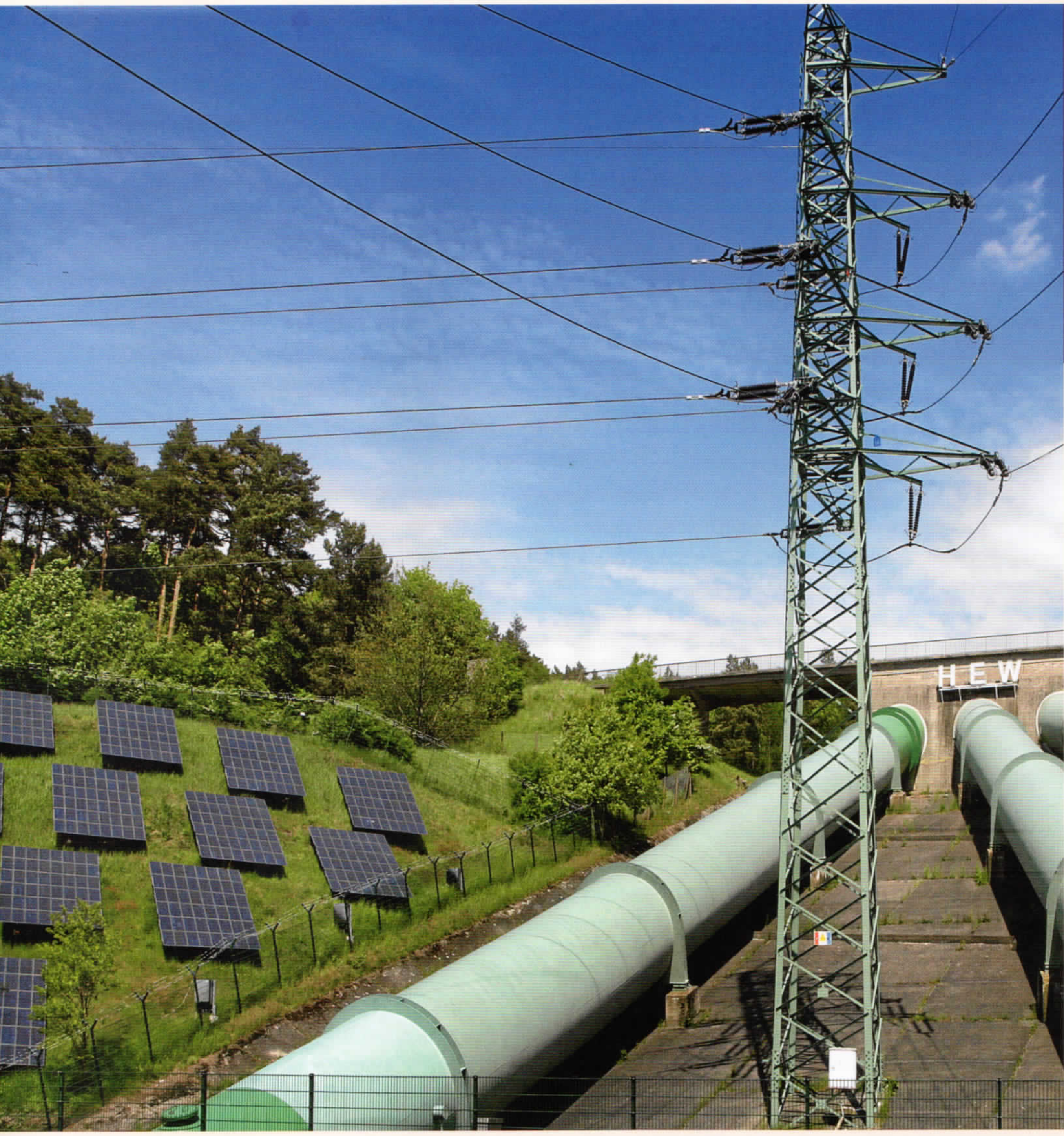
(EN) Integration Technologies
(FR) Technologies intégrées
(ES) Tecnologías de integración



(EN) In order to enable high proportions of renewable energy to be successfully integrated into the power supply system, various areas of the conventional energy system must be rebuilt and the generation, storage and distribution of electricity as well as the demand side must be coordinated.

(FR) Pour bien intégrer des parts élevées d'énergies renouvelables dans le système d'alimentation en énergie, il faut reconvertir différents domaines du système énergétique et accorder la production, le stockage, la distribution de l'électricité ainsi que la demande.

(ES) Para poder integrar con éxito un gran número de energías renovables en el sistema de suministro de electricidad, deberán modificarse distintos ámbitos del sistema energético convencional y coordinarse la generación, acumulación y distribución de la electricidad, así como la demanda.

(EN) Industry overview

European and national targets for energy and climate policy require substantial changes in the energy system. In particular, power generation in Europe will be affected by these over the coming years and decades. At European level, it is planned to increase the proportion of renewable energies in the gross energy consumption to 20 per cent by 2020. At the same time, primary energy consumption and emissions of greenhouse gases should be reduced by 20 per cent each compared with 1990 figures. These plans are intended to counter the increasing dependence on imports, the rising prices of primary energy sources on global markets and, in particular, climate change.

In light of the targets to expand power generation from renewable energies and the decision to abandon the use of nuclear energy by 2022, a far-reaching process to reshape the energy landscape has been initiated in Germany. At home, the proportion of renewable energies in power generation should increase to 35 per cent by 2020, to 50 per cent by 2030 and to 80 per cent by 2050. At the same time, the Federal Government is planning to reduce the demand for power by 10 per cent by 2020, and by 25 per cent by 2050 in relation to 2008 levels; this target should be achieved by increasing energy efficiency in all consumption sectors.

The transition from power generation focusing on central and manageable large power plants to an energy system with high proportions of fluctuating generation from photovoltaics and wind farms brings a wide variety of challenges with it. A fundamental reshaping of the power supply system along the value chain from generation to storage and power distribution to the demand side is needed. Major components for the successful integration of renewable energies include:

- greater flexibility of conventional power plants, in particular combined heat and power facilities, in order to cover the highly volatile residual load when proportions of renewable energies are high;
- sufficient storage capacity to even out fluctuations in the residual load, to deliver operating reserve and other system services, to provide the assured output and absorb the clear surpluses from renewable energies which are to be expected at times in the long term and to balance out longer slack periods;
- sufficient transmission capacities at transport and distribution network level to collect locally generated power in the region and transport it from the generation centres to the load centres;
- the clear increase in energy efficiency on the demand side and tapping load management potential so that power demand can react flexibly to the fluctuations in the supply from renewable energies.

Technologies and applications

If high proportions of renewable energies are to be integrated, various areas of the energy system need to be reshaped. In terms of the transmission networks, there is a growing need to increase transmission capacities and link large areas in Germany and Europe. This is intended to tap potential for renewable energies and storage capacities and balance out the feed from wind and solar power which is dependent on regional climatic conditions.

In addition to the traditional 380 kV three-phase overhead lines, alternative transmission technologies are also available for the necessary network amplifications. High-voltage direct current (HVDC) transmission, for example, is especially suitable for transmitting high output over long routes and for connecting offshore wind farms. High-temperature conductors can be used on existing routes to increase transmission capacity by almost double. What is known as overhead line monitoring facilitates a much higher load on the conductor by monitoring the temperature of overhead lines during relevant climatic conditions (cold, wind). Underground cable solutions or gas-insulated conductors may be suitable for achieving greater acceptance for new routes among the local population. Since the expansion of renewable energies at extra-high voltage level means that conventional power plants will supply less power, additional facilities to compensate for reactive power are needed at this network level to ensure that voltage is maintained.

The transition from a power supply fed purely from generators to a system mostly fed via inverters at low voltage levels means that inverters are needed which contribute to the respective network levels in the distribution network via manageable reactive power delivery for voltage support. In addition, intelligent resources (e.g. adjustable local network transformer stations) can be used for more stable operation of distribution networks with a high installed generation output (e.g. from photovoltaics). Local battery storage can buffer generation peaks and smooth out the feed into the grid. Furthermore, the generation facilities from renewable energies must use relevant remote control options to contribute to the stability of the power grid and hence to the reliability of power supply.

As the proportion of renewable energies increases, there will also be a need to develop flexibility on the demand side to balance generation fluctuations. In industry, measurement and control technology combined with process and automation technology can be used to make sliding loads viable so as to respond to the supply situation in the power market. In private households, this can be achieved by using smart meters combined with building automation technology and controllable devices.

As the proportion of the power supply accounted for by renewable energies increases, the importance of energy stores also increases. Important tasks in this include balancing fluctuations in generation and demand, delivering system services as a substitute for the less frequent use of conventional power plants and, in terms of perspective, absorbing generation surpluses from renewable energies and bridging slack periods. Pumped storage plants are the only technology currently available for storing electricity on a large scale.

Regulatory framework

A regulatory framework and measures to reshape the system are required to do justice to the requirements of an increasing proportion of renewable energies in the energy system. In Germany, the Power Industry Act (EnWG) regulates the overall framework for the general supply of electricity and gas. For example, in Germany, under the regulations set out in the EnWG, the grid expansion requirement for the next ten years is ascertained annually by the four transmission network operators and approved by the Federal Network Agency. However, the EnWG also, for example, governs installation obligations for smart meters. For example, smart meters must be installed in new-build projects, for end customers with an annual consumption of more than 6,000 kWh, when operating plants of over

(EN) In the industrial sector, variable loads can be made use of with the aid of measurement and control technology in combination with process and automation technology, in order to react to the supply situation on the electricity market.

(FR) Dans le secteur industriel, des charges décalables peuvent être exploitées avec l'aide de la technologie de mesure et de contrôle en conjonction avec la technologie d'automatisation et des processus, afin de répondre à la situation de l'approvisionnement sur le marché de l'électricité.

(ES) En el sector industrial pueden aplicarse distintas cargas gracias a las técnicas de medición y control, así como a las técnicas de proceso y automatización, con el fin de activar la situación de la oferta en el mercado energético.

7 kW under the Renewable Energies Act and the Act on Combined Heat and Power Generation or at the customer's request.

The Renewable Energies Act (EEG) governs the promotion of the expansion of renewable energies for power generation for hydroelectric power, wind power, photovoltaics, geothermal energy and energy from biomass. The EEG has evolved constantly over the past years and, in addition to its original purpose of introducing renewable energies into the power supply, is now also increasingly pursuing a goal of better integrating them into the energy market by means of instruments such as the "market premium". The Act on Combined Heat and Power Generation (KWKG) governs the promotion of the modernisation and new-build of combined heat and power plants (CHP) in light of the target to achieve 25 per cent power generation from combined heat and power plants in Germany by 2020.

The Power Grid Expansion Act (EnLAG) sets out the energy need for a series of urgent power line construction projects in the extra high voltage transmission network (380 kV). The Network Expansion Acceleration Act (NABEG) governs the process for identifying suitable route corridors at national level and for the definition and approval of plans for inter-regional and international route planning in the extra high voltage network.

With a view to a successful transformation of the energy system, the focus is increasingly directed at not only an appropriate regulatory framework but also social issues. There is a fundamental and broad-based consensus in Germany on the higher goal of sustainable energy supply. At the same time, the reshaping process will necessitate a change in the environment with respect to the necessary power supply infrastructures: new energy generation facilities, power grids and energy stores need to be built, and these require social acceptance.

Outlook

In addition to the expansion of renewable energies, the future development of the energy system will be determined mainly by the targets to implement a common European single market. Crucial factors will include not only a Europe-wide linking of energy markets, but also the dismantling of technical trade bottlenecks by the successive delivery of relevant transmission capacities at the border connection points and within the individual member states. Balancing effects of a geographically distributed, fluctuating feed of renewable energies can then be better utilised, system services can be delivered internationally and storage capacities for the European power system can be widely developed.

The Europe-wide Ten Year Network Development Plan (TYNDP) by the European Network of Transmission System Operators for Electricity (ENTSO-E) envisages a network expansion requirement of 39,000 km of new routes by 2022. Longer term, facilitating the broad-based load flows expected in Europe in future by means of “electricity highways” in the form of a higher network level based on high voltage direct current (HVDC) transmission is being considered.

In parallel with this, a wide variety of research and model projects in Germany are currently trialling the options for using modern information and communications technology (ICT) for intelligent control of the power grids. The use of smart metering is also being investigated with a view to making the demand side more flexible, e.g. as part of the umbrella E-Energy research programme. The European Union has set itself a target of achieving Europe-wide market penetration of 80 per cent for the use of smart metering by 2020. To this end, standards and norms are being developed and cost-benefit analyses are being conducted at economic level to clarify the benefits of a universal roll-out in the member states and to prepare for relevant decisions.

Until now, pumped storage plants have been used almost exclusively for large-scale energy storage in Germany. In the medium term, compressed air stores may supplement the role of pumped storage plants in the power supply system with a similar spectrum of tasks. The prerequisite for this is that research and development efforts succeed in making a technological leap to create adiabatic compressed-air stores and therefore that greater efficiency – and hence sufficient economic viability – can be achieved. In the medium to long term, greater storage capacities can be achieved by feeding hydrogen and / or synthetic methane into the natural gas network (power-to-gas concept). As discussions currently stand, it can be assumed that significant generation surpluses can be expected in Germany from around 2025/2030 and the power-to-gas system solution approach can be economically implemented on a large scale.

Other regions of the world can also benefit from the experience gained so far in Germany on these issues.

FR Aperçu du secteur

Les objectifs européens et nationaux en termes de politique énergétique et climatique nécessitent des modifications considérables du système énergétique. Ces changements concerneront en particulier l’approvisionnement en électricité en Europe au cours des années et des décennies à venir. Au niveau européen, on prévoit d’augmenter de 20 pour cent la part des énergies renouvelables dans la consommation brute

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