Renewable energy market in UK

CATALINA SPATARU, BRUNO ARCURI

UCL ENERGY INSTITUTE
14 Upper Woburn Place, London, UK, WC1H 0NN

c.spataru@ucl.ac.uk

Abstract:
This chapter focuses on the renewable energy market in the UK. First we discuss the impact of privatization, then show what preconditions might be important. The main conclusion drawn from the analysis is that in the UK, as well as in other countries, new policy frameworks need to guide the transition from an energy system designed to achieve short-term efficiencies through market operation to a long-term approach that would embrace new uncertainties. Both market interests and environmental protection need to be secured in order to guarantee the levels of investment needed in the UK's renewable energy market.

Key words: markets, renewables, regions, UK, solar, wind

1 Introduction

The UK is producing most of their electricity from fossil fuels (coal and natural gas). Figure 1 shows the generation mix in the UK (2015) and Figure 2 shows the electricity generation by source in the UK between 1998 and 2015.

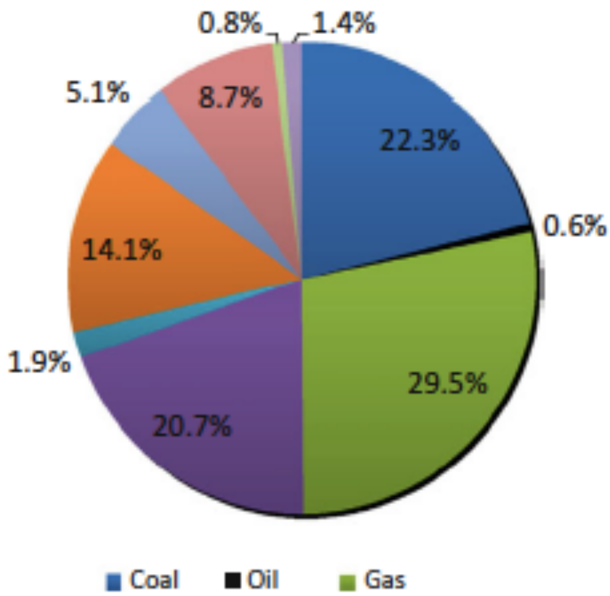

Figure 1 - Electricity mix in the UK 2015 (Data source: DECC 2016)

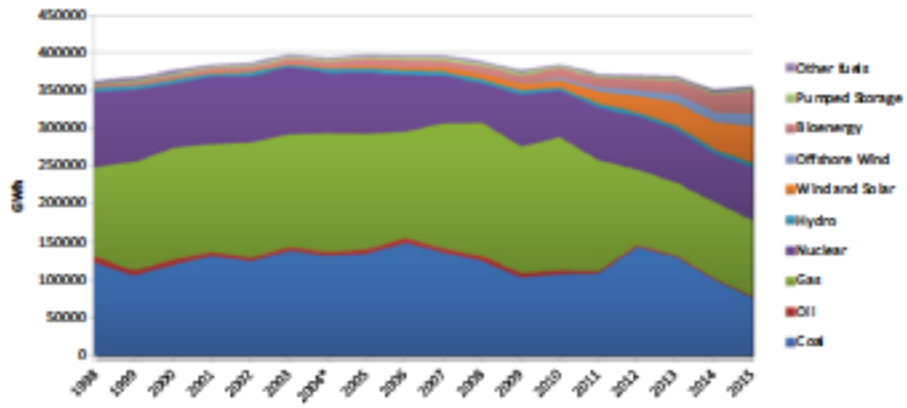

Figure 2 - Electricity generation by source in the UK between 1998 and 2015 (Data source: DECC 2016)

In the UK, the high reliance on fossil fuels often provoked a price premium compared to continental Europe. In the last years we have seen a trade-off between gas and coal based power production in the UK. Indeed the rise in gas prices since the Fukushima disaster made the share of natural gas fall from 46% in 2010 to 28% in 2012 in the UK electricity mix. On the contrary, the share of coal rose from 28% to 39% during the same years favoured by decreasing coal and carbon prices (European Commission, 2012).

2 Trade

The British Isles are historical net importers of electricity. There are currently four interconnections in service:

- The IFA interconnector to France
- The BritNed interconnector to the Netherlands
- The Moyle interconnector to Northern Ireland
- The East-West interconnector to the Republic of Ireland.

Most of the UK's imports come from France, followed by the Netherlands. Ireland and Northern Ireland import their electricity from Britain (Figure 3).

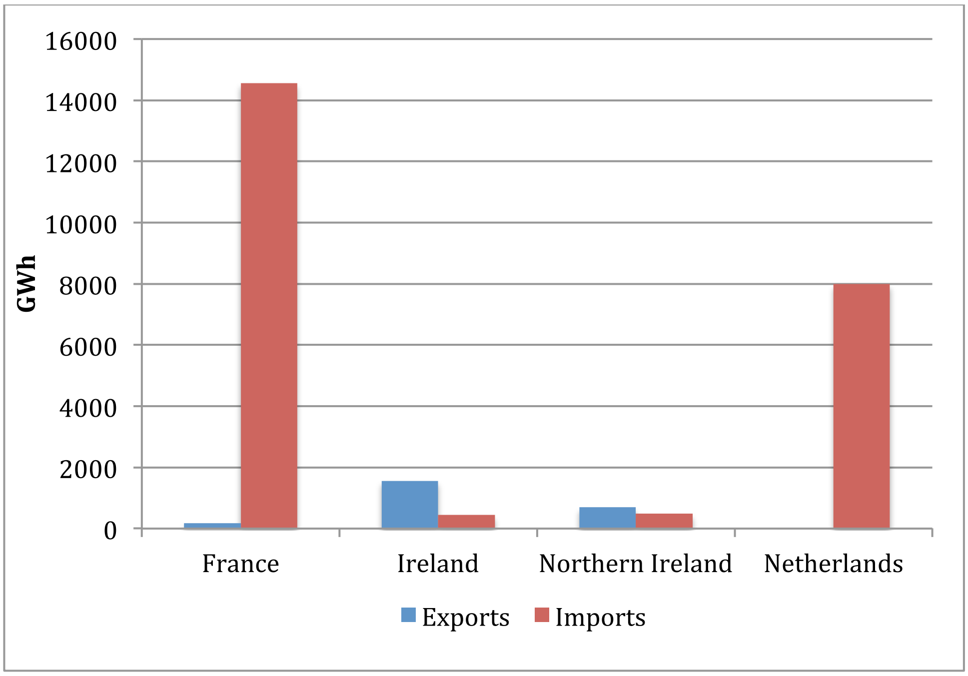

Figure 3 - Physical electricity exchanges between Britain and its neighbours in 2015 (Data source: ENTSOE 2016)

3 Market structure

3.1 Transmission and distribution network

England and Wales have an ownership unbundled transmission system operator (TSO). The independent TSO, National Grid, owns and operates the transmission network (National Grid, 2016).

Figure 4 - Electricity Transmission Network Operators in the UK (Adapted after (National Grid, 2016))

Scotland follows a legally ownership unbundled model. Scottish Power and Scottish and Southern Energy are vertically integrated companies who are involved in the whole electricity chain, from generation to retail and manage the transmission network through their subsidiaries (respectively Scottish Power Energy Networks and Scottish Hydro Electric Transmission).

The Office of Gas and Electricity Markets (Ofgem) is in charge of the regulation of the energy market in Great Britain. It is a non-ministerial government department and was created in 2000 by the merging of Offer and Ofgas (Birchall & Dunstan, 2010). On the distribution side, the UK counts 7 DSOs as shown in Figure 5.

Figure 5 - Electricity Distribution Network Operators in the UK (Adapted after(National Grid, 2016))

Private companies supply energy to consumers and consumers can choose which companies they buy energy from.

3.2 Generation and retail

Six main companies often called the Big Six dominate the electricity supply in the UK. The Big Six are:

- British Energy (subsidiary of Centrica),
- Scottish and Southern Energy,
- ScottishPower (subsidiary of Iberdrola),
- RWE Npower,
- EDF energy,
- EON.

According to Sheffield Energy Resources Information Services (SERIS), in 2012 the Big Six controlled 96% of the retail residential electricity market and 82% of the non-residential electricity market. 21 smaller retailers ensured the rest of the supply (SERIS, 2012). As the market opened to competition in the late 1990s, which is earlier than in most European countries, the switching rate between suppliers is one of the highest in Europe (15% in 2011) (European Commission, 2012). Regarding generation capacities, SERIS estimated that 74 companies owned about 94% of the generating capacity in 2012[1]. SERIS also assessed that the Big Six owned 71.3% of the total electricity generating capacities in 2012 (SERIS, 2012).

[1] Based on the last Seven Year Statement of National Grid combined with DUKES estimates.

4 History of the market

From 1990 to 2001, in England and Wales, wholesale electricity was traded through an electricity pool mechanism. The pool mechanism was relatively simple. Each electricity producer was asked to inform the pool of the electricity prices and quantities that it could provide. National Grid planned the schedule of generation based on this information and a day-ahead estimate of the electricity demand and calculated the pool price. National Grid was also in charge of balancing the real-time demand and supply (Simmonds, 2002). The New Electricity Trading Arrangements (NETA) replaced the pool in March 2001. NETA installed a classical bilateral electricity trading market composed of: a forward and future market, short-term exchanges, a balancing mechanism and a settlement process (Simmonds, 2002).

In 1rst April 2005, the NETA were transformed to include Scotland in the scheme and became the British Electricity Trading and Transmission Arrangements (BETTA) (National Grid, 2011). BETTA covers four types of electricity markets: the forward/future markets, the power exchange markets, the balancing mechanism market and the ancillary services market. Their organisation is described in Figure 6. 90% of the electricity is sold through the forward/future market, 3% through the power exchanges and 2-3% through the balancing mechanism market (Wilson et al. (2011)).

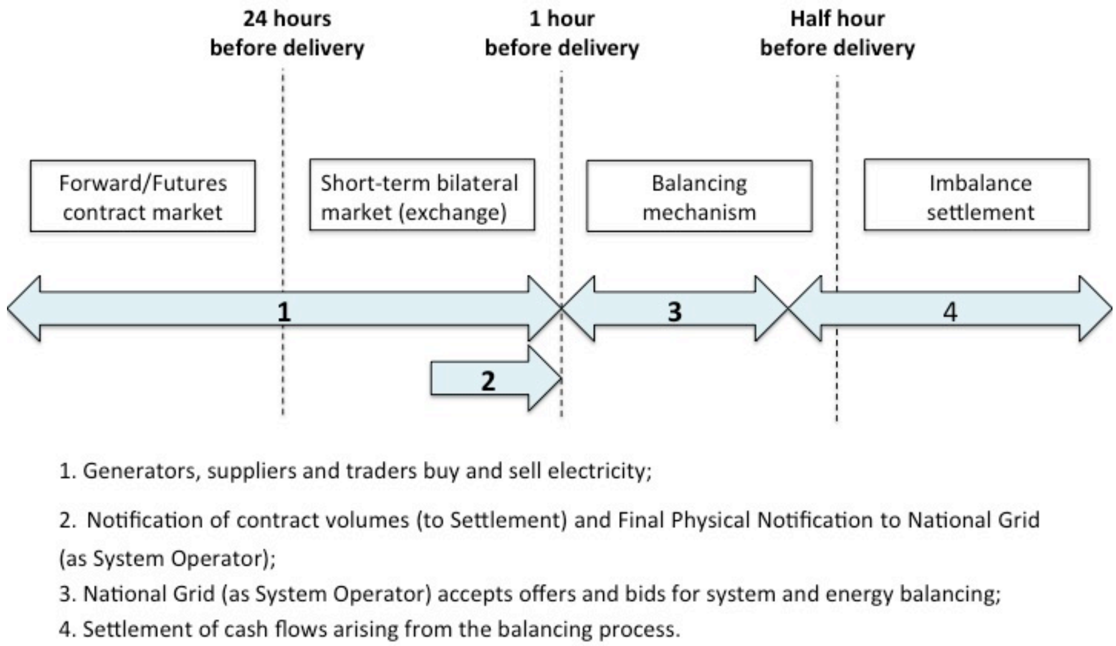

Figure 6 - Organisation of the electricity markets (Adapted after (National Grid, 2011))

The markets operate on a half-hourly basis. The only mechanism mandatory for all companies is the imbalance settlement.

The UK has three power exchanges, which is rare in Europe:

- APX Power UK was created in 2000 and was first named UKPX (APX, 2016).
- N2EX was launched in 2010 by NASDAQ OMX Commodities and Nord Pool Spot for the UK contracts.
- ICE was formed in 2000 and is the first network of exchanges and clearinghouses in the world.

The energy markets are regulated by the Gas and Electricity Markets Authority (GEMA), which is the organisation responsible for setting strategy and policy priorities, making decision on regulatory matter such as price control and enforcement. GEMA operates through the Office of Gas and Electricity Markets (Ofgem). Ofgem's principal objective is to protect electricity and gas consumers by promoting competition and regulating and delivering government schemes. According to Ofgem (2016), the scenario for renewable energy in the UK can be described with the following facts and figures:

- In 2015/16, 90,283,516 certificates (ROCs) were issued for eligible renewable electricity generated under the Renewables Obligation;
- Up to June 2016, 771,998 solar panel installations were registered for the Feed-in Tariff;
- The generation capacity from Renewables Obligation accredited UK offshore wind farms is 5GW;
- The investment in offshore transmission projects totalled £2.9 billion to date, connecting 4.4 GW of offshore wind.

5 Renewable Energy Source Integration: Challenges

Renewable energy sources (RESs) (wind and solar) are difficult to predict due to their variability. Wind speeds can vary from minutes to seconds and tend to be weakly correlated with high power demand; cold, windless winter evenings and hot, windless summer days (Grimston, 2014). The Royal Academy of Engineering (2014) points out that considering consented and under construction wind projects, the UK totals 20.7GW of wind capacity.

The electric system becomes exposed to weather risk when a significant proportion of the generating capacity comes from intermittent renewables. Darwall (2015) connects the weather risk and uncertainties inherent in farming to the reason the government heavily subsidises farmers, comparing this scenario to subsidies supplied to electricity generators. The report states that severe market distortions were introduced to the energy market due to Government interventions to support investment in renewables, which transferred weather risks and system costs to the rest of the energy system. This would mean that renewables might increase the amount of subsidies and support to nuclear and Combined Cycle Gas Turbine (CCGT) to keep the lights on.

Wind power substitutes the costs of fuel inputs, offering very low variable costs but making it a capital-intensive electricity generation source (Hughes, 2012). When the wind blows at optimal speeds, wind farms force coal and gas power plants to reduce their output as they present higher variable costs. This scenario produces adverse impacts on prices and costs for thermal power plant investors. On the other hand, investors of wind and solar power are paid for the energy produced by the weather and, as stated by Darwall (2015), might be paid even without producing in certain circumstances.

A study done by Ofgem (2009) assumed that onshore wind capital costs (£1,2m/MW) are twice the size of that of CCGT (£0.6m/MW), and for offshore wind this number is nearly five (£2,8m/MW). A report by UKERC (2010) also states that the capital costs of offshore wind have doubled in five years from approximately £1.5m/MW in to over £3.0m/MW in 2009, attributing this increase to factors such as commodity prices. Renewables also demand transmission infrastructures to built or reinforced. According to RenewableUK (2012), 10-20% of the capital costs of developing an offshore wind farm accounts to electricity transmission infrastructure. The UK government estimates a substantial investment in offshore networks worth up to £15 billion to be spent until 2020 to connect rounds 1,2 and 3 of offshore wind (House of commons, 2010).

6 Incentive and Market-Distortion Effects

Policy interventions in the electricity market create unintended distortions that require further interventions. In this sense, subsidised intermittent electricity introduced to the market depresses the profitability of other generators and, not only lower the returns from investing in replacement capacity necessary to maintain continuity of supply but also makes it harder to predict (Darwall, 2015). When there is low demand and high penetration of renewables, negative energy prices might appear as observed in Denmark, Germany, Canada and US (California).

A report by OECD/NEA (2012) states that these distortions are likely to become more pronounced as the wind and solar capacities are expanded. Two effects caused by the introduction of renewables on the market might cause underinvestment in dispatchable technologies, and therefore a decrease in security of supply at times of unfavourable meteorological conditions:

- **Compression effect:** Lower and more volatile wholesale energy prices impacting investment returns of conventional generating assets, which is amplified by favourable weather conditions for renewables;
- **Pecuniary effect:** Renewables investors are subsidised and therefore isolated from the effect of their output on the market, while conventional generators do not affect renewables generators.

7 Enhancing competition and protecting consumers

Subsidies for intermittent renewables have damaged the functioning of the electricity market (Darwall, 2015). An effective market would require removing subsidies and ensuring that renewables account for the risks they provide to the system. To accelerate the return to market pricing:

- Price support and incentives for planned renewable projects should be removed;
- Legal means to remove or reduce price support and obligations to purchase renewable power should be deployed;
- The costs of the grid expansion and reinforcements should be allocated to the renewables assets, taking them out of the National Grid's Asset Value;
- A revised and updated Pool should be designed with international experience so that all generators make bids to sell their energy production.

Reviving the Pool would facilitate other generators to entry in the market by reducing the market barriers and power of the Big Six. This right/obligation to sell at the Pool bid price would encourage renewable power producers to deal with conventional producers and internalise the intermittency costs of renewables, removing the need for a capacity market run by the government.

The structure of electricity prices is complex due to the various tariffs. Green electricity suppliers have different rates for their electricity production, depending on the region. The predominant green tariffs on the market are: green source (which buy electricity from suppliers marketing renewable generation) and green fund (customers voluntarily contribute money into a fund supporting new renewable initiatives.

8 Analysis of the proposed Electricity Market Reform

The electricity market is in need of wide-range reform (DECC, 2011). The Government's vision for the Electricity Market Reform, which is to establish a market that delivers secure power, an increase share of renewables and carbon reduction simultaneously, will require a number of policy responses. According to Pollitt & Haney (2013), the increase in government intervention in the electricity market in recent years was motivated by good reasons. The UK has set an 80 percent carbon reduction target by 2050, compared to the levels of 1990, as part of the 2008 Climate Change Act, and the electricity sector is key to the decarbonisation strategy.

There were four elements in the EMR proposed by DECC (2011):

- Contracts for Difference (CfD);
- Carbon Price Support (CPS);
- Capacity Market (CM);
- Emissions Performance Standard (EPS).

Achieving carbon and renewable targets put the electricity sector in line for large scale decarbonisation. Pollitt (2012) describes the logic behind the four elements and questions whether this is good economics. Fixed prices for low carbon generation (CfD) offer certainty and are high enough to support nuclear as well. Carbon Price Support (CPS) raises the price of carbon for fossil generation and encourages switching, also benefiting from reduced CfD payments and raised tax revenue. The Capacity Market (CM) allows fossil generation to back up for intermittent renewables via an availability payment, even though fossil generation is pushed to margin and has low plant utilization. Emission Performance Standards (EPS) then ensures that fossil generation plants are not built in case price based incentives are not right. Pollitt

(2012) also highlights that the motivation for EMR clearly lies with the Committee on Climate Change, 5 year carbon budgeting and the 2008 Climate Change Act.

The key objective of the EMR is to guarantee the level of investment needed in new low-carbon generation capacity and infrastructure, in the most cost-effective way possible (DECC, 2011). The white paper estimates investments of up to £110 billion in electricity generation (£75 billion) and, transmission and distribution (£35 billion) by 2020. Studies prepared by the Cambridge Economic Policy Associates (CEPA) and presented in the white paper suggests that using CfD would lead to an overall saving of around £2.5 billion over the period up to 2030.

The EMR key dates are shown below:

- **November 2008**: The 2008 Climate Change Act is introduced. The Committee on Climate Change is established as an independent body to advise government on meeting carbon budgets;
- **December 2008**: The Committee on Climate Change publishes the first report, setting the electricity sector as key to the decarbonisation strategy, including heat and transport;
- **October 2009**: The Committee on Climate Change First Progress Report details key EMR elements;
- **May 2010**: Coalition Agreement specifies 4 elements of EMR;
- **Dec 2010**: DECC publishes EMR proposals;
- **November 2012**: Energy Bill introduced to the House of Commons;
- **December 2013**: The Energy Act 2013 introduced the Contracts for Difference (CfD) and a Capacity Market (CM)

The "2010 to 2015 government policy: UK energy security" policy paper, by DECC (2015), states that the EMR currently operates two key mechanisms: Contracts for Difference (CfD) and a Capacity Market (CM).

8.1 Contracts for Difference

The EMR proposes a system whereby the government contracts electricity at fixed prices for a long period to be supplied by low-carbon generators. The government would pay the difference between the electricity average wholesale price and the price established in the contract. The EMR white paper indicates that the EU Emissions Trading System (EU ETS) carbon price has been volatile or too low to encourage investment in low-carbon electricity generation in the UK.

8.2 Capacity Market

Capacity market is a mechanism that introduces payments to generators that maintain availability and supply electricity to the market when it needs, therefore guaranteeing security of supply. At high levels of renewables, a capacity market might encourage small intermittent generators that do not contract back up generation directly with fossil generators. The practical problem with capacity markets is that it is not clear who decides the level of capacity and how.

9 UK Electricity Market Reform and the EU

The UK EMR has been designed for the country's electricity market and targets, however the national electricity market operates in a European context. Keay (2013) points that there is a tension, and possibly an incompatibility, in the idea of separating the national energy and emission goals and the single European electricity market. As described on the last section, the UK EMR proposes a system in which liberalization and environmental concerns transforms the electricity sector into a public/private partnership, whereby the government (not the markets) defines the country's generating mix.

The EMR white paper claims that without the EMR, the electricity sector would have emissions intensity in 2030 of over three times the level advised by the Committee on Climate Change. Although this intervention in the market might be needed to support the development of low-carbon power generation, it goes against the concept of a single market in which the sources with the lowest costs, independent of country of origin, should be able to compete across the European market. Other EU countries also have energy and emission goals, but the UK's renewables targets are still seen as one of the most ambitious. This might result in a complicated or compromised operation of the European single market.

Legal issues may arise from the reforms given that they are designed to support specific sources of electricity generation. State aids such as subsidies or other forms of support of member states of the EU like the UK are bound to the EU State Aid rule. The Commission can reject or modify proposed measures for state aids, under the EU law. According to DECC (2012), the UK government is designing the EMR to be consistent with European legislation. The policy review document also highlights that the UK government is working closely to the EU energy regulatory authorities group ACER and the EU transmission system operators group ENTSO-E, to implement both the Contract for Differences (CfD) and Capacity Markets.

Keay (2013) also raises questions related to specific elements of the EMR. As the UK approach points to a permanent involvement of the government in the electricity market, the longer the duration of the aid the more likely it will generate distortions on the competition. In the case of imports, it might be more difficult to maintain a certain UK scheme when contracting output from plants in other countries in Europe. It is also difficult to assess the contract of capacity market outside the UK as in principle these auctions can be extended to other places in Europe, however the UK's system might not be prepared to rely on non-domestic capacity markets. National capacity markets are more likely to serve national needs and create two separate income streams for generators (capacity and energy payments), lowering the average energy price and creating potential distortions when markets with and without capacity markets are coupled. A European solution would need to address the various issues related to the operation and specifics of national markets and power exchanges.

10 Discussions and Conclusions - Lessons for the UK

The UK implemented the Contract for Differences (CfD) and Capacity Markets (CM) to address environmental and energy challenges, employing the market system to engage the private sector in investing in renewable energy. Unfortunately, CfD and CM can attract investors more focused on guaranteed rewards than on business innovations that could eventually reduce costs (Whitmill, 2012). This guaranteed remuneration might undermine the idea that businesses need to think outside the box to ensure profitability (Onifade, 2016). As a solution, the government might adjust the policy to encourage innovation, as discussed by scholars (Bolton & Foxon, 2015; Finon, 2013; Kozlov, 2014).

There are concerns about the structure of this hybrid system where the government, as the administrator of a market system, would be transferring the burden of financing the currently unstable renewable energy economy to the private sector (Darwall, 2015). The author defends that the EMR is the market without its discipline, combined with the inefficiency of the state without financial control and accountability. The electricity sector becomes a public/private partnership analogue to the Private Finance Initiative (PFI), existing in a zone where the state controls but is not financially accountable for the costs, which are paid by consumers not taxpayers.

Onifade (2016) supports these concerns but highlights that, compared to previous regimes, the government's role in the CFD/CM system appears to be minimal. The central issue around the influence of neoclassical economics on energy policy thinking is therefore profit maximization versus public interest. It is acceptable throughout the world that governments should protect the public interests by performing regulatory and monitoring functions within the energy sector. In this sense, although the criticism is plausible in terms of profitability of the investment in the energy sector, the EMR in the form of the CFD and CM policies clearly considers environmental protection the priority. Bolton & Foxton (2015) argue that in the UK, as well as in other countries, new policy frameworks need to guide the transition from an energy system designed to achieve short-term efficiencies through market operation to a long-term approach that would embrace new uncertainties.

Both market interests and environmental protection need to be secured in order to guarantee the levels of investment needed in the UK's renewable energy market. Scholars (Blyth, McCarthy, & Gross, 2015; Bolton & Foxon, 2015; Finon, 2013; Kozlov, 2014; Kannan, 2009; Levi & Pollitt, 2015; Pye, Sabio, & Strachan, 2015) have addressed some aspects of this.

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