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Smart grids

Energy rethink requires intelligent electricity networks

An efficient grid infrastructure is a prerequisite for speeding up the integration of renewable energies into the electricity supply. As such, the German government's energy concept agreed in autumn 2010 is pursuing the right approach. However, while the establishment of a European supergrid is likely to develop its own momentum, smart grids cannot achieve market success without stronger political support – whether that be via direct investment subsidies or statutory directives. In fact the potential savings for households often probably amount to a few euros, which calls for the ordinary citizen to be very passionate about the issue given the expenditure required.

Smart grids are intended to enable global savings of more than 1 bn t CO_2 equivalent by 2020. The new technology is intended to further stabilise grid utilisation given the peak loads associated with decentralised generation using renewable energy sources. This is intended to guarantee the security of supply in future and also to help save more than 1 billion t CO_2e worldwide by 2020; this is equivalent to cost reductions over the next 20 years of USD 2.5 bn p.a. in the US and EUR 7.5 bn p.a. in Europe.

Global market for smart grids will be worth EUR 100 bn between 2010 and 2014. According to the EU Energy Commissioner, Europe has a total of some 45,000 km of power lines requiring modernisation or new cables that need to be laid. The capital expenditure this entails will probably add up to EUR 400 bn for the distribution networks; including the transmission grid and the supergrid the figure rises to no less than EUR 600 bn. The investments required are enormous.

Interlinking the power grid and the data network considerably increases the complexity of the traditional business model. In order to handle such data volumes sensibly power companies will have to fundamentally restructure both their infrastructure and business models. This opens up the possibility of new competition scenarios and cooperation between previously discrete industries – not only power supply and communications sectors in particular but also the petroleum sector (especially via electromobility).

Volume of personal data generated will rise significantly. In view of the decentralised structure of the future power supply and the large number of players involved the appropriate technology will be required to guarantee the architecture and organisation, security and confidentiality of personal data. All the more so because this data reveals a good deal about individuals' lifestyles. The issue of protecting privacy will thus become a key criterion for customer acceptance of smart electricity meters and modern power supply networks.

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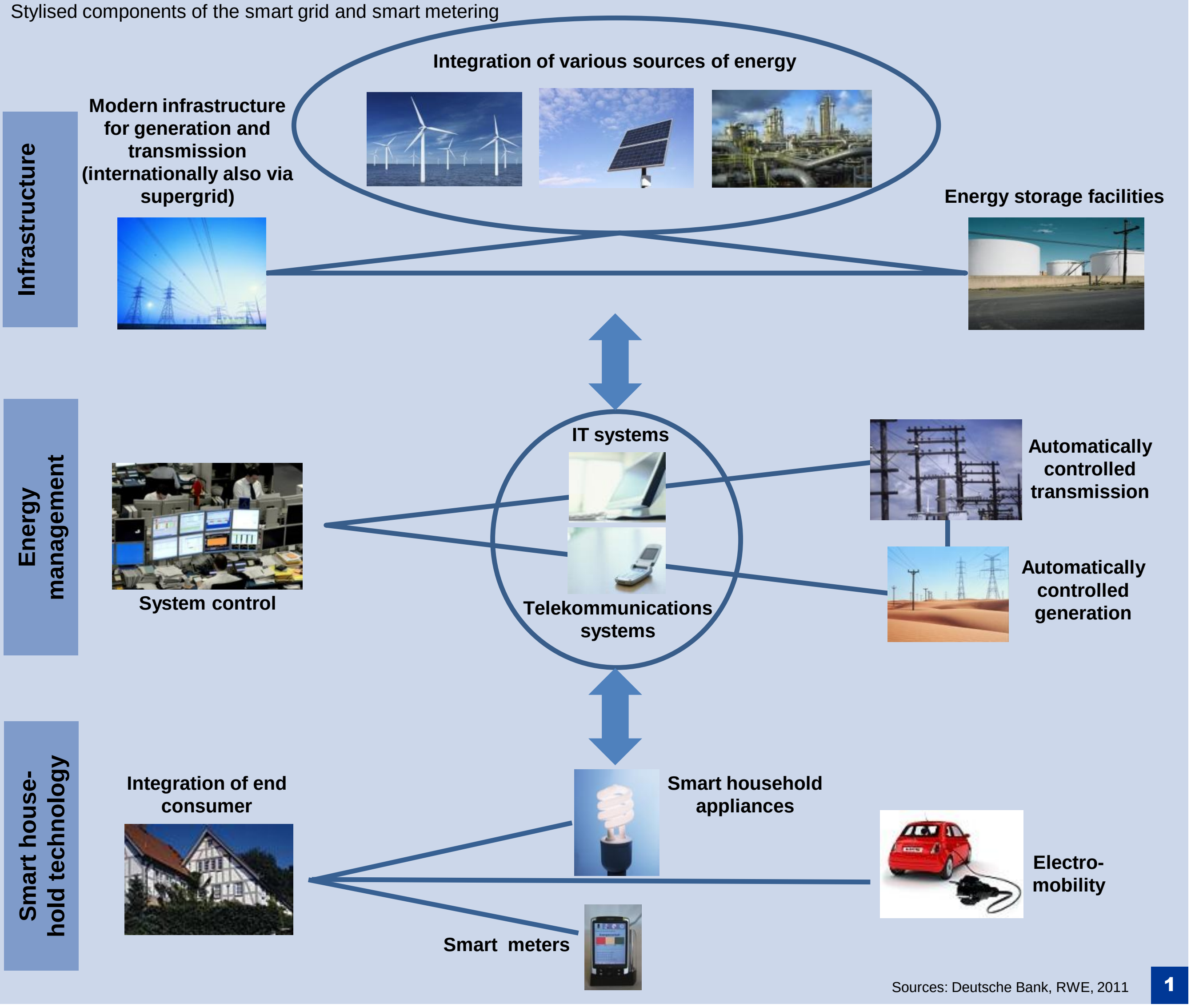
Information and communications technology form the foundations for smart grids

Stylised components of the smart grid and smart metering



Sources: Deutsche Bank, RWE, 2011

1

Faster grid expansion in Europe will boost the rationality of the European electricity supply system

Global challenges require cross-border solutions

The biggest energy policy challenges are global. These include the mounting climate risks, the resumption in energy price rises and the growing Europe-wide dependence on imported fossil fuels – above all petroleum. The policies pursued at the national level over the last 60 years have failed to deliver real progress in these areas of energy policy in Europe. A national bias and pronounced inertia stood in the way of improvements.

If Europe wants be a trailblazer for a modern energy and environmental policy in future, it needs to make swifter progress on major infrastructure projects, first and foremost in the electricity sector. While the EU-wide liberalisation of the electricity and gas markets at the end of the 1990s was "only" meant to bring about the first phase of competition in the line-based energy business, the objectives and challenges now are much more extensive and complex.

Progress necessary at all grid levels

The ultimate goals are the Europe-wide optimisation of power generation and consumption. At the level of the electricity networks this optimisation objective has two dimensions: one *conditio sine qua non* for cross-border optimisation is firstly the establishment and expansion of a truly European supergrid for long-distance transmission of electricity. And secondly, at the distribution level – the local micro level so-to-speak – there is the simultaneous availability of smart grids.

German government's Energy Concept points in right direction

The German energy concept formulated in autumn 2010 is to be welcomed inasmuch as it incorporates both dimensions. It accentuates the fact, moreover, that closer integration of renewable energies is barely possible without an efficient grid infrastructure. Faster grid expansion would play a major role in helping to boost rationality and efficiency in Europe's electricity supply:

Construction of North Seas Offshore Grid has many benefits for wind power

— New high-capacity transmission grids will enable more new wind capacity to be installed in future primarily in northern Europe, particularly in the North Sea region, but also in the Baltic region. Firstly, the advanced grid links help to even out and thus stabilise the varying regional volumes of wind energy generated in the different northern wind farms. Secondly, modern grids enable the intelligent integration of further green technologies such as tidal and hydroelectric power stations. Thirdly, surplus electricity can be managed better via pumped storage (also foreign, for example Norwegian) facilities or other innovative storage technologies (e.g. compressed air, hydrogen, electric car batteries). These objectives are pursued via the North Seas Countries' Offshore Grid Initiative that culminated in a Memorandum of Understanding (MoU) at the end of 2010. This European initiative is already regarded within the energy sector (by the industry association Bundesverband der Energie- und Wasserwirtschaft, BDEW among others) as a successful example of how the urgently needed expansion of the European electricity networks can be promoted across national borders. The Initiative enables the necessary further system and market integration of renewable energies into the European electricity supply structures. The capital investment costs of implementing the North Seas project alone total an estimated EUR 30 bn over 10 years.

One good example of progress in the European grid infrastructure

— From a European perspective the North Seas Offshore Initiative has the advantage that it enables the implementation of the many planned wind power projects in the North Sea. The total capacity of these projects easily comes to more than 100 gigawatts (GW). These additional 100 GW of offshore capacity are equivalent to no less than 100 coal-fired power stations each able to generate 1,000 megawatts (and thus obviate the need to build such plants).

Germany is one main beneficiary

— Especially for Germany with its big offshore expansion plans, the North Seas Offshore Initiative is of very major importance. Of course the European direct current (DC) supergrid also needs to integrate the other parts of Europe. That is why high-voltage DC superhighways also need to be laid from northern Europe to centres of consumption in central and southern Europe. For the still-to-be-built electricity superhighways will allow the long-distance transmission of electricity from north to south and prevent any surplus from going unused on days when high winds blow.

Greater rationality possible across European power stations

— The availability of high-capacity grids would offer the advantage that greater numbers of photovoltaic (PV) or other sun-reliant technologies (for example electricity derived from solar thermal equipment) would be installed in the Mediterranean region, where the sunshine is more intense than in the current PV subsidy paradise Germany, and thus that considerably higher volumes of energy could be generated. This approach goes well beyond the popular desert energy initiative Desertec which is admittedly based on the premise of the availability of high-voltage, low-loss direct current cables.

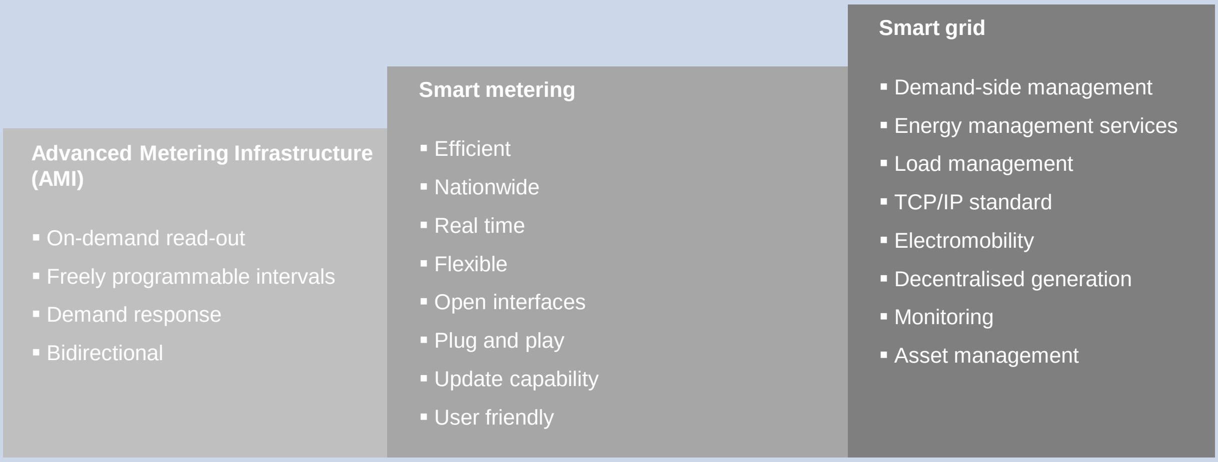
Unused hydropower potential in Europe can be tapped

— Moreover, the modernised power grid could finally enable the exploitation of Europe's hitherto still untapped close to 40% of economically usable hydropower potential (e.g. in the countries with major potential in the Alps, Scandinavia and south-eastern Europe) and its utilisation to supply Europe with electricity. By contrast, electricity from biomass will probably continue in future to be generated mainly in rural areas and fed into the grid.

Electricity superhighways must also take up conventionally generated power

— The future European electricity superhighways need to be equipped with sufficient capacity that they can also transmit the electricity from fossil-fuelled (preferably CO_2-free) power plants or nuclear power plants. From a European point of view it is barely conceivable that the special preferences of individual countries (e.g. Germany with its declared exit from nuclear power) can prevent autonomous investment decisions about the energy mix being made in other countries. A truly European supergrid would, if nothing else, enable the EU to benefit from large volumes of electricity from Ukraine, where the utilisation of total power station capacity is still relatively low.

Elements in the successes of smart grid and smart metering



Source: Power Plus Communications AG, 2010 **2**

Construct smart grid and supergrid at the same time

Competition in Europe receiving a new boost

Constructing the all-European supergrid, comprising the North Sea Ring, Desertec and the planned continental European DC cables, would require investments of more than EUR 100 bn. At the end of the day, however, there would be huge benefits for Europe – first and foremost for Germany (which on account of its ambitious energy policy rethink will in future probably become more reliant on electricity imported from third countries) – and for investors. Constructing a high-capacity grid infrastructure across the whole of Europe would moreover finally create the infrastructural conditions for a truly functional European internal electricity market. The thereby facilitated stiffer cross-border competition in the European electricity market could rein in the discernible rise in prices that has

Selected types of power grid

Traditionally, central large-scale power stations feed electricity into ultra-high and high-voltage grids. Electricity then flows via distribution grids (low, medium and high voltage) to customers. In the process, the electricity is transmitted from higher to lower voltage levels. The transmission grid (high-voltage and ultra-high voltage) balances electricity supply and demand.

In the new world of many renewable sources of power, electricity will be generated increasingly often at decentralised locations and fed into the distribution grids. This may lead to a change in the traditional flow of energy; in extreme cases this may even result in a (temporary) reversal.

The energy future – with solar parks in North Africa, offshore wind farms in northern Europe and hydropower plants and pumped-storage facilities in Scandinavia – requires low-loss electricity cables, so-called high-voltage direct current lines. They will make up the still-to-be-constructed European supergrid that will enable the low-cost, long-distance transmission of electricity from the new central generation sources to centres of consumption in the first place. For simplicity's sake the term electricity superhighway is used.

been occurring for a number of years. This in turn would benefit all electricity customers: industry, small and medium-sized enterprises and the many households.

From an energy and environmental policy standpoint it is therefore essential to expedite the combined construction of the smart grid and the supergrid. Ongoing progress in grid technology in addition to information and communications technology provides new opportunities for modernising the power generation, electricity distribution and consumption structures throughout Europe.

Since not only the big grid companies have an interest in transmitting large volumes of electricity over long distances, the construction of the European supergrid is likely to develop a momentum of its own. By contrast, rapid commercial success for the smart grids is predicated on stronger political incentives. However, should policymakers improve the conditions for households in the same way as they did with subsidies for green electricity granted under the Renewable Energy Sources Act, this would definitely also stimulate household demand for smart grid solutions. Nevertheless, the modernisation of Europe's power grids remains an extremely complex task; especially as energy-efficiency and cost optimisation also impact on households' established usage/consumption patterns – from the times for doing the laundry to those for cooking.

Smart grid promising

New technology supposed to increase security of supply

Smart grid signifies an energy supply based on modern information and communications technologies. Siemens calculates that the global market for smart grids is worth EUR 100 bn just for the period 2010 to 2014 alone.[1] Given load peaks associated with decentralised power generation using renewable energy sources (for example, in bright sunshine many collectors supply energy simultaneously), the new technology is intended to make grid utilisation more constant. The aim is both to guarantee security of supply going forward as well as help reduce global emissions by 2020 by more than 1 billion t CO_2e (CO_2 equivalent: the unit for measuring the greenhouse effect of emissions, standardised on the basis of CO_2).[2] According to Siemens, this corresponds to an annual cost reduction of USD 2.5 bn in the US and of EUR 7.5 bn in Europe over the next 20 years.

Smart grid gaining approval

While the unilateral control of the grid infrastructure has been functioning for a long time, smart control of consumption and generation still has to be installed. This entails considerable investment. Nonetheless, the smart grid is a topic that basically has the broad approval of politicians and the general public; at least as long as no concrete grid expansion plans or costs are available. Accordingly, many countries are attaching high priority to the restructuring of their electricity grids. As soon as possible, electricity is to flow through smart power grids worldwide.

Smart is in demand

Goodbye to the old model of steady central supply

The long-established electricity grid is geared towards the traditional supply situation, in which energy is fed in at a few points quite steadily and the relatively few, foreseeable supply peaks are absorbed by managing the consumption of bulk users.

At present, however, this supply situation is changing rapidly. More and more households are feeding energy into the grid as

[1] Siemens (April 2011). Factsheet Smart Grid, Hannover Messe.
[2] Ibid.

decentralised small-scale generators as yet without any facility for central management. So wind power and solar energy are becoming more important for energy management alongside fuel cell heating and mini combined heat and power units.

Numerous laws, ordinances and programmes are to achieve the goal

Numerous legal stipulations driving smart grids and smart metering

The political will to fashion a smarter energy supply system and in addition to make greater use of alternative sources of energy is reflected in a raft of laws, ordinances and programmes. In Germany these include the Energy Act (EnWG), the Renewable Energy Sources Act (EEG), the Energy Efficiency Act (EnEfG), the Renewable Energies Heating Act (EEWärmeG), the Metering Access Ordinance (MessZV), the e-Energy subsidy programme, the national development plan for electromobility as well as the EU directive on renewable energies:

Energy Act

The Energy Act (EnWG) of October 2008 includes the obligation that residential property being newly built or undergoing large-scale renovation must have electricity meters installed that make actual energy consumption and the actual usage period transparent to the end consumer.

Renewable Energy Sources Act

The Renewable Energy Sources Act (EEG) regulates the remuneration for and take-up of electricity generated from renewable sources by utility companies and grid operators. The law, which is being imitated in nearly 50 countries around the world, is aimed at boosting the volume of electricity generated from renewable energies in accordance with the energy and environmental policy objectives of Germany and the EU.

Energy Efficiency Act

The aim of the Energy Efficiency Act (EnEfG) is to reduce energy consumption in Germany by a total of 9% compared with the period 2001 to 2005. In order to achieve this, energy productivity is to be doubled by 2020 in comparison with 1990.

Renewable Energies Heating Act

The Renewable Energies Heating Act (EEWärmeG) of August 2008 requires that the renewable energy share of energy consumption for heating rise to 14% by 2020 (2010: 9.8%).

Metering Access Ordinance

The Metering Access Ordinance (MessZV) of October 2008 establishes a modern framework for the metering of electricity and gas and incorporates the EU demand that 80% of households be fitted with smart meters by 2020.

National development plan for electromobility

The German government's national development plan for electromobility from August 2009 specifically aims to accelerate the development of electric vehicles.

E-Energy subsidy programme

In its e-Energy subsidy programme commenced in 2008 the German government sets aside EUR 140 m for flagship projects in six model regions until 2012 (e.g. "The Harz renewable model region", "Mannheim model city").

Supply situation and prices volatile

The energy supply is associated with ever-increasing volatility, which given the limited scope for storing temporary surplus energy peaks to cope with demand overhangs also feeds through to the energy price. For example, in Germany the wind turbines located mainly in the northern part of the country generate large amounts of energy. These frequently regional peaks in output are already very difficult to manage via Germany's high-voltage grid.

Smart energy management required

Given this trend in the power generation mix there is no mistaking the calls in many countries for a rapid transition to smart energy management. Since such energy management is based on modern information and communications technology the increasing availability of powerful and low-cost IT hardware with fast data rates is a major pillar of these innovation efforts.

Commercial success is founded on functioning technology

The EU directive on renewable energies dating from December 2008 calls for a renewables share of primary energy consumption of 20% by 2020 (2008: 10.3%); the German energy industry act seeks to raise the renewables share of the electricity mix to 30%. According to the German government's "Energy Concept" this share is to rise to no less than 80% by 2050.

Power grid based on modern technology

According to this Energy Concept for the period up until 2050, the grid infrastructure will play a key role in achieving the German government's ambitious energy objectives. On the one hand, the expansion of the "electricity superhighways" is intended to facilitate better integration into the European system. On the other, the construction of smart grids based on modern information and communications technology will enable demand-side load management in future in which electricity demand is adjusted more closely to supply. The improved infrastructure, it is expected, will enable the growing fluctuations in power generation and consumption to be reconciled in an economically sensible fashion.

Decentralise centrally planned architecture

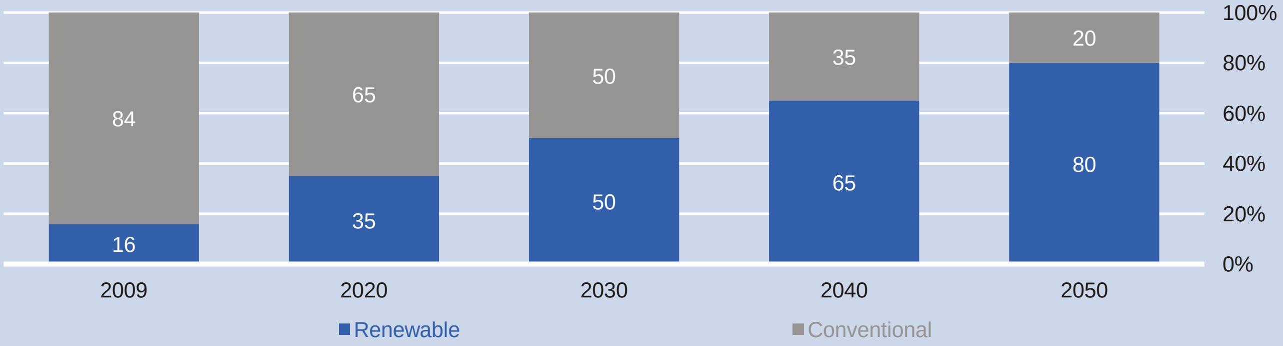
This remodelling of the power grids is a complicated undertaking. Ultimately it is a matter of simultaneously modernising and decentralising an architecture that has been centrally planned for many decades. For the German electricity distribution networks alone investments of EUR 25 bn should be made by 2030.

Call for technical standardisation

Beyond these challenges the experiences gained from the first pilot projects point towards barriers to success that may be traced back to an inadequate degree of technical standardisation. On the technical side the aim must therefore also be to establish vendor-neutral, non-proprietary communication standards that are compatible with the differing design and geographical requirements found locally. In the US it is the National Institute of Standards (NISt) that concerns itself with standardisation. The NISt cites 150 areas in which technical standardisation of interfaces would be necessary to guarantee the efficient exchange of information between system components in the smart grids.

German government's Energy Concept – targeting renewables for generating electricity

Shares of electricity generated from renewable and conventional energies (%)



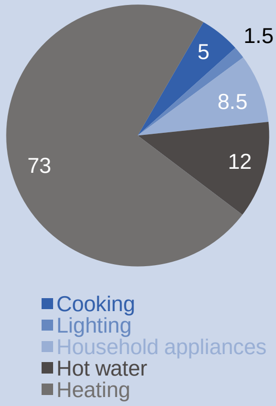
Source: Energiekonzept, 28/09/2010 **3**

The smart meter: Basis of the smart grid

In order to leverage the potential of smart grids, households as well as low-volume consumers should be provided with "smart meters" (bidirectional communication-enabled electricity meters, see chart). These smart meters measure current consumption, convey this information to the energy supplier and display it (e.g. via monitors in the living area) together with current charges for the end consumer.

Household appliances account for just a small fraction

Breakdown of energy consumption of an average German household (%)



Source: Siemens, 2011 4

End consumers can then either utilise the smart controls in their devices themselves or for a transitional period mainly use smart sockets to shift their consumption to periods when electricity tariffs are cheaper and moreover to also identify oversized energy wasters and eliminate them where possible.

Selected volume of devices with control potential

As regards control in accordance with energy efficiency criteria, basically only the following four classes of device come into question for household use:

— Devices that can be deployed at a variety of times: devices that after initialisation perform the assigned service fully automatically without being tied to a narrowly defined completion time; e.g. dishwasher or washing machine.

— Devices whose primary function is storage: devices that can also store their assigned service prospectively; e.g. fridges or freezers and air conditioners (for the cooling to be provided), hot water boilers or storage heating (for the heating to be provided) and compressed air pumps (for the compressed air to be provided).

— Storage batteries/accumulators in technical devices, especially electric vehicles whose next deployment is not imminent and can therefore be charged at a later time; e.g. the electric car.

— Small-scale generators with primary use storage for the bundled energy product; e.g. fuel cells or mini combined heat and power units which generate heat that is stored in addition to electricity.

It should be noted, however, that even with these 4 classes of device that enable energy efficient controlling to make sense at all, the scope for time-shifting usually does not extend to more than several hours. This means that even in this narrowly defined class of devices the flexibility of sensible energy efficient controlling is considerably limited. Siemens estimates that just 8.5% of the typical German household's energy consumption can be influenced via household appliances (see charts).

Countries at different stages with smart meters

Smart meters measure, control and make clear

Smart meters are intelligent devices whose functionality extends to both measuring and controlling the energy consumption of individual household consumers. To do this a concentrator (which is also a multi-utility-communication controller) collects consumption data and guarantees its transfer between utility and consumer via bi-directional communication infrastructure (e.g. DSL, in-house powerline).

In the knowledge of the fundamental connection between smart meters and smart grids (see chart 2, p. 5) Germany has now heralded the beginning of the end of the traditional meter by law and ordinance. According to the EU directive all German households must be equipped with smart meters by 2022. Other countries have basically already made more progress in this respect. Sweden, for example, has already completely switched over to smart meters – the devices, however, contain little in the way of smart technology. In addition, Italy and Austria are currently also implementing the physical changeover.

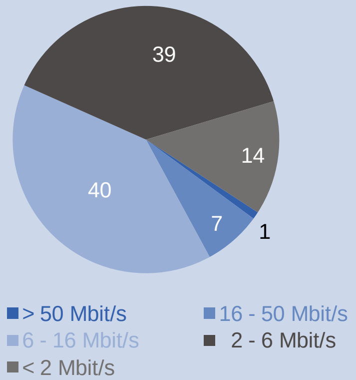
In many countries there is still no certainty as to which specifications the smart meter must ultimately satisfy in detail with respect to communication, control and display. Nevertheless there is no denying that the link-up between data network and energy grid enabled by smart grids and smart meters hugely increases the complexity of the business model of the utility. After all, the aim is to log individual consumption at the household level including decentralised energy feed-ins in near real time and to also display this data immediately with the current tariff.

Progress is based on a powerful communications network

Progress with smart metering requires a communications network that is sufficiently powerful to transfer consumption data gathered at the household level, current price information and control signals in near real time.

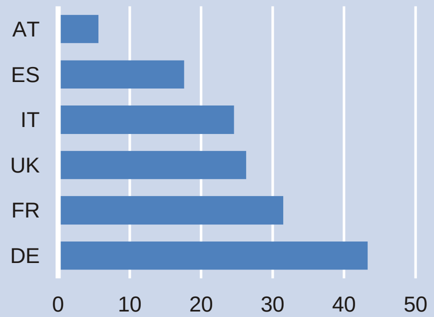
Powerful IT applications and network intelligence are thus necessary to process the huge volumes of data generated in a timely fashion

Majority still do not have fast internet
DSL lines by downstream bandwidth (%)



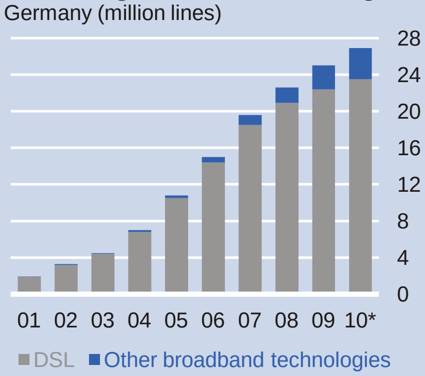
Source: VATM, DIALOG CONSULT, 2010 **5**

Broadband roll-out is major project
Estimated investment required for broadband roll-out (EUR bn)



Source: EIB, 2011 **6**

Germany is a DSL country
Germany (million lines)



* Estimate

Sources: BNetzA, DB Research, 2010 **7**

and to instigate the appropriate responses. The buzzword used by a number of marketing professionals in this regard is the “internet for energy”. This “internet for energy“ covers the complex information processes from energy producer right through to end consumer across all sector boundaries in a complete system. To put this into perspective, however, it should be pointed out that smart grids will in future also only utilise a small proportion of the modern fibre-optic network and thus not grow into the main driver of the also costly expansion of the telecommunications network. According to the European Investment Bank’s – undoubtedly conservative – estimates a total of more than EUR 220 bn needs to be invested in broadband infrastructure in the EU, with nearly 60% of this amount accounted for by Germany, France, the UK and Italy (see chart).

The petroleum sector also has a foot in the door

The smart grid and smart metering pave the way for new business models and on top of this new competition relationships and opportunities for cooperation between previously discrete industries – especially the electricity business, IT, communications and the petroleum business.

The oil industry could for example gain direct access to consumers in the energy market via electromobility by expanding the offering at filling stations to include “electricity pumps”. In this scenario the oil company could act as a dealer in electrical energy. It is advisable to offer the end consumer an all-in-one supply package of energy for his vehicle, household and commercial space at an attractive price.

For telecommunications companies the door is wide open

For telecommunications companies, too, the smart grid and smart metering open up the opportunity to expand their business model to now include the lucrative energy sector as well. The business model associated with the migration to smart metering is thus much closer to the business model of the telecommunications companies than that of traditional power utilities. In this case it is more about handling large volumes of customer data and the bidirectional exchange of information. Accordingly, telecommunications companies hope to succeed with offerings that extend beyond the home automation, data transfer and information processing sectors to also include all-in-one offers that cover the supply of energy to the end consumer.

Smart metering technology: The devil lies in the detail

Although the expansion of the fixed and mobile broadband communications networks continues apace[3], it is particularly the physical attributes in residential buildings as well as the required modem operating times that constitute practical obstacles to making progress with smart metering. With regard to the physical attributes of residential property it is particularly relevant that electricity meters are usually installed in the basement. These smart meter modems are however in most cases a long way away from the link to the fixed-line communications network. Furthermore, basement walls and ceilings are often thick, meaning that the modems can only be

[3] See Federal Ministry of Economics and Technology (2009). Finanzierung – wichtiger Bestandteil eines erfolgreichen Breitbandausbaus. Fourth National IT Summit. Breitband der Zukunft. Beiträge zur Umsetzung der Strategie der Bundesregierung: Arbeitsgruppe 2: Konvergenz der Medien. Berlin.

integrated inadequately into the data stream via wireless broadband technology.

An interesting alternative means of linking the meter to the data connection could be via in-house powerline. With in-house powerline, data is transmitted inside the home via the electricity circuit. This means that everywhere that electricity flows information can also be fed into the data network – and thus can also be displayed via monitors in the living area.

High-voltage chip could generate new impetus

With regard to technically and economically practicable control options at the household level – leaving aside in-house powerline – high-voltage chips are certainly also interesting. The idea is that the manufacturers of household appliances integrate these high-voltage chips into every one of their products. When the high-voltage chip is connected to the mains it is meant to automatically log into a central control server and report the features of the device to be controlled (e.g. fridge, washing machine or lighting). Thus, without any expensive new installation or configuration, simply connecting the appliance to the electricity socket is meant to enable the sensible control of its consumption at the household level. The technology of high-voltage chips thus holds appealing potential to establish itself as a link in the last stage between a central control element and the individual appliance in the home. Should high-voltage chips, however, actually become established in the mass market, the hitherto planned concepts for smart metering at the household level would have to be reconsidered.

Admittedly, criticism is also to be heard. It is claimed that the potential monetary savings for households made possible by smart metering and above all the use of time-differentiated tariffs provide insufficient incentives for the investment and changes in behaviour required. The estimated potential savings amount to a mere 3% of average annual electricity costs of some EUR 800. As such, users are required to possess a high level of intrinsic excitement about the issue.

In addition, another economic impediment emanates from the operating times of the modem, which functions as an interface between the meter and the data connection. The modem would have to be constantly in operation to enable the consumption-related information to be transferred. However, today's DSL modems have power ratings of up to 25 watts per hour, which could add up to as much as 220 kW over one year – that is twice the electricity consumption of a modern energy-efficient fridge. Under these circumstances the additional energy consumption of the modem alone would make the economic efficiency of smart metering extremely doubtful.

Given the above-mentioned challenges arising from the physical attributes of the buildings and the modem operating times, no standard solution for transferring data is in sight. At present the aim instead is to use the wealth of technical capabilities to derive the best individual solution for each specific case.

Enormous investment efforts necessary

The migration to smart grids and smart metering requires enormous investment efforts. The German Energy Agency, or dena, estimates that 3,600 km of cables need to be installed in the German electricity grid alone by 2020.[4] According to the EU Commissioner for Energy there are 45,000 km of cables that need to be modernised and/or laid in Europe.

This translates into capital investment totalling EUR 400 bn in Europe, according to calculations by the European Commission. This figure could increase up to fivefold, if – due to public protests among other things – this mammoth project is to be implemented using alternatives to overground cabling that are considerably more expensive (e.g. underground cables).

Development promoted

For the UK the British Department of Energy and Climate Change (DECC) estimates that the required upgrading with 47 million smart meters by 2020 will cost nearly EUR 10 bn (equivalent to around EUR 350 per household). The British government plans to subsidise the development of smart meters to the tune of EUR 6.5 bn and that of the smart grid with EUR 550 m.

US paving the way to modern grid infrastructure

The independent Electric Power Research Institute estimates that EUR 140 bn needs to be invested to provide the US with a smart grid. The US government plans to provide funding of nearly

4 See dena (2011). Netzstudie II. Berlin.

EUR 3 bn for the replacement of the often decrepit energy grid with a modern reliable alternative.

Dilemma facing smart meter roll-out

Other drivers needed besides legal requirements

The roll-out of the smart grid and smart metering is driven particularly by the legal demands – which can also be interpreted as indirect taxation of the owners. All the same, these specifications for the roll-out are already explicitly limited to the technically and economically feasible and thus leave open a back door for potential investors. That is why other drivers apart from the legal requirements are needed for the smart meter roll-out to actually progress swiftly.

Core business of utilities affected

It would prove critical if the energy utilities – whose involvement is required not only as investors, but also as energy consultants for their end consumers – were to regard the new technology merely as an imposed obligation. Superficially, this could be presumed since smart meters cost more than conventional meters, require more frequent servicing and by enabling the consumer to reduce consumption reduce the volume of energy revenues – thus negatively impacting the original core business of the power utilities. The consultants A. T. Kearney estimate that smart metering could reduce the electricity consumption of German households by 13 terawatt hours (TWh) and thus the revenues they generate by EUR 2.8 bn.[5] Indeed, the new technology provides utilities with the opportunity to sell themselves as expert energy consultants and modern providers of energy services. Experience in Germany shows that even big supra-regional utilities have long been providing interesting offerings based on the new energy technologies and enhancing their image substantially.

Get consumers to join in!

Landlord/tenant dilemma holding back progress

In addition to these major tasks on the technical and entrepreneurial sides the stated objectives for the smart grid and smart metering can only be achieved if property owners and end consumers can individually be won over on this issue. The aim has to be to speed up the necessary in-home investment (in modern, attractively designed consumption displays and smart sockets) and to actually check that they have then been installed. Because these two groups are by no means identical, the parties find themselves facing a landlord/tenant dilemma. The tenant benefits from lower energy costs yielded by smart energy management. By contrast, the owner of the property has to fund the investment, and while he can offset this expense against his tax bill, in most cases he will be unable to pass it on in full to the tenant who actually benefits. The planned reform of tenancy law in respect of energy-efficiency refurbishment provides that during the construction phase the landlord will no longer be obliged to accept reduced rents for three months.

Education required

Beyond this fundamental landlord/tenant dilemma concerning energy-efficiency refurbishment of property[6], the important thing is to educate consumers in the first place about the personal benefits they derive from the new technology and to encourage them to modify their behaviour. To date, consumers have still not been informed about the smart grid and smart metering and they are taking a wait-and-see approach. Accordingly, during an Accenture

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5 See A. T. Kearney (2008). Smart Metering: Missing Link für den Umbau der Energiewirtschaft? Dusseldorf.

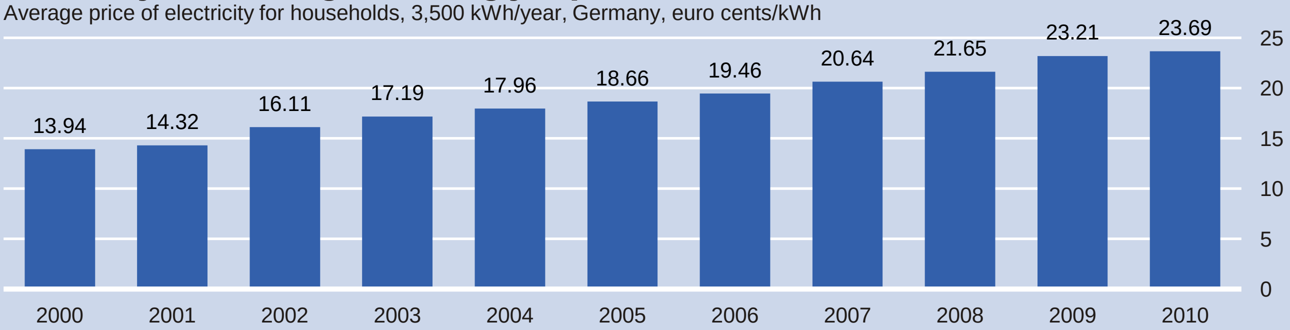
6 See Rakau, Oliver (2011). Energy efficiency refurbishment is often cost-effective, but … Deutsche Bank Research. Talking Point. Frankfurt am Main.

survey in 2010 just 31% of German consumers stated that they were basically informed that their costs could be cut via the time-variable electricity tariffs to be introduced and matching user behaviour – for instance by using energy-intensive devices during times of the day when consumption is low and electricity is cheaper.

Apart from the above situation, consumers are proving to have reservations about a time-based pricing system, with 88% of those surveyed being opposed to such electricity tariffs because they regard them as hampering their decision-making freedom. Also, 30% of respondents are afraid that time-based tariffs will reduce their own quality of life, while 44% have data protection concerns pertaining to the disclosure of individual energy consumption profiles and the use of these profiles for purposes other than the primary reason for their collection. In fact, 44% of those surveyed were afraid that time-based tariffs would lead directly to higher energy costs. This negative mindset may possibly stem from their experience in recent years (see charts 8 and 9).

Electricity is becoming increasingly expensive

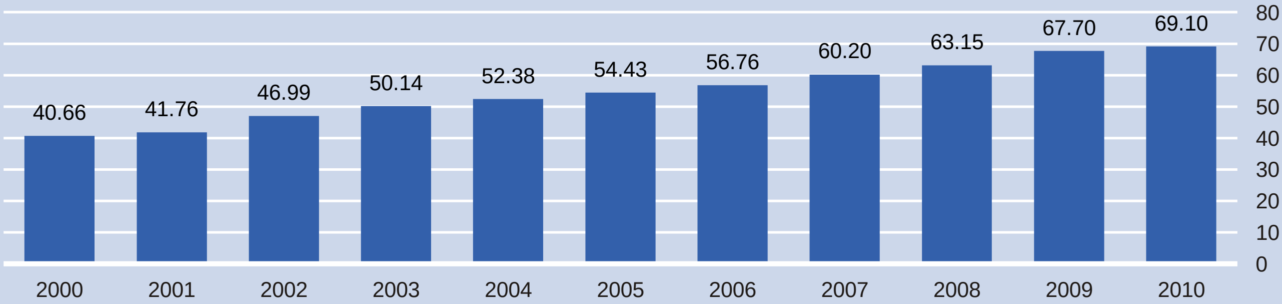
Average price of electricity for households, 3,500 kWh/year, Germany, euro cents/kWh



Source: BDEW, 8/2010 **8**

Households having to pay ever-increasing amounts for electricity

Average monthly household electricity bill, 3,500 kWh/year, Germany (EUR)



Source: BDEW, 8/2010 **9**

Gain confidence with robust data protection rules

Privacy is the key criterion for customer acceptance

With the smart grid the volume of personal data generated will rise sharply even if the maximum degree of restraint is shown. This would apply even more strongly if the concept of smart metering, controlling and storing at the household level were to be extended to the consumption of water, gas and electromobility. Given the highly decentralised structure of the future energy supply system and the large number of players, the appropriate technology, architecture and organisation are needed to guarantee the security and confidentiality of the personal data gathered – this is even more important considering that this personal data in its entirety reveals a substantial amount of information about an individual's lifestyle. The issue of invasion of privacy will thus become a key criterion for customer acceptance of smart electricity meters and modern power supply networks. This aspect is addressed for example by the EU initiative "Privacy by Design". The objective is to establish a sustainable balance between the civil right to informational self-determination and the societal need for climate protection.

Data needs to be handled responsibly

This means that in practice the aim is to keep readings and data transmissions as transparent as possible for the customer. The data collection and data processing procedures should be explained to the customer from the outset. Personal data could, wherever this is possible, be (pseudo-)anonymised.[7] Furthermore, a clearly regulated right to receive notification of data utilisation, deadlines for the deletion of personal data collected and a related statutory data protection audit process for users would be necessary steps towards building confidence.

Conclusion: Smart energy management is the only way forward

No rapid market success for smart grids without political incentives

An efficient grid infrastructure is a prerequisite for speeding up the integration of renewable energies into the electricity supply. As such, the German government's Energy Concept is the right approach. However, while the establishment of a European supergrid is likely to generate a certain amount of its own momentum, stronger political incentives are a prerequisite for the market success of smart grids. Power utilities need to invest large sums so that end consumers can cut their energy consumption significantly and alternative suppliers of renewable energies can feed their energy into the grid.

Enormous investments required

The migration to smart grids and smart metering requires enormous investment efforts. Europe probably has 45,000 km of power lines requiring modernisation or new cables to be laid. This translates into capital investment totalling EUR 400 bn in Europe just for the distribution grid. These necessary investments are admittedly enormous.

Landlord/tenant dilemma an obstacle

In addition to these major tasks on the technical and entrepreneurial sides the stated objectives for the smart grid and smart metering can only be achieved if property owners and end consumers can individually be won over on this issue. A decisive challenge arises from the fact that these two groups are by no means identical and therefore, because of their differing interests, there is a landlord/ tenant dilemma.

High intrinsic motivation required

The certainly understandable fundamental criticism underscores that the potential monetary savings for households made possible by smart metering and above all the use of time-differentiated tariffs provide only minor incentives for the investment and changes in behaviour required. The estimated potential savings amount to a mere 3% of average annual electricity costs of some EUR 800. As such, users are required to possess a high level of intrinsic excitement about the issue.

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[7] *Anonymise*: Personal data is altered so that either it can no longer be attributed to a specific person or only matched after expending a disproportionately large amount of resources.
Pseudo-anonymise: Codes are used as substitutes for personal identification details. These are intended to make it much more difficult for the persons concerned to be traced.

Incentives necessary

Without stronger political incentives – be they direct investment subsidies or statutory directives, which can also be interpreted as indirect taxation of the property owner concerned – the topic of smart grids is likely to fall short of expectations. The energy policy rethink currently being propagated provides the government with the perfect opportunity to more vigorously promote smart grids and grid expansion.

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