

Smart Metering Information Management

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1 Information Management Within the Energy Industry

The energy industry in Germany is currently undergoing a far reaching transition. This especially applies to power generation because of the government's objective to increase the generation of electricity from renewable sources to 80% until 2050 (BMU and BMWi 2010). However, the agents concerned with power transmission and distribution to the final consumer have been facing extensive changes since the liberalization of the energy market. These developments provide challenges for information management in the power industry. To enable differentiation, a 3-level model is

introduced, referencing the business engineering approach (Österle and Winter 2003). The model categorizes agents according to their value creation, and information according to its form and processes. The infrastructure is classified according to its essential system elements. The interdependence of all parts is the basis of the 3-level model. **Figure 1** illustrates how the information level is distinct, yet constitutes the connecting element. It enables the vertical exchange of data between the technical infrastructure of the grid and the agents in the energy market as well as the automated control of information flow within the agent and infrastructure level.

The expansion of renewable energies, funded by the Renewable Energies Act, can be assigned to the infrastructure level. Renewable energies are much more volatile than energy production from fossil sources. The complexity of balancing feed-in and demand increases measurably. The number of agents has risen since the liberalization of the energy sector in 1998. Earlier on, the four big power supply companies had established a monopoly-like structure along the value chain from generation to transmission and sales. Since the enforcement of

the Energiewirtschaftsgesetz, these businesses are required to separate their branches financially as well as organizationally. This is commonly referred to as unbundling.

Despite the amount of change on the agent and infrastructure levels during the last years, the standards, processes, and business models on the information level are still in their infancy.

2 Smart Metering and Smart Grid

The vision of a future energy supply system consists of employing new, *smart* technologies to facilitate the network control of distribution grids. Additionally new features are supposed to provide incentives for customers to consider the kind of generation before consumption. Simultaneously providers of electricity would gain opportunities for growth. These features shall be put into practice by a *Smart Grid*. The term Smart Grid (an intelligent energy supply system) "comprises the networking and control of intelligent generators, storage facilities, loads and network operating equipment in power transmission

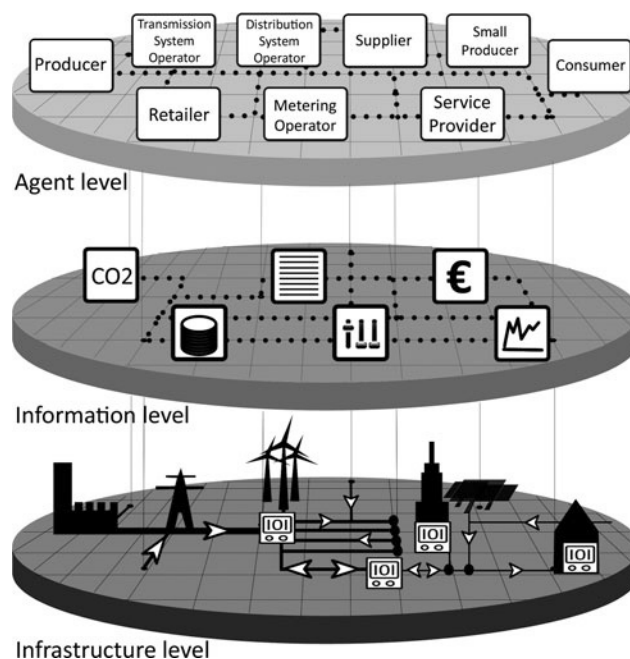
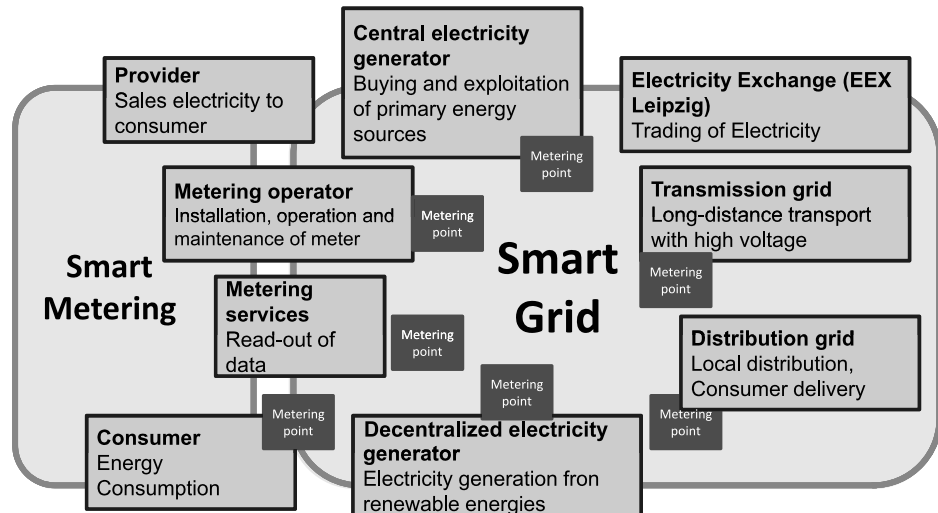


Fig. 1 Level Perspectives of the Energy Industry (BMWi 2011b)

Fig. 2 The Connection between Smart Metering and the Smart Grid



and distribution networks with the aid of Information and Communication Technologies (ICT)” (VDE/ITG 2010).

Essential prerequisite for an *intelligent* energy supply system is the usage of digital meters, so called *Smart Meter*, instead of the analogue Ferraris meter. The *smart meter* is both a digital metering point for the household’s energy consumption and an established control element of the regional distribution grid. It can be equipped with a communication module which also enables bidirectional flow of information. The transfer of data can be facilitated by different means of transmission (e.g., power line communication, mobile radio, broadband).

Only with the help of a wide spread of metering points can the necessary information about the state of the electricity grid be gathered and analyzed for controlling purposes (Watson et al. 2010).

Smart Metering is the processing of information through gathering, evaluating and aggregating consumption and usage data, inspections and diagnosis of voltages, feed-out and operating status executed in real time, and sending of control signals. The data can be measured and processed in different granularities and different intervals. While the term Smart Grid includes the control of energy feed-in, for example the regulation of different renewable energy sources as virtual power plants to cover the base load, Smart Metering focuses on the chances resulting from digital metering units. The introduction of the latter would create opportunities for rating and pricing (see Fig. 2). The *European Smart Metering Alliance* (ESMA) places the customer in the center: “Smart Metering is designed to provide utility customers information on

a real time basis about their domestic energy consumption. This information includes data on how much gas and electricity they are consuming, how much it is costing them and what impact their consumption is having on greenhouse gas emissions” (ESMA 2010). A continuous *meter-to-cash* process can be conducted once the information of intelligent meters are automatically collected, transmitted, analyzed, and provided for further applications within an integrated system landscape.

3 Status Quo of Smart Metering Initiatives

The EU-directive on energy and climate policy (Europäische Union 2006) and the implementation decree for the introduction of new incentives for energy control and saving (EnWG 2005 § 21, § 40) have laid the foundation for the usage of intelligent energy metering units and the liberalization of the metering business in Germany. In accordance with the 20–20–20 regulation of the EU-commission (20% higher energy efficiency, 20% renewable energy of total energy consumption, and 20% less greenhouse gas emissions) the transition from conventional Ferraris meters to smart meters should be accomplished in 80% of the homes by 2020 (EU-Kommission 2007). Currently the paragraphs § 21b and § 40 EnWG are most relevant to *Smart Metering*. Thus, since January 2010 every new building and facility which undergoes basic reconstruction has to include digital meters. § 40 compels energy providers to offer a

tariff which has incentives for energy saving and control of usage. Tariffs can either depend on usage or on the time of day. Furthermore the federal ministry of economy and technology has emphasized that metering is to be favored in competition (BMW 2011a). Also the federal network agency recommends neither to provide guidelines for a comprehensive roll-out nor to commit prematurely to a national expansion rate (BMW 2011a).

Currently there are a lot of pilot projects in Germany, but no ambitions for an extensive implementation. So far no agent in the energy industry has seized the initiative. The mostly regulated distribution grid operators await changes in the incentive regulation and an explicit judicial mandate. Electricity providers, on the other hand, question the investments capability for refinancing. Additionally, all those involved criticize the absence of business models, organizational structures, and standards ensuring inter-operability. The majority of the pilot projects in Smart Metering in Germany are publicly funded. They are dedicated to actively prepare for future challenges and to test the full spectrum of technological possibilities (Müller-Elschner 2010). Research indicates the varying state and speed of efforts for the extensive introduction of Smart Meter around the world (see Table 1). The importance of governmental guidelines to shape the development is evident.

In Australia and the United States of America procedures like Demand Response have already been tested. This is an attempt to shifting energy consumption into favorable time and tariff models. Analyses have shown that even with

Table 1 State of the introduction of Smart Meter in Europe (ERGEG 2007)

Introduction of Smart Meters (SM) in European countries	Liberalized market for SM and metering operators (MO)	Usage of SM in Homes (in % and year)	Comments on development	Accountability for Smart Meter Rollout
Netherlands	Yes, since 2000	3% (2008)	Reorganization of accountability in 2008	Only regional distribution grid operators
England	Yes, in separate steps from 2000–2005	>0,5% (2007)	Consolidation of procedures until end of 2010	Metering operator for smart meter; grid operators for services
Italy	No, expansion with government sanction 2001–2005	86% (2008)	Independent initiative of electricity provider ENEL	Distribution grid operator
Sweden	No, only standards for billing	59% (2009)	High degree of usage of innovative meters in already 97% businesses	Regional distribution grid operators
Germany	Yes, since 2008	Pilot projects	No guidelines in effect	Open

few consumers cost reductions of 3% can be achieved. The overall energy demand does not decrease significantly, but a better utilization of supply over the full day results (Fox-Penner 2010). Other research aims at the area of controlled vertical interaction, which can reduce grid costs and improve services along the value chain (VDE/ITG 2010).

4 Importance of Information Management to Smart Metering

The manifold shifts imply a change of paradigm in the energy industry. A unidirectional electricity distribution from generators to consumers with steadily decreasing voltages is replaced by decentralized feed-in of renewable energies with an n:m relationship: consumers become producers, “Prosumers”, models for distribution become demand driven, steady processes turn dynamic. These changes have a profound impact on the concerned agents as well as on the management of data and information. The pivotal challenges for information management with Smart Metering are illustrated in Fig. 3 for all the levels of the information management by Heinrich and Lehner (2005).

Strategic tasks for information management in the coming years will include the inevitable integration of information and communication technologies into every branch of the energy industry’s value chain.

Also sustainable business models need to be developed and assessed. Furthermore the quantitative electricity consumption will not rise with smart metering; consumers are likely to become more

sensitive. Energy providers will have to design new, IT-driven business models and advanced concepts of customer retention, because the pure sale of electricity will turn into a commodity. Innovative providers and service contractors will enter the market. Analogies to the evolution of the telecommunications industry become evident. The most significant characteristics are the accelerated shift towards more competition, increasing selection options for customers and intense involvement of information technology in the business landscape, especially due to extreme increase of internal and external data exchange.

A consensual governance framework needs to be drafted. This would provide a basis for effective and efficient interaction amongst the agents for Smart Metering purposes and furthermore facilitate balancing feed-in and consumption. The governance framework assigns responsibilities for the processing of information through generation, transfer, storage, and analysis to the agents by introducing guidelines and process definitions.

Furthermore, a variety of *tactical tasks* emerge from Smart Metering for the information management. Process-oriented data are produced; handling these imposes high requirements on data security. Those requirements need analysis so that a concept can be constructed which considers both: data security and the interests of data usage. Initial technical approaches to solve this problem have been adopted. However, a solution for the information management is lacking. Independent standards for data generation would make sense. In the worst

case meters will have to be replaced with every change of the provider. There is a variety of technologies for data transfer that need examination with regard to security, reliability, and cost efficiency. In addition it is not yet determined with which granularity the data for electricity consumption and grid occupancy must be transmitted and stored. A compromise between the necessary information on user behavior and grid control on the one hand and the resulting amount of data on the other has to be reached.

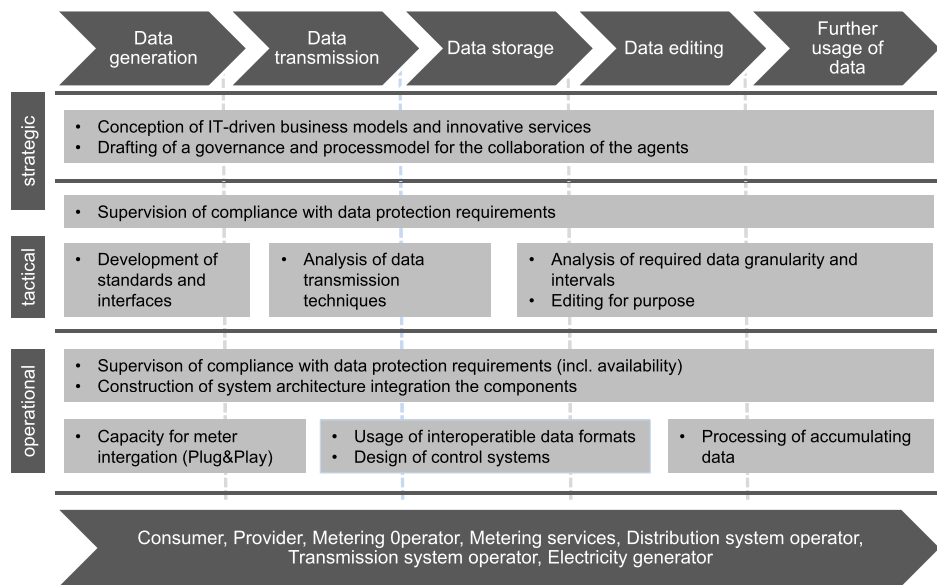
Amongst other things, the *operative tasks* of information management include the guarantee of grid safety against external attacks. It must be possible to compensate internal outages to ensure security of supply. Considering 40.2 million homes in Germany (Statistisches Bundesamt 2011) and an hourly or minutely data transfer, the arising amount of data is tremendous. The continuous processing of these mass data accumulating again and again is a big challenge to information management, for example for the architecture of standard software.

5 Summary and Outlook

The inherent necessity of Smart Metering in an electricity supply system that is becoming more volatile and decentralized through the feed-in of renewable energies is recognized. Yet implementation is still in very early stages.

Investments need refinancing; agents want to participate from the economic benefits with sometimes particular and

Fig. 3 Challenges in Information Management with Smart Metering



competing interests (e.g., Electricity generators, grid operators, providers, and distributors). Last but not least, the customer expects considerable added value through new service offerings and flexible tariffs.

Growing regulatory pressure towards more energy efficiency, rising awareness for sustainability with the consumers, advancing decentralized energy feed-in, innovative service offerings, and novel applications for customers will promote the Smart Metering technology.

Scope and type of the outlined challenges attest that the information management discipline can and must provide solutions for the described challenges of Smart Meter deployment.

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