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BDEW Roadmap

Realistic Steps for the Implementation of Smart Grids in Germany

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Contents

1. Introduction

System-oriented feed-in and storage, optimum network capability and increased flexibility of demand can make an important contribution to the economically efficient development of renewable energies.

The transformation of the energy system („Energiewende“) has a considerable impact on the distribution network. More than 90 percent of renewable energies are connected to the distribution network.

This was the reason why BDEW decided in 2011 to undertake a study on the need for extensions and alterations to conventional power plants and analyse the related costs. As a next step, BDEW analysed the potential of smart technologies in the network and the market. In this context, smart grids have been subject to a realistic view. Current investigations show the contribution which new technologies and the increased utilisation of information and communication technology can make to a reduction of costs. During the next few years, macroeconomic cost-benefit analyses will show whether and to what extent smart grids will become an important part of sustainable, efficient network extension and of the further development of the energy market. Regulatory impediments established e.g. in the context of incentive regulation still need to be eliminated in order to be able to invest in new technologies.

Based on ambitious premises, the BDEW Roadmap „Realisation of smart grids in Germany“, is aimed at describing in a snapshot the most important steps towards the implementation of intelligent energy networks in Germany.

It outlines the measures that need to be carried out during the next ten years in order to enable smart grids to make a contribution to the Federal Government's objective to develop an energy supply system based on renewable energies. Firstly, an extensive vision of smart grids („Vision 2022+“) which takes up and carries on the public discussion is described. On this basis, the Roadmap outlines the requirements in terms of the legal and regulatory framework and the potentials and tasks of players involved.

BDEW considers this Roadmap as a first step of a follow-up development process for the realisation of smart grids in Germany. BDEW will pursue this process cooperatively with the players involved and put it forward to the public discussion.

2. Executive Summary

The energy industry transition to renewable energy must be accompanied by an improved coordination of supply-dependent and conventional generation, energy storage, energy infrastructure and possibilities for increasing the flexibility of demand. Intelligent networks aim to balance supply-dependent generation with price-dependent demand and achieve an efficient expansion and restructuring of the grid as well as a high quality of supply. The market players gain the opportunity of creating new business models and contributing to the optimisation of the energy system through increased flexibility.

The BDEW roadmap for the realisation of smart grids outlines which measures must be undertaken by 2022 in order to implement intelligent energy supply in Germany. For the purposes of the roadmap, the coming decade is divided into three phases: the development and pioneer phase (2012 to 2014), the establishment and configuration phase (2014 to 2018) and finally the realisation and market phase (2018 to 2022). The detail sees the process broken down into ten steps: the foundation for smart grids is laid through a combination of stringent regulation for the separation and interaction of market and network, the development of a consistent legal and regulatory framework, research and development as well as the creation of standards. This basis must be developed as soon as possible. Building on this, firstly, the infrastructure modernisation should then take place (sensors, smart meters, network automation, energy information network). Secondly, grid users (generators, storage facilities, consumers) will be able to offer and obtain new products on the energy market of the future. These products follow from the core principle of a smart grid: to ensure stability and efficiency through flexibility of both the networks themselves and their users.

Development and pioneer phase: creating the correct framework conditions

Step 1: Separation and interaction of market and network

The basis for smart grids is that the legal and regulatory framework takes into account the so-called **traffic light concept**, which **governs the fundamental interaction between market and network on the basis of system conditions of "green", "amber" and "red"**.

Network operators must be given the ability to choose between network expansion and demand for flexibility in the marketplace in the interests of a (cost) efficient network expansion and restructuring and quality of supply. Firstly, this leads to a market in which network operators can demand local and temporary flexibility dependent on their network situation (amber phase).

Secondly, a market is created which contributes to the optimisation of the energy system through unrestricted increases in flexibility (green phase). Starting with the traffic light concept, rules and regulation governing flexibility markets must be drawn up, which create the framework for processes, balancing, billing etc. The functional interfaces between market and grid must be configured. Thresholds must be defined as to when the green/amber/red phases begin and end. Maximum voltage levels should also be defined, up to which the various mechanisms are respectively sensible.

Step 2: Legal and regulatory framework

The Federal Government first set the course towards the realisation of smart grids in Germany with its amendment of the German Energy Industry Act (*Energiewirtschaftsgesetz, EnWG*) in the summer of 2011. The steps taken must now be concretised in the coming months into **regulations which can be implemented by the market**. In this context, there must be clarification as to the information exchange between market players ("energy information network"), the legal and organisational requirements for increasing industrial flexibility potential ("interruptible loads"), the interruption of appliances in the distribution network and the introduction of intelligent metering systems (smart meters) with a definition of the respective market roles. The network operator also needs clarity in respect of the incentive regulation, in order to decide whether investments in smart grid technologies as well as research and development can be made in an economically viable way.

For the purposes of the necessary increased interaction between DSO and TSO, between market and grid in the amber phase as well as between market and grid with the end consumer, an **energy information system must be developed as a joint infrastructure**. This system, comprising communication devices at the end consumer's location, a communications infrastructure from the end consumer, remote facilities, as well as network control and market systems is completed by a so-called communications and services platform for the non-discriminatory data transmission between the various players. It is recommended allocating the task of building and operating this infrastructure to the DSO allowing the use of ICT subcontractors.

Up until now, issues of flexible generation and storage as well as controllability have not been adequately dealt with under the EnWG; hence the envisaged Ordinances should be expanded. In this way, the Ordinance on low voltage interruptible appliances (Sec. 14a EnWG) could in future become an "Ordinance on flexibility on the low voltage level", the provision on switchable loads (Sec. 13 EnWG) could become an "Ordinance on flexibility on the medium and high/extra high voltage level".

Although the challenges resulting from the modifications to energy supply are primarily concentrated on electricity, the development of so-called **hybrid networks** must be further investigated. In this context, the interruptibility or controllability should be extended to other types of energy (in particular, gas, heating).

Financial incentives are required to ensure that network users can benefit from a system oriented behaviour (management and control of feed-in and output). For example, network fees could form a possible incentive to influence network usage behaviour with the effect of reducing network loads. For this purpose, the **network fee system** should be further developed – in particular on the basis of the user-pays principle. Furthermore, suppliers should be able to offer **variable tariffs based on a system of incentives, approved by the German Federal Network Agency** (*Bundesnetzagentur, BNetzA*), which take local flexibility in the networks into account. In the case of gas network access, the interruptible agreements could serve to balance capacity shortfalls on the upstream network level. For the transmission grid, there exists already today the possibility, under Sec. 13 Par. 4a EnWG, to conclude agreements with interruptible customers.

In particular, distribution network operators need incentives and security for investments in smart technologies, which would ensure a cost efficient network operation for the future. Therefore, the **incentive regulation** must be more flexible and more modern. Most importantly, the time delay on the distribution network level must be eliminated in order to safeguard the profitability of replacement and expansion investment. In addition, investments in efficient network technologies and the short depreciation cycles for investments in information and communication technology (ICT) should be given increased significance.

The incentive regulation should also promote research and development of distribution network operators. The working group on “Sustainable Power Grids” in the German Federal Ministry of Economics and Technology (*BMWi*) is of the opinion that the realisation of the energy system’s transformation (“Energiewende”) requires a stronger involvement on the part of the network operators, in particular in the area of network technology, system management and the practical trial and testing of new technology in demonstration projects. In light of this, it is important that network operators can have part of their expenditure for research, development and demonstration recognised under certain conditions as a cost which is permanently beyond the control of the operator.

Step 3: Research and development, pilot and demonstration projects

In the area of research and development, a harmonisation and integration of the various projects on the basis of a **uniform R&D strategy** should be undertaken. A further development of the 6th Energy Research Program and the respective funding initiatives would be a good option in this respect. In doing so, a close integration of energy and ICT research funding should also be aimed at, in order to develop ICT for smart grids[1]. For R&D projects in the area of smart energy supply, an **evaluation process** based on commercial and technical performance indicators should be introduced. On the basis of the findings of the model projects which have been carried out to date, BDEW recommends a detailed investigation of the **innovation and efficiency potential of hybrid networks** as well as the necessary technical and process related modifications.

Step 4: Standards, data protection and data security

An especially important factor is the public acceptance of smart grids. Data protection and data security are crucial requirements for such acceptance. BDEW proposes the implementation and continuous development of data protection in the smart grid in a **separate data protection ordinance** in the scope of the amendment of the German Metering Access Ordinance (*Messzugangsverordnung, MessZV*).

In order to guarantee data security, a **binding catalogue of requirements for IT security** must be developed in the scope of energy law (Sec. 11 Par. 1a EnWG) by the industry as

[1] In future, the relevant research and development will be bundled within the Federal Government energy research programme. The e-energy projects were funded by the “Convergent ICT” item of the BMWi.

well as representatives of the German Federal Office for Information Security (*BSI*) and the Federal Network Agency (BNetzA). In a following step, the development and maintenance of a code of practice for implementation should be ensured as a help for businesses.

Of particular significance in terms of a successful configuration is a **close coordination** between the legislation surrounding possible applications (BMWi and the Federal Environment Ministry, *BMU*), the technical specification (BSI), the development of standards (German Forum for network technology / network operation, *FNN*, and the German Commission for Electrical, Electronic & Information Technologies, *DKE*) as well as the adaptation of responsibilities in the market roles and market communication (BDEW). This close coordination is necessary in order to obtain planning and investment security and to enable investments to take place.

Establishment and configuration phase: adapting infrastructure and processes

Step 5: Measurement sensors in the grid; roll-out of smart metering systems

Actions to manage and control the energy system must be measured in order to ensure a stable network operation as well as to enable billing and balancing to be undertaken. In this context, the **introduction of intelligent metering systems** was codified in the 2011 EnWG. Secondly, **sensors to record the network situation** must be set up – where consumption and load structure in the respective network area require it – so that smart usage and management of the grid becomes possible. Alongside this, a respective IT infrastructure must be set up to process the associated information.

In respect of the **introduction of smart metering systems**, as infrastructure jointly utilised by market players and network operators, this should build on the existing market processes and responsibilities of the respective market roles. The established market processes within the energy industry should form the basis for business communication in a smart grid and must be adapted in the short term for the use of the Smart Meter Gateway and in the medium term for the application of the traffic light concept.

The introduction of smart metering must be accompanied by a joint information campaign in order to increase end consumers' awareness of the potential benefits of the new technology and thus acceptance for the associated costs. The starting point for this must be an independent cost-benefit analysis which is undertaken prior to the establishment of further mandatory installations under the EnWG and which is not distorted by optional (non-energy related) services. In the scope of a cost-benefit analysis, it must also be clarified whether the introduction of modular metering systems across energy types (electricity, gas, heating, water) to measure feed-in and consumption is economically viable.

In the case of the so-called **communications and services platforms**, which provide the aggregation, plausibility verification and secure distribution of data from smart metering systems to authorised market participants, uniform rules must be created with the help of which the large number of data classes, which are sent in the smart grid, can be managed. In connection with the increasing market integration in renewable energy, direct marketers will require a **communication interface** in the future, through which they can access the marketed power plants. This will likely be provided through a combination of smart metering with an energy management gateway. When designing the interface, it must be ensured that the controlling and management signals of the network operator, which serve to maintain network stability, have priority over those of the direct marketer.

Step 6: Management & control; automation of the networks

Network automation will become necessary in many distribution networks. However, automation technologies will have to be installed according to macro-economic cost-benefit factors dependent on the challenges within each distribution network (regional circumstances of network topology, meteorology, etc.). Independent of the size of the challenges, modular technical concepts and an estimation, as accurately as possible, of the addition of renewable energies will be required.

Step 7: Local and global optimisation within the energy system

The mutual exchange of information and data between the (electricity) network operators must be improved in order to realise the efficient interaction of local and global technical optimisation (distributed network management). For this purpose, an **efficient, i.e. data minimising, energy information network** must be set up. The network sensors and the so-called communications and services platforms, on which the secure aggregation and plausibility verification of data from smart meters is undertaken, can serve as a basis for the energy information network. The aim is a grid group / grid node oriented aggregation of operation data as well as the collection of aggregated and projected or measured active power values of the power plants, divided according to energy sources. Each network operator should be responsible for the aggregation of data on his level (subsidiarity within the meaning of data protection and data security). The energy information network must also ensure that the market participants have the data relevant for them at their disposal.

In addition to wholesale energy supply, **regional marketplaces** should also be created in which suppliers/aggregators can offer the network operators bundled energy generation and bundled energy consumption as **local flexibility**. The remuneration should be determined not by the price per kilowatt-hour but by a separate system of incentives, approved by the German Federal Network Agency (*BNetzA*). Network operators would then invite tenders for demand according to flexibility with respective remuneration. In a subsequent step, suppliers can use these to offer variable tariffs. However, BDEW rejects the notion of regional marketplaces with special energy prices (which deviate from the wholesale market) due to the local network situation as this dissolves the uniform price zone.

Step 8: Storage and electric mobility, hybrid networks

A **concept** should be devised as to how **energy storage facilities** can participate in **flexibility markets across energy types**. Optimum locations for storage can be generation facilities, network bottlenecks and/or locations with heating networks (power to heat), natural gas lines (power to gas) and where necessary CO_2-sources (in the case of methanation). R&D efforts should be concentrated on considerably enhancing the commercial viability of the storage options so that these may be increasingly deployed from 2020.

Electric vehicles require an intelligent technical network integration (including compatible communications interfaces) and charging control as well as a balancing of the feed-in and output. Therefore, the requirements for electric mobility should be taken into account separately when configuring the smart metering systems. To avoid an uncoordinated network expansion, it is imperative that all electric vehicles and their charging facilities are equipped with the possibility of managing their charging. Furthermore, in connection with electric mobility, in particular new, efficient, consistent and workable market processes must be defined (e.g. billing processes for customers at public charging stations).

Realisation and marketing phase: create transparency and develop new products

Steps 9 and 10: Variable generation and variable demand

In future, there will be an interplay between intelligent generation and load management on the market. In order for suppliers to be able to offer system services, framework conditions have to be developed, in addition to the statutory legislation which enables a uniform, non-discriminatory access of all market participants to new regional markets for local flexibility, which guarantee the **transparency of the tendering for system services**. Furthermore, the existing **balancing and billing regimes** have to be further developed. First products should be developed in the short term which support the consolidation of electricity, heating/cooling and gas networks into hybrid networks

3. Vision 2022+

In 2022, renewable energies will have a share of at least 35 percent in the German energy supply. At the same time, energy efficiency and energy saving will contribute to the achievement of the Federal Government's goal of a reduction of CO_2 emissions.

The energy generation's volatility will considerably increase; it will however be offset by the flexibility of the network and network users. Flexibility is an important key to stability.

Optimisation will be achieved across all levels of value added according to macro-economic cost and benefit aspects. The balance of the energy system will be maintained by the smart interaction of producers, storage facilities, suppliers and consumers. New business models based on new technologies and processes form an innovative energy market and make an essential contribution to safeguarding security of supply. At that time, regulation will provide clear incentives for development and reconstruction on the basis of innovative technologies. The development of electricity generation from renewable energies will be closely coordinated with the network development and restructuring measures.

Intelligent feed-in management is made possible, among other things, by virtual power stations. To this end, centralised and decentralised generation technologies are linked in a way so as to smooth fluctuations in electricity generation and prevent congestion or voltage problems in distribution network segments. The active participation of consumers enables intelligent load management to be carried out. Moreover, storage facilities for the technical and economic optimisation of the energy system will be utilised from 2020. Small storage facilities will be pooled to form virtual storage facilities.

The connection of all these components into a secure, efficient and sustainable energy system will be ensured by flexible interacting transmission and distribution networks which use modern information and communication technologies (ICT). Centralised and decentralised structures will be complementary and adjusted to one another.

Interacting with the market, distribution networks grow into active networks which ensure the integration of renewable energies into the energy system over the entire supply area. The increase in decentralised energy supply is effectively managed by interacting, regionally specialised distribution networks. In the transmission grid, energy generated remote from the consumers in renewables-based plants (in particular offshore wind farms) in the North is transported across North-South interconnections to the load centres in Central and Southern Germany, and Europe-wide electricity transits, which need to be carried out due to cross-border energy trading, are controlled.

Regarding the interaction between market and network, institutionalised rules and regulations have developed on the basis of the so-called traffic light concept. This concept distinguishes system conditions and leads to efficient processes complying with unbundling in the smart energy supply system that is based on interaction. Where predictable, temporary congestion occurs within a limited area, network operators act as customers purchasing flexibilities and can alleviate the situation by interacting with the market. This enables optimum dimensioning of the energy networks to be ensured in economic terms.

Smart grids grow in an evolutionary manner and continuously tap new optimisation potential. The attractiveness of different flexibility options varies according to the system condition, physical circumstances (weather, distance between generation and consumption, etc.) and available technologies. The smart energy market is the place where these flexibility options are traded in the form of products (flexible power or also services).

Services in the field of energy management are of great importance to private households, the housing sector, commercial businesses, industrial enterprises, municipal and social institutions.

Improved efficiency of the system is achieved by an increasing convergence of the electricity, gas, heating and transport networks. This enables e.g. excess renewables-based generation which cannot be used or stored in the electricity supply system, to be utilised within the whole range of energy applications.

4. Definition – What is a smart grid?

BDEW defines a smart grid as an energy network which integrates the consumption and feed-in behaviour of all market participants connected to it. It represents an economically efficient, sustainable power supply system with low losses and a high level of availability.[2] The interaction between market and network is of crucial importance.

In the short term, smart grids are mainly oriented to the electricity market; in the medium and long term, electricity, gas, heating and transport networks will be increasingly interconnected to form hybrid networks.

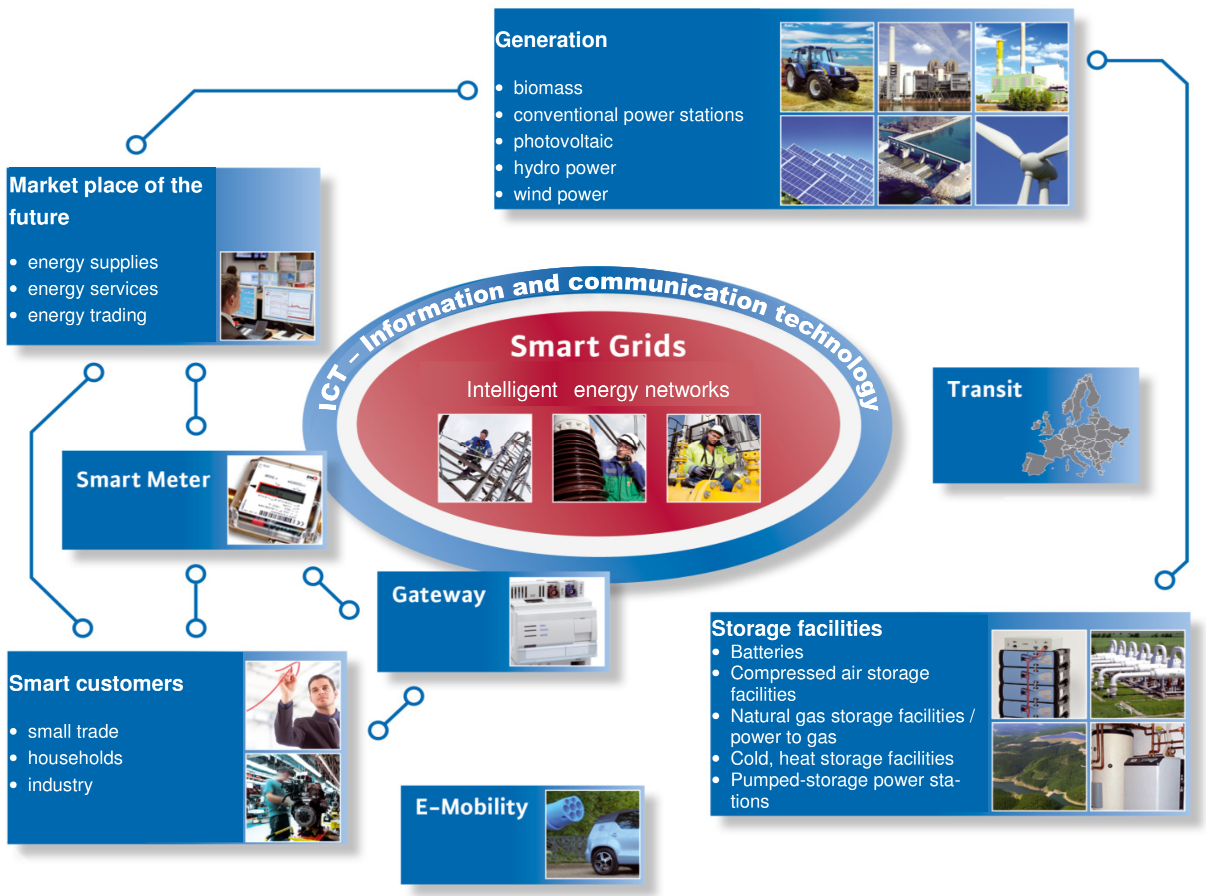

Figure 1: Components of smart grids (BDEW)

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[2] Cf. EU Commission Task Force for Smart Grids, Expert Group 1 (2011): "Functionalities of smart grids and smart meters":
"A Smart Grid is an electricity network that can cost-efficiently integrate the behaviour and actions of all users connected to it –generators, consumers and those that do both – in order to ensure economically efficient, sustainable power system with low losses and high levels of quality and security of supply and safety. […] Though elements of smartness also exist in many parts of existing grids, the difference between a today's grid and a smart grid of the future is mainly the grid's capability to handle more complexity than today in an efficient and effective way. A smart grid employs innovative products and services together with intelligent monitoring, control, communication, and self-healing technologies. […] The implementation of this concept will be made possible by the participation of all smart grids actors, according to their specific roles and responsibilities. (Network Operators, Grid Users, Other Actors)"

5. Phases and steps towards the realisation of smart grids in Germany

The following chapters outline the realisation of smart grids in Germany as they may be implemented up until 2022. For the purposes of the Roadmap, the coming decade is divided into three phases: The development and pioneer phase (2012 to 2014), the establishment and configuration phase (2014 to 2018) and the realisation and market phase (2018 to 2022).

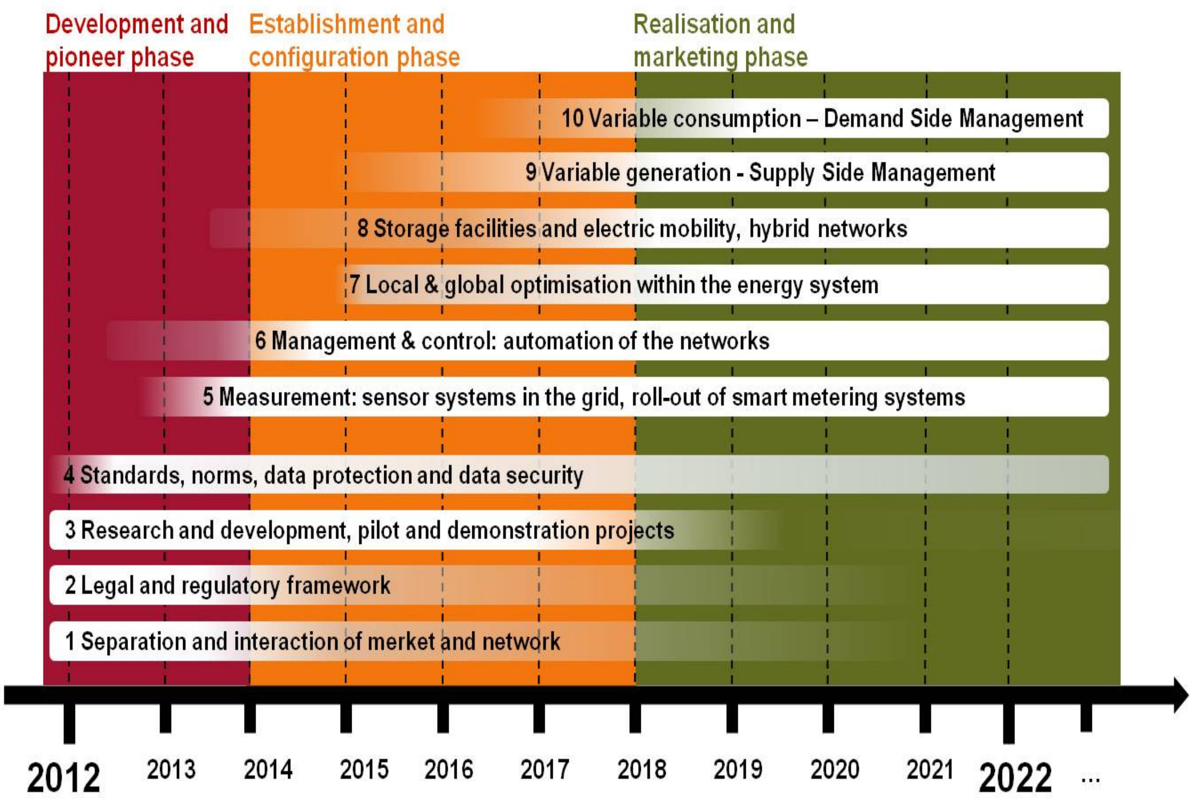

Figure 2: 10 steps towards smart grids in Germany (BDEW, Eurelectric basis)

The detail sees the process broken down in ten steps, which enable smart grids to be successfully implemented. Important bases for smart grids are laid by the stringent separation and regulation of the interaction between market and network, the development of a consistent legal and regulatory framework, research and development as well as the creation of standards. These bases must be developed as soon as possible.

Building on this, firstly, the infrastructure modernisation should then take place (sensor systems, smart metering systems, network automation, energy information network). Secondly, grid users (generators, storage facilities, consumers) will be able to offer and obtain new products in the future energy market. These products follow from the core principle of a smart grid: to ensure stability and efficiency through flexibility of both the network and its users.

The following chapter describe the different steps in detail. From the establishment and configuration phase, particular focus should be, inter alia, on

- the potential that can be tapped (possible flexibility of the network and its users) by a correct adjustment of the legal and regulatory framework,
- market players and the tasks they have to cope with,
- the significance of the different steps within a European/international context.

The ten steps represent a clustering approach. A rigid separation is not possible and not aimed at because of the great variety of interactions. The steps building upon each other result in a parallel development of all relevant components for smart grids. The Roadmap describes the evolutionary emergence of smart grids in Germany, based on the increased penetration of distribution network structures by new innovative technologies. With regard to transmission networks, focus is on an improvement and extension of existing intelligent structures.

5.1 Establishment and pioneer phase

Step 1: Separation and interaction of market and network

Who?	What?	When?
▪ All market participants (systemic approach)	▪ Rulings on division of work / definition of interfaces between regulated & competitive players	▪ Immediately, up until 2nd quarter/2013, at the latest

Unbundling and efficient processes

Previous model projects (E-Energy) underlined the complexity of the establishment of smart grids. Unbundling provisions play an important role in this context. The network operator makes the network available to all users at equal terms and conditions, on the basis of uniform supply, switching and data transfer processes, and makes these activities appropriately transparent.
Setting up smart grids means enormous changes: market processes and market communication need to be adjusted to practical applications in order to enable the interaction of smart technologies.
To be able to meet the requirements, particularly the role and the tasks of network operators are currently redefined. They are responsible for the stability of the system, they know the technical challenges they have to cope with for the reorganisation of energy supply, and they guarantee neutrality as regulated players.

The last point mentioned above is an important prerequisite for the development of competitive dynamics. The network operators set up the infrastructure for market solutions and make it available to market participants in a non-discriminatory manner. They will extend their present infrastructures in accordance with the requirements of the market, consumers and system stability and, where reasonable in technical and economic terms, intelligently develop these infrastructures. As system service providers, they thus establish an important basis for sustainable and customer-oriented products of suppliers.

There are many functional interfaces between the network and the market which constitute a basic prerequisite for economically efficient infrastructures in the smart grid of the future. The separation of responsibilities between regulated and non-regulated areas in the supply sector can be ensured if these interfaces are designed in a process-related way.

The traffic light concept – Basic rules for the future energy market

The interaction of all market-relevant roles (suppliers, traders, generators, storage facility operators, etc.) and the legally regulated roles (network operators, meter operators, etc.) can be represented by means of a simple traffic light concept.[3] This concept provides a comprehensible basic scheme enabling the partly complex and various interactions and interdependencies between all market participants, i.e. network users and network operators responsible for the system, to be described.

The aim of the traffic light concept is to define the sharing of functions between the regulated and the non-regulated area in terms of the control of suppliers and consumers so as to ensure permanent system stability and a free market for smart products. Network operators responsible for the stability of the system determine the current and forecasted condition of their network areas (three traffic light phases: „green", „amber", „red") and continuously inform the authorised market participants accordingly in an automated manner. These use this information to handle their business models in an optimum way or to offer new „smart" products.

During the **„green traffic light phase"**, the „market phase", there exist no critical system-related network conditions. All market products can be offered and obtained without restrictions. The market can utilise its potentials within the energy supply sector through financial incentives and thus make an essential contribution to the integration of intermittent generation feed-in. The network operator shall monitor the system. This does not exclude the use of control energy. During the **„red traffic light phase"**, the „network phase", there is an immediate risk to network stability and security of supply. The responsible network operator must exert direct control on its own equipment and the market (generation, storage or consumption units). The latter is based on legal provisions or contractual agreements by automated network mechanisms[4], in order to avoid a total or partial network failure or limit the effects of the network failure (Section 13 paragraph 2 EnWG). The stability of the system is thus maintained by specific action.

With regard to the „green" and „red" network conditions, relevant instruments have already been determined in the EnWG and EEG. During the „red phase" the existing mechanisms consist in direct instructions to the appropriate generating units, load shedding and feed-in management for renewables-based plants. In the interest of security of supply, this phase is to be prevented by all means.

The „green phase" is ensured by the legal obligation to extend the network. Consequently, the network operator is required to dimension the network for the maximum theoretical feed-in capacities and the maximum peak consumption announced, if reasonable in economic terms. The market can offer its current products unrestrictedly at any time.

However, the development obligation requires that networks be designed for maximum load. This would lead to economically and financially unnecessary investments. The aim of smart grids is to avoid such unnecessary investments and thus to ensure economically optimum network dimensioning. To this end, market and network need to become „intelligent" and in-

[3] Not to be confused with the traffic light concept entitled „ENTSO-E Regional Alarm and Awareness System. (RAAS)" which is restricted to network operators only.

[4] Technical system protection equipment, such as five-stage plan (frequency-responsive disconnections = load shedding), voltage and fault-current protection control, measures against voltage collapse, etc.

teract. The intelligence of the networks is based on hardware and software components whereas the intelligence of the market is mainly based on new products benefitting network users that show a system-oriented behaviour.

The amber phase – intelligent interaction of network and market

Basically, a relief of network capacities is to be achieved and network development avoided by procuring flexibility in the market. If the prices for flexibility exceed the costs of network development, it is inevitable to expand the network.

The intelligent interaction of network and market takes mainly place during the so-called **„amber phase"** where local and global system congestion, i.e. bottlenecks in distribution and transmission networks, are managed and remedied by all market participants. The market can continue to take place without restrictions.

Distributed decentralised generation structures lead to complex network situations. For instance, the coordinated provision of services maintaining system security is important during the amber phase in order to enable measures for local relief to be carried out. Example: Several Megawatt of flexibility are required at a network node; the local feed-in management is of decisive importance. Among other things, the following measures can then be carried out:

- Pooling of supplies and consumption: Market players (suppliers/aggregators, traders) collect flexibility on the basis of agreements with generating plants and consumers. Network operators address requests to market players which assure them of the respective flexibilities. The local constraint of the required flexibility is not affected when called in from the pool.
- Cascading: Transmission and distribution network operators interact in order to guarantee the system security. The market players may be involved inasmuch as the flexibility after having been requested by the upstream network operator is called off by the downstream distribution network operator.[5]
- Network-related and market-related measures (e.g. control energy, interruptible loads) with payment for active and reactive power under Section 13 paragraphs 1a and 4a EnWG
- Re-dispatch at the distribution network level (focus on generation, according to Section 13 paragraph 4a EnWG in principle also possible for loads / supplier obtains information about balancing group error).
- Exemption from priority feed-in under Section 8 EEG and feed-in management under Section 11 EEG.

From a system-related point of view, the following mechanism is required during the „amber phase":

The network operator will access the contractually assured flexibility (generators, consumers, storage facilities, etc.). This can be done indirectly through measures agreed with suppliers or

[5] Cp. BDEW (2012): Praxis-Leitfaden für unterstützende Maßnahmen von Stromnetzbetreibern

directly in accordance with direct agreements. To this end, it is absolutely necessary to involve the balance responsible party and find a scheme for distributing the costs incurred.

As a result, network users can adjust their behaviour and benefit from their participation in maintaining the system stability. Compulsory interventions with respect to network users do **not** happen during the amber phase.

The utilisation of flexibility is requested by the distribution network operator either directly from the network user or from the supplier according to the contractual agreement. If there is sufficient time to respond, the responsible network operator will notify the forecasted demand of system services to the market participants. On the basis of values available from experience and the updated system forecasts, the responsible network operator will continuously forward its system services demand to the market participants.

The detailed network limit values and control variables, concerning in particular the „amber phase“, still need to be developed and tested e.g. in pilot/demonstration projects. In order to establish a fast and, where possible, automated functionality it is necessary to equip this traffic light concept with the agreed network rules and a global and local control mechanism. The aim is to install an automated traffic light concept comprising regional control parameters (voltage, network loading) and global control parameters (frequency).

What is to be done in concrete terms?

- The basis for smart grids is that the legal and regulatory framework is opened to the so-called amber phase. In the interest of efficient network development and restructuring as well as security of supply, network operators must be enabled to choose between network development and demand for flexibility in the market.

  On the one hand, this leads to a market in which network operators can demand local flexibility, limited in time, dependent on the situation in their network. On the other hand, a market comes into being (during the green phase) which contributes to the optimisation of the energy system through unrestricted increases in flexibility.

- Starting with the traffic light concept, rules and regulations (processes/ balancing/billing) must be drawn up for flexibility markets.

- The functional interfaces between market and network must be configured. Thresholds must be defined as to when the green/amber/red phases begin and end. Maximum voltage levels should also be defined, up to which the various mechanisms are respectively reasonable.

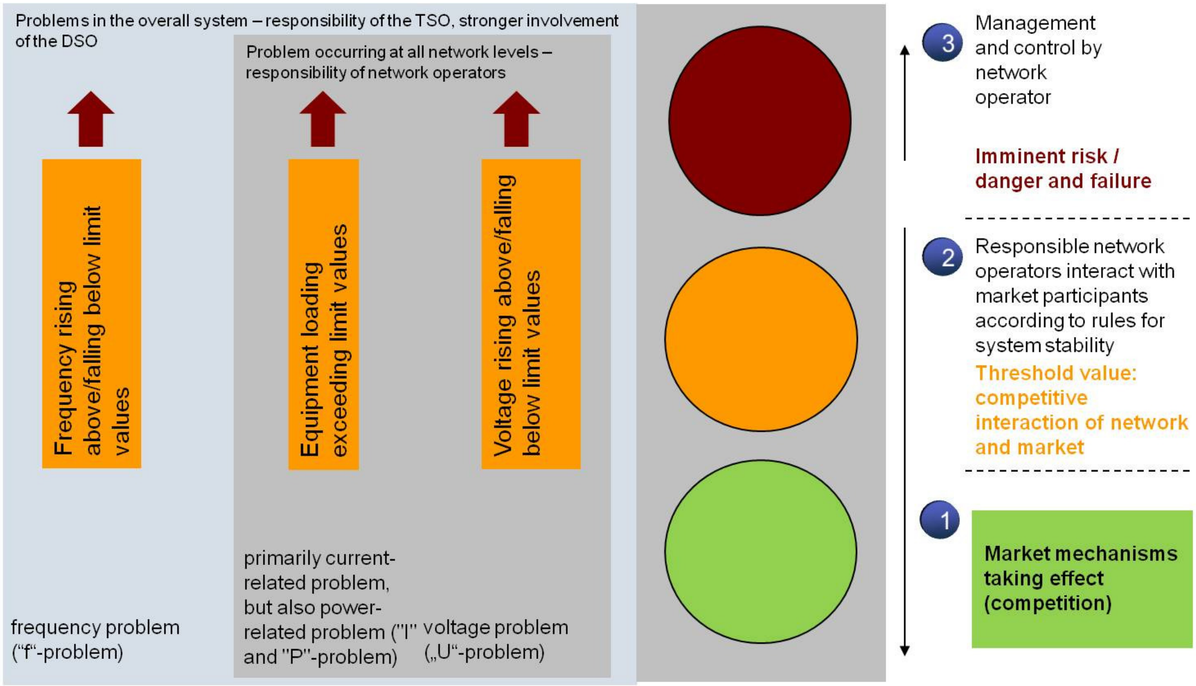

Figure 3: Traffic light concept (BDEW)

Step 2: Legal and regulatory framework

Who?	What?	When?
▪ Federal Government ▪ Bundestag (taking account of European legislation/initiatives) ▪ Federal Network Agency	▪ Consistent EnWG/EEG ▪ Configuration through Ordinances ▪ Taking account of the Metrology Act, EU legislation and telecommunication regulation	▪ Immediately, by the second quarter of 2013, at the latest.

Energy Industry Act (Energiewirtschaftsgesetz - EnWG)

The Federal Government first set the course towards the realisation of smart grids in Germany with its amendment of the German Energy Industry Act in the summer of 2011. The strategic direction thus defined has now to be implemented and further developed, in particular with respect to the following items:

- Installation of an energy information system (Sec. 12 Par. 4 and 5 EnWG: Tasks of transmission system operators - TSOs) → secure, modern network operation through information provided by generators to network operators and exchange among network operators.
- Connection and disconnection of major consumers at the high and extra-high voltage levels (Sec. 13 Par. 4a EnWG: Responsibility of TSOs for the system) → Technically and economically reasonable agreements on industrial flexibility potential.
- Network relief and network optimisation (Sec. 14a: Control of interruptible consumption equipment at the low-voltage level)
- The introduction of smart metering systems (Sec. 21 b to e and g: Meter operation, installation of measuring devices, metering systems) → Requirements to be satisfied by metering systems, data protection and data security as well as collection, processing and utilisation of personal data.
- Setting up of variable tariffs (Sec. 40 Para. 5: Electricity and gas bills, tariffs) → Billing and balancing rules, new products.

<u>Requirements of the Federal Network Agency: Installation of an energy information system</u>

The installation of an energy information system is a core component of the smart grid. By the strong development of decentralised renewable energies, distribution network operators increasingly support transmission network operators in terms of safeguarding their responsibility for the system (voltage control, system/operational management, restoration of supply, implementation of feed-in management, under-frequency load shedding). Within BDEW, transmission and distribution network operators therefore develop joint approaches to solutions for mutual information and data exchanges. On that basis, a sector-wide concept will be devised taking generators and suppliers into consideration.

The following principles should be taken into account for the configuration of an energy information system:

- The TSOs are responsible for the system; in future, they will receive stronger support from distribution system operators than today. In order to enable responsibility for the system to be assumed by all network operators, data and information is required from all upstream and downstream network levels. The demand differs as a function of the network area.
- With a view to ensuring an efficient energy information system, a network group / network node oriented aggregation of operation data is recommended, completed where necessary by consumption and generation data.
- The general effect on transfer points is the actual influence on adjacent networks. This effect can only be identified by aggregated and processed data. Individual values for generating plants and consumers in the meshed network do not represent the node oriented effect on upstream and downstream networks. Aggregated and projected or measured active power values of generating plants, divided according to energy sources, are required. Individual values are to be accordingly provided only for plants subject to Sec. 13 Para. 1a EnWG.
- As the interactions between the networks occur bi-directionally, the information and data exchange must also be carried out bi-directionally.
- It is recommended taking account of sensitivities (effect of generating plant on network nodes). The distribution network operator has knowledge of this, depending on the current topology and operating mode of the network.

In order to be able to comply with its system responsibility and the legal tasks under Sec.12 Para. 4 and 5 EnWG, online values, planning data, metered values and master data must be available to the TSO as a basis for network operation management. To this end, the TSO must be able to address the distribution network operators as well as generators and suppliers. The basis for that is an appropriate communication and data infrastructure which should be designed in a subsidiary way.[6] Besides, market-relevant data must be made available to the market participants.

[6] BDEW (2012): Smart grids in Germany – Fields of action for DSOs on the way to smart grids

What is to be done in concrete terms?

- The transformation of the energy system requires that TSOs and DSOs provide joint approaches to solutions to comply with their responsibility for the system. Mutual information and data exchange between electricity network operators must be intensified.
- In order to enable system responsibility to be assumed by all network operators, specific data and information is required from all upstream and downstream network levels.
- With a view to ensuring an efficient energy information system, a network group / network node and location oriented aggregation of operation data is recommended. In addition, aggregated and projected or measured active power values of generating plants, divided according to energy sources, are required. Each network operator should be responsible for the aggregation of data on its own level (subsidiarity).
- Concerning the configuration, it is necessary to make sure that market-relevant data are made available to the market participants. In this context, existing rules on data exchange need to be taken into consideration in order to avoid double registrations.

Ordinance on the integration of interruptible loads

Particularly interruptible loads of industrial customers[7] can in future make a higher contribution to the maintenance of system stability, although there are wide differences in terms of the estimations of the volume[8] and the costs of the potential that can be additionally activated in future.

According to Sec. 13 EnWG, transmission system operators have rights and obligations concerning the maintenance and restoration of secure system operation. Under Sec. 13 Para 2 EnWG, they are entitled and required in case of emergency to adopt all necessary measures, while liability is ruled out and any performance obligations are suspended. According to Sec. 13 Para. 4a EnWG, the exemption from liability does not apply where no agreements with interruptible loads have been concluded which are technically and economically reasonable. In any case, correct balancing and compensation of burdens shall be guaranteed by the involvement of the balance responsible party (particularly with regard to the payment of penalties in the case of non-observance of the schedule).

Technical and economic aspects still need to be put in more precise terms in an Ordinance of the Federal Ministry of Economics. The Ordinance should include guidelines which legally guarantee the priority of connections and disconnections. The previous Ordinance on this subject-matter is not sufficient. With reference to the aforementioned optimum dimensioning and localisation of services contributing to the system security, BDEW considers that it is essential to make sure that

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[7] A distinction is made between two types of interruptible loads: those which can be disconnected within one second, and those which can be completely disconnected within 15 minutes.

[8] The political advisory forum of the Federal Network Agency estimates the potential of interruptible loads at approx. 2,700 MW.

- The technical effectiveness of a connection or disconnection of load as one of the most important criteria for the prequalification and selection of the appropriate measure is correspondingly taken into consideration;
- functioning, liquid markets, such as the control energy market, are not jeopardised;
- a payment scheme is selected, e.g. based on an energy price;
- agreements are concluded only by mutual consent (customer and TSO); the balance responsible party shall be informed accordingly.

What is to be done in concrete terms?

- First of all, the technical effectiveness of a connection or disconnection of load should be taken into consideration for setting up the relevant rules.
- As a matter of principle, it is imperative to determine rules on technical requirements, pooling of interruptible loads, availability and period of interruption, tendering and payment as well as interactions under Sec. 19 Para. 2 StromNEV (Electricity Grid Access Fees Ordinance).
- In this context, the Network Codes currently drawn up or under development by ENTSO-E/G should be taken into consideration.[9]
- The Ordinance on interruptible loads under Sec. 13 EnWG should be designed analogously with the Ordinance under Sec. 14 a EnWG (interruptible consumer installations at the low-voltage level → in future possibly „Flexibility in the low-voltage network“, interruptible loads → in future possibly „Flexibility in the medium and high/extra high voltage networks”).
- Generators and storage facilities not falling under Sec. 13 (1a) EnWG, should be made available to the DSO as flexibility through market mechanisms within the meaning of Sec. 13 (1a).

Ordinance on interruptible consumer installations in the low voltage network

The Ordinance on interruptible consumer installations at the low-voltage level, embodied in the Energy Industry Act (EnWG) under Sec. 14a, is a first step towards the configuration of the legal framework for smart grids in conjunction with the rules on smart metering systems and variable tariffs. All things considered, the Ordinance must however be extended:

- Intelligent control cannot only be applied to consumer installations but also needs to be applied to decentralised generating plants and storage facilities.

[9] Network Codes are currently developed at EU level by ACER and ENSTO-E/G; they comprise rules on network connection conditions (necessary technical equipment of generation and consumption installations) and framework conditions regarding security of supply.

- In addition to interruption, a reduction of output and connection/increase of output has to be taken into consideration as well. To this end, rules have to be developed between market and network in the form of contractual agreements.
- Basically, the plant management (i.e. the product offer and the energy forecast) should be subject to competition.

  Regardless of the initiating market role, the responsibility for the technical design of control rests alone with the network operator. However, a distinction has to be made between indirect and direct control. The Federal Network Agency must ensure by appropriate requirements that only qualified parties are allowed to offer indirect control (cf. direct marketing of renewables-based power under the Renewable Energy Sources Act).
- Sec. 14a EnWG has been restricted to date to electricity distribution networks. The ruling must be extended to gas networks and their users (cp. natural gas filling stations, gas heat pumps, power to gas, etc.) because an optimisation of the energy system requires the utilisation of potential across energy types.

The Ordinance should be drawn up on the basis of the traffic light concept described in the previous Chapter. In principle, the aim should be that in case of temporary local congestion foreseeable in the medium term, network operators should provide shortage signals to the suppliers (invite tenders for flexibility demand) which are integrated in the suppliers' tariffs. In this way, the market can create flexibility by incentives and support an efficient energy infrastructure.

A basic prerequisite for a sustainable concept is a functioning set of rules for balancing, i.e. coordination between the demand of the distribution network operator and suppliers/aggregators implementing the agreements.

Network fee system

With regard to network fees, it is indispensable to find a sustainable solution. It has to be analysed how greater importance can be attached to the user-pays principle. Primarily the large number of decentralised generating plants with intermittent feed-in causes costs to the upgrading of infrastructures for the transformation of the energy system („Energiewende"). Storage facilities, on the other hand, can serve to reduce the network load.

Basically, a greater orientation of network fees on power appears to be reasonable. As a result, network fees would be based to a much larger extent than today on network costs.

Power has always been the main cost driving factor in the network. But as the energy volume will considerably decrease in future as a result of the increase in individual auto-generation and decentralised generation, the assumption that power-induced costs correspond approximately to the energy costs, is increasingly no longer justified. Moreover, the importance of power as controllable variable in smart grids continues to increase. Finally, the spread of smart meters will enable load-profile metering to be carried out in future for many small customers. Alternatively, customers without load-profile metering can also opt for single or multi-stage capacity fees.

Furthermore, it has to be clarified what a network fee system of the future may look like to set efficient incentives for flexibility in combination with variable tariffs of suppliers. The network fee may provide a possible incentive for influencing the behaviour of network users and thus reduce the network load.

Basically, two forms of differentiation of the network fees can be distinguished: special fees and variable network fees.

Variable network fees vary as a function of the network loading (tendering for capacity, auctioning of flexibility, no real-time pricing). With regard to short-term non foreseeable congestion, there arise considerable challenges in terms of variable network fees if access to flexibilities is necessary within a few minutes. In this context, it is advisable to take account of the fact that short-term local variations of fees cause substantial transaction costs for the foreseeable future and contradict the principle of transparency. It appears to be particularly aggravating that variable network fees do not guarantee reliably available access to flexibilities needed by the distribution network operator. Thus, the network fee is only part of the electricity price; particularly in volatile electricity markets, expected in the future, electricity prices and network fees will interact.

On the other hand, separate network fees are fixed reduced fees which enable a defined control of flexibilities to be carried out by the network operator. The following applies to both variants: For temporary local network congestion, distribution network operators also need temporary local flexibility.

What is to be done in concrete terms?

- Intelligent control cannot only be applied to consumer installations but also to decentralised generating plants and storage facilities. The Ordinance according to Sec. 14a EnWG should be correspondingly extended.
- In addition to interruption, a reduction of output and connection/increase of output has to be taken into consideration as well.
- Ultimately, like other suppliers of flexibility, interruptible loads should be able to participate in a single market at the same terms and conditions. This is the only way to make sure that always the cheapest supplier or the most efficient technology is given a chance.
- Sec. 14a EnWG should support the development of hybrid networks. To this end, connection and disconnection or increase and reduction of output are to be extended to other types of energy (in particular gas, heat).
- The status quo in terms of network fees is not sustainable. A basic orientation towards the user-pays principle in the low-voltage network, too (e.g. on the basis of capacity fees) is recommended.
- The network fee provides a possible incentive for influencing the behaviour of network users and thus reduces the network load. It has to be clarified as soon as possible how the network fee can be transformed into variable tariffs in the context of the Ordinance.

Amendment of the Metering Access Ordinance (Messzugangsverordnung - MessZV): Introduction of smart metering systems

The introduction of smart metering systems can make an important contribution to the development of intelligent energy supply because

a. They enable the timely metering of energy quantities in the scope of feed-in and load management. Hence, intelligent metering systems create transparency and are the interface between consumers/prosumers and suppliers. On the basis of metered values, suppliers can offer products which enable energy purchase or energy production to be optimised.

b. According to the current specification of the German Federal Office for Information Security (BSI) they can also supply network status data which can support a more efficient network operation. From today's perspective, this is however almost exclusively of importance to distribution network operators in rural areas.

c. They shall also serve in future as interface for switching and control signals and will thus be the terminal point of the smart distribution network. That means: If a customer has agreed on a variable tariff for energy purchase or concluded an agreement on feed-in management, the smart metering system in combination with the Gateway energy management constitutes the technical infrastructure for control and regulation. Depending on the rate of dissemination and collaboration of ultimate consumers, this function can be of high relevance to network operators.

To avoid disproportionately large costs with the introduction of metering systems, the main objective must be to integrate them into the existing market processes which need however to be partly adjusted. In the opinion of BDEW, an amendment of the Metering Access Ordinance is primarily required to this end. Besides, sets of rules and regulations need to be completed by technical specifications (such as the BSI protection profile and the technical guideline BSI TR-03109). In order to facilitate the transition to smart metering systems and smooth operation, it is necessary

- not to agree on obligations to install new metering systems or new metering devices with additional functionalities before the results of the cost-benefit analysis of the Federal Ministry of Economic are available;
- to concede appropriate temporary arrangements for investments in modern metering systems;
- to coordinate the consultation and implementation periods for hitherto incompatible market processes and data formats with the introduction of new metering systems;
- to resolve existing conflicts and uncertainties with regard to the rules laid down in the Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz - EEG) and Cogeneration Act (Kraft-Wärme-Kopplungsgesetz - KWKG),
- to present clear-cut rules for the connection of metering equipment for gas,
- to ensure that the costs incurred by the network operator through the introduction of smart metering (e.g. costs for ICT and current operation) are taken into consideration without delay.

What is to be done in concrete terms?
- The introduction of smart metering systems should build on the existing market processes and responsibilities of the respective market roles. - Prior to a stipulation of further cases for compulsory installation under the Energy Industry Act, a valid cost-benefit analysis must be available. - The introduction of smart metering must be accompanied by the Federal Government by a widespread information campaign in order to increase end consumers' awareness of the potential benefits of the new technology and thus acceptance for the associated costs. - For the development of smart metering systems it is essential to make sure that sustainable and secure concepts are set up for balancing and accounting. - The Incentive Regulation Ordinance must be adjusted in connection with the Metering Access Ordinance → Recognition of costs for the network operator in fulfilling its function as legally defined (liable) meter operator. - The smart metering system should collect metered values with a maximum granularity of 15 minutes, in order to limit the data volume and complexity (e.g. plausibility verification and formation of replacement value, and archiving in the case of minutes values including their transmission through telecommunication networks).

Introduction of variable tariffs

Variable tariffs are a core element of the future energy market. In addition to the network fees described in the previous Chapter (cf. page 24), price signals are required which enable the customers to benefit from a system-oriented behaviour. Thus, variable tariffs permit new business models.

Temporary local adjustments of energy generation and consumption need to be carried out in certain electricity distribution networks. Consequently, price signals must also have a local component. It is conceivable that network operators request flexibility in regional marketplaces where suppliers offer aggregated energy generation or demand. Network operators could pay for the flexibility so that suppliers are able to set incentives by variable tariffs, in addition to the energy price (cp. step 7).

On the other hand, in gas distribution networks (in connection to existing rules on interruptible contracts) it is conceivable to grant a reduction of power price elements. This may be of particular interest to customers in network areas where it is not possible to serve the complete power peak due to congestion (e.g. in upstream networks).

According to Sec. 40 Para. 5 EnWG, energy utilities, in their function as electricity suppliers, must offer a tariff to electricity customers (where technically feasible and economically reasonable) which provides an incentive for energy saving or energy consumption management. Tariffs complying with this requirement are in particular tariffs depending on the load and the time of day. Time-dependent tariffs provide an incentive for adjusting the consumption behaviour. It is however not certain whether this incentive is accepted by the customer. Variable tariffs depending on the load, on the other hand, can guarantee flexibility if they are based on appropriate contractual agreements.

As the aim of the introduction of time-dependent tariffs for electricity customers is to provide a financial incentive for demand-shifting during certain periods, the expected load changes must simultaneously be reflected by correspondingly adjusted load profiles as a basis for electricity procurement and balancing, i.e. that the supplier must be able to transform the customer's demand shifting into its procurement portfolio. It is therefore necessary to develop a concept which enables changes in the electricity customers' consumption behaviour due to new tariffs to be simultaneously transferred to the management of the suppliers' procurement portfolio and the balancing procedure.

The establishment of smart metering systems in the market for customers with relevant adjustable loads would make a contribution to the implementation of a sustainable solution. These systems offer the following options:

- With regard to balancing, customers with such metering systems could be treated as customers with metered load profile, i.e. that they could be included with their load-profile into the supplier's balancing group.
- If transformation into the metering system is possible, pricing can also be carried out locally, and only tariffed values must be transmitted (principle of data saving). Tariff periods can be determined on a fixed or flexible basis (e.g. on the respective day before the delivery date). For the purpose of balancing, complementary models would have to be set up between firm profiles and load/meter reading profiles (e.g. generic tariff-related profiles).

Both implementation options comply with future needs as they enable suppliers to offer individual time and load dependent tariffs. In this way, much larger market price signals could be taken into consideration for pricing.

What is to be done in concrete terms?

- Basically, the design of corresponding tariffs should be left to the suppliers in the market. The conditions on which DSOs contract flexibility should however be standardised.
- The methods of accounting and balancing (standard load profile (SLP), recording load profile metering (RLM)) applied to date should be analysed in terms of their sustainability. They should be refined in order to avoid considerable costs arising for the adaptation of the market communication.
- An efficient concept based on the user-pays principle has to be developed in order to enable changes in the consumption behaviour of electricity customers due to variable tariffs to be simultaneously applied to the management of the suppliers' procurement portfolio and the balancing procedure.
- In developing the concept, it is important to pay particular attention to the aspect of data minimisation.

<u>Incentive Regulation Ordinance</u>

The Incentive Regulation Ordinance was set up in the light of the requirements for efficiency increase. The system aims at an efficient operation of existing networks, but it does not pay attention to future challenges. In many respects, the current incentive regulation does no longer comply with the increased demands on the network operators' investment activities, which also result from the Federal Government's energy concept. Even network operators achieving a hundred-percent efficiency are in certain cases not incited to invest in replacements or expansions. Distribution network operators with a particularly high need for expansion and modernisation, are not enabled to make profitable investments, mainly due to the delay of capital recovery by up to seven years. This effect always occurs when the revenue cap defined on the basis of old capital assets cannot cover the increasing cost. In order to remove this investment impediment, BDEW suggests extending the existing incentive regulation to a licensing procedure to resolve the time delay problem. In an international environment, such procedures are usual in modern regulatory systems.

The new licensing procedure is characterised by cost-orientation for capital costs. The aim here is to remove arising cost barriers in case of a particular high demand for investments. Using the arising capital costs as a basis is a widespread approach in other European countries. Regardless of the licensing procedure, the network operator must however also in the regular procedure be able to generate the costs incurred from the implementation of measures required in political or regulatory terms completely through network fees.

Pushing research and development ahead

Incentive regulation introduced in 2009 does not provide sufficient incentives for research and development activities of network operators. For implementing the „Energiewende", a stronger commitment of network operators is however required, particularly in the areas of network technology, system management and practical technology tests in demonstration projects. Wherever possible, this should be done in close cooperation with plant manufacturers as main vehicles of innovation and technological progress.

Against this background, the platform „Sustainable energy networks“ recommended allowing network operators to have part of their expenditure for research, development and demonstration recognised under certain preconditions in the scope of incentive regulation as permanently uncontrollable costs. This recommendation must be implemented as soon as possible, for instance by corresponding adaptations of Sec. 11 Para. 2 of the Incentive Regulation Ordinance or comparable regulations. Alternatively, existing rules on Sec. 23 (investment measures) and Sec. 10 (extension factor) can also be extended or adjusted here.

The preconditions shall include, among other things:

- The restriction to projects which are approved and supervised by experts in the scope of public research funding (BMWi, BMU, BMBF, et al.). → It has to be examined here how access to research funding can be made easier for distribution network operators in particular. In addition, BDEW recommends coordinating research funding by the EU, the Federal Government and the Federal States and making it more transparent.

  An adequate own contribution of the network operator to the total costs of the project as a function of its significance in energy terms, the technical and economic risk, and the readiness of network operators to realise research projects cooperatively with other network operators. → It has to be transparently specified here what is meant by adequate own contribution.

- The obligation to publish research results. If necessary, this can also be done with a certain delay in order to enable patent applications for copyright results to be filed. → It has to be clarified in which form the results should be published.

Metering systems: Direct reimbursement of costs for legal installation obligations[10]

A departure from the concept of an evolutionary „introduction“ of smart grids, as this is likely to happen in the field of „smart metering systems“, means a government-initiated additional burden which has to be timely taken into account during the current regulatory period in the DSOs’ revenues. Due to the volume of expenditure to be expected and the related regulatory uncertainty, the way via the regulatory account, as intimated by the Federal Network Agency, can under no circumstance be used for that purpose. At least as long as the problem of time delay has not been basically resolved, all that is needed are corresponding investment budgets or an adjustment of revenues by the resulting additional costs through the permanently uncontrollable costs are needed.

[10] Cp. BDEW Statement (16/08/2012): „Berücksichtigung von Kosten im Messwesen im Rahmen der Anreizregulierungsverordnung“

Network components required for the development of smart grids

Where required for the consumption and load structure in the respective network area, sensor systems to record the network situation must be set up so that smart usage and management of the network become possible. Alongside this, a respective IT infrastructure must be set up to process the associated information (cp. step 5). The establishment of an energy information system also involves considerable technical, organisational and financial expenditure and expenditure of time. In addition, investments have to be made in automation in order to enable efficient control (cp. step 6). **The expenditure required for all these components must be recognised in incentive regulation without any dely.**

Storage facilities

The great importance of storage facilities should be reflected in regulation. The following adjustments need to be made here:

- Exemption from end consumer charges: In the opinion of BDEW, storage facilities are no end consumers. Withdrawal of electricity from the network for the purpose of later redelivery shows the difference between electricity storage facilities and end consumers. Likewise, BDEW considers that imposing end consumer charges, such as network fees, on electricity storage technologies is opposed to the obligatory implementation of the European Renewable Energies Directive.
- Expansion of the term „energy storage facility“: Storage facilities are functionally valuable for the transformation of the energy system ("Energiewende"). Due to the present market situation, the construction and operation of storage facilities are uneconomical today and in the foreseeable future. With regard to its meaning in regulatory terms, the concept of „energy storage facility“ must be clearly and comprehensively defined. This is to make sure that storage systems which mainly have a stabilising effect on the energy supply network are supported through appropriate regulations.

Virtual power stations: Structural characteristics and parameters

In the last BNetzA efficiency comparison of electricity distribution networks, a structural characteristic „installed decentralised generation capacity“ has been taken into consideration. Additional expenditure for the integration of decentralised generating plants did not necessarily lead to a lower efficiency value. This structural parameter should be retained in the next efficiency comparison.

It is to be seen as positive that changes with regard to decentralised supplies have been taken into account in the extension factor since 2011. Cost increases attributable to modifications of the supply function during the regulatory period can be taken into account through this factor. In this context, not the real cost increases are mapped, but changes of structural parameters are converted into an extension factor of the revenue cap. The extension factor is also applied to distribution network operators using the simplified procedure. From the point of view of plant manufacturers, offering of reactive power control or keeping interruptible consumer equipment available for the reduction of network fees can lead to the emergence of new business models by offering network and system services. However, as the network operator cannot charge the costs incurred, there is no incentive for implementing such measures. Consequently, it would be advisable to recognise in future that the decentralised maintenance of system services enables expansions in the distribution network to be avoided.

What is to be done in concrete terms?

- Infrastructure forms the basis of the energy market. Network operators must be enabled to efficiently set up and rebuild this infrastructure and make it available in a non-discriminatory way to market participants. Distribution network operators need incentives and certainty for their cost-efficient network investment: First of all, it is essential to remove the time delay in order to ensure the profitability of replacement and expansion investments.
- Project approval and authorisation procedures need to be abridged and simplified in order to expedite investment activities and reduce costs.
- Incentive regulation must also fund research and development activities of distribution network operators. The recognition as permanently uncontrollable cost is urgently recommended.
- Regulatory interference in competitive areas should be generally foregone.

Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz - EEG)

Regarding the market and system integration of renewable energies, the development of technical standards in terms of the continuous provision at any time of the measured actual supply will be of major importance. For direct marketers of electricity from wind power and photovoltaic plants, the availability of this information is a decisive factor to improve their forecasts concerning generating plants depending on renewable energy availability.

Moreover, the controllability of plants will be of greater interest to direct marketers in the future when market price signals have an effect on generating plants in the course of market integration. This concerns in particular controllable plants like e.g. biomass facilities. For instance the market premium model introduced in 2012 already provided incentives for plants' reduction of output in the case of extremely negative Energy Exchange prices. This requires however a communication interface through which direct marketers can have access to the marketed generation. This interface should be the so-called Smart Meter Gateway (cp. step 5). It has to be made sure in this context that the control signals of the network operator serving the maintenance of network stability shall have precedence over the direct marketers' control signals.

What is to be done in concrete terms?

- It is essential to set up technical standards which guarantee the continuous provision at any time of the measured actual supply.
    - Direct marketers should have the possibility to have access to the traded generation through the Smart Meter Gateway. It has to be made sure in this context that the control signals of the network operator serving the maintenance of network stability shall have precedence over the direct marketers' control signals.
    - The priority or subordination of network control processes between virtual power stations and EEG shall be described.

Step 3: Research and development, pilot and demonstration projects

Who?	What?	When?
▪ Energy suppliers ▪ ICT developers / manufac-turers ▪ Research institutions	▪ R&D ▪ Pilot projects ▪ Major demonstration projects (publicly & privately funded) ▪ Evaluation ▪ Communication of progresses, findings & needs	▪ Up until 2018

Research and development are of crucial importance when it comes to the identification of „technological gaps“ and the implementation of theoretical approaches to pilot and demonstration projects. Electricity networks are a heterogeneous field of research which simultaneously shows close interrelations with adjacent research fields. This applies for instance to energy storage facilities, centralised or decentralised generating plants or different types of consumers (private households, industrial consumers). Especially in the field of ICT it is important, from the energy sector's point of view, to effectively adapt the existing technologies.

The energy sector recognises the obligation to clearly describe the technological requirements for a smart grid and the requirements with regard to its supply task, the benefit for customers, and the functionality of technologies. Furthermore, optimum harmonisation and interconnection of the different projects should be realised on the basis of a uniform R&D strategy[11]. A classification of subjects in the field of modern electricity network technologies can help to identify possible cooperation between different players/sectors (network operators, traders, energy logistics specialists, industry, science) and show potential synergies. Possible classifications are: „basic research“, „development of components“, „system behaviour and integration“ and „pilot and demonstration projects“.

In most cases, the problem of numerous R&D activities is to transform the results after termination of the project into a marketable product. The legal and regulatory framework conditions turn out to be an obstacle in this respect (cp. step 2). Regulation should support the network operators to the effect that the use of intelligent technologies becomes an economically attractive alternative to conventional network development. The investigation and market launch of smart technologies must be funded, depending on the efficiency of the technologi-

[11] Future R&D projects will be implemented in the scope of the energy research programme. E-Energy was/is funded by the BMWi programme "Convergent ICT".

cal approach. [12] Examples are the subjects of data security, active control of customer facilities, availability of information and communication systems, and many more.

Due to the R&D activities undertaken during the past years, both on a national and international level, it can be established that numerous technologies (smart operating equipment) are rather at a prototype stage or part of ongoing demonstration projects. New innovative market-based concepts (demand side integration, cp. step 10) and solutions are in the development stage, but they are frequently faced with the aforementioned obstacles.

The previous model projects (E-Energy) have furnished first results[13], which must be used as a basis. The approaches available in the electricity sector must be extended to so-called hybrid networks. The energy systems electricity, gas, heating and transport will increasingly interact in future so that a more intensive, optimised and coordinated utilisation of existing infrastructures will be possible (cp. step 8). R&D projects should therefore focus on the following subjects:

- Investigation of necessary sensors and actuators
- Conceptual development for an overall end -to-end information security and system reliability:
    - Study about necessary adaptations of processes in terms of energy economy, including questions on accounting/balancing (e.g. for „wind gas“, „wind heating“, etc.)
    - Public acceptance of smart grids[14]
    - Analysis of the acceptance regarding the control of heating systems, air conditioning systems, heat buffers and electric vehicles
    - Assessment of the contribution of flexibility potentials and analyses of economic efficiency with regard to trading[15]
    - Studies on volume potentials, rates of efficiency and the macro-economic benefit of energy storage and energy transformation processes
    - Electric mobility
    - Assessment of possible business models (power-to-gas, power-to-heat, etc.)
    - Investigation of the economic and regulatory framework conditions

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[12] Cp. Innovative Regulierung für Intelligente Netze (IRIN, September 2011): Abridged version of the final report (German only), p. 22; Handlungsempfehlung 2: Innovationsbudget und Innovationsfonds

[13] Cp. BAUM (2012): A look at the results of the E-Energy model regions

[14] Cp. Stiftung neue Verantwortung (2012): Smart zur Energiewende – fünf Schlüssel zu gesellschaftlicher Akzeptanz von Smart Grids (German only)

[15] Cp. BDEW (2012): Smart Grids in Germany – Fields of action for distribution system operators on the way to smart grids, p. 10

What is to be done in concrete terms?

- Optimum harmonisation and interconnection of different R&D projects should be based on a uniform R&D strategy. The refinement of the 6th energy research programme of the Federal Government would be a good option in this respect.
- With regard to research funding in the field of intelligent network management, the funding initiative on sustainable electricity networks is of crucial importance and needs to be supported.
- The effectiveness of demonstration projects has to be analysed on the basis of concretely defined functionalities required for the future network operation.
- The clear and uniform compliance with economic and technical key performance indicators (KPI) must be measured in a clear-cut manner against the respective expectations.
- Model projects must be carried on and extended to hybrid networks (electricity, gas, heating, transport).
- National R&D efforts must be coordinated with the activities undertaken at European level, particularly with the European Electricity Grid Initiative (EEGI).
- Close interlinking of activities in the field of electric mobility with smart grid projects and integration of all results is absolutely necessary.

Step 4: Standards, data protection and data security

Who?	What?	When?
▪ Energy suppliers ▪ Manufacturers ▪ International, European and national standardisation institutions ▪ Associations ▪ Federal Government, Bundestag, German Laender, Federal Network Agency	▪ Definition of rules and regulations in the smart grid ▪ Development of a legal framework for data protection in the smart grid ▪ Uniform, internationally acceptable IT security objectives for a smart grid ▪ Refinement of market communication allowing for future applications ▪ Refinement of inter-operable technical standards for network and IT technology as well as communication and data protocols taking activities at EU level (M490) into consideration	▪ By early 2013 ▪ By the end of 2013 ▪ Consistent only from 2014, because regulatory framework not stable yet.

The aim of **step 4** is to establish the necessary process-related technical and legal basis for the development and refinement of data protection and data security requirements and the necessary standards in the smart grid.

Energy supply companies, associations, traders, international European and national standardisation institutions, the Federal Government and the Federal Network Agency must carry out the necessary projects on the basis of coordinated timing and with a clear-cut allocation of tasks.

The development of new metering systems has clearly shown that it is absolutely necessary to coordinate the legal embodiment of application possibilities (BMWi and BMU), technical specifications (BSI), the elaboration of standards by the FNN and DKE working groups and the possibly required adaptation of tasks in market roles and market communication.

Investment and planning security for the use of metering systems is only guaranteed if the technical availability of these new appliances coincides with the obligations of use and the rules and regulations required to this end. The larger the difference between the two moments, the higher is the risk of misdirected capital expenditure.

BDEW proposal on the coordination of the different activities

Step A – Legal framework: European and national legislators should define the requirements for a smart grid cooperatively with the energy sector and transform them into national and European guidelines, laws or regulations.

Worth noting here are the establishment of a sector-specific data protection rule in the Energy Industry Act (EnWG), the harmonisation with the currently developed basic regulation on data protection and the embodiment of security requirements in a catalogue of targets also within the EnWG.

As a result, only these efforts ensure a stable and reliable investment framework and form the basis for setting up and developing the technical standards.

Step B - Standards: Market communication between the market participants ranks among the most important standards in the energy industry. Market communication defines and regulates Germany-wide the interaction of market participants in the regulated area, i.e. the way of business communication with the network operator.

Based on the legal requirements, market communication, e.g. in the field of smart metering, should map the integration of smart meter gateways, and in the field of smart grids the operation of a communication and services platform and the implementation of the traffic light concept (cp. steps 1 & 5).

These sector agreements define standardised process and data format descriptions as well as technical application rules e.g. on data protocols and transmission channels. Subsequent to step A, these requirements can be coordinated in a binding manner.

Due to the complexity of these coordination processes, BDEW advocates that existing time buffers between step A and B be used to enable a discussion process on the different possibilities of implementation to be initiated.

Step C - Norms: Subsequent to the development of standards, norms will be refined or cooperatively developed on an international level, if reasonable and feasible. Through the recognised standardisation bodies DKE, CEN, CENELEC, ETSI, it is possible to ensure European and international compatibility but also the acknowledgement of German rules.

Detailed BDEW proposals on data protection and data security

The subjects of data protection and data security are currently intensively discussed from different perspectives. Consequently, there are large differences of opinion as to the requirements to be met by the companies and to be prescribed by the legislator.

Requirements in terms of data protection (e.g. personal data) and security (e.g. market and network data) must be clearly identified in order to avoid misconceptions in public discussions.

From the point of view of BDEW, the aim is to channel the different views and approaches of data privacy activists, consumer protection groups, the customers and users and to develop and jointly confirm a **branch-specific data protection Ordinance** on handling of personal data that might be related to individuals.

Data protection in the smart grid

BDEW explicitly welcomes the sector rules on data protection newly adopted in the EnWG 21g. BDEW considers that the statutory powers on the further design of the rules, conceded there and in Sec. 21i form the basis for a sustainable development of data protection law for a smart grid.

In terms of structures, the BDEW advocates that

- the rules for the configuration of the statutory powers in the scope of the amendment of the Metering Access Ordinance (MessZV) be summarised in a separate data protection ordinance;
- applications be defined to the necessary extent as authorisation, as to be found in 21g EnWG, and supported by opening clauses in order to enable legal certainty to be obtained for non-defined applications.

In terms of contents, the BDEW advocates that the rule on the obligations to inform end consumers laid down in Sec. 21h EnWG be regarded and developed as a crucial element of the customer's data sovereignty. The number and type of institutions responsible for data handling will increase in principle. At the same time, it will become more difficult for the customer to exert its data sovereignty.

Customers should therefore have the possibility to inform themselves independently and at any time, e.g. through a Website („data protection cockpit") about

- the data collected by the authorised entities and sent from the Gateway,
- the existing tariff and status data profiles in the smart meter gateway,
- the collected and transmitted values relevant to accounting,
- the existing agreements and legal provisions used for the collection, processing and utilisation of personal data,
- the possibilities of contact with the authorised parties for the clarification of questions according to Sec. 35 of the Federal Data Protection Act BDSG.

In technical terms, smart meter gateway data can be used exclusively for the purpose of visualisation.

This kind of representation intensifies the customer's requirements for:

- transparency,
- data sovereignty,
- and exertion of the possibility of intervention if it comes to wrongful remote reading.

In terms of the contents of the information provided to the customer, it is necessary to clarify which data are personal data according to Sec. 3 Para. 1 BDSG. Thus, the question is whether individual data about personal or factual circumstances of an identifiable natural person are concerned or data related to a certain location or plant which does not enable conclusions to be drawn on personal circumstances. The examination can be made e.g. on the basis of the following data categories:

1. Data on network planning, operation and management (direct or indirect control data)
2. Data on the implementation of business relations between the end consumer and e.g. the energy supplier
3. Data on the compliance with a legal provision

This distinction is imperative because e.g. the selection of a data protection tariff for energy supply (cumulated data transmission) must not exclude the utilisation and indication of data relevant to network operation.

At the same time, it is certainly difficult to clearly assign the data to one of the data groups and subsequently to user classes because certain data in the energy supply system are used several times for different purposes. These „hybrid data“ are found today mainly at the network user's meter point and mostly represent the data for billing of the „energy used (kWh)“ and the power made available or the available capacity (kW/kVA)“. These data are required for network operation, balancing and accounting of the energy supplied. All market, network planning and network control processes use these „hybrid data“.

From BDEW's point of view, the aforementioned problems can be solved by the precise determination of the application purposes for the respective authorised party, the minimisation of data used for balancing procedures and, where possible, the use of pseudonyms.

For the wording of the sector-specific rule in the amendment of the Metering Access Ordinance, BDEW will elaborate an appropriate proposal on the **design of data classes** and the related **powers and purposes**.

Data security in the smart grid

For energy networks and operators of generating plants there exist already comprehensive legal and sector-specific measures and components to provide security for hedging their own systems against dangers/risks resulting from the use of information and communication technologies.

The provisions for IT security include:

- the specifications of the German Federal Office for Information Security for secure smart metering and general IT requirements to be met by the operator of smart metering-systems,
- the BDEW Whitepaper including requirements for control and telecommunication systems,
- guidelines for the application of the BDEW Whitepaper,
- the newly developed ISO IEC 27019, 27001 and 27002 IT security standard for operators of energy networks and generating plants,

- internal security analyses and requirements of the companies to be able to identify critical processes and adopt protection measures,
- BDEW specifications and implementation guides for secure communication between the market partners in the scope of market communication,
- the communication guidelines of the Federal Network Agency for secure market communication.

With a view to harmonising the existing solutions sector-wide, the BDEW suggests a sector-specific security catalogue which summarised the relevant requirements in a transparent, consistent and binding manner.

The scheduled security catalogue for operators of energy networks according to Sec. 11 Para. 1a EnWG can provide a basis for that purpose. This catalogue could define general requirements for IT security in order to ensure a uniform minimum level. In addition, it is desirable that the specific requirements for IT security from TR 03109 for operators of smart metering systems be integrated into the catalogue.

In substance, the catalogue determines that companies introduce a uniform company-wide information security management system (ISMS). With the standards ISO/IEC 27001, 27002 and ISO IEC 27019, the sector has set up rules and regulations which comply with these requirements on a national and international level in a sector-specific way. These standards form the basis for the security catalogue.

BDEW will additionally draw up a sector-specific guideline for the implementation of an ISM system according to ISO 27001, taking account of DIN SPEC 27019 and BSI basic protection. This guideline provides reliable support to the companies for the implementation of the requirements and enables the sector to respond independently and in a binding manner to the new requirements and update this catalogue at regular intervals.

What is to be done in concrete terms?

Market processes and technologies

The established market communication processes within the energy industry should form the basis for business communication in a smart grid and must be adapted in the short term for the use of the smart meter gateway, and in the medium term for the application of the traffic light concept.

Data protection

- Implementation and continuous refinement of data protection in the smart grid in a separate data protection ordinance in the scope of the amendment of the German Metering Access Ordinance (MessZV).
- Firm legal basis for the end consumers' data sovereignty through a data protection cockpit based on Sec. 21h EnWG

Data security

- Development of a binding catalogue of requirements for IT security in the scope of Sec. 11 Para.1a EnWG by the industry as well as representatives of the German Federal Office for Information Security (BSI) and the Federal Network Agency (BNetzA)
- Development and maintenance of an implementation guide as support to the companies subsequent to the setting up of the catalogue

5.2 Establishment and configuration phase

Step 5: Measurement sensors in the grid; roll-out of smart metering systems

Who?	What?	When?
▪ DSO, meter operator, supplier, operator of virtual power stations, energy service provider	▪ Installation of smart metering systems and control systems at customer groups determined by the legislator with necessary functions, as far as required by the market.	▪ Continuously until 2020

Sensor systems in the network

A system optimising network, supply and demand management requires an improvement of the information basis for all players in the energy system. In order to be able to guarantee in future a high efficiency and quality of supply of the German networks, it is necessary to improve first of all the knowledge about the current network status. Only this information provides the basis e.g. for a reasonable management of demand, observance of the voltage range conforming to standards or an assessment of the loading of network segments. Consequently, the establishment of sensor systems to record the network status becomes more or less an obligatory act of an intelligent (distribution) network use and control, as far as required by the consumption and load structure in the respective network area. Alongside this, a respective ICT infrastructure must be set up to process the associated information. Hence it is necessary to invest in the setting up of communication links, server structures and computer centres.

After all, sensor systems provide necessary up-to-date measured values. These values can be completed at selected points by additional measurements on the end customer's premises by means of smart metering systems if there is a need on the part of the networks.

Roll-out of smart metering systems – benefits and tasks

The smart metering system is generally capable of providing network status data which can be used by the network operator for network control or asset management.

A smart metering system makes remote meter reading possible for the meter operator. Under certain conditions, it is possible to realise savings of operating costs, e.g. by on-site meter readings. However, there are additional system costs on the other hand, so that these savings may be overcompensated especially in densely populated areas and further synergetic effects have to be exploited to ensure an economically efficient operation.

Benefits from the use of smart metering systems can be mainly obtained from the market roles of trade and supplier. These include:

- Forecast: optimisation of consumption and supply profiles
- Products: demand side integration and supply side management (cp. steps 9 & 10)
- Processing of consumption data for the customer and, where applicable, offer of services (energy management, home automation, etc.)

On the basis of information obtained from sensors and smart metering systems, it is possible to guarantee an optimum utilisation of the network in conjunction with technologies for network automation and innovative products of suppliers. The comprehensive knowledge about important system parameters (voltage, current intensity and frequency) is needed to give system-stabilising instructions to active components (controllable suppliers and consumers) and to active network elements.

Ensuring acceptance

The introduction of smart metering systems and the smart grid as a whole must be accompanied by the Federal Government in the scope of a broad information campaign in order to increase the end consumers' awareness of the potential benefits of the new technology and thus acceptance for the associated costs. The starting point for this must be an independent cost-benefit analysis which is not distorted by optional (non-energy related) services.

The information campaign should be developed cooperatively with the associations of the relevant stakeholders (energy industry, consumers, crafts business, etc.).

Interaction of market and network

The collection, visualisation, transmission and evaluation of measured values constitute a process at the interface between market and network. In the light of the multi-step process chain and the different legal and technical requirements, a particularly clear-cut allocation of responsibilities and obligations to the market roles affected by the data flows in the smart grid is necessary (cp. step 1).

Communication and services platform as service provider for the network and the market

In this context, public discussions about the development of a smart grid refer to the conception of a communication and services platform in the smart grid (sometimes also called „data hub"). The core idea of this platform is to manage the large number of data classes or at least a specific selection of data classes (e.g. data relevant for accounting and balancing) sent in the smart grid.

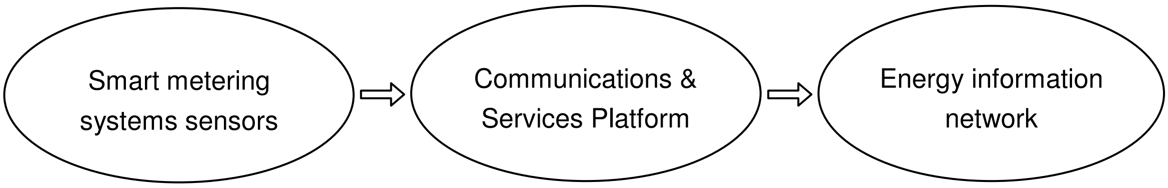

Figure 4: Interaction of basic components for market communication in the smart grid (BDEW)

From the sector's point of view, the following points need to be taken into consideration for the design of the communication and services platform:

- The existing market processes should remain usable to a large extent. A timely smooth introduction of smart metering systems and network connection points can otherwise not be guaranteed.
- The function of plausibility verification of data relevant to accounting and balancing shall remain with the network operator. Decentralised radial communication of data classes relevant to the smart grid would not be feasible for the urgently needed plausibility verification which in this case could not be ensured by the network operator.
- Electricity meter operators shall act as gateway operators across sectors and be responsible for the installation and maintenance of smart metering systems. This enables existing market processes to be used to a large extent by involving the meter operator in the technical plausibility verification, evaluation of failure information and allocation of metered values to the meter point.[16]
- With regard to the prohibitive costs that would inter alia be associated with the change of the meter operator in its function as gateway administrator, the BDEW advocates that the electricity network operator role functions as gateway administrator.
- Market roles which are not active in the regulated area, should be able to generate business models on the basis of smart grid relevant data. The data required to this end shall be made available to authorised market participants by sending the relevant data from the smart meter gateway. In the opinion of BDEW, the respective tasks assumed by the network operator can be defined as „basic services".

[16] does not apply to public charging infrastructures

What is to be done in concrete terms?

- Where required by the consumption and load structure in the respective network area, sensor systems to record the network situation must be set up so that smart network usage and control become possible. Alongside this, a respective IT infrastructure must be set up to process the associated information.
- The introduction of smart metering systems must be accompanied by a joint information campaign in order to increase end consumers' awareness of the potential benefits of the new technology and thus acceptance for the associated costs. The starting point for this must be an independent cost-benefit analysis which is not distorted by optional (non-energy related) services.
- Smart metering systems represent an infrastructure that is jointly utilised by market players and network operators. Prior to their introduction, it is therefore necessary to develop rules for their operation and refine market processes.
- Uniform rules must be created which enable the large number of data classes, which are sent in the smart grid, to be managed. It is recommended coordinating these activities with those of the Expert Group 3 of the EU Commission's Smart Grid Task Force.
- The requirements for electric mobility should be taken into account separately when designing the smart metering systems.

Step 6: Management & control; automation of networks

Who?	What?	When?
▪ Network operators ▪ Meter operators	▪ Automation of networks enabling dangers to be recognised more quickly and removed efficiently. ▪ Sophisticated network operation/network control ▪ Smart metering and control in the interest of optimum network performance	▪ Continuously

New technologies for automation which provide the necessary real-time information for network operation and decision-making support for necessary interventions, are increasingly gaining in importance. While for historical reasons transmission systems show already a high degree of automation and investments are primarily made in an extension of automation, distribution networks need to be upgraded by new technologies mainly in the context of the control issue, provided that the associated costs will be recognised in incentive regulation.

Essential reasons for investments in distribution network automation are inter alia:

- The integration of decentralised energy generation into the distribution networks and the maintenance of their high degree of reliability by making the increasing complexity of power flows transparent.
- The improvement of distribution network operation and maintenance and fast failure analysis and fault location.
- Active load dispatching and re-dispatching in the operation of distribution networks.

Automation of networks will become possible in future through the interaction of different technologies which fulfil different functions:

- Communication and data infrastructure: The communication infrastructure forms the backbone of future smart grid systems. Without communication links, the use of information and the resulting targeted control of actuators in the network will not be possible.
- Smart local network substations: Existing local network substations are equipped with „intelligence“ or replaced, where necessary, by new intelligence, making full automation possible. That means that the new technology permits remote diagnosis and remote action, includes protection functionalities (e.g. so-called „self healing“ measures) and is connected to the system control centres through modern communication and data infrastructure.
- Network control technology: Modern network control technology is based on new applications or mathematical algorithms, respectively, which enable e.g. a fault analysis to be car-

ried out on the basis of data supplied by smart local network substations, and fault location from the known network topology as accurately as possible. A reconnection of this area is possible in an automated way after isolation of the point of fault. Subsequently, a fault analysis can be carried out, the results of which are of value for the design of the maintenance and investment programmes.

An optimisation of the medium and low voltage networks takes place through decentralised network control technology applications in the smart local network substations. These control the network segments in terms of voltage range, load flow, etc. independently on the basis of target values determined by the network control centre. The new applications of the network control technology also include in particular the feed-in management.

- Technologies for voltage control: Mainly the widespread use of photovoltaic plants is a challenge to the stability of distribution networks due to problems in terms of voltage control. For instance controllable local network transformers and controllable inverters capable of feeding reactive power into the grid can be used in future as part of the network automation. Experience obtained from pilot projects shows that the use of controllable local network transformers enables about 90 percent of all voltage deviations to be corrected. The use of smart control based on the interaction of newer types of converters and a smart local network substation can help to improve the utilisation of the existing distribution network infrastructure under certain conditions by 20 to 25 percent.

It is not reasonable to make an economic-efficiency analysis that is restricted to the use of individual technologies. In many cases, efficiency potentials are obtained only by the combination of new technologies and the associated possibilities of automation. In this context, consideration has to be given to the fact that distribution network automation is not required over the entire supply area. It must be installed as a function of the challenges in the respective distribution network. To be able to assess possible costs and benefits, a guideline should be drawn up on the basis of a differentiated analysis. This guideline should take the long-term nature of investments in operating equipment into consideration and be updated, where necessary, in the light of the technological developments.

What is to be done in concrete terms?

- Automation must be installed in the light of challenges faced in the respective distribution network (regional conditions of the network topology, meteorology, etc.). Modular technical concepts and a reliable assessment of the development of renewable energies are required for network planning.

Step 7: Local & global optimisation within the energy system

Who?	What?	When?
▪ DSO, TSO, generators, suppliers, aggregators, traders, storage facility operators, consumers	▪ Increased coordination of technical optimisation (local, global) between the network operators ▪ Increased coordination of economic optimisation between the market participants	▪ From 2014

The increasing utilisation of decentralised renewable energies in the distribution network gives rise to a bidirectional energy flow between the transmission grid, the distribution network and connection owners. Consequently, the following measures are required:

- Continuous coordination between transmission and distribution networks with a view to maintaining the system stability with due regard to generators and suppliers (primarily technical optimisation)
- New concepts for future energy trading (economic optimisation)

Coordination between transmission and distribution networks

There is a broad consensus of opinion that the challenges of the future can be efficiently coped with by interlinking the information and communication technology of participants. The basic idea is to use reserves and shifting potentials of network operators, generation or consumption facilities with a view to providing system services and optimising energy logistics.

There are interactions (mutual influence of so-called global and local optimisation, cp. Figure 5) between European and German transmission grids and distribution networks, which are going to increase with the development of renewable energies.

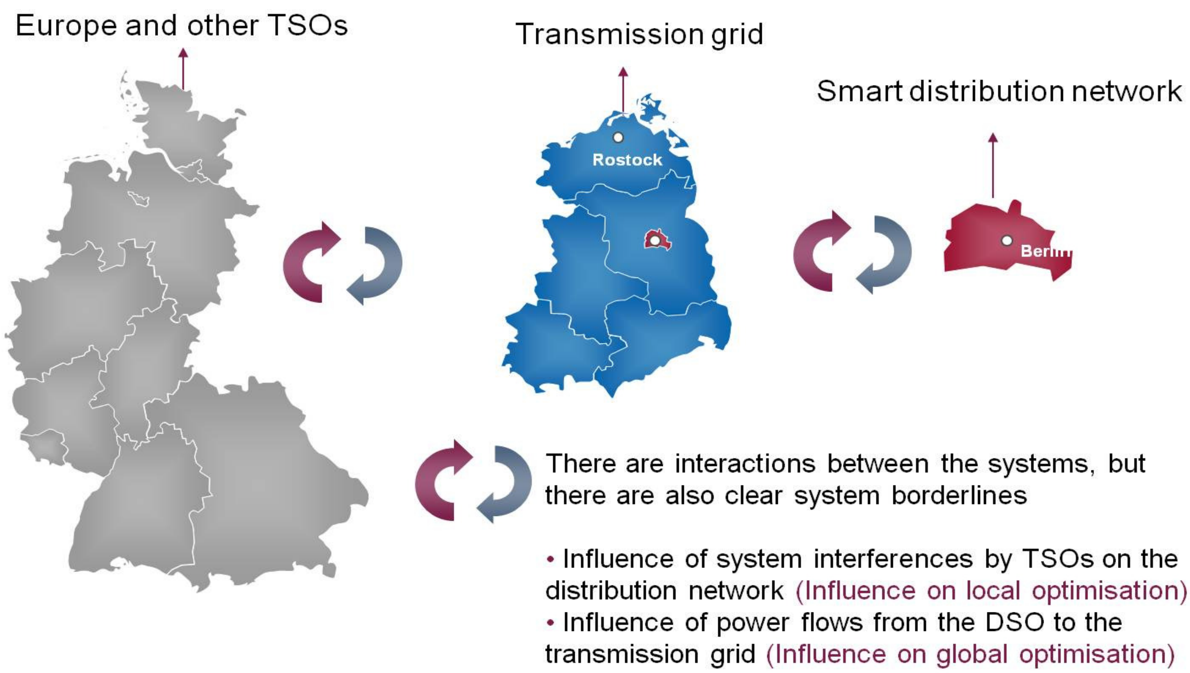

Figure 5: Interactions between local and central market participants (BDEW)

Measures and actions in the smart grid, particularly those which exceed responsibilities or system limits, must therefore be reasonably coordinated with all players involved in order to produce an efficient and targeted effect. This applies to market-based and network-relevant measures which are requested by the upstream network operator and implemented or delegated by the downstream network operator. The dimensioning, localisation and requisition of measures can be carried out only by the network operator immediately concerned, and is communicated and implemented through informative and operative cascading.

The complexity of a centralised system with too many components can be reduced by means of a division into defined network clusters in order to be able efficiently manage the network capacity. The clusters can be broken down into the following categories:

- Distribution network clusters (local networks): Defined section of a supply network, e.g. local distribution networks, transformation substation districts, network groups, where possible, with subgroups
- Distribution network system clusters (local/decentralised): Defined distribution network area which interacts in a system-relevant way and functions as a subordinated distribution network with respect to the transmission grid; i.e. major municipal utilities or regional distribution networks
- Transmission grid system clusters (global/central): Sphere of activity/control area of a transmission system operators, where applicable, identical with national frontiers.
- System clusters: Interconnected power system

Basically, it is worth noting that this kind of network clustering with distributed network management will neither jeopardise the interconnected system nor the competitive market design and the uniform price zone Germany-Austria. For obvious reasons, the aim of the network clustering approach is not to generate a large number of autonomous network islands which are permanently self-sufficient. With good reason, the Federal Network Agency underlines that there is the risk of a decrease in the quality and security of supply in that case. The security of future energy supply is rather based on the interconnection of network clusters into an integral whole within which the TSOs are responsible for the system and the integrated Europe-wide wholesale market functions as smoothly as possible. In terms of system management, the TSOs will be supported in future to a larger extent than today by the distribution network operators.

In such a system, the coordination of joint measures for the maintenance of system security is of decisive importance. In this context, it has to be noted that optimisation and system interventions within a network cluster will have an impact on other clusters.

In the light of intermittent generation and the associated real-time requirements as well as in view of the growing complexity attributable to decentralised generation and consumption control, an economically efficient implementation of distributed network management requires the automation of processes. Therefore, activities aiming at the automation of distribution networks are currently carried out.

For the further discussion, it is necessary to put the network cluster model in more concrete terms, particularly with regard to the interaction between the distribution network and the market. It has to be made sure though that the competitive market design is not affected and practicability is guaranteed.

Development of the future energy market (economic optimisation)

The objective of the EU is to complete the internal market by 2014 on the basis of a competitive market design. Energy trading is based on the fundamental idea that a competitive balance of supply and demand, thus a so-called optimum (efficient) allocation, will be brought about in the uniform price zone Germany-Austria. This principle must be retained.

In addition, a regional component is required in the energy market, which taps the available services of decentralised generation and consumption facilities relevant to the system security, and guarantees their long-term availability. The aim should be to utilise the efficiency of the smart grid and of the wholesale market (local and global optimisation within the market). Suppliers and DSOs, for instance, must have the opportunity to interact during the amber traffic light phase. On the basis of network clusters and, where there is local congestion that cannot be timely removed at low cost by network development, it is advisable to create regional marketplaces for flexible capacity, which fit in pricing in the wholesale market and do not exert an influence on the latter.

During the amber traffic light phase, DSOs request for flexibility at a certain time in a certain place in the network. This is the only way to remedy congestion. Suppliers or aggregators will consolidate in future decentralised generation and decentralised consumption. Based on agreements, they will form a pool of positive or negative loads (feed-in and withdrawal) and offer flexibility from this pool to the wholesale market and regional marketplaces for the purpose of network-relevant measures. The offer of trading in flexibility does not compete with wholesale trading, because payment is not effected through the energy price but by means of an incentive scheme approved by the Federal Network Agency. That means that DSOs can pay suppliers for the procurement of flexibility. On the other hand, the DSO must be able to claim payment through the network charges, if economic efficiency is ensured (costs for flexibility permanently lower than network development) or delays caused by third parties in network development or restructuring measures.

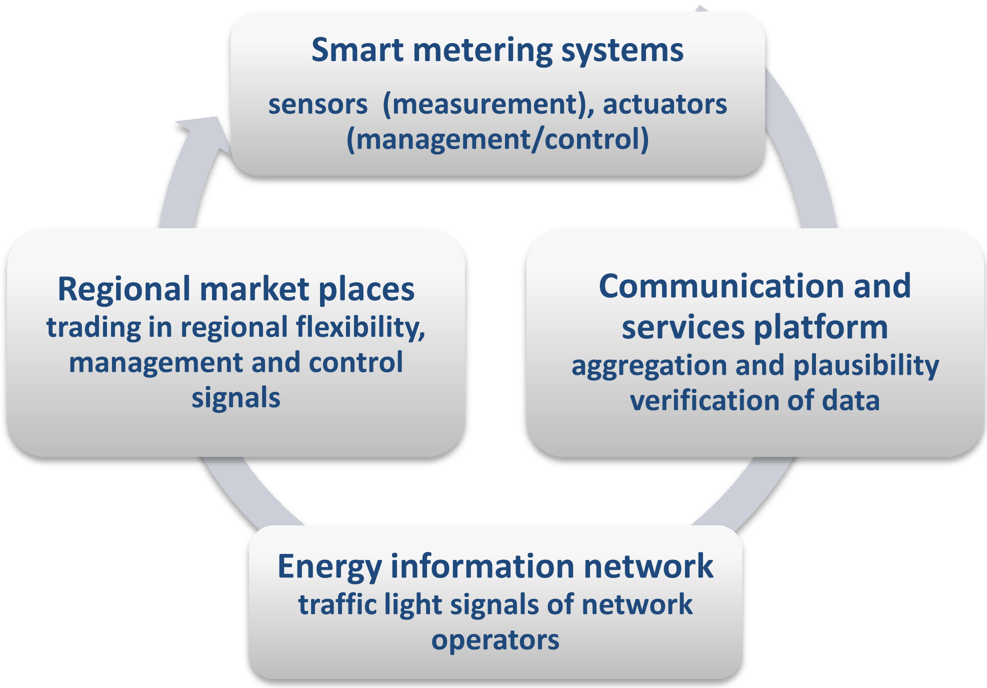

Figure 6: Market communication in the smart grid in connection with regional marketplaces (BDEW)

What is to be done in concrete terms?

- In order to ensure the efficient interaction between global and local technical optimisation, it is recommended establishing the model of distributed network management, based on sensor systems, technologies for network automation and the energy information network described under step 2.
- Where permanent or temporary local congestion exists in the distribution network, regional marketplaces for flexible power should be established in addition to wholesale trading, in which market participants (generators, suppliers/aggregators can offer the network operators bundled energy generation and bundled energy consumption as regional flexibility. The payment should not be determined by the energy price but by a separate system of incentives approved by the Federal Network Agency.

Step 8: Storage facilities and electric mobility, hybrid networks

Who?	What?	When?
▪ Energy service providers, suppliers, DSO, TSO, generators and retailers or fitters	▪ Time-related balance between energy supply and demand. Stabilisation of energy supply by provision of services in the energy network.	▪ Continuously, first steps from 2018

In the long term, energy storage facilities will be a very reasonable functional element of the energy supply system. For a share of 80 percent of renewable energies, an economically most efficient power system will require approximately 14 GW or 70 GWh (5 hours) of short-time storage and about 18 GW or 7.5 TWh (17 days) of long-time storage, in addition to the storage facilities existing today.[17]

Energy storage facilities ensure the efficiency of the energy system by making quantities of electricity available generated from renewable energies and simultaneously make an important contribution to the maintenance of security of supply. Basically, a distinction has to be made between load-shifting storage by functional energy storage facilities (energy conversion and use in the target application such as in the case of compressed air, cold/heat, etc.) and direct electricity storage where the electrical energy after the storage process is fed back as electricity into the energy system or the local network (batteries, pumped-storage power stations).

In the energy supply system of the future, energy storage facilities will have a wide variety of applications, such as

- Absorption of excess power from renewable energy sources
- Network load management to avoid load peaks and thus reduce the necessary network development measures
- Stabilisation of the electricity network by the provision of system services for frequency and voltage control (active and reactive power)
- Network support after a power outage (black start support)
- Support to energy management in network clusters
- Portfolio optimisation

These functions can be fulfilled by different storage technologies which differ in terms of the storage duration (short-time, hourly, daily or seasonal storage, cp. Figure 4), the positioning

[17] Cp. VDE (2012): Energiespeicher für die Energiewende (German only), p. 141

(centralised or decentralised) and the ratio between power and energy quantiy stored (power or energy storage).

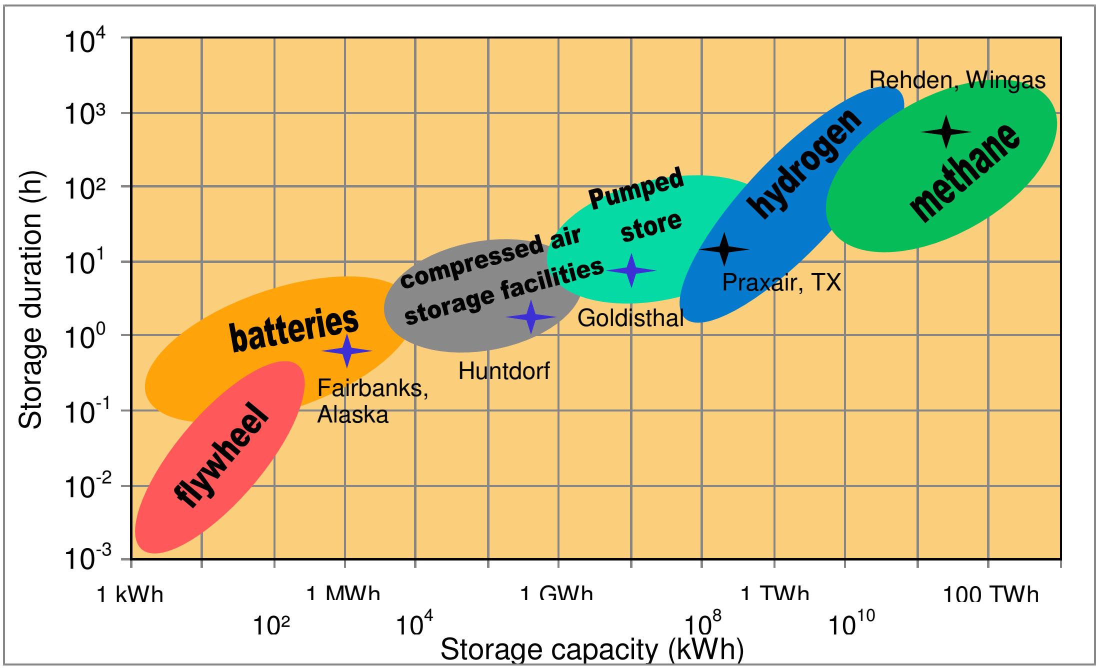

Figure 7: Comparison of the potentials of different storage options (DLR 2012)

- At the present time, the following storage technologies are intensively discussed: Pumped-storage power stations: Pumped-storage power stations have represented to date the only large-scale electricity storage technology that has proved to be successful for decades. Today, they function as an important stabilising element in the energy supply system. Contrary to prevalent prejudices, recent analyses of potentials assume that there is considerable development potential of pumped-storage power stations in Germany. In this respect, it is necessary to promote public acceptance.
- Batteries: Due to the particular characteristic of battery storage facilities to absorb or release electricity very quickly, they can make an important contribution to the stabilisation of the power system. They will be primarily located in a decentralised way in the distribution network, e.g. in private household and in the small trade sector. Due to their potential, R&D support is reasonable. As result, considerable economies of scale are likely to occur over the next few years so that an economically efficient use of batteries will be possible in future.
- Compressed air storage facilities: Storage of energy in the form of compressed air may be used in addition to pumped storage. The currently low rate of efficiency is to be improved by heat storage and recovery. Further pilot projects are required in order to achieve economic efficiency by technological refinement.

- Excess power to heating networks (Power-to-Heat): The utilisation of excess power during periods of high feed-in of renewables-based electricity for heat supply to heating networks could represent a quickly accessible low-cost option for the integration of renewable energies. It should be considered in conjunction with heat storage facilities, heating networks and cogeneration plants. The storage of excess electricity from renewable energy sources is accompanied by the reduction of fossil fuels which would otherwise be required for heat generation. A similar approach, though offering less potential, is the storage of electricity in cooling networks.
- Power to gas (P2G)/methanation: This technology which is currently in the research and development stage could above all make the seasonal storage of renewables-based excess electricity possible. In the long term, P2G is an effective possibility of storage, though it requires as a first step significant technological development so that its economically efficient operation is to be expected for the period beyond 2022. This is a key element for the implementation of hybrid networks and the associated use of excess renewables-based electricity quantities in gas applications (heating, mobility, etc.).

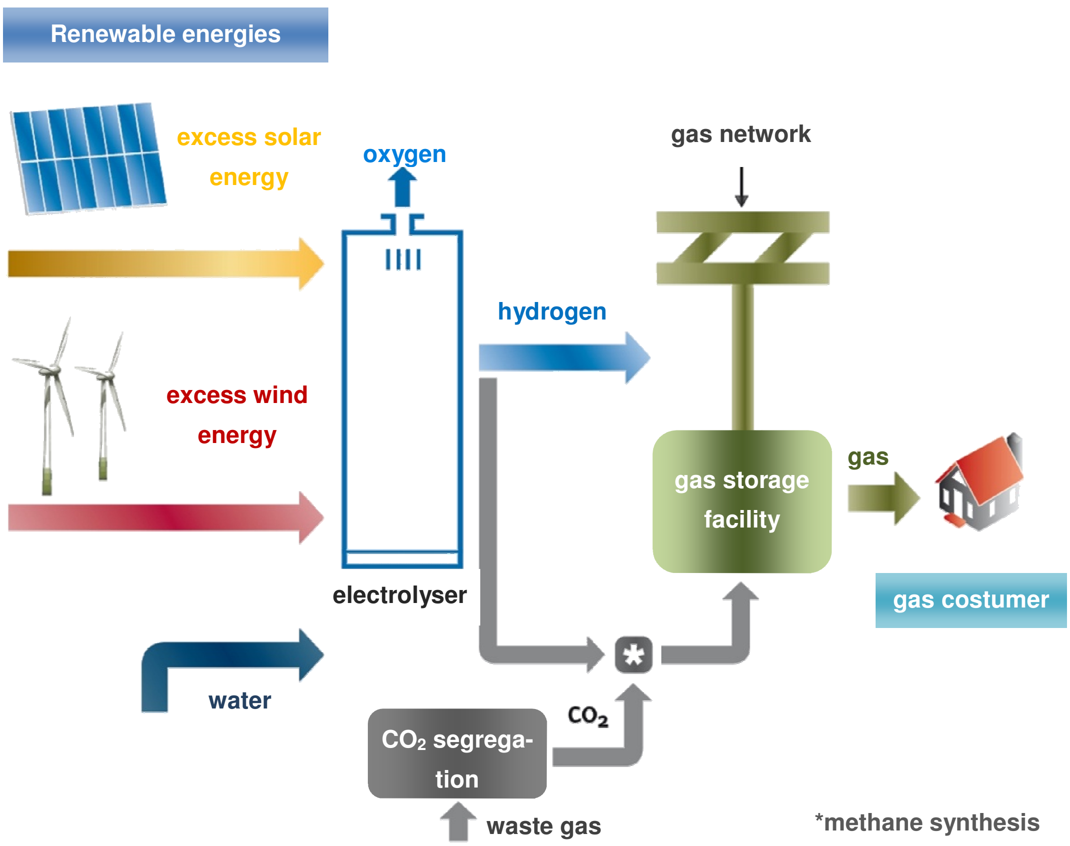

Figure 8: P2G principle (BDEW)

The economic efficiency and optimum technical application of storage technologies depends on the ratio of the necessary storage capacity to the installed capacity and on the connection to the respective network level. Batteries are e.g. well suited for the storage of electricity from photovoltaic plants. Wind power plants could in future be connected to heating networks. Consequently, all types of storage are needed and should interact in a market across all types of energy. It is recommended setting up a concept for that purpose.

In order not to jeopardise the development of electricity storage facilities, it is necessary to create appropriate regulatory framework conditions. All types of storage technologies must therefore be permanently exempted from the payment of end consumer charges.

Electric mobility

As a component of the smart grid, electric mobility can contribute to a better integration of renewables-based electricity and thus support a sustainable energy supply.

Support to smart grids: Electric vehicles as storage facilities

The batteries of electric vehicles represent a considerable storage potential when there is a signification market penetration and an appropriate development mainly of private charging infrastructure with sufficient charging capacity. They enable electricity generated from wind and solar energy to be stored when it is not needed elsewhere or directly on site (e.g. producer's consumption of electricity from its own photovoltaic plant).

The government programme for electric mobility of May 2011 laid down a target of six million electric vehicles by 2030. According to the second report of the national platform for electric mobility of May 2011, the storage potential of the batteries of these vehicles amounts to nine Giga-watt. For comparison purposes: The installed power of all pumped-storage power stations in Germany currently totals approximately seven Giga-watt and is likely to amount to around eight Giga-watt in 2030. The sample calculation assumes that 30 percent of the vehicles are connected to the network, with an average battery size of 15 kilowatt-hours and an average charging/discharging capacity of 3.7 kW.

An essential prerequisite for the utilisation of this storage potential of electric vehicles is an intelligent technical network integration (including compatible communication interfaces) and charging control as well as balancing of feed-in and output. The charging control also contributes to reducing the need for network development. Furthermore, in particular new, efficient, consistent and functioning market processes must be defined (e.g. billing processes for customers) on the basis of the necessary legal and regulatory framework conditions (cp. step 2, interruptible load, control of interruptible consumer appliances). It will ultimately depend on the market processes whether there will be a demand for electric vehicles and vehicle manufacturers will offer vehicles with bidirectional converters capable of feeding electricity back into the grid.

Research and development

The government programme for electric mobility of May 2011 defined R&D beacons, with a particular focus on ICT and infrastructure. Intensive investigations are currently carried out inter alia of ICT interfaces with the energy system and the optimum integration of the charging infrastructure into the electricity network (e.g. controlled vs. uncontrolled charging). A close interconnection of beacons and showcases with E-Energy and ICT projects and a combination of all results obtained is absolutely necessary (cp. step 3).

Electric vehicles as additional consumers

Should electric vehicles be of minor importance as storage facilities in comparison with stationary storage facilities due to their lower connection capacity, high degree of decentralisation, and low availability, they will nevertheless play an important role as additional flexible consumers. The application of renewable energies in the mobility sector will distinctly increase beyond 2022 and represent a core element of hybrid networks.

Hybrid networks

In future, there will be a growing coalescence of the energy systems electricity, gas, heating and transport so that a more intensive, coordinated use of the existing infrastructure will be possible (utilisation of existing degrees of freedom). Any interlinking of infrastructures can be classified as domain-wide process coupling. The following technical possibilities of simple coupling are available:

- Power to Gas (P2G)
- Power to Heat (P2H)
- Power to Mobility (P2M): electric mobility
- (Bio-) Gas to Power (G2P)
- (Bio-) Gas to Heat (G2H)
- (Bio-) Gas to Mobility (G2M)
- Mobility to Power (M2P): battery

These simple couplings can be combined with one another. It has of course to be noted that any interlinking gives rise to efficiency losses which are reflected by the economic viability. Against this background, arbitrary network coupling is excluded.

A conceivable coupling model can e.g. be a wind farm generating electricity which can temporarily not be completely supplied to the electricity grid. In this case, the surplus generation can in future be converted into so-called renewable hydrogen or renewable methane through the P2G procedure and supplied to the natural gas network. Thus, electricity generated from renewable energies can either be seasonally stored in gas storage facilities or used for gas applications. Conceivable applications are e.g. the reconversion to electricity in a gas-fired power station (G2P), utilisation in heat production (G2H) or in the mobility sector (G2M).

Independent of the creation of the necessary regulatory framework conditions (cp. steps 1 and 2) and the promotion of research & development for the technical implementation of the respective coupling (cp. step 3), the following questions must be answered:

- Where does the existing infrastructure support coupling processes?
- Where is the largest potential for couplings (efficiency analysis, etc.)?
- What location and time-related flexibility is possible with regard to the connection of electricity with gas, heat, mobility? (Thesis: A power-operated application of hybrid networks is advisable in the light of the transformation of the energy system.)
- How can transition processes be optimised in operational terms?
- How can process coupling be established over the entire area? (e. g. bivalent consumers)
- How are economic processes to be adjusted? (e .g. balancing/accounting)
- What should a homogenous information and communication technology for the support of coupling look like (cp. steps 5 and 6)? How can this technology be installed in an economically efficient way?
- Must optimisation be regionally implemented due to the high complexity of hybrid networks?
- Can system-related promotion incentives be provided with a view to pushing the coupling of networks ahead with regard to the necessary need for action?

What is to be done in concrete terms?

- All energy storage facilities must be exempted from end consumer charges which are incompatible with the system.
- A concept should be devised as to how energy storage facilities can participate in energy markets across energy types. In addition, R&D efforts need to be concentrated on considerably enhancing the economic efficiency of storage options.
- Optimum locations for storage can be generation facilities, network bottlenecks and/or locations with heating networks (power to heat), natural gas pipelines (power to gas) and, where necessary, CO_2 sources (in the case of methanation).
- Electric vehicles require an intelligent technical network integration (including compatible communication interfaces) and charging control as well as a balancing of feed-in and withdrawal. To avoid an uncoordinated network development, it is imperative that all electric vehicles are equipped with the possibility of controlling their charging.
- Furthermore, in connection with electric mobility, in particular new, efficient, consistent and functioning market processes must be defined (e.g. billing processes for customers).
- A close interconnection of beacons and showcases with E-Energy and ICT projects and a combination of all results obtained is absolutely necessary.
- After the clarification of basic questions as to the potential and necessary technical and process adjustments, concepts for the coupling of networks must be developed and promoted.

5.3 Realisation and marketing phase

Variable energy generation and consumption will in future be ensured over the entire supply area by new production of the players in the final customers' market, and represent the major pillars of smart energy supply. In particular energy suppliers/aggregators will take care of an optimised energy logistics which implies inter alia the following aspects:

- Efficient coalescence of generation and consumption as well as optimisation of the use of storage facilities
- Enabling the integration and balancing of intermittent generation and thus reduce unnecessary decreases in output of renewables-based generation.
- More efficient management of balancing groups within shorter periods
- Utilisation of load shifting potential and operation of virtual power stations
- Offer and provision of system services by the supplier (cp. steps 1 and 7)

Many of the products will be services in the form of so-called energy management systems which give the customer the opportunity of benefitting from system-oriented behaviour. In this way, customers can reduce costs by managing/controlling their energy consumption and increase revenues by managing/controlling their energy generation. A so-called energy management system of suppliers which is connected to the customers' smart metering systems ensures the necessary information on when an adjustment of energy generation and demand offers an added value. It reduces complexity, provides an overview of variable tariffs and offers customers a simple decision-making basis.

Due to the extension of control energy market to the distribution network level and the introduction of efficient processes for trading in load flexibilities, it is possible to limit the necessary development of distribution network to the necessary degree. Network operators continuously consider network developments and market-oriented load shifting. To enable system services to be offered in future beyond the control power market, it is necessary to develop in addition to the legal provisions which make the new non-discriminatory regional market accessible for all market participants (cp. step 2), framework conditions which

- guarantee the transparency of tendering for system services (cp. tendering for control energy taking account of the network cluster level) and
- create suitable balancing and accounting regimes (common generation and consumption balancing)

With regard to the creation of hybrid networks, first products should be developed in the near future to develop the coalescence of electricity, heating/cold and gas networks and ensure an optimum utilisation of their storage potentials. The interaction of the different sectors must be designed in a way so as to give rise to an overall economic optimum. The respective rules must be developed.

Step 9: Variable generation - Supply Side Management

Who?	What?	When?
▪ Generators, DSO, TSO, suppliers, aggregators, storage facility operators, Balance Responsible Parties (BRP)	▪ Further development of flexibility and system services markets ▪ Further development of aggregation into virtual power stations	▪ From 2014

Virtual power stations

Where there is a large number of decentralised generating plants, the importance of approaches for the system-wide integration of intermittent electricity generation (particularly from wind energy and photovoltaic plants). While the technical integration mainly touches upon issues of network integration and the provision of system services, the economic integration of renewable energies into the electricity market must primarily be ensured by free trading in the long term. Cogeneration plants, heat pumps and further flexibility options like electric heaters, electric vehicles, etc. offer a high potential, when bundled in virtual power stations, to make a significant contribution to the compensation of the considerable gradients of the residual load (cp. figure 5). The macro-economic value added by the operation of virtual power stations mainly is that a major part of non-utilised flexibility of decentralised and centralised generating plants will in future be aggregated and tapped to cover the residual load. The framework conditions and the associated attractiveness of the respective business models of virtual power stations will be the key to future success (direct marketing, control energy balancing group management, network and system services on the basis of aggregated generating units). The necessary aggregation is implemented by suppliers/aggregators.

Distribution network level

From a market perspective, virtual power stations can in future make a contribution towards removing congestion, voltage range violations, etc. in the distribution network in an economically viable manner. This requires that several individual plants of the virtual fleet of power stations are connected to one and the same network group of the distribution network operator concerned. Ideally, power fed into the grid can be shifted in a way so as to remove congestion without changing the aggregate power in the balance. Moreover, the design of the legal and regulatory framework conditions is a basic prerequisite (cp. amber traffic light phase in the traffic light concept, step 1, and EEG, step 2).

Transmission system level

Balancing of the residual load is reliably and efficiently carried out today and in future by the provision of control power. By pooling of smaller generating plants, virtual power stations can participate in the control power market and contribute to its enhancement and increased flexibility if they comply with the prequalification requirements. The necessary prequalification procedures for the provision and supply of control energy for every individual plant ensure a reliable availability of the participant in the control energy market.

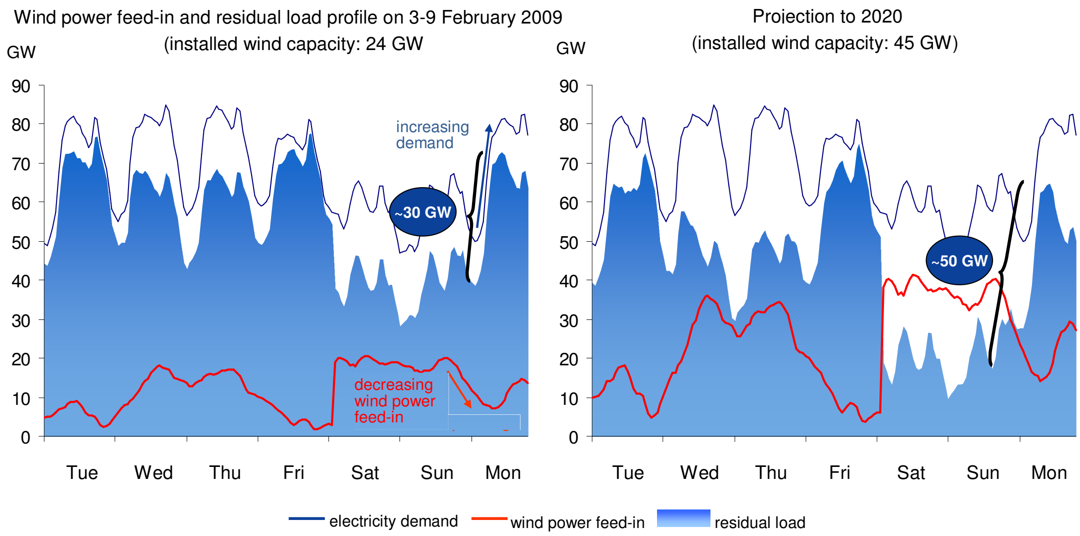

Figure 9: „Generation structure 2020/2030“: Integration of renewable energies into the system

Control of sudden power changes not only in terms of their size but also of their gradient (BDEW)

<u>Variable generation of the conventional fleet of power stations</u>

It is likely that the installed renewables-based electricity capacity will rise from approx. 54 GW today to at least 120 GW by 2030. As evaluations of real feed-in data show, feed-in from photovoltaic or wind power plants can temporarily be almost zero, while high feed-in capacities of more than 50 percent of the installed renewable capacities can only be provided during five to ten percent of the hours per year.

The flexibility of conventional power stations is therefore needed to maintain the security of supply. They will be kept available in future as back-up systems for periods of insufficient electricity generation from renewables. Their utilisation will be reduced by 40 percent on an average compared to the current situation. Because significantly high sudden load changes are likely to occur already in 2020, it is advisable to set up appropriate legal framework conditions as soon as possible.[18]

[18] Cp. BDEW (2012): Discussion paper of 25/09/2012: „Strategic reserve – Safeguarding of the Energy Only Market, Discussion of a bridge solution to safeguard security of supply without interference leading to market distortions“.

Step 10 Variable generation - Demand Side Integration

Who?	What?	When?
▪ All market participants on the feed-in and withdrawal side	▪ Development of widespread information and awareness-raising campaigns on smart grids and the possibilities offered to consumers on the basis of consensus between the government and the sector ▪ Development of commercial demand-response programmes including dynamic electricity pricing and flexible or contractual agreements in the interest of optimum network performance, load aggregation and trading of load reduction in the market (e.g. EEX, EPEX, control energy)	▪ From 2014

Demand Side Integration is the umbrella term for Demand Side Management (DSM) and Demand Side Response (DSR). Demand Side Management comprises the direct influence on demand side energy consumption. To this end, energy consumption can be increased or reduced at a certain time. In this context, either contractual agreements on the provision of flexibility have been concluded in advance or, where there is imminent risk, direct intervention is required in order to maintain the stability of the system. Demand Side Response comprises the response of the consumer to a (mostly financial) incentive signal, that is to say a time-of-use dependent tariff, e.g. with on-peak, mid-peak and off-peak prices. Customers can optimise their energy purchase by shifting some of their electricity use to lower-price periods.[19]

This bipartition particularly plays a role during the amber traffic light phase. Depending on the response time, a distinction is made between two mechanisms (cp. step 1, p. 13). If congestion can be forecasted, there is a possibility for suppliers to set incentives for flexibility (DSR) on the basis of information from network operators. Where this is not possible, the situation must be remedied at short notice (DSM).

An appraisal of the potential of technical components in the smart grid, carried out within the BDEW among its member companies, showed a high value for controllable loads in the distribution network (cp. Figure 10). It is however important to differentiate industry, small trade and households as customer groups. For instance, the load shifting potential is lower in households than in small trade and industry. As a first step, focus should thus be on industrial load management. Consequently, priority should also be given to the elaboration of the Ordinance on interruptible loads (cp. step 2).

[19] Cp. VDE (2012): Ein notwendiger Baustein der Energiewende: Demand Side Integration

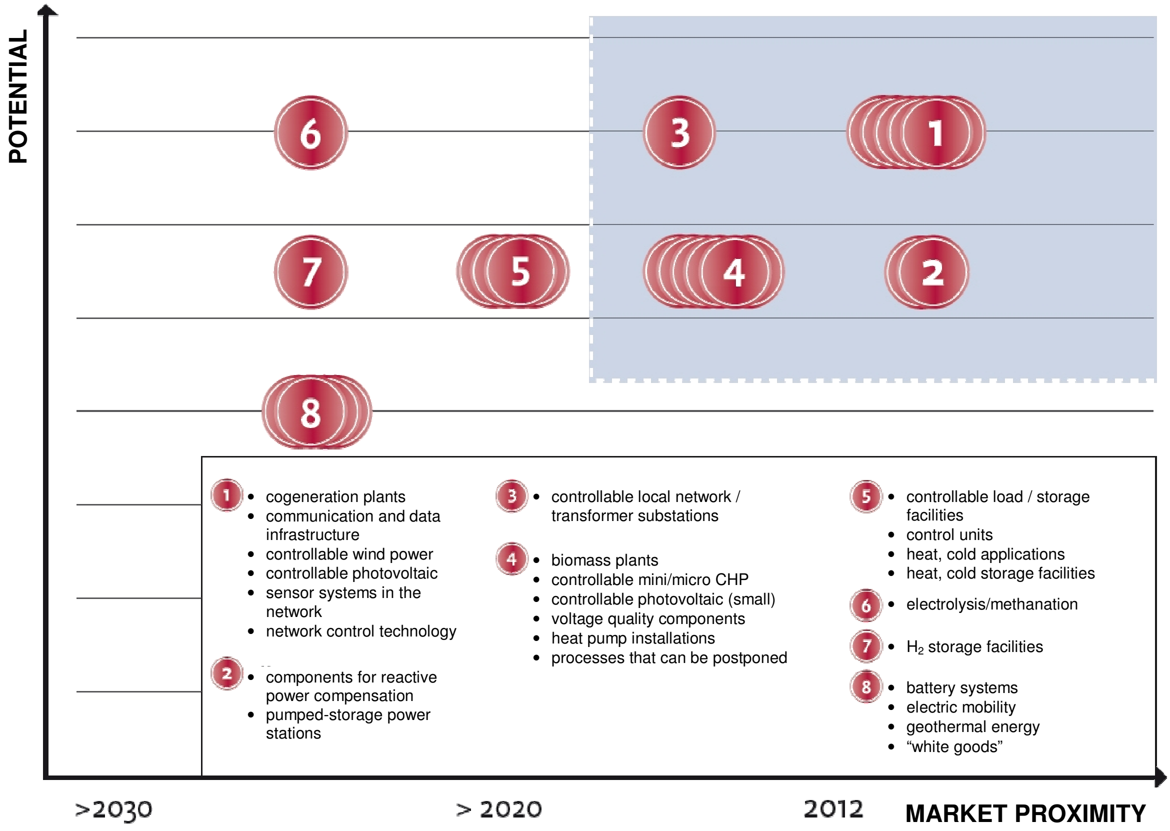

Figure 10: Potential and market proximity of technical components in the smart grid (BDEW)

Furthermore, for a valid appraisal of the load shifting potential, it is essential to consider the demographic change and the development of new technologies (such as electric mobility). As a result of developments like the implementation of electric mobility, there will be a considerably higher potential in future for the coordination of load shifting. With a view to tapping this potential, suppliers or (designed as a new market role) so-called aggregators/demand side manager will generate products which enable loads to be aggregated.

A basic prerequisite for functioning load management is the customer's willingness to actively participate in the market. Suppliers as the customers' (business) partners will develop here solutions that simplify the practicability of processes and their complexity, and ensure easy handling in terms of energy utilisation particularly in the household sector. Household customers' energy management systems connected to smart metering systems enable, apart from optimised supply of energy, smart home solutions (efficient energy use) to be implemented.

The decisive factor for the success of smart products is to manage the balancing act between a market-oriented design of the legal framework which guarantees system stability (ensuring compatibility of technical components, etc.) and openness to technologies, procedures and processes which support the development of the great variety of smart products.

Possible development: From the price per kWh supplied to the price per kW produced

It is conceivable that the importance of prices per kWh supplied will decrease in the long term and that of prices per kW produced will increase. In this case, the smart grid and generation facilities will make capacities available which can be traded by wholesalers and energy suppliers in products with pure power price elements. In the wholesale market, virtual power stations and energy sinks might then be traded through power-based products and availability premiums. Suppliers offer dynamic flat rates (products with variable power availability) to their customers on the basis of the procured capacities. The product range comprises inter alia home automation and security services as well as approaches to partial self-sufficiency.

What is to be done in concrete terms?

- In order for suppliers to be able to offer system services in future, it is necessary to develop, in addition to the legal provisions enabling all market participants to have access to the new non-discriminatory regional market (cp. step 2), framework conditions which guarantee the transparency of invitations to tender for system services (cp. invitations to tender for control energy at the level of network clusters) and suitable balancing and accounting regimes.
- First products should be developed as soon as possible, which support the integration of electricity, heating/cold, gas networks into hybrid networks.
- The regulatory framework for virtual power stations is complex and a great number of requirements influence the economic environment of virtual power stations indirectly[20] and need to be coordinated.
- It is advisable to swiftly establish a legal framework which provides adequate economic incentives for the operation of conventional power stations as backup systems.[21]

[20] Of relevance are inter alia the provisions laid down in: KWK-G, EEG, EnWG, EnergieStG and StromStG, Energie- und Stromsteuerdurchführungsverordnung, ARegV, StromNEV, protection profiles of the German Federal Office for Information Security and StromNZV.

[21] Cp. BDEW (2012): Strategic Reserve – Safeguarding of the Energy Only Market.

6. Conclusions

The increasing decentralisation of energy generation, but also the objectives pursued in the field of energy efficiency and energy saving require that adjustments be made in terms of infrastructures (smart network development and restructuring), but also in terms of market processes and market communication. The energy sector's business models are undergoing a change. In order to be able to guarantee secure, inexpensive and environmentally friendly energy supply in the future, the aim must be to aggregate and coordinate dispersed energy generation and consumption, where this is reasonable in technical and economic terms. A necessary prerequisite to this end are smart grids, on the one hand, and regional market places for flexible power/flexibility, on the other hand.

That also means that there will be increased interaction between market players and regulated network operators. In order to make sure that this continuous interaction complies with unbundling requirements, it is possible to use the so-called traffic light concept. This concept distinguishes responsibilities as a function of system conditions and creates a market which enables an economically reasonable network development and restructuring to be carried out.

As a first step it is important to design and harmonise the legal and regulatory framework conditions on the basis of the traffic light concept. It is essential to find solutions inter alia for the following questions:

- What type of flexibility is needed (differentiation not only of network levels, but also of urban and rural distribution networks and regions)?
- How should incentives for flexible generation, networks, storage facilities and loads be designed (variable tariffs, network charges with partly regional effects)?
- What data will be collected and used in the smart grid and in what way? How can data protection and data security be guaranteed in the light of a high data volume (smart metering system, communication and services platform, energy information network)?
- How must market processes be adjusted?
- How can the development of new technologies and concepts be supported?

By means of this Roadmap, the BDEW has provided first concepts, appraisals and answers to the question as to which players will have to cope with which tasks within what time horizon.

Smart energy supply offers great potentials. For tapping them, it is essential to recognise that there are no simple "either/or" solutions. A differentiated consideration is required.

7. Annex

7.1 Glossary

Aggregator: An aggregator aggregates flexibility, i.e. positive and negative loads. An aggregator can be regarded as a market role to be newly defined or as a function that is fulfilled by existing market roles, such as the supplier.

Smart metering system: Smart metering systems consist of a metering device which continuously measures the consumption, and the gateway which ensures secure data communication.

Norms: They describe the technical minimum requirements, i.e. the generally recognised state of the art.

Prosumer: Con*sumer*s increasingly become also *Pro*ducers.

Standards: Companies or sectors agree common standards, for instance in the technological field in order to simplify market processes and make them cost-efficient. Standards enable market processes and technologies to be applied in a uniform and recognised manner. Companies define their specific corporate standards on the basis of their specific requirements and by taking account of the respective laws, ordinance, sector-specific standards and norms.

Aggregate power: In terms of accounting, aggregate power is the sum of positive and negative energy quantities per time unit.

Interruptible consumption equipment at the low-voltage level: e.g. electric appliances in households or electric vehicles.

7.2 List of abbreviations

ARegV	Anreizregulierungsverordnung – Incentive Regulation Ordinance
BDSG	Bundesdatenschutzgesetz – German Data Protection Act
BMBF	Bundesministerium für Bildung und Forschung – Federal Ministry of Education and Research
BMWi	Bundeswirtschaftsministerium – Federal Ministry of Economics
BMU	Bundesumweltministerium – Federal Ministry for the Environment
BNetzA	Bundesnetzagentur – Federal Network Agency
BSI	Bundesamt für Sicherheit in der Informationstechnik – Federal Ministry for Information Security
DKE	Deutsche Kommission Elektrotechnik, Elektronik, Informationstechnik im DIN und VDE – German Commission for Electrical, Electronic & Information Technologies of DIN and VDE
DSM	Demand Side Management
DSR	Demand Side Response
EEG	Erneuerbare-Energien-Gesetz – Renewable Energy Sources Act
EEX	European Energy Exchange
Egex	European Gas Exchange
EnWG	Gesetz über die Elektrizitäts- und Gasversorgung (Energiewirtschaftsgesetz) – Electricity and Gas Supply Act (Energy Industry Act)
EU	European Union
EEGI	European Electricity Grid Initiative
FNN	Forum Netztechnik/Netzbetrieb im VDE – Network Technology/Network Operation Forum in the VDE
R&D	Research and Development
GW(h)	Gigawatt(hour)
ICT	Information and Communication Technologies
KDP	Kommunikations- und Dienste-Plattform – communication and services platform
KPI	Key Performance Indicator
kW(h)	kilowatt(hour)
CHP	Combined heat and power generation
KWK-G	Kraft-Wärme-Kopplungsgesetz – Cogeneration Act
MessZV	Messzugangsverordnung – Metering Access Ordinance
M490	EU Commission - Smart Grid Standardisation Mandate

P2G	Power to Gas
RLM	Registering load profile metering
SLP	Standard load profile
StromNEV	Stromnetzentgeltverordnung – Electricity Grid Access Fees Ordinance
TSO	Transmission system operator
DSO	Distribution system operator

7.3 List of figures

7.4 References

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7.5 Players and market opportunities (graphic representation)

Decentralised energy generators

- More efficient utilisation of decentralised generators and higher connection density
- Reduction of costs for network access by the implementation of alternative network control concepts (active network operation) → Currently economically inefficient generator projects can become profitable.
- Enhanced market opportunities if there is a possibility of intermediate storage of primary energy or electricity (coordinated connection and disconnection of generators and consumers depending on energy supply and demand, e.g. virtual power station)

End consumers (industry, small trade, households)

- Tapping of energy efficiency and energy shifting potentials through demand side management, demand response activities, energy information, variable tariffs
- Coupling of energy management activities in household with smart home applications: security, automation of households, etc.
- Support of electric mobility as a bulk application by the use of smart grid technologies (smart grid control, metering systems, etc.)
- Strengthening of the competitiveness of industrial enterprises: Cost reduction by shifting of energy purchases and process optimisation

Suppliers

- Aggregation of decentralised generators and consumers, configuration and operation of virtual market places
- Optimisation of consumption profiles and forecasts
- Development of new products/(energy management-) services for consumers
- Offer of new system services to network operators, contribution to the maintenance of system stability
- More efficient management of balancing groups at shorter notice

Transmission and distribution system operators

- Transparency through sensor systems, efficiency by automation technology and remote control equipment
- Safeguarding of the system stability, new supporting system services, support to network operation by efficient connection/utilisation of decentralised suppliers with many dispersed consumers and storage facilities
- Innovative asset management: Optimisation of existing network capacities and network development
- Connection of electric mobility over the entire supply area
- New and larger transport capacities for point-to-point transmission requirements (e.g. through HVDC for the grid connection of offshore wind power plants)
- Effective interaction of global and local optimisation, e.g. in terms of control energy or system services

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