Governing for Demand Management Innovations in Germany: Politics, Policy and Practice

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Abstract:

This working paper analyses governance for demand management innovations in Germany, related energy system outcomes, and issues still outstanding. Demand management is understood in its broad sense here to include demand reduction, demand side response, and distributed energy, but it is also understood to be pivotal to an affordable and sustainable energy system transformation. The working paper is informed by the IGov theory of governing for sustainable energy innovations in that it governance is also understood in a broad sense to include objectives, policies, regulations and market rules. The paper takes sustainable energy governance to be an iterative process that is contingent upon a variety of domestic political and energy structures that affect choices made, as well as the effectiveness in practice of attempts to govern for sustainable demand innovations. The paper is divided into 5 sections including an introduction and conclusion. The first two sections set the scene by setting out the energy market and political contexts within which governing for demand management takes place. Section 4 is divided into three sub-sections each of which focuses in more detail on each of the three aspects of demand management outlined above. This includes analysis of the policies focused on enabling demand management, market innovations, issues still outstanding and current attempts to address these issues including those suggested within the government's 2015 White Paper on electricity market reform. The conclusion includes some lesson drawing for British sustainable energy governance. German energy governance has so far supported distributed and community owned renewable generation, allowed sufficient support and space for the entrance of new business models and technologies, as well as enabled new markets in demand reduction and energy efficiency. The paper shows, however, that much needs still to be done to refocus governance away from supply to demand side policies and, in particular, to enable and integrate more demand side response into electricity and heat markets. There is some awareness within energy policymaking communities that demand response and flexibility are cost effective and efficient methods of better integrating markets, but it remains to be seen if current policy suggestions will be sufficient to enable significant improvement.

Keywords: Governance, Distributed Energy, Demand Side Response, Energy Efficiency, Germany, Energiewende, Energy System Transition

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Glossary of Terms

AbLaV	Ordinance on Contractual Agreements Concerning Interruptible Loads
AGEB	Arbeitsgemeinschaft Energiebilanzen
ARC	Act against Restraints of Competition
ARegV	Incentive Regulation Ordinance
BAFA	Federal Office for Economic Affairs and Export Control
BEB	Bürgerenergie Berlin (Citizens' Energy Berlin)
BKartA	Bundeskartellamt
BMUB	Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit (Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety)
BMWi	Bundesministerium für Wirtschaft und Energie (Federal Ministry for Economic Affairs and Energy)
BNetzA	Bundesnetzagentur (Network Regulator)
BRP	Balance Responsible Party
CCGT	Combined cycle gas turbine
CfDs	Contracts for difference
CHP	Combined heat and power
DECC	Department of Energy and Climate Change (UK)
dena	German Energy Association
DSO	Distribution System Operator
EEG	Erneuerbare-Energien-Gesetz (Renewable Energy Act)
EEX	European Energy Exchange
EnLAG	Power Grid Expansion Act
EnWG	Energiewirtschaftsgesetz (Energy Industry Act)
EOM 2.0	Energy-only-market 2.0
EPEX	European Power Exchange
ESCO	Energy service company
EU	European Union
EXAA	Energy Exchange Austria
FiT	Feed-in-Tariff
GB	Great Britain
GW	Gigawatt
IT	Information Technology
KfW	KfW Banking Group
KW	Kilowatt
kWh	Kilowatt hour

MW	Megawatt
MWh	Megawatt hour
NABEG	Grid Expansion Acceleration Act
NAPE	National Action Programme on Energy Efficiency
NCG	NetConnect Germany GmbH & Co
OTC	Over the counter
PJ	Petajoules
PV	Photovoltaic (solar)
RD&D	Research, development and dissemination
RES	Renewable energy sources
SMEs	Small and medium sized enterprises
SRU	German Advisory Council on the Environment
StrEG	Stromeinspeisungsgesetz (Feed-in-law)
StromNEV	Electricity Grid Access Charges Ordinance
StromNZV	Electricity Network Access Ordinance
TSO	Transmission System Operator
TWh	Terawatt hour

List of Figures and Tables:

Contents

1. Introduction

This IGov working paper analyses German governance for sustainable energy system transformation with an emphasis on demand management. Following the Department of Energy and Climate Change (DECC), and recent IGov working papers, demand management is conceptualised here in broad terms to include demand reduction; demand side response/flexibility and distributed energy (DECC 2014; Lockwood 2014; Kuzemko 2015c). Governance is also defined broadly here to include a wide range of actors, beyond merely formal government bodies, as well as including policy objectives, policy instruments, regulations and market rules (Kuzemko et al 2016). Furthermore energy governance for demand management takes place within the context of sustainable energy governance more broadly, and is closely related to renewable energy policy, as well as in relation to pre-existing political and energy market interests and institutions.

Germany has been held up within academia, if not always in other fields, as an example of comparatively effective environmental governance and, more specifically, governance for (distributed) renewable energy generation and energy efficiency (Mitchell et al 2006; Toke and Lauber 2007; Mikler and Harrison 2012; Rosenow et al 2012; Rifkin 2014; Hall et al 2016). Indeed, some argue that Germany has managed to reach ‘phase II’ of its sustainable energy transition (Kitzing and Mitchell 2014; Interview 17), whilst other countries such as Great Britain languish within an (extended) phase I (Kuzemko 2015a). This is not to say that governing for German energy system change has been uncontested, straightforward or unproblematic but just that the weight of political decision-making appears to have come down in favour of long-term, sustainable practice change over continuity. This is despite heavy opposition over time from those groups, in particular the coal industry, energy intensive industry and large utilities, that stand to lose the most from a sustainable energy transition. Opponents within and outside Germany claim that the energy transition is too expensive, with clear, negative implications for international competitiveness and for energy consumers.

Supporters on the other hand go so far as to suggest that Germany, in embarking on its bold journey to transform its entire energy regime, is helping to lay the groundwork for a Third Industrial Revolution (Rifkin 2014: 2). In order to get an idea of the scale of the task involved it is worth remembering that actively governing for something as profound as a complete shift in energy markets is highly complex, and largely unprecedented. As such, whilst there is a wide range of opinion about Germany’s energy transition there is little doubt about the scale of what they are trying to achieve, and this makes Germany a highly interesting subject for analysis. As does the fact that, as result of about 25 years of critical engagement with climate and energy policies in Germany, a huge amount of theoretical and practical knowledge on transformation processes has been gathered (SDSN 2015: 6).

In analysing governance, outcomes and issues outstanding this paper focuses more on the practical knowledge amassed by policy makers in Germany and opportunities for policy learning. Of particular note are the ambitious Energiewende targets that extend Germany's transition beyond a greening of supply by providing a long-term picture of where demand levels should be going. These targets are important to the extent that they provide leadership and a vision of the future energy market, but also to the extent that they drive new policy choices in the event that targets look like they may be missed. For example, it seems clear that the Climate Action Plan of 2014, and recent decisions on the decommissioning of some coal generation, were made in order to stay on track to meet 2020 emissions reduction targets. In addition market changes already secured, such as high and growing volumes of renewable electricity, also drive governance changes and a refocus on system integration. This implies governance as a goal-oriented but also iterative process, as well as some important policy flexibility and willingness to learn (see also Schüppe 2014).

This is a highly important time for the German energy transition, popular and Parliamentary commitment to the Energiewende targets remains high, but there is much more debate now about *how* these targets should be reached, the costs of doing so, and how costs are distributed. The emphasis, for many, is on improving opportunities for demand side response and on carrying the Energiewende forward in a way that pays more attention to whole system integration whilst better managing the costs of transition. The government's recent green and white papers on reforming heat and electricity markets place some emphasis on these questions, but as explained in Section 4, provides only some of the answers.

In terms of lay-out, this introduction is followed by 4 further sections. Section 2 offers an introduction to energy demand in Germany, to gas and electricity trading markets, to the main groups involved in energy generation, transmission, supply and consumers, and to how these sectors are governed. Section 3 outlines the main bodies involved in governing for demand management in Germany, as well as some insights into their mandates and how they inter-relate with one another within processes of policy-making and regulation. Section 4 is divided into 3 further sub-sections each of which focuses on a different aspect of demand management governance, related outcomes and practice changes, and challenges to existing policy. Although this working paper is not a comparative analysis Section 5, the conclusion, offers up some potential lessons for Great Britain that can be drawn from Germany's experiences.

2. Overview of Demand, Energy Markets, and Actors

Previous IGov papers have set out our framework for analysing governance for sustainable energy innovations (see Kuzemko et al 2016; Lockwood et al 2016 forthcoming; Kuzemko 2015c), and this paper takes some aspects of this framework as a basic structure for the analysis. For example, as mentioned above, governance is understood in broad terms to include multiple actors, not all of whom could be classed as government actors, as well as varying levels of political instruments – from objectives and formal targets, through new laws and policies, down to market regulations and rules (see Kuzemko et al 2016). In addition, governance decisions are taken within the context of domestic *political and energy market institutions* that tend to influence what governance choices are made and what directions the German energy transition, more broadly, takes.

This section therefore offers an overview of energy demand and of gas and electricity markets in Germany in order to make clear the energy market context within which attempts to govern for, and difficulties faced in delivering, demand management innovations take place. This section includes subsections that explain:

- the current demand situation in Germany;
- energy markets, with some emphasis on the changing electricity mix;
- the main markets for gas trading, and electricity trading and balancing;
- the principal market sectors and how they are governed.

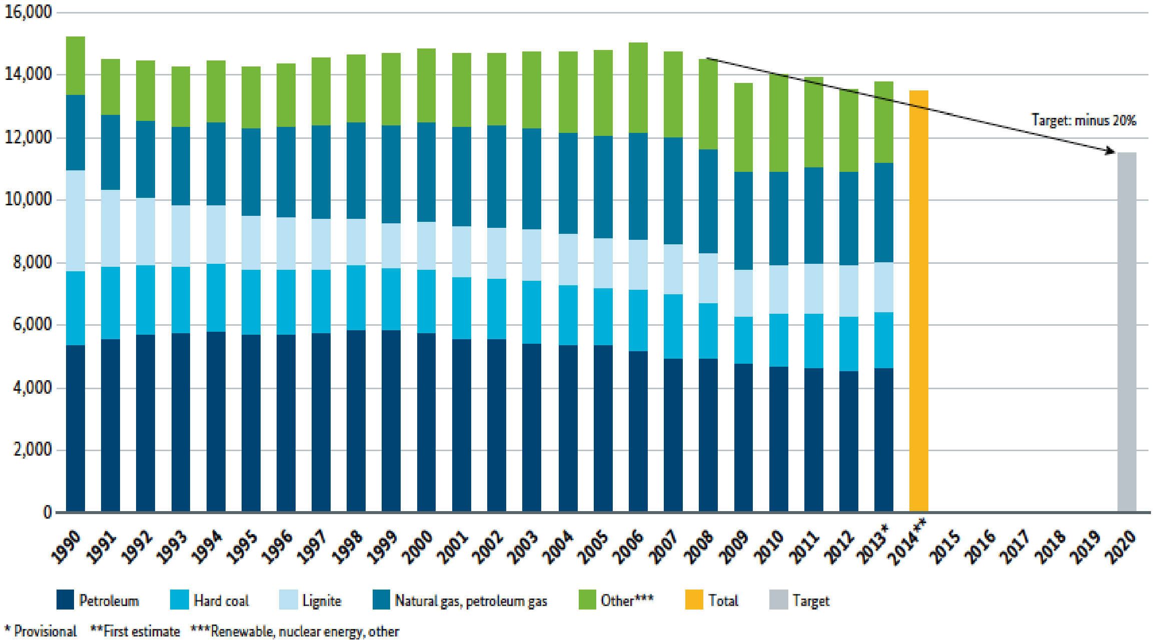
2.1 Energy Demand in Germany

Primary and final energy consumption has been falling in Germany for some years now. Between 1990 and 2011 primary energy consumption fell almost 12%, whilst final energy consumption has also been falling, and has continued to fall through 2014.[1] According to the German Arbeitsgemeinschaft Energiebilanzen (AGEB) (roughly translated as the Working Group on Energy Balances), which monitors the Energiewende and statistics from the energy industry, levels recorded in 2014 are the lowest since reunification in 1990 – see Figure 1. Some claim, however, that temperature corrected these results are perhaps not as strong given that each year, except three, has been warmer (Rosenow 2013).

[1] See Energy Transition: The German Energiewende website for infographics on improvements in primary energy consumption and energy efficiency at: http://energytransition.de/2014/12/infographs/

Figure 1: Development of primary energy consumption by energy source

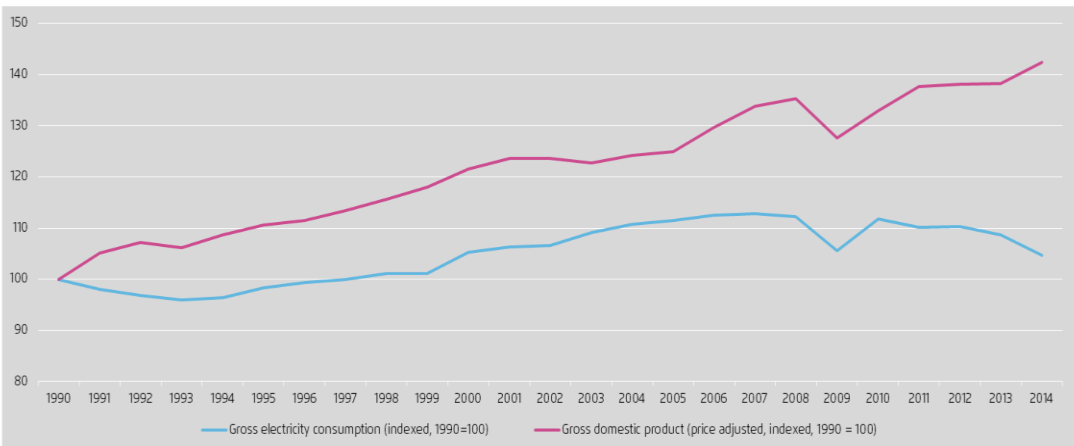
Adjusted figures in petajoules (PJ)



Source: AG Energiebilanzen in BMWi 2014b: 9

Energiewende demand reduction targets, that drive policy decisions, also use 2008 as the comparator year and on this measure demand has also been falling: primary energy consumption fell 9% between 2008 and 2014. Demand for electricity has also been on a downward trend since 2007 (see Figure 2). It fell by 4% between 2013 and 2014, while the economy grew by 1.4%, and this had led to some to argue that Germany has managed to delink economic growth from demand growth (Agora 2015d). Longer term, however, electricity demand is expected to rise, partly because of the current political refocus on enabling growth in the electric car market. Indeed, the BMWi is currently considering a €2bn incentive programme for electric cars, partly to add more EV charging stations and to support the acquisition of more electric vehicles for Federal offices (Richardson 2016).

Figure 2: Indexed economic growth and electricity usage (1990 = 100)



Source: Agora 2015d

In terms of breaking demand down between sectors, in 2014 the ‘household, services and commerce’ sector represented 40.6% of final energy consumption; transport 30.4%; and the ‘manufacturing and mining industry’ sector represented 29% (AGEB 2015a). It is worth noting that whilst there has been steady progress in the ‘households, services and commerce’ sector, final energy consumption in the transport sector has grown by 1% and it was flat for the ‘manufacturing and mining industries’ sector between 2005 and 2013 (Clean Energy Wire 2015). In terms of the ‘manufacturing and mining industries’ sector this is partly because there has been relatively high growth in industry since 2005, and it should be noted that this sector did well in 2014 versus 2013 by using 3.3% less energy. Within these figures it is also notable that energy consumption for heating is far larger than for electricity and growing, indeed in 2020 electricity is estimated to be 25% of total energy consumption in 2020, whilst heat will be 47% (Agora 2013: 18). What these breakdowns suggest is that there needs to be continued focus on demand reduction in particular in the transport and heating sectors – and there does appear to be some (small) shift in emphasis within policymaking circles from a quite narrow focus on decarbonising electricity to better address transport and heat issues.

In terms of improvements in energy consumption Germany is considered to be one of the most productive industrial nations in the world (BMWi 2014c: 2), given that consumption has fallen whilst GDP has steadily grown. One example of growing energy productivity is that, in 2014, 4.8 gigajoules of energy were needed to produce goods worth €1,000, having fallen from 5.2 gigajoules in 2013, and 7.6 in 1990. Indeed the American Council for an Energy Efficient Economy (ACEE)’s 2014 efficiency ‘scorecard’ ranks Germany as no. 1 for progress out of all countries included in the benchmark, and the 2014 numbers released since this report are even more impressive (Young et al 2014: 82).

As outlined in section 2.3 below, Germany has achieved much in terms of transitioning its supply system in a distributed way and in terms of citizen-community ownership, but more needs to be done in terms of refocusing governance away from a supply to a demand-side focus and in terms of improving flexibility options (Agora 2013). As will be discussed in more detail in section 4.2 below, in terms of flexibility the main emphasis for new policies has so far come from the need to integrate increasing amounts of intermittent electricity supply (see Agora 2013: 6). It was estimated in 2013 that only about 2 to 3% of demand was flexible (i.e. approx 1.5GW in total load of 50 to 80GW), whilst looking just at technological potential it was estimated that over 50% of demand could respond to supply (Agora 2013: 27).[2] Some scholars claim that flexibility will be the new ‘paradigm’ of the Energiewende, but also that further

[2] Base load in Germany is between 35 and 40 GW (minimum consumed at all times during the year) (Agora 2013: 9).

governance and structural changes will be needed for this paradigm to become reality (Pescia & Graichen 2015).

2.2 Heat and Power Markets

As briefly mentioned in the introduction to section 2, IGov considers that energy institutions, or regimes in socio-technical transitions (STT) terminology, that exist prior to an energy transition constitute a highly important context for change (Unruh 2000; Kuzemko et al 2016). This section, therefore, provides an overview of heat and power supply as of 2014, with an emphasis on the changing energy mix as well as a brief energy sector history. This reveals what energy sources have been important within Germany's political economy and what kinds of energy infrastructures became embedded – both of which have relevance for the types of path dependencies that Germany needs to break in order to transition successfully.

Germany has, like the UK, enjoyed considerable indigenous coal resource, and there is often a correlation between indigenous resources and energy mix and infrastructures (Kuzemko et al 2016). Indeed, up until the 1960s electricity was almost entirely sourced from domestic hard coal and lignite, although most other resources were imported (Pahle 2010: 3432). The strong domestic standing of coal, in employment and political terms, is also important to German historical energy decisions as well as to current governance decision-making around when and how to phase coal out.

It has, however, been less well endowed with other traditional energy sources and this had important implications for how Germany responded to the 1970s crises (Jacobsson & Lauber 2006; Giddens 2009; Julian 2014). In the first years of the 1970s oil and natural gas had been starting to amend the power generation mix but Germany was an importer of oil and gas. One response was a new emphasis on energy conservation and efficiency (BMWi 2014c: 2). The oil shocks also highlighted the growing dependence on foreign energy markets and, in response, Germany switched priorities back to coal and nuclear as *domestic*, and therefore more reliable, sources of power (Jacobsson & Lauber 2006: 261; Pahle 2010: 3432; Jordan-Korte 2011: 203). However, given how controversial nuclear power became in Germany, especially post the Chernobyl nuclear disaster, a new emphasis on developing renewable resources started to emerged (Jacobsson & Lauber 2006: 261). Interestingly the coal industry, and other associated industry and trade union groups, did not fight the introduction of the first renewable support mechanism in 1991 and acted moreover as allies with the renewables sector in the anti-nuclear movement (Ibid; Mez 2012; Interview 2).

Partly because of the degree to which it has become embedded in socio-economic terms, coal has remained a far less controversial source of electricity than nuclear. Today lignite, or 'brown' coal, is still mined in Germany and employs tens of thousands of people. It is difficult to transport economically due to high water content, and this infers that lignite-based power generation needs to be local (Interview 5). Hard coal is, on the other hand, now largely imported (87%) and is not considered as important politically or economically. Still in 2014, lignite and hard coal together provided some 44% of generated electricity (Baake 2014; Butler 2015), although this does represent a drop from 2012-13 when there had been a switch back to coal largely for price reasons. The impact on emissions of increased coal usage in 2012-13 was clearly negative and led to a growing realisation, in 2014, that Germany might miss its EU emissions reduction target for 2020. For reputational as well as popular political reasons, missing this target is not considered to be a viable option, hence the government rethink about how and when to phase coal out which resulted in the proposed 'Klima Levy' (Interviews 4, 5 and 19; Kuzemko 2015b). The Klima Levy coal phase-out programme did not, however, get passed due to firm opposition from coal unions and those gas and electricity companies, Vattenfall and RWE, that still produce a large percentage of their electricity from coal. Instead the government decided to place 2.7GW of coal on standby, some of which was already due to be decommissioned in the near term, and a new capacity reserve was announced essentially as compensation for plant operators (see Kuzemko 2015b). The total cost of decommissioning this initial 2.7GW is estimated at €1.6bn (Lang & Lang 2015).

It should be noted that hard coal power generation did fall in 2014, lignite stayed flat, and greenhouse gas emissions fell by 5% versus 2013 (Pescia et al 2015: 35; Agora 2015d). The figures for 2015, however, don't look as promising with initial, estimates of a small rise in emissions versus 2014 due, in part, to a colder winter (Amelang & Appun 2015). Arguably Germany's inability to initiate a more ambitious phase-out of coal, despite its firm commitment to ambitious emissions reduction targets, reflects the government's need to balance and co-ordinate changes to an industry that has been historically so important.

The political treatment of coal, and its continuing position within Germany's energy mix, contrasts markedly to that of nuclear. Some claim that the Energiewende is as firmly based on popular anti-nuclear sentiment, exacerbated by the 1986 Chernobyl and 2011 Fukushima nuclear disasters, as it is on climate change (Schreuers 2002; Mez 2012 and Interviews 2, 3, 4, 5 and 6). Although, to make matters more complicated, Germany has yet to find an acceptable site for nuclear waste because of political difficulties even though geologically acceptable sites have been identified (Interviews 2 and 20). There are also some more practical considerations for not accepting nuclear as a low carbon option in Germany, for example Reinhardt Baake has suggested that the costs of new nuclear plant (in the UK) will be between 100 to 150% more expensive than renewables (Baake 2014).[3]

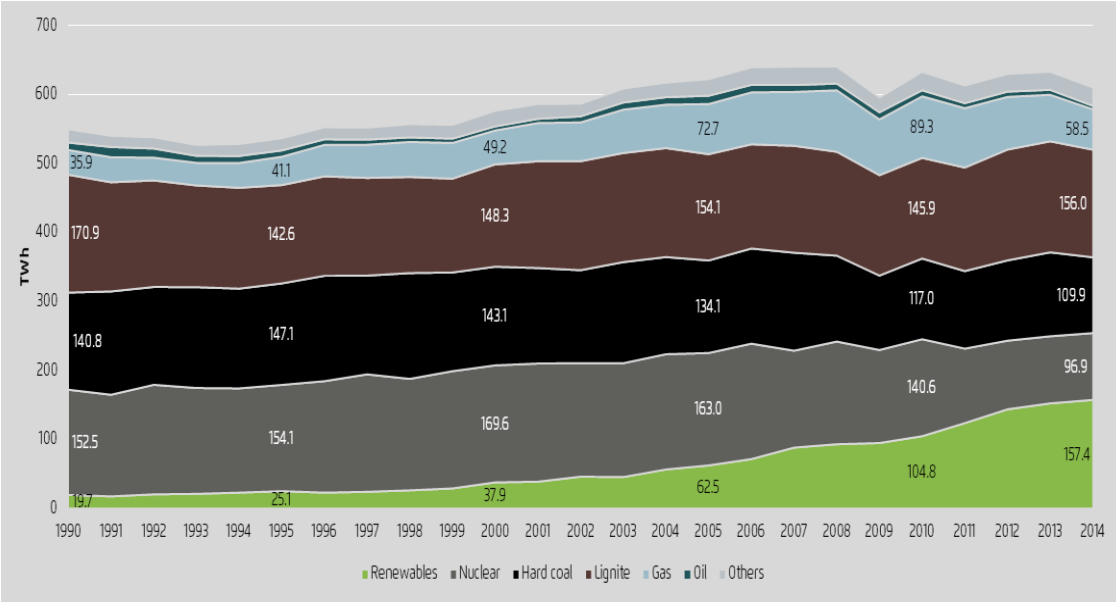
Whatever the reasoning, the Energiewende commits to a phase out of nuclear energy by 2022: 11 units were shut down by 2015; 4GW of power capacity is to be eliminated between 2015 and 2019, and a further 8GW between 2020 and 2022 (Agora 2013: 21; Pescia et al 2015: 10; Lauber & Jacobsson 2015: 3; Interview 15). So it is expected to fall from 17.6% of electricity generation in 2011 to zero by 2022. What this importantly means is that, in terms of decarbonising the energy system and given the hitherto strong focus on electricity, renewables become singularly important to achieving the German energy transition. Because renewables have certain structural characteristics, intermittent with low operational costs, the German administration now have a clearer picture of what other electricity (and heat) system changes need to happen to accommodate this source of energy (Interviews 11 and 15). By contrast countries, like the UK, that continue to rely on nuclear as one low carbon option will have to optimise their system to cope with 'on all the time'/centralised nuclear as well as intermittent renewables.

Under various support schemes, but in particular the Renewable Energy Resources Act (EEG), renewable electricity generation has grown quite rapidly (see Figure 3), with the defining characteristic that much of this new renewable capacity is citizen owned and/or distributed (Pescia et al 2015: 9).[4] Together renewables provided 161.6 TWh of electricity generation in 2014, which was equal to 25.8% of the overall generation mix in 2014, from 6.6% in 2000 when the EEG was introduced. A breakdown of these renewable generation numbers shows that wind contributes the largest portion (8.6%); followed by biomass (8%), PV (5.8%) and hydro (3.4%) (Agora 2015d; AGEB 2015a). Measured as a percent of domestic power consumption renewables stood at a slightly higher 27.3% in 2014 (Agora 2015d). The amount of available hydro-electricity is expected to remain stable, and whilst biomass will continue to grow it will ultimately be limited to 10% of power generation long term due to land availability and food security reasons (Agora 2013: 5). It is also important to note that generation costs for PV and onshore wind have declined rapidly as diffusion has increased such that they are now cost competitive with conventional sources for new investments (Pescia & Graichen 2015: 5).

[3] For more details on cost comparisons between various renewable sources of power and nuclear (based on Hinckley C in the UK) see Fürstenwerth 2014. For further details of falling renewable costs in Germany see Pescia et al 2015: 18.

[4] See also BMWi 2015b for details of renewables growth (by product) in electricity, heat and transport sectors.

Figure 3: Development of Gross Power Production 1990-2014 in TWh



Source: Agora 2015d.

It is expected that renewables will continue to grow, both as a source of electricity and of heat, indeed the Energiewende target is for over 80% of electricity consumption to come from renewables (by 2050). Within this wind and PV sectors are expected to become a significant input. This is set out within the specific targets that Germany set for annual growth rates for each renewable source, referred to as the 'Ausbau Korridor' (for more information see section 4.1). According to the German energy regulator, Bundesnetzagentur (BNetzA), by 2022 wind and PV will be generating about 70% of the power obtained from renewable sources (Agora 2013: 6). Because of the remarkable growth rates achieved in solar PV, especially between 2011 and 2014, Germany is considered to be a world leader in terms of installed capacity, and in terms of capacity per head of population (REN21 2015). Solar capacity now exceeds 39GW, there are more than 1.5m PV homes, and costs fell 80% in the 5 years to 2014 (Fürstenwerth 2014; Interview 10).

Given the substantive changes made to the EEG in 2014, discussed in detail in section 4.2, energy analysts are keeping a close eye on additions in 2015. So far although total capacity exceeded 39 GW for the first time in July 2015, addition rates are down on 2014. Clearly the intention has been to slow the extremely fast rate of PV growth experienced from 2011 to 2014, however some fear that current addition rates will not allow Germany to meet its 2015 target of 40,000 MW in new additions (Clean Energy Wire 2015b). Others fear that the changes will have a particular impact on the distributed and/or citizen-owned nature of onshore wind and PV generation.

Much focus over the past year or so has been on the remarkable growth of offshore wind. Germany is expected to add more than 2,000 MW of capacity in 2015, an almost fourfold increase over 2014, thereby taking total installed capacity to 3,100 MW (compared to the UK at 5,300 MW) (edie newsroom 2015).[5] Some issues for grid redesign and demand management associated with this turn to growth in the more centralised, corporate owned offshore wind sector will be raised in section 4.1. Especially if fears about slowing additions of new PV, which tends to be citizen/community owned and more distributed in nature, turn out to be well founded. It should be noted, however, that onshore wind did continue to grow in 2015, albeit at a slightly slower pace than offshore wind. By 2035 onshore wind is expected to provide the lion's share of renewable energy (Pescia et al 2015: 15). It is also estimated that, by the time 40% of power comes from renewable sources (expected in 2025), only 10 to 25 GW of conventional capacity (operating between 6000 to 8000 hours per year) will still be needed (Agora 2013: 9).

Because of the growth in renewables, and the steady growth expected to come, a greater governance emphasis is now being placed on interconnection, flexibility and controllable supply, with relatively less emphasis on storage, except for batteries for use in conjunction with PV (Agora 2013: 6). Almost 25% of electricity demand (approx 15 to 25GW) occurs during only a few hours of the year, i.e. less than 200, and this, together with the growing proportion of renewables in the mix, means that there will be a need for more controllable capacity (estimated 20GW by 2020) (Agora 2013: 16). Another recent report claims that flexibility is the new 'paradigm' of the power sector, but less has been achieved so far here, in particular in comparison to renewable growth achievements (Pescia et al 2015: 1). It has been the growth in renewables that, as such, has so far pushed the agenda on flexibility.

Lastly in this section we can turn to the important cross over fuels and technologies, gas and CHP, that are currently both used for electricity and heat generation. The long-term goals within the Energiewende require that electricity and heat be increasingly produced from renewable sources and the electrification of fossil-fuel intensive sectors like transport, heating and cooling (Pescia et al: 9). However, there is a long-term role for CHP, and gas-fired electricity, in providing flexibility services in terms of controllable supply. Today gas is mainly used for heating and cooking in Germany rather than directly for electricity (Interview 20). In 2014 gas generated 9.6% of electricity, mainly in the form of combined cycle gas turbine (CCGT) generation and electricity generated as a by-product of gas-fired CHP. Open-cycle gas turbines have already been used for generating electricity at peak times for many years now, and can reach full capacity in 10 minutes (Agora 2013: 17). It is expected that cost efficient open-cycle turbines will

[5] The UK will drop in 2015 from being the global leader in terms of *rate of installation* to the no. 3 slot behind Germany and China.

be able to meet some of the controllable reserve requirements at a reasonable cost: €35-70m per GW per year (ibid).

It is harder to find numbers on CHP (as a side product from heat) and its contribution to the electricity mix. This is partly because it most often seems, understandably, to be included in the statistics for gas and coal generation. One analysis estimated that (in 2010) CHP constituted about 50% of electricity produced from gas and 20% from coal (Möller 2010: 20). Eurostat estimated that in 2012 CHP in total generated 12.4% of gross electricity in Germany, and one interviewee suggested that the number is now around 13% (Interview 20). This compares with 50% for Denmark and 5.5% in the UK (Eurostat 2013). According to official government targets electricity generation from CHP, as a side product from heat, should increase to 25% by 2020 (Agora 2013: 9; Interviews 20 and 25), and that this, together with biomass, will then constitute the largest amount of controllable generation in Germany (at approximately 33% of electricity generation).

In terms of sources of heat in Germany, 49.3% comes from natural gas, 26.8% from petroleum; 6% from firewood and coal and 4.4% from electricity. CHP is 20% of current heating supply, but based in turn on fossil fuel technologies (coal and gas mostly) (Interview 23). Again according to Eurostat (2013), Germany sourced only 10% of its heating and cooling from renewable sources in 2012 which is quite a low within Europe, but not as low as the UK at 2.6%. By 2014, 12.2% of heat was generated from renewable sources (BMWi 2015b: 5). As such, and again given decarbonisation targets, wind and PV must replace oil and gas in heat generation in the medium to long-term, especially if CHP is also to be increasingly used as a controllable source of electricity (Agora 2013: 18; Interview 23). The policies currently in place to enable growth in CHP for electricity are outlined in section 4.2, and some of the issues surrounding innovation and governance here also analysed.

2.3 Wholesale Trading, Balancing and Ancillary Services Markets

The section explains, again as context for the analysis to come, how the principal wholesale and ancillary services markets for gas and electricity operate. What is of particular interest in terms of demand management is to understand what the rules market arrangements are for trading demand response. Demand flexibility arrangements are understood, by some, to be less well developed in Germany, certainly compared to some US markets, despite claims that flexibility will be the new energy market paradigm in Germany.

2.3.1 Gas Trading

As already mentioned, relatively little electricity is generated directly from gas, and given its lower carbon intensity than coal it is puzzling for some why this might be given Germany's ambitious electricity decarbonisation targets. One explanation is that the coal industry has a long socio-economic history in Germany and that the 1970s energy crises resulted in a re-emphasis on domestic (coal) over imported (gas) sources of energy. Indeed Germany currently imports 87% of its gas needs: 37% from Russia, 33% from Norway, 25% from the Netherlands as well as 98% of its oil consumption (Pescia et al 2015: 26). These fossil fuel import requirements represented a net trade deficit of approximately €90bn in 2014 – with the bulk of this cost coming from oil and gas imports. This provides a further incentive to switch out of gas (and oil) consumption to improve this trade balance, as well as to improve energy security by reducing import dependency (ibid: 27; Interview 11). It should be noted that Germany is becoming an increasingly important transit country for gas, especially with the completion of the Baltic Sea gas pipeline, which brings gas into Europe from Russia, and it also has the largest quantity of gas storage in Europe at 27bn cubic meters (BNetzA 2014: 192).

The Energy Industry Act (Energiewirschaftsgesetz or EnWG) of 2005 paved the way for the liberalisation of gas trade for all end users, and the BNetzA became the regulator for gas transmission and distribution. There are two gas balancing zone operators, Gaspool Balancing Services GmbH and NetConnect Germany GmbH & Co (NCG), covering two market areas within Germany and providing access to pipelines for gas transport, trading and balancing services to gas suppliers (WinGas 2015). The two networks differ in that they are for different gas types: L-gas (low calorific) and H-gas (high calorific), but each network represents a consolidation of 3 previously separate networks (Heather 2012: 16). This remains quite a fragmented market in terms of how it is structured and there are 14 gas Transmission System Operators (TSOs) in Germany, although one TSO acts as 'market leader' for each of the 2 networks, and over 700 operators of regional gas distribution systems (IEA 2012: 20; FNB Gas 2015).

Some gas trading takes place via the virtual trading points (hubs) run by NCG and Gaspool on the spot or futures markets over the PEGAS exchange (which is a merger between the European Energy Exchange (EEX) and Powernext, operated by Powernext) (EEX 2015; WinGas 2015). Although the liquidity of natural gas wholesale markets remains considerably lower than that of wholesale electricity markets, trading volumes on the (then) EEX and at the two virtual trading points have been increasing quite sharply (in 2013 by 36% and 20% respectively) (BNetzA 2014: 187). By far the largest share of trading in natural gas, however, still takes place bilaterally or 'over-the-counter' (OTC), often facilitated by broker platforms (ibid:

226). Gas volumes on the whole, in terms of delivery to metered customers, have also been on the rise over the past few years (ibid).

However, in terms of gas-fired electricity on wholesale electricity markets it has, due to the merit order effect and the growing proportion of renewables, been pushed out of the market over the past few years (Pescia et al 2015: 29). Only about 9% of all gas delivered by TSOs and DSOs is now for use in gas power plants (BNetzA 2014: 189). This has led to calls over the past few years for the creation of a capacity market that could provide sufficient incentive for gas-fired power plants to provide flexible supply, however the current electricity market White Paper claims that no such market is needed (BMWi 2015e). Please see section 4.2 for more details.

2.3.2 Electricity Trading

As with gas there are multiple options for trading electricity in Germany, although partly due to the fact that electricity markets are inter-connected with neighbouring markets there are a few more options available to trade electricity. Electricity can be traded on the Energy Exchange Austria (EXAA) spot market in Vienna as Germany and Austria are currently treated as one market for trading purposes. The main markets, however, are the Paris based European Power Exchange (EPEX) Spot, EEX futures (in Leipzig), and the bi-lateral (OTC) markets (BNetzA 2014: 110). In terms of trading demand response the principal market is currently the Regelleistungs Markt (Balancing Market) through its various reserve market products (Bayer 2015). It should also be noted that electricity wholesale markets have been in a pretty constant state of flux over the past few years, with higher rates of renewables, considerable drops in wholesale prices, various market actors in financial difficulties and current plans drawn up for an optimised 'Electricity Market 2.0' (EOM 2.0) (see Bauknecht et al 2012; Schuppe 2015b; BMWi 2014 and 2015).

The majority of electricity wholesale volumes are traded on the EPEX Spot market, which offers trading for standard contracts for the physical delivery of electricity in determined delivery areas within the Austrian, German, French or Swiss transmission systems (EPEX 2015a). Indeed, the EPEX was designed with the intention of integrating European power spot markets in line with the Third EU Energy Package, which entered into force in 2009 (BNetzA 2014: 110; EPEX 2015b). The spot market offers intraday and day ahead trading, gathers in bids and offers and then assigns delivery in an anonymous but transparent manner along the lines of a pool market design (EPEX 2015b; Interviews 3 and 19), and is sometimes referred to as the 'energy-only-market' (EOM) (BMWi 2014a: 11). This is widely considered to be a liquid and transparent market with prices resulting from a large and open competition between the orders of the exchange members, reflecting the best available information at the time (EPEX 2015b; see also

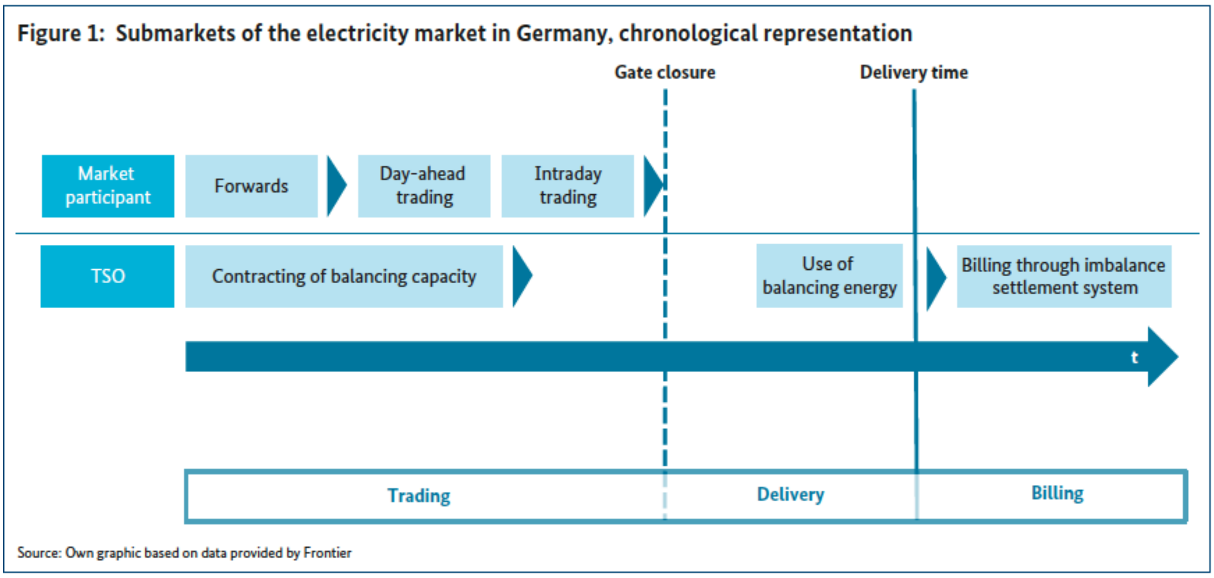
Interviews 19 and 25). Trading is governed by a trading agreement made up of Market Rules, Code of Conduct and Operational Rules which all parties must sign before they are granted membership (EPEX 2015a; AIIFL 2013).

The Physical Electricity Index (Phelix) refers to the base load and peak load price index published daily on the Power Spot Market for the German/Austrian market area which is calculated and published by the EPEX Spot and the Leipzig-based EEX futures (also a pool market) (Julian 2014: 15)]. There is another index, the European Electricity Index (ELIX), which is calculated for Germany/Austria, France and Switzerland. It corresponds to the market price for all these areas and, as a result, it represents the market price for electricity in an integrated European single market (EEX 2015c). The EPEX Spot was established as a joint-venture between the EEX and the French company Powernext. The EEX still operates market platforms for energy derivatives, which offers access to the most liquid financial power future in Europe, the Phelix Future, and roughly 15% of electricity is traded here (EEX 2015b).

Power market participants can also opt to trade bilaterally, some do so to avoid exchange fees and others, usually large-scale consumers, want to ensure good value base load contracts whilst topping up in the pool (BNetzA 2014: 125; Interview 3). Prices at EEX often serve as a reference for these bi-lateral contracts and all prices resulting from bilateral trades are published on the EEX Transparency Platform, which implements statutory publication requirements and voluntary commitments by the industry (AIIFL 2013: 12; BNetzA 2014: 125; EEX 2015d). EPEX Spot offers OTC clearing for intraday contracts but the take up is very low, however EEX OTC clearing for futures contracts has a high take-up rate and it is seen by BNetzA as a useful interface, in transparency terms, between exchange and non-exchange electricity wholesale trading (BNetzA 2014: 129). BNetzA monitors all aspects of German power markets, including each of these trading options and publishes detailed reports annually, including what percentage of bilateral trading is ‘intra-group (BNetzA 2014: 127).[6]

[6] These detailed reports are available here:
http://www.bundesnetzagentur.de/cln_1432/EN/Areas/Energy/Companies/DataCollection_Monitoring/DataCollection Monitoring_node.html

Figure 4: Submarkets of the electricity market in Germany



Source: BMWi 2014a: 9

Although IGov's research on Great Britain's (GB) power markets has suggested that liquidity and transparency associated with market rules (vertical integration and bi-lateral trading) present barriers to entry and expansion for new market entrants, this appears not to be the case in Germany (Kuzemko 2015c; Interviews 3, 5, 18, 19, 25). This is, of course, not to say that there are no important problems given the rate of growth of renewable energy being sold on wholesale markets. There are two main issues here: one that has to do with falling wholesale prices, which is a particular problem for conventional generators, and the other with intermittency – and both these issues are driving new strategies and policies, some of which are focused on ensuring greater generation and demand flexibility.

Like the GB wholesale power markets Germany organises prices according to the merit order. At certain points in time (i.e. when it is particularly sunny or windy) renewables push more expensive electricity (hard coal and gas) down the merit order curve, lowering the marginal cost and at times resulting in negative wholesale prices (Agora 2013: 20; Buchan 2012: 24; Interview 18). BNetzA's monitoring of wholesale electricity price movements shows that, between 2008 and 2013, mean spot prices fell 45.7% (BNetzA 2014: 114). It is unclear whether this is just due to renewables, however, as the biggest price drop was between 2008 and 2009 when European markets slowed rapidly post the financial crisis. In addition to pushing prices down renewables also have the effect of reducing the operating times of fossil-fuel power stations (especially gas and hard coal), again with clearly negative implications for conventional power generators (Agora 2013: 21).

A further important implication of prices falling is that because renewable generators receive the wholesale market price plus the difference between the wholesale price and the EEG subsidy level, falling spot market prices result in subsidy costs increasing – costs which are socialised through consumer bills (Interview 25). These costs are, however, not evenly distributed because large-scale power users, until 2014, have been exempt from paying their proportion of the EEG subsidy and so the impact of higher EEG costs falls on other power users.[7] In addition, because they are exempt from subsidies and some other system costs, the price paid by heavy users bears a higher correlation to wholesale prices and they, therefore, benefit directly as renewables put downward pressure on prices without paying the costs (Morris 2015). Rising costs, unequal distribution of costs amongst energy users, and political and policy consequences are explored in more detail in section 4.1.

The second main issue, which informs much of the current political debate in Germany, is that of intermittency of renewables. As already observed one solution is to concentrate efforts on ensuring greater controllable generation whilst also encouraging flexible demand, details of which are in section 4.2. Some market rules have, however, already changed to allow for increased intermittency. EPEX announced the introduction of a separate day-ahead auction for quarter-of-an-hour contracts in December 2014. In the day-ahead auction of the EXAA, in addition to individual hours and blocks, it has also been possible since September 2014 to trade in quarters of an hour (BNetzA 2014: 15 and 111). This expansion of trading opportunities is designed to allow for increased feed-in of electricity from 'supply-dependent (regenerative) sources (ibid 2014: 111).

As has already been mentioned German electricity markets, and transmission networks, are coupled with 15 neighbouring countries, and there is 'one price zone' between Germany and Austria (BMWi 2014a: 8-10). Although some consider that the degree of complexity associated with being interconnected with so many other electricity markets is overall unhelpful (Interview 19), much emphasis is placed by policy makers on the possibilities for flexibility that these active interconnections offer (Baake 2014). This is because demand from other countries can help to stabilise prices at times of high renewable generation in Germany (Agora 2013: 30), and vice versa when there is low supply. These interconnections are, indeed, said to be part of the reason why the German electricity system has stayed so stable despite the large increase of renewables. There do, however, seem to be issues emerging with close market interconnections for other countries. The Association for the Cooperation of Energy Regulators (ACER) has recommended that Germany and Austria's common market should be split at

[7] As discussed in sections 2.3.5 and 4.1, the rules changed in 2014 but energy-intensive users still pay only a very small proportion of subsidy costs.

certain times, and BNetzA agrees with plans to split as soon as 2018 (Schlandt 2015b). Because transmission infrastructure between Germany and Austria is insufficient when volumes are high electricity often flows via other countries, including Poland, Hungary, the Czech Republic and Slovakia, and these loop flows are destabilising their grids (ibid). A further issue is that there is no formal matching of traded power market flows between Germany and Austria (Reid 2015).

Some fear that greater supply intermittency, current market rules that result in low incentives for gas and hard coal, coupled with nuclear decommissioning will together result in a supply security risk. This is one of the arguments that the German Industry Association (BDI) uses to argue for a slowing down of, and other changes to, the Energiewende. Again, the Capacity Market is a subject that this paper covers in more detail in section 4.2, but suffice to say at this point that this has been a subject of considerable political debate in Germany. Many have pointed to Capacity Markets being implemented elsewhere, for example in some parts of the US, Brazil, Spain, UK and South Korea, to ensure system reliability and have argued that Germany should follow suit (Agora 2013: 20). Thus far the decision, by the BMWi, has been *not to* implement a Capacity Market, although some lignite power stations, due to be decommissioned, will receive a 'reserve' payment for not participating in wholesale markets for a limited number of years (Kuzemko 2015b). The current White Paper suggests that an updated 'Electricity Market 2.0' will improve rules such that there will be sufficient security of supply as well as greater demand response to help integrate renewables (BMWi 2014 and 2015).[8]

2.3.2.1 Balancing and Ancillary Services Markets

Currently the principal opportunities for trading in demand response are in the RegelLeistungs Markt (Balancing Market) run collectively by the 4 TSOs. There has also been a trial ongoing called the Ordinance on Contractual Agreements Concerning Interruptible Loads (AbLaV) which has been paying high prices for demand response, mainly to electricity-intensive users, but there seems some uncertainty with regard to the future of this trial (Bayer 2015: 59). As part of its market monitoring function the regulator has concluded that there is a high degree of liquidity in the system balancing energy markets (BNetzA 2014: 16). Ancillary services markets are split into 3 product types: the Primary (which must be available within 30 seconds of being requested), Secondary (must be available within 5 minutes) and Tertiary (must be available within 15 minutes) control reserves (BNetzA 2015: 9; Interviews 5, 7 and 25). Most demand response activity is currently taking place in the Secondary and Tertiary (Minute) control reserves (Brewitt 2014). It is only since 2010, however, that there has been a single control

[8] For details about all options being considered, including Electricity Market 2.0, please visit the BMWi's website here: http://www.bmwi.de/EN/Topics/Energy/Electricity-Market-of-the-Future/electricity-market-platform,did=679854.html

power market for Germany, as prior to this it was split amongst the 4 TSO regions.[9] Germany is unique in that it requires demand response providers to drop load (positive DR) to balance the grid, as well as to increase their load when there is more renewable power than the grid can handle (Tweed 2014).

TSO areas are subdivided into balance responsible perimeters, or balancing groups (BMWi 2015e: 39; 50 Herz 2015), and every producer and consumer in Germany is assigned to a balancing group. These are, in turn, managed by a Balance Responsible Party (BRP), sometimes referred to as an Access Responsible Party (ARP), and each BRP must sign a standard, but onerous, balancing group contract with the relevant TSO provided by BNetzA (50 Herz 2015). The contract covers all business transactions, such as trading, supply and grid activities and it includes all obligations to be fulfilled by each contract party up until settlement of control power used. The BRPs must report how much electricity they will supply to the grid and from which particular facility or from which particular grid connection point they wish to take electricity from the grid (BMWi 2014a: 11). Each TSO settles control power used with the BRPs each month. When resolving network balancing issues the TSOs rely on registered Balance Service Providers (BSPs) of which there are over 5,000 in Germany (Koliou et al 2014: 247). The TSO procures balancing power for a certain period from any BSP and sells it to the BRPs that cause the imbalance in any given control area (ibid).

It is worth mentioning, at this stage, that the government's 2014 green gaper on how to redesign German electricity markets argues that balancing markets need to be developed further to account for higher amounts of variable generation, as Germany moves towards its 2020 and 2050 renewable targets (BMWi 2014a: 22). Although current costs associated with balancing, as calculated by TSOs using the imbalance system, are not considered to be of principle concern there are moves afoot to bring costs down by making the market more liquid/competitive, partly by improving rules associated with access (ibid). There is also the intention to provide better incentives to BRPs to actively manage their balancing group on the intraday market (currently only 30-50 of them do so) where low prices would enable cheaper balancing (BMWi 2014c: 23). Details of this, and implications for demand response and local markets, are covered in sections 4.1 and 4.2.

BRPs can also market loads for portfolio optimisation on energy only markets (BNetzA 2015: 13). Generally, however, the marketing of loads outside of the system balancing energy markets, and of the AbLaV, still only takes place to a small extent, and not through aggregators,

[9] For details of this process see the Regelleistung platform here: https://www.regelleistung.net/ext/static/market-information?lang=en

but rather through larger loads with a balancing group of their own (BNetzA 2015: 13). The principal reasons given are that prices are too low and because the existing system of network charges works against making demand response profitable. The general feeling from interviews and secondary documents is that not enough is being done to encourage active demand response in electricity markets, and certainly German ancillary services markets are viewed as less advanced than US markets like PJM and ERCOT (Agora 2013: 17; Tweed 2014; Bayer 2015: 60; Interviews 5, 6, 7 and 19). One innovation, however, has been the requirement that the TSOs come together to publish all ancillary market tender details on one platform.[10] More details about the governance of demand response, current successes and issues still outstanding will be covered in section 4.2 – in particular the many complaints from aggregators about current market rules that provide barriers to enhanced demand response (at household level) in Germany. One primary concern is that aggregation, and demand response more broadly, are not yet codified in the market by energy industry laws such that aggregation is not yet a legally 'recognised' energy service (BNetzA 2015; Tweed 2014).

2.4 Principal Market Actor Groups and Governance Summary

This last part of section 2 provides an introduction to the principal market actor groups in Germany, with some emphasis on companies that are innovating most on the demand side and their business models, and the evolution of the market in terms of the somewhat embattled incumbents (the 'Big 4'). Generally speaking it should be noted that Germany has seen a healthy amount of new market entrants in terms of renewables (especially distributed); marketing of distributed renewables; municipal services; ESCOs and (to a lesser extent) aggregators. It is also notable that the Big 4 are in a reasonably precarious position (financially, but also in terms of being able to influence policymaking) than in other some countries, for example Great Britain. It is notable that the German gas and electricity markets were liberalised quite recently (in the 1990s) and the unbundling of grids from generation has been a particular focus of liberalisation. As it stands, however, there is still a high degree of co-ownership within retail and distribution markets – and both of these markets are highly fragmented.

This section also briefly introduces the most relevant policies and regulations already in place that impact upon the structure of each market segment. However, the details of how governance impacts upon demand management in Germany will be covered in section 4. There has been a very high degree of energy policy and market structure change in Germany over the past decades, but more is still to come. The BMWi issued a chart of the key projects of the energy transition that need to be finalised just between 2014 and 2016 and it includes 26

[10] All details of upcoming tenders, and of tender results, can be accessed here: https://www.regelleistung.net/ext/

different new papers, acts, plans and strategies (BMWi 2014d). This, as with energy governance in many countries, is a reasonably fast changing landscape.

2.4.1 Power Generation

The most significant policies for generation have been those around nuclear decommissioning and around enabling an ever-greater share of (distributed) renewables in the electricity mix. Germany started using policy relatively early to support renewable electricity generation in the form of the 1991 Stromeinspeisungsgesetz (StrEG) (Feed-in-Law), but also using state funding to support RD&D and new energy research institutions (Jacobsson & Lauber 2006: 257; Jordan-Korte 2011: 202; Fuchs 2014: 46-49). Since 2000 the Renewable Energy Act (EEG), or Erneuerbare-Energien-Gesetz in Germany, and the Heat-Power Cogeneration Act (Kraft-Wärme-Kopplungsgesetz) have both provided the foundation necessary to promote renewable energy technologies. Today renewable policies are designed with new and specific targets in mind – not least the Energiewende objectives of growing renewables to 40-45% of gross electricity consumption by 2015; to 55-60% by 2035, and 80% by 2050 (Bayer 2015: 7).

In 2015 it is estimated that renewables already accounted for 30% of all power generated and 33% of domestic power demand (Morris 2016), and as will be seen below much of this new production is distributed in nature/not owned by the Big 4 generators. In 2015 generation costs in Germany ranged between 6-9 cts€/kWh for onshore wind and 8-9 cts€/kWh for PV, making these renewables cost-competitive with conventional energy sources for new investments (Pescia & Graichen 2015: 5). The EEG is widely considered to have been so successful in enabling new renewable generation – partly because of the 'risk-free' nature of the FiT design underpinned by the guaranteed return and priority access rules (ibid; Toke & Lauber 2005; Mitchell et al 2006). The determination to keep risks to a minimum has translated into very knowable schedules of costs and return for small-scale producers – allowing them into a market that might otherwise be dominated, as is the case in Britain, by large-scale generators. Hence the term 'the people's Energiewende', albeit generally speaking the people that can afford to become household producers have often been middle class or farmers (Borchert 2015).

Remuneration rates for renewable generators have been amended several times to reflect changing cost structures for wind and PV, but also to reflect other changes to electricity markets. The most significant policy changes for wind and PV generators were the introduction of 'Direct Marketing', in 2012, and the quite comprehensive changes announced in 2014 to the EEG, often referred to as EEG 2.0. Direct Marketing gave generators of renewable electricity the option to market electricity themselves on wholesale markets. Using this route to market means that a generator does not receive the fixed FiTs paid under the EEG but they instead claim a market premium (Marktprämie) in addition to the revenue obtained on wholesale markets (Lang & Lang 2015a). Once operating within the market premium system, however, generators become responsible for future production forecasts and for balancing any differences (BMWi 2014a: 19). This includes developing methods of forecasting the weather as accurately as possible (Interview 24).

The 2014 EEG remuneration changes were quite substantial – in particular for PV. For example, in 2013, small rooftop remuneration was 19.5 cts€/kWh, but this changed in 2014 to 13.1 cts€/kWh, with larger PV at 9.2 cts€/kWh (Appun 2014). New rates for other renewables, as of 2014 are as follows:

- Onshore wind: new generation to receive between 6 and 8.9 cts€/kWh, depending on local wind conditions (making up for variability between locations);
- Offshore wind: facilities that become operational before 2020 can choose between a fixed payment of 15.4 cts€/kWh for 12 years; or 19.4 cts€/kWh for eight years (reduced to 18.4 cts€/kWh from 2018). After this period, the basic reward is reduced to 3.9 cts€/kWh, depending on distance to shore and depth of the sea.

EEG 2.0 was significant also in that new remuneration rules were set for renewable generators, above a certain size, along the lines of contracts for difference instead of the fixed FiT system. Those generators funded via contracts for difference (CfDs) will be expected to take more market risks and to 'professionalise' (Tisdale 2014; Julian 2014). EEG 2.0 also made Direct Marketing compulsory for most renewable generators. In addition, in order to better control the rate of growth in renewable generation, especially PV, the BMWi has announced annual capacity corridors (Ausbau Korridor) for PV, onshore wind and biomass growth through to 2020. Once the annual cap for each technology has been reached no further installations will receive remuneration (Appun 2014: 1). These changes were made in response to claims that renewables had expanded too quickly, leaving other parts of the system, not least distribution, needing to catch up, whilst subsidy costs and electricity bills were also rising too quickly. Further details of the EEG, of the 2014 amendments, and their potential implications for the distributed nature of renewable energy can be found in section 4.1.

Like in GB the German power generation market has been dominated by an oligopoly of large utilities, but only since liberalisation in the late 1990s when many municipal utilities were bought out and the 'Big 4' created (Thalman 2015c: 1; see also Burger and Weinmann 2014). The 'Big 4' consists of RWE, E.ON, Vattenfall and Energie Baden-Württemberg AG (EnBW) and their market dominance has applied much more in the case of generation than of supply. In 2010 they collectively produced 90% of Germany's power generation (Möller 2010: 24), but by 2013 this number had reduced to 67% (BNetzA 2014: 12). In 2013 RWE was by far the largest power generator with 29% of the market, followed by Vattenfall at 16% and EnBW E.ON with 11% (BNetzA 2014: 27). According to one interviewee the market dominance of the Big 4 is continuing to fall because of company restructurings, nuclear decommissioning, and attempts to sell traditional (non-renewable) generation assets (Interview 20).

Notably all of the Big 4 have been losing generation market share and now have dramatic commercial problems: the decision to phase-out nuclear has had a particularly significant impact on them, but they were all latecomers in terms of investing in renewable generation, and falling wholesale prices are also having a clearly negative effect (BNetzA 2014: 29; Lauber and Jacobsson 2015: 17; Schuppe 2015a; Thalman 2015c; Interview 3). One oft sighted reason for not investing earlier in renewables is that the sector was considered too small scale and not large enough to make a difference to their traditional utility business model (Interviews 3, 13 and 14). The traditional utility model was not only based on centralised generation, but also on investments of sufficient scale to make a discernible difference to the bottom line of these large companies (Thalman 2015c: 1). In the 2000s the Germany utilities had chosen to invest in non-renewable generation assets, often abroad, in the expectation of higher returns than the 7/8% expected in German renewable investments but some of these investments had, later, to be written off (Interviews 4, 5, 17 and 18). As a collective group they have lobbied strongly against various Energiewende decisions and policies (Jacobsson and Lauber 2006). This type of relationship between the German government and the big energy utilities is in marked contrast to that between the UK government and the 'Big 6' where various energy policy decisions (including the type of support structure for renewable generation) have favoured the traditional utility over more progressive generation models (Mitchell et al 2006; Kuzemko 2015c).

The Big 4 traditional utilities are currently in a process of restructuring – arguably led by E.ON which has announced that from 2016 it will be spinning off its fossil fuel and nuclear generation and focusing on 3 new 'pillars': distribution (E.ON currently operates about 19% of Germany's power distribution network); renewables and customer services and solutions (Interview 15). E.ON had been hit hard by the decision to phase out nuclear given its heavy exposure (53% of its German power output in 2013 was still nuclear) (Appunn and Russell 2015: 1). In 2014 E.ON reported losses of €3.2bn which it put almost entirely down to the decimation in value of traditional generation assets in Germany (Reuters 2015). In order to bolster its exposure to 'new' energy markets it will continue with strategic co-investments in start-ups globally and integrate innovative companies into the new business. However, to reach sufficient scale and for innovative businesses to have a real impact on its business model it will need to invest in a large quantity of new ventures (Interview 15). E.ON started to invest in renewables in 2007 and renewables represented 8% of their generation mix in 2013 (Appun and Russell 2015: 1 and Interview 15).

As already mentioned, in addition to the nuclear phase-out decision Germany has already started its coal (lignite) phase-out programme – albeit very slowly and with greater compensation for utilities than was the case for nuclear. Although all of the Big 4 have reasonably large exposure to coal, Vattenfall together with RWE are the main producers of electricity from coal (lignite) and they also own lignite mines (Interviews 3, 5, 17, 18 and 19). Vattenfall are owned by the Swedish state and, in accordance also with Swedish energy and climate commitments, they have announced their intention to sell all of their German coal generation assets (89% of their German power generation comes from coal). Vattenfall and RWE, together with some coal unions, lobbied strongly against the first coal phase-out plan (the Klima Levy) and with some success given what some see as reasonably generous compensation (reserve capacity) payments (Interviews 17, 18 and 19; Kuzemko 2015b). Vattenfall, as is the case with the other Big 4, are now focused on offshore wind in terms of current and future renewable generation investments in Germany, and there is some feeling that German support for offshore wind is one way of preventing these large utilities from going bankrupt (Interview 13).

As such, although the government's stance in support of (distributed) renewable production has resulted in extremely difficult market conditions for the utilities there seems to be some reluctance to allow them to collapse completely – see section 4.1. This reluctance may be related to energy security objectives but also to the fact that two of the Big 4 are all, or part, owned by German municipal investors (Interviews 13 and 15). EnBW is 100% owned by municipalities (Interview 5); and RWE is part owned by various Cities and municipalities including the State of North Rhine Westphalia's 20% stake (Interview 13).

There are around 900 municipal energy companies, called *Stadtwerke,* most of which are involved in power and heat generation, supply and distribution, and some are also involved in waste services, water services, gas supply, transport and broadband internet (often following a 'multi utility model'). As much as some municipalities have investments in some of the Big 4, so too are some Stadtwerke owned, or part-owned, by the Big 4. Although, as a collective group, Stadtwerke market share in electricity supply is 46%, their generation market share is much lower at 12% (Schlandt 2015: 1). Prior to liberalisation the Stadtwerke had operated according to the 'territoriality principle'. In the immediate post liberalisation phase many predicted that Stadtwerke involvement in energy would become a thing of the past, and many were bought out by private companies (Eberlein 2007). However, this now appears not to be the case and some municipal utilities have recently been renationalised as councils and citizens have voted not to renew their contracts with private companies (Schlandt 2015). Growing interest in municipal energy has been underpinned by German Federal support for distributed renewables, and in 2013 13.5% of Stadtwerke power generation came from renewable sources with a further

44.4% coming from energy efficient CHP (German Association of Local Utilities in Appunn 2015; Russell 2015: 2). Many Stadtwerke also have CHP assets connected to district heating (Interview 3), and some, like privately owned innovators such as Lichtblick, have been developing new business models that better incorporate CHP using smart grids and data to provide better supply flexibility (Julian 2014).

Given that the IGov definition of demand management includes distributed renewable energy, and associated attempts to create local markets, it is worth also noting here that Stadtwerke, in addition to electricity supply and generation, tend also to be increasingly invested in distribution networks (Buchan 2012: 9; Interview 5).[11] There have been some very high profile cases of citizens voting in elections for Cities and other municipalities to take back contracts for distribution (see for example current attempts to repurchase distribution in Berlin). Currently over 860 Stadtwerke own and run local electricity distribution grids with 600 of them doing the same in gas (Buchan 2012: 9). Although Germany has a long history of municipal service provision, including energy services, the municipal movement is seen as having been re-popularised. This reflects some cultural preference for local over national service provision, and for energy 'owned by the people' (Bürgerenergie) (Interviews 4, 5, 6 and 13), and a desire to keep the benefits of energy systems local thereby allowing for municipal investment in other local services such as libraries and swimming pools (Interview 5). It should be noted, however, that energy remunicipalisation efforts take place within the broader context of a general utility remunicipalisation movement that also includes a number of water infrastructure repurchases (Beveridge and Naumann 2014).

The other significant change in generation markets is the already mentioned rapid growth in citizen (prosumer) and community ownership of renewable generation assets, which has been facilitated by the design of the EEG (see section 3.2), but also by the wider 'People's Energiewende' movement. The historical context here is of collective civic action going back to Germany's pre-20th century structure as a collection of city-states, indeed rural co-operatives were largely responsible for bringing electricity to the countryside (Buchan 2012: 10). In 2013 46% of renewables were owned by citizens, 41% by institutional investors and 12.5% by the big energy companies (Borchert 2015). Citizens include private households (there are now over 1.5 million PV households), and local and regional citizens' energy cooperatives, including the Baugruppen that use off the shelf contracts to buy land and build collective renewable generation (ibid and Interview 21). Citizens can join a co-operative for between €100 and €500 (Buchan 2012: 10). Individual household generation, if used onsite, can benefit from 'self-

[11] The applicable unbundling rules are such that companies need to hold distribution and supply assets in legally separate divisions.

consumption' privileges including steep discounts on EEG and grid fees (BMWi 2015e: 16). For more information about the governance of, prospects for and issues around distributed energy (and local markets) in Germany see section 4.1.

2.4.2 Transmission Networks

As in Britain, transmission and distribution electricity networks are increasingly considered vital to an integrated energy system transition and they are also regulated businesses, with set formulas governing revenues and profit potentials. There are further similarities in that transmission companies are also system operators and in that it is felt, by most progressive energy policy analysts, that much still needs to be done with networks to enable better system integration (Interviews 19 and 25).

There are also some important differences, however, not least because Germany has 4 electricity, and 18 gas, transmission owners/system operators. Germany took a particular approach to liberalisation in that it did not restructure the gas and electricity sectors through structural unbundling prior to liberalisation, and also did not create a national pooling system or grid (Eberlein 2007: 91). The 4 electricity TSOs together make up the German interconnected system, which is also connected with 9 other Northern European electricity grids (Amprion 2015a). The 4 electricity TSOs are: 50 Herz (ex-Vattenfall, now owned by a Belgian state-owned company Ilea); TenneT (ex-E.ON, now a Dutch, state-owned company); Transnet BW (ex-EnBW); and Amprion (ex-RWE, who maintain a shareholding) (Appun 2015). Interestingly, the split between TSO areas still reflects the post WWII Allied occupation zones (Interview 20).[12] In 2009/2010 the ownership structure of the grids changed as most of the Big 4 divested themselves of grid assets (Möller 2010: 24; Fuchs et al 2013: 21), with the exception of EnBW which still holds a majority shareholding in Transnet BW.

Prior to liberalisation TSOs were regulated at the Land level, with the shift to Federal level regulation taking place in 2003. Most of the rules governing the transmission system are set out in EnWG 2005 and 2012, and in the associated Electricity Network Access Ordinance (StromNZV) and Electricity Grid Access Charges Ordinance (StromNEV) (Regelleistungs.net 2015). The principal point of governance contact for all TSOs, electricity and gas, is with BNetzA which has been responsible for setting the revenue-cap network pricing formulas (BNetzA 2015b), and for driving forward the extensive (and contested) nation-wide grid expansion and improvement programmes (Power Grid Expansion Act (EnLAG)). Also involved in TSO governance is the Bundeskartellamt (BKartA) as well as the EU regulator ENTSO-E.[13]

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[12] For a brief synopsis of the development of the interconnected German, and Northern European, electricity grids see Amprion 2015a.

[13] The ENTSO-E 'Continental Europe Operation Handbook' containing the full range of rules for transmission operators can be found here: https://www.entsoe.eu/publications/system-operations-reports/operation-handbook/Pages/default.aspx

TSOs are responsible for the reliability, balancing, operation, planning, modernisation and expansion of transmission networks and they recoup their investments through regulated network charges which are socialised through customer bills (Interview 1). In terms of reliability it should be noted that, despite rapid growth in renewables, the German power grid ranks amongst the most reliable in the world. Indeed, in 2012 it suffered one quarter of the disruption of the UK, and in 2013 disruption numbers improved again (Appunn 2015a), albeit curtailment rose in 2014 due to rapid increases in offshore wind generation (Morris 2015e).

In 2005 the legal framework, under EnWG, was changed to abolish the system of cost-plus regulation for electricity and gas network operators and it was replaced with the Incentive Regulation Ordinance (ARegV). The mechanism is calculated on a regulated rate of return (totex) basis, on the assumption of a 9% cost of capital, and is reviewed every 5 years (Lang & Lang 2015b). Each TSO may decide tariffs levels (subject to a non-discriminatory clause) as long as total revenues come in within the cap. Some interviewees have suggested that the UK's RIIO (performance based regulation) is more advanced than the current German incentive regulation model in terms of incentivising modernisation (Interview 19). The need for improved incentives seems to be broadly recognised given that the emphasis on capital expenditure tended to reward expansion rather than whether grids are becoming 'smart'/more *energy* efficient or not (Interviews 11, 14, 19, 24 and 26). In 2015 a 'Modern Regulatory Framework for Modern Distributed Networks' amendment to the ARegV was announced, which included five suggestions with a particular emphasis on improving energy efficiency, and is still under discussion (Lang & Lang 2015b). The review of TSO regulation is still ongoing (as of February 2016).

The connection of power generation to the transmission grid is regulated by the Generation Interconnection Regulations (2007), under which network operators are required to connect, and grant non-discriminatory third party access to their infrastructure. Mandatory access is qualified by technical impossibility or economic unreasonableness (AIIFL 2013: 10). As this is an interconnected system there is a requirement for the 4 TSOs to coordinate closely (Interviews 7 and 11). One TSO, Amprion, has a more important role in that it coordinates the pluralistic load and frequency control for the 4 German control areas (Russell 2015: 2). It is also responsible for the coordination of exchange programmes and subsequent system accounting both for the entire German transmission grid and the northern part of the European UCTE interconnected system (Belgium, Bulgaria, Germany, The Netherlands, Austria, Poland, Romania, Slovakia, Czech Republic and Hungary) (Amprion 2015b).

Each TSO is responsible for maintaining the balance between electricity generation and consumption within their own control areas at all times, and to provide balancing energy to the balancing groups (electricity producers and consumers) (Amprion 2015c). To do so they need different types of control reserve (primary, secondary and tertiary/minute reserves – as laid out in section 2.3.2) (Regelleistung.net 2015).[14] The German TSOs now operate under a joint control reserve procurement system. Since 2006 the minute reserve required by the 4 TSOs has been procured via joint tender and, for this purpose, the common TSO platform, Regelleistung.net, was established. In 2007 joint tender for primary and secondary control reserve was introduced which is also processed via the Regelleistungs.net platform (ibid). Under StromNZV, as of 2012, each TSO must guarantee that a certain amount of technically required control reserve (the 'core portion') will be available within their control area in the instance of grid disturbances. The TSOs organise a monthly tender for a total capacity of 3,000 MW of interruptible load (TenneT 2016). Sitting behind these platforms and markets is the 'Grid Control Cooperation' (GCC), which is a network control concept through which the 4 TSOs optimise their control energy use and control reserve provision through an intelligent communication between the load-frequency controllers of the TSOs.[15]

TSOs have further responsibilities in connection with the operation and management of renewable generation under EEG law. In essence they have been the administrative linchpin of the renewable subsidy system, not least in that they have been responsible for paying renewable generators the relevant FiT amount for their electricity, which they then sell on the wholesale markets and make up the difference by collecting the renewable surcharge from consumers (Buchan 2012: 11). The volumes sold by TSOs on power exchanges is already starting to diminish as direct sales, under the new Direct Marketing rules, start to increase (BNetzA 2014: 15). They have also been obligated to connect renewables to the grid as well as being responsible for re-dispatch in the event of grid bottlenecks, at which time conventional plants are first advised to reduce production and if that doesn't have the desired effect renewable generators are then asked to reduce production (BMWi 2014a: 12). If required to reduce production the generator receives compensation the costs of which are also redistributed to consumers through network charges (in 2013 redispatch cost €115m) (ibid). Despite priority access under ENSO-E UCTE transmission codes some amendments have been made to allow grid transmission operators the right to refuse access in the case of network constraints (Interview 11).
TSOs trade power with one another for technical/balancing reasons, but they have also been obliged to trade renewable power due to EEG law. This is partly due to the fact that every customer across Germany has to pay the same level of EEG surcharge tariff, has to have the

[14] Details of the tariff system for the settlement of imbalances is available here: http://www.amprion.net/en/control-energy
[15] For more information about how the GCC works please see here: https://www.regelleistung.net/ext/static/gcc?lang=en

same proportion of renewables, and of different forms of renewable energy sources (RES), in their overall electricity portfolio (Buchan 2012: 19). Clearly, however, different types of renewable generation tend to be based in different regions: offshore wind is all based in the North and there is more solar power in the South. For example, 50Hertz has 42% of total (mainly onshore) wind capacity and 30% of total renewable capacity, but only 20% of the country's total electricity load (demand) (ibid). If customers in the 50Herz had to cover the EEG surcharge associated all the renewables generated in that region they would pay a disproportionate proportion of the nationalised EEG cost. Because of this extra trade the money TSOs manage far exceeds their turnover as grid operators. To use the example of 50 Hertz again, in 2011 they had a grid operational budget of €570m but it managed a financial flow in EEG payments and subsidies of €4.4bn (Buchan 2012: 20).

In governance terms, some suggest that there has been too much focus on greening generation and not yet enough on improving grids to provide for system integration and demand management (Interview 12). The recent expansion of offshore wind in TenneT's area, combined with the decommissioning of nuclear plants in the South, has led to a requirement on TSOs to build new transmission networks to connect production in the North with demand in the South (Appun 2015). At least every 3 years BNetzA submits a grid development plan and an environmental sustainability report, as required under the Environmental Impact Assessment Act (UVPG), to the Federal Government to be used as a basis for BMWi to produce draft grid legislation. So far, 50Hertz and TenneT have been most affected by expansion requirements (Interview 26). TenneT, who were recently required to connect considerable new quantities of offshore wind, did not initially have the financial capacity to do so (Interview 26), and TSOs are generally understood to be not very well capitalised. It is estimated, by BNetzA, that 2,650km of new power lines will be needed by 2023 (Appunn 2015). If new lines cross Land borders then the Federal Government and BNetzA are responsible for deciding the corridors for new cables, if not this decision is taken by Land authorities (Russell 2015: 4). Each TSO must now also invest more time in co-ordination and long-term planning, not least in the form of developing 10-Year National Demonstration Plans and greater co-ordination with 40 other EU TSOs (ibid). Much of the legal basis for these new responsibilities can be found in the 2009 Power Grid Expansion Act (EnLAG), the 2011 Grid Expansion Acceleration Act (NABEG), as well as the EnWG of 2011 (BNetzA 2015c).

Despite the fact that the Federal Government made grid expansion a priority, there has been considerable opposition to new transmission grids, from local populations most effected as well as from Land governments (especially Bavaria), as well as considerable delays in grid expansion (BNetzA 2014: 13; Appun 2015). The longstanding dispute over the North-South grid expansion has only recently been settled (Reuters 2015; Guardian 2015a). There have been some arguments in favour of a partial re-nationalisation of the power grid based on the assumption that there will be less opposition to expansion if the proceeds return to the public purse (Dohmen and Traufetter 2013). On the other hand, however, some more progressive energy groups have questioned whether such considerable high voltage grid expansion is necessary – especially under conditions of Direct Marketing and potentially greater regional generation and use of electricity (Russell 2015). Further discussion of governance for and remaining issues around grid improvements to better distributed energy, local energy markets and the integration of flexible demand will be covered in section 4.1.

2.4.3 Distribution Networks

Partly because of Germany's municipal electricity history 98% of the electrical network is made up of low voltage distribution grids (BNetzA 2014: 18; Julian 2014: 6). This is a very fragmented market: in 2013 there were 884 distribution system operators (DSOs), with numbers growing slowly, of which 812 had fewer than 100,000 connected customers, 75% supply less than 30,000 metering points, and 88.4% have networks of under 1,000km in length (BNetzA 2014: 19 and 188; Bayer 2015: 9). BNetzA has overall responsibility for the regulation of DSOs. However small DSOs, with under 100,000 customers and/or whose networks do not cross Land borders, can be regulated at the Land level. 11 Länder have maintained regulatory control over small DSOs, whilst 5 have delegated responsibility back to BNetzA.

Another striking feature is that local networks are largely still integrated and many DSOs are also suppliers (Interview 19). The EnWG 1998 removed the Stadtwerke's previous territoriality principle, and in 2005 according to EU anti-trust law Stadtwerke were required to legally unbundle retail (supply) from distribution (Julian 2014: 12). However there is an exemption from the statutory provisions on legal and operational separation of network and retail businesses that applies to DSOs with less than 100,000 connected customers. In Germany 90% of electricity (and 95% of gas) DSOs fall under this 'de minimis' rule. This means that distribution and supply businesses can belong to one owner but operations (staff) and information must be unbundled (EC 2014: 91; Bayer 2015: 8). The Big 4 still operate a significant portion of the distribution grid through concession contracts with municipalities. Under these contracts municipalities rent out their distribution franchises for up to 20 years, but under the EnWG the concessions can be renegotiated according to non-discriminatory rules. As we have already seen, in section 2.3.1 on generation, Stadtwerke are increasingly taking over DSO concessions as contracts come up for review (Bayer 2015: 8).

In addition to unbundling there are two other main strands of DSO governance: revenue cap regulation and the drive to improve distribution infrastructures so that DSOs can perform more complicated (smart) functions within the Energiewende (BNetzA 2011). The distribution network has been central to the transition to renewables given its role within the EEG and with 98% of local renewable power generators connected to the distribution grid (Russell 2015: 3), albeit with the advent of Direct Marketing DSOs formal function is being reduced (Interviews 18 and 25). DSOs are responsible for working out network demand charges, which are set on average each year, and suppliers can't go over the agreed peak or risk facing fines (Interview 18). Grid fees paid by all customers (except household) are also based on demand peak and they therefore tend to keep below peak (Interview 19).

DSOs have been instructed, by Federal government and BNetzA, to strengthen the 'intelligence' of their networks and make more technical improvements to enable and monitor 'reverse' flows of power (Energy Transition 2015b). Some have upgraded their analytical tools to become better at day-ahead weather forecasting to improve predictions of amounts of wind and/or solar electricity coming onto the grid (Interview 24). However, partly because this is such a fragmented market and partly because levels of renewable generation differ greatly according to DSO area, upgrades and improvements have so far been patchy. Indeed, DSOs as a group are sometimes considered as less than capable of innovation and/or as a block to efficient integration of renewables (Energy Transition 2015b; Interviews 19 and 26).

A further complicating factor has to do with split regulation between Land and the Federal regulator, according to company size, but also some developments of the distribution grid are subject to local (Land) regulations and other requirements (Russell 2015: 3). Various interviewees highlighted a lack of transparency in DSO financial reporting, claiming that revenues may be higher than they should be, as well as a degree of regulatory capture (Interview 19, 25 and 26), with clear implications for costs born by those customers that pay grid surcharges and in the light of escalating electricity prices. Alongside calls for greater transparency of distribution network costs, some have also expressed the view that unless they improve DSOs should be increasingly bypassed (Clausen & Jahn 2015; Interviews 19, 25 and 26).

This view of DSOs is in sharp contrast to the potential held up for DSOs elsewhere (see Mitchell 2016) as linchpins of distributed, demand focused energy services. This is also not to say that there is no progress in Germany – indeed there are pockets of real innovation where DSOs do act in conjunction with other electricity and heat infrastructures to facilitate local markets. The community movement, as already mentioned, is very strong in Germany and there is also a continuing movement by Stadtwerke to provide full local energy services. By the end of 2012, 190 communities had been successful in bidding to run their local grid – a movement sometimes referred to as 'Rekommunilisierung' (re-communalisation) (Julian 2014: 13; see also Buchan 2012: 12). One of the most oft-cited examples is Elektrizitätswerke Schönau which is a clean energy co-operative which purchased the local grid from the incumbent utility in the 1990s and which now offers consultancy advise to other municipalities seeking to follow suit. Municipal takeovers can also take place on a large scale as seen when the citizens of Hamburg voted to remunicipalise electricity, gas and district heating distribution grids (Land & Lang 2013), and in (still ongoing) attempts to do the same in Berlin. For more information on DSOs, communities and their role facilitating local markets see section 4.1.

2.4.4 Suppliers, ESCOs and Aggregators

Gas and electricity supply markets in Germany, as in generation, have evolved quite differently to Britain. For example there are greater numbers of innovative market entrants and supply markets are more localised with more municipal utilities supplying local areas. This is partly because during the post-war era German governments tended toward decentralisation and gas and electricity sectors, unlike France and the UK, were not nationalised during this time period (Julian 2014: 4). Indeed, it has only really been since liberalisation that national scale gas and electricity companies started to become influential in supply and generation markets (Burger and Weinmann 2014; Julian 2014).

In governance terms, liberalisation was enabled and maintained in Germany through the introduction of the Energy Industry Acts of 1998 and 2005 (EnWG). The 1998 Act was implemented partly to enforce new EU rules on unbundling, and suppliers had previously been exempt from the general prohibition on cartels (Brunekreeft & Keller 2000). The EnWG also lays out the terms and conditions for interactions between suppliers and other areas of the gas and electricity system: generation, distribution and transmission in particular. Partly because this is a fragmented market, and many suppliers are small companies, it has not been considered practicable to have a supplier obligation (Interview 25). Under section 40(5) EnWG suppliers of electricity must offer final consumers load-based or peak/off-peak tariffs in particular, if this is technically feasible. During the 2013 reporting period only around 10% of suppliers offered load-based tariffs, whilst 76% offered peak/off peak tariffs (BNetzA 2014: 143).

According to the regulator in 2013 there were 1,160 electricity and 780 gas suppliers in Germany (BNetzA 2014: 29 and 192), and consumers can chose between an average of 80 (for households) and 97 suppliers in each network area. Gas and electricity retail markets are largely considered to be functioning and competitive (BNetzA 2014: 16). The Big 4 electricity suppliers, E.ON; EnBW; Vattenfall and RWE, had 43.8% market share of the retail electricity market in 2013, and 34% of industrial and commercial customers (BNetzA 2014: 16). For gas the largest 3 companies (Gazprom Wingas, E.ON and EmBW) had 33% and 22% market shares of metered and non-metered customers respectively, also in 2013, whilst municipal suppliers held 31% of metered and 53% non-metered consumer market shares (ibid: 192).

Only 21% of electricity and 13% of gas household customers had switched away from their default provider in 2014, whilst switching rates for commercial and industrial customers are 12% per annum.[16] BNetzA are reporting increasing rates of switching across markets - in household, commercial and industrial customer segments (ibid). One explanation given for household customers, and to an extent small and medium sized enterprises (SMEs), remaining with default, municipal providers is that many want expenditure on electricity and/or gas to remain in the local area as those monies can then be invested in other local services through the municipal authority (Interviews 19 and 21). There is also notable sentiment against large, national scale energy companies and generalised preferences for local service provision (Interviews 4, 6, and 19). Indeed, many municipal companies explicitly differentiate themselves through 'local' area branding (Interview 14).

Traditional gas and electricity suppliers are under pressure and margins are low for suppliers and there is no longer much margin available in supplying industrial and commercial customers (only SMEs) (Interview 21). However, default suppliers, often Stadtwerke, can make a better margin out of default gas and electricity contracts because prices for a default tariff are approximately 10% higher than flexible or fixed term contracts. The EnWG 'de minimus' unbundling exemptions, outlined in section 2.4.3, apply to over 700 DSOs which means that these companies can own supply and distribution (Interview 19). For those companies falling supply margins can be supplemented by distribution income, given that margins are higher and predictable here (Interviews 3 and 19).

Although the cost of electricity in wholesale markets has been falling, for household supply so much of the tariff is made up of non-controllable (network and policy) costs that it has become hard to compete on price (see Möller 2010: 24). Predictions are, however, that the cost of sourcing power for energy suppliers (the sum of EEG surcharge and the price on the power exchange) will remain relatively constant between 2015 and 2035 (Agora Energiewende 2015).

Because of the rate at which new supply and generation actors have entered German electricity markets some scholars have characterised the German transition as one based on 'unleashing new entrants' (Geels et al 2015; see also Schuppe 2015c). In Britain, by contrast, the transition is characterised as one based on government 'working with incumbents' to drive change and various rules and regulations make it very difficult for energy start-ups (Kuzemko 2015c). In Germany the rules governing suppliers have not acted as a barrier to entry to small and innovative new actors, although some rules around ancillary market access are an issue for aggregators (Interviews 1, 3, 10, 13, 16, 19, 21 and 25).

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[16] The proportion of heating currents household customers with a supplier other than the local default supplier was 2% in 2013 (BNetzA 2014: 17).

For example, there are only two pages within the EnWG that refer to requirements for companies seeking to establish a traditional supply operation – as opposed to corporate licences in Britain which are hundreds of pages long and imply a large initial financial and operational commitment (Interviews 19, 21 and 25; Kuzemko 2015c). In Germany a start-up just needs a standard business case (which is often an off-the-shelf contract) and a permit with BNetzA. In the application to the regulator an electricity supply company needs to demonstrate that it has the technical and commercial capacity to provide secure services and to comply with minimum standards required by BNetzA (AIIFL 2013: 13). In practice this amounts to: i) announcement of the intention to supply to households; ii) provision of the name of company (the regulator publishes a list of all suppliers); iii) a description of company competences (staff should include someone who knows about electricity supply, consumer rights, IT and/or finance - with information linked to CVs) (Interview 19). The BNetzA can limit the business if it does not consider it sufficiently competent, and suppliers do not need a licence for industrial supply (ibid). In addition, if a supplier or generator wants to be a BRP they also need a contract with the relevant TSO which sets out the terms of use of the grid and of balancing responsibilities (Interview 3).

The main administrative barrier to energy is usually associated with establishing the contracts with DSOs. A DSO contract, called a Lieferanten Rahmen Vertrag (Supplier Framework Agreement), is about 30 pages long and requires suppliers to have certain IT competencies, i.e. they must have an 'online' platform (Interview 21). In instances where this is too high a hurdle companies looking to start-up can establish themselves via a different route, for example under a white label contract, until they are ready to move out (Interview 21). Indeed, because so many suppliers are small, sometimes with as few as 5 to 10 employees, there is quite an established market for outsourcing of gas and electricity supply services (Interview 25).

This market for outsourcing, portfolio management and consultancy services is, indeed, where many new supply market entrants have been establishing themselves although many, like GETEC, Lichtblick and Grundgrün, tend to have multiple market offerings. Outsourcing and consultancy services include IT and/or procurement, 'off the shelf' white label and co-branding contracts (for business-to-consumer and business-to-business markets). There are quite a few other business strands for new suppliers: supply of 'green' electricity, direct marketing of renewables, and grid access and balancing responsibility services, remote controllability and aggregation (Interviews 21 and 25). There are roughly 25 supply service providers operating in Germany, for example Rhenag (focused on IT) and the innovative municipal Schwäbisch Hall (Interview 25). One of the main criteria for success here is to, unlike the Big 4, remain flexible and have the ability to offer new products as markets are expected to change a few more times over the coming decades (Interview 21).

Because of the popularity of municipals, and because the supply market for ‘green’ electricity is reasonably established, price is not the only successful method of competing for traditional supply customers. There is a comparatively large customer base for green energy, in 2013 17% of all consumers purchased ‘green’ electricity (BNetzA 2014: 17), but price still remains important as a possible point of differentiation (Interview 25). Within the green electricity supply market some companies, Lichtblick and Naturstrom, tend to offer ‘guarantees of origin’ to customers but the physical path is not green because much renewable electricity is connected to the grid along with other forms of electricity and hard to differentiate (Interview 25). These companies purchase the ‘guarantees of origin’, which are traded separately from electricity Europe wide, and they are still cheap to buy because demand for them never really grew as anticipated within Europe (ibid).

Other companies, such as Grundgrün, buy direct from and have fixed contracts with renewable generators (such as wind farms) and in this way can specify that the electricity supplied is green (ibid). This green electricity can be sold onto the energy only market, or direct to customers, and Grundgrün’s claim is that 95% of their electricity is delivered within 15 minutes of it having been produced. In order to be successful here Grundgrün have had to develop multiple relationships with renewable generators and an IT company that specialises in forecasting of renewable load and in trading (Interview 25). Opportunities for purchasing direct from renewable generators have grown since amendments were made to the EEG in 2012 and 2014 to enable direct marketing of renewables. Under pre-2012 EEG rules, and prior to Direct Marketing, renewable generation entered into the market through a central system whereby most renewable generators feed into the wholesale market via the 4 TSOs (Julian 2014: 15). When first introduced as part of the 2012 EEG amendment Direct Marketing was voluntary, but it will be compulsory, under EEG 2.0, for most plants that started operations after 1 August 2014 (Lang & Lang 2015d). Direct marketing is also seen as a necessary market structure for the renewable generators that will start falling out of the EEG system as of 2018. There are quite a few companies offering Direct Marketing services to renewable generators, including Grundgrün, GETEC, Licktblick, Sunnic and most of the Big 4 – but margins here are low as the business model basically consists of predicting (weather) and selling onto exchanges (Interview 14).

Direct marketing of renewable electricity is, however, also seen as one element of how energy markets are becoming more localised (Julian 2014: 15; Grundgrün 2015). Many companies seeking to become more involved in localising distribution and supply are municipals and some, like Schwäbish Hall, are progressing their own models through ownership of generation (renewables and CHP), distribution grids and efficiency services (Hockenos 2013). Some new market entrants, like Grundgrün, are working towards facilitating localising distribution and supply as one route towards better integrating German heat and electricity markets (and reducing electricity that moves across grids). Grundgrün has recently established a new 'regional business model' where electricity producers, and other companies such as property managers, can launch their own regional power brand through co-branding with Grundgrün (GG 2015a). Grundgrün will manage the entire process, offer customer support and supply all or part of the power, while dealing with risks and other constraints. According to Eberhard Holstein, founder and CEO of Grundgrün:

By agreeing to match the feed-in time and quantity to regional consumption, our generating partners GreenTEC Campus and BürgerGrünStrom are helping us to prove that the energy transition can be a success for everyone involved at every level – from generators to consumers (Grundgrün 2015a).

Some of the new, innovative market actors, such as GETEC, are also ESCOs focused on specific energy efficiency 3rd party services. This is already a big market in Germany, worth approximately €5bn with around 500 companies including the Big 4 (Interview 3). ESCOs are also often owned by technology companies looking to increase sales of their products, for example boilers, and or by small electricity/gas providers (ibid). The broader context here is the degree to which governance decisions have specifically be taken in order to enable and support business development around low carbon sectors such as efficiency (see BMWi 2014c). Section 4.3 provides more detail on low carbon industrial development strategies and how they provide conditions conducive to new efficiency business model development.

ESCOs have also branched out into offering new services. MVV (Mannheim), operated mainly as an ESCO for 10 years, but now also offers household aggregation services and decentralised 'virtual power plants'. These services are offered in conjunction with companies, such as General Electric (GE), that are seeking to underpin sales for their low carbon product base. The 'virtual power plant' brings together owners of renewable generation assets with flexible power consumers to create markets at the aggregate level (see Schuppe 2014c; Lichtblick 2015). One of the best-known new business models here is that of Lichtblick**,** the green electricity and gas supplier, who developed the SchwarmEnergie-concept in order to cope with the requirements of a fragmented and decentralised electricity market. It is also based on the notion that strict separation of consumers and producers is going to be superseded if markets continue to develop along current trends (Schuppe 2014c; Interview 18). The basic idea is to interconnect thousands of involved small-scale market players by means of appropriate smart control systems and software that can quickly rewire and provide a "virtual power plant" at an aggregate level (see Figure 4 below), with a pilot scheme already rolled out.

Figure 5: Synopsis of the SchwarmEnergie Concept (*Lichtblick*)

Source: Schuppe 2015c

It should be noted at this point that a number of aggregators have raised some concerns with how aggregation is currently governed, although this subject will be covered in more detail in section 4.2. There are two aspects of governance that are seen to be acting as barriers to market entry and/or expansion: one is that the strict pre-qualification rules for taking part in ancillary service markets (Interview 25); and the other is the fact that aggregators are not separately categorised in German energy legislation (BNetzA 2015). It should also be noted that this rapidly changing supply and service industry forms a new political constituency in Germany, not least in the form of the politically active Bundesverband Neuer Energiewirtschaft (Association of the New Energy Industry). Such groups, with energy efficiency and renewable energy associations, together form a significant new forum for representing and further embedding the Energiewende in Germany (see also Section 3.5 on this point).

2.4.5 Consumers

This sub-section provides an introduction to consumers and their issues in two main parts – households (and SMEs) and large business and industrial customers. Indeed, the market fundamentals and the ways in which they experience the Energiewende are quite different for each group. One important differentiating aspect of how consumers experience the Energiewende is how much different consumer groups pay of system and other costs passed through their supplier bills. In order to understand how this works in Germany it is worth listing the many components of electricity tariffs that households, SMEs and many larger businesses pay that are not controlled by suppliers: net network tariff; charge for billing and metering; EEG and CHP surcharges; electricity tax; other surcharges; offshore transmission levies; and the concession fee (BNetzA 2014: 145). Together these can amount to over 70% of the price paid (ibid: 149; see also Thalman 2015a). What this means for many, especially households and SMEs that are not exempt from surcharge and grid fees, is that falls in wholesale prices have not resulted in lower bills and, indeed, due to rising EEG surcharges most electricity users have faced higher electricity bills over the past few years.

In 2013 the household category consumed 28% of power and also 28% of all gas volumes delivered by gas suppliers (BNetzA 2014: 185; Thalman 2015a). This category has faced steeply rising prices for electricity and, until 2014, also for gas. A ‘model’ 3-person household will spend €280 per month on energy, 37.6% of which will be petrol, 31.8% heating and 30.6% electricity (Thalman 2015b: 3). BNetzA’s 2014 annual monitoring report notes that, based on volumes, only 9.65% of household gas consumers switched supplier in 2013, but the bulk of this was associated with moving house. In the same year 26.5% of household gas customers remained on standard contracts with the default supplier, 59.6% had remained with the default supplier but on a new contract, and only 13.9% had switched away from their default supplier (BNetzA 2014: 244). Retail tariffs for household gas consumers are more weighted towards wholesale prices than electricity tariffs and this is because taxes and fees make up a lower proportion (approx. 47% in 2013) (ibid: 254). Indeed, gas prices paid in Germany, unlike electricity prices, are closer to the European average. It should also be noted that energy efficiency plays a part in making sure that heating households is affordable, whilst German social security pays the heating costs of those on welfare thereby avoiding unnecessary winter deaths.

With regard to electricity, in 2013 79.1% household consumers remained with default suppliers (with 34.1% on standard contracts) with the remaining 20.9% having switched away to a new supplier (BNetzA 2014: 138 and Interview 25). It is generally considered that switching is reasonably easy, there are price comparison websites in operation, and there are low levels of complaints about suppliers (Interview 25). Some interviewed claim that household consumers tend to remain with the default supplier because they are often the local municipal company and in this way any utility profits made stay local, whilst and Big 4 national companies are also less trusted (Interviews 4, 5, 6 and 8). It may also be the case that because the bulk of household electricity bills, as mentioned above, are not under the control of suppliers this dampens price competition.

The price paid for electricity by a ‘model’ family of three, with an annual consumption of 3,500 kWh, rose 70% between 1998 and the second half of 2015, which is partly because the EEG surcharge rose tenfold taking it to 21% of a household customer’s tariff (Thalman 2015b: 2). Although estimates show that 2015 household electricity prices will have fallen (for the first time in years) this trend may not continue. Estimates show that EEG surcharges will continue to rise between 2017 and 2023, at which point they are expected to start declining (Agora 2015a). Customers (mainly household) that have not been able to pay bills, including vulnerable users, fall out of ‘competition’ and must be served by the default provider (Interview 19), although there is also some welfare support covering electricity costs (Interviews 3, 4, and 6).

Although German households pay the second highest electricity price per unit (highest price is Denmark) electricity still represents about 2.5% of an average household’s disposable income, below the European average, and has stayed steady for some years now (Thalman 2015b: 2). This may be partly because energy efficiency, again, has a role to play here. Over the past 20 years household electricity demand has fallen 10% such that an average German household in 2011 used a third of the power of an equivalent household in the US, and less than other industrial countries like France, Britain and Spain (Thalman 2015b: 3).

Overall, however, rising prices remain a thorny issue in Germany and more research is now emerging about how the costs of the Energiewende are being distributed between consumer groups. This research reveals that those that can afford to invest in renewable generation, and who ‘self-consume’, have received EEG benefits but paid little or nothing towards surcharges or network costs because of exemptions (Bardt & Niehues 2012: 250). This unequal distribution of costs and benefits means that politics of Energiewende has been focused recently on issues such as ‘rich farmers getting richer’ whilst those that can least afford it paying a proportionally higher price. This, some fear, may lead to a broader questioning of the Energiewende (ibid). Indeed, some of the reasoning behind the quite dramatic changes to the EEG in 2014 was to start getting EEG surcharges under control. EEG changes, in turn, have implications for the rate of expansion of medium-scale solar and onshore wind generation, and possibly also for Germany's distributed energy revolution. All details on issues associated the politics of rising prices, EEG policy changes and implications for distributed energy can be found in section 4.1.

Like 'self-consumers' many commercial and industrial electricity consumers have also been exempt from various costs and charges, meaning that those that are not exempt must also pick up these system and transition costs. This, as with electricity markets in many other countries, is a question of scale and of paying less per unit according to size of demand. Large, interval metered consumers tend to switch suppliers and use their size to negotiate better deals – indeed in both gas and electricity markets only 1% of interval metered consumers have remained on default contracts (BNetzA 2014: 144 and 242), and many have the option to buy direct from wholesale markets. Clearly within the commercial and industrial category there are multiple sub-categories (BNetzA 2014: 143). 70% of all power is consumed by commercial enterprises and industry, which comprises less than 10% of those enterprises, consumes around 50% of that total (BDEW in Thalman 2015a). There are a range of possible exemptions with the most intensive users having been exempt from EEG surcharges; grid fees; electricity tax; the concession levy; and the CHP surcharge. What this means is that the prices paid vary considerably within the commercial and industrial category, for example a large electricity user with minimum exemptions paid and average price of 14.56-15.56cents/kWh in 2014, whilst a large user with maximum exemptions paid 4.14-4.64cent/kWh (ibid).

The main reason given for industrial exemptions is that of international economic competitiveness and these arguments are used to lobby government for continued preferential treatment via important industry bodies such as the BDI (Federation of Germany Industry) and VCI (German Chemicals Association) as well as some workers' unions (Interviews 17; 20 and 24). 'Competitiveness' has now been made an explicit policy goal of the Energiewende. Recent research suggests that Germany currently enjoys record employment, a growing economy and rising exports (Thalman 2015c). Furthermore, wholesale prices for electricity have fallen 38.4% from the peak in 2011 to 2015 and those industries with the most exemptions benefit considerably from these reductions given the degree to which their tariffs are correlated with wholesale prices. Despite falling electricity wholesale prices heavy industry, in particular chemicals industries, continue to lobby against various aspects of the Energiewende applying the reasonably successful threat of moving production elsewhere if their cost bases are not protected from excess energy charges (Morris 2015b). This remains a bone of contention for other consumer groups that bear the brunt of these costs – again, as discussed in detail in section 4.1.

3. Who Governs the Energiewende?

This section provides an overview of German (Federal Level) energy policy-making structures as well as some explanation of how each one fits into the energy governance structure as a whole. Overall it can be claimed that Germany has made a concerted effort, at Federal and some Land levels, to devise new policies and rules that will enable sustainable energy system innovations – at times in the face of heavy opposition. German sustainable energy governance can be described as providing international leadership and space for learning about energy innovations, but it can also be characterised as having changed substantially over the past two decades. Germany now has clearly defined targets set at the Federal level that stretch out to 2050, a host of Acts, laws, policies and regulations established (and revised) in order that targets will be met. Germany has also been extensively involved in international climate mitigation governance and knowledge sharing.

The Energiewende has, since 2011, sets the medium and long-term direction for energy governance bodies to follow in particular through its ambitious and detailed targets (see Table 1). Further direction is set by the Climate Action Programmes – the next of which is due in 2016.

Table 1: Key German Energiewende Targets

		2020	2025	2030	2035	2040	2050
Greenhouse gas emissions	Reduction of GHG emissions compared to 1990 levels	-40%		-55%		-70%	-80 to -95%
Nuclear	Phased shut down of all nuclear power plants by 2022	11 by 2015	Rest 2022				
Renewable Energies	Share in final energy consumption	18%		30%		45%	Min 60%
	Share in gross electricity consumption		40 to 45%		55 to 60%		Min 80%
Energy efficiency	Reduction of primary energy consumption compared to 2008	-20%					-50%
	Reduction of gross electricity consumption compared to 2008	-10%					-25%

The desire to meet these targets has engendered multiple new strategies and policies at Federal, and Land levels, involving a host of public and private sector actor groups, often working in coordination. Recent analysis has suggested that Germany is one of the few countries that has reached 'Phase 2' of its energy transition. That is to say that it has been through the initial (technical and political) learning and capacity building phase and now needs to more efficiently integrate renewables, partly by pursuing a more whole systems approach with better coordination between different aspects of energy system (Kitzing and Mitchell 2014).

Another way of looking at where Germany stands in terms of governing for sustainable energy innovations is to view it as in Phase 2, but of a four Phase transition (Interview 17). From this viewpoint, Phase 2 should last between 10 and 15 years and renewables should grow to 40% of energy consumption during this phase. This period is expected be politically difficult as it will be 'existential' for incumbents and involve yet greater cost issues for customers. During Phase III, when renewables increase to 50-75% of energy, companies should either have adjusted or ceased to exist, and costs are expected come down. Phase IV is when significant storage will be needed, and, as a result, costs will go up again. Significantly more demand management is needed in Phases 2 and 3 as there will be 1,000+ hours per annum when wholesale prices are negative (Interview 17). This paper poses some questions, in section 4, about how Germany is doing so far on getting to Phase III, in particular by encouraging greater demand management.

3.1 German Public Bodies

The broader political context has been influential over the pathways that Germany has chosen in attempting to meet its Energiewende targets. It has also had implications for which battles that it has had to fight, which actors have been able to innovate, and which are losing out. It is consideed significant here that Germany, as a Federal Republic, has a more devolved system of political authority in that this provides a degree of institutional support for distributed energy (Kuzemko et al 2016). Länder have their own governments, banks and regulators, whilst two Länder also have their own Climate Protection Law (North Rhine Westphalia and Baden Württemberg) (Interviews 4 and 5). Furthermore, as mentioned in section 2, municipal utilities (Stadtwerke) only lost their monopoly rights, and rights to distribute and supply in the local area, in the early 2000s. As such they retain a much more recent institutional memory of the gas and electricity business and this is combined, in some areas, with a high degree of support for the Energiewende and community energy in particular (see Julian 2014).

A number of scholars have referenced popular support in Germany as another important political context that has enabled a deeper and faster energy transition than many other countries, and this support has been maintained by ensuring that reasonably broad sections (although not all) of society benefit from sustainable change (Schreuers 2002; Lockwood 2014). For example hundreds of thousands of new jobs have been created in Germany in renewable and energy efficiency industries and associated supply chains (Interview 2). The renewable sector alone accounts for 370,000 jobs (Pescia & Graichen 2015: 6), whilst yet more are employed in energy efficiency services and product manufacture (Interview 2).

It is, however, also significant that although Germany is a market economy it has tended to place more emphasis on the role of the state as 'enabler' of profound change (BMWi 2015c).

There has also been a reasonably significant emphasis on welfare, worker rights and economic distribution as integral parts of its 'Social Market Economy' (Toke & Lauber 2007; BMWi 2016). What this means is that although the costs of the Energiewende have not been evenly distributed, there has been more welfare support for vulnerable users of electricity and heat with positive implications for energy poverty. Indeed, energy transitions cannot be considered sustainable if vulnerable users are not protected. The German government, at Federal and Land level, also has a more embedded history of taking action where necessary and not just to 'correct' market failures – but to create new markets and engender profound change (Mazuccato 2013). For example German government bodies were directly involved in rebuilding Germany twice in the last 70 years, post WWII and during reunification (Beveridge and Kern 2013: 4). Such skills learnt in directing change, in addition to being prepared to learn-by-doing, have been important in driving the Energiewende forward.

Electoral and party politics have also been important to Germany's energy transition (Jordan-Korte 2011; Fuchs 2014; Beveridge and Kern 2014; Interviews 2, 13, 14 and 15). There has over time been a relatively high degree of cross party support for sustainable change, in fact 85% of MPs voted for the Energiewende in 2011 (Pescia & Graichen 2015: 10). Some scholars have claimed, however, that the Green and Social Democratic (SDP) government coalition, from 1998 to 2005, was pivotal to progressing more radical policies, not least the EEG, to engender more profound change (Jordan-Korte 2011; Fuchs 2014; Beveridge and Kern 2014). Another important, and related, aspect of the context for energy policymaking was the decision, in 2002, to take responsibility for renewable energy away from the Bundesministerium für Wirtschaft (BMWi) and give it to the Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMUB) (Jordan-Korte 2011: 204). This is because the BMUB was more focused on environmental outcomes in energy systems than BMWi had been, but also because they were more flexible, innovative and capable of policies to support change (ibid; Interview 17). Lastly, it should be noted that Germany has had a long and sustained research, development and dissemination (RD&D) policy with the specific intention of innovating, learning and knowledge building, but also with the intention also of making sustainable energy beneficial to the German economy.

In terms of the Federal government, there are three main institutions at the Federal level in Germany. They are the Bundestag, which is the National Parliament of the Federal Republic of Germany (equivalent to Britain's House of Commons); the Bundesrat, which is made up of representatives from the 16 Länder; and the Federal Cabinet. The Bundesrat is the Parliament of the Länder and it is also a constitutional body. Each Land has been allocated a different number of votes according to population, the Länder with the smallest populations (i.e. Bremen and Hamburg) have 3 votes and the largest (i.e. Bavaria and Baden-Wurttemberg) have 6.

There are 69 votes in the Bundesrat in total. Any new legislation that affects state competences and all constitutional changes must be voted on in the Bundesrat where it can be passed into law or vetoed and sent back to the Bundestag. Each Land is, in this way, represented at Federal level in addition to having its own government, Environment Ministries,[17] and regulators (Interview 3) (see section 3.2 for more details on Land level governance). The Federal Cabinet is made up of representatives of the elected government of the day and beneath this sits the Federal Committee of State Secretaries for Sustainable Development.

What sets Germany apart, in comparison to Britain, is that members of the Bundestag have over time been heavily involved in fighting for and maintaining the sustainable energy transition, and in particular the FiT system of renewable support. The degree of involvement of Parliamentarians in regular adjustments to the EEG is also, according to one stakeholder, unique (Interview 19). Many Parliamentarians are considered knowledgeable about the energy sector and this arguably enhances their ability to be involved in policymaking (Jacobsson & Lauber 2006; Interview 19). In order to help maintain sufficient knowledge capacity, the Bundestag has an 'academic research service' that can be called upon to write reports and to explain technical and academic issues (lawyers, economists, social scientists) (Interview 5). As a sign of Parliamentary commitment to sustainable energy system change, in the late 1990s the Bundestag made a strong stand against the BMWi, the big utilities and the EU who wanted to reduce the FiT (ibid). In 2014 the Bundestag established its own Parliamentary Advisory Council on Sustainable Development whose role is to monitor and support sustainability legislation and the National Sustainability Strategy.

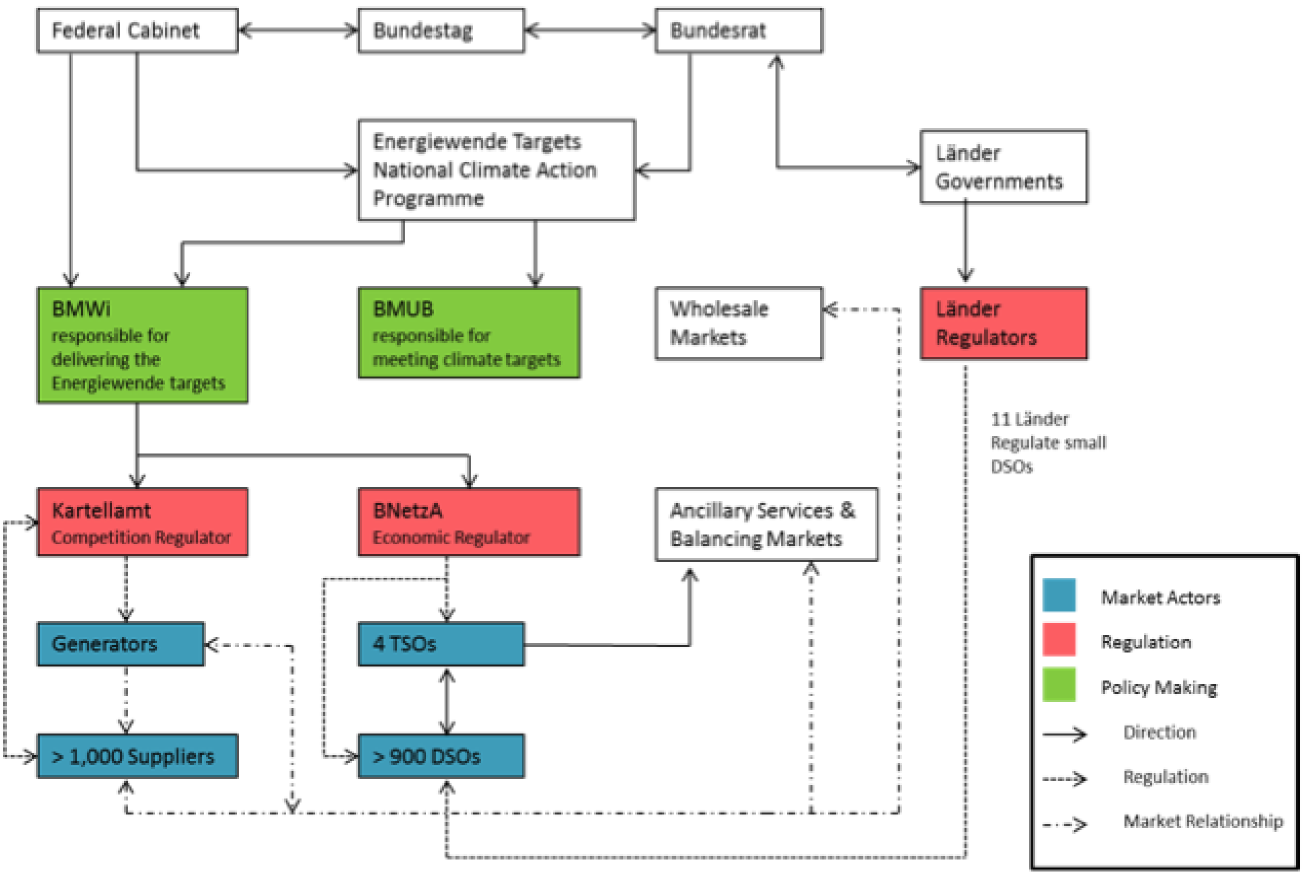
The 2013 Federal elections reinforced Germany's 'grand coalition' of CDU/CSU (conservatives) and SDP parties, with Angela Merkel as Chancellor. In 2013 SDP's Sigmar Gabriel became the Federal Minister for Business and Energy (Beveridge and Kern 2013: 4). This coalition has been responsible for a number important decisions: to re-start the phase out of nuclear power; to move responsibility for renewables to the BMWi; and the quite substantial re-write of the EEG. The next Federal elections are due towards the end of 2017, with a coalition debate expected early in 2018. The influence of the Green party, which was considered so important to early sustainable energy legislation (Schreuers 2002), has been waning at the Federal level. It does retain more influence in some Länder, most notably the Green party is in a coalition government in Baden Württemberg with the SDPs.

[17] See here: https://www.umweltministerkonferenz.de/Mitglieder-UMK-Mitglieder.html.html for a list of Land Environment Ministries (in German).

3.1.1 Government Departments

The landscape of governance bodies involved in energy governance in Germany is complex, especially given that each Land also has energy and climate policies and a utilities regulator. This section provides an overview of the main actors involved at the Federal level, as does Figure 5. Responsibility for the Energiewende is essentially split between BMUB and BMWi in that they share 'co-competence', although BMUB retains overall responsibility for climate change mitigation. Some have observed that co-competence between these departments exists without commensurate levels of co-ordination between them (Interview 17). New energy legislation is prepared and drafted by the Ministries and then passed to the Bundestag, and in some cases also Bundesrat, for a decision. Ministries are also responsible for issuing statutory instruments, i.e. subordinate legislation which specifies further details of a law, in particular with regard to enforcement (BMUB 2015). The (economic) regulators (BNetzA and Kartellamt) are, once legislation is passed, then required to sort out regulatory details (Interview 19). For example, BNetzA was mandated to devise the details of balancing rules together with TSOs.

Figure 6: the German Energy Governance Structure



The BMUB, which in English is the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety, was responsible for renewable energy policy from 2002 to 2014 at which time renewable energy was passed back to BMWi (Jordan-Korte 2011: 204). The BMUB was set up in 1986 in the aftermath of the Chernobyl nuclear disaster and is, as such, seen as a ‘new’ Federal Ministry (Interview 17). As already mentioned above, it is considered significant that the BMUB held responsibility for renewable energy policy for so many years given their reputation for being dynamic, innovative and flexible. They have also tended to favour the ‘early dissemination’ approach, which is an approach to new technologies which came from Southern Germany and emphasises learning-by-doing (Interview 17).

Although BMUB lost responsibility for renewable energy in 2014, they retain overall responsibility for meeting climate targets, as well as for greenhouse gas emissions reduction and the ETS (Interviews 2, 10, 17 and 19). It also shares co-competence in household and buildings efficiency with the BMWi. It is made up of seven specialist directorates-general, plus one that deals with strategic aspects and one for central functions. Barbara Hendricks is the Federal Minister in charge, a total of 1,200 staff work at BMUB, and the annual budget is more than €3.8bn (BMUB 2015a). The BMUB teams that had been responsible for energy efficiency and renewable generation moved to the BMWi (Interviews 1 and 2). There are four federal agencies that operate under the auspices of the BMUB which, in turn, employ more than 3,000 staff: the Federal Environment Agency, the Federal Agency for Nature Conservation, the Federal Office for Radiation Protection and the Federal Office for Building and Regional Planning (which includes a Federal Institute for Research on Building, Urban Affairs and Spatial Development) (BMUB 2015b).

Of these agencies the most involved in areas of policy relevant to this paper is the Federal Office for Building and Regional Planning which works with its own research institute and staff at the BMWi on improving buildings efficiency. Responsibility for buildings efficiency is a new brief for BMUB and it was felt both that the urban development sector needed to ‘wake up’ to the environment and that this could be achieved better by BMUB (see BMUB 2015a; Interview 2). Given the size of this brief, and that construction represents a decent amount of the Federal budget,[18] BMUB has now become one of the larger Federal ministries (Interview 2). They are responsible for deciding how the ‘Energie und Klima Fond’ (Energy and Climate Fund), to be used for the promotion of environmentally-friendly, reliable and affordable energy supply, is spent (LSE 2015). This fund is special in that it is separate from the Federal budget, i.e. other fund’s unspent monies must be paid back at the end of the year whilst the Klima Fond is secured for a set period of time (Interview 17). The Klima Fond has made investments in national (micro CHP and municipal climate plans) and international (i.e. support ETS in China) climate initiatives (Interview 17).

[18] The Buildings Rehabilitation Programme alone had available funds of €1.8bn for 2012-14.

The BMWi, in English the Federal Ministry for Economic Affairs and Energy, had been responsible for renewable energy pre-2002, and maintains its responsibility for fossil fuel generation and gas. The primary task of the BMWi is to: “reinvigorate the social market economy, stay innovative in the long term and strengthen the social fabric in Germany” (BMWi 2015c). A ‘social market economy’ is one where the state guarantees the free play of entrepreneurial forces, whilst at the same time endeavouring to maintain the social balance, partly through decent welfare provision but also through organised coordination between employees and employers (see Toke & Lauber 2007). For example, the social partnership of trade unions and employer associations is enshrined in the institutionalised settlement of conflicts as outlined in the collective labour law.

Beneath this overall task the BMWi has sub-tasks including *innovation, making infrastructure ‘fit for the future’, and energy reforms*. The BMWi’s energy objectives also a include a focus (in equal measure) on climate and environmental sustainability, security of supply and affordability.[19] This is partly because the BMWi is *mandated* by the new Energiewende targets and it shares co-competence with BMUB for the energy system transition overall (Interviews 2 and 17). As stated by the BMWi qualitative goals guide the medium- and long-term restructuring of the energy sector (BMWi 2014a: 6). The 2020 Energiewende targets are, in turn, made binding within the Climate Action Programme 2020, adopted in December 2014 (Interview 2). The 2020 Climate Action Programme, devised by the BMUB, will be followed by a Climate Action Plan 2050 in 2016. As such although the BMWi is not a Ministry that is focused specifically on sustainability (in comparison to the BMUB) it does have a clear energy reform mandate to guide its actions. Indeed, in the event that Germany is not on track to meet Energiewende targets the relevant BMWi personnel/directorate-general must formulate new policies, for example recent legislation on decommissioning coal-fired electricity generation (Interviews 2 and 23).

Within the BMWi there are 10 directorates-general, with two dedicated to energy: ‘Energy Policy – Heating and Efficiency’; and ‘Energy Policy – Electricity and Grids’ (BMWi 2015c). ‘Heating and Efficiency’ has three sub-divisions: international, industry and households, buildings and research; and ‘Electricity and Grids’ also has three sub-divisions: Energiewende principles; electricity and grids. As already mentioned, personnel that had been involved in energy and grids at BMUB moved pretty much wholesale across to the BMWi in 2014 (Interview 16), which does give some continuity of policy-making and ensures less loss of institutional memory and expertise in renewables. Another aspect of energy at the BMWi is that Rainer Baake was

[19] This contrasts with energy policy in GB which makes little mention of environmental sustainability (just climate), and which also fails to articulate equality between the trilemma of energy objectives (climate change; security of supply and affordability).

appointed the new ‘Staatssekretär’ (Secretary of State) for Energy and, as such, heads up both energy directorates-general as well as the ‘Europa Politik’ directorate-general. This is significant not just in continuity terms, he had previously been Secretary of State at BMUB, but also because he is widely considered to be one of the leading architects of the Energiewende as well as a very clever strategist (Interviews 2, 3 and 17). Some consider Sigmar Gabriel’s decision to hire Baake as a shrewd move given the degree to which Baake is trusted by sustainable energy stakeholders (Interview 3).

The decision to move energy from BMUB to the BMWi reflected the feeling at the time that renewables had been over-subsidised as well as the political orientation of the new coalition, and the related, greater focus on economic costs and competitiveness. It may also, however, reflect the desire to better integrate the Energiewende into mainstream economic policy (Interview 17). There was, however, widespread concern amongst the more progressive energy community that sustainability might get swallowed up, and that energy teams would end up forming an embattled units, within BMWi. This concern was based on the fact that the BMWi is not a ‘sustainability or environmental’ focused organisation but also because it is viewed as more economic efficiency and market oriented than the BMUB, as well as less innovative (Interviews 1, 2 and 17) (Interviews 2 and 9). Thus far, however, the energy teams appear to have retained more control and decision-making power than had been expected (Interview 1), and others have observed a slight culture change in the form of more ‘in-house’ coordination and working across energy sub-teams (Interviews 16 and 19). There has, however, been some discussion of taking energy out of BMWi after the next election and setting up a separate energy/climate body (Interview 17).

The BMWi includes six further authorities some of which have particular roles in energy governance. These include the Federal Office for Economic Affairs and Export Control (BAFA); the Federal Institute for Geosciences and Natural Resources; the Federal Cartel Office (Kartellamt or BKartA); and the Federal Network Agency for Electricity, Gas, Telecommunications, Post and Railway (BNetzA). BAFA has administrative tasks in the areas of foreign trade, promotion of economic development and energy. With respect to energy BAFA’s main task is to assist in the promotion of renewable energy and energy efficiency in Germany. It gives grants for PV units in schools and for biomass units, in runs a ‘Local consultations to save energy’ programme it givens grants for consultations between qualified engineers and homeowners and it works closely with the German Energy Association (dena) (BAFA 2015). It also runs a grant system for the German hard coal industry to facilitate the closure of uncompetitive coal mines – including the system of ‘Anpassungsgeld’ (adaption payments) to cover the gap, for older coal workers, between mine closure and the start of pension payments (ibid).

Lastly, Germany also has a new dispute settlement body for renewable energy, the Clearingstelle EEG, which is commissioned, and partly funded, by the BMWi under the terms of the 'Renewable Energy Sources Act' (EEG) 2014 (Clearingstelle 2015). Priority access for renewables is considered so central to the success of the Energiewende that this Federal clearing/complaint body was set up to reinforce priority access rights. It was, however, recently decided that DSOs/TSOs can curtail renewable access if there are system wide network constraints, with compensation payable in such cases, and only after all other generators have been turned off (Interview 11). It is notable, also, that in 2014 curtailment of renewables increased significantly versus low levels recorded in 2012/13 (Morris 2015e).

3.1.2 Energy Regulation

Regulation of gas and electricity markets in Germany is split between two regulators: the infrastructure regulator, BNetzA, and the competition regulator, Bundeskartellamt (Kartellamt). Although they are both agencies of the BMWi, they are classed as 'independent'. It is also worth noting that each Land also has its own Kartellamt and infrastructure regulator that includes energy (Eberlein 2007: 91). There are rules governing how regulation is split between Land and Federal levels. For example, of the 16 Länder 5 have delegated responsibility for gas and electricity regulation back to the Federal level. This number was 6, but Lower Saxony recently took regulatory responsibility back. Moreover, if a company is large (i.e. has 100,000 customers or more), or is in more than one state, and/or if the Land decides not to regulate gas and electricity, then that company will be regulated at the Federal level by BNetzA and the Kartellamt.[20] In most cases there are only a few people in a regulatory body that is housed within the Ministry of Economic Affairs of each Land (Interview 26).

The Kartellamt is a longstanding governance body, which has had an historically important role based on the 1958 Act against Restraints of Competition (ARC) which is considered so fundamental that it is also referred to as the 'Basic Law of the Market Economy' (Kartellamt 2015). It is an independent competition authority whose task is to protect competition in Germany and to acts as the enforcer of applicable competition statutes (Kartellamt 2015; AIIFL 2013: 3). More recently it has also played a key role in respect of the process of liberalisation in gas and electricity markets and of the unbundling of utilities. It works together with the BNetzA to monitor developments in electricity and gas markets and, under Section 48 of the German ARC, it focuses on transparency, including that of wholesale prices, the degree and effectiveness of liberalisation, and the extent of competition on wholesale and retail levels on energy exchanges (ibid). The emphasis on transparency has been further underpinned by the recent establishment of a joint 'Market Transparency Unit'. This unit is part of BNetzA, but the

[20] In the UK the gas and electricity regulator, Ofgem, has recourse to the Competition and Markets Authority (CMA) in the event of unresolved issues, but the CMA is not directly involved in gas and electricity market regulation.

Kartellamt will work jointly with BNetzA to continuously monitor electricity and gas wholesale prices and to ensure that they are set by competition.

The BNetzA, also located in Bonn, is a much newer organisation in that it was established only in 1998. It is responsible for infrastructure regulation so, in addition to gas and electricity, it also regulates postal, telecommunications, and railway networks. It does so within the context of the broader liberalisation process across infrastructure sectors, driven in part by the EU. Prior to 1998 infrastructure had been considered as public goods and not subject to competitive market rules (Eberlein 2007). Gas and electricity were only added to BNetzA's mandate in 2002, after a long debate about whether an energy regulator would be required (Interviews 1, 2, 17 and 19). One of its main tasks is to provide, through liberalization and deregulation, for the further development of electricity networks, and to implement and enforce regulatory policies applicable to the gas and electricity sectors (BNetzA 2015e; AIIFL 2013: 3).

The legal framework that provides the basis for the BNetzA's activities is made up of the two Energy Industry Acts (EnWG) and the Grid Expansion Acceleration Act of 2011 (BNetzA 2015d and 2015e). The BNetzA is focused, in particular, on grid and network modernisation, domestic and 3rd party access, the security of supply, and supply to household customers (BNetzA 2014: 3). It has regulatory oversight of the electricity and gas networks including, as seen in section 2, rate-setting power for TSOs and DNOs (Interview 22). It also works closely together with the TSOs on balancing rules and market operation. The role of the BNetzA is, however, also growing especially given the Energiewende (Interviews 1 and 11). This includes ensuring that renewable generation is integrated and that each part of the electricity system plays its correct role in bringing renewables to market. The BNetzA now also runs renewable tenders and collects all relevant data regarding renewables (Interview 19). Since 2011 BNetzA has become responsible for the faster expansion of the electricity grid through the implementation of the Grid Expansion Acceleration Act (BNetzA 2015d). Within this it has a role in approving plans for Grid Expansion, and overseeing whether required projects get built (Buchan 2012: 22). The BNetzA also now runs renewable tenders, and collects all relevant data regarding renewables (Interview 19).

Finally, in terms of responsibilities, the BNetzA works closely together with the Kartellamt on market monitoring, which is conducted through the annual Market Monitoring Report and the 'Energy Transition' progress reports (BNetzA 2014; BNetzA 2015e), as well as in operation of the Market Transparency Unit (MTU) (BNetzA 2014: 278). Its role as Germany's national market monitoring body is laid out under EU Regulation No. 1227/2011 (on wholesale energy market integrity and transparency) and in section 35 of the Energy Act (EnWG).

Although independent in its decisions, BNetzA is formally an Agency of BMWi and its role is to implement policies, ordinances and Acts that have been decided upon through policy-making processes undertaken by the Ministries. As such BNetzA is referred to as having an ‘execution only’ role, not dissimilar to the Danish energy (economic) regulator (see Lockwood 2015). For example, once it had been decided at the Ministries that DNOs need new incentives, to improve smart aspects of their networks, BNetzA then help to set the appropriate level and to implement the new rules (Interview 1). The work of the BNetzA is, however, slightly more nuanced and can be described under three functional headings: *expertise*, *implementation* and *administration*. Examples of each of these functions are given here below, with particular reference to their role regarding the new (2014) renewable generation rules:

1. *Expertise:*

BMWi has some responsibility for designing key elements of the renewable support scheme. These duties are in turn related to meeting the ambitious Energiewende renewable targets by 2020, 2030 and 2050, and to monitoring the Ausbau Korridor. The BMWi (and BMUB where necessary) works with BNetzA when drafting a new law in order to assess if the new rules will work in practice, and to this extent the Ministries tend to rely on BNetzA’s engineering and administrative expertise (Interviews 22 and 23). For example, BNetzA provided expertise to BMWi when designing the rules of the new renewables support scheme announced in 2014. This included contributing to the drafting of renewable legislation and participating in discussion fora where new elements for the schemes were discussed (e.g. how to introduce tendering procedures). In addition, BNetzA designs the (subordinance) rules for the marketing of renewables by the TSOs and for the balancing scheme, both of which are important for the functioning of the overall renewable support scheme (Interview 22).

2. *Implementation*:

The role of implementation is perhaps more straightforward for an ‘execution only’ regulator, but we can look here at some of the details of its role in implementing the new tender system for renewables. For example, new tendering procedures for setting the level of support for freestanding PV installations is being fully implemented through BNetzA. As such, it manages all administrative procedures linked to the call for tenders including the awarding of decisions to a selection of bidders. The technology specific reference values for PV installations are calculated (according to a predefined degression scheme) and published every month by BNetzA. Furthermore, TSOs set the level of the annual renewable surcharge under the scrutiny of BNetzA, which also controls the calculation basis of the TSOs for determining the annual renewables surcharge (Interview 22).

3. *Administration*:

BNetzA administers a few regulatory programmes, often through the market monitoring and transparency unit. This includes oversight of the equalization mechanism between the TSOs for renewables quantities sold on the market. It ensures that the TSOs correctly charge energy suppliers with the renewable surcharge, especially when it comes to allocating the different surcharge levels (e.g. reduced surcharge for energy-intensive industries and self-consumption) to the electricity consumed. In relation to this, and to its transparency responsibility, BNetzA ensures that network operators transmit and publish all financial information related to the payments of renewable support made to generators (Interview 22). BNetzA supervises network operators in their congestion management activities, to ensure that renewable capacities are only curtailed as a last option.

In the near future, and it the interests of transparency, BNetzA will also be responsible for administering a new registry covering all renewable installations as part of the implementation of the Installation Register Ordinance. In the medium term it is expected that the scope of the registry will be widened to cover all electricity producing installations (i.e. also conventional) as well as all relevant market players.

3.1.3 Other Governance Bodies

The landscape of energy governance in Germany extends beyond Parliament, government ministries, agencies and regulators, as might be expected given the central importance of the Energiewende and given how complex governing for an energy system transition can be. There is not the space here to provide an exhaustive list of all organisations involved, but there are two other bodies that will be briefly described here as they play important roles in informing and implementing energy demand policy in Germany.

The first is the KfW Banking Group (KfW) which plays a vital role in implementing energy efficiency policy, largely through offering discounted loans and grants for building works that will enhance the sustainability of houses and other buildings. The KfW was set up in 1948 as part of the Marshall Plan, and remains government owned today with a continuing Federal budget for sustainability loans (Interview 3). It describes itself as a ‘promotional bank’ and has had, from the outset, a focus on development, sustainability and the environment and supporting small to medium sized businesses (KfW 2015). As such although it is a bank with a profit mission it also serves a public role in that it is directly mandated according to specific missions, for example to develop SMEs/entrepreneurs via start-up/venture capital; as well as to support energy efficiency and sustainability ventures (ibid; Interview 3). To this end the KfW works closely with the BMWi sub-division that concentrates on promoting efficiency in buildings, and one or more KfW representatives will be involved in devising new funding schemes/policies (Interview 3). The KfW provides an interesting communication and network function in that they also have direct contact with small (household) and medium-sized (SME) players, including housing companies, landlords and subcontractors (Interview 3). Although, in section 4.3, this paper will focus on the KfW's role in energy efficiency, it should be noted that they also offer discounted and full interest payable loans across the sustainable energy spectrum – including a recent loan of €5bn to offshore wind farms in Germany. As will be mentioned in section 4.1, access to affordable funding for sustainable energy works and/or companies is often also available through the various Länder and municipal banks, the Landesbanken and Bürgschaftbanken, which can be highly useful for locally developed, civil energy projects (Hall et al 2016; Interview 3).

The second organisation to be outlined briefly here is Germany's Energy Agency (dena) which also plays a role in energy efficiency but in a research capacity. dena was set up in 2000 and is a for-profit company owned by public and private sector groups, including the Federal Republic of Germany; the KfW Group; Allianz SE and Deutsche Bank (dena 2015). Its assigned role is to provide a centre of expertise for energy efficiency, renewable energy sources and intelligent energy systems within the context of Germany's energy transition (ibid). One of dena's first research projects was to study the country's unmet grid needs, but following a group restructuring in 2015 it is now more focused on smart grids and energy efficiency research and consultancy (Interviews 1 and 3). In addition to its research function dena provides consultancy advise, and networking opportunities, to a wide range of stakeholders including private consumers and households, the building and energy industries, and local authorities and other public institutions. The Federal Government finances dena's comprehensive energy efficiency campaigns and has a particular interest in its activities as researcher, networker and advisory body in efficiency (BMwi 2014b: 13).

Together these two organisations provide useful funding, research and networking opportunities on energy efficiency in Germany. There are other institutions worth mentioning that provide important government oversight (and advisory) roles in environment and sustainability. One example is the German Advisory Council on the Environment (SRU), which was established by charter of the Federal Ministry of the Interior in December 1971. Its members are appointed by BMUB and they provide an advisory and oversight function for the success of the Federal Governments policies with respect to environmental sustainability (SRU 2015). There is also an undersecretary committee for sustainable development (UCSD); the Parliamentary Advisory Committee for Sustainable Development (PBNE) referenced above, as well as a Scientific Advisory Council (Rat für Nachhaltige Entwicklung) appointed by the Chancellor – all with sustainability mandates (Heinrichs & Law 2014: 2631).

3.2 The European Union (EU)

There is not the space here to explore Germany's relationship with the EU in any real detail, it should be noted that the EU has been important (although not always helpful) in many senses to Germany energy policymaking. Although the EU has come to share Germany's interest in sustainability, as evidenced by the 20-20-20 agreement of 2007 and its various Directives on energy efficiency, renewable growth and carbon emissions, it has had different ideas about how climate goals should be reached. In 1996 the EU, in particular DG Competition, came down on the side of German large utilities and the BMWi in calling for Feed-in-Tariff rates (that were starting to have a positive effect of the diffusion of wind turbines) to be cut (Jacobsson & Lauber 2006: 265). More recently the 2014 overhaul of the EEG was also seen as having taken place partly because of EU pressure (Lauber & Jacobsson 2015: 10; Interview 13). In these ways the EU has formally, and informally, encouraged Germany to be more 'market oriented' in its energy governance.

However, as the EU has further developed a regional approach to energy, so German energy policy has become closely inter-linked with that of the EU. This is, in particular, with regard to liberalisation, unbundling and greater European interconnections. Much Federal level legislation refers directly to EU directives, in particular the EU Directive on energy efficiency has been transposed into Germany law through the National Action Plan on Energy Efficiency (NAPE) (Interviews 1 and 3), and ENTSO-E works closely with German regulators on balancing market rules. The EU furthermore has produced a 'Demand Response Action Plan for Europe', which suggests that Europe should take example from the US market for demand response (see also Mitchell 2016), as well as Framework Guidelines on Electricity Balancing and a Demand Connect Code (via ACER) (Koliou et al 2014: 249). Another, more progressive, example of working together with ENTSO-E is the European Electricity Grid Initiative, which seeks to facilitate new knowledge flows and exchanges that can contribute to the delivery of a European Smart Grid in the EU29 (GRID+ 2016).

Overall, it has become important for national measures to fit the European framework (Baake 2014). But this not to say that German policy follows that of the EU – indeed Germany's Energiewende targets are more ambitious and, in that they extend to 2050, longer-lasting and their methods of meeting policy objectives have involved greater state participation. Germany must also adjust policies to make up for it perceives as EU policy gaps. For example, Germany decided that the Federal Minister for Economic Affairs and Energy should present a regulatory proposal and draft a law to define a carbon emissions budget for the electricity sector (Baake 2014). This was to act as a transitional instrument to cover the time until the European ETS starts working again.

4. Governing for Demand Management

It is worth setting out here what a ‘demand oriented’ energy system would look like, before proceeding in the rest of section 4 to outline how governance and demand innovations are progressing in Germany – the successes, issues and potential solutions. A demand-oriented system would have these characteristics, in addition to low carbon supply (see DECC 2014; Ofgem 2015; Agora 2010):

A distributed energy system, and preferably also with high rates of citizen and/or community involvement;

- Flexibility of demand (and supply) to support higher amounts of renewable electricity generation;
- New business models that enable demand response, efficiency and flexibility (including aggregators of demand and supply);
- Smart, energy efficient and interconnected networks;
- Open availability of relevant market data;
- Storage where necessary.

As set out in section 2, Germany’s energy transition has so far been most successful in terms of renewable electricity growth, the distributed nature of renewables, new business models, the degree of citizen and/or community involvement, and energy efficiency, but less so in terms of demand response and flexibility (see also Buchan 2012: 28). Questions have arisen, however, as to whether the 2014 EEG revisions will come to have negative implications for distributed and citizen-owned aspects of renewables. Clearly the risk-free nature of support for renewables has thus far done much to enable diffusion, technical learning in practice, affordable capital, and reductions in costs of PV and onshore wind (Pescia & Graichen 2015: 5; Noothout et al 2016). Germany has been relatively successful, not least with the support of the KfW, in improving the energy efficiency of housing stock and other buildings and there has been quite a high degree of innovation in generation and supply business models. Much has, therefore, been achieved but for its energy markets to become more demand oriented, better integrated and more efficient there is plenty left to do – not least with regard to flexibility, smarter grids and demand response (Agora 2010; ibid).

There is little doubt that Germany has led the way in many aspects of sustainable energy transition: including both technology and policy experimentation and learning, leading one scholar to claim that Germany is the world’s ‘experimental laboratory in the matter of greening the energy industry’ (Schuppe 2014a; see also Rifkin 2014). There has been a relatively high level of popular support for renewables, in close connection to popular opposition to nuclear power, but there have also been strong coalitions seeking to at best undermine, and at worst prevent, a low carbon transition. In this way Germany's transition can be seen as involving a series of turning points, including the 1986 Chernobyl and 2011 Fukushima nuclear disasters which did so much to underpin political will to decommission nuclear power. This, of course, left renewable energy as the only available source to decarbonise supply. This year (2016) will also be important as debates regarding the next Climate Action Plan, which will include more details on how Germany intends to meet its 2050 targets, will start. 2017 will also be important as it is a Federal election year.

4.1 Distributed Energy and Citizen Ownership

Although decentralised energy and citizen ownership are by no means the only guiding principals of the Energiewende, they are openly recognised as important to its long-term success and in embedding sustainable changes into the fabric of society. As outlined in section 2.4, the facts show that this organising principal has worked in practice given the distributed and citizen-owned nature of changes to the energy system so far (Burger & Weinmann 2014). What is notable is that so many scholars and policy analysts ascribe this aspect of change to governance choices made. Specifically it is considered highly significant that the EEG subsidy design included priority access to the grid but also enabled, in practice, very low risk market conditions for new, renewable investments. These low risk market conditions have led to Germany having the lowest cost of capital for renewables in Europe as well as making renewable generation more accessible to a broader range of actors partly through it (Mitchell et al 2006; BMWi 2014c: 21; Burger & Weinmann 2014: 49; Nouthout et al 2016). Other governance decisions have been important here. For example the decision that the KfW should continue to have such a considerable focus on sustainability and that loans should be discounted has, in practice, provided affordable and accessible financial support for new, small and medium sized sustainable market players (Fuchs 2014: 46).

These decisions were no accident but reflected certain ideas behind policy design. Indeed one important stakeholder, in the PV industry, claims that the 2000 EEG was designed to be so accessible for particular reasons:

German policymakers, including Alternative Nobel Prize winner Hermann Scheer… had a clear vision in the beginning of 2000 that only a reliable mass market would allow PV manufacturers to achieve economies of scale that could reduce the cost of photovoltaic electricity over time (Mike Ahearn, Chairman of First Solar in Mendonça et al 2010: xiv).

Such ideas continue to find purchase today. One recent Ministerial document claims that Germany has long recognised the importance of decentralised energy supply because it can (theoretically) lead to: efficient use of electricity and heat production; significantly lower transmission losses; energy security; job security and the regional accumulation of value (BMWi 2014c: 20). It seems clear, certainly in the mind of Rainer Baake currently the Minister for Energy, that Germany's '…future energy system will be highly decentralised… millions of generators will be linked to customers via smart systems' (Baake 2014).

Arguably, some other socio-political institutions have also been important in enabling a more distributed system: not least popular interest in renewables and environmental solutions, as well as the Bürgerenergie and municipal utility (Rekommunalisierung) movements. As seen in section 2.4, these movements are strong in some parts of Germany and are seen by some as an ideological alternative to national level governance and to the power of national/international utilities (Interviews 4, 5, 6 and 13), as well as to market-liberal globalisation (Beveridge & Naumann 2014). In addition the German Stadtwerke have recent experience in and knowledge of public utility services whilst many have specific interests in sustainable innovation that reflect local citizens' support. These kinds of local, institutional capacities are in marked contrast to the UK's more centralised political and energy system, although there are arguments that very small-scale distribution networks and retail services have not so far been particularly efficient (Interview 19).

It is also considered politically important that many benefits of system change have accrued to citizens and communities more than they have to large corporations. This is not just because of the ability of individual households and community groups to make money from generating renewables, but also because of the policy of creating new markets and jobs in sustainable industries. For example, PV markets now have well established supply chains, especially in terms of knowledge and skills, and this has helped to keep costs of new PV down given that 50% of the initial costs are for installation and mounting (Interviews 3, 4, and 5). Keeping costs down, as well as access to affordable finance, makes PV a more attractive and realistic option for individuals/households and communities. The governance approach of ensuring new Green markets and jobs means that there are now sufficient numbers of sustainable energy companies to form new energy associations, with increasing ability to influence governance choices. In addition, the interests of those employed within new energy industries are aligned with the Energiewende (see Lockwood 2015a on feedback effects).

This is not to say, however, that there are no issues here – indeed 2015 and 2016 are seen as incredibly important years in terms of *how* renewable markets develop, how coal will be decommissioned, and new market rules. Three areas of particular importance to Germany's distributed energy innovations and future are discussed below. Each of these issue areas is currently being politically debated, and some governance changes are underway:

1. Growing objections to fast rising electricity bills, related changes to the EEG (mainly to bring subsidy costs down), and potential implications for the distributed nature of renewables;
2. Within the context of growing price sensitivity one current (unresolved) debate centres around whether it should continue to be quite so distributed in nature – certainly much recent investment has been in large-scale projects (North-South grid expansion and offshore wind);
3. The emergence of more localised energy markets, what is facilitating this in Federal and Land governance terms, and what needs to change to support the creation of independent local markets (with some focus on the role of DSOs).

4.1.1. Rising System Costs and 2014 EEG Changes

Although the benefits of Germany's energy system transition have been more widely distributed than many countries, in particular the UK, they have by no means been distributed equally (Bardt & Niehues 2012: 250). The unequal distribution of benefits might not have become so much of an issue it had not been for the rapid, and high rises in consumer electricity bills (in particular), and for the uneven nature of cost distribution. Surveys have shown that German electricity prices have been consistently amongst the highest in Europe (Schuppe 2014a), whilst the cost of the EEG surcharge has risen most years since its inception, (Pescia & Graichen 2015: 6). In 2016 the EEG surcharge stand at 6.354 cts€/kWh his equated to an annual cost of €23bn that must be distributed through consumer bills (Netztransparenz 2016). EEG surcharge costs are expected to rise until 2023 when they are expected fall, to 4.4 cts€/kWh in 2035 (Pescia & Graichen 2015: 6; SDSN 2015: 57). In some instances surcharges, system costs and taxes make up 70% of customers bills, such that falls in wholesale prices have made little difference to household and SME customer bills. Others have argued that the trend of growth in distribution losses, partly due to the changing locations of generation in relation to centres of demand, as well as the lack of transparency about (distribution) network costs have also had negative implications for costs (Interview 19). This has led to some debate about setting prices regionally rather than nationally (ibid).

As already mentioned these costs are not, however, distributed evenly largely because of the system of exemptions outlined in section 2.4.4. The group of exempted consumers has been growing steadily, it grew by 20% from 2005 to 2012, and by 2014 10% of all customers were exempt from, or paid heavily reduced, surcharges and fees (Appunn 2014; Interviews 3, 14 and 20). Since 2009, Germany has had a policy of incentivizing 'direct consumption' of renewable energy, but to qualify as a direct or self-consumer electricity from (for example) a solar array must never touch the public grid – it must either be consumed or stored locally for later consumption (Morris & Pehnt 2015: 50). Exemptions for heavy users and for self-consumers, however, together represent costs shifted to SMEs, householders and non-exempted commercial users (Thalman 2015a). For example, as a comparison, in the first half of 2014 a heavy industrial user with maximum exemptions was paying 4.14-4.64 cts€/kWh whilst an average SME paid 15.56 cts€/kWh. This is partly because high-energy users were gaining a double benefit due to high exposure to falling wholesale prices in their bills. Businesses not exempt from surcharges, some of which are represented by the powerful BDI, have entered strongly into this debate with arguments about Germany losing out in international competitiveness stakes and the risks of losing foreign direct investment as a result. The European Commission opened an in-depth enquiry into compliance with EU state aid rules centred on EEG exemptions which added some pressure on the German government to address subsidy cost issues (Lang & Lang 2015c).

Although the distribution of costs is recognised as regressive, it seems clear that energy efficiency policies have gone some way to offsetting the impacts, which is why so many claim that the Energiewende needs to be more about energy efficiency now as well as on system-wide integration (Öko 2015; SDSN 2015). As a reminder, although prices per unit are high in Germany, overall energy costs per household are not.

On top of the growing issue around the scale and distribution of cost increases there have also been claims that generators of renewables had been over-subsidised, in particular as costs had fallen faster than anticipated (Interviews 24 and 25). Part of the distribution of costs debate has become centred on wealthy Southern (Bavarian) farmers, who have been doing very well financially out of PV, and on claims that, in terms of individual households, it has mainly been the middle classes that have been able to afford PV (Bardt & Niehues 2012). Others have explicitly claimed that it was because of the strength of the renewable lobby that necessary downward adjustments to the FiT were delayed (Interviews 2 and 11). There are also claims that the PV construction industry had also been too sheltered for too long by the EEG, and had not reduced their business costs quickly enough, which ultimately made them vulnerable to lower cost Chinese imports (Interviews 2 and 26). As part of this cost-related backlash much focus was also aimed at those that, under German law, had been able to avoid paying, or paid reduced, EEG and other system costs with accusations of rent-seeking and gaming. Other complaints were centred on claims that renewable electricity was being sold at exchange prices across borders but being paid for by German consumers (Interview 18), indeed it is estimated that in 2015 8% of German electricity was exported (Morris 2016).

There are arguments that the focus on economic costs is too narrow, not least in that it fails to include other important external costs, such as costs associated with those impacted by climate change or with respiratory illnesses due to emissions from coal-fired power (Lauber &

Jacobsson 2015: 18). One BMUB report claims that the external costs of hard coal and of lignite amount to 10.75 cts€/kWh and 8.94 cts€/kWh respectively.

Whatever the merits of external cost arguments, however, concerns about costs and benefits and how they are distributed were very important in shaping the political debate around the time of the last elections and have had direct implications for policy since. Distribution issues have found a degree of public purchase and this is important because if this aspect of the Energiewende is seen as being overtly unfair then the whole system can be called into question (Bardt & Niehues 2012: 250). The shape of the political debate is also significant currently because although recent surveys confirm very high levels of support for Energiewende targets (currently at 90%), only 45% of citizens think that the Energiewende is properly managed (Pescia & Graichen 2015: 10). Targets themselves, therefore, seem not to be open to question – *but the means of achieving them increasingly is*. This is why current debates, and subsequent decisions so important.

In terms of direct policy impact of debates about rising prices paid, and distribution of costs, some of the 2014 EEG revisions, referred to as the Renewables Act 2.0 (EEG 2.0), were made specifically to alleviate concerns about costs and exemptions (Lang & Lang 2015c). Although EEG subsidies have been revised regularly over time, for example in 2004, 2009 and 2012, changes that had been scheduled for later were brought forward to 2014. The previous (2004, 2009, 2012) processes of revising the FiT had gone through the Bundestag and were considered quite lengthy, whilst renewable costs were decreasing at a faster pace (Interview 19). It was felt that the Government needed to be seen to be taking action in the face of the price and cost debates. Arguably EEG changes, and the shift of renewable policy into BMWi, also reflected the political flavour of the new government (Interviews 2 and 13).

Not all amendments, however, were designed to address cost concerns. EEG 2.0 also introduced important mid-term renewable targets, to 2025 and 2035 (Pescia & Graichen 2015: 14), and provided more provisions for the Clearingstelle, the renewable dispute settlement body (Clearingstelle 2016). Although it should be noted that the 2025 and 2035 targets, of 40-45% and 55-60% share of renewable electricity in domestic demand, will also act to limit capacity additions (Morris 2016). Another main objective was to improve integration of renewables into the electricity system, and improve market price signals, by making Direct Marketing by owners of most renewable power plants (operational post August 2014) mandatory (Lang & Lang 2015c). Exceptions to the Direct Marketing rule are for small plants with an installed capacity of up to 100kW (Lang & Lang 2015d). EEG 2.0 was also designed to pave the way for another overhaul of the EEG in 2017 when financial support under the EEG will be determined by auctions. Discussions over exactly what the new rules will look like are currently underway (Morris 2016).

There are, however, 2 main ways in which changes to the EEG were designed to improve costs, and their distribution amongst consumer groups (Pescia & Graichen 2015: 14). The first also seeks to address issues raised by the European Commission's inquiry into exemptions, in that EEG 2.0 stipulates that heavy industry and new self-consumers (over a certain size) must start to pay a proportion of grid fees, surcharges and taxes (Interviews 2, 3, 5, 6 and 19). Household self-consumers remain exempt (i.e. for arrays below 10KW, or around 40 to 50 panels), as do off-grid systems (Morris & Pehnt 2015: 50).[21] Up until the end of 2015, 30% of the EEG surcharge will be applied to self-consumers, and this rises to 35% in 2016 and 40% in 2017 (ibid; Appunn 2014a: 2). Self-consumers of power that is not from renewable sources or from highly efficient CHP plant have to pay 100% of the surcharge (Appunn 2014a: 2). Exemption changes are less severe for the energy-intensive consumer group in that they the net network tariff can be reduced by up to 90% depending on load factor (i.e. a 90% load factor results in a 90% grid fee reduction), whilst the electricity tax can be remitted, reimbursed or refunded (BNetzA 2014: 146; Interview 19). Reasons given for the relatively small change to exemptions are that workers jobs would be at risk if exemptions were drastically reduced (Appunn 2014a: 2).

The second main way in which the Government sought to limit the cost impacts of the EEG was by slowing down the rate of new plants added – given claims that it was as much the unexpected rate of growth of PV, in particular, that had resulted in higher EEG costs as it was the actual level of payment. For example, in 2011 7.5 GW of PV was installed (Appunn 2014: 1). Instead of just capping the EEG premium, a new annual 'capacity corridor' (Ausbau Korridor) has been announced for each technology and the feed-in remuneration will be adjusted depending on the amount of newly installed capacity (Appunn 2014: 1; Pescia & Graichen 2015: 14). The annual corridor for PV is 2.5–3.5 GW, below recent growth rates (Interview 10), but the 2.4-2.6 GW corridor for onshore wind is slightly above average growth rates and it doesn't include 're-powering' (Appunn 2014: 1; Morris & Pehnt 2015: 51; Interview 10). The aim is for total offshore wind capacity to reach 6.5 GW by 2020, although this may be raised to 7.7 GW, and 15GW by 2030 (Morris 2016; Appunn 2014: 1; Reichardt et al 2015: 6). The Ausbau Korridor for biomass is 100 MW per annum with a focus on plants that operate with bio-waste and liquid manure NOT food-based biomass (ibid; Interviews 5, 9 and 13), and bio-energy will be limited to 10% of power generation over the long term, from 6% in 2012 (Agora 2013: 5).

[21] It is worth noting here that the BMWi's EOM 2.0 white paper suggests that exemptions from grid charges will be abolished for installations that enter into operation after 2021. Existing installations, and those build pre-2021, will be covered by existing rules.

Each year those installations that would take Germany over its annual capacity targets will not receive remuneration. There will be regular adjustments of EEG surcharges, also in the instance that capacity additions do not meet Ausbau Korridor targets in which case the FiT will not be reduced as much. In this way FiT levels will relate to annual targets, and BNetzA has been assigned the task of monitoring (Interview 5). The government also hopes that this more predictable plan for renewable additions will allow for greater planning security and allow better coordination with grid expansion and improvement (Appunn 2014: 1).

Other reforms are also significant in particular, as discussed below, for the distributed nature of renewables. Put simply the market rules for PV and onshore wind have changed and with more changes to come (in 2017). Between 2014, when EEG 2.0 came into effect, and 2017 a set level of remuneration per kWh will be maintained for renewable electricity (Appunn 2014: 1). The new system is a contracts-for-difference (CfD) scheme so instead of a set feed-in payment, that is automatically paid to the producers of renewables, the EEG now requires mandatory direct marketing for most of its producers. It obliges producers to sell their electricity themselves but, in order to limit financial risk, producers receive a market premium when selling their power directly and this is calculated using the FiT as a reference point (Oxera 2014). This premium is calculated as the difference between the average monthly wholesale price on the EEX and the set remuneration for electricity according to each technology/source stated in the new law (ibid).

Post 2017, however, the payment for new, medium to large scale renewable generation (i.e. above 150 KW) will no longer be set by the government but by a competitive bidding model and auction process (ibid; Morris 2015c). Financial support for new renewable plants will be given to those investors offering the lowest price for the electricity their installation will produce. Although the EEG 2.0 did not yet give details on this model, auction pilots for ground-mounted PV have started to take place (BNetzA 2015g). The first auction, operated according to a ‘pay-as-bid’ mechanism, had set a maximum price of 11.29 cts€/kWh whereas the actual average auction price of 9.17 cts€/kWh was very close to the latest comparable feed-in-tariff for PV of around 9 cts€/kWh (Appunn 2015b: 1). It is expected that the next auction will be operated according to a ‘uniform pricing’ scheme. It is notable, however, that the small-scale, ‘on roof’ PV market is not expected to become part of the auction process (in line with exemptions according to size, i.e. less than 150 KW) (Interviews 3, 25 and 26). The first wind auctions are expected to start in 2017, drawing on lessons learnt from solar park auctions (Interviews 3 and 19), and it is expected that there will be exemptions here too, but according to a different scale. EEG 2.0 also allocates balancing costs to the generator creating an incremental and uncertain operating cost.

Clearly the support system for renewables is undergoing quite considerable change, and will continue to do so and, as such, the implications for the distributed nature of the energy transition are as yet unclear. Although changes to PV markets are focused on medium to large-scale generators, there have been widespread fears that German renewable markets now face a tipping point (SDSN 2015: 60; Morris 2015c and 2016). New renewable generators will increasingly need to assume system responsibility, face more market risk and are required to professionalise to qualify for auctions. Under the old FiT system any project worth doing could go forward, whereas under the auction system government and/or utility 'experts' determine the maximum growth rate (Morris 2016).

One expectation is that the requirement to professionalise in order to qualify for auction is expected to be more difficult for the medium sized PV generators, in particular those above the 150KW exemption but not by much. Overall the abolishment of old feed-in-tariff system reduces the security of investment for private households, with potential implications for the cost of capital, as well as energy cooperatives (Borchert 2015: 1). Prior to reforms the cost of capital was low precisely because of the risk profile of feed-in-tariff (see Mitchell et al 2006), but post reforms renewable generators will be exposed to greater revenue uncertainty and therefore the cost of capital is expected to increase (Tisdale et al 2014: 2). With regard to onshore wind, in particular, there is concern that planning permission will become more of an issue, as has often has been the case in the UK (Interview 19). This is partly why so much onshore wind capacity has been added over the past two years, 4.74 GW in 2014 and 3.5 GW in 2015, as there has been a rush to get projects completed before the new auctions for wind start in 2017. Wind pre-qualification will be harder, and plants will be expected to take more risks, but it should also be noted that investors involved at this scale are usually larger anyway (Interview 25).

As such the fear is that the shift to an auction/bidding system will reward scale and/or those with organisational abilities to qualify over those that are less professionalised and that there is a need to strike a balance between cost efficiency and the distributed nature of renewables (Interview 19). Certainly, since EEG 2.0 there has been less small PV being added and in 2014 total PV additions, at 1.9GW, came in below the bottom of the growth corridor (Interview 19). Small scale PV, in particular, is impacted by stricter self-consumption rules and the partial removal of self-consumption privileges (as envisaged when changing EEG) (ibid). Clearly value has been placed on having a more cost efficient system, but there remains the question of whether a value can be placed on having a distributed system (ibid). Keeping hold of previously gained successes in establishing a distributed system and making sure that it becomes more distributed is important. This is not just because of the governance emphasis on the need for a distributed system, but because less well distributed benefits and less citizen/co-operative direct engagement may well reduce support for the Energiewende. So much so that one key consultancy group have observed that '…a market design that no longer permits the participation of citizens and SMEs would endanger the future of the Energiewende' (Agora 2013: 26).

4.1.2. Centralised Generation and Transmission Projects

In addition to fears about the impact of renewable policy changes on distributed energy there are arguments about increasing state support for more generation and infrastructure projects of a more centralised and/or large-scale nature. One example is the growing emphasis on support for offshore wind (Morris 2015c). Some claim that the German Federal Government is currently interested in keeping the Big 4 from facing bankruptcy whilst also involving them in the Energiewende more actively (Interviews 3, 4, 5 and 10), and that this is being done through offshore wind support. Others claim that the re-emphasis onto large-scale, offshore wind projects also reflects the greater influence of the Big 4 over the Conservative-Liberal coalition (Fuchs 2014: 49). For example, RWE and E.ON had expressed preferences for auctions for large scale and/or offshore renewable projects within the consultation process for EEG 2.0 (Interviews 3 and 10). So whilst some have argued that offshore is more expensive, and unnecessary in a distributed system, some of the Big 4 have argued that it is an efficient way of producing electricity and costs are falling fast (faster than PV at the moment) (Interview 24).

Whatever the motivations, the new renewable rules are more favourable towards offshore wind and the rate of growth has been considerable over the past year or so. Clearly it is easier for large, professional organisations to qualify in auctions, but changes made to the rules for offshore wind mean that, even if not connected to the grid, generators can still get the subsidy (Interview 20). Of more concern going forward is that within the new 2025 and 2035 renewable electricity limits the amount allocated to offshore wind, 6.5 GW by 2020/possibly to be raised to 7.7 GW, may well imply less available capacity for onshore wind (Morris 2015c). For those more interested in a continuation of Germany's distributed energy revolution spending on such large-scale generating capacity does not make sense, after all it remains more expensive than onshore by some margin (Interview 3), but it might also pose contradictions with political statements about the distributed nature of Energiewende.

There are further complications here. The amount of offshore wind farms coming online in the North of Germany has implications for system reliability and costs, and this is important within the context of price sensitivity and the growing focus on economic costs. One example is the North-South transmission project. Considerable investment is planned (and being made) to build new grids to transmit offshore wind generation from the North to the South, where there is a high amount of demand and where nuclear plants are being decommissioned. In 2014 there was an increase in curtailment, when 1.16% of renewable electricity was curtailed, because wind power in the North could not reach demand centres in the South (Morris 2015e). It is worth noting that, under current BMWi proposals for electricity market redesign (see below), TSOs will have more ability to curtail renewable (green) generation (Schlandt 2014). There has been a fair amount of opposition to grid expansion, from the State of Bavaria and from NIMBY groups as well as some reluctance on behalf of grid operators to make the investments (Fuchs et al 2013). Because grid permits remain in the hands of Länder this has meant that Bavaria has had some ability to stop transmission expansion thus far (Interview 26). Overall, only 438km of the total 1,887km of lines planned, in the Power Grid Expansion Act (EnLAG) of 2009, had been completed by 2014 (BNetzA 2014: 13).

A further implication, in term of economic costs, of the growing amount of offshore wind along Germany's Northern coast is the rising costs of 're-dispatch', especially on stormy/high wind days and related growing compensation payments for turning off generation. These costs are passed onto most, i.e. non-exempt, consumers in the TSO areas most affected (50 Herz and Tennet) (Interview 19). What this means that consumers in North and Eastern Germany, where most of the wind power capacity is located, and where 50Hertz operates, "… pay for the fact that southern Germany does not agree to have power lines built to receive the electricity" (Andreas Jahn in Appunn 2015a). There are arguments that the North-to-South power lines are not required, partly because of cost implications and partly because Germany should continue to focus its infrastructure investments those that facilitate a decentralised system (RA Kraemer 2014; Appunn 2015a), but these appear not to influence policy design currently. The BMWi's White Paper But sees grid expansion within Germany as a precondition to well-functioning electricity trading and for the continuation of the single price zone (BMWi 2015e: 14).

4.1.3. Localising Markets

Localising energy markets, from generation through to supply, are seen as one solution to some of the problems discussed above, not least in that they can enable more localised use of electricity, i.e. used where produced, which lowers overall distribution and transmission costs. In addition local markets are seen as potentially beneficial in terms of local economic development (Klagge and Brocke 2012). The, thus far, distributed nature of Germany's energy transition and growing degree of municipal involvement together provide some useful building blocks for local markets (Hockenos 2013). In this context, municipal utilities are sometimes seen as drivers of innovation. There are a few examples of quite progressive municipal companies that have developed models for generating, distributing and supplying energy locally – in ways that to some extent balance local sources of supply with demand. These are seen as sites where experimentation and learning takes place whereby innovations, and lessons learned, can be used to develop municipal projects elsewhere. They also provide the useful function of leadership and proving that energy markets can function in different (local and sustainable) ways.

One early example is Schwäbish Hall, a small market town which acted early to break away from the Big 4, establish its own production facilities, and invest in CHP, IT, and commercial expertise (Hockenos 2013). Today sixty percent of Schwäbish Hall's electricity is produced in the town's 30 CHP facilities, as part of a three-part strategy of combining renewable generation with CHP and energy efficiency. The Schwäbish Hall Stadtwerke has a staff of 500 people and an annual turnover of €237m. It plays an active role as the partner of localities seeking to copy this three-part strategy, and in this way acts as a 'trailblazer' and to help spread knowledge. It is also progressive in that it made provision for direct citizen investment and involvement and is now a community-owned utility (ibid). On a larger scale Cities like Hamburg and Mannheim are also progressive – albeit in different ways. In the September 2013 local referendum the people of Hamburg, Germany's second largest city, voted to take all available steps to completely take-over (re-municipalise) electricity, gas, and district heating networks from Vattenfall and E.ON (as contracts expired). Since 2007, 170 municipalities have brought energy infrastructures back into public hands, whilst others have also bought water services back.

Meanwhile there have also been some development projects ongoing, funded by the Federal Government, focusing on smart grids within regions and/or Cities. For example, the Model City Mannheim (MoMa) and Cuxhaven eTelligence projects, from 2008 to 2012, established energy internets which intelligently control and regulate the local electricity system, from power generation via the grid to power consumption (E-Energy 2016). Each tested a complex IT-based system, which smartly integrates electricity from renewables and CHP into the grids and the regional market, and actively involves residential customers (BMWi 2015e: 46). These were two of the six pilot projects, referred to as 'mini core Cities', that were funded under the "E-energy – IT-based energy system of the future" project (BMWi 2016a). Funding was for €140m, and lasted between 2008 and 2012. A new funding programme was launched in February 2015, the "Smart Energy Showcases – Digital Agenda for the Energy Transition" (SINTEG), which will fund 2 projects with a total of €80m for four years (BMWi 2016b).[22]

Many successful attempts to localise energy are either directly or indirectly supported by Land, or municipal, governance and financial bodies (Interview 27; Hall et al 2016). Local authorities are seen as better placed to actively engage with communities on innovations and to encourage community engagement and municipal utilities are also seen as being capable of providing one bridging element between local generation and energy markets (Nolden 2013: 4), and/or as 'active agents' in deploying distributed energy (Burger & Weinmann 2014: 58). In some areas municipals are supported in turn by Land level governance. For example, some Länder, such as

[22] See the BMWi's publication 'Smart Energy: Made in Germany' for a detailed technical overview of each project (BMWi 2014d).

North-Rhine-Westphalia and Baden Württemberg have their own Climate Protection Acts (Klimaschutzplan) with Land level emissions reduction targets as well as grant and loan schemes (Burger & Weinmann 2014: 57; Interviews 4 and 5). In addition some Landesbanken, as well of course as the KfW, play important roles in financing community projects under devolved lending powers thereby facilitating civic ownership structures (Hall et al 2016). This is partly because some Landesbanken owned by Länder are instructed, like the KfW, to lend at affordable rates (i.e. 3%) (Interview 3). It should be noted here, however, that Länder differ quite considerably in terms of regional attitudes the energy transition, and how it should proceed, as well as in terms of amounts of renewable energy generated in each area (Borchert 2015).

Again, the ability of some Länder to support local energy is tied up not just with general feelings of support for sustainable energy, but also with the possibility of benefits accruing locally. These benefits, moreover, are not just viewed as financial in that community energy can be seen as turning 'invisible' energy into a communal good of self-determination (Burger & Weinmann: 59), as part of the (Re-)Kommunalisierung and Bürgerenergie movements, and or a wider 'emotionalization of energy' (Burger & Weinmann: 58). One argument, along the principle of subsidiarity, is that in the instance that a community cannot meet its own demand then it should source additional supply from the next governing level (Julian 2014: 15). Some further popular support for localising energy comes from those communities that are set against the building of the North-to-South transmission lines (ibid).

One last, more practical, enabler of local energy is the new Direct Marketing law which frees up generators of renewables from selling through the central (EEG) system giving them an opportunity to sell directly to suppliers and/or on exchange (see Julian 2014: 15). This is also intended to strengthen market price signals (BMWi 2014a: 19). As seen in section 2.4.3 on supply in German energy markets, a number of innovative, new players are entering this market. These include Grundgrün and their new 'regional business' model, as well Lichtblick's virtual power plant, or SchwarmEnergie, concept – both of which are highly reliant on the swift communication of data and on up-to-date IT (see p. 33-34). One interviewee noted that the BMWi is currently (December 2016) preparing to enable guarantees of origin (GOs) for EEG power plants on a *regional basis* which would enable suppliers, like Grundgrün, to create regional offerings based on GOs (Interview 25).

There are a number of obstacles, also, to local markets emerging in Germany – mostly associated with the lack of locational marginal pricing and with balancing. The BMWi's report on the outcomes of the 6 E-Energy projects observes that although technologies have advanced market rules, especially around balancing and prequalification for taking part in balancing markets, will need to be changed to better enable local markets (BMWi 2014d: 28). One interviewee claimed that it is still too expensive to be 'off grid' because of the cost of balancing services (Interview 19). Others have claimed that a new market framework is needed for local balancing markets, in addition to national balancing (see also Julian 2014: 15). For the time being, in the E-Energy regions, the feasible flexibilities at distribution grid level are mainly used for balancing within the respective balancing groups and not transferred up to the transmission grid level (BMWi 2014d: 28). It is also understood that large-scale storage innovations would better enable localised markets, but these innovations are seen as long-term and are not a current focus for German energy governance.

Lastly, in terms of obstacles, although in some visions of how energy markets should transition DSOs should become active facilitators of localised energy services (see Mitchell 2016 on Distributed Service Providers), this has not yet been the situation in Germany (Interviews 19, 24, 25 and 26). Indeed, thus far, there have been many complaints that DSOs as an overall group have done as much to hinder distributed energy than to enable it not least due to the lack of transparency in terms of distribution network costs (Clausen & Jahn 2015: 37). Clearly there are examples of more progressive DSOs, like Hamburg who plan to use local distribution to better integrate renewables and enable local supply. In most instances, however, generation, supply and distribution tend not to be run in an integrated fashion even when owned by the same Stadtwerke.

One interviewee claimed that when some municipalities buy back distribution that the grids become less efficient, thereby raising the overall cost of distribution (Interview 24). These costs are, however, not transparent given that the BNetzA have not published aggregate data on distribution network costs (Clausen & Jahn 2015: 37). Some have argued that without sufficient transparency of the regulatory process, and allowed costs, new and innovative market players will hesitate to enter the market (ibid). Others see distribution essentially as a steady, and high, rate of return business that, under legal unbundling, can be used prop up traditional supply revenues. Another part of the problem with DSOs has that they have not been sufficiently motivated through current rules, nor have many had sufficient expertise, to change and become 'smarter' or, indeed, more transparent (ibid). This is a highly fragmented market and many small DSOs already found it hard to build up sufficient IT systems to facilitate switching at the time of residential liberalisation, and they are now being asked to overhaul systems again (Interview 26). Indeed, the BNetzA have identified a real 'intelligence gap' in networks and consider that closing this gap will be a major challenge for DSOs (BNetzA 2011: 2).

Indeed some argue that Direct Marketing rules came into being in part to give renewable generators the opportunity to avoid having to deal directly with inefficient distribution companies, with networks that have been prone to congestion because of an inability to forecast correctly

(Interviews 19, 24 and 26). Although most grid legislation has been focused on the transmission expansion project, there are some moves afoot to improve distribution grids – mainly focused on improved forecasting and pathways to digitalisation. In November 2015 the Federal Cabinet adopted draft smart grid legislation, the Digitalisierungs Gesetz (Digitalisation of the Energiewende), which sets out plans on how to develop smart grids and the programme for adopting smart meters from 2017 onwards (BMWi 2015d). The draft Act also includes technical preconditions and data protection rules for the electricity sector to become digitised.

There have also been long standing discussions over new price formulas, i.e. incentive regulation, to incentivise DSO smart grid improvements over capacity growth, which at the time of writing had not yet been concluded (BMWi 2015e: 15; Interviews 24 and 26). BNetzA decides the level of the cap, but it has already taken 5 years to agree new remuneration for smart grids, and the debate over new incentive regulation is still ongoing. Some claim that, as currently set, the price cap will limit investment in those areas where there are high quantities of renewables and where distribution grids will need to become 100% smart (Interview 24). Some distributors have been negotiating for other changes, for instance currently DSOs must guarantee renewable generators that they will be able to take 100% of their capacity, whilst the suggestion is to guarantee a smaller percent (i.e. 70%) and pay compensation for the rest (ibid). The BMWi's White Paper points out that DSOs are given the possibility to take account of peak shaving in their grid planning (BMWi 2015e: 50).

4.2 Demand Response and System Flexibility

Germany's energy transition has, so far, been focused on increasing the share of renewables in the energy mix and on energy efficiency but it has more recently become more overtly about better renewable integration and how to reach a 'smarter' energy future. Up until quite recently renewables had been integrated partly because there had been overcapacity on the grid (Schulz 2014; Morris 2015e), but this is no longer the case placing greater emphasis on the need for flexibility. This section analyses the various governance decisions and innovations within the broad areas of flexibility (including supply flexibility) and demand response. There are many possible elements that could be included here, but this section will focus on governance for, innovations in, and issues outstanding in:

1. Demand side response
2. Aggregation
3. CHP (as flexible supply and efficiency)
4. Smart meters
5. Storage

Other areas, such as international grid and market integration, are not covered in this section but suffice to say that Germany's electricity markets are increasingly interconnected, as outlined in Section 2, to other European countries. This is seen as a clear positive in terms of flexibility, according to the current State Secretary for Energy:

… the better the integrated the grids in Germany and Europe are, the easier and cheaper the energy transition will be… grids can offset fluctuations (in wind and solar) (Baake 2014).

Indeed, exports of German electricity rose by 40% in 2015 versus 2014, which means that Germany exported almost as much electricity as it generated using natural gas in 2015 (Amelang & Appunn 2015). However, interconnected markets are also seen as a negative to the extent that renewables, paid for by German electricity users, are sold abroad at lower, market prices with implications for the distribution of costs and benefits of the Energiewende.

It is also worth noting that, based on the BMWi's white paper on electricity market reform, Germany is not planning to establish capacity markets to enable flexible fossil fuel generation (BMWi 2015e). The Federal Minister for Economic Affairs and Energy, Siegmar Gabriel, opposes capacity markets on the basis that they tend to preserve existing structures rather than making the electricity market fit for energy transition and other challenges of the future (ibid: 3). Germany is currently planning some changes to upgrade electricity markets, to the Electricity-only-Market 2.0, aspects of which are analysed in the below sections where relevant. It should also be noted that Germany has made a decision on a capacity reserve which is essentially made up of payments to compensate coal-fired electricity generators whilst coal is slowly decommissioned. Specifically, 6 coal-fired electricity plants will be paid for NOT taking part in the energy only markets and payments will cease when those plants are decommissioned (after 4 years from 2015). Again, details on the capacity reserve are currently unfolding.

4.2.1. Demand Side Response, Market Rules and Barriers

It seems clear that the main factor driving governance for greater flexibility, on the demand and supply side, is the need to better integrate fluctuating renewable electricity (see Baake 2014; Interviews 4, 5, 17, 19 and 26). Too little attention has been paid to actively controlling electricity demand so far, there is no clear regulatory framework in place for demand response, and Germany is seen as not as advanced as some US states in devising new rules (Klobasa et al 2013; Schulz 2014). Indeed, Germany is seen as lagging behind certain US states in terms of making firm governance decisions, for example on 'capability' markets designed to enable increased availability of controllable loads (Agora 2013: 17; Bayer 2015; see also Mitchell 2016).

Still what drives much of the debate in Germany is the fact that electricity infrastructure and markets have changed so much over the past few years. For example, falling wholesale prices reflecting generation overcapacity, increased fluctuation of generation, increasing levels of re-dispatch, changing locations of generation, and slow grid upgrades have led to fears about security of supply. This has, to an extent, been addressed through the expensive provision of a ‘cold reserve’. For example BNetzA recommended, in the run up to the Winter of 2012-13, that the TSOs require a ‘cold reserve’ of 2.5 GW to ensure reliable grid operation. Ultimately, however, what needs to happen is greater consolidation of renewables through improved system optimisation in order, ultimately, to find the best combination of demand and supply side responses (see Agora 2013: 22).

Indeed, various reports claim that there is still a lot of untapped opportunity for large-scale load flexibility (see Klobasa et al 2013; BMWi 2014a: 24). One estimate, as mentioned in section 2.1, is that whilst in 2013 only about 2 to 3% of demand was flexible over 50% of demand could in practice respond to supply (Agora 2013: 27). Others claim that some electricity demand can be temporarily shifted without much additional investment, and in many cases affordable thermal storage systems for storage for intermediate products such as chemicals can be introduced (Agora 2013: 27). Experience in the US, furthermore, shows that the costs of increased demand flexibility are often substantially below those of supply-side solutions.

In Germany there are various markets and instruments for balancing generation and demand and ensuring system reliability including:

- the energy markets (spot, day-ahead and intraday);
- the reserve markets;
- the Ordinance Governing Reserve Power Plants (a transitional instrument in place until 2022, but which might become part of a capacity reserve that differs from region to region) (BMWi 2014a: 29);
- and the Ordinance Governing Interruptible Loads (Jacobs et al 2014: 29).

In terms of the energy only markets, as outlined in Section 2, there have already been some changes to day-ahead and intraday rules to allow for greater flexibility, for example quarter hour products on the intra-day market (since 2011) (BMWi 2014a: 21). This change, from the previous one-hour unit, is seen as having boosted competition, improved routes to market for, and integration of, renewables, as well as allowing balancing responsible parties to adhere more closely to their schedules (BMWi 2014a: 21).

The Ordinance Governing Interruptible Loads, of December 2012, has required the TSOs to put 1,500 GW of immediately interruptible loads (with an activation time of 1 second), and a further 1,500 GW of quickly interruptible loads (15 minute activation time), out to tender (Bayer 2015; Koliou et al 2014). Although mainly used to maintain frequency, these loads could (conceivably) be used for financial purposes in the event of very high spot market prices, however unlikely in current market conditions (Bayer 2015: 59). There are very strict prequalification rules for this market: DR interruptible load are defined as major consumption units connect at at least 110 kV voltage level and a minimum interruptible load of 50 MW is required (Koliou et al 2014). Partly for these reasons there are no aggregators operating within this market (ibid), there is some concern about the ability for more load resources to participate in future (Bayer 2015), and according to one interviewee it is likely that the BNetzA will recommend that this ordinance is not extended (Interview 19).

Aside from the Ordinance reserve, and in the absence of any capability market or mechanism, the main markets where demand response can participate are the reserve markets run by the TSOs (Bayer 2015: 58). Most of those involved in demand response on the ancillary services markets are large industrial companies, conventional power plants (for reserve power), and pumped storage plants, although there is a small proportion of flexible load (Jacobs et al 2014: 31). Some are involved independently, TSOs have various direct contracts with ‘big’ providers for demand response (Interview 27), whilst others (usually medium sized businesses) operate through an intermediary/aggregator. For example, Grundgrün offers an electricity product tied to the price on the exchange for capacity-profiled customers, like the Berlin based Bierfabrik, whereby if prices fall because a lot of solar power is being produced, the customer can profit by deliberately shifting its demand (BMWi 2015e: 43).

The current reserve market rules are also seen as being overly strict (see Koliou 2014: 250), although for those that qualify they can earn €2,500 per month per MW of reduced capacity (Koliou 2014: 251). Rules remain overly strict despite the changes that have already been ordered by the BMWi, and implemented by the TSOs via BNetzA, which included lowering the minimum bid size and shortening tendering periods for primary and secondary balancing capacity (BMWi 2014a: 22). Flexible loads must be able to provide 100% of the contractually agreed power for the offer period of seven days with twelve hours each (secondary reserve) or for four hours per day (tertiary reserve) – see Table 2. Suppliers of tertiary and secondary reserve must be able to supply at least 5MW, and the pre-qualification process for all markets can take between 3 and 6 months (ibid; BMWi 2015e: 65; Agora 2013: 28; Interviews 14, 21, 25 and 26). The rules, see below, are seen as having put some industrial demand response off participating in the balancing markets (Agora 2013: 28; Koliou et al 2014: 250). Moreover, the rules governing reserve markets, in terms of pre-qualification, size and availability, are seen as more suitable to flexible generation than demand (Bayer 2015: 58; see also Tweed 2014). This is because existing market rules for flexibility services were developed with a focus on generation side resources (Koliou et al 2014: 250).

Table 2: Auctioning Rules on Reserve Markets

Reserve	Frequency of action	Product duration	Minimum bid size	Pooling
Minute/Tertiary	Each working day	4 hours	5 MW	Yes
Secondary	Weekly	High (8am to 8pm) Low (8pm to 8am) Sat/Sun: all day	5 MW	Yes
Primary	Weekly	1 Week	1 MW	Yes

Source: BMWi 2015e: 65

There are other aspects of current market rules that dampen potential for demand side response. One oft cited problem is that prices on offer for demand response are low and, as such, there is too little available market revenue for demand response (Jahn 2014; Interviews 1, 5, 16, 18, 19, 21 and 25). This is partly due to the fact that a large amount of conventional base-load generation still feeds into the grid at low energy prices but is not flexible enough to fill net demand requirements, resulting in an oversupply of capacity, lack of market value for flexibility, and uneconomic curtailment of renewables (Jahn 2014). Even for large businesses the up front investments required to take part in load response are off-putting, unless the business is a particularly high-energy user (Klobasa et al 2013: 14), which combined with low prices on offer mean that too few take part. Furthermore, bidding zones currently fail to address grid congestion cost-effectively and, although SOs have to re-dispatch supply to ease congestion, demand response is not yet taken into account here (Jahn 2014). What is missing, according to one interviewee, is a regulatory regime for managing local grid congestion, along the lines of a smart-grid/market regime (Interview 26). This is needed to ensure that, at times of congestion, generators and consumers do not only respond to price-signals from the energy exchange but would also be able to respond to signals from local DSOs (ibid). This would require transparency, the availability of local data and clear channels of communication between DSOs, generators, suppliers and other market actors within local areas.

Some of these issues have been recognised by the government and there has been a longstanding political debate over whether to have a *capacity market* or not. Government has been under pressure from conventional generators to establish a capacity market on energy security grounds; whilst more progressive stakeholders have been calling for greater possibilities for demand response within electricity markets along the lines of the US PJM market. Much of the official debate has been framed in energy security and renewable integration terms, rather than around introducing a ‘capability’ style market which would, for example, provide a range of specified incentives for demand side response/flexibility (SDSN 2015: 60; Interviews 4, 5, 6 and 7). The BMWi has issued both a green and white paper on electricity market redesign which outlines a clear reluctance to create capacity markets - instead the current proposal is to establish an updated version of current markets called the 'energy-only-market 2.0' (EOM 2.0). According to the BMWi specific support for flexibility options will not be necessary because (improved) pricing signals from electricity markets should automatically provide incentives for the most cost-efficient option, whilst establishing a new capacity market was also seen as a more risky option (BMWi 2014c; Schlandt 2014).[23] However, although legislation was due to be announced by the end of 2015, and implemented in 2016, no final announcements have been made at the time of writing (i.e. February 2016).

In the EOM 2.0 white paper the BMWi have outlined 20 'no regret measures' that, if implemented, will alter the regulatory framework for the electricity sector (BMWi 2015e: 55). Overall these measures are aimed at improving price signals for consumers and producers; expanding and optimising the grid system; intensifying European integration and co-operation; delivering on climate protection goals; and maintaining a single price zone for Germany (BMWi 2014a). Given that the BMWi's intention is to better integrate demand response within the energy-only-market getting the price signals right will be vital.

One area that is highlighted in the recent green and white papers on electricity market reform is the need to further develop balancing markets rules – especially given ever-greater volumes of fluctuating renewables. A number of suggestions have been put forward, including improving the price signals for flexibility by extending short-term trading, on the assumption that if trading closed closer to the delivery time this could reduce the need for balancing capacity (BMWi 2014a: 21). Others have made more specific suggestions, i.e. a reduction in the product interval, on ancillary markets, from 24 hours to 1 hour, and/or holding day-ahead auctions for all products (Jacobs et al 2014: 32; Bayer 2015: 59; see also Jahn 2014). The BMWi have picked up on these ideas by observing that the secondary balancing capacity and the minute reserve should be tendered every day and perhaps, in addition, that a new short-term balancing energy market, or a secondary market for the provision of balancing capacity, should be introduced (BMWi 2014a 21; BMWi 2015e: 64). The green paper proposes that Minute Reserve product length could be reduced from 4 hours to hourly blocks, which could be supplemented by the possibility to offer block bids (BMWi 2015e: 64). It has also put forward the idea that a uniform pricing procedure be established for balancing markets whereby market participants could offer bids at the level of their marginal cost of the last unit deployed, thereby simplifying bids (ibid).

There is recognition of stakeholder suggestions that there should be separate bid invitations for positive and negative primary balancing capacity and adaptive sizing (i.e. the volume of

[23] For a summary of the pro's and con's of Capacity Markets vs. EOM 2.0 according to the BMWi see p. 45 of the 2014 Green Paper (BMWi 2014a: 45); and p. 55 of the White Paper for a list of all currently suggested amendments to electricity market governance (BMWi 2015e: 55).

balancing capacity put out to tender could be adapted to the particular supply of wind and solar) (ibid: 21). The green paper makes a commitment to considering all these options, as well as to examining the possibility, with BNetzA, of a situation-based balancing capacity bidding process that depends on the supply of wind and solar (ibid: 23). The BMWi will also oversee talks between TSOs and plant operators to modify pre-qualification standards and to open balancing markets up to new providers (ibid: 23; BMWi 2015e: 63).

Another area of focus in the green and white papers with specific relevance for enabling demand response is the current rules around network charges and exemptions. The overall argument is that some aspects of current network changes disincentive demand side response (Agora 2013: 27-28; Interviews 19 and 26). For example, for many industrial consumers grid tariffs are calculated at least in part using the energy prices that result from individual maximum load. As a consequence, industrial customers are at a disadvantage when their yearly maximum loads increase due to demand response measures even if, seen from a whole systems perspective this would be beneficial when i.e. wind power is plentiful (Agora 2013: 27; BMWi 2014a: 24). Another disincentive for commercial demand reduction is that by using over 7,000 hours (load factor) and above 10 GWh per annum business customers can become classed as 'high intensity, base load users' thereby qualifying them for grid tariff exemptions. A company just below this threshold might want to increase demand to qualify for exemptions but, conversely, one just above it is not incentivised to reduce demand (BMWi 2014a: 24; Jahn 2014). In addition, grid fees are applicable to flexible load, but do not apply to flexible generation – thereby reducing the incentive for load to participate (Jacobs et al 2014: 35; Bayer 2015: 59).

BNetzA is currently (February 2016) running a consultation for a further round of improvements to secondary and minute reserves (BNetzA 2015). Furthermore, as with balancing market rules, the BMWi commits in the white paper to re-examining the structure of network charges to address some of these concerns and make demand side response more attractive. Suggestions include a strengthening of capacity prices through charging on the basis of kW instead of kWh and an optimisation of exemption regulations so that privileged consumers can respond with flexibility without losing their privileges in the process (BMWi 2014a: 24). The white paper also suggests that registered meter customers should be charged per hour according to the wholesale price and this should be fixed in the day-ahead auction to give some visibility of prices per hour and thereby incentivise greater flexibility (Interview 25). All of these suggested solutions are about fixing current market structures rather than creating new (capability) markets, partly because this is seen as a more cost effective route. It remains to be seen whether these changes will stimulate more wide-spread demand side response.

4.2.2. *Aggregation of Flexible Load*

To the extent that demand side response has been a component of markets, large consumers have dominated the market. However, as can be seen from Table 2 above, the Minute, Secondary and Primary markets all allow for the pooling of loads and there are a number of aggregators operating in Germany at the moment. Aggregators are seen as providing useful functions in that they: identify and evaluate (small and medium sized) flexible consumers, provide the necessary technical connection, and deliver the flexibility to the market (Jacobs et al 2014: 35; BMWi 2015e: 68), as well as providing various balancing services to TSOs (Hogan & Weston 2014: 25).

Those companies that are currently active in Germany are either specialist aggregators, such as Entelios AG (purchased last year by the large US aggregator, EnerNOC); suppliers with new business models like Grundgrün, Next Kraftwerke and Lichtblick; and ESCOs like GETEC. As outlined in Section 2.4.4 some innovative suppliers, such as Lichtblick, Kraftwerke and Grundgrün, have been active for a few years now in developing virtual power plants and offering generation and load aggregation services (see Koliou et al 2014; Schuppe 2014a). According to one company that offers aggregation services much of their ability to do so is based on the development of smart IT systems that can facilitate communication and remotely adjust consumption and/or manage load (Interview 25).

Entelios AG is Germany's only commercial independent aggregator in Germany and is Germany's leading demand response aggregator through managing industrial load and flexible CHP/biogas plants (EnerNOC 2014: 11; Brewitt 2014). It offers fully automatic industrial 'Demand-Response-as-a-Service' solutions that provide pooling that meets secondary control reserve requirements (Kolious 2014: 251). It employs high-end demand management technologies with the capability to aggregate loads, on-site generation, and industrial process storage to capture sub-meter data and make that data available in real time (EnerNOC 2014; Brewitt 2014). Availability of data is clearly of paramount importance for all aggregation services. Aggregators (of supply and demand) mostly operate on balancing markets, in particular the Minute and Secondary reserve markets (Interviews 14 and 25). However, suppliers that offer aggregation services can be simultaneously active in lots of markets thereby having visibility of multiple flows and the opportunity to amass information that can lead to better risk management (Interview 25).

So far, however, aggregation of demand response is seen to be just 'at the door' in Germany, but not yet fully participating in markets (Interview 19). This is partly because in the absence of real time data and given standard load profiles for smaller customers it remains difficult to aggregate demand from small-scale and/or household consumers (Interviews 14 and 25). Both of these issues might be partially addressed through a broad roll-out of smart meters – see Section 4.2.4 below. It is also economically difficult for aggregators at the moment partly for the governance reasons outlined in section 4.2.1 above: i.e. because incentives for demand side response remain low (Interviews 16 and 18), and because of pre-qualification requirements and strict balancing market rules (BNetzA 2015: 16). For example, although primary and secondary reserve requirements have been reduced in Germany, planning periods are still too long for many aggregators (Koliou et al 2014: 251). For aggregators that are new market entrants, lacking in experience of balancing participation, shorter planning periods would decrease forecasting errors (ibid).

Aggregation of distributed generation has to some extent been facilitated, see Sections 2.4.4 and 4.1, by new Direct Marketing rules that allow for new routes to market for distributed renewable generation. However, when it comes to legal structures in place to support aggregation, very little exists. Although there is a legal definition of an aggregator in Article 2(45) of the EU's Energy Efficiency Directive there is no definition in German legislation (BNetzA 2015a: 4). Indeed, aggregators are sometimes referred to in policy documents as 'pool suppliers' (BMWi 2015e). Furthermore, the EU definition is rather narrow: '… a load management service provider that bundles short-term consumer loads for the purpose of sale or auction in organised energy markets' (BNetzA 2015a: 4). The BMWi also points out that there are currently no specific rules on the rights and obligations of aggregators in the EOM 2.0 (BMWi 2015e: 68).

There is some work being done at EU level to improve legal recognition of and to provide greater governance support for aggregators. The European Commission has established a working group at DG ENER including E3G and ACER's work on the Network Code on Electricity Balancing (ibid). In addition, the European Association 'Smart Energy Demand Coalition' (SEDC), as a supporter of the aggregator model is playing a major role in trying to shape opinion in Europe and in depicting the framework condition of the German electricity market as an obstacle to the development of the aggregator model (BnetzA 2015: 3).
One of the principal areas of concern is that the dependency of the aggregator on the existing market roles of balancing group manager and/or supplier represents a significant barrier to market entry and expansion (ibid: 15). This has led to calls for the establishment of 'aggregator' as an independent market role with its own rights and obligations, with the Swiss and French model having been presented as exemplary solutions (BNetzA 2015: 16).

Aside from the lack of clear legal identity and associated rights, the main obstacle identified in quite a few reports has to do with the bundling of roles. Basically aggregators, because they have no separate identity under German law, are usually registered as suppliers. However, this bundling of roles creates an unnecessary barrier to market entry by placing service providers (i.e. demand aggregators) in a position of either being in direct competition with incumbent suppliers or being required to negotiate balancing exposure remedies with such suppliers (Hogan & Weston 2014: 25; Interview 25). Aggregators retain responsibility for the balancing account for delivery and so have to be a supplier as well and this limits the market (Interview 25).

Furthermore, within the context of unbundling rules each market participant has a separate role and aggregators must make separate arrangements with each market participant (Klobasa et al 2013: 14; Jahn 2014). As such, demand response aggregators require individual contracts with balancing group managers; electricity traders; TSOs and DSOs for which there are still no standard rules or contractual obligations (Jacobs et al 2014: 35). Bilateral agreements are also necessary between the supplier and the aggregator regarding procedures for compensating the energy withdrawn from the supplier's balancing group (BNetA 2015: 14). Important questions also need to be resolved within market governance rules regarding the role of the consumer that provides demand response through an aggregator. Currently suppliers take balancing responsibility for end-users but it is unclear with the provision of demand response who the consumer will transfer the responsibility to (Koliou et al 2014: 251).

There has, therefore, been some discussion about whether aggregators should be able to act without becoming a 'balancing responsible partner' (BRP) for wholesale markets but being a BRP for ancillary services markets only (Interview 19). Other have argued for a separating out of the roles of electricity supplier and balancing responsible party on the basis that demand aggregation is a separate service provided to customers at their discretion (Hogan & Weston 2014: 25). Under the French and Swiss models that provide legal rules for aggregators, discussed above, the requirement for a bilateral agreement would replaced by a fixed, standardised procedure that indemnifies the supplier and/or balancing group manager. The TSO, as a so-called neutral entity, would be responsible for both the balancing out of balancing groups and the settlement of monetary demands (BNetzA 2015: 16). One group, the 'Transdisciplinary Panel on Energy Change', proposes that the role of aggregators should be defined in the EnWG, and standard contracts and communication interfaces should be introduced (Jacobs et al 2014: 35).

Generally speaking there is, however, little being done in governance terms yet to directly address some of the above issues. Some of the issues, around market incentives/prices and pre-qualification rules, are partially addressed by some of the 'no regret measures' of the EOM 2.0 white paper outlined in Section 4.2.1. BNetzA was asked by BMWi to make a study the aggregators concerns and this has led to a position paper in 2015 (BNetzA 2015: 16). This paper concludes that when it comes to the integration of new roles, such as aggregator, competition must be protected and existing market participants taken into consideration (ibid). ‘Special treatment’ for new market participants does not, according to the BNetzA, seem justified and is therefore not eligible for support from the BNetzA.

The EOM 2.0 white paper does cover some of these issues, and ‘no regret’ measure no. 10 is: ‘Clarifying rules for the aggregation of flexible electricity consumers’ (BMWi 2015e: 55). Suggested solutions are that the “rights and obligations of aggregators in the electricity markets will be evaluated” and, to this end, that the BMWi and BNetzA will enter into a dialogue with the relevant stakeholders (ibid: 68). As a ‘first step’, the BMWi suggests that access for aggregators to the balancing energy markets is to be simplified. In the minute reserve aggregators already have the right to access balancing groups, but this right will also be extended to secondary balancing markets.

4.2.3. Combined-heat-and power (CHP) and Flexible Generation

According to Rainer Baake, the current Secretary of State for Energy, the German energy system needs to become more flexible also through the means of flexible generation.

Conventional electricity generators have always needed to adapt their output to the constant… changes in demand. Now they need to also take account of the weather-dependent output of electricity from the wind and the sun (Baake 2014).

Within this context combined-heat-and-power (CHP) is widely viewed in Germany as a flexible generation technology which is a good complement to the expansion of renewables (BMWi 2014a: 37). In theory, demand side response and controllable generation (through use of pumped storage) will together reduce the need for expensive start-up and shutdown procedures at fossil-fuelled power plants (Agora 2013: 9). It is also a widely held view that preference, in governance terms, should be given to gas-fired CHP over non-combined, conventional generation (BMWi 2015e: 18). Currently, as seen in section 2.2, CHP is mainly sourced from coal and gas and not from renewables.

As such, German legislators have implemented measures such as the Heat-Power Cogeneration Act (KWKG), announced in 2002 and revised in 2009, which includes an incentive scheme. This law was, however, concentrated on making heat production more efficient and lower emmission, but was not concentrated on enabling CHP as flexible generation. There is no special payment but the incentive comes from a bonus for the power produced: i.e. since 2009 CHP operators have received support of 5.41 cts€/kWh for small installations, decreasing according to size of plant to 1.8 cts€/kWh for the largest plants. Biogenic CHP is supported with

FiTs under the EEG (Appunn 2015c: 2; Interviews 3, 19 and 23). CHP from renewable sources, like renewable electricity in the EEG, has priority access to the grid. There are further benefits for micro- and industrial CHP including exemptions from grid fees, the EEG surcharge and other levies and taxes on the power price (Appunn 2015c: 3), worth up to €700m per annum (Interview 19). The initial aim of KWKG was to get 25% of German gross power production from CHP (it was 14.5% in 2010 and 16.2% in 2013) (ibid; Appunn 2015c: 2).

One third of all installed CHP generation in Germany is produced by industrial companies, a half comes from general supply stations operated by local utilities, whilst the remaining share is made up of biogenic and small, decentralised (micro-CHP) facilities (Appunn 2015c: 2). There are some new CHP products and services coming to market. For example, Lichtblick's EcoBlue natural-gas-powered CHP cogeneration plants, developed in partnership with Volkwagen. When installed the EcoBlue plants provide 100% of heat and hot water, whilst also supplying power to the grid. Lichtblick retains ownership of and maintains the systems, and controls each unit's operation wirelessly from a central location as part of its swarm power concept (see Section 2.4.4). These CHPs can be run when electricity is needed, and can also store heat in water (GreenSpec 2015).

Generally speaking, however, because of decreasing wholesale prices and shorter operating hours market conditions for much existing CHP have been very difficult (Appunn 2015c: 3). This has applied in particular to the more environmentally friendly gas-fired CHP which, according to many municipal utilities, is very difficult to operate without a loss (ibid). Partly for these reasons quite considerable changes were announced to the KWKG in mid-2015 – which will apply from January 2016 to December 2020. The new law contains a downward adjustment to the CHP target from 25% of total electricity generation to 25% of *thermal power generation* (or 110 TWh from 140 TWh by 2020) (BMWi 2015e: 74; Appunn 2015c: 2; Interview 23). With the exception of plants with a capacity below 100kW, power from CHP plants has become subject to mandatory Direct Marketing, but at the same time the total sum of CHP premiums that can be paid annually, in addition to revenue, has been raised from €750m to €1.5bn (Lang & Lang 2015e). New support levels are also higher than under KWKG 2009: 8 cts€/kWh for capacity up to 50 kW; 5 cts€/kWh for capacity between 50 kW and 250 kW; 4.4 cts€/kWh between 250 and 2,000 kW; and 3.1 cts€/kWh above 2,000 kW (ibid). These premiums only apply to plants that feed into the grid for the general supply, and not to new or existing coal-fired plants including those that are modernised (ibid). It is expected that those that will benefit from these changes will largely be Stadtwerke, whilst industrial CHP came off relatively less well (Interviews 19 and 23). In addition the decision to remove some tariff exemptions for self-supply may have implications for some micro-CHP (Interviews 19 and 23).

Still these changes were largely focused on improving the environmental quality of efficient CHP generation rather than establishing conditions for CHP to become a more easily utilised source of flexible generation. As such, the operation of CHP and biomass power plants is not generally dictated by demand for electricity, rather CHP facilities are generally still driven by the need for heat with electricity as a by product. In addition, most biomass currently operates in continuous mode, as this is the best way to make use of EEG remuneration rules (Agora 2013: 10). This is despite the fact that more than 1.5m residential heat-pumps and thermal storage space-heating systems already have the capability to be enabled and disabled for fast response. In some instances CHP, on 'must-run' mode can drive out renewable generation (Interview 26). To make CHP more flexible thermal storage and electric heating are required but both add extra investment costs, in addition CHP that is run in 'self-consumption' mode is less flexible given that economic incentives (partly related to exemptions) reward staying off grid (ibid).

Again, various rules seem to be at fault here. For instance, by regulation heat-pumps and thermal space-heating systems can only be used to balance local network operation with predictable, ex-ante announcements. As such, some argue that regulated operators should be allowed to interrupt heating systems for system requirements (Jahn 2014). Others argue that a shift of decision-making from the system operator to supplier could lead to more load flexibility, given that all suppliers bear the economic cost of procurement decisions and are more dependent on the accurateness of forecasts than DSOs (Klobasa et al 2013: 15). However, the transaction costs for existing space heating systems are still too high to make this flexibility accessible, largely due to network charges (Interview 19).

The EOM 2.0 white paper does attempt to solve some of these issues around CHP as flexibility and there is an overt recognition of the need to *clarify the role* of CHP plants in the restructuring of the power plant fleet (BMWi 2014a: 37). 'No regret measure 16' is about better integrating CHP generation into the electricity market (BMWi 2015e: 74). Some measures suggested that are more to do with lowering emissions from CHP have already been implemented through the above-mentioned revisions to the CHP law. One proposed measure, more targeted at improving flexibility, is to increase the eligible volume of investment in electric heating networks and thermal storage. This, it is proposed, will enable the installation of the larger heat storage units that are needed so that unchanged levels of demand for heat can be met whilst also allowing for the flexibilisation of electricity generation (ibid). In addition, as part of the KWKG 2016 the government has committed to a further, comprehensive evaluation of CHP power generation by 2018. Again, these suggestions tend to solve only a few of the issues facing a further flexibilisation of CHP outlined in this section.

4.2.4. *Smart Meters*

The BMWi openly recognises a role for smart meters within the Energiewende, and broader plans for a digitalisation of the economy – however specific rules have not yet been finalised. In the EOM 2.0 white paper smart meters are seen as useful in that they provide market players with information about the development of consumption and generation and pass on price signals to consumers quickly, thereby replacing forecasts based on estimates and imprecise load profiles (BMWi 2015e: 71). They are also seen as important to generating new business models and market opportunities for companies in the energy sector, small-scale producers, commercial operations and large private consumers. All this is seen as a vital part of moving the electricity sector into the age of the modern industrial society (i.e. "Industrie 4.0") (ibid).

Pilot studies, such as the Cuxhaven E-Energy projects, that installed smart meters in households (often along with software/apps on smart phones and tablets) found that, when used in conjunction with innovative tariffs, they did enable good levels of demand response and greater efficiency (BMWi 2014d: and 2015e: 47). There is a small, emerging 'smart home' market in Germany with products being offered by RWE (i.e. the Nest), Google/telecoms, and Amazon (Interview 14). Households who want to be more proactive and/or who want to install a new meter need to pay €100. In total, in 2013, estimates are that there were 500,000 smart or intelligent meters installed in Germany.

The German Federal government has, partly in response to the EU Smart Meter Directive (Interview 19), made a decision on smart meters as part of the updated Energy Industry Act (EnWG). Some interviewees have noted, however, that the decision has been difficult, that smart meter legislation has been delayed since 2010, and that some companies have already gone bankrupt waiting for legislation to be announced (Interview 26). The legislation follows a differentiated but compulsory phasing in programme. Measurement systems are to be installed, as of 2017, in new buildings, in buildings undergoing major refurbishment and for customers consuming over 6000 kWh per annum. They are also to be installed in new plant operators, under EEG or power-heat coupling law, with an installed capacity of more than 7kW (Bayer 2015b: 35). A measurement system is defined as a device connected to a communication network which reflects the actual energy consumption and actual time of use (ibid).

The cost benefit analysis, prepared by Ernst & Young for the BMWi, released in 2013 made more distinction between available meters. 'Smart' meters were defined as those capable of communicating information on energy consumption and time of use to energy companies, whilst 'intelligent' meters show end users their actual energy use via an in-home display but do not communicate the information to the utility (ibid). 'Intelligent' meters can, at some point in time be upgraded to 'smart' meters. As a result of this analysis it was decided, as part of the EU

Electricity Directive, that 'smart meters' should be installed for the groups mentioned above, whilst it is recommended that household/small consumers replace current meters with 'intelligent' ones, but only within the normal replacement cycle for meters. It sets an indicative goal of equipping 80% of consumers with 'intelligent' meters by 2020. The EOM 2.0 white paper's 'no regret measure 13' which reiterates the need to gradually introduce smart meters in Germany (BMWi 2015e: 55). Although no final decisions have been made as of the time of writing (February 2016), it appears that Germany will stick with the EnWG roll-out system, although there does seem to be some discussion about lifting the obligation for new buildings and buildings undergoing major renovation (Lang & Lang 2015f).

There appear to be a number of other obstacles in the way of Germany adopting the EU Smart Meter Directive in practice (Interviews 19 and 25), in addition to the lack of detail in terms of new rules. The first is that, as in the UK, there are concerns that without more suppliers offering flexible tariffs according to time of day (i.e. time of use tariffs) then smart meters will have little benefit (Amelang & Thalman 2015). The second is that German consumer protection regulation, regarding data handling, makes smart meters more expensive and too expensive to include a mandated roll-out to small and/or household consumers (Interviews 1, 19 and 26; BMWi 2015e: 71). The EOM 2.0 white paper states that there will need to be a 'data communications ordinance' which will stipulate who can and/or should receive what data, how often, from whom, and for what purpose (BMWI 2015e: 71). Because of how important consumer protection is in Germany the Federal Office for Information Security (BSI) is also involved in the development of protection profiles and technical guidelines. They are expected to stipulate a very high standard for the smart meter gateway (ie. the metering system's communications unit) (ibid). However, others point out that some questions remain unanswered about who is responsible for the data that is revealed through smart meter use (Interview 19).

The EOM 2.0 white paper proposes that, in addition to the 'data communications ordinance' there should be two other ordinances associated with smart meter roll-outs:

- A Measurement System Ordinance: which contains the technical requirements, i.e. standards and technical guidelines for data protection, security, and interoperability;
- A Rollout Ordinance: which regulates who is obliged to install smart meters in the sense of the law and by when.

It further suggests that the roll-out should also use standardised technology which can be applied in many different settings (BMWi 2015e: 71), but some argue that meters have not yet been developed that comply with German security/consumer protection standards (Bayer 2015b: 36). Others have pointed out that some meter contracts can only be for 3 years and this makes them less financially viable (ibid: 37; Interview 19).

There seems to be a further issue with the currently intended role for DSOs in the roll out of smart meters. DSOs have ‘default’ responsibilities for smart meters and for meter reading (Interview 25). If they can’t manage this, and there is suspicion that they won’t be able to, then they will have to auction rights to all smart metering responsibilities and/or co-operate with a service provider (Interview 26). In addition, if the DSO can’t install the meter for €100 then the price will be capped (Interview 19).

4.2.5 Storage

This section very briefly covers governance for storage/batteries and innovations in German markets. This is worth mentioning here because of Germany’s reasonably well-developed track record of support, and because of some interesting innovations in PV storage (Interviews 14 and 17; Arcus 2016). As with most areas of energy governance, there are various views about the role of storage within the long energy system transition process. One is that large scale storage will only really be needed in the long-term, i.e. as a ‘Phase 4’ measure. Specifically from this perspective it will not be needed in any widespread sense until 2035, or when renewables have reached 60% of gross electricity consumption (Deutsch & Graichen 2015: 1). This view is partly based on comparative costs arguments, for example one claim is that it is cheaper to build more grid, and inter-connect with other countries, than it is to invest in storage (Agora 2013: 14-15).

However, others claim precisely the opposite: that storage will solve the need to build more (especially low-voltage) grids by enabling more off grid projects (BMWi 2015e: 45; Interviews 20 and 24). The claim is that battery storage systems, combined with PV power units, can enable households and firms to use a greater proportion of the decentralized power they generate and to purchase less electricity from the system. Certainly partial exemptions from taxes, surcharges and fees from prosumption, although reduced, can still make investments in facilities of this kind attractive from an individual economic perspective in the medium term. However, fees avoided by prosumers are paid for by other consumers so this route is arguably less attractive in terms of whole system costs (Agora 2013: 15). Some important organisations, such as the Committee on Energy, Science and Technology, are pushing for more investment in storage.

The official BMWi line, in the current white paper, is that more battery storage will only be needed when there is a much higher share of renewables (BMWi 2015e: 45). There are, however, two main initiatives already in place to subsidise investments, and to support R&D, in storage technologies (BMWi 2016c):

- The Inter-departmental Funding Initiative for Energy Storage: this focuses on wind to hydrogen storage systems; batteries in distribution grids and thermal storage systems;

- The Funding Programme for Decentralised Battery Storage Systems: this is sponsored by BMUB and the KfW banking group and subsidises investments in battery storage systems that are operated in conjunction with PV installations.

The Funding Programme for Decentralised Battery Storage Systems started on 1 May 2013. The incentive programme operates with low interest loans from the KfW and a grant, which is financed through Germany's federal budget, towards the repayment of the investment costs for the storage system (ibid; BMWi 2015a). Subsidies will continue until the end of 2015, with discussions under way to extend the programme and indications, from Minister Gabriel, that they should continue (Enkhardt & Beetz 2015; Interview 19). According to the KfW bank 10,100 storage batteries for small PV systems have been subsidised since the programme started totalling €163m in subsidies (as of 1Q 2015).

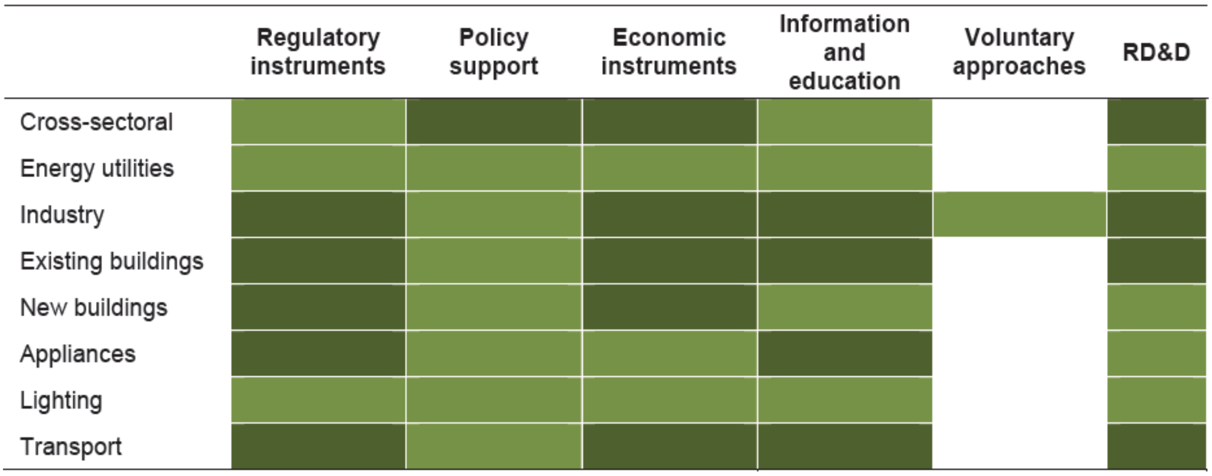
Tesla has been making big moves in the battery market, and not just in Germany where they have teamed up with Lichtblick in the household market to expand sales of Tesla products (Interview 14). They have announced the new 'Powerwall Home Battery' with the prospect of storage costs per charge cycle of 20cts€/kWh, and this has raised expectations about the potential for the use of storage with PV (Deutsch & Graichen 2015: 1). The Powerwall is a home battery that charges using electricity generated from solar panels, or when electricity rates are low, and powers the home in the evening (Tesla 2016). It is automated, compact, simple to install, and even looks quite good. This is a growing market. It is reported that German consumers are increasingly attracted to solar plus storage because consumer electricity tariffs are so high, and because self-consumption still results in some discount in grid, EEG and other fees. Although PV sales are expected to drop in 2015, it is also expected that a third of all residential PV systems will be sold with a battery pack (from only a fifth in 2014) (Deign 2015). Aside from Tesla, other companies involved in this market are BSW-Solar and E3/DC.

There are other innovations being developed – some by GETEC, Germany's largest ESCO. On 3 November GETEC, Daimler, and The Mobility House announced the launch of the world's largest stationary (non-vehicle) storage made from used vehicle batteries (The Mobility House 2015). GETEC are also due to sign a special purpose vehicle deal with Daimler to use old batteries from electric cars to provide network regulating services to 50 Herz (Interview 21). The next innovations might come from using ex-mobile phone batteries and selling battery capacity at auction and for peak shaving (ibid). Another research project ongoing is called MobiliTy – Smart Mobility Thüringen and it is focusing on the technical realisation of demand side management via electric mobility (BMWi 2015e: 43-45).

4.3 Energy Efficiency

A number of scholarly articles have focused on energy efficiency policy in Germany up to 2013 – often with a specific focus on buildings efficiency policy and also making reference to the achievements of KfW lending and grant schemes (Rosenow 2013; Rosenow & Galvin 2013; UCL 2011). Certainly Germany has been active in energy efficiency policy-making for some decades now. Energy efficiency was part of the response to the 1970s energy crises when Germany, as an importer of fossil fuels, responded by making its economy less vulnerable to such shocks (BMWi 2014c: 2; Seefeldt 2015: 4). As seen in section 2.1, Germany has been relatively successful in improving energy efficiency and policies have so far are seen as having been effective - in terms of lowering emissions, improving affordability and also in terms of creating new energy efficiency markets (Prognos in BMWi 2014b: 12; Youngs et al 2014; IEA 2015; Cludius et al 2015b). Indeed, as Figure 6 illustrates Germany has a wide variety of policies already in place to improve energy efficiency and not just in utility, industry and buildings sectors. It is notable that Germany has emphasised regulatory and economic instruments and RD&D support over voluntary approaches to ensuring improvements in energy efficiency.

Figure 7: German Energy Efficiency Policies (by Type and Sector)



DARK GREEN = Several relevant policies are in place. GREEN = At least one relevant policy is in place. WHITE = No relevant policies have been identified in EE PAMS.

It is widely claimed that there is, however, much yet to be done and efficiency remains a very active arena for German Federal policymakers. One of the two energy divisions within the BMWi has an overall emphasis on energy efficiency, i.e. the ‘Energy Policy – Heating and Efficiency’ directorate, whilst there has also been some talk of establishing a Federal Agency for Energy Efficiency within BMWi (Interviews 3, 19 and 23). Overall responsibility for buildings efficiency lies with BMUB but in practice there is co-competence for buildings efficiency whereby BMWi tends to set the strategy and BMUB operationalises policy (Interview 3).

Clear policy direction has already been set in that energy efficiency has been labelled as a core policy goal, indeed it is referred to as "…the twin pillar of the energy transition" (BMWi 2014a: 2; BMWi 2014b: 4). The Energiewende targets a reduction of 20% in primary energy consumption by 2020, and of 50% by 2050 compared to 2008 levels; a 10% reduction in electricity consumption by 2020, and 25% by 2050; as well as an average annual increase in productivity of 2.1% (BMUB 2013; Agora 2016). In addition, beneath these formal Energiewende targets there is an official sub-goal of renovating existing stock at a rate of 2% per annum, with all stock to have been renovated by 2050 (Interview 5). This should deliver 20% more energy savings for heat by 2020, and by 2050 an 80% reduction in primary energy consumption in the buildings sector and a near climate-neutral building stock (BMUB 2013). This is why the biggest share of potential CO2 reductions specified in the Climate Action Plan 2014, 25-30 million tonnes, is to come from energy efficiency measures (Appunn 2014b). As is the case with other energy transition policies, Federal targets drive efficiency policy:

Targets sets by the Federal Government… for reducing energy consumption compared with the baseline year 2008… form the basis and frame of reference for this policy (NAPE) (BMWi 2014b: 8)

German energy efficiency policy has not, however, been just about the low carbon transition per se, but it is also seen as an *opportunity* to make the transition as cost efficient as possible whilst also improving Germany's green industrial base. There is an official aim to boost "Germany's leading global position as a business location" as well as enabling Germany to succeed on world markets through new business models, innovations for energy-saving measures and innovative new products (BMWi 2014b: 2). The BMWi has produced a report entitled 'Energy Efficiency: Made in Germany'. This report outlines government policies on enabling energy efficiency industry in Germany as well as highlighting the new industries that have been established to provide products for energy efficiency in industry, buildings service technology, and transport sectors (BMWi 2014c). This report states that under conditions of rising energy prices and looming resource scarcity prosperity and competitiveness depend on Germany's ability to use energy as efficiency as possible (ibid: 2). In this way energy efficiency has multiple policy drivers behind it, and it can be said that there has been more political emphasis thus far on efficiency than there has been on demand response. Indeed, the BMUB has stated its ambition for Germany to become the "world champion' in energy efficiency" (BMUB 2016).

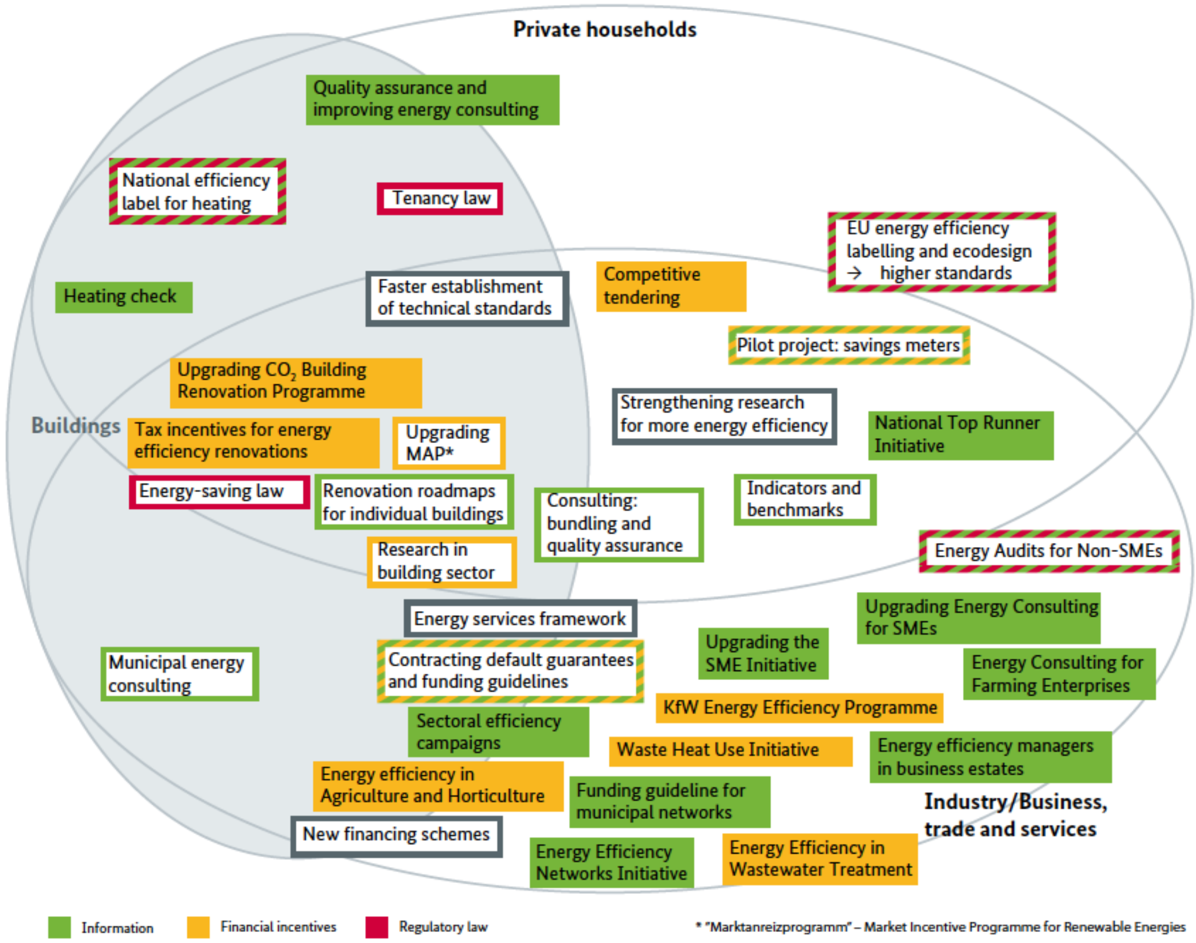
4.3.1 The National Action Programme on Energy Efficiency (NAPE)

Despite Germany's early action on energy efficiency, and its reasonably successful subsidised loan and grant schemes, there are those that were not convinced that enough was being done, partly because of the overall bias towards supply side (nuclear and renewables) policy (Burger & Weinmann 2014: 49; Amelang 2015b: 2; Seefeldt 2015: 4). Some felt that the buildings efficiency programmes were developing too slowly in terms of implementation, with too much reliance on the 'selbstläufer' (auto-pilot) of the market and not enough regulation, supervision and co-operation (Buchan 2012: 31). Others suggested that the improvement in industrial efficiency was not as good as superficial numbers would suggest because of the links between industry energy efficiency measurements and low capacity use during the economic slowdown/crisis of 2008-2010 (Schlomann & Eichhammer 2013: 3). In addition, there were claims, in 2013, that although ambitious targets had been adopted in 2010 there had been a lack of policy action, which was blamed on the previous administration and on certain personnel at the BMWi (Amelang 2015b; 2).

In addition to critiques within the domestic market Germany had also been under some pressure from the EU to take greater action on energy efficiency and to transpose the EU Directive on Energy Efficiency into German national policy. Germany has, as part of the EU Directive, submitted three Energy Efficiency Action Plans (NEEAPs) to the EU in 2007, 2011 and 2014 (ibid: 2; Interview 3). In addition, partly in response to internal critique, Germany adopted a new 'National Action Plan on Energy Efficiency' (NAPE) in December 2014 and it was enacted as part of the Climate Action Plan 2020 (SDSN 2015). Within the NAPE there was an emphasis on near term incentives and on creating a market for the longer term where efficiency is well established as a business opportunity that can thrive without the need for financial support (Amelang 2015b: 2; BMWi 2014b; Interview 3).[24] NAPE also places emphasis on supplying more information and advice about how to make savings to individuals, businesses and municipals (BMWi 2014b). It also proposes a quite comprehensive range of specific measures (see Figure 7) to both oblige and incentive more energy efficiency, with the specific aim of meeting Energiewende demand reduction and other climate mitigation targets (BMWi 2014b: 4; Interview 3).

[24] For a quick overview of all the measures contained in the National Action Plan on Energy Efficiency see BMWi's webpage here: http://www.bmwi.de/EN/Topics/Energy/Energy-Efficiency/nape,did=680402.html

Figure 8: Proposed Measures Included in the NAPE



Source: BMWi 2014b: 6

The NAPE was just starting to be 'rolled out', in Summer 2015, at which point of the 34 proposed measures 10/12 were 'live', 10 were in preparation and 10 were still under discussion (Interview 3). The NAPE included one significant new measure, the 'tax incentives for energy efficiency renovations'. This was designed to encourage improvements in buildings through tax exemptions for retrofits, and a write-off of retrofitting costs against tax over 10 years. €1bn in annual tax breaks were planned over the 10 years, and this measure was expected to save 2.1 million tonnes of CO2 (Appunn 2014b: 1). Although this measure passed in the Bundestag, it was opposed (by Bavaria) in the Bundesrat and is, as a result, no longer part of the NAPE. It has since been replaced by a new €165m per annum energy efficiency incentive programme which will support: investment grants for fuel cell heating systems; more funding for efficient heating systems to replace old systems; special funding for increasing energy efficiency and residential value (Lang & Lang 2015g).

Aside from the tax incentive scheme the other main new NAPE measure, discussed below, is a competitive tendering system in which bidders can compete for funds: €15m was available in

2015, growing to €150m per annum from 2018 to 2020. NAPE also includes new regulations on energy efficiency ratings as part of the 'National Top Runner Initiative' (NTRI), designed to save 5.1 million tonnes CO2; a mandatory audit every 4 years for all large companies; and the new 'Energy Efficiency Network Initiative' which is expected to save 5 million tonnes of CO2 (Appunn 2014b: 1). Lastly, some additional financial support for the KfW grant and subsidised loan schemes was also announced – taking the annual amount available up to €2bn for energy efficiency renovations. Taking all the NAPE measures together energy efficiency incentives are the biggest items, aside from broadband expansion, that increased state aid in the Federal budget for 2016, as measured by the Federal Ministry of Finance (Lang & Lang 2015h).

4.3.1.1 Measures Aimed at Industry

It might be worth, at this point, distinguishing between NAPE measures aimed at industry, in terms of improving operational efficiency, and those aimed at buildings and household sectors. Arguably, so far, more emphasis in policy terms has been placed on households, but measures aimed at industry were included – partly in response to claims, above, that improvements in industrial efficiency would not have been so good in the absence of economic crisis. Indeed, 40% of the energy used in Germany is consumed in trade and industry and in the services sector (BMWi 2014c: 15), whilst recent figures show that final energy consumption remained flat in the 'mining and manufacturing' industries between 2005 and 2013 Clean Energy Wire 2015). There appears to have been a degree of reluctance on the part of some industry members to become more efficient and certainly, as outlined in section 4.1, grid and tax exemption rules tend to disincentivise demand response.[25] One important industry body, the BDI, has argued for tougher regulation of household efficiency rather than for industrial efficiency mandates. One argument is that greater energy efficiency in industry would be commercially unattractive because energy use is attached to the quality of the product (i.e. in steel and chemical processes) (Interview 20).

One survey of international advances in energy efficiency, which places Germany in the No. 1 position, argues that advances in industrial energy efficiency are related to the incentive programmes in place, rather than to voluntary energy-savings targets (Young et al 2014: 47). Germany has funding programmes to increase energy efficiency in manufacturing production processes by providing subsidies for upgrading technology and equipment (ibid). Some legislation is aimed at the energy efficiency and product manufacturing industries. For example, the NTRI, which is part of NAPE, aims to speed up the production and penetration of high-

[25] Although exemptions from electricity and energy taxes are only granted to companies that have introduced energy or environmental management systems (AIIFL 2013: 7; BMWi 2014b: 15).

quality efficiency products through application across Germany of the Energy Labelling and the EU Ecodesign Directives.

In terms of policies aimed at improving the efficiency of industrial production processes the new 'Energy Efficiency Network Initiative', which also is part of NAPE, is designed to encourage the establishment of business efficiency new networks (BMWi 2014b: 21). This initiative has been constructed with the intention of saving 5 tonnes of CO2 equivalent by 2020 (ibid). These new networks are intended to improve knowledge sharing and co-ordination between companies within localities, and they are underpinned by state aid (Appunn 2014b; BMWi 2014b: 2). Each new group will be based on a set legal structure and although membership is voluntary it will be monitored by BMWi. Networks need to prove that: they have suitable structures; they share information; and that members are pursuing concrete steps to be more efficient (for example, process steam/industrial by-product could be distributed to a local utility for house heating) (Interview 20). The plan is to have 500 energy efficiency networks of between 8 and 15 businesses with collective energy efficiency targets and that each should develop pilot projects for the introduction of energy management systems in its member companies (ibid).

These networks are also a way of enabling companies to produce the new mandatory energy audit every 4 years (Clean Energy Wire 2014). It should be noted that Germany also has a well-established ESCO market that can be useful in enabling greater commercial energy efficiency. The ESCO industry in Germany is worth about €5bn per annum, with 500-550 companies currently operational (Bertoldi et al 2014: 79; Seefeldt 2015: 6). In addition, the Germany Energy Agency (dena) has an ongoing campaign entitled 'Energy-Efficient Systems in Trade and Industry' (BMWi 2014c: 13), which provides advice on how to save money and on payback periods. The assumption is that, on average, companies can still reduce the electricity consumed by pumps by approx. 30% (ibid).

With regard to smaller companies, the KfW has a targeted Energy Efficiency programme whereby SMEs can obtain low-interest loans to finance energy efficiency measures including: building services; building envelopes; machinery; process cooling and heat, heat recovery/waste heat use; and new information and communications technology (BMWi 2014c: 14).

The BMUB, BMWi, BDI and the German Federation of Skilled Crafts have also launched a programme aimed at SMEs, the 'Mittelstandsinitiative Energiewende', which provides information and advice on how to reduce energy consumption and costs using efficiency measures (BMUB 2013). The incentive for SMEs to improve energy efficiency are greater than for larger (industrial) companies to the extent that they, as outlined in Section 2.4, often tend to pay higher electricity tariffs. In addition EU state aid rules allow for more direct support for SMEs than for large companies (Interview 3). The NAPE upgrades the SME programme by increasing the grants available under the Energy Consulting programme (as of January 2015), and SME's can also obtain low-interest KfW loans for efficiency improvements (BMWi 2014b: 14). NAPE also focuses more efforts on information exchange and other activities for raising energy efficiency awareness (ibid: 38), and dena has a particular role in providing additional information for diverse SME target groups (ibid: 13). It also provides greater regulatory obligation on SMEs by introducing Energy Audits (ibid).

4.3.1.2 Buildings and Household Efficiency

As already argued in sections 2.1 and 2.3, there have been many improvements so far in German household energy efficiency and these have contributed towards lower bills paid per household, which is one important aspect of avoiding energy poverty (see Cludius et al 2015b). However, despite the many improvements already made, the buildings sector still offers the largest potential for energy efficiency in Germany, not least because it comprises 40% of primary energy consumption, and approximately 33% of CO2 emissions (Agora 2013: 32). This is partly because 70% of buildings were built before 1979, i.e. before the First Thermal Insulation Ordinance, with estimated potential savings *still* of up to 80% (BMUB 2013; AboutDena 2015). In addition, according to the BMWi, approximately 85% of the energy consumed in buildings is attributed to heating and hot water generation, which means that the potential for energy savings remains huge (BMWi 2014c: 23). It is, however, important to get policies right here because investment cycles in the building sector are quite long, so if a household installs some measures today it would be unlikely to do so again for some time to come (SDSN 2015: 57).

Generally speaking Germany has tended to adopt a three-tiered approach to buildings efficiency: setting standards, offering support and supplying information. In terms of setting standards Germany is quite advanced, having had quite prescriptive buildings energy efficiency requirements since 1977. It regulates standards for new builds, as well as minimum energy-efficient standards that must be met when performing extensive building renovations. It also sets pre-requisites for renovation based on the latest technological developments (BMWi 2014c: 30; Interview 3). The Energy Conservation Regulations (EnEV), adopted in 2009 but still valid now, was the latest in a long line of building energy efficiency codes. It is a performance-based code that requires a mandatory energy frame calculation to establish the expected primary energy consumption of residential and non-residential buildings (GBPN 2016). Buildings standards are used in different ways, as a stick and as a carrot, and requirements have tended to get stricter every 5 years (in line with the Energy Savings Ordinance of 2013). On site inspections occur during construction and after completion, and builders can be refused permission to construct and/or to allow any unfit building to be occupied through construction licensing procedures (ibid; SDSN 2015: 57). One example of using standards as an incentive is the high efficiency mortgages system whereby, if a house/building meets certain standards (i.e. Passiv Haus, KfW90 and KfW 55 standards), then the borrower/occupant can benefit from reduced interests rates (Interview 17). Albeit interest rates are low anyway in Germany at the moment so savings can be as low as .10% (ibid).

In terms of offering support, the best-known buildings efficiency policy in Germany is the subsidised loan and grant scheme operated by the KfW bank to support retrofits as well as new builds (Rosenow 2013: 170; Buchan 2012: 31). Part of the success of KfW household efficiency loan schemes is attributable to the (very) low interest rates, but also to the fact that the KfW recycles monies repaid back into new sustainability loans. Another important factor is the size of funding available. For example, funds to support household energy efficiency improvements, and the CBRP, were €1.8bn per annum between 2012 and 2014, but the NAPE allocated a further €200m per annum taking the total to a not inconsiderable €2bn per annum from 2015 (Interviews 3 and 20). Historically, of the total amount lent, around 80% of funds have been allocated as 'soft' loans, currently at an interest rate of approximately .50%, and the other 20% in the form of grants (Interview 3). Another important aspect of KfW efficiency schemes is that they are accompanied by qualified, expert advice and installation so that works are carried out to a high standard (UCL 2011). In addition on this point, and in contrast to the UK, energy efficiency markets are well established with plenty of training having been made available for energy efficiency installers.

Municipal loans are also considered to have been important to enabling building retrofits and efficient new-builds and there are various programmes at municipal level: the Municipality Loans (2007-9); Energy Efficiency Refurbishment – Municipals (2009 – now); and Social Investment - Energy Efficient Refurbishment (Rosenow 2013: 183; see also Hall et al 2016). Clearly subsidised loan programmes are partly effective to the extent that householders are aware of the need to, and advantages of, making energy efficiency improvements to their homes. In this sense some argue that municipalities are in a position to implement energy efficiency information and education policies given their greater proximity to citizens and entrepreneurs (SDSN 2015: 58). This would include working, alongside charities and NGOs, to help remove the lack of transparency regarding existing support schemes available for local actors (ibid). This can also be done by working with landlords, given that 80% of the property market in Germany is rented (Interview 6).

Traditionally the KfW has been heavily involved in buildings efficiency but some new NAPE measures are not implemented via the KfW, and in this sense it is seen as an attempt to find new channels of support (Interview 3). One example of this is the new Wettbewerbliche Ausschreibungen, or Competitive Efficiency Tender (CET), which is designed to spearhead a new approach for promoting close-to-market, cost-effective buildings efficiency solutions (BMWi 2014b: 29). One analysis suggests that this tender system resulted from long discussions about whether to follow the EU Energy Efficiency Directive Article 7 recommendation of introducing a supplier obligation and the ultimate rejection of this idea on the grounds of Germany's highly dispersed retail market (Seefeldt 2015: 7). The idea is that the CET will motivate energy service providers, municipal utilities, energy cooperatives and manufacturers to find economic ways to save energy in the tendered funding area and to offer cost effective measures for carrying them out (BMWi 2014b: 30). This is seen as a better (more market based) route than conventional funding schemes, i.e. FiTs, where a standardised high rate of funding can result in inefficiencies (ibid).

The CET targets €100,000 plus size efficiency projects, i.e. in SMEs, hospitals or schools (BMWi 2014b; Interview 3), as there are relatively high costs to enter the tender process implying some need for professionalisation. Bidders can compete for funds to implement (mainly) electricity efficiency projects given the KfW has some focus already on heat efficiency, but its remit may be expanded at a later date. The programme was intended to start in 2015, but due to delayed financial permissions from the Ministry of Finance, the start of the CET is now expected by June 2016. It is expected to start with available funding of €15m in the first year, €50m the second, €100m the third, and €150m by 2018. Funding is allocated on a least cost per lifetime kWh savings basis (Interview 3). In each periodic tender there is a fixed budget and so the instrument is controlled by the quantity of monies available. Applications should be bidding for funding only to cover 10% to 30% of costs and have to find the cheapest possible solution for their assigned quantity of energy savings (Seefeldt 2015: 9). Given the kind of requirements associated with this system ESCOs can help to bring companies and/or institutions to tender and act as intermediaries (Interview 3). There is some security available for ESCOs if the bidder drops out of the tender system in the form of Land level insurance policies (i.e. via Bürgschaftbanken). This instrument is not associated with the CET directly, but is a general measure available to ESCOs should they need to offload some of the risk of client insolvency (Interview 3).

4.3.2 Green Industrial Policy and Energy Efficiency Markets

There have been various reports, see also Section 2.1, of Germany's overall success in reducing primary energy consumption, and in de-linking economic growth from energy demand growth (Young et al 2014; BMWi 2014c). Although there are still some regulatory impediments to the expansion of ESCO markets in Germany this is a generally well functioning market (Bertoldi et al 2014: 79; Interview 3), partly due to the fact that there have been positive regulatory responses to concerns raised in the past (Bertoldi et al 2014: 81). It is also notable that German homes are much better insulated than UK (Praetorius et al 2009: 64), and although energy prices are high an average German household in 2011 used less energy than households in the US, Britain, France and Spain (Thalman 2015b: 2).

In terms of progress made, however, it is worth drawing attention to areas less discussed: energy efficiency market creation and embedding energy efficiency economically and socially. This is where energy efficiency policy instruments and regulations work, in practice, in tandem with other policy areas – in particular green industrial policy. It has been a specific goal in Germany to establish economic success stories underpinned by innovation and by a 'greening' of industry. The thinking here is that:

… energy efficiency makes up a major component of the investment strategy for Germany. Energy efficient investments usually yield a higher rate of return than current long-term investments on the capital markets (BMWi 2014c: 2).

As such, with approximately €8 billion already invested in environmental protection, and export volumes in the region of €3 billion for capital goods which help to protect the environment, Germany considers itself to have been successful in promoting 'green' technologies (BMWi 2014c: 4). Specifically when it comes to energy efficient technology, Germany considers itself to be the international market leader and chief innovator (BMWi 2014c: 3). For example, German firms have large market shares in gas and oil condensing boiler technologies and renewable energies in the heat market (mainly solar thermal systems; heat pumps and wood burning systems as central heating systems) (ibid: 24).

All this has created quite extensive employment in energy efficiency markets and this extends across insulation and retrofit markets, developing and producing new technology and relevant supply chains (Interview 2; Kuzemko 2015c). It is notable that much of the new market and job creation is accredited to energy governance decisions. German specialists are now also employed as consultants and/or skilled craft providers on a global scale. According to the BMWi this has come about partly through the combined work of the (former) Federal Ministry of Transport, Building and Urban Affairs (BMVBS), the Federal Ministry for Economic Cooperation and Development (BMZ), and its international division the Society for International Cooperation (GIZ) (BMWi 2014c: 30; Interview 3). They made decisions to adopt a process of well-structured, high quality transfer of knowledge as part of international energy efficiency projects (ibid: 30). Another BMWi claim is that it is partly as a result of strict buildings standards, such as EnEV, enshrined in the legislation that there has been a high demand for renovations and that a large percentage of the labour force employed in skilled crafts or in the planning/consulting sector is currently involved in energy-efficient renovations (BMWi 2014c: 30).

4.3.3 Issues and Fields of Action for the Future

The pressure remains on the BMWi and BMUB to continue to devise new strategies and policies, beyond the NAPE, and there is a feeling that momentum is being lost (Interview 17). The principal worry for energy efficiency policymakers is the expectation that the ambitious 2020 target of a 20% reduction in primary energy versus 2008 is likely to be missed (Interview 3). There are related, persistent critiques that not enough is being done, a greater emphasis again on energy efficiency in the public debate, as well as pressures from groups like the European Climate Foundation which has been campaigning for renewed efforts (Interview 4). More specifically, some have argued that progress has been slow to turn NAPE measures into reality and it is clear that projects like the CET have been delayed (Amelang 2015b: 2). Others claim that improvements in reality lag behind expectations (SDSN 2015: 56); and it was clearly a disappointment to lose the tax exemption scheme in the Bundesrat (Interview 3).

Another critique is that too much of the NAPE is centred on legal standards and information campaigns, whilst there is not enough is fiscal or financial stimulus (SDSN 2015: 55). Overall, given that no country has taken up a comparable challenge in terms of targets for consumption reduction, there will need to be a renewed emphasis on making energy efficiency and demand response a first priority of the Energiewende (Amelang 2015b: 2; RAP 2015). BMWi has announced that it is to launch a new, long-term and comprehensive strategy in the first quarter of 2016 to strengthen the position of energy efficiency within the Energiewende (Interview 19). One main recommendation is that there should be one body, the above mentioned Federal Agency for Energy Efficiency, assigned the task of co-ordinating all energy efficiency and demand reduction measures (RAP 2015). According to interviewees, this strategy will be called the ‘Green Book for Energy Efficiency’ (Interviews 3 and 19), and much (in terms of staying on track in terms of the Energiewende) rests on the new strategy.

The latest BMWi EOM 2.0 white paper does place energy efficiency firmly in the centre of two of its six stated ‘fields of action for the future’ – albeit strategies outlined appear as yet quite undefined and far off. ‘Field of action no. 4’ is about applying sector coupling to use renewable electricity for heat, mobility and industry in future – specifically on the assumption that ‘Power-to-Heat’, ‘Power-to-Mobility’ and ‘Power-to-Industry’ will result in greater energy efficiency and lower overall costs (BMWi 2015e: 85). This is based on the BMWi’s expectation that heat pumps (powered by ambient heat and renewable electricity) will run at 340% efficiency, as opposed to 85% with gas heating, and in transport electric mobility will run at 80% efficiency, compared to 25-40% with the internal-combustion engine (ibid: 85 and 87). For sector coupling to proceed electric vehicles will need a much improved charging infrastructure and heat pumps will need the installation of surface heating systems during the construction and refurbishment of buildings – and both these fields of action will need time to comprehensively address (ibid:

87). To some extent ‘No Regret Measure 11’ lays some of the groundwork for greater electric mobility: recharging points will be categorised according to law stipulating rights and obligations of operators of recharging points; rules are to be put in place governing non-discriminatory access for the users of electric vehicles to the charging infrastructure; and an ordinance to enable payment and billing at the recharging points (ibid: 69). It also appears, see section 2, that the BMWi is considering a €2bn incentive scheme to support greater electric mobility.

‘Field of action for the future no. 5’ is yet more focused on energy efficiency: it is about enabling more joined-up thinking between energy efficiency and energy market design in future. Electricity consumption has been falling due to the energy efficient use of traditional electricity applications, but it is expected to rise in the long-term due to greater electric mobility and heat pumps (ibid: 88). Greater efficiency in traditional electrically driven applications, combined with higher flexibility, should lead to more availability of power for new applications – hence the two areas are understood to be closely linked (ibid). As such policymakers at the BMWi are considering greater coordination between incentives for efficiency and flexibility, as well as between efficiency and power market design. One proposition is to connect high-efficiency heat pumps and electric mobility applications so that they can recharge the battery and heat storage systems at times of low residual load (i.e. large volumes of renewable power relative to demand) (ibid: 88).

5. Conclusions and Lessons for Britain

This IGov working paper on governing for demand management in Germany has provided an overview of electricity and heat markets in Germany and how they are governed; an outline of the governance bodies that are most involved in demand management policy and strategy; as well as a more detailed analysis of governance in the areas of distributed energy; demand side response and flexibility; and energy efficiency. What is clear from this extensive analysis is that the energy transition is seen as a long-term governance project that is central to the German political economy. Current demand management policies and strategies are embedded within, and result from, a relatively long history of sustainable energy policy and so there has been much to analyse.

This is not a comparative analysis, although it has included some reference to differences between German and British sustainable energy governance and innovations. Indeed this analysis has been undertaken in recognition that governance for energy transitions varies quite considerably between countries in practice – even when governance is designed to deliver on the objective of reducing GHG emissions (see Kuzemko et al 2016). The IGov team is interested in drawing some conclusions that have relevance to governing for demand management in Britain – based on the notion that energy markets are changing whilst British sustainable energy policy appears not to recognise, nor be adjusting to make the most of, these changes (Mitchell 2015b). The concluding remarks about German governance for demand management are phrased in such a way, therefore, as to highlight some useful lessons for Britain. These lessons can be drawn from assessing which governance structures, policies and strategies have worked to engender and diffuse demand management innovations, but also by taking stock of what has work less well.

This lesson drawing exercise is, however, undertaken in full recognition that the underlying, domestic politics of energy is in many ways different in Germany and Britain – and this results in different sets of interests and narratives that both drive forward and challenge sustainability in a variety of different ways. Indeed domestic political and energy structures have resulted in rather different understandings of what a sustainable energy system should look like, as well as informing different types of sustainable energy transition. This is most evident in that the British government considers nuclear electricity to be sustainable whilst the German Federal government clearly holds the opposite view. The result of Germany's decision to decommission nuclear, within the context of its firm commitment to reducing GHG emissions, is that renewable energy becomes the central supply-side answer to achieving a sustainable energy system. Hence in Germany almost all supply-side efforts are targeted at greater (affordable) diffusion of renewable electricity and heat, whilst in Britain so much focus has remained on re-establishing nuclear electricity as a low carbon option, as well as on supporting oil and (shale) gas industries.

Both Germany and Britain claim leadership on the international stage in climate mitigation, but arguably Germany has committed more political capital and government effort to achieving this in practice, at least in the electricity and heat sectors (Steinbacher & Phale 2015). Germany was one of the first countries to trial the now popular feed-in-tariff regime to support new, renewable technologies, but it is arguably the Energiewende targets that make it stand out today. This is not just because the level of ambition is amongst the highest in the world, but also because targets extend beyond a narrow focus on emissions reduction to set short, medium and long-term targets for demand reduction and renewable energy. These provide clarity about the long-term position of sustainable energy within the German economy, as well as an important sense of security for investors in sustainable energy markets.

However, what is most useful about these targets is that they overtly drive policy. The BMUB and BMWi are mandated according to climate and Energiewende targets, new strategies and policies have been launched when Germany has veered off course, and policies are framed with the specific intent of making sure that targets are met. This relates back to the point about international leadership – in having made such ambitious and publically visible commitments Germany must meet them not only to save face but also to show that sustainable energy systems are possible and that governance can be a central part of their achievement. This is clearly not to say that all German energy policymaking has been an out-and-out success but that policymakers have been prepared to try new policies, to learn from mistakes and to make changes where necessary within a long-term, iterative governance process (see also Schüppe 2014a). This contrasts with the current situation in Britain where targets, although binding and long-term, are restricted to emissions reduction. Britain does not have formal renewable or demand reduction targets beyond EU 20-20-20 commitments, indeed the previous coalition government was one of the principal proponents of getting rid of EU country-level renewable targets for 2030. Although publically the current Conservative government claims that it will meet the 15% 2020 EU target for renewables, in private it has admitted that the likely UK renewable share of energy consumption by 2020 will be around 11.5% (Buchan & Keay 2016: 3). As such the British government offers less certainty to investors and other potential stakeholders, such as citizens and communities, about what its pathway to emissions reduction will look like.

Energy governance differs in other ways, not least in that Germany's version of market capitalism, the Social Market Economy, holds out the potential for a greater role for the state in driving forward complex change. This has allowed Germany to adopt ambitious targets, offer relatively high levels of state subsidy for emerging technologies, direct funding towards low cost lending for sustainability, and drive forward nuclear (and coal) decommissioning, amongst other things. In this way Germany's tendency towards leadership in the international sphere is reflected by the willingness and ability of the Federal government to take leadership in transitioning the energy sector. Although there have been clear economic costs associated with German energy market interventions, with implications for consumers, some have worked out as less expensive in practice that British, more market-oriented support mechanisms (see Mitchell et al 2006). It is also notable that the costs inferred in current British contracts for difference for nuclear power makes new nuclear electricity more expensive than German onshore wind or PV (Fürstenwerth 2015).

When thinking about economic costs and affordability it is also notable that German policies such as the risk-free FiT and KfW lending schemes have helped to ensure that Germany has the lowest cost of capital for renewables in the world (Noothout et al 2016). Arguably this is also tied in with the clear statement of intention inferred in its Energiewende targets. Also notable is that previous commitment to buildings energy efficiency policy has resulted in better-insulated German homes which is also a positive for energy affordability (see Cludius et al 2015b). In addition, those most vulnerable have been better protected in Germany from the winter cold through specific welfare support which means that Germany doesn't suffer from the same unnecessary winter deaths that Britain experiences. This is all part of a transition that is more inclusive of citizens and that does not put them at any unnecessary health risk.

It is, furthermore, noteworthy that Germany, like Denmark, successfully separates policymaking in energy from regulation by clearly defining Ministries as having responsibility for policy, whilst economic regulators are concentrated on implementation and advice. The BNetzA and Kartellamt's roles as monitors of electricity and gas markets, as well as of progress in terms of the sustainable transition, are also useful in terms of transparency, availability of information, and holding market actors to account. This fits with IGov's view that there should be clear mandates and responsibilities for each governance body within the context of complex energy system transitions. It also fits with the tentative IGov framework for governance which suggests that Britain should have an 'economic' regulator that takes its direction from an Energy Policy Committee that would be responsible for sustainable energy system transition (Mitchell 2015c).

Beyond these governance structures and approaches it is clear that the German Federal government has recognised the value of having a distributed energy system, which it has partly achieved through the risk-free FiT, related low costs of capital, and community and citizen involvement. This too stands in marked contract to Britain's energy transition thus far, particularly in terms of the relatively low degree of community, municipal and citizen involvement in its transition. Indeed most renewable energy in Britain is owned by large utilities. Germany's decision to aim for a distributed system is not necessarily, however, about delivering network savings by reducing demand on the grid. And their thinking seems not to be as joined up as it could be given the amount of large-scale offshore wind that has been added and the subsequent need for North to South transmission lines.

It does appear, however, to be more about the broad diffusion of technologies and distribution of the benefits of change beyond utility companies. This strategy has, in effect, led to a deeper societal embedding of the Energiewende as more people can benefit from and be actively involved in sustainable change. Arguably the distributed nature of Germany's energy transition is also further enabled by the Federal system which distributes authority away from 'the centre' and by institutional capacity at Land and municipal level, including utilities, lending and supportive policies. Civic and municipal involvement in the Energiewende is then also allied with other more sustainable vested interests in the form of new industry groups representing solar, wind, and efficiency markets. This relates to another potential lesson for Britain. Germany has formally recognised the transition as an opportunity and has had a green industrial policy in place to establish Germany's domestic and international position as a 'green' energy player.

This has ended up being a useful strategy in that the increasingly competitive global low carbon energy market, within which Germany has established a strong position, was worth $600bn in 2014 and is set to grow significantly in the coming years (Goldman Sachs 2015).

One last positive of aspect of German governance for sustainable energy transition is that there has been far less reliance on incumbent energy companies to drive the transition coupled with more of a focus on creating an enabling environment for new business models (see also Geels et al 2015). Innovative new business models, especially in the form of ESCOs and green suppliers, have been able to enter the market and provide new demand side services to customers. The tendency not to rely heavily on incumbent companies may be related to the difficult relationship between utilities and government in the 1990s, when the Bundestag had to stand up to coalitions against the FiT, but also to the fact that Germany does not have indigenous oil and gas reserves and a powerful oil and gas industry to contend with. On the other hand Britain has several high value, internationally influential energy companies that will lose out as a result of sustainable transition, but it has also placed a heavier emphasis on these existing market actors in driving change. Germany has an embedded, but arguably less economically powerful, coal industry that has made coal decommissioning harder to achieve but not impossible.

What this means, in practice, is that processes of change are deeply political, and that the nature of the domestic energy politics are important in both countries, albeit in Germany there has been broader based and longer-standing popular support for protecting the environment. Each government has been lobbied and informed by coalitions that seek either to prevent or slow down the pace of change and coalitions in support of sustainable change – and they must make decisions about how to respond within the terms of these debates (see also Kuzemko et al 2016). What is important is that the German government appears to have overtly recognised that some companies will lose out from change, to have thought in more depth about time frames over which those interests will be lost, as well as how to compensate those with sunk costs in fossil fuel industries.

Again this analysis does not suggest that Germany has managed to get governance for demand management right in every respect in particular as it, like Britain, has been too focused on supply-side policies. For example, the focus on renewable expansion in Germany resulted in the costs of renewable technologies falling faster than reductions in the FiT and a perhaps heavier than necessary burden on non-exempt consumers. Tax, surcharge and grid fee exemptions, in particular for energy intensive industries, have placed further pressure on other consumers and this has, arguably, led to a politicisation of Energiewende policies, if not of targets. This, in turn, has made market conditions for some small, distributed renewable players more difficult in that the EEG 2.0 requires that many participants take greater risks. The supply-side policy, of support for offshore wind, has led to more large-scale generation coming online, the need for new transmission lines, and a refocus on national-scale system properties.

The flip side of the supply focus, including nuclear decommissioning, has arguably also been that demand policy has not received as much governance attention and is not as well established. Energy efficiency policy, and in particular KfW loans, have resulted in a good standard of efficiency in many homes – but leave the homes of many that cannot afford to take loans untreated. Perhaps the current government (unlike the Red-Green coalition) is not one to innovate in governance terms here, and certainly they seem to be deferring decisions on efficiency and demand side response to the next administration. There is, however, a degree of awareness within the BMWi that there are barriers to entry to demand response and aggregation of load, whilst exemptions that appease the energy-intensive industry stand in the way of effective price signals for demand response. As such there is also recognition that policies must improve and that new strategies need to be drawn up in order that Germany can meet demand reduction targets. Those that argue for whole system governance and for demand response as part of cost effective and sustainable system integration seem, however, to find themselves currently at the more progressive side of German sustainable energy governance circles. It certainly remains to be seen if current policy suggestions will be sufficient to enable significant new demand management innovations.

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Interviews

1. Academic and Government Advisor, June 2014 and September 2015
2. Academic and Government Advisor, June 2014
3. Academic and Government Advisor, June 2014, July and September 2015
4. Academic, June 2014 and July 2015
5. Academic and Government Advisor, June 2014 and July 2015
6. Academic and Government Advisor, June 2014
7. Academic, June 2014
8. Academic, June 2014
9. Energy sector consultant and government advisor, June 2014
10. Energy sector consultant, June 2014
11. Academic and Government Advisor, June 2014
12. Academic and Government Advisor, June 2014
13. Energy sector consultant, June 2014
14. Academic and Government Advisor, June 2014 and July 2015
15. Senior executive at Big 4 energy company, July 2015
16. Executive at Big 4 energy company, July 2015
17. Energy sector consultant and government advisor, July 2015
18. Senior executive at Big 4 energy company, July 2015
19. Consultant, Advisor and ex-independent company executive, July 2015 and September 2015
20. Executive at the Bundesverband der Deutschen Industrie (BDI), July 2015
21. Senior executive at ESCO, July 2015
22. Executive at Bundesnetzagentur, September 2015
23. Senior civil servant at BMWi, September 2015
24. Senior executive at Big 4 energy company, September 2015
25. Senior executive at innovative supply company/aggregator, September 2015
26. Energy sector consultant, September 2015
27. Energy sector consultant, June 2014

(This list was amended on 18/5/16 to correct a mistake)