (2014) Scenarios for the Development of Smart Grids in the UK : Literature Review. . (January), 1–184.

Xenias, D., Axon, C.J., Whitmarsh, L., Connor, P.M., Balta-Ozkan, N., Spence, A. (2015) UK smart grid development: An expert assessment of the benefits, pitfalls and functions. *Renewable Energy*. **81**, 89–102.

Zhou, Z., Benbouzid, M.E.H., Charpentier, J.F., Scuiller, F. (2017) Hybrid Diesel/MCT/Battery Electricity Power Supply System for Power Management in Small Islanded Sites: Case Study for the Ouessant French Island. In O. H. Mohammed, Y. Amirat, M. E. H. Benbouzid, & G. Feld, eds. *Smart Energy Grid Design for Island Countries*. Springer, pp. 415–445.