



Department for  
Business, Energy  
& Industrial Strategy

# Market Information Report: Great Britain

Produced for UK/Canada joint challenge on  
smart grids and energy storage

21 November 2018



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# Executive summary

This report is produced by Mott MacDonald on behalf of the United Kingdom Government Department for Business, Energy, and Industrial Strategy (BEIS) in parallel with the Natural Resources Canada, Innovation, Science and Economic Development Canada and Environment and Climate Change Canada. The two countries jointly operate a challenge fund on smart grids and energy storage. This document provides a high-level overview of the UK energy systems for any Canadian organisation looking to participate in the challenge.

The analysis presented here is aimed at helping companies to understand

- the energy market in Great Britain (GB)
- the drivers for innovation
- the market opportunities and access to these

The UK government is looking to spur innovation to help decarbonise electricity and heating alongside the transportation sector. In addition to decarbonisation, security of supply and affordability are the main focuses.

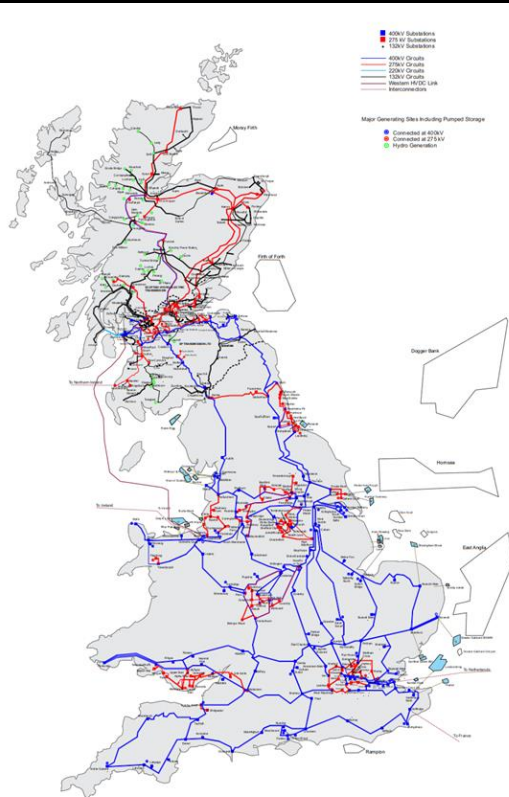
Challenges that have been identified are:

- Sourcing bulk low carbon generation to replace retiring nuclear, coal and gas plant and meet load growth from electrification of transport and heat sectors
- Satisfying flexibility needs for grid operation to accommodate large amounts of intermittent renewable generation
- Storing energy, both on a diurnal basis and over multiple days
- Finding a low carbon solution to meeting heat demands, especially in the residential and building sector (where heating is currently mostly natural gas).

The report has been prepared by Mott Macdonald based on the methodology developed by MaRS and presented in their “Going Global” series.

**Table 1: United Kingdom electricity sector snapshot**

**National Grid's Gas and Electricity Transmission system**



The UK market consists of both Great Britain's (GB) system (shown to the left) and Northern Ireland's system. These are interconnected through a sub-sea cable between Northern Ireland (to the west of mapped area) and Scotland (in the North). This report focuses on the GB market (England, Scotland and Wales) as the main market in the UK.

The map shows the Transmission system in Great Britain with major generation sites (including off-shore wind) and substations. The load centre of the system is, broadly speaking, in the middle/south of England and renewable generation (including hydro) forms a very significant share in the north.

GB is well interconnected with further interconnections between England and the Republic of Ireland, France, Belgium, Norway (under development) and the Netherlands. Northern Ireland is closely interconnected with the Republic of Ireland (and operated as one network).

Small island systems are operated for the populated islands, such as the Shetland islands (in the North).

Virtually all the population has access to grid connected electricity.

Source: National Grid ETYS 2017  
<https://www.nationalgrid.com/sites/default/files/documents/ETYS%202017%20Appendix%20A.pdf>

**Table 2: UK Electricity Statistics**

Installed generation capacity	103.9 GW
Electricity generation	300.3 TWh
Electricity coverage	100%
Transmission & Distribution Losses	7.6%
Environmental Targets	<p>The UK government aims to cut greenhouse gas emissions (CO<sub>2</sub> equivalent) by 37% by 2020, and 80% by 2050, compared with 1990 levels<sup>1</sup>. As part of its EU obligations, a target is in place for renewable energy sources to account for 15% of gross energy consumption by 2020<sup>2</sup>.</p> <p>In addition, the Scottish government has announced that 100% of its power generation will be from renewable energy sources by 2020.</p> <p>Northern Ireland set a target to procure 40% of power and 10% of heat from renewable sources by 2020.</p> <p>The Welsh government estimates that twice the amount of power consumed in Wales can be procured from renewable sources by 2025.</p>

Source: Global Data Power statistics

<sup>1</sup> <https://www.theccc.org.uk/tackling-climate-change/reducing-carbon-emissions/carbon-budgets-and-targets/>

<sup>2</sup> [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/48128/2167-uk-renewable-energy-roadmap.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/48128/2167-uk-renewable-energy-roadmap.pdf)



**Table 3: Key Smart Grid and Energy Storage Findings**

Opportunities in smart grids and energy storage	Barriers to smart grids and energy storage
<ul style="list-style-type: none"> <li>• UK government committed to smart grids and energy storage. Clean growth highlighted as a priority in industrial strategy.</li> <li>• All distribution network operators are transitioning to distribution system operators, requiring a step change in requirements control and management of energy systems.</li> <li>• Increase in intermittent renewable generation creates a need for additional control and management of energy system.</li> <li>• Electrification of heating and transport offer large market opportunities.</li> <li>• Energy storage growing quickly driven by participation in National Grid ancillary services and the use of Behind-the-Meter (BtM) battery storage.</li> <li>• Strong academic and professional services network for developing innovative ideas.</li> </ul>	<ul style="list-style-type: none"> <li>• Complex and highly competitive market environment</li> <li>• Electrical load has been flat/falling in recent years.</li> </ul>
Business Opportunities	Barriers to Business
<ul style="list-style-type: none"> <li>• Large, open market ranking very high on ease of doing business index with close relationships to Canada</li> <li>• The CETA agreement between Canada and the European Union facilitates trade between the Canada and UK.</li> <li>• No language and cultural barriers</li> </ul>	<ul style="list-style-type: none"> <li>• Canadian and UK electrical power system operate on different standards (ANSI / IEC), frequency (60 /50Hz) and voltages</li> </ul>

# 1 UK's Electricity Sector

One of the leading European and OECD countries, the United Kingdom is an open and globalised economy ranking 10th largest exporter in the world. According to the World Bank in 2017 unemployment rates fell to below 4.5% and economic growth was 1.7%.

**Table 4: Country Facts**

GDP per capita (current US\$) 2017	39,720
Population	65.6 million
Total Trade / GDP	37.1%
Currency	Great British Pound (£)
Main exports	Financial Services, Cars, Packaged Medicaments
Main imports	Gold, Packaged Medicaments, Vehicle Parts, Refined Petroleum
Main trade partners	Germany, China, US, Netherlands, France

Source: <https://data.worldbank.org/country/united-kingdom>  
<https://atlas.media.mit.edu/en/profile/country/gbr/>

## 1.1 Electricity Sector overview

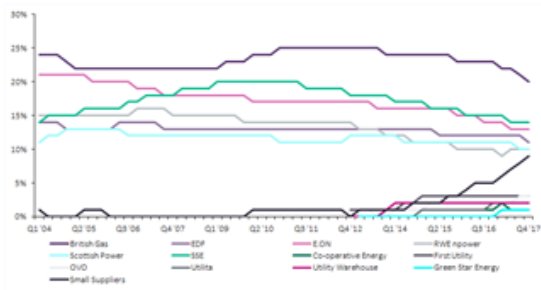
The UK electricity network was privatized in 1990 and is operated by an independent system operator (National Grid). In the wholesale market, private generators, suppliers and traders buy and sell energy through a power exchange or through direct power purchasing contracts within the regulatory frameworks overseen and regulated by Ofgem [Office of Gas and Electricity Markets]. The energy market is complemented by the Balancing Mechanism (BM) (executed by National Grid and administered by Elexon through the Balancing and Settlement Code) and markets for ancillary services, wherein the independent system operator procures system services, to ensure grid stability.

In GB the electricity market comprises many generators and suppliers with no dominant players, although a group of six big vertically integrated companies do together account for a significant share of supply and generation. These six energy suppliers [the big six] have dominated the UK energy market since the gas and electricity networks were privatized, but over 60 smaller rivals have emerged as effective competition in recent years. The six largest electricity suppliers' market share of retail sales dropped to 78% at the end of 2017 from 85% a year earlier<sup>3</sup>.

Transmission and distribution is operated on a regulated geographical monopoly basis in Great Britain with three transmission companies (of which National Grid is the largest) and 8 distribution companies owning 14 regional distribution networks. All companies are privately owned, with about half of the current market capitalisation being foreign owned.

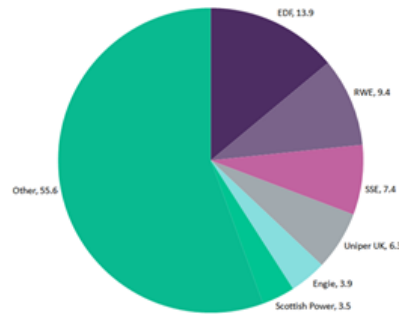
<sup>3</sup> <https://www.ofgem.gov.uk/data-portal/electricity-supply-market-shares-company-domestic-gb>

**Figure 1: Electricity Supply Market Shares by company**



Source: Global Data

**Figure 2: GB Power Market, Market share of Leading Generation Companies (2017)**



Source: Global Data

## 1.2 Energy Generation

GB's wholesale electricity market is one of the most competitive in the world, with many generation and supply (retail) companies trading largely on a bilateral basis.

Generators above 100 MW are obliged to register as a Balancing Market Unit (BMUs) and adhere to the Balancing and Settlement Code. Smaller generators (below 100 MW) can be licence exempt, allowing them to generate "independently" from the wholesale market's contract notification at gate closure (1 hour before delivery).

Many distributed renewable generators are such small generators, mostly supported through mechanisms such as Contracts for Differences (CFDs), Renewable Obligation Certificates (ROCs) and Feed-in-tariffs (FITs).

The UK has a fleet of so-called Behind the (consumer) Meter (BTM) generators for back-up and self-generation, which have been used to mitigate consumer's network charges during system peaks. However, tightening emissions limits and changes to rules on network charges has shifted interest away from such fuel-based generators towards BTM battery storage.

## 1.3 Energy Transmission

The transmission network is a fully integrated national network which is owned by different groups in various parts of the country. National Grid Electricity Transmission own the transmission networks in England and Wales. Scottish Power Transmission Limited owns the networks in south and central Scotland, and Scottish Hydro Electric Transmission Limited owns those in the north of Scotland. Transmission is carried out through 275 kV, and 400 kV lines (also 132 kV in Scotland). Most transmission (>95%) is carried out through overhead lines. Offshore wind farm connections are owned by Offshore Transmission Owners (OFTO). It is a regulated monopoly with price controls and government oversight through a performance-based regulation called RIIO (Revenue = Incentives + Innovation + Outputs).

The Connection Use of System Code regulates the charging framework through which the network users pay for the transmission system. Information about these charges is published for each year including a 5-year forecast in the network charging statements (National Grid) and include

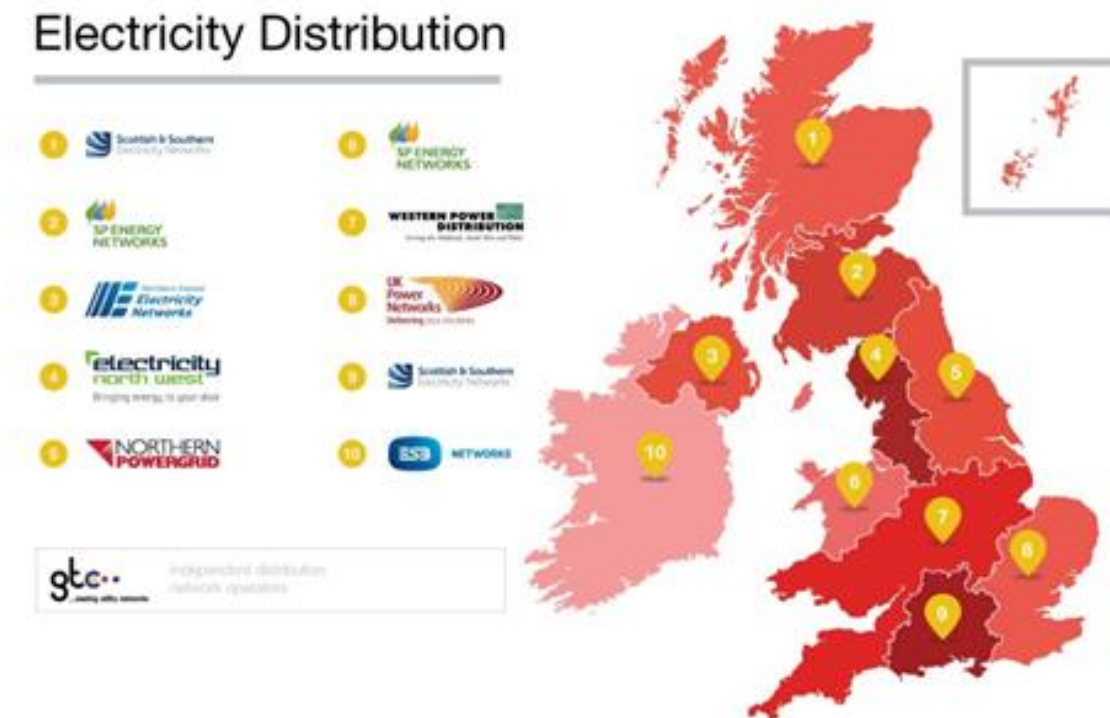
- Connection Charges
- Transmission Network Use of System (TNUoS) charged to generators and loads. Distributed loads (those connected to DNOs) are charged on the basis of average power consumption through the three-annual peak demand half hours in a winter, the so-called TRIAD, where the charging tariff varies by location.
- Balancing System Use of System (BSUoS) Charges to recover the cost for balancing the network which includes the procurement of ancillary services, wholesale trades, and bid/offer acceptances for balancing

### 1.4 Energy Distribution

The 14 distribution networks are supplied by the transmission network through Grid Supply Points (GSP) at 132 kV feeding into Bulk Supply points (BSP) at 33 kV with channels further down the voltage level into primary (11 kV) and secondary substations (400/230kV).

The Distribution Use of System (DUoS) charges are applied to each kWh consumed to recover the cost of the distribution network.

Figure 3: Distribution network operators



Source: ENA

## 1.5 Commercialisation

Suppliers buy electricity in bulk from generators in the wholesale market and sell it to their customers in the retail market. Both these markets are fully competitive but regulated by Ofgem to protect consumers. Non-physical traders can also participate in the market.

Most trading takes place using bilateral contracts through brokers, or via a power exchange and is mostly fixed well in advance of delivery. This wholesale market operates up to an hour before delivery, the so-called gate closure. After gate closure, market participants are exposed to the BM, (as they are all required to enter their contract volumes for production and consumption and a set of bid and offer prices) for deviations from their physical position at gate closure. The BM works on a rolling half hour basis, with the SO optimising over a rolling 90-minute window (3 trading periods).

The BM is the core of the new trading arrangements, BETTA [British Electricity Trading and Transmission Arrangements] which were introduced GB-wide in 2005, replacing the mandatory gross Electricity Pool. The BM provides a mechanism by which market participants can contribute to balancing supply and demand. Generators and suppliers whose metered positions deviate from their notified contract positions are exposed to cash-out prices for their imbalances and these are typically punitive<sup>4</sup>. The system operator is the sole counterparty to all BM trades.

Balancing action instructed by National Grid can also be done through Ancillary Services when required, some of which is procured in separate markets through auction. These include services for short-term reserve, operating reserve, and frequency management, among others<sup>5</sup>. These ancillary services are being reformed to allow for smaller market participants to take part. This represents a large opportunity for energy storage and demand side response technologies.

In addition, the Electricity Market Reform (2013) introduced the Capacity Market; National Grid procures generation (or demand side response) capacity under an auction mechanism to ensure there is sufficient supply available during periods of system stress (long-term reserve)<sup>6</sup>. This has been a major driver for energy storage and DSR in recent years. However, a recent reappraisal of how energy storage is assessed (de-rating factors) has made this less lucrative for short duration energy storage.

## 1.6 Market Regulation

The 1989 Electricity Act with amendments in 2004, 2008, 2010 and 2011, established a regulatory framework for a licensing regime – under which generating, transmitting, distributing, and supplying power requires a license. Ofgem, the regulator, is responsible for granting licenses. Ofgem is supervised by the Gas and Electricity Markets Authority (GEMA) and tasked with protecting the interests of customers, including ensuring supply security and reducing Greenhouse Gas (GHG) emissions. BEIS is responsible for energy and climate change policies<sup>7</sup>.

The Health and Safety Executive (HSE) is responsible for enforcing electrical safety legislation, in particular the safety aspects of the 2002 Electricity Safety, Quality and Continuity Regulations and the general safety legislation common to all industries, including the Health and Safety at Work Act of 1974. Formerly an agency of HSE, the Office of Nuclear Regulation (ONR) is an independent regulatory body which plays a key role in the regulation of nuclear power.

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<sup>4</sup> <https://www.elexon.co.uk/documents/training-guidance/bsc-guidance-notes/beginners-guide/>

<sup>5</sup> <https://www.nationalgrid.com/uk/electricity/balancing-services>

<sup>6</sup> <https://www.emrdeliverybody.com/cm/home.aspx>

<sup>7</sup> <https://www.gov.uk/government/organisations/department-for-business-energy-and-industrial-strategy/about>

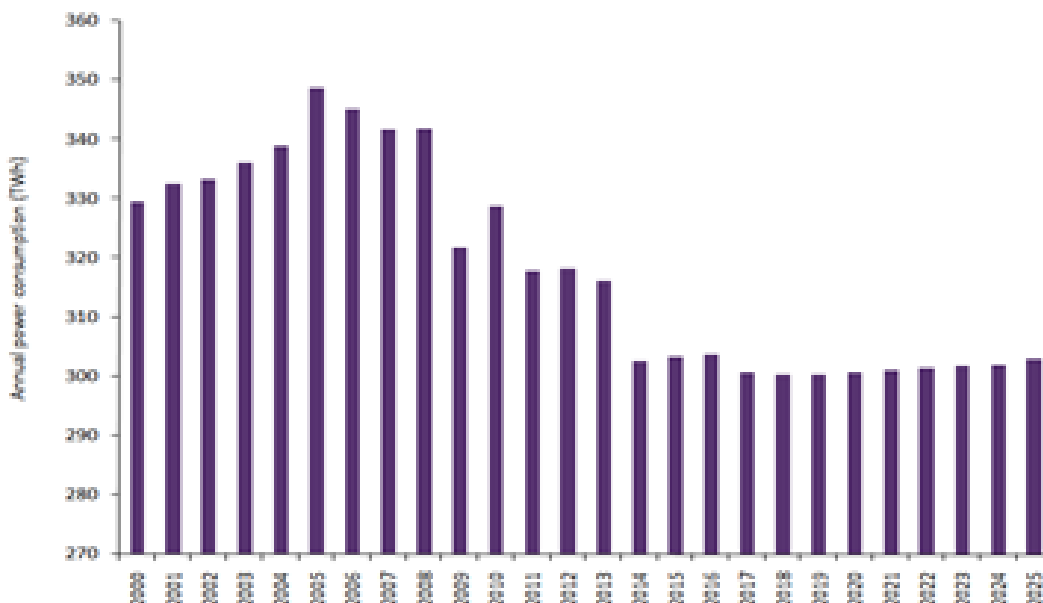
## 2 Electricity Supply and Demand Mix

### 2.1 Supply & Demand

The UK has seen a steady decrease in power consumption since 2005. The system is well interconnected with other European countries and a net importer of electricity.

Although the UK has its own oil and gas reserves, mainly in the North Sea with potential for further exploration across the country for newly discovered shale gas, it relies on imports for its primary energy needs. Gas supply is diverse with various interconnections and pipelines servicing the country's demand and thereby limiting exposure to shocks. For winter 2016-17, 42% of UK supplies came from Norway, 38% from UK production fields, 10% from European pipelines and 4% from liquefied natural gas (LNG) from global markets.<sup>8</sup>

**Figure 4: UK Power Market, Annual Power Consumption (TWh), 2000-2025 (estimate)**

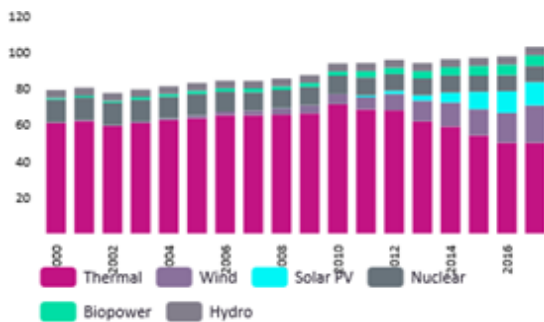


Source: Global Data

The UK generates power from a diverse range of sources, including coal (rapidly diminishing), gas, hydropower, renewables, and nuclear power (Figure 7). Thermal power is its main source of power generation and gas-fired power plants constitute the majority of this. Nuclear power generation currently constitutes a major source of power, and there are plans to build new nuclear power stations to replace the aging fleet. The government recently launched a support fund for an Advanced Modular Reactor (AMR) Feasibility and Development (F&D) project.

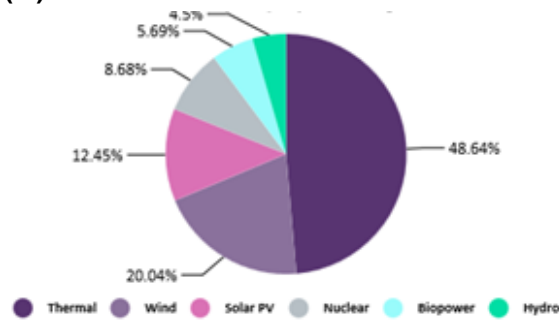
<sup>8</sup> [https://www.ofgem.gov.uk/system/files/docs/2017/10/state\\_of\\_the\\_market\\_report\\_2017\\_web\\_1.pdf](https://www.ofgem.gov.uk/system/files/docs/2017/10/state_of_the_market_report_2017_web_1.pdf)

**Figure 5: Capacity by Technology (GW) 2000-2017**



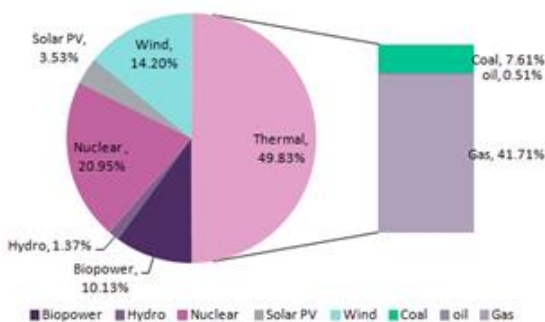
Source: Global Data

**Figure 6: Installed capacity by technology (%) 2017**



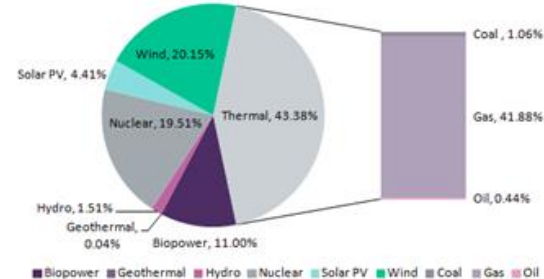
Source: Global Data

**Figure 7: Power Generation Mix by fuel type (2017)**



Source: Global Data

**Figure 8: Power Generation Mix by fuel type (2022 estimate)**



Source: Global Data

## 2.2 Renewable Generation

The government is committed to increasing the share of renewables in its energy mix. A renewable energy roadmap set the target to achieve 15% renewable energy consumption by 2020. Having introduced carbon emission targets and other initiatives to increase the role of renewable resources, the UK has seen a steady increase in renewable generation capacity (Figure 5). With renewable energy now being widely accepted as a competitive source of electricity, the share of renewable generation is expected to rise (Figure 7 & Figure 8).

Large-scale offshore wind generation has become a significant contributor in the generation mix with the UK's large wind energy resource making for an attractive market with average wind speeds among the highest found anywhere in Europe (Figure 10). Distributed solar (including rooftop solar) has also seen significant growth following the introduction of various support mechanisms, despite the UK's less attractive solar resource (Figure 9). About 3GW of old coal fired capacity has been converted to biomass firing.

Hydropower generation, mainly in Scotland generates around 1TWh a year. Pumped storage plants (PSP) are in use with legacy plants in operation and there are a number of potential developments for further PSP particularly in Scotland. However, the cost and environmental



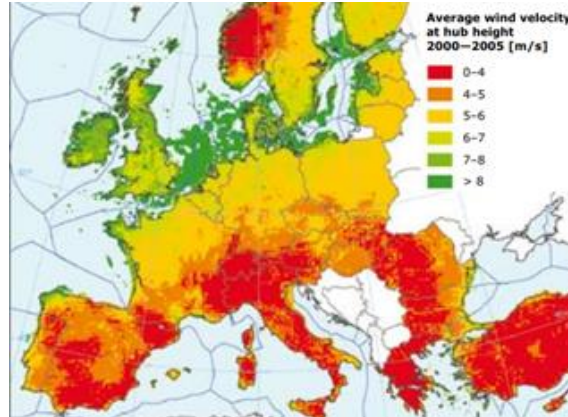
impact versus the role in future energy systems of such schemes are the subject of an ongoing debate. Similarly, the UK's tidal energy potential has been untapped to date (e.g. funding rejected for Swansea tidal lagoon project<sup>9</sup>), though Scotland is experimenting with underwater turbines<sup>10 11</sup>.

**Figure 9: Solar irradiance (kWh/kWp)**



Source: Solar GIS <https://solargis.com/maps-and-gis-data/download/united-kingdom>

**Figure 10: Average wind speeds (m/s)**



Source: European Environment Agency. Europe's onshore and offshore wind energy potential <https://www.energy.eu/publications/a07.pdf>

Electricity generation in the UK is rapidly shifting towards a low-carbon mix driven by constraints on legacy coal stations and strong support through long term government backed offtake contract for renewables (mainly wind and solar) and nuclear. The government has also made efforts to reduce carbon emissions from other sectors to comply with national and EU level emission targets. Pathways for electricity generation in the future include renewables and low-carbon sources such as gas and nuclear. The outlook for power generation in the UK is one with heavy reliance on intermittent renewable sources, backed by inflexible nuclear generation. Therefore, there is a need for the grid to be transformed to handle the increasing variability and complexity of different system interactions.

#### Opportunities

- Competitive and open entry markets
- Adoption of new technologies and new business models
- Decarbonisation of transportation and heating should translate into significant growth of the power market
- Nuclear decommissioning and new-built nuclear

#### Challenges

- Complexity of markets and regulatory frameworks
- Falling energy consumption

<sup>9</sup> <https://www.theguardian.com/business/2018/jun/25/government-rejects-plan-for-tidal-lagoon-in-swansea>

<sup>10</sup> <https://www.bbc.co.uk/news/uk-scotland-highlands-islands-43743453>

<sup>11</sup> <https://www.ft.com/content/24321f5a-9561-11e7-a652-cde3f882dd7b>

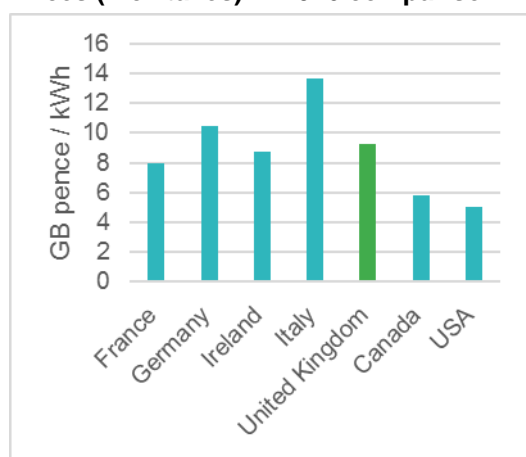


## 3 Quality and Resilience of Electricity Supply

### 3.1 Electricity Prices

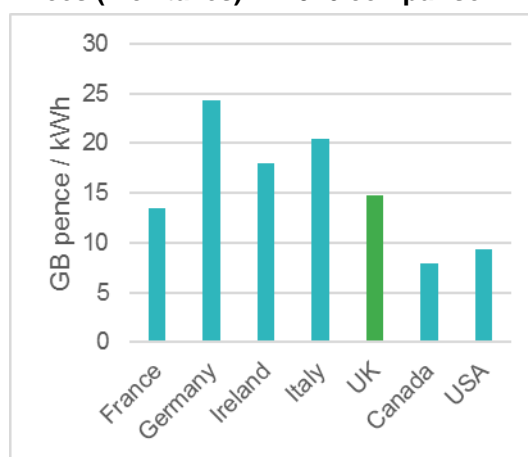
UK electricity prices are close to the average of IEA and European countries. In comparison to Canada and the US, the prices are significantly higher.

**Figure 11: Average Industrial Electricity Prices (incl. taxes) in 2016 comparison**



Source: UK government  
<https://www.gov.uk/government/statistical-data-sets/international-industrial-energy-prices>

**Figure 12: Average Domestic Electricity Prices (incl. taxes) in 2016 comparison**



Source: UK government  
<https://www.gov.uk/government/statistical-data-sets/international-industrial-energy-prices>

### 3.2 Quality and Reliability

Interruptions are generally rare in the UK. The Distribution Network Owners are incentivised to minimise interruptions using two metrics; Customer Minutes Lost (CML) and Customer Interruptions (CI). The DNOs are required to improve performance in these metrics each year. In recent years the following innovations have been rolled out:

- Increasing LIDAR surveys of OHLs
- On-line condition monitoring
- Automation of switching at high voltages (11kV and above)

Potential areas for further innovation include:

- Enhanced Inspections
- LV automation
- Improved diagnostics / fault location

### 3.3 Transmission and Distribution Losses

Electrical losses in the GB system are approximately 7.6%. These levels are relatively low compared to networks in other developed countries. The increasing use of large scale renewables (often located remotely from load centres) may lead to higher levels of loss in future.

Ofgem (the regulator) requires system owners to provide forward-looking programmes of work to understand and target loss reductions. Improvements are incentivised by Ofgem who have a losses discretionary reward fund to reward successful projects. The regulator has made it clear it welcomes further innovation in this area.

### 3.4 Network Connectedness

The GB system is generally well connected. There is however a north-south divide, either side of the England-Scotland border, where the boundary transfer capacities between the load centres in the South and a large proportion of renewable generation capacity in the North represent a constraint. Even with further North-South HVDC interconnections (bootstraps) being built (transmission capacity set to rise to 6.6 GW), this constraint is made more severe under high renewable generation scenarios projecting there to be a requirement for 9-13GW of transfer capacity by the mid-2020s.

The GB system is connected to the island of Ireland through interconnectors between England and the Republic of Ireland as well as through a Scotland - Northern Ireland interconnector. Further interconnectors exist with France, Belgium (under construction), the Netherlands and Norway (under development).

### 3.5 Exposure to Severe Weather

The World Risk Index measures a country's vulnerability and exposure to severe weather, disaster risk and environmental degradation. According to the World Risk Report (2017), relative to other countries, the UK has a medium level of exposure to natural hazards including storms, floods, and sea level rise. This is compensated for by low risks related to vulnerability, susceptibility, good coping, and adaptive capacities. The UK is ranked 135th out of 171 countries and falls in the low risk category.

### 3.6 Smart Grid and Energy Storage (non-hydro) Overview

The UK aims to improve its power transmission infrastructure, especially through the implementation of smart grid technology to allow the integration of higher shares of renewable generation and to improve energy efficiency. The government presented a comprehensive Smart Systems and Flexibility Plan in 2017<sup>12</sup> outlining how the energy system will be transformed.

Current developments include the roll out of Smart Meters to all UK consumers (by 2020) in the country. Current Smart Meters are based on the Smart Metering Equipment Technical Specifications (SMETS1) communications platform, which are based on a first-generation technology infrastructure. SMETS2 is to be introduced for new installations in 2018/19.

The battery / non-hydro energy storage market has recently taken off in the UK with close to 100 MW of projects installed up to 2017 and 300MW expected by end 2018. This has been driven by falling technology costs, National Grid's procurement strategy for ancillary services

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<sup>12</sup> [https://www.ofgem.gov.uk/system/files/docs/2017/07/upgrading\\_our\\_energy\\_system\\_-\\_smart\\_systems\\_and\\_flexibility\\_plan.pdf](https://www.ofgem.gov.uk/system/files/docs/2017/07/upgrading_our_energy_system_-_smart_systems_and_flexibility_plan.pdf)

(for frequency management), the capacity market and business modes for the co-location of batteries either with large industrial loads or renewable generation. Key applications to date are: frequency regulation, peak charges avoidance, distribution grid support, investment deferral, renewable capacity firming, voltage support, congestion relief, and reserve. A new application supporting EV charging could provide a very large new market, with one developer, PivotPower, planning to install 2 GW by 2022 (in 40 installations).

Electric Vehicles are also seen as a major part of the future smart grid environment. The UK government has set a target to phase out the internal combustion engine by 2050.

**The UK has one of the most advanced and most competitive power systems in the world. The UK's electricity sector attracts a lot of investment as it is typically innovative in terms of technology deployment. There are incentives in place to improve interconnections with other networks, network reliability and increase monitoring and control of the network.**

#### **Opportunities**

- Increasing shares of intermittent and inflexible generation opens market opportunity for smart grid technology (e.g. battery storage, Demand Side Response, etc.)
- Regulator and government work together to remove barriers to smart technologies, including storage, enabling smart homes and businesses, and opening markets to deliver greater flexibility. This includes removing barriers to participation in established markets, such as the balancing mechanism and ancillary services markets.
- Incentives in place for operational flexibility, improvements in network reliability and reduction in losses.

#### **Challenges**

- The market in recent years has had low load growth meaning relatively low investment for load growth near population centres.
- Complex and shifting regulatory framework means developers need to build in a risk premium.

## 4 Incentives for environment, sustainability and innovation

### 4.1 Climate Targets and Policy

The UK is a member of the Kyoto Protocol (via the EU) and is signed up to the Copenhagen Accord and Paris Agreement emissions reductions targets.

At the Paris climate summit, the UK committed to “Mission Innovation”. This includes an expectation to double (from 2015) relevant energy research and development to over £400 million in financial year 2020-21<sup>13</sup>. In addition, the UK government Industrial strategy has highlighted clean growth and future of mobility as key priorities for the UK<sup>14</sup>.

### 4.2 Energy Systems Innovation

The UK government has produced the Smart Systems and Flexibility consultation exercise<sup>15</sup>. This highlights the benefits advances in energy storage, demand side control, smart tariffs and ultra-low emission vehicles could offer the UK energy system.

To incentivise advances in these areas the government has several programmes including:

- BEIS funding for innovative smart energy systems<sup>16</sup>
- Faraday Challenge<sup>17</sup> – incentivising battery energy storage
- The Network Innovation Competition<sup>18</sup> and Network Innovation Allowances<sup>19</sup> to incentivise innovation for network operators and owners
- Funding from UK Research and Innovation (a body merging the UK Research Councils and Innovate UK)<sup>20</sup> including the Energy Entrepreneurs Fund<sup>21</sup>

In addition to these government programmes

- All DNOs are transitioning to Distribution System Operators (DSO)
- National Grid as system operator is opening up and expanding ancillary services for energy storage and DSR <sup>22</sup>

The office of low emission vehicles is providing funding to promote ultra-low emission vehicles and charging infrastructure through incentives such as:

- No excise duty for EVs
- Enhanced capital allowance for electric cars bought for fleets

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<sup>13</sup> <http://mission-innovation.net/participating-countries/united-kingdom/>

<sup>14</sup> <https://www.gov.uk/government/publications/industrial-strategy-the-grand-challenges/industrial-strategy-the-grand-challenges>

<sup>15</sup> [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/631656/smart-energy-systems-summaries-responses.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/631656/smart-energy-systems-summaries-responses.pdf)

<sup>16</sup> <https://www.gov.uk/guidance/funding-for-innovative-smart-energy-systems>

<sup>17</sup> <https://www.gov.uk/government/collections/faraday-battery-challenge-industrial-strategy-challenge-fund>

<sup>18</sup> <https://www.ofgem.gov.uk/network-regulation-riio-model/current-network-price-controls-riio-1/network-innovation/electricity-network-innovation-competition>

<sup>19</sup> <https://www.ofgem.gov.uk/network-regulation-riio-model/network-innovation/electricity-network-innovation-allowance>

<sup>20</sup> <https://www.ukri.org/>

<sup>21</sup> <https://www.gov.uk/government/publications/energy-entrepreneurs-fund-phase-7>

<sup>22</sup> <https://www.nationalgrideso.com/insights/future-balancing-services>

- 100% first-year-rate enhanced capital allowances for electric vans
- An exemption for electric vans from van benefit charge for five years (£3,000)
- An exemption for electric cars from company car tax for five years and a 10% reduced company car tax rate for cars with emissions equal to or lower than 120 g per km

### 4.3 National Strategy for Renewables

The National Renewable Energy Action Plan (NREAP) mandates a target share of 15% in gross energy consumption, 31% in power consumption, 12% in heating and cooling, and 10.3% in transport, by 2020. Achievement of these targets is supported by the following policies:

- The Renewables Obligation (RO) required electricity suppliers to source a specified and increasing proportion of their electricity from renewable energy sources or pay a buy-out price. This set a minimum value for renewable generation per MWh. This supported new renewable new generators until March 31, 2017 but has since been replaced by Contracts for Difference (CfD). In the most recent CfD auction, established renewable technologies, (onshore wind and solar) were excluded from funding.
- Carbon Price Floor (CPF), aimed at improving investor confidence by providing incentives for investment in a low-carbon future
- Emissions Performance Standard (EPS) was set at 450 grams (g) of Carbon Dioxide (CO<sub>2</sub>) per kilowatt hour (kWh).
- The UK participates in the EU ETS European Emissions Trading Scheme.
- NREAP mandates a target share of 10% biofuels in transport fuel consumption by 2020.
- NREAP establishes a final energy savings target of at least 9% for the 2008–2016 period.
- For smaller generators, the Feed-in Tariff Scheme provides a subsidy for each kWh generated (and fed into the network).
- The Climate Change Levy (CCL) was introduced in 2001 to encourage energy efficiency and promote investment in renewable energy technologies. The tax is charged on the use of coal, gas, liquefied petroleum gas (LPG), and power in industry, agriculture, and other public-sector industries. The CCL exemptions exist for power generated from “new” renewable energy sources. The government also provides for 100% capital allowance in the first year for energy-saving technologies.
- The Large Combustion Plant Directive (LCPD) and Medium Combustion Plant Directive (MCPD) are European legislation that set limits on pollutants from combustion of fuel. As a result, many polluting power stations have shut down in the last few years. Similarly, the Industrial Emissions Directive requires fitting nitrogen oxide emissions reduction technology.

**The UK's climate and renewable energy targets are ambitious and will require significant changes to the electrical generation type to facilitate them. This change is in progress.**

**As well as direct changes to electrical generation type the government aims to decarbonise the transport and heat sector to further decrease carbon emissions. This is likely to require the electrification of both, this has the potential to drive electrical demand growth.**

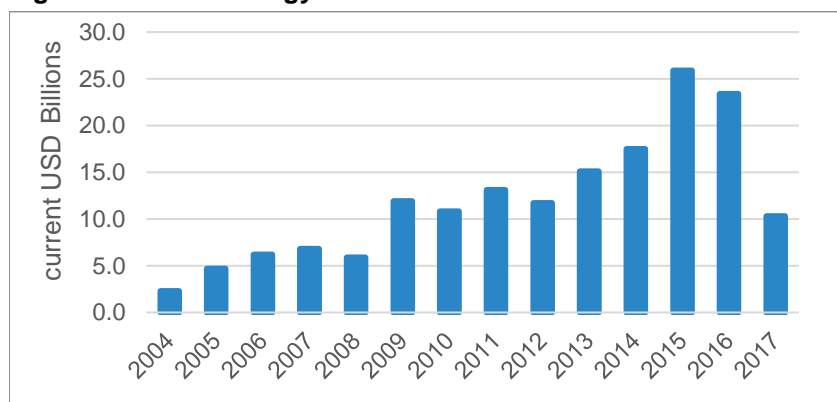
**To facilitate both the transformation in electrical generation and the increase in electrical demand, significant changes in electrical grid and energy storage will be required. The UK Government are actively incentivising innovation in these areas and the market opportunities are increasing.**

## 5 Business Environment

### 5.1 Clean Energy Investment

Clean energy investment has seen a sharp decline in 2017 which needs to be seen in the context of a general decline in European clean energy investment. A decline in capital costs of renewables coupled with reduced or un-awarded subsidies for new solar and onshore wind projects may be the reason for this decline in investment.

**Figure 13: Clean Energy Investment in the UK**



Source: Bloomberg New Energy Finance Clean Energy Investment Trends 2017: <https://about.bnef.com/clean-energy-investment/>

### 5.2 Quality of Business Environment

According to the World Bank, the UK ranks 7 out of 190 countries for doing business. Transparency International ranks the UK number 8 out of 168 countries in its Corruption Perception Index in 2017.

**Table 5: Ease of doing business indicators**

Topics	2018 Ranking
Overall	7
Starting a Business	14
Dealing with Construction Permits	14
Getting Electricity	9
Registering Property	47
Getting Credit	29
Protecting Minority Investors	10
Paying Taxes	23
Trading across Borders	28
Enforcing Contracts	31
Resolving Insolvency	14

Source: <http://www.doingbusiness.org/data/exploreeconomies/united-kingdom>

**Table 6: Doing Business in the UK**

<b>Facts</b>	
Why the UK	<ul style="list-style-type: none"> <li>• The UK is the fifth largest economy in the World<sup>23</sup></li> <li>• The UK is Canada's largest export market in the European Union</li> <li>• London, the UK's capital, is one of the world's most important financial centres</li> </ul>
Trade relations	<ul style="list-style-type: none"> <li>• The UK Canada trade relations are governed by the CETA agreement between Canada and the European Union. Detailed information about exporting to the EU is provided by the Canadian Trade Commissioner Service<sup>24</sup>. The Canadian government provides detailed guidance on standards, tax, documentation, labelling on the trade commissioner website.</li> <li>• The UK has been an active member of the EU since its accession in 1973. UK citizens narrowly voted to leave the EU in the referendum of 23 June 2016. The UK and the EU are currently negotiating the terms of the UK's withdrawal and will discuss a framework for their future relationship ahead of the UK's scheduled departure from the bloc on 29 March 2019. This may impact on the applicability of the CETA agreement. Both Canada and the UK have highlighted that ensuring free trade continues is a priority.</li> </ul>
Travel and Visas	<ul style="list-style-type: none"> <li>• Direct flights between Canada and the UK are operated very frequently by many providers. Flight time is about 8 hours between London and Toronto and 10 hours between London and Vancouver.</li> <li>• The UK is in the GMT time zone (GMT+1 during British Summer Time) while Toronto is GMT-5 (GMT-4 in summer) and Vancouver is GMT-8 (GMT-7 in summer)</li> <li>• The UK is part of the European Union, but not part of the Schengen area (passport free travel area in the EU).</li> <li>• VISAs are generally required for business travel, but more detailed information is provided by the UK government<sup>25</sup></li> <li>• The currency used is the Great British Pound (GBP). Its symbol is £.</li> </ul>
Peculiarities	<ul style="list-style-type: none"> <li>• UK runs 50 Hz, whereas Canada runs on 60 Hz electricity</li> <li>• Different standardisation. UK typically used IEC based standards, Canada typically uses ANSI standards</li> </ul>

**The UK in general (and the electrical section in particular) are open to foreign investment and innovations. The UK and Canada have a close relationship, with few cultural or trade barriers and FDI between the countries in both directions is very high.**

**Standards are not aligned between the UK and Canadian electrical systems. The issue of different voltage, frequency and standards for electrical equipment means that most electrical equipment will require modifications for export.**

**The UK Canada trade relations are governed by the CETA agreement between Canada and the European Union. This may no longer apply after the UK leaves the EU. In this case the UK and Canadian governments have both highlighted a commitment to facilitate free trade between the two countries post Brexit.**

<sup>23</sup> <https://www.imf.org/external/datamapper/NGDPD@WEO/OEMDC/ADVEC/WEOWORLD>

<sup>24</sup> <http://tradecommissioner.gc.ca/european-union-europeenne/market-facts-faits-sur-le-marche/0000256.aspx?lang=eng>

<sup>25</sup> [https://www.gov.uk/check-uk-visa/y/canada/work/six\\_months\\_or\\_less](https://www.gov.uk/check-uk-visa/y/canada/work/six_months_or_less)

## 6 Conclusion

### Currently the UK energy sector is focused on:

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**Highly liberalised wholesale and retail markets:** GB is one of Europe's most liberalised power markets with a 28-year track record of competitive generation, retail, and private regulated network businesses. Prices in the wholesale and retail market respond to underlying commodity prices (fuel and carbon) and to supply and demand pressures.

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**Mature regulatory framework but complex and often fluid:** While GB has a mature regulatory framework, it is complex and multi-layered, requiring industry participants to spend some time understanding the rules. What is more, the framework is often revised, as is now underway, in response to changing market, technology and political drivers.

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**Need to replace legacy generation plant in 2020s:** GB has significant tranche of legacy nuclear, coal and gas generation capacity most of which will need replacing during the 2020s. This will require a very significant build of new renewables and nuclear plant to provide bulk low carbon energy. Imports may also play a big role, with total capacity potentially reaching 18GW in the late 2020s from the 6GW currently operational or under construction.

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**Significant renewable generation expected to increase:** Wind (both on and off-shore) is the main renewable energy resource, with bioenergy/wastes currently in second place ahead of solar. Most of the growth in wind is expected to come from offshore – with some expected to be floating foundations. There is significant potential for onshore wind, but this is currently ineligible for government support. The bioenergy/waste contribution is dominated by Drax's three large generating units converted from coal to wood chips. Solar generation is expected to overtake bioenergy in the 2020s.

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**Government provides a generally supportive framework for deployment of clean technology:** GB is one of the few jurisdictions in the world to set a mandatory national carbon target and a set of carbon budgets. Carbon emitting power generators are subject to one of the highest carbon prices resulting from the UK's carbon price support add-on to the European Union's carbon allowance (EUA) price. Development of low carbon technology is supported through a combination of RD&D programmes, and long term off-take agreements (CfDs) which are awarded through competitive auctions.

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**Broad political support for decarbonisation agenda:** Both the two main political parties (Conservative and Labour) are committed to decarbonisation and support British initiatives in clean tech.

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#### RD&D funding is being allocated to two main cleantech areas:

- energy storage and smart systems
  - new nuclear – mainly advanced modular reactors.
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**Government committed to smart grids and energy storage:** All distribution network operators are transitioning to distribution system operators.

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#### Electrification of Heating and Transport offer large market opportunities

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**Dominant players in the GB market** – the so-called big six generator-retailers – have lost considerable share in the last decade with 56% and 78% of the generation and retail markets respectively. This has provided considerable space for new independent players in both generation and retail sectors.

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**National smart meter roll-out underway:** GB has embarked on a programme to install smart meters at all consumers requesting them by 2023. These two-way smart meters will, in principle, allow household customers to participate in smart demand and local energy/flexibility trading initiatives.

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**Resilience of supply:** Britain has a high quality of supply and a low risk of disruption from severe weather. This reflects the comparatively low weather risks and reasonable in-built design margins. Since 2015, GB's Capacity Market (CM) has provided dedicated remuneration to generators making capacity available during stress periods, such that under most reasonable circumstances the British system should have a high generation adequacy. Since 2010 the achieved loss of load expectation (LOLE) has averaged well under half the 3 hours target level.

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# Appendices

A.	Institutions in the electricity sector	20
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## A. Institutions in the electricity sector

**Table 7: Non-governmental**

The Energy Networks Association (ENA)	This is the industry body for UK energy distribution network owners / operators (DNOs). These DNOs play an important part in the incorporation of smart grid technology in the electricity distribution sector and setting standards for equipment.
National Grid TSO	Operates the GB electricity transmission network
Elexon	Administer the Balancing and Settlement Code (rules governing the metering of electricity generation)
EMR delivery body	National Grid's execution of the Electricity Market Reform <ul style="list-style-type: none"> <li>• Capacity Market</li> <li>• Contracts for Differences</li> </ul>

**Table 8: Government**

Department for Business, Energy, and Industrial Strategy	Government department responsible for business, industrial strategy, science, research and innovation, energy and clean growth, and climate change. Formed by the merger between Department for Energy and Climate Change and the Department for Business, Innovation and Skills.
Ofgem	Regulates the gas and electricity market in the UK

**Table 9: Key Smart Grid Organisations**

Energy System Catapult	Independent authority working with researchers, industry and government, the Energy Systems Catapult aims to clear the barriers blocking innovators from bringing new products, services and business models to market.
Institution of Engineering and Technology	The Institution of Engineering and Technology is a multidisciplinary professional engineering institution headquartered in the UK.

