UKERC
UK Energy Research Centre

UKERC Technology and Policy Assessment



What's in a bill? How UK household electricity prices compare to other countries

Phil Heptonstall and Rob Gross
October 2018

Preface

Authors

Phil Heptonstall
Rob Gross

Imperial College Centre for Energy Policy and Technology

About UKERC

The UK Energy Research Centre (UKERC) carries out world-class, interdisciplinary research into sustainable future energy systems. It is a focal point of UK energy research and a gateway between the UK and the international energy research communities. Our whole systems research informs UK policy development and research strategy. UKERC is funded by The Research Councils UK Energy Programme.

www.ukerc.ac.uk
Follow us @UKERCHQ

The Technology and Policy Assessment (TPA) Theme of UKERC

The TPA was set up to inform decision-making processes and address key controversies in the energy field. It aims to provide authoritative and accessible reports that set very high standards for rigour and transparency. Subjects are chosen after extensive consultation with energy sector stakeholders and upon the recommendation of the UKERC Research Committee and Advisory Board, comprised of independent experts from government, academia and the private sector.

The primary objective of the TPA is to provide a thorough review of the current state of knowledge using systematic review protocols. New research, such as modelling or primary data gathering may be carried out when essential. It also aims to explain its findings in a way that is accessible to non-technical readers and is useful to policymakers.

Summary

The prices paid for electricity by domestic customers in the UK has been a regular discussion point in both policy debate and the media. A particular concern is the contribution that policies to incentivise low-carbon generation and energy saving make to the bills paid by householders. In response to these concerns, UKERC has undertaken a Rapid Evidence Assessment (a constrained form of systematic review) to examine in detail the data available on prices in the UK and other countries. The overarching question this review seeks to address is:

How do the impacts of government policies funded through consumer electricity bills differ between countries?

This paper reviews evidence on electricity prices paid by household (i.e. domestic) consumers with a focus on the UK and selected case study countries (Germany, France, Sweden and Australia), supplemented by consolidated EU-wide data to provide a broader context. Policy can affect both prices and bills, for example energy efficiency policy may decrease bills by reducing demand, however to allow the most direct comparison possible, this working paper focuses on data for prices per unit of electricity, rather than overall bills.

The evidence reviewed demonstrates that there is generally good and transparent data available that address how policies impact prices in the UK and in the case study countries. However, the overall picture is complex, with multiple categories of consumers covering domestic, commercial and industrial users, with very wide ranges of consumption levels across and within categories, and regional and supplier variations within individual countries. In addition, a wide range of policies affect electricity prices, with a further level of complexity added where compensatory actions are targeted at some groups of consumers. This complexity may help to explain some of the continuing controversy in the area since it allows different stakeholders to interpret and represent the facts differently, or select different subsets of those facts, to suit vested interests or political positions.

However it is clear from the available data that, compared to the full set of EU countries, UK domestic energy prices are relatively low for gas and relatively high for electricity. Focusing on the case study countries, UK domestic electricity prices for the most representative 'typical consumer' band are consistently lower than in Germany, and similar to prices paid by consumers in France, Sweden and Australia.

There is a marked difference in the relative contribution that each price component makes to the overall price charged to the consumer, with the energy and supply component being higher in both percentage and absolute terms for the UK. By contrast, the taxes and levies component (which includes most policy costs) is considerably higher in both percentage and absolute terms for Germany than in all the other case study countries. Policy costs are lowest in Australia, whilst the UK has the lowest absolute contribution from taxes and levies of the four EU case study countries. Network costs are most significant in Sweden and Australia. The data shows that policy has contributed to increases in domestic electricity prices in the UK and other countries over the past five years. However, domestic electricity bills have not increased at the same rate as prices, due to the effects of energy efficiency policies designed to reduce overall consumption.

The data also suggest that at an aggregate level, the fraction of UK electricity generation that benefits from low-carbon support schemes is above the EU average but the total cost of these schemes, per unit of electricity production, is below the EU average. This suggests that, in aggregate, support for low-carbon generation in the UK is relatively good value for money compared to the EU average.

Power generation and delivery infrastructure, physical geography, and the economic and policy context also differ significantly from one country to another and within individual countries. This leads to substantial differences in absolute costs and different distributions of those costs between cost components and between consumer groups.

A significant reason for the range of costs in the country case studies is the range of approaches to the allocation of policy costs, charging for the use of transmission and distribution networks, and electricity market structures. For example, Germany chooses to levy a larger share of low-carbon policy costs on domestic consumers with some industrial consumers largely/wholly exempt. In contrast, in the UK costs are shared more evenly across domestic and industrial consumers, with relatively limited compensatory measures available for some categories of large industrial consumers.

Electricity price formation is complex and affected by policies in all of the case study countries considered in this review. Different policy approaches, geographical factors and mixes of power generation mean that comparison requires caution, avoiding over-simplification. Nevertheless there is no evidence to support the contention that policy costs are the principal source of high domestic power prices in the UK. Furthermore, the evidence does not support the contention that policy costs in the UK, or indeed absolute household prices, are high compared to the country case studies or the majority of Western European nations.

Contents

SUMMARY		**1**
1.	**INTRODUCTION**	**4**
1.1	The subject context and research question	4
1.2	Methodology	6
1.3	Structure of this working paper	6
2.	**THE EVIDENCE BASE ON PRICES AND POLICY COSTS**	**8**
2.1	The evidence review process	8
2.2	Overview of evidence sources	8
3.	**MAIN FINDINGS**	**10**
3.1	Overview	10
3.2	UK energy prices and cost of low-carbon policy relative to other EU countries	12
3.3	Breakdown of domestic electricity prices for the UK and selected countries	15
4.	**DISCUSSION AND CONCLUSIONS**	**21**
4.1	The UK relative to other case study countries	21
4.2	Allocation of costs	21
4.3	Complexity and controversy	22
4.4	Conclusion	24
REFERENCES		**25**
ANNEX		**27**

1. Introduction

1.1 The subject context and research question

Electricity and gas prices in the UK have been a source of continuing debate and discussion, both in energy policy circles and in the wider public discourse. Concerns have been expressed both over the size of bills and the contribution that policies[1] to incentivise low-carbon generation and energy saving (summarised in Box 1.1) make to the total cost of energy to consumers (Thomas, 2017a). This is despite the fact that the average share of household incomes that is spent on energy bills has been relatively stable over recent decades (Evans, 2017). Nevertheless, there remains a view, strongly and repeatedly expressed by some, that UK energy prices are relatively high and that policy is to blame (npower, 2013; Evans, 2017; Ford, 2017; Thomas, 2017a; Pfeifer and Pooler, 2018). There is also a clear area of tension between some in the energy industry, who ascribe recent price rises to government policies, and the UK government who argue that low-carbon generation and energy saving policy costs make up a relatively small component of total bills (Thomas, 2017e).

Partly in response to these concerns, the UK government announced in August 2017 that they had commissioned a review of the key factors affecting energy bills (focused on electricity prices), including 'energy and carbon pricing, energy efficiency, distributed generation, network regulation, innovation and R&D', with the terms of reference including 'recommending ways to keep energy prices as low as possible' (BEIS, 2017a). The results of that review were published in October 2017 (Helm, 2017), with proposals including the identification and ring-fencing of the legacy costs of low carbon power, making this component explicit in bills, and the creation of a default tariff to replace the Standard Variable Tariff, with explicit cost components, showing wholesale costs, fixed costs, levies, taxes, and margins.

Publication of the Helm Review was followed by a call for evidence, intended to inform the UK Government's assessment of the review's findings and recommendations. Legislation has also been brought forward that will require Ofgem, the GB energy regulator[2], to cap 'poor value tariffs' (BEIS, 2018a). At the time of writing the government has not made a formal response to any of the observations made in Prof. Helm's review. Even when it does it is unlikely that debate over energy policy, prices and consumer bills will end. This UKERC TPA working paper therefore aims to inform the ongoing debate over energy prices.

Research question

The overarching question this paper addresses is:

How do the impacts of government policies funded through consumer electricity bills differ between countries?

This paper reviews evidence on electricity prices in the UK and selected case study countries (Germany, France, Sweden and Australia) to assess price differences and understand the extent of those differences. Case study countries were selected on a combination of: comparability to the UK in terms of economic development; to represent differing energy resource and power generation contexts; and data availability. The focus is on electricity prices faced by household (i.e. domestic) consumers in the case study countries, and the calculated impact of current policies, not the modelled/forecast impact of future policies. A comprehensive analysis of prices faced by commercial and industrial consumers can be found in Grubb and Drummond (2018), the main findings of which are summarised in Box 3.1 in Chapter 3. Gas prices were not examined in detail because to date, policy has generally had a much greater impact on electricity prices. Also as we show in Chapter 3, UK gas prices are in the lower quartile of the EU range for all domestic consumers and almost all commercial and industrial consumers.

1. Strictly speaking, some of these policies relate to Great Britain only (i.e. they do not cover Northern Ireland). For example, wholesale electricity prices for Northern Ireland are set within the Single Electricity Market of the island of Ireland, and are not subject to the Carbon Price Support Mechanism.

2. The regulator for Northern Ireland is UREGNI.

Box 1.1 UK policies summary

In the supporting documentation for their most recent analysis of the impact of policy on energy bills, the Committee on Climate Change identified those policies which affect gas and electricity bills (CCC, 2017g). The following policies were specifically identified as having an impact on electricity bills for UK domestic consumers, grouped into 'Climate policy costs' and 'Non-climate policy costs':

Climate policy costs

- Carbon price – the combined impact of the EU Emissions Trading System and the UK's Carbon Price Support mechanism.
- Direct support for low-carbon generation – the combined impact of all currently active (in the sense that they are being paid for) mechanisms i.e. the Renewables Obligation, Contracts for Difference, and Feed-in-Tariffs.
- Energy efficiency policies – the combined impact of the Energy Company Obligation, Carbon Emissions Reduction Target, and the Community Energy Saving Programme (this group of policies appear in both 'climate' and 'non-climate' policy costs since parts target carbon emissions and parts target social objectives).
- Capacity Market – this was introduced partly to account for the impact of a significant amount of low-carbon intermittent generation on security of supply – but it is important to note that a wide range of non-carbon factors also underlie the decision to implement a capacity mechanism.

Non-climate policy costs

- Value Added Tax
- Smart meter roll-out programme – this includes the supporting infrastructure that is being delivered under the remit of the Data Communications Company.
- Warm Homes Discount
- Energy efficiency policies – the combined impact of the Energy Company Obligation, Carbon Emissions Reduction Target, and the Community Energy Saving Programme (this group of policies appear in both 'climate' and 'non-climate' policy costs since parts target carbon emissions and parts target social objectives).

The CCC analysis does not allocate the indirect costs to household consumers of those energy taxes levied only on commercial and industrial consumers i.e. the CRC Energy Efficiency Scheme (formerly known as the Carbon Reduction Commitment) and the Climate Change Levy.

Both DECC and the CCC analyses include the 'wholesale price effects of policies' (DECC, 2014a), otherwise known as the 'merit order effect' (CCC, 2017a) to account for the downward pressure on wholesale electricity prices caused by an increased share of generation from zero-marginal costs renewables. Also specifically included in the CCC analysis are the 'additional costs associated with low-carbon generation' such as the effects of the variable nature of output from low carbon sources such as wind and solar, any additional transmission and distribution costs and the effect of VAT on the total cost of climate policies.

Other policies may bear upon household consumer bills (but not prices) e.g. the 'historic energy efficiency policies' and 'products policy' aimed at reducing energy consumption (DECC, 2014a). Finally, it should be noted that in many countries, including the UK, electricity suppliers may also supply gas to their customers which creates the opportunity for those suppliers to spread electricity-specific policy costs across both electricity and gas prices.

1.2 Methodology

The research was undertaken using a systematic review protocol (see Box 1.2), which typically provides a rationale for the choice of sources and lists the main databases, bibliographies, catalogues, personal contacts and other sources that are to be searched. The protocol also specifies the years to be covered and the search criteria used. In addition to those documents found during the search process, the project team also reviewed any other documents which had been suggested by expert group members (see Annex).

Search terms

The search terms and evidence categorisation are described below:

'energy+bill+policy+impact'
'electricity+bill+policy+impact'
'gas+bill+policy+impact'
'low+carbon+policy+cost+impact'
'renewable+energy+policy+cost+impact'

Although the focus of this paper is on electricity prices, 'gas' was included in the search terms to ensure that evidence that dealt with energy bills more generally was found during the search process. The search terms were applied to the databases below. The search terms used and the total number of hits returned from each string were recorded. Where a particular search string returned a large number of hits, only the first 100 results were examined for initial relevance, based on the document title and abstract. The number of hits deemed relevant on this initial examination were recorded, along with details of each document that passed this first stage assessment.

Databases/sources

Google, Google Scholar, and Elsevier Science Direct were used. The first three search strings were applied to each source, and the final two search strings were applied to Science Direct only.

Relevance ratings

A rating (1-4) was assigned to each piece of evidence that appeared to be relevant based on the initial examination. This allowed the project team to subsequently focus their attention only on documents which were most directly useful in addressing the research question i.e. documents assigned a relevance rating of 1 or 2.

These relevance ratings are:

1. Article shows clear data and/or discussion directly focussed on the research question.
2. Article shows clear data and/or discussion that is related to but not directly focussed on the research question.
3. Article mentions at least one of the terms above, but is not focussed on the research question.
4. Article found to be irrelevant or duplicate on closer inspection.

1.3 Structure of this working paper

The remainder of this working paper is structured as follows: Chapter 2 provides an overview of the evidence base on how policy costs are reflected in energy prices and the sources of data (both quantitative and qualitative) used by the project team. Chapter 3 describes the main findings, and Chapter 4 discusses the key messages and concludes the working paper.

Box 1.2 The UKERC Technology and Policy Assessment Theme

Guiding principles

The UKERC technology and policy assessment (TPA) team was set up to address key controversies in the energy field and to provide authoritative inputs to decision-making processes through accessible and credible reports that set high standards for rigour and transparency. The principles by which the TPA ensures these standards are:

- Appropriate stakeholder participation and engagement including consultation on prospective assessment questions, and consultation on emerging findings.
- Clarity and transparency of analysis, including clear, published criteria for choosing and refining questions, and protocols that can be readily criticised and replicated.
- Expert scrutiny and the consideration of a range of perspectives, including selection of an expert team to work on each assessment, appointment of advisors to bring a range of perspectives to each assessment, and the solicitation of commentary and input during the assessment process.

The TPA approach

The TPA approach learns from the practice of systematic review, which aspires to provide convincing evidence for policymakers and practitioners, avoid duplication of research, encourage higher research standards and identify research gaps. This ***evidence based*** approach is common in areas such as education, criminal justice and healthcare.

The goal is to achieve high standards of rigour and transparency. However, energy policy gives rise to a number of difficulties for prospective systematic review practitioners and the approach is not common in energy. We have therefore set up a process that is inspired by the evidence based approach, but that is not bound to any narrowly defined method or techniques.

This assessment protocol describes this process in detail. It provides a specification of the means by which we will consult stakeholders and solicit expert input, specifications for searching the literature, and criteria against which relevant findings will be assessed.

Assessment sequence

The TPA has identified a series of steps that need to be undertaken in each of its assessments. These steps, derived from the practice of ***systematic review*** in non-energy policy analysis, are outlined in Figure 1.1.

Figure 1.1. Typical process for TPA studies

Scoping prospective issues	Solicit expert input	Define criteria for assessment	Review literature	Synthesis and analysis	Prepare draft report	Consult, peer review and refine	Publish and promote
Questions/issues							
What are key problems and issues	Need to reflect a range of informed opinion	Ensure transparent, rigorous and replicable process	Need to review literature thoroughly	Need to apply rigorous criteria to evaluation of relevant studies	Need to identify key issues and discuss initial findings with stakeholders	Need to seek peer review and gain wide ranging criticism of initial work	Need to ensure report reaches key audience
Actions							
Write scoping note Seek feedback from advisory group Seek feedback from online listing of initial scoping	Appoint expert group Hold expert/ stakeholder workshop	Develop assessment protocols Discuss expert group and AG Place protocols in public domain	Apply protocol to literature search Detailed and transparent 'trawl' Identify relevant sources	Apply protocol to evaluation and synthesis of literature Detailed and transparent assessment of evidence base	Write preliminary draft assessment	Host stakeholder workshop to discuss draft report Send draft report for peer review Make appropriate revisions to draft report	Design and graphics Publication Launch events
Outputs							
Scoping note	Web publication of expert group	Assessment protocols			Draft report	Final report	Published report

2. The evidence base on prices and policy costs

2.1 The evidence review process

The process described in the previous chapter was used to identify and rank in order of relevance evidence sources including academic journal papers, 'grey literature' reports, working papers and presentations from industry, regulators and governments. Eleven combinations of search strings and search databases were used, and 1,100 separate document titles and abstracts were examined to assess whether they contained quantitative or qualitative data that was felt to be relevant to the research question.

In addition to the 51 documents identified as initially relevant through this process, a number of other documents were suggested by members of the expert group and/or were already known to the project team. In total therefore, 62 documents were examined in detail to determine the key attributes of each, and allow the project team to allocate each one a relevance rating, based on the criteria described in the previous chapter. The key attributes were:

- The country or region that a document was concerned with.
- Whether the impact of policy on energy prices and bills was quantified.
- Whether the focus was domestic and/or industrial energy prices.
- Whether the focus was electricity and/or gas prices.
- Whether the document provided any analysis of the factors contributing to the policy impact on energy prices.
- Whether there was any methodological explanation or discussion.

Of the 62 documents, ten were allocated a relevance rating of 3 (i.e. the document mentioned at least one of the search terms but, on closer examination it was deemed to be not sufficiently focussed on the research question to be useful), and three documents were allocated a relevance rating of 4 because they were found to be irrelevant or duplicate. This left a total of 49 documents, with 27 of these being assigned a relevance rating of 1 because they directly address the research question, and 22 documents being assigned a relevance rating of 2 because they contain clear data and/or discussion that is related to but is not directly focussed on the research question. A full list of documents that were reviewed, together with their respective key attributes, is shown in the Annex.

2.2 Overview of evidence sources

Following the initial review and categorisation process described above, the project team focussed on those documents that were most directly relevant to the research question (those with a relevance rating of 1 and 2).

The project team found that in the academic literature reviewed, the focus in respect of energy prices, bills and consumer impacts tends to be on overall macro-economic cost minimisation, carbon policy, the cost of carbon and the aggregate cost effectiveness of policies, and the potential impacts on wholesale (rather than end consumer) energy prices. Much of the academic literature that does address energy prices, bills or consumer impacts is focussed on distributional impacts across consumer groups (in particular for vulnerable groups such as low-income households). Other sources focus on how consumers respond to the provision of detailed consumption data and feedback on bills, including consumer behaviours in relation to demand-side response schemes, willingness-to-pay studies and the scale and impact of rebound effects.

This contrasts with a substantial grey literature on how policies impact prices and bills, typically from energy regulators, governments, NGOs and consumer groups. Notable UK sources include Ofgem (Office of Gas and Electricity Markets), CCC (Committee on Climate Change), DECC (Department of Energy and Climate Change) and the NAO (National Audit Office). Many of these analyses are carried out annually (or at least periodically), and earlier versions of some have been carried out for a decade or more.

Documents with a UK focus dominate in the evidence base reviewed by the project team, although this may partly be a function of the search approach, terms and databases adopted. Nevertheless, useful analyses (though some with less methodological detail) were identified for other countries and regions including Ei (the Swedish Energy Markets Inspectorate), the Australian Energy Regulator, the Australian Competition and Consumer Commission, and Clean Energy Wire (Germany). Detailed data on energy prices, with varying level of disaggregation into price components, is also available from Eurostat (the statistical office of the European Union), the IEA (International Energy Agency), and CEER (Council of European Energy Regulators).

Taken together, the set of documents examined in detail by the project team cover a range of quantitative data and qualitative analysis, the majority of which provide at least some assessment of the policy impact on consumer prices and bills, covering electricity and gas in both the domestic and industrial sectors. The majority of documents in this evidence base also provide some degree of analysis of the contributing elements of energy prices and bills, although only a minority go on to provide a methodological explanation or discussion of how those components are calculated. The focus of the following chapter is on the price data extracted from this evidence base.

3. Main Findings

3.1 Overview

This chapter analyses the data identified in the evidence base described in Chapter 2, focusing on domestic consumer electricity prices in five countries – the UK, Australia, France, Germany and Sweden. The primary sources for the quantitative data described below are, for each of these countries respectively:

- UK – Committee on Climate Change (CCC, 2017a; CCC, 2017g), Department of Energy and Climate Change (DECC, 2014a), Department for Business, Energy and Industrial Strategy (BEIS, 2017b), Office of Gas and Electricity Markets (Ofgem, 2017), Council of European Energy Regulators (CEER, 2017), and Eurostat (Eurostat, 2017).
- Australia – Australian Energy Regulator (AER, 2017), Australian Energy Market Commission (AEMC, 2016) and earlier-year versions of this report, Australian Competition and Consumer Commission (ACCC, 2017), and Business Council of Australia (Synergies Economic Consulting and Roam Consulting, 2014).
- France – Council of European Energy Regulators (CEER, 2017) and Eurostat (Eurostat, 2017).
- Germany – Clean Energy Wire (Thalman and Wehrmann, 2017), Council of European Energy Regulators (CEER, 2017), and Eurostat (Eurostat, 2017).
- Sweden – Swedish Energy Markets Inspectorate (Ei, 2016), Council of European Energy Regulators (CEER, 2017), and Eurostat (Eurostat, 2017).

These data sources are complemented by the qualitative analysis and insights drawn from the remainder of the evidence base. To allow the most direct comparison possible, this working paper focuses on prices per unit of electricity, such as €/MWh, rather than overall bills. However, the total bill paid by a consumer is a function of the price per unit, the number of units consumed, and any other charges that are not levied on a per unit basis (which for domestic consumers would typically be confined to standing charges). Nevertheless, since some policies may be specifically aimed at reducing overall bills (for example by mandating or encouraging energy efficiency improvements), and so offsetting the effects of policies on prices, this issue is returned to in the discussion.

The price of electricity faced by consumers is composed of multiple elements including the cost of generation, long-distance transmission and local distribution, retailing costs, profit (where those elements are provided by private companies), taxes, and of course those policy costs which are recovered through consumer bills. The word 'consumers' covers a very wide range of groups with hugely varying consumption levels and usage profiles from the very lowest-consuming domestic customer to the very highest-consuming industrial users. As a result, for almost all the evidence sources used in this working paper price data is typically presented for ranges of consumer types and consumption levels, with varying levels of detail as to how much each component of electricity prices contributes to the overall total.

For example, Eurostat, which provides data on electricity and gas prices for the 28 member states of the EU plus five other countries [3], splits domestic electricity price data into five annual consumption bands and gas price data into three bands. Industrial price data is split into seven consumption bands and gas into six bands. As Table 3.1 shows, customers in the largest domestic band consume at least fifteen times more electricity per year than customers in the smallest domestic consumption band. Within each of these bands prices are disaggregated into three components – energy and supply costs, network costs, and taxes and levies.

3. Data is provided to Eurostat by 'National Statistical Institutes, Ministries, Energy Agencies, or in case of monopolies by single electricity companies' (Eurostat, 2017). UK data is provided to Eurostat by the UK government (DECC, 2014g).

Table 3.1 Eurostat consumption bands (Eurostat, 2017)

Band	Description	Consumption Level (per year)
DA	Household (domestic) – electricity	< 1,000kWh
DB	Household (domestic) – electricity	1,000 – < 2,500kWh
DC	Household (domestic) – electricity	2,500 – < 5,000kWh
DD	Household (domestic) – electricity	5,000 – < 15,000kWh
DE	Household (domestic) – electricity	> 15,000kWh
D1	Household (domestic) – gas	< 20GJ
D2	Household (domestic) – gas	20 – < 200GJ
D3	Household (domestic) – gas	> 200GJ
IA	Non-household (industrial) – electricity	< 20MWh
IB	Non-household (industrial) – electricity	20 – < 500MWh
IC	Non-household (industrial) – electricity	500 – < 2,000MWh
ID	Non-household (industrial) – electricity	2,000 – < 20,000MWh
IE	Non-household (industrial) – electricity	20,000 – < 70,000MWh
IF	Non-household (industrial) – electricity	70,000 – < 150,000MWh
IG	Non-household (industrial) – electricity	> 150,000MWh
I1	Non-household (industrial) – gas	< 1,000GJ
I2	Non-household (industrial) – gas	1,000 – < 10,000GJ
I3	Non-household (industrial) – gas	10,000 – < 100,000GJ
I4	Non-household (industrial) – gas	100,000 – < 1,000,000GJ
I5	Non-household (industrial) – gas	1,000,000 – < 4,000,000GJ
I6	Non-household (industrial) – gas	> 4,000,000GJ

3.2 UK energy prices and cost of low-carbon policy relative to other EU countries

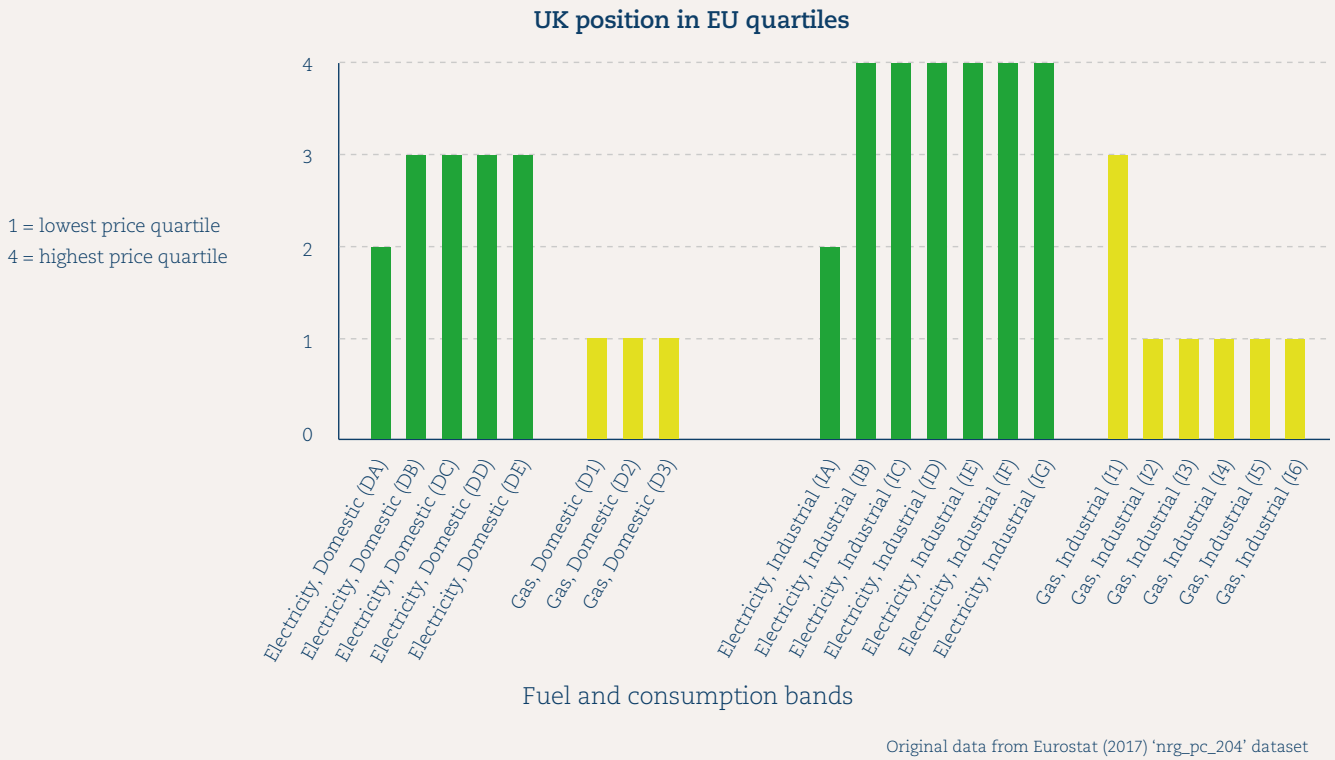
To set domestic electricity prices in a broader context this section summarises how UK energy prices compare to other EU countries. In addition, because much of the focus of the wider discussion described in Chapter 1 has been around the costs of policies to support low carbon (and in particular renewable) generation, this section also shows how the UK compares with the other EU case study countries in this respect.

Overview of total UK energy prices relative to EU countries

Figure 3.1 shows the UK position relative to all other EU countries in respect of electricity and gas prices for both domestic and industrial consumers. Drawing on data from Eurostat for the first half of 2017, the UK quartile position is shown for each of the consumption bands shown in Table 3.1, with quartile 1 containing those countries with the lowest prices for the respective band, and quartile 4 containing those countries with the highest prices for that consumption band.

For domestic prices (what Eurostat terms 'household'), the UK ranks in quartile 2 or 3 (mostly in quartile 3) for electricity, and quartile 1 for gas. For industrial prices, (what Eurostat terms 'non-household') the UK ranks in quartile 2 or 4 (mostly in quartile 4) for electricity, and quartile 1 or 3 for gas (mostly in quartile 1). Broadly, what Figure 3.1 shows is that total UK prices are relatively low for gas and high for electricity when compared to all other EU countries. It is worth noting however that UK domestic electricity prices for 'medium' level consumers are below the median price for the EU15 richer countries (BEIS, 2018c). Whilst industrial prices are not the focus of this working paper, the disparity between the UK's relative position for industrial electricity and gas prices is quite striking. The reasons for the UK's relatively high industrial electricity prices are analysed in detail in (Grubb and Drummond (2018), and summarised in Box 3.1.

Figure 3.1. UK position relative to other EU countries (total prices)



Original data from Eurostat (2017) 'nrg_pc_204' dataset

Box 3.1 Overview of findings from 'UK industrial electricity prices: competitiveness in a low carbon world' (Grubb and Drummond, 2018)

This report compared industrial electricity prices in the UK with France, Germany and Italy, using data from Eurostat, and focusing on bands ID-IF (i.e. spanning an annual consumption range of 2,000 – 150,000 MWh.

The report found that since 2012, UK industrial electricity prices had risen relative to the comparator countries, driven primarily by a combination of: differential fuel prices benefitting those countries (particularly Germany) with a large contribution from coal-fired generation relative to the UK, substantial investment costs of new plant combined with relatively expensive previous policy mechanisms such as the Renewables Obligation, adverse currency movements, and the effects of other policy costs such as Carbon Price Support paid for through electricity prices.

Additional drivers identified by the authors included: differences in the cost recovery approach between countries (particularly in respect of network costs), the merit order effect of large volumes of close-to-zero marginal cost renewable generation driving down wholesale prices, a focus on keeping costs lower for key industries such as through tariff design favouring large industrial users in France and Italy (at the expense of other groups of consumers), longer-term electricity purchase contract periods (particularly In France), and better integrated systems and markets. The report recognised the substantial effects of the compensatory measures available to some large industrial consumers in the UK, designed to offset the effects of policy on prices. According to the UK government, these compensatory measures can ameliorate the policy effects on electricity prices faced by energy-intensive industries by up to 80% (Rudd, 2016).

Overall, what emerges is a complex picture of varying impacts and compensatory measures, so it is perhaps not surprising that this is an area of considerable debate. Nevertheless it is clear that average UK industrial electricity prices in 2016 were significantly above the EU average, especially if compensatory actions are excluded (and these are not available to all industrial consumers).

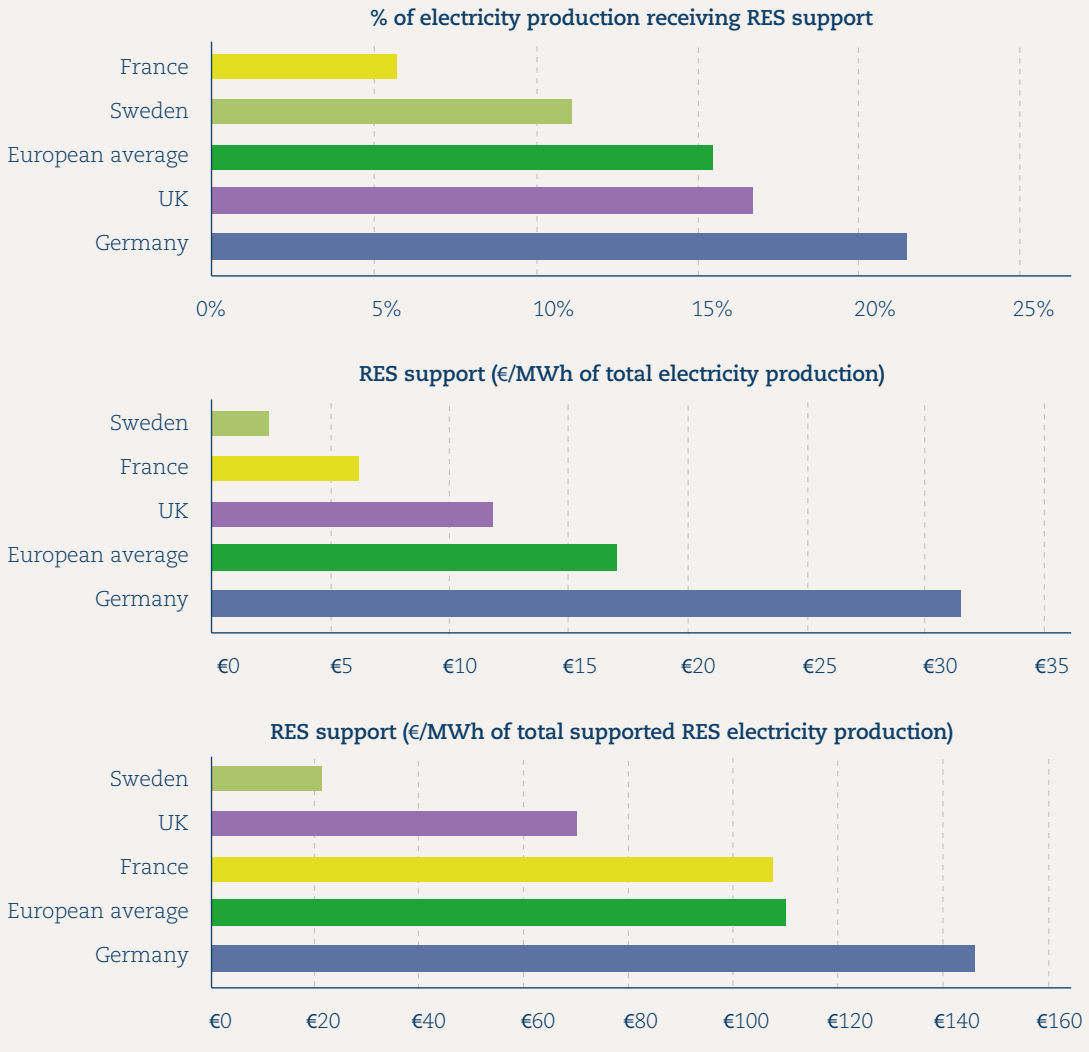
The key policy recommendations of the report were to: remove barriers to investment, improve the co-ordination of network and generation infrastructure investments, improve access to EU markets, facilitate direct cross-border electricity purchases, allow large users to access ancillary services markets, encourage long-term electricity supply contracts, and to allow deployment of the lowest cost low-carbon generation such as onshore wind. It is notable that some of these recommendations are aimed at reducing overall costs and others are aimed at reducing costs for industrial consumers specifically, which draws attention to the fact that electricity prices are an issue of both absolute costs and the distribution of those costs.

UK support costs for renewable generation relative to EU case study countries

The UK position in respect of domestic electricity prices relative to selected countries is explored in more detail in the following sections, with a focus on the policy cost component of those prices. However, before moving on to that analysis, it is helpful to understand the overall position with regard to policy support for renewable electricity generation in the UK, and how this compares to other countries. Using data from the Council of European Energy Regulators (CEER, 2017), Figure 3.2 shows the total share of renewable electricity production in receipt of policy support and the cost per MWh of that support, for the UK and the selected EU case study countries.

The first two panels of Figure 3.2 show that the share of total UK electricity production receiving renewables support in 2014 was 16.8% (representing almost all renewable generation other than hydro power), compared to an EU average of 15.5%, and that the cost of that policy support for renewables, spread across total electricity production for the UK was €11.87/MWh, compared to an EU average of €17.13/MWh. In other words, the fraction of total electricity generation receiving renewables policy support was above the EU average but the costs of that policy support were below the EU average. The third panel of Figure 3.2 shows that the policy costs of supporting renewable generation, when spread across only renewable electricity production (as opposed to all electricity production) are lower than for two of the case study EU comparator countries, and lower than the EU average. The weighted EU average costs shown in the final two panels are influenced considerably by the very large share (in both relative and absolute terms) of renewable electricity that receives support in Germany, and the relatively high cost of that support per unit of renewable generation (which in turn means that total renewable support costs are substantially higher in Germany than any other EU country).

Figure 3.2. Total policy cost comparisons



Original data from CEER (2017)

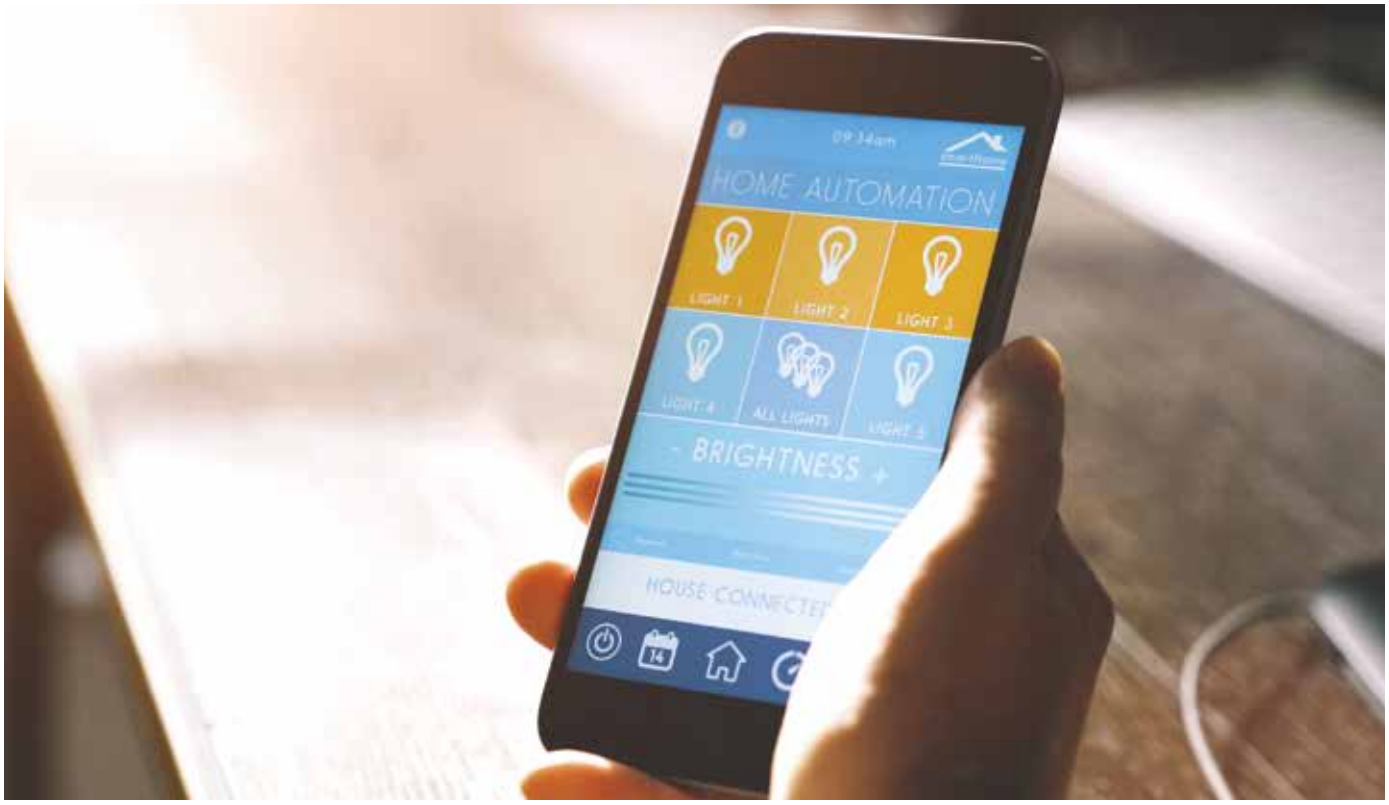
3.3 Breakdown of domestic electricity prices for the UK and selected countries

Choice of consumption band

This section focuses on a comparison of electricity prices for domestic consumers in the UK, the three other selected EU countries and Australia. As explained above, 'domestic consumer' covers a very wide range of annual consumption levels, but many national governments and regulators use the concept of a 'typical consumer' to simplify comparison and analysis. For example, the UK government use a consumption of 3,800kWh/year as being 'representative' of domestic electricity consumption (BEIS, 2017b) and the Australian Energy Market Commission's (AEMC, 2016) 'representative consumer' is between 4,000 and 8,500kWh/year (varying between states with an average figure of just under 6,000kWh/year). Annual average domestic electricity consumption levels for the case study countries are approximately: 3,900kWh for the UK, 5,000kWh for France, 3,100kWh for Germany, 7,800kWh for Sweden, and 6,800kWh for Australia[4] (WEC, 2016).

For comparison, the EU-wide average is approximately 3,600kWh/year and the global average is approximately 3,400kWh/year (ibid).

Therefore, the price data used in this section is for the Eurostat consumption band DC (2,500 – < 5,000kWh/year) for the UK, France, Germany, and Sweden (Eurostat, 2017) since this is consistent with typical domestic consumer levels used by BEIS, Ofgem, the CCC and, the central values for Elexon profile class 1 ('Domestic Unrestricted Customers') (Elexon, 2013). For Australia, prices are from the 'national level summary' data which uses a weighted average of each state's 'representative consumer' (AEMC, 2016; AER, 2017). Eurostat data is provided in nominal Euros (i.e. not inflation adjusted) and no currency conversion or inflation factors are applied. Australian Energy Market Commission data is provided in Australian Dollars so are converted to Euros using historical exchange rates from OFX (2017) to allow comparison.



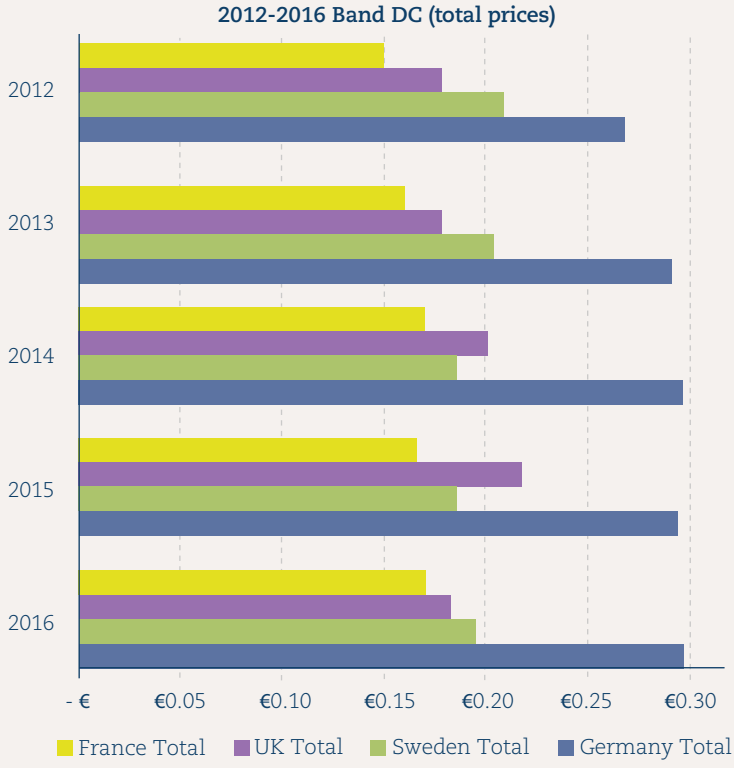
4. Countries with relatively high use of electric heating or significant air conditioning loads would be expected to have higher average electricity consumption levels.

Comparing the UK to other EU case study countries

Figure 3.3 compares UK domestic electricity prices with the selected EU countries, from 2012 through to 2016. Domestic consumers in Germany have considerably higher prices than those in the UK, France or Sweden with prices being up to 50% higher in Germany, and 'amongst the highest in Europe' (Thalman and Wehrmann, 2017), although it should also be borne in mind that average domestic consumption levels are lower in Germany than in the UK which offsets these higher prices to an extent. The price differentials between France, the UK and Sweden are much more modest, typically less than 0.05/kWh, with the UK being mid-way between French and Swedish prices for three of the five years reviewed. The data show how relative prices have moved around – with the UK moving from between France and Sweden in 2012, to considerably higher in 2015 and then back again, in part driven by € to £ exchange rate fluctuations. German prices have been consistently higher throughout.

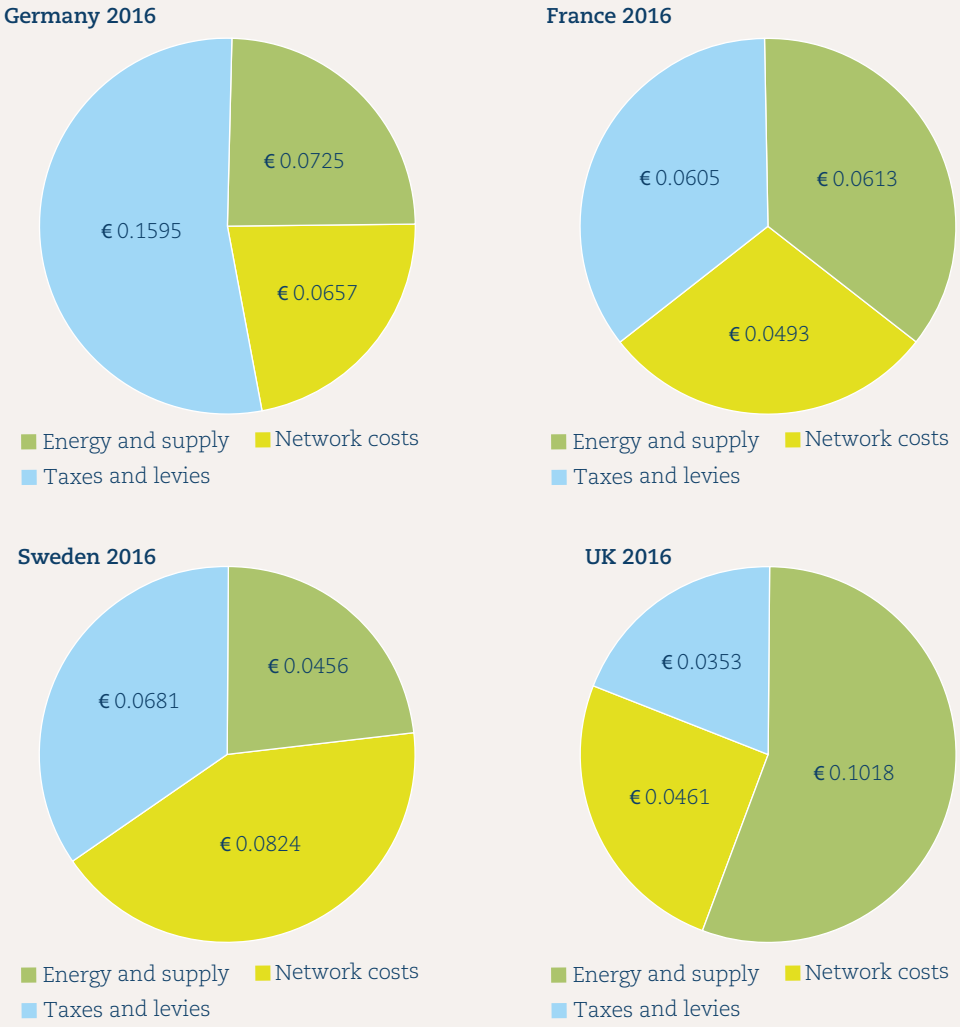
The pie charts in Figure 3.4 show the breakdown of the total 2016 prices in Figure 3.3, from which three key points can be made. The first point is that taxes and levies form a very substantial component of prices in Germany, on both an absolute and percentage share basis, when compared to the other selected EU countries. Data available from Clean Energy Wire (Thalman and Wehrmann, 2017) suggests that German wholesale prices are declining as a result of the 'merit order effect' (see Box 1.1), but that this is more than offset by 'surcharges, taxes and grid fees'. The authors of that analysis also suggest that wholesale price reductions have not been passed on to consumers. Data from the same source shows that the sum of taxes and levies components have more than doubled in absolute terms in the decade up to 2017, and represent 85% of the price rise in that period. The authors also observe that German domestic consumers pay more than one third of renewable electricity support costs but represent less than one quarter of total electricity consumption. In part, this is because the financial value of the package of compensatory measures intended to reduce the effects of policy on industry is much greater in Germany than in the UK (EEF, 2016).

Figure 3.3. Domestic consumer band DC prices for UK, Germany, France and Sweden (€/kWh)



Original data from Eurostat (2017) 'nrg_pc_204_c' dataset

Figure 3.4. Breakdown of 2016 domestic consumer band DC prices for UK, Germany, France and Sweden (€/kWh)



Original data from Eurostat (2017) 'nrg_pc_204_c' dataset

There are some minor differences between the Clean Energy Wire and comparative Eurostat band DC data[5] but these differences are not sufficiently large as to undermine the consistency of the results between Clean Energy Wire and Eurostat. Such differences in price breakdowns are not confined to Germany. The Swedish Energy Markets Inspectorate (Ei, 2016) price breakdown of 27% electricity trade price, 27% network costs, and 46% tax and VAT is not consistent with the comparable Eurostat datasets, although this is masked by the Ei data showing considerable variation between years.

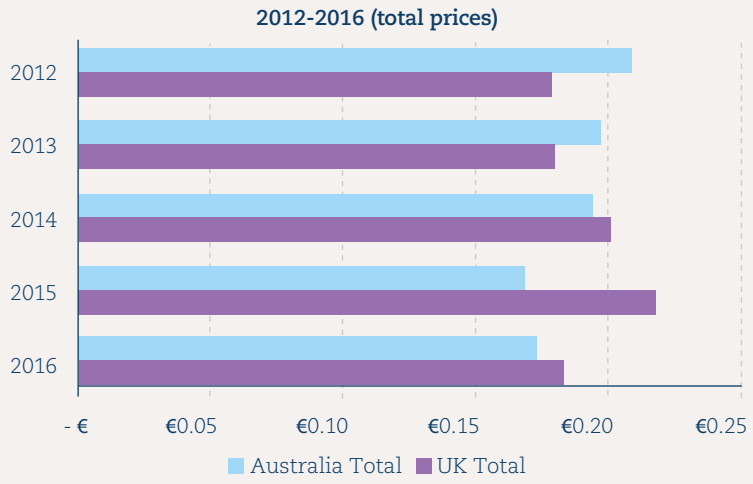
The difference relative to the Eurostat data in Figures 3.3 and 3.4 may be because the breakdown provided by EI is for a 20,000kWh/year consumer, rather than 2,500-5,000kWh/year. The breakdown provided by EI is for a typical consumption level of a detached, electrically heated house, and the fact that this example consumption level is used by the EI report does draw attention to the large differences in absolute consumption levels between different countries, and classes of consumers within countries.

5. e.g. for 2016, total prices are respectively €0.2877/kWh and €0.2977/kWh, acquisition/sales components are €0.0626/kWh and €0.0725/kWh, grid fees are €0.0701/kWh and €0.0657/kWh, with taxes and levies €0.155/kWh and €0.1595/kWh.

The energy and supply component makes a contribution to the share of UK total price that is considerably larger in absolute terms than the other EU countries shown. This breakdown is consistent with analysis from the GB regulator (Ofgem, 2017), which provides a detailed disaggregation of a typical domestic electricity bill, confirming that for 2016 wholesale and supplier operating costs were a little over 50% of the overall total (the data also incidentally suggests that supplier profit margins were very small or non-existent). Again, there are some relatively minor differences in the detail of the breakdown, but not sufficient to change the overall message, with the Ofgem and Eurostat data agreeing to within one or two percentage points, reflecting the 'broad consistency' in estimates noted in Bolton (2014). Nevertheless, as CCC (2017a) shows, UK household electricity prices have increased substantially in the last decade or so, with 2016 prices being 61% higher than 2004, although the impact on final bills has been mitigated by policies aimed at reducing consumption through energy efficiency. Approximately half of the increase is attributed to the impact of policies with the remainder attributed to wholesale electricity price rises, due to coal and gas price changes. This is in line with the earlier analyses carried out for the Department of Energy & Climate Change (DECC, 2010; 2014a). Other analysts have also argued that although policy is certainly a driver of electricity prices, it is not the most significant, and that in any case policies to increase generation from renewables are 'an effective insurance against rising fossil fuel prices' (Croft et al., 2012).

The final, more general point is the level of dissimilarity between the country breakdowns, with significant differences apparent, even for those countries which have roughly similar total electricity prices. In part, this is a function of the generation mix of each country, which varies considerably, along with geographical and other factors affecting network costs. Electricity production in Sweden, for example, is dominated by large-scale hydro and nuclear power whereas UK production is dominated by gas, renewables in the form of large-scale wind, biomass and solar, and nuclear power (Ei, 2016; BEIS, 2018b). It is also notable that policy costs represent the largest share of German domestic prices, energy/supply costs dominate in the UK, network costs are the largest fraction in Sweden, and French prices have a more even split across the three cost categories. However because the UK has introduced carbon price additional to the EU ETS price this serves to increase wholesale prices.

Figure 3.5. Domestic consumer prices for UK and Australia (€/kWh)



Original data from AER (2017), AEMC (2016) and Eurostat (2017) 'nrg_pc_204_c' dataset

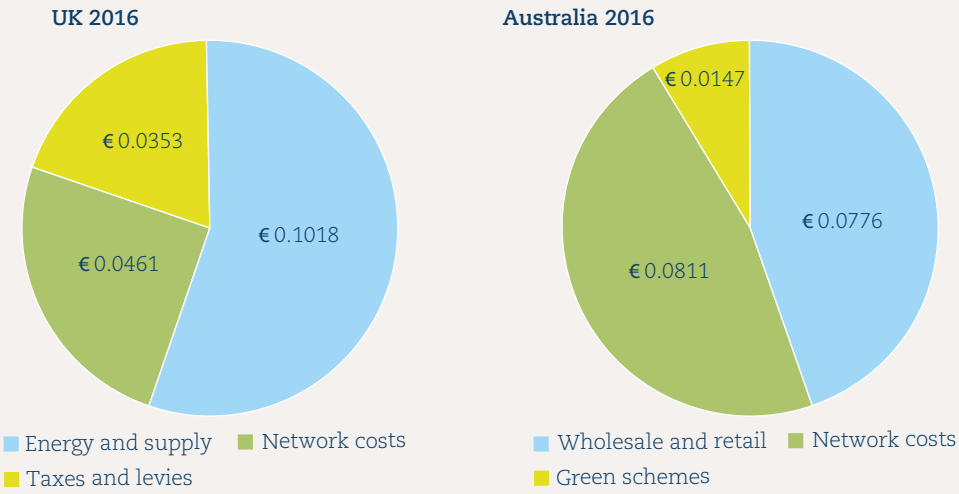
Comparing the UK to Australia

Figures 3.5, 3.6 and 3.7 compare UK domestic electricity prices with those in Australia from 2012 through to 2016, and provide a breakdown of component factors for two of those years, 2014 and 2016. Note that whilst the Australia data is taken from the Australian Energy Market Commission and Australian Energy Regulator (AER, 2017), the source of that data appears to be the AEMC Price Trends Report (AEMC, 2016) and earlier-year versions of these reports.

Figure 3.5 shows that UK prices have differed significantly from Australia, in part driven by € to AUS$ exchange rate fluctuations, but that by the end of the period in question, total prices for domestic consumers in the UK and Australia were relatively close, being within a few percentage points of each other. Despite the relative similarity of overall prices between the UK and Australia, Figure 3.6 shows that the breakdown of total price into components is markedly different with energy and supply costs being much higher in the UK. Network costs are much higher in Australia than the UK, partly as a result of differing geographies but also for the reasons described in more detail below.

Comparison of the 'taxes and levies' and 'green schemes' components for the UK and Australia respectively shows that these moved in opposite directions between 2014 and 2016. Figure 3.7 shows, that in 2014 the UK share of the total electricity price that was attributable to taxes and levies was approximately 5%, whilst approximately 15% of the total Australia electricity prices was attributable to green schemes. By 2016 (see Figure 3.6), this had changed considerably with the UK taxes and levies share being approximately 19% and the Australian green schemes share being approximately 8%. This was a result of a combination of: (i) methodological changes to the calculation of UK data provided to Eurostat which had the effect of moving some policy costs that were previously in the 'energy and supply' category into the 'taxes and levies' category (BEIS, 2015), (ii) an increased contribution from the combined effects of UK policies (BEIS, 2016), and (iii) a substantial reduction in policy costs in the case of Australia, largely due to the abandonment of the Australian carbon pricing scheme in mid-2014 (Synergies Economic Consulting and Roam Consulting, 2014; AER, 2017). As noted above, UK carbon price support increases fuel prices for gas and coal electricity generation and does not appear as a separate levy. The Australian Energy Markets Commission and the Australian Energy Regulator data includes the effect of carbon pricing under the 'green schemes' category rather than the 'wholesale and retail' category.

Figure 3.6. Breakdown of 2016 domestic consumer prices for UK and Australia (€/kWh)



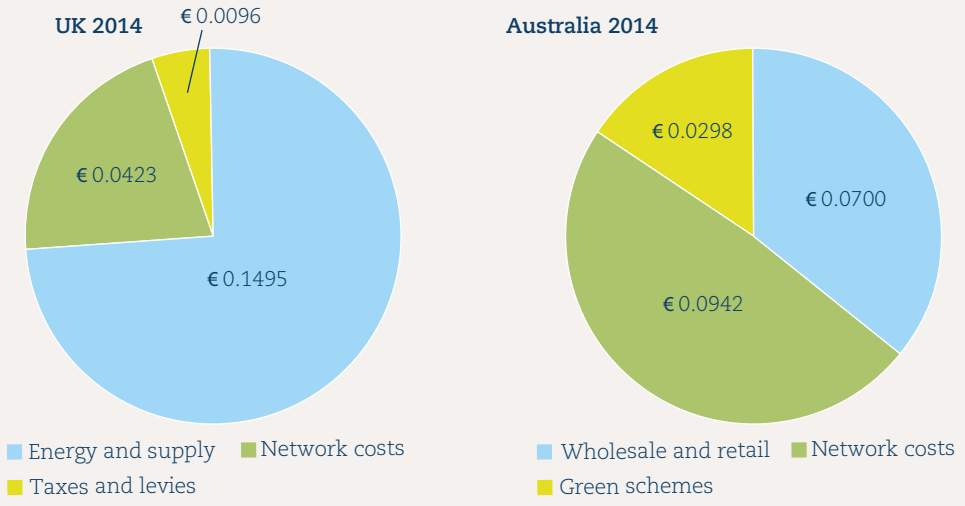
Original data from AER (2017), AEMC (2016) and Eurostat (2017) 'nrg_pc_204_c' dataset

The Australian data also shows considerable variation within the country, reflecting Australia's vast size and relative lack of electrical interconnection. The wholesale and retail share varies between 41% and 48% (with a national average of 45%), the share attributed to transmission varies between 5% and 13% (nationally 8%), with figures for distribution costs varying between 29% and 41% (nationally 38%), and 'Green Schemes' proportion varying between 6% and 14% (nationally 8%).

The Australian Energy Regulator also notes a long-term trend of real-term, rising wholesale prices, and that household electricity prices are above the OECD average, but lower than the UK and most of Europe. The regulator goes on to suggest that gas prices have contributed to higher electricity prices but that the 2008-2013 price rises were mainly due to network cost increases, reflecting the investment that was required to meet expected future demand growth (AER, 2017), and rising labour and materials during the period (Roam Consulting, 2012). The adverse effects of this increase in investment were compounded by what the Australian Competition and Consumer Commission suggests was a lack of adequately robust challenging of network operator cost estimates and a degree of over-investment (ACCC, 2017).

Overall, the evidence from the case study countries shows that there is a considerable volume of analysis available in the public domain providing detailed data on the drivers of electricity prices, and the role of policy. The following chapter reflects on the key findings from the review and identifies the principal messages that can be drawn from the evidence base.

Figure 3.7. Breakdown of 2014 domestic consumer prices for UK and Australia (€/kWh)



Original data from AER (2017), AEMC (2016) and Eurostat (2017) 'nrg_pc_204_c' dataset

4. Discussion and Conclusions

4.1 The UK relative to other case study countries

Key points:

- There are substantial differences between countries in the contribution that each component of electricity prices makes to total prices.
- The UK policy costs component is relatively low compared to the other EU case study countries, with the energy and supply component being relatively high.
- UK domestic electricity prices are higher than many EU countries but not amongst the highest.
- UK low-carbon policy costs per unit of electricity are lower than many EU countries.

Overall, it is clear from the evidence reviewed that, compared to other EU countries, UK domestic energy prices are relatively low for gas and relatively high for electricity. Gas prices faced by all groups and bands of consumer are in the lowest quartile of the distribution across the EU, other than for the smallest industrial consumption band. Conversely, electricity prices faced by all groups of consumers (with the exception of the very smallest consumption bands) are in either the highest quartile (in the case of industrial electricity prices) or the third quartile (domestic electricity prices).

Focussing on comparisons with the other case study countries, UK domestic electricity prices for the most representative 'typical consumer' band are consistently lower than in Germany, and similar to prices paid by consumers in the other case study countries of France, Sweden and Australia. There is however a marked difference in the relative contribution that each price component makes to the overall total price charged to the consumer, with the energy and supply component being higher in both percentage and absolute terms for the UK. By contrast, the taxes and levies component is considerably higher in both percentage and absolute terms for Germany than in all other cases. The UK has the lowest absolute contribution from taxes and levies of the four EU case study countries, with policy costs lowest overall in Australia. Network costs are most significant in Sweden and Australia.

Fossil fuel prices and particularly network costs affect electricity prices in all of the case study countries to varying degrees, but policies also make a significant contribution to electricity prices in all four of the EU case study countries, with considerably less influence in Australia. The necessarily long-term nature of low-carbon support mechanisms, coupled with ambitious targets for future deployment of low-carbon generation suggest that this is likely to continue. However, this impact will be (and has been) ameliorated by the substantial cost reductions observed for many low-carbon power generation options, coupled with the 'merit order' effect of zero-marginal cost renewables.

The data examined also suggest that at an aggregate level, the fraction of UK electricity generation that benefits from low-carbon support schemes is above the EU average. However, the total cost of these low-carbon support schemes, when spread across all units of UK electricity production, is below the EU average. This suggests that, in aggregate, support for low-carbon generation in the UK is relatively good value for money compared to the EU average.

4.2 Allocation of costs

Key points:

- Countries make different choices over the distribution of policy and network-related costs between consumer groups.
- Markedly differing contexts means that caution should be exercised when comparing both total and components of electricity prices between countries.
- The case study countries all pass low carbon policy costs through to consumer bills but it is also possible to use general taxation to promote low carbon energy.

A significant reason for the range of costs in the country case studies is the range of approaches to the allocation of policy costs, charging for the use of transmission and distribution networks, and electricity market structures.

For example, Germany chooses to levy a higher share of low-carbon policy costs on domestic consumers with some industrial consumers largely/wholly exempt, in contrast to the UK where costs are shared more evenly across domestic and industrial consumers, with relatively limited compensatory measures available for some categories of large industrial consumers.

Power generation and delivery infrastructure, physical geography, and the economic and policy context can also differ significantly from one country to another and within countries (particularly in very large countries). This leads to substantial differences in absolute costs and different distributions of those costs between cost components and between consumer groups, with large differences across EU countries and internationally (EIA, 2017; Eurostat, 2017).

In all our case study countries policy costs are passed to consumers through bills (albeit via wholesale prices in the case of carbon pricing) and policy costs are reported and attributed clearly at an aggregate level. In some instances, for example the US Federal production tax credits for renewables, costs are not levied directly on consumers through electricity prices and bills but are paid though general taxation (IER, 2015). In other instances, even where policy costs are passed directly through to consumers, the cost attributable to policy can in some cases be harder to determine. For example, in California, the Renewable Portfolio Standard (RPS) policy costs are passed through to consumers through the California Public Utilities Commission (CPUC) cost approval process, which in turn is based on the utilities' costs, including the costs of meeting the RPS (BloomEnergy, 2010; Heeter et al., 2014; CPUC, 2017).

Some analysts argue that charges levied through electricity prices are regressive, and that funding investment in low-carbon power through general taxation may allow a more equitable distribution of the impacts (Less, 2012; Advani et al., 2013; Barrett et al., 2018), a view which is shared by at least some sections of the energy supply industry (Thomas, 2017d). Others also observe that some historical support costs for some technologies (such as in the case of nuclear power in the UK and France) were funded through general taxation, so have not appeared directly in consumer prices or bills (Croft et al., 2012; WNA, 2018).

4.3 Complexity and controversy

Key points:

- The overall picture is complex, with a wide range of consumer types and multiple policy impacts.
- The evidence for policy impacts is largely well understood but complexity creates the opportunity for differing interpretations of the facts, which may help to explain some of the continuing controversy in the area.

For the case study countries detailed data are publicly available and a combination of regulators, governments, industry, and consumer groups collectively provide very detailed analyses (e.g. CCC, 2012; CCC, 2014; DECC, 2014a; Ei, 2016; ACCC, 2017; AER, 2017; CCC, 2017a; CCC, 2017g; Ofgem, 2017; Thalman and Wehrmann, 2017). Despite this, there is complexity associated with policy costs and electricity price formation.

This complexity has two chief dimensions, the first being the multiple categories of consumers covering domestic, commercial and industrial users, the associated very wide ranges of consumption levels (which are relatively large even within groups, with huge variation between groups), and regional and supplier variations within individual countries. These variations can be considerable, even within the same consumer segment. For example, data available from Ei, the Swedish Energy Markets Inspectorate, shows that prices paid per unit of electricity by domestic consumers in the period 2010-2015 varied by between 16% and 63% (relative to the lowest price within the respective consumer segment), depending on the consumption level and contract type (Ei, 2016).

The second dimension of complexity is that a range of policies bear upon electricity prices, with a further level of complexity added where compensatory actions, typically intended to ameliorate the effects of specific policies, are targeted at some groups of consumers. The UK for example has around a dozen individual policy costs and taxes which have a direct impact (see Box 1.1), and Germany has more than half a dozen policy costs and taxes which contribute to the price paid for electricity by domestic consumers (Thalman and Wehrmann, 2017).

As observed by the National Audit Office (NAO, 2016), the challenge of calculating impacts on prices is further increased where the actual cost of a policy is dependent upon the difference between an agreed support level and (varying) wholesale electricity prices, such as in the case of the UK Contracts for Difference. It is also important to note that some policies that provide subsidies that are funded through levies on bills also reduce wholesale prices, thereby offsetting some of the increase. In addition, some policies bear upon the unit price of electricity and others bear upon the total size of bills (and may affect overall costs in different directions). Whilst it is clear that policy has contributed to increases in domestic electricity prices in the UK and other countries, it is also clear that UK domestic electricity bills have not increased at the same rate, and at least some of this ameliorating effect is the result of policies intended to reduce consumption, an effect which is likely to continue as the stock of household appliances are replaced with more efficient devices (CCC, 2017a). Those analyses which attempt to determine the future impacts of policies, such as DECC (2014a) and CCC (2017a), face additional uncertainty over selection of the hypothetical counter-factual against which those future impacts will be assessed, drawing attention to the considerable uncertainties over future costs, regardless of the effects of policy initiatives.

It is possible that complexity provides an environment which facilitates the ongoing debate around the degree to which electricity price rises are driven by policy costs. For example, some electricity industry analyses have argued that policy costs have been significant drivers of price increases (npower, 2013; Thomas, 2017a). Others, including the UK government, have argued that policy costs are not the main driver of price increases (e.g. Kyriacou, 2011; Full Fact, 2013; Mitchell, 2017). This debate has been characterised by: a degree of conflation of policy impacts with concerns over market structures, supplier profit margins, transmission and distribution charging regimes (Pfeifer, 2018); conflation of social policies and low-carbon policies (Full Fact, 2013); and sometimes by a lack of clarity over whether it is prices or bills that are being discussed (see above). In part, this may be the result of the inconsistent use of terminology (Bolton, 2014), or perhaps a lack of clarity over the constituent elements of prices and bills (npower, 2013; Mitchell, 2017). It also reflects the fact that the complexity associated with electricity price formation may provide the opportunity for data to be interpreted and presented in a variety of ways. This paper did not set out to explore future costs, but doing so introduces further complexity, since it requires views to be taken of both future wholesale/fossil fuel prices and the cost/subsidy needed for low carbon options.

4.4 Conclusion

The evidence reviewed for this paper demonstrates that there is generally good, and sufficiently transparent data available that address how policies impact on prices in the UK and in the case study countries used for comparison.

Data is available from governments, regulators and related data-sources such as Eurostat that provide a disaggregation of the direct effects of policies, an assessment of other price drivers, and the distribution of impacts between consumer classes. Taken together, these analyses make it very clear how typical energy prices across different categories of consumers are composed.

The case study data demonstrates that UK domestic consumer electricity prices are quite similar to those in France, Sweden and Australia and lower than those in Germany. The data also show that policy costs represent a smaller absolute fraction of prices in the UK than in the other European case studies. In contrast it appears that the share of wholesale prices is relatively high in the UK. The differences result in part from different mixes of generation, geographical differences affecting network costs and from allocation of costs between larger/industrial consumers and households. UK wholesale prices are also affected by the carbon price support mechanism, which is levied on generation fuels and does not appear separately in the taxes and levies component. The Australian case study shows how policy costs can change quite markedly in a short space of time as a result of political decisions – notably the removal of carbon taxes.

The high quality of data revealed in the review raises the question as to why, given that detailed information appears to be available, there is continuing disagreement over how policies influence consumer bills. It is possible to speculate that because electricity price formation is quite complex and affected by a range of polices, data can be interpreted and presented in range of ways. There may also be short-term variation in prices resulting from variable market conditions such as fossil fuel costs which do not reflect the wider underlying longer-term trends. This may allow different stakeholders to represent the facts differently, possibly to suit vested interest or political positions. Uncertainty and confusion may also arise from a lack of clarity over whether the area of concern is the unit cost of energy (for example the cost per kWh of electricity) or the total size of bills, since some policies put downward pressure on the latter through improved energy efficiency. Further confusion may be caused where low-carbon policy impacts are conflated with other policy and taxation drivers and/or concerns over market structures, regulator-driven charging regimes and supplier profit margins.

The multi-faceted quality (and attendant challenge) of quantifying the impact of policy on electricity prices can therefore be distilled into three components:

'When' – are the impacts being assessed, in the past, present or future?

'Who' – which group (or groups) of consumers are being assessed, are they householders or industry, how much electricity do they consume and how big a share of their total costs does electricity represent?

'What' – which category of impacts are being assessed, is it only those that bear directly on prices shown in bills, those impacts passed through to electricity consumers though the wider economy or paid for by general taxation, and are compensatory measures accounted for?

Electricity price formation is complex and affected by policies in the UK and all of the case studies considered in this review. Different policy approaches, geographical factors and mixes of power generation mean that comparison requires caution, avoiding over-simplification. Nevertheless there is no evidence to support the contention that policy costs are either the principal source of high domestic power prices in the UK or are high compared to the country case studies or indeed the majority of Western European nations.

References

ACCC 2017. *Retail Electricity Pricing Inquiry – Preliminary report*. Australian Competition and Consumer Commission, Melbourne.

Advani, A., Johnson, p., Leicester, A. & Stoye, G. 2013. *Household Energy Use in Britain: A Distributional Analysis*. Institute for Fiscal Studies, London.

AEMC 2016. 2016 *Residential Electricity Price Trends*. Australian Energy Market Commission, Sydney.

AER 2017. *State of the energy market, May 2017*. Australian Energy Regulator, Australian Competition and Consumer Commission, Melbourne, Victoria.

Barrett, J., Owen, A. & Taylor, P. 2018. *Funding a Low Carbon Energy System: a fairer approach?* UK Energy Research Centre, London.

BEIS 2015. *Changes to Eurostat tables methodology*. Department for Business, Energy & Industrial Strategy, London.

BEIS 2016. *Consumer-funded policies report*. Department for Business, Energy & Industrial Strategy, London.

BEIS 2017a. *Independent review to ensure energy is affordable for households and businesses*. Department for Business, Energy & Industrial Strategy, London.

BEIS 2017b. *Quarterly Energy Prices: September 2017*. Department for Business, Energy & Industrial Strategy, London.

BEIS 2018a. *Domestic Gas and Electricity (Tariff Cap) Bill*. Department for Business, Energy & Industrial Strategy, London.

BEIS 2018b. *Energy Trends: electricity (generation, trade and consumption)*. Department for Business, Energy & Industrial Strategy, London.

BEIS 2018c. *Quarterly Energy Prices*. Department for Business, Energy & Industrial Strategy, London.

BloomEnergy 2010. *Understanding California's Electricity Prices*. BloomEnergy, Sunnyvale, California.

Bolton, P. 2014. *Components of an energy bill*. House of Commons Library, London.

CCC 2012. *Energy prices and bills – impacts of meeting carbon budgets*. Committee on Climate Change, London.

CCC 2014. *Energy prices and bills – supplementary tables*. Committee on Climate Change, London.

CCC 2017a. *Energy prices and bills – impacts of meeting carbon budgets* Committee on Climate Change, London.

CCC 2017g. *Energy Prices and Bills – impacts of meeting carbon budgets – Annex*. Committee on Climate Change, London.

CEER 2017. *Status Review of Renewable Support Schemes in Europe*. Council of European Energy Regulators, Brussels.

CPUC 2017. *California's Renewables Portfolio Standard – Annual Report*. California Public Utilities Commission, San Francisco, California.

Croft, D., Preston, I., Guertler, P. & Carrington, J. 2012. *Impact of future energy policy on consumer bills*. Association for the Conservation of Energy, London.

DECC 2010. *Estimated impacts of energy and climate change policies on energy prices and bills*. Department of Energy & Climate Change, London.

DECC 2014a. *Estimated impacts of energy and climate change policies on energy prices and bills*. Department of Energy & Climate Change, London.

DECC 2014g. *International Comparisons – data sources and methodologies*. Department of Energy & Climate Change, London.

EEF 2016. *Energy Costs and the Steel Sector: A UK Steel Briefing*. EEF, London.

Ei 2016. *The Swedish electricity and natural gas market 2015*. Swedish Energy Markets Inspectorate (Energimarknadsinspektionen, Ei), Eskilstuna.

EIA 2017. *Electricity data – Average Price by State by Provider (EIA-861)*. US Energy Information Administration, Washington DC.

Elexon 2013. *Load Profiles and their use in Electricity Settlement*. Elexon, London.

Eurostat 2017. *Energy statistics database*. European Commission, Luxembourg.

Evans, S. 2017. *In-depth: The challenges facing the Dieter Helm 'energy cost' review* [Online]. Carbon Brief. London Available: https://www.carbonbrief.org/depth-challenges-facing-dieter-helm-energy-cost-review [Accessed 26th September 2017].

Ford, J. 2017. Critics attack 'rushed and unambitious' energy pricing review. *Financial Times,* 14th September 2017.

Full Fact 2013. *How much do 'green taxes' add to energy bills?* Full Fact, London.

Grubb, M. & Drummond, P. 2018. *UK Industrial electricity prices: Competitiveness in a low carbon world*. UCL (Report Commissioned by the Aldersgate Group), London.

Heeter, J., Barbose, G., Bird, L., Weaver, S., Flores-Espino, F., Kuskova-Burns, k. & Wiser, R. 2014. *A Survey of State -Level Cost and Benefit Estimates of Renewable Portfolio Standards.* National Renewable Energy Laboratory, Golden, Colorado.

Helm, D. 2017. *Cost of Energy Review.* Department for Business, Energy & Industrial Strategy, London.

IER 2015. *Estimating the state-level impact of federal wind energy subsidies.* Institute for Energy Research, Washington DC.

Kyriacou, C. 2011. *The true cost of energy and climate change policies on bills.* BusinessGreen, London.

Less, S. 2012. *The Full Cost to Households of Renewable Energy Policies.* Policy Exchange, London.

Mitchell, C. 2017. *The claims green policies will add £150 to your energy bill don't stack up. New Statesman,* London.

NAO 2016. *Controlling the consumer-funded costs of energy policies: The Levy Control Framework*. National Audit Office, London.

npower 2013. *The Changing Cost of UK Energy.* RWE npower, Swindon.

Ofgem. 2017. *Understanding the profits of the large energy suppliers* [Online]. London Available: https://www.ofgem.gov.uk/gas/retail-market/retail-market-monitoring/understanding-profits-large-energy-suppliers [Accessed 26th September 2017].

OFX. 2017. *Historical Exchange Rates* [Online]. UKForex Ltd. London Available: https://www.ofx.com/en-gb/forex-news/historical-exchange-rates/ [Accessed December 2017].

Pfeifer, S. 2018. UK energy network operators face tough price controls. *Financial Times,* 7th March 2018.

Pfeifer, S. & Pooler, M. 2018. UK industry pays 33% more for electricity than rest of Europe. *Financial Times,* 5th February 2018.

Roam Consulting 2012. *Impact of renewable energy and carbon pricing policies on retail electricity prices (update)*. Clean Energy Council, Melbourne.

Rudd, A. 2016. *Letter to Angus Brendan MacNeil MP.* Department of Energy & Climate Change, London.

Synergies Economic Consulting and Roam Consulting 2014. *Impact of Green Energy Policies on Electricity Prices.* Business Council of Australia, Melbourne.

Thalman, E. & Wehrmann, B. 2017. *What German households pay for power* [Online]. Clean Energy Wire CLEW Berlin Available: https://www.cleanenergywire.org/factsheets/what-german-households-pay-power#dossier-references [Accessed 26th September 2017].

Thomas, N. 2017a. British Gas warns energy policy weighs heavily on bills. *Financial Times,* 3rd August 2017.

Thomas, N. 2017d. Centrica CEO says government policies should be funded by general taxation. *Financial Times,* 8th May 2017.

Thomas, N. 2017e. Centrica to raise electricity prices 12.5% *Financial Times,* 1st August 2017.

WEC 2016. *Average electricity consumption per electrified household*. World Energy Council, London.

WNA 2018. *Nuclear Power in France*. World Nuclear Association, London.

Annex

Expert Group

The project team engaged with a small team of expert advisors to bring their experience and perspectives to bear on the subject. The expert advisors were asked to comment on the scope of the project and the approach, advise and assist the project team in the selection of relevant evidence sources, and review draft outputs. The expert advisors were:

Mike Hemsley, Committee on Climate Change
Christopher McDermott, Ofgem
Paul Drummond, UCL

The project team are very grateful to the expert advisors for their contributions and input. The team are also grateful to Josh Emden of IPPR for suggesting several useful background evidence sources. Responsibility for the contents of this research report rests entirely with the authors.

Full list of documents reviewed

Lead author	Year	Short title	Relevance rating (1-4)	Country/ Region	Quantified bill impacts?	Domestic and/or industrial?	Electricity and/or Gas?	Analysis of contributing factors?	Methodological explanation or discussion?
ACCC	2017	Retail Electricity Pricing Inquiry – preliminary report	1	Australia	Y	Both	Both	Y	Y
Advani	2013	Household Energy Use in Britain: A Distributional Analysis	2	UK	Y	Domestic	Both	Y	
AEMC	2016	2016 Residential Electricity Price Trends	1	Australia	Y	Both	Electricity	Y	
Amountzias	2017	Pricing decisions and market power in the UK electricity market: A VECM approach	4	UK	N	Both	Electricity	N	
Ang	2016	Financial impacts of UK's energy and climate change policies on commercial and industrial businesses	1	UK	Y	Industrial	Both	Y	

Full list of documents reviewed									
Lead author	**Year**	**Short title**	**Relevance rating (1-4)**	**Country/ Region**	**Quantified bill impacts?**	**Domestic and/or industrial?**	**Electricity and/or Gas?**	**Analysis of contributing factors?**	**Methodological explanation or discussion?**
Australian Energy Regulator	2017	State of the energy market, May 2017	1	Australia	Y	Both	Both	Y	
Bassi	2013	Climate change policies and the UK business sector: overview, impacts and suggestions for reform	2	UK	N	Industrial	Both	Y	
BEIS	2017	Quarterly energy prices tables annex – September 2017	1	UK	Y	Both	Both	N	
Bolton	2014	Components of an energy bill	1	UK	Y	Domestic	Both	Y	
CarbonBrief	2011	Electricity prices to rise 25% because of green measures say CCC – impact on bills less clear cut	2	UK	Y	Domestic	Both	N	
CCC	2017	Energy Prices and Bills Report 2017	1	UK	Y	Both	Both	Y	
CCC	2012	Energy prices and bills – impacts of meeting carbon budgets	1	UK	Y	Both	Both	Y	
CCC	2017	Energy Prices and Bills Report 2017 – Annex	1	UK	Y	Both	Both	Y	Y
CCC	?	Energy prices and bills – supplementary tables	2	UK	Y	Both	Both	Y	Y
Citizens Advice	2015	Generating Value? A Consumer Friendly Electricity Generation Policy	2	UK	Y	Domestic	Electricity	Y	
Constable	2012?	Shortfall, Rebound, Backfire: Can we rely on energy efficiency to offset climate policy costs?	2	UK	Y	Domestic	Both	Y	
Coyne	2016	Firms ill prepared for 'huge' capacity costs on energy bills	2	UK	Y	Industrial	Electricity	Y	

Full list of documents reviewed									
Lead author	**Year**	**Short title**	**Relevance rating (1-4)**	**Country/ Region**	**Quantified bill impacts?**	**Domestic and/or industrial?**	**Electricity and/or Gas?**	**Analysis of contributing factors?**	**Methodological explanation or discussion?**
Croft	2012	Who Pays? The impact of energy policy on consumer bills	1	UK	Y	Domestic	Both	Y	
DECC	2014	Estimated impacts of energy and climate change policies on energy prices and bills: 2014	1	UK	Y	Both	Both	Y	Y
DECC	2013	Policy impacts on prices and bills	4	UK	Y	Both	Both	Y	
DECC	2010	Estimated impacts of energy and climate change policies on energy prices and bills	1	UK	Y	Both	Both	Y	
DECC	2010?	Draft Energy Bill – Summary of the Impact Assessment	1	UK	Y	Both	Electricity	Y	
DECC	2010?	Energy Bill Summary Impact Assessment	2	UK	Y	Both	Electricity	Y	
DECC	2010	Impact Assessment of Feed-in Tariffs for Small-Scale, Low Carbon, Electricity Generation	2	UK	Y	Both	Electricity	Y	
DECC	?	International Comparisons – data sources and methodologies	2	UK	N	Both	Both	N	Y
del Rio	2017	A techno-economic analysis of EU renewable electricity policy pathways in 2030	3	EU	N	Both	Electricity	N	
EC	2017	Eurostat energy database	1	EU	Y	Both	Both	Y	
EEF	2016	Energy Costs and the Steel Sector: A UK Steel Briefing	1	UK	Y	Industrial	Electricity	Y	
Ei	2016	The Swedish electricity and natural gas market 2015	1	Sweden	Y	Both	Both	Y	
EnergyUK	2016	Energy bill breakdown	1	UK	Y	Both	Both	Y	

Full list of documents reviewed									
Lead author	**Year**	**Short title**	**Relevance rating (1-4)**	**Country/ Region**	**Quantified bill impacts?**	**Domestic and/or industrial?**	**Electricity and/or Gas?**	**Analysis of contributing factors?**	**Methodological explanation or discussion?**
Evans	2016	Factcheck: The carbon floor price and household energy bills	2	UK	Y	Domestic	Both	Y	
Farrell	2015	Who should pay for renewable energy? Comparing the household impacts of different policy mechanisms in Ireland	3	Ireland	N	Domestic	Electricity	N	
Full Fact	2013	How much do 'green taxes' add to energy bills?	1	UK	Y	Domestic	Both	Y	
Good Energy	2015	What's the impact of renewables on the price of energy?	2	UK	Y	Domestic	Electricity	N	
Hickman	2013	How much are UK green policies adding to energy bills?	2	UK	Y	Domestic	Both	Y	
Hughes	2012	The Impact of Wind Power on Household Energy Bills	2	UK	Y	Domestic	Electricity	N	
Kay	2013	What Are These Green Levies? And What Are Their Impact On Your Energy Bills?	2	UK	Y	Domestic	Both	Y	
Kyriacou	2011	The true cost of energy and climate change policies on bills	2	UK	Y	Domestic	Both	N	
Le Fevre	2015	The Role of Gas in UK Energy Policy	2	UK	Y	Both	Gas	Y	
Less	2012	The Full Cost to Households of Renewable Energy	2	UK	Y	Domestic	Both	Y	
Lockwood	2016	The UK's Levy Control Framework for renewable electricity support: Effects and significance	3	UK	N	Domestic	Electricity	Y	
Mitchell	2017	The claims green policies will add £150 to your energy bill don't stack up	2	UK	Y	Domestic	Electricity	Y	Y

Full list of documents reviewed									
Lead author	**Year**	**Short title**	**Relevance rating (1-4)**	**Country/ Region**	**Quantified bill impacts?**	**Domestic and/or industrial?**	**Electricity and/or Gas?**	**Analysis of contributing factors?**	**Methodological explanation or discussion?**
N/A	2009?	The Impact of the Energy Strategy 2050 on the Danish Consumer	1	Denmark	Y	Domestic	Both	N	
NAO	2016	Controlling the consumer-funded costs of energy policies: The Levy Control Framework	1	UK	Y	Domestic	Both	Y	
npower	2013	The Changing Cost of UK Energy	1	UK	Y	Domestic	Electricity	Y	
O'Gorman	2014	Impact of the carbon price on Australia's electricity demand, supply and emissions	2	Australia	Y	Both	Electricity	Y	
Ofgem	2017	Understanding the profits of the large energy suppliers	1	UK	Y	Domestic	Both	Y	
Ofgem	2017	Understand your gas and electricity bills	4	UK	Y	Domestic	Both	Y	
Passey	2017	Designing more cost reflective electricity network tariffs with demand charges	3	Australia	N	Domestic	Electricity	N	
Roam Consulting	2012	Impact of renewable energy and carbon pricing policies on retail electricity prices (update)	1	Australia	Y	Domestic	Electricity	Y	
Rudd	2016	Response regarding the impact of energy prices on energy intensive industries	2	UK	Y	Industrial	Both	N	
Sahraei-Ardakani	2012	Distributional impacts of state-level energy efficiency policies in regional electricity markets	3	US	N	Both	Electricity	N	
SSE	2016	New SSE bill design aims to end energy bill confusion	3	UK	N	Domestic	Both	N	

Full list of documents reviewed									
Lead author	**Year**	**Short title**	**Relevance rating (1-4)**	**Country/ Region**	**Quantified bill impacts?**	**Domestic and/or industrial?**	**Electricity and/or Gas?**	**Analysis of contributing factors?**	**Methodological explanation or discussion?**
SSE	2017	Changes to standard GB domestic energy prices	3	UK	Y	Domestic	Both	N	
Synapse	2017	Analysis of Massachusetts Electricity Sector Regulations, Electricity Bill and CO2 Emissions Impacts	2	US	Y	Both	Electricity	Y	
Synergies	2014	Impact of green energy policies on electricity prices	1	Australia	Y	Both	Electricity	Y	
Thalman	2017	What German households pay for power	1	Germany	Y	Domestic	Electricity	Y	
Thomas	2017	Centrica warns over effect of price cap on energy bills	3	UK	N	Domestic	Both	N	
Thomas	2017	British Gas warns energy policy weighs heavily on bills	1	UK	Y	Domestic	Both	N	
Waters Wye Associates	2010	The Cumulative Impact of Climate Change Policies on UK Energy Intensive Industries	1	UK	Y	Industrial	Both	Y	
Wiser	2016	A Retrospective Analysis of the Benefits and Impacts of U.S. Renewable Portfolio Standards	3	US	N	Both	Both	N	
Zhou	2012	Comparative Analysis and Policy Study on Residential Electricity Bills in Selected ADB Member Countries	3	Various	N	Domestic	Electricity	N	

UKERC
UK Energy Research Centre

10 Princes Gardens
London SW7 1NA
tel: +44 (0)20 7594 1573
email: ukercpressoffice@ukerc.ac.uk

www.ukerc.ac.uk