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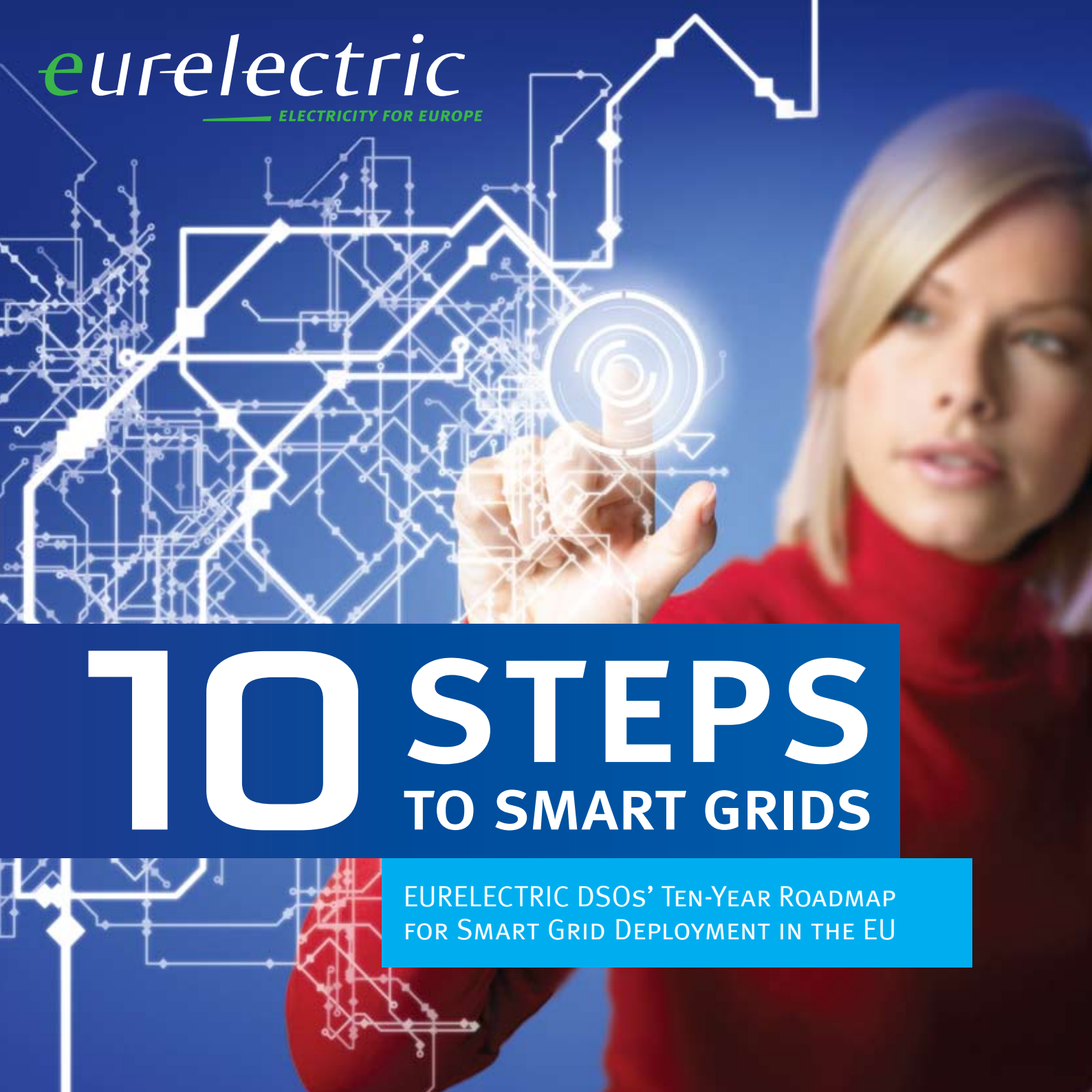
ELECTRICITY FOR EUROPE



10 STEPS TO SMART GRIDS

EURELECTRIC DSOs' Ten-Year Roadmap for Smart Grid Deployment in the EU

10 Steps to Smart Grids

Smart grids will not be rolled out in a single swoop. Instead, their implementation is an incremental and continuous step-by-step learning process, characterised by different starting points throughout Europe. Smart grids are not an instant revolution, but a steady evolution which has to include the customer as well as energy suppliers and producers.

We believe that there is a great need for more awareness about what the deployment of smart grids will include, in particular with a view to identifying the most important steps for policymakers and industry. To support the transition from the traditional to the new flexible power system, this paper develops an indicative EU roadmap for the deployment of smart grids within the next 10 years. Our 10 steps point out what we today see as milestones on the way towards new commercial customer-oriented solutions which will contribute to a successful EU energy policy in terms of sustainability, security of supply and competitiveness. While the facilitation phase (our first four steps) will require EU support, the following deployment and large-scale commercialisation will take place in those member states where smart grids are considered to be economically viable, taking into account the energy supply mix, current and future demand, and the status of networks.

Defining Functionalities & Services of Smart Grids

Smart grids require smart components. In order to pave the way towards flexible European grids by 2020, we need clarity on the desired functionalities and services of smart grids and their possible implications for the power system. EURELECTRIC suggests the following categorisation:

Smart network management

- Conventional grid development combined with...
- Faster fault identification and self-healing capabilities via grid automation
- Advanced network operation and control
- Smart metering

Smart integrated generation

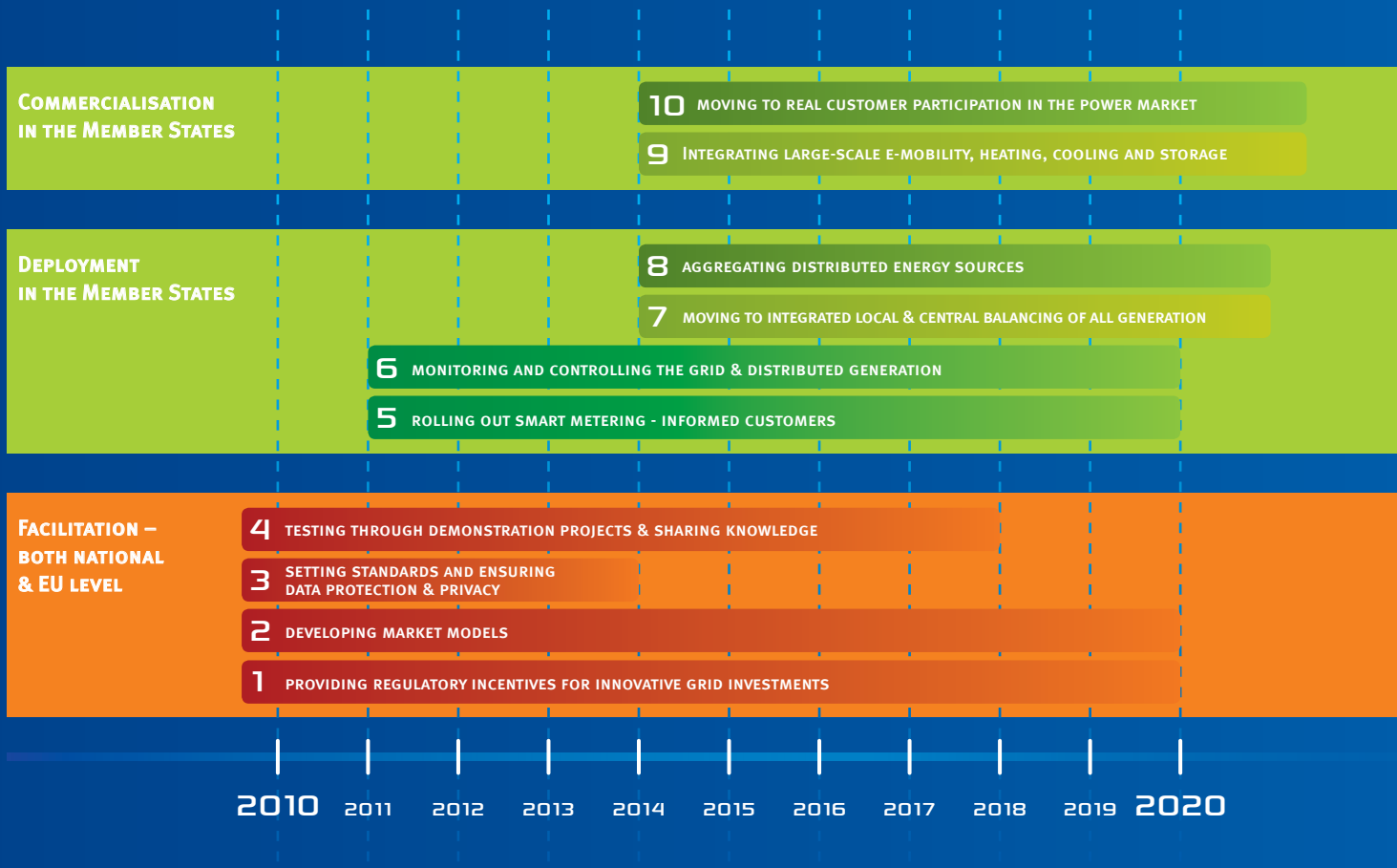
- Balancing the power grid with a large share of variable renewables, including distributed generation
- Integrating electric vehicles and heating & cooling systems
- Intelligent storage solutions

Smart markets & customers

- Developing demand response programmes & load control
- Aggregating distributed energy sources including e-mobility

Implementing smart grids requires 10 steps to be taken, many of which are closely interrelated and will develop simultaneously rather than in isolation.

Nevertheless, we cluster them in three development phases: A **facilitation phase** at both national and EU level will include the development of regulation and market models, standardisation and testing promising projects. Building on this phase, a large-scale introduction of in particular "smart network management" and "smart integrated generation" functionalities in the member states will follow in the second, **deployment phase**. Finally, the implementation and **commercialisation phase** will see new services offered by commercial parties. This will involve a large number of stakeholders and is expected to take longer, most probably beyond 2020.



EURELECTRIC DSOs' Ten-Year Roadmap for Smart Grid Deployment in the EU

why

Main drivers of a new flexible power system

Modernising Europe's electricity system is vital for Europe's energy policy ambitions. Indeed, the European electricity industry will have a key role to play in supporting these ambitions. The European Union has set three targets for 2020: it aims to reduce its CO_2 emissions by 20%, achieve a 20% share of renewable energy sources (RES) in overall energy consumption, and be 20% more energy efficient. These 2020 goals translate into significant CO_2 reductions for the electricity industry and an increased RES share in electricity consumption from today's 18% to some 34%. By 2050, we plan to achieve an effectively carbon-neutral power portfolio, in which the share of electricity from RES will amount to more than 50%.

The increasing share of **variable renewable energy sources** will prove challenging to the electricity system's stability, security and reliability. Already today, these challenges are making themselves felt in several European regions. By 2020, intermittent RES such as wind and solar are expected to represent 17% of the EU's total electricity consumption.[1] On the one hand, this figure will include large-scale renewable generation sources such as offshore wind farms, whose development will require substantial investments in the *transmission* grid. On the other hand, *distribution* networks will need to accommodate an increasing number of small-scale sources. In France, for example, 900 MW of variable RES are already connected to the distribution grid; in Germany the figure is about 50 GW.

At the same time, **electrification of transport** will be needed to further decarbonise the economy. For a significant deployment of electric vehicles by 2050, Europe needs to target a 10% share of electric vehicles by 2020. These vehicles will need to be charged through the electrical system. Together with the electrification of heating and cooling, they will further contribute to the projected growth in electricity demand.

As a result, the assumption that the demand for electricity dictates the amount of electricity produced no longer holds. Power will not only flow in one direction from the power system to the consumer, but increasingly from the customer to the power system as well.

1: The European Commission on the basis of the National Renewable Energy Action Plans.

how

Bringing customers on board

The traditional solution to the challenges ahead entails building additional distribution lines and enhancing the capacity of flexible generation sources for balancing purposes, so as to prevent congestion when variable RES run at their full production capacity. Notwithstanding the fact that a lack of public acceptance currently hinders the building of new power lines in Europe, such a system would also be underutilised when variable RES production is low. For instance, wind plants generate electricity only about 20 to 40% of the time. For photovoltaics, the figure is about 10 to 20%.

In contrast to the orthodox solution, EURELECTRIC believes in promoting **flexibility**, both on the supply and on the demand side, thereby avoiding an over-sized distribution grid, saving costs for the customers, and optimising the intake of variable renewable generation.

To achieve this flexibility, **customers need to become actively involved**. This will only be successful if electricity retail prices and grid tariffs reflect the actual market and grid situations. Both customers and the retail market must become more responsive, optimising the use of electricity to the benefit of all. Well-functioning retail markets need to be boosted, allowing suppliers to deliver competitive, innovative and sustainable products to customers.

Increasing system flexibility and establishing new commercial services is a must. But it will only be achievable if distribution system operators (DSOs) have real-time system information at their disposal which allows them to operate the grid safely and to dynamically manage distributed generation and demand. Not only power, but **information too will need to flow in both directions**. To achieve its overarching energy and climate policy goals, Europe thus needs more intelligent mid- and low-voltage grids by 2020 – so-called “smart grids”.

what

What is a Smart Grid?

A smart grid is an electricity network that can intelligently integrate the behaviour and actions of all its users to ensure a sustainable, economic and secure electricity supply. As a tool that provides much-needed flexibility, smart grids offer potential benefits to the entire electricity value chain (generators, TSOs, DSOs, suppliers and consumers) and to society as a whole.

Smart grids will enable DSOs to monitor the electricity flowing within their grids. On the basis of collected data, they will be able to adjust to changing conditions by automatically reconfiguring the network and/or by taking control of connected demand and distributed generation. While smart grids equip DSOs with new tools to keep the system highly reliable and affordable, they will also create new opportunities for customers and service providers.

Benefits of Smart Grids:

While maintaining system security and quality of supply, smart grids can:

- Integrate more variable renewable generation[2]
- Reduce costs of renewable integration compared to conventional investment
- Provide new incentives for customers to mitigate increases in their electricity bills by actively managing their electricity consumption
- Reduce the frequency of outages and costs of avoiding them
- Make more efficient use of the existing infrastructure to produce, transport and consume electricity, resulting in less need for new lines
- Enable a massive penetration of electric vehicles and flexible recharging
- Optimise the use of energy resources and increase overall energy savings

2: For instance through dynamic line-rating, later also through the flexibility offered e.g. by electric vehicles and storage.

who

DSOs as key enablers for Smart Grids

Smart grids imply a huge cultural change in the way electricity is distributed, touching upon issues from long-term network planning to real-time network operation. DSOs, currently responsible for transporting electricity from the transmission system to customers (excluding supply), will be at the heart of the new, intelligent electricity system. They will increasingly move beyond their traditional role of "building and connecting" towards "connecting and managing", and will become enablers for producers, service providers and customers to meet on an open market place. While smart grids will benefit all parts of the electricity value chain, DSOs will bear the lion's share of the initial investments to encourage development of commercial solutions. Such solutions cannot develop before the introduction of smart grid functionalities that will provide all actors with swift, transparent and accurate information and help to maintain network stability.

Incentivising investment & cooperation

The International Energy Agency has estimated the investment needs in Europe's distribution grid at 480bn euros by 2035.[3] Yet DSO investments in smart technologies are currently being hampered by two things: sub-optimal rates of return and regulatory instability. Regulators tend to take a narrow view when evaluating the cost efficiency of investments, penalising DSOs for extra expenditure on RD&D or smart grid pilot projects. Before anything else, action at the European level should thus encourage efficient regulation at the national level that focuses on longer term grid requirements and provides a fair rate of return.

National regulatory barriers and lack of incentives for investments[4] which are currently hindering the deployment of smart grids need to be highlighted at EU level. In its assessment of legislative measures the European Commission should confirm the leading role of DSOs in smart grid development and exploit best practices at national level with a view to elaborating national roadmaps. Both European and national RD&D spending on a new intelligent energy economy should substantially increase, with priority given to solutions with a high probability of attaining market viability. Smart grids fall squarely into this category.

Apart from a strong political commitment to establish the right regulatory conditions, movement towards intelligent power systems will require increased cooperation among all players in this area, including customers. We need a change in the energy market that can encourage customers to be more active and flexible in how much electricity they use and when. More accurate and frequent consumption data will allow energy suppliers to offer innovative products and services based on individual consumption profiles and customer preferences. Given the opportunity to easily manage their electricity use and receive information about its value, customers could be stimulated to change their consumption habits.

3: World Energy Outlook, 2010.

4: For details see EURELECTRIC report "Regulation for Smart Grids".

Smart Grids

- An important enabler for achieving the EU's ambitious energy targets.
- A continuous process of change for using the right technologies that make a difference.
- 10 important steps that can change Europe's energy future.

1

Providing regulatory incentives for innovative grid investments

WHO?

National regulatory authorities encouraged by policy/legislative action at EU level

WHAT?

- Reward network companies for cost-efficient grid and RD&D investments
- Include the cost of demonstration projects in tariffs

WHEN?

As soon as possible

Smart grids benefit everybody. But DSOs will bear most of the costs and risks of rapidly introducing new technologies on a large scale because traditional methods of regulation do not always provide the right incentives for investments in innovation. For many regulated companies therefore, their current return on investment is lower than their cost of capital.

Regulators should thus allow enough commercial space for investment in future technologies that can improve the networks. They should introduce a stable long-term regulatory framework that will provide network operators with a reasonable rate of return for cost-efficient grid investments as well as incentives to increase efficiency, foster market integration and ensure security of supply. At the same time, a clear line needs to be drawn to distinguish which business should be regulated and which should be market-driven (*see step 2*). Smart metering deployment and grid automation, for instance, must be tariff-financed (*see steps 5 & 6*).

Developing market models

2

Smart grids will be a platform for new business models. Analysing different market model scenarios is crucial in order to demonstrate the benefits of smart grids for different parts of the value chain. There should be no prescriptions for any specific market design and no one-size-fits-all approach. Nevertheless, a clear decision is needed on what should be regulated and what should be left to the market, in order to incentivise development of smart grid solutions. A well-functioning division of work between regulated and commercial players, and well-functioning interaction between market players should be ensured, not least by defining the roles, responsibilities and interfaces among individual actors (customers, DSOs and suppliers/aggregators).[5] In addition, all market model options should provide a framework for development of demand response programmes to ensure a **customer-focused** demand response market that can provide customers with a range of products which suit their preferences.

In this context, **DSOs** should become market facilitators and enablers of active demand.[6] DSOs will also become information hubs. They must play a central role in collecting smart metering and other network data and making the data available to third parties. With these data, suppliers will be able to provide customers with innovative products and services. DSOs will liaise with customers when necessary to agree on load management measures in cases where the distribution grid's reliability needs to be guaranteed.

WHO?

Network operators and commercial enterprises in cooperation with the European Commission and regulators

WHAT?

- Divide work between regulated and commercial actors
- Outline roles & responsibilities of different actors

WHEN?

As of now

5: The European Commission has established a Task Force Smart Grids to contribute to this. Results are available at: http://ec.europa.eu/energy/gas_electricity/smartgrids/taskforce_en.htm.

6: National legislation might also mandate DSOs to carry out energy services in several countries.

3

Setting standards and ensuring data protection & privacy

WHO?

Network operators, energy suppliers, ICT suppliers and technology providers, the European Commission, European standardisation organisations,[7] ACER

WHAT?

- Develop interoperable technical standards and communication & data protocols
- Ensure adequate data protection

WHEN?

Main standards by the end of 2012

Standards will provide a cost-efficient solution for market actors. They will enable interoperability, avoiding the high compliance costs of divergent national approaches that could otherwise hold back the large-scale implementation of smart grid functionalities.

Different types of standards need to be defined. Technical standards for communicating and collecting data need to be developed in order to integrate the various communication technologies and electrical architectures of the smart grid solution. To facilitate the large-scale deployment of e-mobility, a standardised charging interface will be necessary to ensure interoperability and connectivity between electricity supply points and the charging infrastructure for electric vehicles. Standardised communication and data protocols will enable DSOs to improve the transfer of verified customer data to service providers. Finally, an assessment of data risks is required: resolving any data privacy and security issues is indispensable to ensuring customers' confidence. European network codes, as foreseen by the EU's Third Energy Package, should take into account innovative solutions when introducing requirements that are considered relevant at EU level.

7: CEN, CENELEC, ETSI.

Testing through demonstration projects & sharing knowledge

4

"Smart" technology is already available, but testing it through pilot and large-scale demonstration projects is needed in order to gain practical "in-the-field" experience prior to its massive deployment. Involving customers and market operators in demonstration projects is crucial. The pilots and demonstrations will provide continuous input to adjusting regulatory, market and technical solutions in such a way as to support the efficient balancing of the network and customer participation. Funding of smart grid demonstration projects, as proposed within the European Electricity Grid Initiative,[8] is especially vital.

Projects' 'smartness' level needs to be qualitatively and quantitatively assessed, taking into account potential energy savings, demand reduction, deployment of centralised generation and payback periods. Measuring results by indicative key performance indicators (KPIs) should provide a clear understanding of the development, and provide a catalyst to encourage investments by public European funds. Additionally, a knowledge sharing platform should offer TSOs, DSOs, policymakers and grid users a comprehensive overview of progress, results and needs of smart grids projects throughout Europe and should help to maximise the efficiency of investing in RD&D.

WHO?

Network operators, energy suppliers, ICT suppliers and technology providers, research institutes, with support of the EC

WHAT?

- Run pilot and large-scale demonstration projects financed through both private & public schemes
- Evaluate benefits of the projects
- Share knowledge to maximise the efficiency of investment in RD&D

WHEN?

Up to 2018

8: For details see the EEGI Roadmap 2010-18 and Detailed Implementation Plan 2010-12, available at http://ec.europa.eu/energy/technology/initiatives/doc/grid_implementation_plan_final.pdf.

5

Rolling out smart metering – Informed customers

WHO?

DSOs & commercial parties with support of regulators

WHAT?

- Roll out smart meters equipped with essential functionalities
- Install in-home displays and portal solutions to enhance customer experience and stimulate demand response
- Integrate smart meters with home appliances

WHEN?

Continuously by 2020

A smart meter is an essential device that integrates data collection and communication within smart grids. Thus, many smart grid functionalities cannot be deployed without smart metering. Supplemented by in-home displays and portal solutions, smart meters contribute to higher customer awareness. Using open standards, smart meters will enable dynamic pricing, in turn incentivising customers' involvement. In doing so, they will catalyse the development of retail markets and enable enlarged business models like network operation and asset management (*see step 6*). Later on, they will be integrated with home appliances and home automation networks.

The roll-out of smart meters is a continuous process which is subject to national cost-benefit analysis. Some countries (e.g. Sweden and Italy) have already invested in installing certain smart functionalities such as remote reading of electricity meters.[9] Nevertheless, meters installed by **DSOs** should only cover functionalities that are essential for optimal grid operation.[10] They should be fully tariff-financed (*see step 1*). Tariff-financing should also include the data and information systems required for DSOs to make meter data available for market use, i.e. IT-systems to collect, validate and transmit data effectively. Commercial parties will then introduce more customised services which could be added by those consumers who are interested. For example, the roll-out of in-home displays and home automation is a market function.

9: In a majority of member states, intelligent metering systems are subject to a positive assessment by cost-benefit analysis to be conducted by 2012 (as required by the 3rd Energy Package).

10: For details see the EURELECTRIC report "Towards a Smarter Network Management by European DSOs".

Monitoring and controlling the grid & distributed generation

6

Remote monitoring and automatic fault detection at the level of medium and low voltage networks are currently the exception, but throughout the next decade, network operators will invest to make their grids smarter. While conventional grid development will continue, additional communication systems will have to be installed. These, in combination with smart meters, will provide **DSOs** with real-time information about distributed generation and load on the grid. Automation will ensure quality of supply (voltage, frequency, etc.) and minimise negative implications for grid users, for instance by reducing the duration of outages. Besides locating faults, newly installed detectors along the lines and substation devices should also provide, in cases of simple disturbances without damages, "self-healing" capabilities. All processes during normal system operation, emergency situations as well as restoration following faults should be automated. Innovative changes in tools used in control rooms[11] should also be implemented.

WHO?

DSOs and where necessary TSOs with support of regulators

WHAT?

- Automate the grid to identify faults faster and be capable of healing them
- Advanced network operation and control
- Smart metering

WHEN?

Continuously by 2020

11: SCADA - Supervisory Control and Data Acquisition Systems/DMS system, voltage management etc.

7

Moving to integrated local & central balancing of all generation

WHO?

DSOs, TSOs, suppliers, aggregators, consumers & generators

WHAT?

- Define roles and responsibilities in balancing the two-way power flow to maintain system reliability
- DSOs to support balancing and become closer partners of TSOs

WHEN?

As of 2014 onwards

Until now, DSOs have distributed power on a top-down basis. This will change as more and more capacities will be connected to the distribution grid, which will have to accommodate vast amounts of distributed generation and new load types such as electric vehicles, heating and cooling. Higher shares of distributed energy sources will lead to increased variations in voltage. In order to "keep the system running" and to maintain service quality and reliability, bi-directional flows will need to be continuously monitored and managed. In addition to smart network technologies, enhancing the distribution network's resilience to variable intake will require smart processes for a dynamic network operation.

In order to manage the distribution system and to contribute to the stability of the transmission grid, there is a clear need for **DSOs** to take on additional system obligations. Preferably DSOs will support balancing of load and generation. They should be allowed to dispatch distributed generation or ask network users to contribute to voltage regulation. At the same time, they might be required to contribute to the security of the transmission system by temporarily taking some of their connected users off the system, and – exclusively in cases of emergency – to operate partial networks in an island mode. TSOs, acting as overall electricity system operators, will remain responsible for ensuring a secure, reliable and efficient electricity system. A clear definition of roles and responsibilities between DSOs and TSOs as well as a structured and organised exchange of information will be necessary.

Aggregating distributed energy sources

8

Today, small-sized distributed generation units often cannot directly interact with the market and the TSOs. Aggregating units will make distributed energy sources (photovoltaics, wind, CHP and later also electric vehicles) more visible to TSOs and DSOs as local system managers, helping them to balance the system at acceptable cost and better coordinate defence schemes in transmission and distribution grids. Distributed energy resources can be aggregated into **virtual power plants** (VPPs), thus creating a provisional interface to exploit technical and economic synergies. Such a multi-fuel and multi-owned power station system could provide various ancillary services[12] (e.g. balancing power and power-frequency control) as an alternative to large centralised power plants. This could also increase liquidity of reserve markets. In this context, **DSOs** should work as information hubs and perform a reliable and swift change of supplier. They could also become ancillary services providers, which will lead to an optimised operation of distribution networks.

WHO?

Generators, DSOs, TSOs, aggregators and suppliers

WHAT?

- Further develop markets for balancing and ancillary services
- Make use of aggregation into virtual power plants (VPPs)

WHEN?

As of 2014 onwards

12: Services necessary for secure operation of the system, purchased by TSOs – generation capacity for balancing and regulating power, inertia and short-circuit capacity.

9

Integrating large-scale e-mobility, heating, cooling and storage

WHO?

DSOs, energy service companies (ESCOs) and retailers

WHAT?

- Deploy grid infrastructure for charging of electrical vehicles
- Provision of ancillary services by flexible loads and supply means such as storage

WHEN?

Continuously, at the large-scale from 2018 onwards

Load management is one of the main justifications for smart grids with their objective of managing existing resources in such a way as to meet user needs in the most cost-effective manner. Electric vehicles (EVs) will be preferably charged in times when the demand is low and supply abundant, e.g. from wind and sun. At the same time, their batteries will be used as storage facilities for the grid in periods when the production of variable renewable sources is high.

On the other hand, a significant penetration of EVs will result in higher power demand and un-forecast mobility in connecting to the grid. Customers' expectations of easy and convenient access to charging stations will have to be reconciled with the capacity of the local electricity grid to deliver the electricity without overloading the distribution grid. Active demand management, intelligent electricity grids and meters are thus indispensable for the efficient integration of EVs into the electricity system. Potential synergies with variable renewables have to be harnessed. Charging programmes on the basis of market and load signals will contribute to balancing power supply and demand and lower intraday price volatility. With the rising influx of variable renewables, other forms of flexible storage will also need to be developed and implemented. In addition, the potential of heating and cooling applications needs to be evaluated.

Moving to real customer participation in the power market

10

Real active demand response will only become an inherent part of electricity retail markets once price regulation has been removed and customers have smart meters and additional interactive tools (*see step 5*) at their disposal. More accurate and frequent consumption data will enable suppliers to offer a wide range of services to customers. Dynamic pricing and time-of-use tariffs will incentivise customers to show more interest in their consumption patterns and modify their energy usage. Flexible power price structures and tailored contracts should incentivise peak loads at times with a surplus of renewable power generation, and reduction of loads at times with low levels of renewable power generation. The aggregators of load reduction will sell this load reduction on the wholesale market. Without reducing customers' comfort, the net reduction in load moderated by **DSOs** will be sufficient to ensure security of supply and reduce costs as a result of more accurate planning of grid capacity and reduced need for reserve capacity. Customers will also become actively involved in the decentralised energy system as 'prosumers' who sell back their own electricity.

WHO?

Suppliers, ESCOs, aggregators and member states

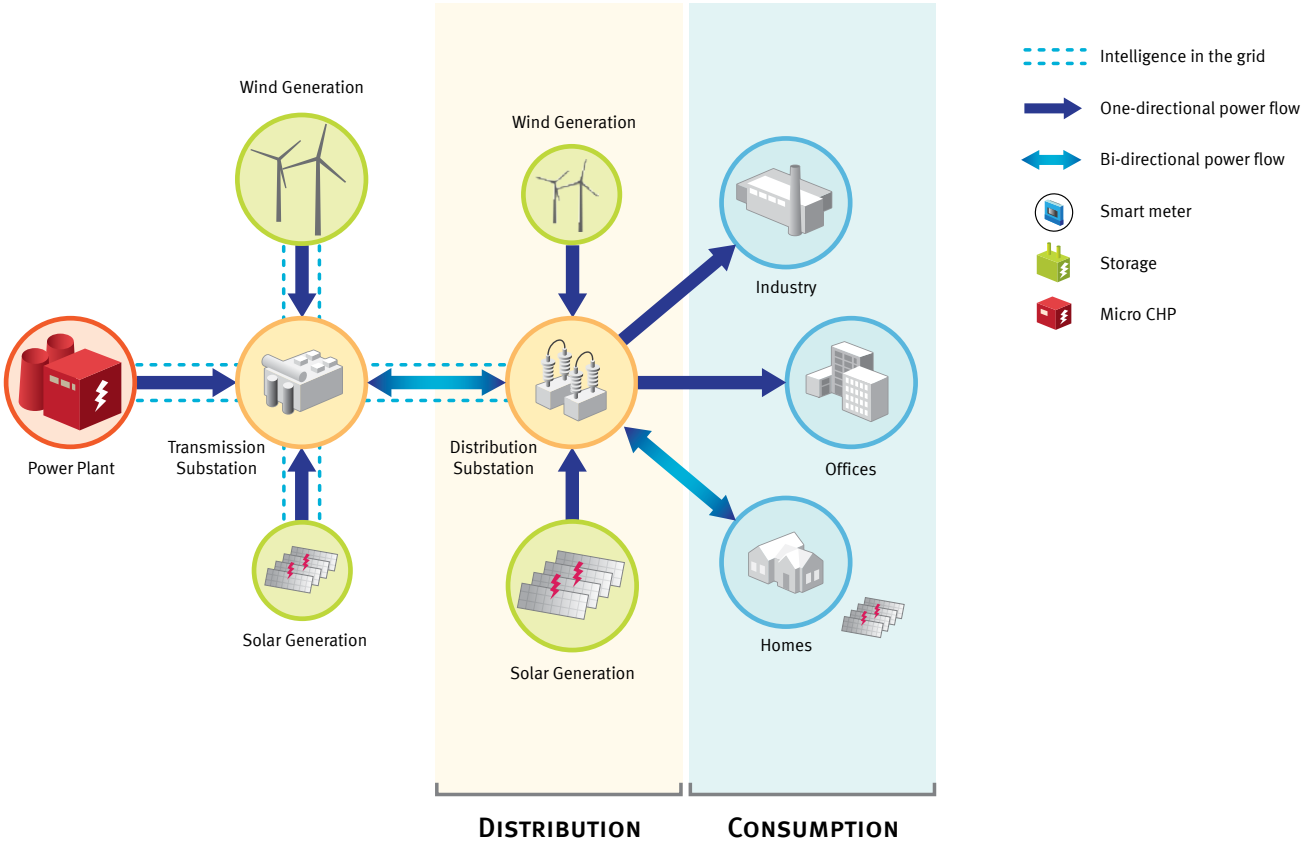
WHAT?

- Development of commercial demand response programmes, including dynamic pricing & flexible contracts
- Load aggregation and selling load reduction on the market

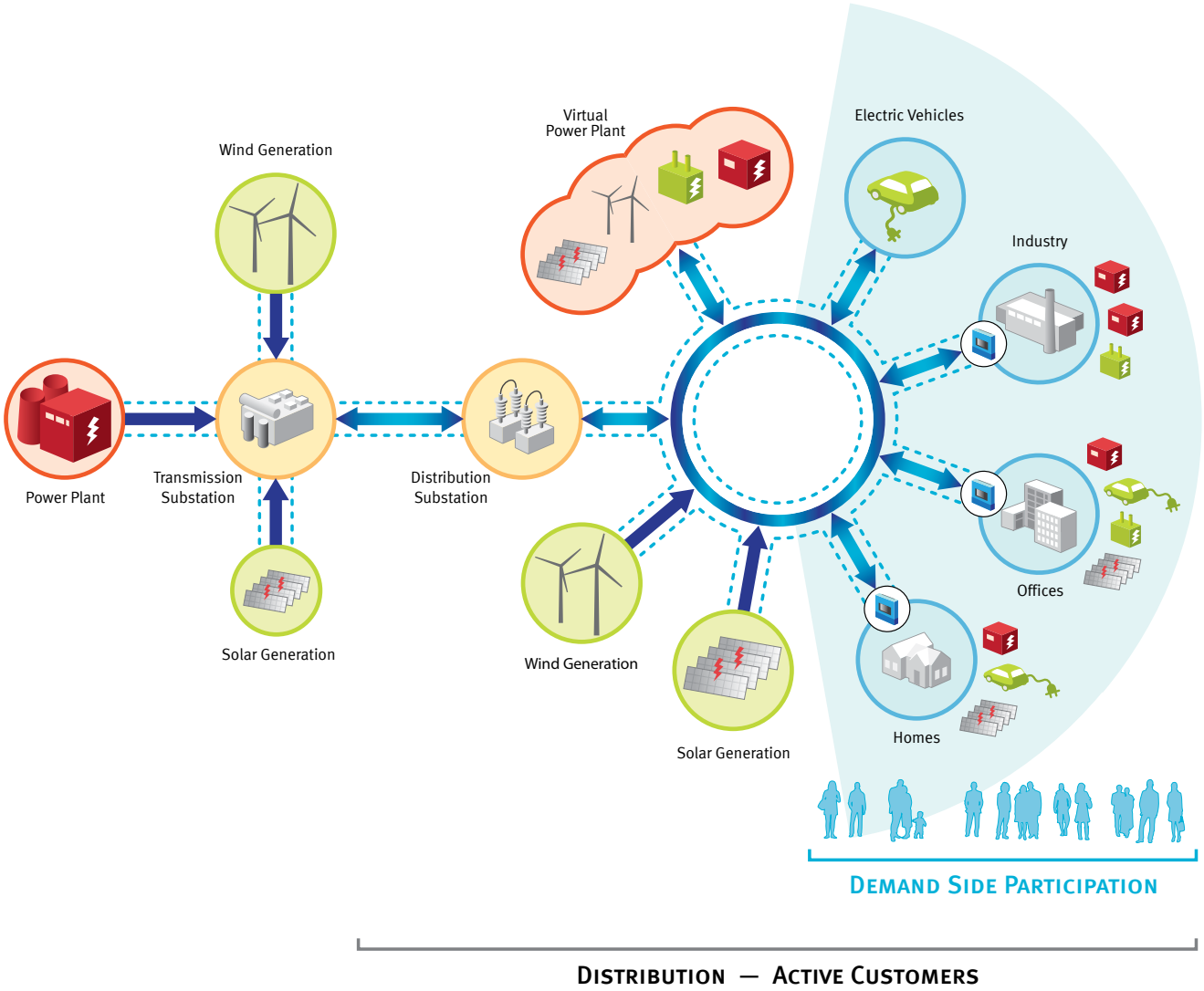
WHEN?

As of 2014 onwards

Power system of TODAY



Smart system of
TOMORROW



EURELECTRIC DSO's Directors Gathering

DSOs are increasingly going beyond their traditional role of providing quality electricity to consumers at low cost, and they are therefore facing new challenges regarding investments and operations. To better reflect this evolution and to communicate to the European energy scene with a clear and common DSO voice, EURELECTRIC has decided to reinforce the DSO representation in its structure through setting up a new strategic body – the DSO's Directors Gathering. Its mission is to contribute to EURELECTRIC's overall strategy and working programme on DSO issues. Its 20 members (for the first time elected in June 2010) represent more than 2,000 DSOs across Europe. In addition, more than 100 distribution experts are actively involved in the various EURELECTRIC working groups which are supported by the EURELECTRIC Networks Unit.

Other EURELECTRIC Reports related to Smart Grids

- **Towards a Smarter Network Management by European DSOs** (April 2011)
- **European Electricity Industry Views on Charging Electric Vehicles** (April 2011)
- **Regulation for Smart Grids** (February 2011)
- **Market Models for the Roll-Out of Electric Vehicle Public Charging Infrastructure** (September 2010)
- **The Role of Distribution System Operators (DSOs) as Information Hubs – a EURELECTRIC Networks Committee Paper** (June 2010)
- **EURELECTRIC Policy Statement on Smart Meters** (April 2010)
- **EURELECTRIC Comments on ERGEG Position Paper on Smart Grids** (March 2010)
- **Smart Grids and Networks of the Future – EURELECTRIC Views** (May 2009)

Available at **www.eurelectric.org**

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ELECTRICITY FOR EUROPE

The Union of the Electricity Industry – EURELECTRIC is the sector association representing the common interests of the electricity industry at pan-European level, plus its affiliates and associates on several other continents.

EURELECTRIC's mission is to contribute to the development and competitiveness of the electricity industry and to promote the role of electricity in the advancement of society.

EURELECTRIC's Full Member structure is based on national representation, via the national electricity association, where such a body exists, or the leading electricity enterprise in each country. Currently there are 33 Full Members, including all 27 EU Member States, current applicants negotiating to join the European Union, plus other European OECD countries.

Membership is enriched by European and International Affiliate Members representing the electricity industry across the rest of Europe, in the Mediterranean basin and on other continents, and by Business Associate Members from other sectors with stakeholder links to or interest in the electricity industry.

Union of the Electricity Industry - EURELECTRIC

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