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# Adoption of Smart Grids Technology in the UK: What Lessons for Germany?

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## ABSTRACT

This paper aims at analysing the challenges arising from liberalized metering activities with last resort obligation borne by regulated Distribution Network Operators (DNOs), when adopting Smart Grid technology through the deployment of smart meters. This paper studies on the short and long term how the level of unbundling may create constraints, or contrarily, ease the adoption of smart meters in Germany**.** Short and long term have to be understood practically. The short term refers to effective roll out of smart meters[1]. The long term refers to an integrated use of the whole smart grid technology dedicated to activate both the distribution grid and the demand. This integrated use of the technology would thus allow a real time control of supply, load, intermittences and storage facilities and would maximize the benefits of the future Smart Grids. In other words, as recently stated by the German Green Book on "Smart Grid and Smart Markets" [1], the German's Smart Grids will be achieved only through generalized usage of information and communication technology (ICT) on distribution grids and a large deployment of smart meters.

By using a comparison with the British model, this paper proves that last resort obligations hold back by formerly integrated suppliers, constraint an efficient smart meters deployment in a free metering market. However, it seems that the British model is inconsistent as regard to German's energy policy and that Germany should adopt a smart meters data operator that both guarantees a high degree of independency and of coordination.

***Keywords:*** *Smart meters deployment, Germany, Regulation, Last resort obligations*.

[1] It also refers to smart technology adoption on the distribution grid, but this matter remains out of the present study as it only reposes on regulatory aspects and does not pose the competition-regulated activities governance issue.

# 1 INTRODUCTION

German energy policy is among the most ambitious worldwide in terms of greenhouse gas emissions cuts and integration of renewable energy sources (RES). Its strategy is definitely turned towards enhanced efficiency through an increased use of ICT in its industrial process. If this strategy is mainly supply-side oriented and included in a traditional centralized view of the industry, recent incidents in Fukushima's nuclear power plant will drive Germany to update its carbon emissions reduction strategy. Anticipated phase out of nuclear reactors in 2022 will involve a higher recourse of thermal generation plants and threaten to damage the efforts engaged by carbon reduction policies. As a consequence, these new challenges stress the need for a real Smart Grids strategy. German energy policy and regulation are currently promoting a wider development of renewable energies among which low voltage grid connected generation plants are a major feature. The use of advanced technology on distribution grid would facilitate a more integrated management of the system. As well, a greater participation of demand-side through the deployment of smart meters has become a growing interest over the last years for the authorities to both ease balancing operations and ease peak shedding.

Yet, the integrated Smart Grids envisioned by Germany has to comply with its regulatory environment, or conversely, the current rules will have to evolve to ease the adoption of smart metering technology. According to that, it seems that current regulation in Germany and more particularly the existence of last resort obligation for formerly integrated suppliers in a competitive metering market is likely to lower the benefits expected from a wide roll out of smart meters. However, since GHG emissions cut and efficient and reliable RES-integration are the main target followed by Germany, it appears that the drawbacks implied by this regulation can turn into decisive asset in terms of system coordination.

We will focus specifically on the challenges relied to the adoption of smart metering technology and compare the case of Germany to the case of Great Britain. Indeed, both countries have liberalized their metering activities. But the UK went further in its unbundling and entirely removed the last resort obligation from the distribution network operators. Moreover, the UK succeeded in 2008 in mandating a national deployment plan of smart meters that relies on the suppliers' responsibility.

As stated by Saguan (2009), a smart metering policy depends on the general regulatory framework of metering and the specific energy goals the authorities fixed [2]. This study will hence describe in the first place the downstream architecture of German's and British's electricity supply chain and will then outline the major energy targets fixed by these two countries.

Then, it reveals the current smart metering context of these countries underlying the actions already implemented by Germany and the reasons of smart metering development failures before describing the British model for smart meters roll out and future metering market interactions.

At last, it reveals to what extent the regulatory framework adopted by these two countries can be a strength or a weakness considering their respective energy goals. The study reveals that even though the British model is capable of providing benefits in terms of efficient smart meters deployment and competition, it seems that its extension to the German context would be harmful for its energy goals pursuit.

# 2 TOWARDS A SMART METERING STRATEGY: ORGANIZATION AND ENERGY POLICIES OF GERMANY AND THE UK.

## 2.1 **Organization**:

The liberalization of the electricity industry over the last decades implied great organizational changes on the formerly vertically integrated supply chains. All the European Union member states went through major reforms designed to unbundle the natural monopolies activities from the competitive activities. Yet, one can notice various degrees of unbundling, from account separation to full unbundling. In addition, few countries such as the UK and Germany decided to extend the liberalization to smart metering activities. However, a difference remains between these two market organizations. Whether the first one completely separated the metering activities from the grid operation, the second one maintained the last resort obligation provided by formerly integrated suppliers.

Germany has therefore a particular supply chain architecture where a part of the suppliers competing on the metering market remain regulated under specific situation. The opening of the German retail market began with its first amendment to its Energy Law (EnWG) in 1998 that opened its electricity market and gradually gave the consumers the choice to choose its supplier. The exclusive supply zones that were before then attributed to a local integrated supplier under monopoly were removed and the entering of this act permitted any supplier to compete with each other on new areas. Germany adopted an account separation between the regulated distributors and their formerly integrated suppliers[2]. At last, ten years after these first steps towards an opened retail market, Germany decided to liberalize its metering activities. As stated in the Meseberg report published in 2007 [3], the liberalization of this market was aimed to improve the retail competition thanks to the use of ICT and the development of customized energy offers. Following this report, Germany separated the components of its metering activities which are the installation, maintenance, reading and data recording. Since 2008, any domestic customer can contract with a third party or its formerly integrated supplier, to comply with the tasks of installing maintaining and operating the metering appliances as well as the measuring of the energy supplied. However, some suppliers are still in charge of ensuring last resort obligations on metering activities for domestic consumers. This last resort obligation is part of the "universal service" the biggest supplier of a zone in terms of domestic sites[3] (i.e. usually the former integrated supplier) is in charge of. According to this obligation, suppliers have to provide a basic contract to their domestic consumers that either did not choose to switch supplier nor to sign for a market offer contract [4]. The universal service is fixed by the public authorities and embraces a regulated tariff and, what is a major point in this study, leaves to the last resort obligation provider the complete ownership of the meter and its related activities. As indicated by Ehlers 2009 [5], a last resort provider does not need to operate the corresponding distribution network, but it implies that besides public utilities are increasingly being liberalized, "the State ultimately retains the responsibility to control these utilities in order to ensure public and universal services, which include the provision of sustainable and economically reasonable services". Considering the rate of supplier switch, since the opening of the German metering market, the total number of domestic consumers remaining under this universal contract keeps reducing. But still, in 2010, this contract covered more than 40% of the domestic segment [6]. In case of a meter replacement, these last resort obligation providers are authorized to pass through their metering costs in the regulated tariffs, which creates inconsistencies on a competitive metering market.

Liberalization of the UK metering market followed another path. The metering operations which similarly to Germany were formerly a duty of regulated distribution network operators (DNOs), opened to competition in 2003. New entrants, meter operators and existing independent suppliers, were allowed to operate these equipments against a rental fee charged by the DNO that had proceeded to the installation, and who keeps being the owner of the meter. As in Germany, DNOs had the status of last resort obligation providers regarding these metering activities, but this

[2] Except suppliers under the 100 000 customer threshold, who can choose whether or not to unbundle.
[3] This biggest supplier is evaluated on 1 July every three years, beginning in 2006.

obligation was finally removed in 2008 and the last link between the grid and the consumer's premises were cut.

This decision entered into the UK strategy to make the independent suppliers the unique intermediary between the consumers and the system according their "supplier hub" principle [7]. The purpose of opening the metering market was to induce metering price reductions through competition, enhance the quality of service and promote innovation, but also to avoid any foreclosure behaviours from the DNOs. According to the British rules on metering, any replacement of a meter, whether it reached the end of its life cycle or is incompatible with a new offer, automatically passes on the ownership of the device from the DNO to the supplier. The suppliers are encouraged to offer new added value energy services to their retail consumers and offers such as prepayment contracts or multi energy contracts were developed.

## 2.2 Energy policies:

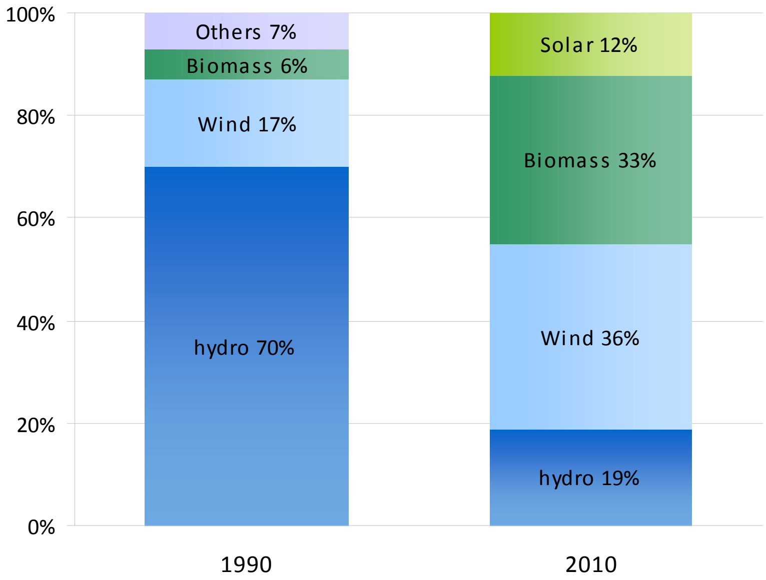
The German energy policy is quite different from the UK's. They engaged in different strategies and technology mix to reach their energy goals and are facing different issues. Even though they both adopted ambitious RES integration targets, a closer insight of renewable energy share in their power mix and further elements of the British supply chain architecture are the key elements to better understand their respective smart metering drivers.

When considering German's RES-integration policy, three significant elements must be underlined. These elements are the growing share of intermittencies coupled to the high growth rate of distributed generation (DG) and a potentially negative impact of the German nuclear phase out on its GHG emissions.

Germany is definitely focused on a gradual transition from its traditional coal-based power generation mix to a lower carbon impact mix that involves a high penetration of renewable energy. As mentioned in the German Energy Law, Two of the main energy objectives are to achieve a secure and reliable as well as sustainable energy supply [8]. According to the objectives set by the government Energy Concept (2010) [9] Germany must be able to achieve a severe cut of its greenhouse gases (GHG) emissions by 2050. Germany targets a reduction of GHG emissions of 40% by 2020, 55% by 2030, 70% by 2040 and by 80 to 95% by 2050, compared to reference year 1990. Electricity consumption is to fall by 10% by 2020 and by 25% by 2050, compared to 2008. At last, renewables are to have a share of at least 35% in gross electricity consumption by 2020, a 50% share by 2030, 65% by 2040 and 80% by 2050.

German authorities engaged well before these objectives in a supportive RES-integration policy that radically changed the landscape of its power system, both physically and organizationally [10]. Within 12 years, the contribution of renewable energies to power generation has increased fourfold, increasing its share from 4,8 percent in 1998 to 17,1 percent in 2010 [11]. The mix of renewables also diversified passing from a mix dominated by hydropower in 1998 to a mix more evenly distributed among the different technologies, where the wind and biomass accounted for respectively 36% and 33% in 2010 (**figure 1)**. In the current mix, the intermittent energy (wind and solar) represents almost half of the renewable generation with a breakthrough of solar energy, mostly decentralized, that was almost nonexistent 10 years ago.

**Figure 1:** Evolution of the renewable energy installed capacity share between 1998 and 2010.




**Source**: BMU 2010 [11].

As any other kind of technology, intermittent renewables have benefits and downsides, the major drawback being its intermittency itself. Indeed the difficulties of forecasting the quantities fed in the network and the undispatchable nature of these generators[4] may deteriorate German's coordination and security of supply, and increase the risk of quality damage. The trade-off between a more sustainable energy system and a reliable supply can be expressed by the required operational reserves that are kept available to pick up the load when sudden drops of intermittent production occur. As well, generators must be ready to provide ancillary services to counterbalance the effects of voltage drop and guarantee the respect of the frequency.

[4] *i.e.* their start-up, and to a lesser extent their stopping, are independent from the operator.

In addition, the renewable energy capacity connected every year to the low voltage grid tends to overrun the capacity traditionally connected to the high voltage transmission grid [12]. As mentioned by the German regulator, 79 percent of the total installed capacity in 2009 was connected to low voltage grid which 99 percent was intermittent [13]. By 2020, the share of DG could reach half of the total renewable energy installed in Germany (**Figure 2**) which explains DG is one of the main drivers of the current investments in low voltage grid expansion and reinforcement[5] [14]. The particular aspect of German decentralized RES-integration landscape is that decentralized intermittent generation adds operating difficulties to the ones already encountered with classical intermittent energies. Among these difficulties the fact the distribution grid was not meant to receive energy and was initially designed solely to transmit energy down to the consumers may imply back feed constraints. Power flows become bidirectional with newly bottom up power flows in contrast with traditional top down power flows. Bidirectional power flows with the emergence of decentralized generation can have negative impacts on the system reliability. They can increase the level of frequency as well as incur voltage problems and require further back up facilities [15]. Moreover, growing fluctuating distributed generation can also cause congestion problems [16], [17]. As regard to the German Energy Roadmap 2010, the solutions adopted to smooth the effects of intermittencies and ease the RES integration are supply-side oriented and consist in approaching the issue from a traditional, centered industry-led perspective[6] [9]. However, the growing contribution of fluctuating energy, where DG should account for half of the installed capacity by 2020, stresses the need for additional investments on low voltage grids in terms of better information and communication infrastructure. A modernized communication infrastructure would improve the coordination between the generators, network operators, consumers, exportation capacities and storage facilities during highly fluctuating feeding periods. In addition, a growing integration of distributed generation needs to go in hand with monitored operations. A wider use of metering, communication and remote operation equipments would enable DG to effectively participate in the balancing market and enhance the system efficiency [17].

Along with RES integration issues, German's plan to anticipate its nuclear phase out will have a significant impact on its energy policy. Germany may be obliged to complete its initial energy roadmap with more demand-side oriented measures. Indeed its nuclear phase out will deprive Germany of 20 percent of its carbon-free electricity supply within 10 year. This represents a need to

[5] The integration costs for generation from renewable energies in the distribution network are projected at a 25 billion.

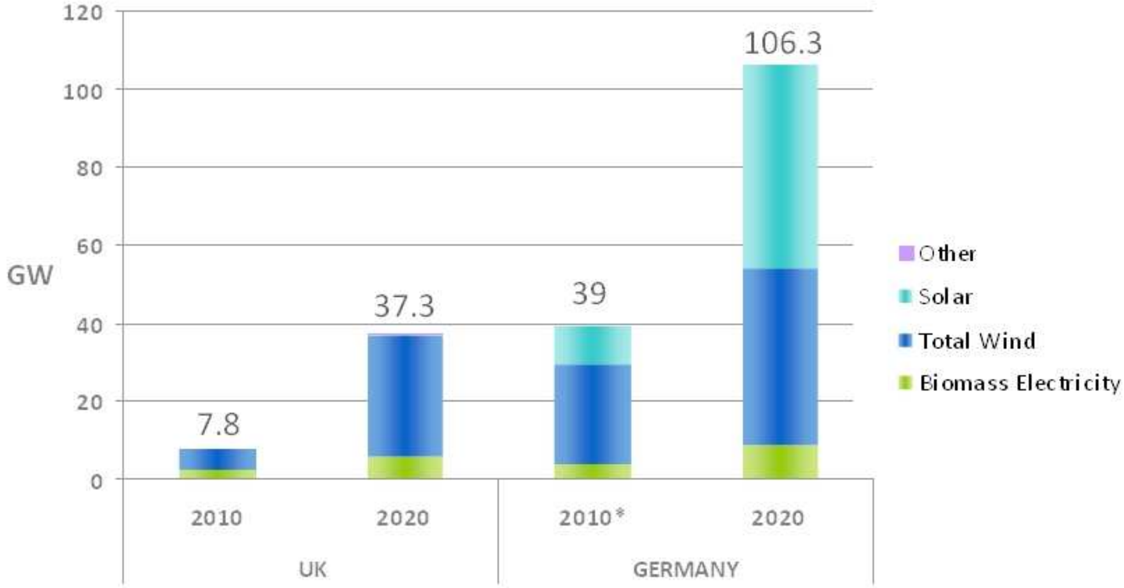
[6] The roadmap is based on the expansion of interconnections to smooth the effects of intermittencies. A strong production during periods of low consumption can thus be embedded in these exports. It supports the development of pumping storage to expand storage capacity and improve supply side flexibility. It also encourages carbon capture and storage (CCS) techniques to mitigate the coal-based power plants emissions.

replace 21,4 GW of its generation capacity. This replacement will primarily be based on the substitution of nuclear power by building 16 GW of coal and gas plants. In addition, the contribution of renewable energies to the generation mix, both centralized and distributed, should be further strengthened if Germany does not want to deteriorate too seriously its carbon footprint. At last, the recourse to GHG emitting power plants should entail the need for efficient demand-response and direct load control programs to mitigate peak demand.

In other words, German nuclear phase out should reinforce the issues linked with renewable and distributed energies already mentioned above. It should also increase the need for a smarter grid management and a widespread of smart metering technology to capacitate the retail consumers in providing demand-response. Demand-response would in the German context ease the integration of highly fluctuating power flows [18], reduce the need for spinning reserves [19] and reduce peak demand that relies on highly GHG emitting peak capacity.

As compared to Germany, the UK also embraced ambitious targets to increase the share of renewable energies in its electricity consumption and to lower its GHG emissions. The UK Climate Change Act (2008) establishes that the UK has to reach a 34 percent GHG emissions cut by 2020 and 80 percent by 2050 as compared to 1990. With its coal and gas-based generation mix, the British sector accounts for 75% of the country's emissions and the UK energy policy aims to lower this rate down to 50% by 2020. According to the UK Renewable Energy Roadmap (2011), renewables are expected to increase by nearly fivefold as regard to 2010 to reach a 31 percent of installed capacity by 2020 among which 80 percent would be provided by intermittent wind farms [20]. However, these targets are not shaping the British smart metering adoption process for three reasons. First, In spite of this effort, the total level of fluctuating energy the UK expects to reach by 2020 remains relatively low as compared to Germany. As a result, the constraints linked to fluctuating feed in would be lower as well. Second, the distributed generation driven by solar energy in Germany would play a lesser role in the UK **(Figure 2).** Indeed, the British renewable energy policy relies quasi entirely on centralized wind generation and biomass plants.

**Figure 2:** Renewable energy in the UK and Germany: Installed capacity in 2010 and renewable energy roadmaps by 2020.




*Estimated data as of 2009.
**Other mainly refers to marine energy in the UK and geothermal energy in Germany.
**Sources**: **UK 2010 & 2020:** UK Renewable Energy Roadmap July 2011 [20].
**Germany 2010:** EEG statistic report 2009 [21].
**Germany 2020:** German Federal Government Renewable Energy Action Plan 2010 [22].

At last as concerning energy efficiency measures, it is unlikely that the UK succeeds in implementing ambitious demand response programs through its smart metering plan that would be dedicated to effectively lower retail consumption. This assertion is built on the lack of incentives vertically integrated suppliers may receive to offer energy savings services. The poor results collected through the smart meter pilot program implemented in 2007 by four of the "Big Six" British suppliers reflect this incompatibility. Indeed, No ambitious dynamic pricing were tested and the pilots only brought benefits to the suppliers in terms of remote reading and billing costs reductions [23]. While nine solutions combining information, real time display, incentive and price-based measures were tested, results in terms of load reduction did not exceeded 4%. Most of the programs were not able to draw any conclusions and some even induced negative attitudes from the consumers[7]. In comparison, the Ofgem (2006) Consultation Paper on Metering Innovation estimated to energy saving potential not to be greater than 1 percent [7]. Another study from Carbon Trust (2007) that tested a pilot of advanced meters for SMEs, pointed out the very similar consumption patterns between smallest SMEs and domestic consumers [24]. According to the study, it seems unlikely cost effective services be engaged with this segment in terms of suppliers'

[7] An alarm system activated in cases of "high consumption" was tested but it only generated aversion towards the system.

benefits only. This weak implication from the suppliers can be explained by the fact they are vertically integrated and own around 60 percent of the total installed capacity and produce more than 50 percent of British electricity. Any program of energy efficiency and savings would result in reduced sales that inevitably would involve a lower production and a loss of profits. In the case of the UK, demand-response programs oppose directly to the firms profit maximisation main interest and can not be implemented efficiently [25. However, even though marginal energy savings are likely to occur for most of retail consumers, larger SMEs and industrials would draw benefits from a widespread of advanced meters that would in turn translate into benefits for the UK in terms of carbon cuts [24].

The major reason to smart meters deployment for domestic and smaller SMEs is to be found out in the UK retail competition completion strategy. According to the British regulator, the Ofgem, the market share of the former integrated suppliers in their respective area keeps on reducing at a 2 percent average rate per year [26]. Despite, less than 30 percent of consumers decided to deal with new entrants[8].

In addition, since the UK liberalized its metering activities, a new barrier to retail competition appeared. The Ofgem observed the DNOs abused of their dominant position in two different ways. They made the switch of supplier contractually complicated and little transparent. The commercial arrangements entered with suppliers sometimes included anti-competitive clauses such as price floor for new meters and fixed quotas of new meters to be provided each year [27]. Some DNOs were penalized by the Ofgem for these behaviors. In particular, National Grid had to pay a fine of £ 41,6 million for hindering competition in its area [26]. Moreover, before 2006, the metering data transfer between the meter, the DNO and the supplier were not standardized. Any switch of supplier implied the new entrant to contact the DNO in charge of the meter to procure him the meter access code, ensure the equipment is compatible with its offer and permit him to operate the meter. The access of meters codes required a specific administrative procedure for each DNO and many errors were recorded in the suppliers' customers databases who had to deal with multiple DNOs. As a consequence, the efficiency gains expected from the free metering market were seriously undermined. A first response was implemented by the regulator in centralizing all the meters access codes on a common platform. The metering data transfer was standardized and the charges of running the platform split between the regulated and independent users. Every user of the platform has the responsibility to feed the meter access database so that when a switching request is made by

[8] Actually, with the development of multi energy offers (that combine gas and electricity), many consumers switched from their former integrated electricity supplier to their former integrated gas supplier, and vice versa, rather than contracting with new entrants.

a customer, the outgoing supplier must inform the platform of this contract termination. Any new supplier is capable of knowing the existing metering equipment characteristics in a reduced time and is responsible for informing the platform in case of replacement.

According to Haney at al. (2009) [28], a well functioning competition on the retail market depends on the innovations realized in metering. However, in 2009, it was estimated that less than one percent of the retail meters had been provided by an independent supplier.
As a consequence, if today more than 90 percent of the domestic and business meters remain under the ownership of DNOs [29], the decision to mandate a national replacement of the electric –and gas– meters by smart meters before 2019 will achieve a perfectly liberalized metering market[9] (amendment of the Energy Act of 2008). The responsibility to deploy the metering equipments rests on the suppliers who are free to develop their own metering products provided the interoperability between the different energy offers and suppliers is respected.

# 3 OVERVIEW OF THE SMART METERING CURRENT CONTEXT :

## 3.1 An involvement from German's authorities undermined by unclear regulatory framework.

As pointed out by Wissner (2011) [19] the use of smart metering in Germany should "form a crucial element of an ICT-equipped energy system […] that helps bring forward upstream and downstream sectors". The smart grids experimentations through the E-Energy initiative currently underway in Germany are good examples of such a connection between the two extents of the supply chain[10].
E-Energy is a nationwide co-funded program smart grids testbed involving both private and public actors. These pilots experiment new local scale approaches to better integrate distributed generation and to promote demand-response (**Table 1).** Two of them implemented VPPs (Virtual Power Plants) for balancing operations. Storage equipments are to be tested as well whether under DG connected batteries or electric vehicles. In three cases, the pilots require a capacitation of the low voltage grids to monitor, control and operate the flows. Many innovative operating models are also tested. Extended bidding scheme for generation and shedding should minimize the overall cost of operating the eTelligence VPP. Green certificates have to be implemented in 2012 in the MeRegio

[9] Only for electricity markets as gas meters remain regulated.
[10] This program was launched in 2008 and should release its first consolidated results by 2013.

Project to effectively lower its carbon footprint, promote green generation and low environmental impact consumption. The Model City of Mannheim is dedicated to identifying the offers that should be developed to encourage consumers to adopt more rational consumption behaviors. New models of data flow management are also experimented, going in hand with a standardization of energy products dedicated to be exchanged on future energy markets. At last, Project RegModHarz which is the only one not involving direct consumers' participation, experiment the new operation processes enabled by a wider use of ICT on the low voltage grids.

**Table 1**: Smart Grids solutions tested through the E-Energy Initiative.

| | **Smart Meters** | **DLC equipments*** | **Storage equipment** | **Distribution grid capacitation** | **VPP** | **New operating model** |
|---|---|---|---|---|---|---|
| Projet eTelligence | x | | x | x | x | Classical bidding and reverse auctions operated by the DNO. |
| Projet E-DeMa | x | x | | | | Test of the MUC** technology in consumers' premises. |
| Projet MeRegio : | x | x | x | | | Implementation of green certificates. |
| Model City of Mannheim : | x | x | | | | Energy offers to be promoted to improve balancing operations. |
| Projet Smart Watts | x | x | | x | | New models of data management. Standardization of new energy products before exchange. |
| Projet RegModHarz | | x | | x | x | Centralized balancing involving a pumping storage power station and auxiliary services. Intermittence simulations and forecasts models. |

* Direct Load Control.
** Multi Utility Communication[11].
**Source**: Compiled by the author from the E-Energy Initiative publications.

At last, all of the six pilots involve retail consumers' activation through smart meters and dynamic pricing and/or through direct load control programs to stimulate demand-response for GHG emissions cut and balancing operations.

[11] Device installed in consumers' premises to remotely collect the consumption data from electricity, gas, water and heat meters and reduces the transaction costs linked to data transfer.

The vision of integrated smart grids is also represented in the German Green Book on *Smart Grids and Smart Markets* published in late 2011 [1]. This Green Book is a decisive step that points out the implication of the authorities in the development of the “Smart Grids of the future” and centralizes the objectives of grids and markets modernization that were mostly scattered before then. This document has no purpose to establish a precise grid modernization roadmap, nor a smart meters deployment framework. Nevertheless, it translates the vision of the government and the regulator to differentiate the Smart Grids modernizations that rest on regulated operators from the competitive activities derived from the Smart Grids.

However, in spite of German’s efforts to promote smart metering technology and demand-response programs, the many actors involved in smart metering claim a lack of clear regulatory framework to invest in this technology. The amendments of German Energy Law (EnWG) attendant to metering liberalization regarding metering and pricing orientations did not succeed in reaching a dynamic metering competition. According to the EnWG, since 2008, any new meter installed in new buildings –or renovated buildings– and every replaced meter must be a smart meter, and no consumer should bear the upfront investment of the installation (EnWG Section 21). This legislation was enhanced in 2011 when the authorities made it compulsory for any consumer whose demand exceeds 6000kWh/year[12] and any generator of at least 7kW connected to the distribution grid to be equipped with a smart meter. In addition, since 2011, all the suppliers must offer a dynamic pricing, containing at least two block rates, to its retail customers (EnWG Section 40). These rules both apply to independent suppliers who charge a meter price determined on the market and to suppliers in charge of last resort obligation whose meter cost remains regulated. Keeping regulated tariffs for domestic consumers under universal service fatally distorts competition, leads to inertias from independent actors and creates barriers to retail competition. As a consequence, the rate of penetration of smart meters has been particularly low in Germany with a penetration rate lesser than 0,05 percent per year [30]. Today, only few of the nearly 860 suppliers
took the initiative to test the technology on a voluntary basis [31], and only two of them succeeded in installing smart meters on a large scale[13] [28] [19].

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[12] As for comparison, the average consumption for domestic consumer is 3 500 kW/year.

[13] RWE plans to deploy up to 100 000 meters in Mulheim, where he is currently involved in the E-Energy “Model City of Mannheim” Project and Yell Strom is the only supplier to offer smart meters on the country scale.

### 3.2 Description of the British model for smart meters deployment and data dispatch :

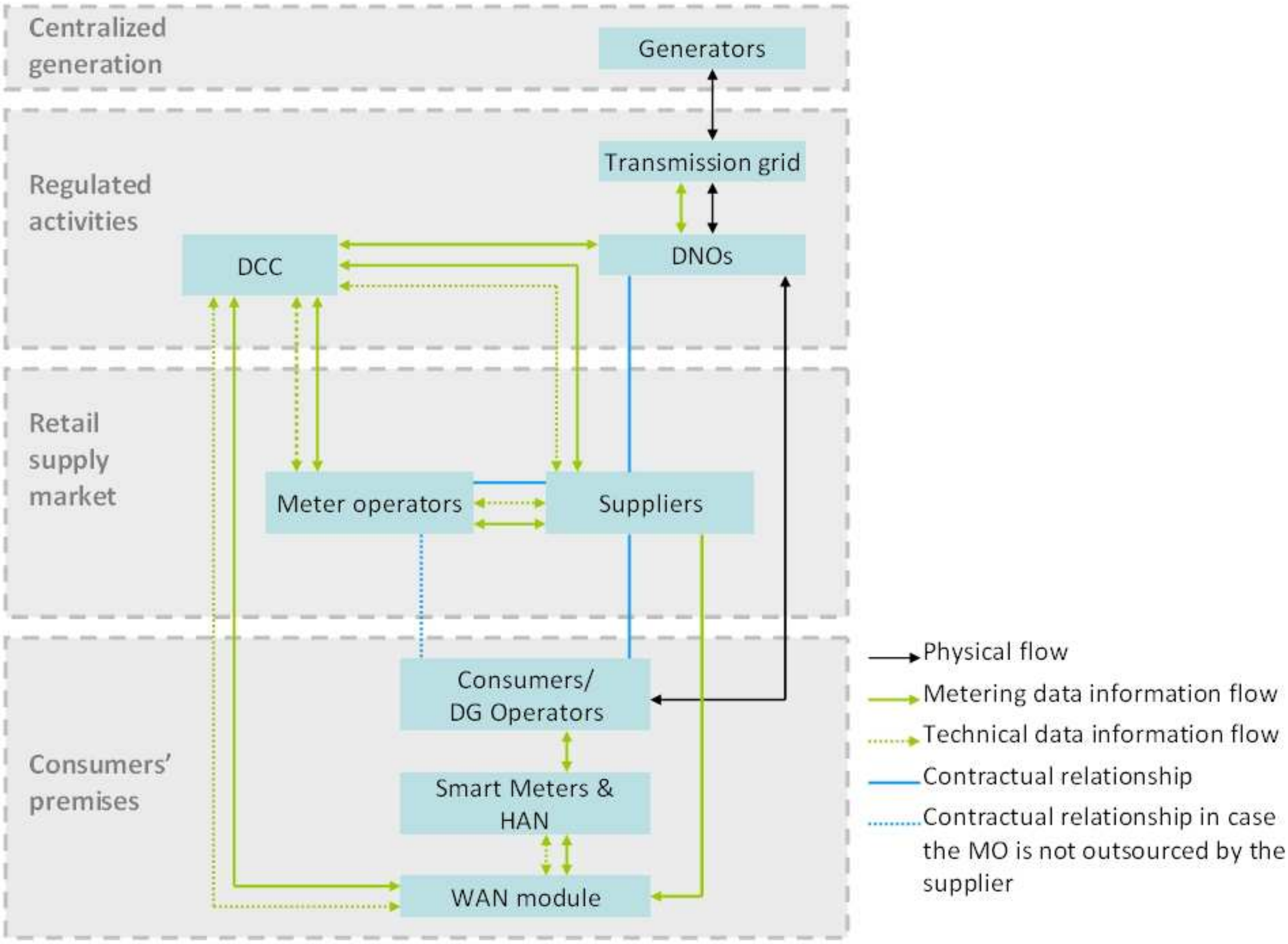
In mandating a complete roll out of smart metering equipments for electricity and gas, the UK had to comply with its supply chain organization and adopt a model of smart metering data transfer that enhances its retail competition. In the first place, one have to distinguish two types of data derived from energy metering. The pure metrological data that effectively designate the quantities consumed over time. And the technical data that designate the metering device used and the contractual agreement passed between a consumer and its supplier/meter operator.

In the British retail competition context, and as noted by Littlechild (2005) [27], the use of smart meters would have the double advantage of enhancing the efficiency of the current metering data transfer by automating this process. The delay of switching as well as the data capture errors would be lowered. The second benefits involves the technical characteristics of the smart meters would be recorded and any technological change or contract switch would remotely and automatically be sent to the designated market organizations. In addition, a better knowledge of individual load curves is expected to be a vehicle for the development of attractive and competitive energy offers that would evenly stimulate the competition and generate greater outputs for consumers [28].

The British Smart Metering Implementation Programme schedules the roll out to be completed by 2019 and designate the suppliers as responsible to offer and install attractive equipments and programs to the customers [32]. It sets the details for deployment, establishes the minimal functionalities expected from the smart metering infrastructures, as well as its compounding devices. One of the key aspects of the British roll out approach is to pursue a least transaction cost strategy in coordinating electricity meters replacement with gas meters replacements. The UK is implementing a smart metering system that enables the centralization of both electricity and gas consumption data through a multi-energy wide area network (WAN) module installed in consumer premises. If the suppliers will effectively inherit of smart meters ownership, the British authorities decided to keep the WAN module as a regulated asset to ensure free access to multi-energy data flows and avoid undermining its transaction costs reduction strategy.

The suppliers are already authorized to proceed to the meters substitution, however the real launch of mass deployment will occur with the implementation in 2014 of the newly regulated entity, the Data Communication Company (DCC). The DCC aims to be an independent intermediary between the suppliers and the DNOs and the rest of the system (**figure 3**). The DCC will replace the current electricity and gas data platforms and centralize their data, sent by the WAN modules. These consumption data will be then transmitted to the suppliers and meter operators for billing purpose. The DCC will also be the intermediary between the consumption sites and the rest of the supply chain. Consequently it will be of its duties to transmit aggregated load curves data to the relevant DNOs for forecasting and operation purposes. In addition, the DCC will be in charge of dispatching the technological data relative to any supplier or contract switch and will become the unique intermediary between the suppliers to ensure a greater transparency and efficiency in the supplier switch process.

**Figure 3:** Organization of the British Smart Metering System.




# 4 LAST RESORT OGLIGATION VS. PERFECTLY SEPARATED METERING ACTIVITIES: IS THE BRITISH MODEL APPLICABLE IN THE GERMAN CASE?

# 5

## 5.1 A current legal framework inefficient at the deployment stage.

As regard to the German metering regulation, it is no surprise the actors claim a lack of clear legal framework to invest and proceed to effective deployment. Unlike the UK, the upholding of public service obligation on metering activities within a competitive metering market impedes a large scale deployment of smart meters. If no review is made to German metering activities organization, either technological barriers coupled with high stranded costs or competitive locks-in are more than likely to occur if a deployment is mandated (**Table 2**). The current organization must evolve if Germany wants to adopt smart metering technology. To argue this, one can take two assumptions for smart meters functionalities; "low level" functionalities and "high level" functionalities. This degree of functionality is decided by the regulator and public authorities and apply to both the equipments procured by suppliers responsible for last resort obligation and by the rest of independent suppliers/meter operators. The only difference being that last resort providers would have to stick with these functionalities whether the other independent operators could develop any functionalities in addition to the minimal functionalities, judged profitable. Setting the functionalities between these two extents will hence represent a trade-off between competition and technological innovation.

Firstly, "low level" smart meters functionalities applied to last resort providers would result in technological locks in and high sunk costs. The smart meters installed by last resort obligation suppliers in the 40 percent of the domestic sites under universal service would in this case remain in consumer's premises for the 20 average years of lifespan, in the case the consumer doesn't decide to get a better equipment. Under this assumption, these consumers would not benefit from potentially future innovations in the energy efficiency programs field. Indeed, it is expected that with a wider use of smart metering technology, learning curves would appear and more efficient and best adapted programs would develop (home automation etc.). If low level functionalities are set in the first place, the last resort providers will not be incentivised to offer more efficient devices than specified. Indeed, in proposing high performance smart meters, these last resort obligation providers would not be ensured the over costs induced by unspecified added functionalities would be recognized as "reasonable costs" by the regulator. So these over costs would not be passed through, but funded at the supplier's expenses. In the case a consumer under universal service contract does decide to change his contract to get more adapted rates and services that might induce the installation of a higher functionality meter, this early replacement would induce important sunk costs and a loss of efficiency.

Nevertheless, the low functionalities option would have the benefits of leaving the independent suppliers and meter operators with a wide range of energy contracts and commercial arrangements to develop. In this case, a competitive smart meters market with high value innovative products would become the main comparative advantage upon which the suppliers would compete and attract new market shares. This efficient development of smart metering competition would in turn be able to attract consumers under the universal service, willing to benefit from more adapted rates and services. However, provided that 40 percent of the domestic segment would be equipped with basic smart meters, their switch to more innovative market contract and installation of a higher functionality meter would one more time induce stranded costs. According to this low functionalities assumption, the presence of last resort obligation would have a quite low negative impact on the smart meters market competition and innovation. But the relatively high share of consumers under universal contract would in turn lower the welfare of integrating smart technology.

On the other hand, "high level" smart meters functionalities would reduce the potential technological locks-in and sunk costs but would in turn hinder competition and induce foreclosure for independent suppliers. Indeed, if last resort obligation suppliers are allowed to develop and install high functionalities smart meters, competitive offers would develop at the margin and attract only niche consumers. Under such an assumption, the gap between the installed technology in the 40 percent sites under universal contract and the state of the art technology would be reduced. These consumers would benefit from more innovative offers, able to bring efficient solutions in terms of load management and would reduce the potentially sunk costs. However, this would result in a reduced wiggle room for no last resort suppliers and would create competitive locks-in on the metering market.

**Table 2**: Positive and negative effects of the last resort obligation in the low and high functionalities cases.

| | **Benefits** | **Drawbacks** |
|---|---|---|
| **Low functionalities** | - Enhanced competition from non last resort provider suppliers.<br>- Rapid development of energy efficiency solutions.<br>- Development of added value market offers that may attract universal service consumers to competitive offers. | - A large quantity of domestic sites under universal service that potentially leads to a loss in terms of learning curves improvements.<br>- Technological locks-in for universal service contract consumers unwilling to switch to a market offer. |
| **High functionalities** | - Lower sunk costs<br>- Reduced technological locks-in that would have benefits in terms of efficient energy programs. | - Foreclosure due to a reduced wiggle room for the suppliers to create added value offers. |

Keeping the last resort obligation in a free metering market leads fatally to inefficiencies. As a consequence, three designs are emerging. The first one that consists in making the distribution grid operators responsible for the smart meters and the metering market should be avoided. Contrarily to countries where distribution network operators are the owner of the dominant supplier[14], leaving the smart metering activities to regulated network operators would in this case simply eliminate the retail supply competition. On the other extent, the solution of adopting the British model with all suppliers interacting in a single set of rules shared by each of them without exceptions would effectively wipe off the issue of foreclosure and technological locks-in. As in the UK, the suppliers would become the owner of the smart meters and the only role of the distribution grid operator would be to sell energy to the suppliers. However, this solution leaves open the issue of short term internal coordination as explained hereinafter. A third solution should be considered. It consists in a step back from pure free metering market in focusing on a pure free metering data market. Indeed, what is of major importance remains the metering data, not the metering asset. Distribution grid operators would be responsible for wide roll out and would remain the owners of the metering assets. For retail competition to be effective, they would have to procure indiscriminate access to metering data and data ownership rights to the suppliers who would in turn be responsible for data management. This solution is the one adopted by Netherlands who was along with Germany and the UK one of the three European countries that extended its downstream unbundling to metering activities. As Germany, it is particularly concerned with fluctuating energy integration and balancing operations. And as the UK, Netherlands mandated a smart meters widespread to be completed by 2016. Dutch government decision to shift back to free metering data market only, highlights the fact that the greatest outputs from smart metering technology will be derived from smart services, enabled by the technology, not from the smart meter market itself. However, these two last designs leave open the question whether or not insuring public services obligations and maintaining last resort services (meters and regulated tariffs) and to what extent keeping guaranteeing energy security for lowest income consumers.

### 5.2 A British model that seems to be inconsistent with the future German integrated Smart Grids.

When widening our focus on a more integrated frame where both low voltage grid operations and supply side management are considered, it seems the British organization is likely to be inconsistent regarding German's energy targets. Considering the integrated Smart Grids, one must think in terms of the trade-off between enhanced competition and enhanced coordination. Where the first one

[14] The ERGEG ( 2009) records six european countries under this organization : Estonia, Finland, France, Italy, Luxembourg, an Slovak Republic [33].

would lead to market based meter procurement, involving high quality devices competitive prices and multiple services, the second one would draw benefits from greater flexibility, security of supply and electricity quality. Regarding the specific issues these two countries are facing, what is pointed out here is that promoting SG technology to enhance retail and metering competition is rather different than promoting SG technology to better operate fluctuating and bidirectional flows. The automation and remote communication enabled by smart meters can facilitate the aggregation of loads and the local scale valorization of smart metering derived services (ancillary services, peak shedding etc.) by aggregators. These aggregators would operate their area as a virtual power plant and valorize its services as any buyer or seller would do in a balancing market.

Yet, short term coordination of balancing settlement and congestion management are the main issues to be tackled by Germany. As a consequence, Germany requires a high overall internal level of control and monitoring coupled to high speed adjustment mechanisms. We refer here to the technico-control dimension in the sense of Kunneke et al. (2010) in opposition to longer term coordination such as investment planning that will be addressed below. The technico-control dimension involves the very short term adjustments realized at the system level to ensure the continuity of service and high quality electricity through the operational balancing and congestion management. These critical functions impose a need for high level transaction coordination within the entire supply chain. If not well coordinated, these critical functions will "fail to deliver the expected services", and lead to high efficiency losses [34].

Adopting the –previously untested– DCC-type model would presumably lead to such coordination losses for the whole German system. A DCC-type architecture would impose the drawbacks linked to the presence of an additional transactional module, in the sense of Glachant & Perez (2007), strengthen by its data dispatching-only functionality [35]. The complete separation between the DCC and the short term system operations in the British model is the major constraint that would face Germany in adopting this organization. Indeed, the DCC is exclusively allowed to execute data dispatch activities. Any kind of short term decentralized operations[15] would have to transit by this additional module before being effectively executed by network operators, resulting in higher coordination risks. If adopted by Germany, the central data-only entity should be entitled to retain at least emergency central control rights and basic ancillary services.

Another issue may arise with the adoption of any new entity. For the system organization to be efficient, the governance of the intermediary entity must guarantee its independency towards both regulated and independent parties to avoid information retention such as the one observed with the

[15] The main focus is on decentralized network operations through aggregation in opposition to already centralized third parties.

opening of British metering market [27], and jeopardize the benefits expected from the SG. The future smart grids infostructure will have to certify its neutrality to ensure effective non-discriminatory access to the smart metering data.

One solution to rally the central coordination requirement without impeding competition was formulated by Friedrichsen (2011) [36]. She points out the fact that both data access and system operation must be executed the same way; neutrally and without any discrimination access. As a consequence, these two functions should be operated by the same operator. The major trade-off resulting from competition goals and high speed adjustment could be addressed through the implementation of an independent system operator (ISO). According to her, “An ISO solution further simplifies the structure by combining system operation and information tasks and avoids the duplication of information infrastructure. It also secures the access to the relevant data for the system operator which is important on reliability grounds“. Indeed, some of the characteristics of ISOs are precisely to be an independent actor responsible for short term reliability in ensuring the real time balancing and in charge of operational dispatching [37]. Among its functions, ISOs have to coordinate the third parties in their ancillary services provision. They are in charge of monitoring congestions and allocate the limited capacities the most efficiently. They also manage cross border interconnections and guarantee regional coordination, as well as nodes congestions. Consequently, an ISO could be entitled to operate and dispatch the same aggregated decentralized ancillary services and decentralized load shedding.

At last, as for any architecture adoption, implementing an ISO may lead to some inconveniences that can be a major importance. At least, two main drawbacks can be mentioned. Both are expected to be faced in any implementation cases, but the second can be of particular importance in the German’s case. Indeed, in the first hand, one of major challenges arising is to implement a governance structure to control the ISO activities and make sure of its actual independency. Indeed, this type of organization can only bring efficiency gains all along the supply chain as long as the ISO is “not suspect to discrimination incentives” and is not integrated to any other activities [36]. A clear separation with generation or selling activities and with the physical networks must be adopted to guarantee the independency of the ISO. In addition, an incentive scheme has to be adopted to avoid that the ISO interests diverge from its initial goal of enhancing the whole system efficiency [37]. On the second hand, the separation between the activities of dispatching and balancing with the activities of physical network management may imply that investment signals are less clear. This is especially to be considered in a country like Germany, where the connection of growing DG requires a planning of low voltage reinforcement and expansion. Finally, the results already advanced by

# 6 CONCLUSION

In a liberalized metering activities context, the obligation of last resort service provider, which is assumed by former integrated suppliers, appears as an obstacle to mandate a smart meters roll out. This appears as a barrier to adopt the right incentives bound to regulated and independent actors and leads to inefficiencies and inertias. In this context of unbundling, emphasizing technological benefits would deteriorate competition and emphasizing competition would imply a potential low benefits smart meters deployment.

According to this observation, and if we refer to British success in mandating its roll out plan, it seems that a large use of smart metering data should go hand in hand with perfectly unbundled metering activities. Yet, such a conclusion can not be drawn regardless of energy policy targets and future implications. If the British solution is capable of bringing advantages from a retail-competition point of view, it is not as clear that it would imply similar benefits to German's RES-integration objective. Quite the opposite the comparison tends to show that if the solution embraced by the UK is capable of reaching benefits with respect to their energy policy, it is not adapted to German's targets. Fully unbundle the distribution and the metering activities and implement a new entity to ensure the coordination between them would be risky in terms of balancing and grid operations. This tends to support the idea that smart metering centralization and grid operation, or at least emergency grid operations, should be borne by a unique entity, completely neutral insuring regulated access to metering data to both the suppliers and the rest of the system. The studies led by Friedrichsen call for the implementation of an ISO that would refocus its traditional activities to include downstream operations. Clearly, the smart grids of the future will call for new architecture designs shaped by the new capacities brought by a greater automation and flexibility. Whatever the authorities decide which design suits the best their interests, the integration of the Smart Grids will require a high degree of independency from the metering data infostructure and will imply new challenges in terms of new rules and regulation settings.

**REFERENCES**


[1] BNetzA, 2011. „Smart Grid“und „Smart Market“ Eckpunktepapier der Bundesnetzagentur zu den Aspekten des sich verändernden Energieversorgungssystems Bonn, Dezember 2011. *Smart Grid "and" Smart Market "Key Issues Paper of the Federal Network Agency on the aspects of the changing energy supply system.* Bonn, December 2011

[2] Saguan M., 2009. Smart Metering: Summary and Conclusions. *Smart Metering Workshop Organized by the Florence School of Regulation*. Florence 6th February 2009.

[3] BMU, 2007. Report on implementation of the key elements of an integrated energy and climate programme adopted in the closed meeting of the Cabinet on 23/24 August 2007 in Meseberg.

[4] Energiewirtschaftsgesetz – EnWG § 36 - 38, 2005 *Energy Industry Act* § 36 - 38, 2005.

[5] Ehlers E., 2009, Electricity and Gas Supply Network Unbundling in Germany, Great Britain and the Netherlands and the Law of the European Union: A Comparison. *Proefschrift ter verkrijging van de ter verkrijging van de graad van doctor aan de Erasmus Universiteit Van Tilburg*, November 23 2009.

[6] Nikogosian V. & VeithVertical T., 2011. Integration, Separation and Non-Price Discrimination: An Empirical Analysis of German Electricity Markets for Residential Customers, *Discussion Paper No. 11-069*, 2011.

[7] Ofgem. 2006. Domestic Metering Innovation. Consultation Document 20/06. London: Ofgem, 2006.

[8] Energiewirtschaftsgesetz – EnWG Section 1 and 2 EnWG.

[9] BMWi, 2010. Energy Concept for an Environmentally Sound, Reliable and Affordable Energy Supply 28. September 2010.

[10] Mendonça M., 2007, Feed-In Tariffs: Accelerating the Deployment of Renewable Energy, *World future Council*, 2007.

[11] BMU, 2010, Erneuerbare Energien in Zahlen: Nationale und internationale Entwicklung. Berlin, Januar 2012. *Renewable energy sources in figures: National and International Development.* Berlin, January 2012.

[12] Kema, 2011. Distributed Generation in Europe – Physical Infrastructure and Distributed Generation Connection. IEPR Committee. April 29, 2011.

[13] BNetzA, 2010. Monitoring Report: Monitoring Report Documents High Degree of Reliability of Power Supply, November 2010.

[14] BDEW, 2011. Atzung des Ausbaubedarfs in Deutschen Verteilungsnetzen Aufgrund von Photovoltaik- und Windeinspeisungen bis 2020, März 2011. *Estimation of the expansion in demand for German distribution networks due to solar and wind power supplies by 2020*, March 2011.

[15] Bayod-Rújula A. A., 2009. Future development of the electricity systems with distributed generation. Original Research Article. *Energy*, Volume 34, Issue 3, March 2009, Pages 377-383

[16] Strbac G., 2007. Electric power systems research on dispersed generation *Electric Power Systems Research, Volume 77, Issue 9, July 2007, Pages 1143-1147.*

[17] Sioshansi, F. P., 2011. Smart Grid: Integrating Renewable, Distributed & Efficient Energy. *Academic Press Inc,* 2011, 568 p. ISBN-10: 0123864526.

[18] Stadler, I., 2008. Power grid balancing of energy systems with high renewable energy penetration by demand response. *Utilities Policy* 16 (2008): 90-98.

[19] Wissner M., 2011. The Smart Grid – A saucerful of secrets? Original Research Article *Applied Energy*, Volume 88, Issue 7, Pages 2509-2518. July 2011.

[20] DECC, 2011. UK Renewable Energy Roadmap. July 2011.

[21] BNetzA, 2011. EEG-Statistikbericht 2009, 28. März 2011. *EEG statistic report 2009*, 28 March 2011.

[22] Bundeskabinett, 2010. Nationaler Aktionsplan für Erneuerbare Energie. 08. 2010. *German Federal Government Renewable Energy Action Plan*, August 2010.

[23] AECOM, 2011. Energy Demand Research Project: Final Analysis, June 2011.

[24] Carbon Trust, 2007. Advanced Metering for SMEs: Carbon and Cost Savings. May 2007.

[25] Brown A. and Salter R, 2011, Can Smart Grid Technology Fix the Disconnect Between wholesale and Retail Pricing? *The Electricity Journal* Volume 24, Issue 1, January-February 2011, Pages 7-13.

[26] Ofgem, 2008. Energy Supply Probe - Summary of Initial Findings. 06/10/2008.

[27] Littlechild S., 2005. Smaller Suppliers in the UK Domestic Electricity Market: Experiences, Concerns and Policy Recommendations. 29, June 2005.

[28] Haney A. B., Jamasb T., & Pollitt M. G., 2009. Smart Metering and Electricity Demand: Technology, Economics and International Experience. *Cambridge Working Paper in Economics* 0905 & EPRG Working Paper EPRG0903. February 2009.

[29] Zhang T. and Nuttall W. J., valuating Government's Policies on Promoting Smart Metering Diffusion in Retail Electricity Markets via Agent-Based Simulation. *Cambridge Working Paper in Economics* 0842 & EPRG Working Paper 0822. August 2008.

[30] French Embassy in Germany, 2011. Les Smart Grids, L'instauration d'un Réseau Intelligent en Allemagne – Contexte et Perspectives. Info Berlin N°6. Juillet 2011. *Smart Grids, The establishment of an Intelligent Network in Germany - Background and Perspectives.* Info Berlin N°6. July 2011.

[31] Intelligent Energy – Europe, 2011, European Smart Metering Lndscape, Deliverable D2.1 of the Project "SmartRegions – Promoting Best Practices of Innovative Smart Metering Services to European Regions. February 2011.

[32] DECC, Ofgem, 2010. Smart Metering Implementation Programme, Prospectus. 27 July 2010.

[33] ERGEG 2009. Status Review of DSO Unbundling with Reference to Guidelines of Good Practice on Functional and Informational Unbundling for Distribution System Operators Ref: E09-URB-20-05 9. September 2009.

[34] Künneke R., Groenewegen J., & Menard C., 2010. Aligning modes of organization with technology: Critical transactions in the reform of infrastructures *Journal of Economic Behavior & Organization*, Volume 75, Issue 3, Pages 494-505. September 2010.

[35] Glachant J. M., & Perez Y., 2009. The Achievement of Electricity Competitive Reforms: a Governance Structure Problem ?. chapitre 9 in Ménard C. and Ghertman M. (2009) *Regulation, Deregulation, Reregulation, Institutional Perspectives*, Edward Elgar.

[36] Friedrichsen N., 2011. Governing Smart Grids - the Case for an Independent System Operator. *Bremen Energy Working Papers* 0011, Bremer Energie Institut.

[37] Pollitt M. G., 2012. Lessons from the history of independent system operators in the energy sector. *Energy Policy*, In Press, Corrected Proof, Available online 9 May 2012.