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# The Digital Transformation of the Energy System – 14 Theses for Success

# Management summary

Digital transformation is affecting all areas of our lives, economy and society — not least our energy system, which has seen digital technologies playing a key role for a number of years now. This is particularly evident in the field of renewable energies, which require a higher degree of coordination due to their decentralized and diverse nature. This study aims to contribute to the next stages of the digital transformation of the energy system. For this purpose, the study puts forward 14 theses and highlights their implications for energy system stakeholders. In doing so, the theses contribute to discussions around energy policy, prompt calls to policy makers and devise concrete recommendations for action.

The theses are divided into five focal points which result from an analysis of the most relevant trends in energy system transformation and digital transformation. Based on the identified focal points, the study specifically describes the state of the digital transformation of the energy system. This is by no means an exhaustive list but is based on the objective of focusing on short- to medium-term measures (up to 2030). The following focal points were selected due to the fact that they offer the greatest leverage for supporting the climate-neutral energy sector with digital tools.

Given that data volumes are increasing rapidly, the economic potential of data is becoming more and more relevant - in the context of the so-called **data economy.** Progressive technical options for measuring, storing and analyzing data are fueling business models based on such data. What's more, the use of data spaces ensures that data can be handled autonomously and stored in a decentralized manner. This enables innovative artificial intelligence methods to be integrated into critical infrastructures and considerably increases the efficiency of all energy sector processes.

Digital sector coupling is another relevant area in which digital transformation will gain importance in the near future. Power-to-mobility, power-to-heat and power-to-gas/H2 are particularly noteworthy examples. When it comes to energy systems integration, digital transformation must take on an (even) stronger role, and digitalized control is a crucial factor.

**Plant communication** remains essential for the digital transformation of the energy sector. There are two primary areas of interest here. The first is at the technical level and covers device data communication with and via the smart meter gateway. The second focuses on the regulatory level and involves data communication between individual market players in the liberalized energy market.

This form of communication is closely interlinked with increasingly **digitalized grid operation** — which, due to growing complexity, also increasingly requires digital grid planning. The digital transformation has gained a considerable amount of momentum at the different grid levels and has been implemented in the maximum-voltage and high-voltage grids in particular. This trend needs to progress into the lower voltage levels to support the grid with system services.

**Cybersecurity** is the last area addressed in the study and is currently at the forefront of the digitalized energy system. Considering that supply security is one of the most pertinent energy policy targets, cybersecurity must be regarded as an essential aspect of the digitalized energy system. In this context, it is not enough to focus solely on defending systems against attacks. Instead, the possibility of faults and vulnerabilities needs to be taken into account when designing systems.

For all these key topics, the study authors have formulated theses which are designed to provide a stimulus for a European strategy for the digital transformation of energy supplies, rather than merely offering a national perspective. However, the authors did prioritize the German regulatory and legal situation for their analysis and concrete recommendations for action.

In summary, the authors believe that digital transformation is key to implementing the energy transition. Without far-reaching and consistent digital transformation ranging from plant control, through the entire grid cascade to the individual sectors, a timely and cost-effective energy transition is not feasible. A data economy may enable the required cross-stakeholder process automation. To further increase the security of the energy supply, cyber resilience must also play a major role in a European digital transformation strategy for the energy system.

**»Digital transformation is key to implementing the energy transition.«**

# Theses for the digital transformation of the energy system

The following 14 theses — derived from the current state of the digital transformation of the energy system — emphasize the potential and reveal obstacles for the digital transformation of the various sectors on a larger scale. The study specifically contains comprehensive information about the significance for stakeholders in the energy sector, messages to policy makers, and concrete recommendations for action. The theses are summarized as follows:

**Thesis 1: In the future, the value of energy will depend on linked data**

The market value of energy normally depends heavily on uncertainties caused by weather-related supply, among other factors. The more data and information available, the easier it is to decrease the number of uncertainties. In addition to uncertainties, the origin of energy is growing steadily in importance (green properties). In both cases, energy can gain value with additional data and proper management in the face of uncertainties, or through its green properties.

**Thesis 2: Digitally driven value creation networks are the future of the energy system**

Effective and targeted digital transformation should not be used to automate existing processes, but should create a new process landscape, transforming value chains into value creation networks. New business models in the energy sector must be consistently thought of in digital terms and, in particular, actively involve users.

**Thesis 3: A sovereign and resilient European energy system requires basic ICT from EU countries**

Resilient energy supply in a digitalized energy supply system must also fully take into account the dependencies created by ICT components. As a first step, these must become transparent to the stakeholders — especially in critical processes. The singular dependencies which are identified must then either be resolved or, alternatively, ended by means of global diversification. EU dependence on basic ICT components (hardware and software) from non-EU countries must therefore be reduced.

**Thesis 4: Without digitalized sector coupling, the costs of transforming energy systems will rise significantly**

Integrating energy systems creates a high level of complexity. Without extensive digital transformation, especially at the interfaces between individual systems, energy systems integration is not economically viable and cannot be implemented in practice.

**Thesis 5: Viable energy business models for digitalized sector coupling at the district level are currently failing due to regulatory hurdles**

Particularly at the district level, where heat, gas and electricity must be progressively integrated, the macroeconomic benefits (e.g., reduction of peak loads at the integration points) of digital business models cannot be monetized. In this scenario, regulations need to be adapted to enable worthwhile, digitalized sector coupling at the district level.

**Thesis 6: Efficient decarbonization of the heating sector can only be achieved through digital transformation**

Just like the technological transformation of the heating sector, the digital transformation of the heating sector is still in its infancy. The two must go hand in hand to enable rapid and efficient implementation. In this context, there is great potential, especially when it comes to flexibilizing the consumer side.

**Thesis 7: The smart metering system are being overtaken by other solutions in plant communication**

The smart meter rollout is subject to continued delays and is becoming less and less valuable for the individual stakeholders due to information channels to the plants that have been established in the meantime. Nowadays, manufacturer clouds are able to reach a large number of plants using communication technology. Data exchange partnerships (such as between grid operators and manufacturers) can already leverage great potential, e.g., in developing flexible properties on a broad scale.

**Thesis 8: The energy transition requires plant communication based on the latest IT technologies and open documentation**

The numerous elements of plant communication rely on communication standards that were developed in the early days of telecontrol technology and for which no further development is planned. New energy plants in particular should use modern IoT protocols that are openly documented.

**Thesis 9: Modern plant communication enables plug-and-play and cross-stakeholder process automation**

Due to the enormous amount of small and micro-plants that will be actively involved in energy system management in the future, it is no longer possible to manually connect plants. The following measures are required: automating connections, automating the change of an aggregator, for example, and automating all processes to ensure operational readiness.

**Thesis 10: Digital transformation is a core area of expertise in future power grid operations**

Digital transformation is becoming an ever more integral part of power grid operations. Grid operators will therefore have to build up their digital transformation expertise within their own company. Cooperation networks offer support for this purpose, especially for smaller grid operators. Viewing digital transformation merely as a purchasable service fails to recognize the impact of technology.

**Thesis 11: Decentralized energy transition equals complete digital transformation right down to the lower grid levels**

The substantial expansion of plants (decentralized generation and new consumers) in the lower grid levels requires active digitalized management of all of the distribution grids. This makes it possible to ensure the supply quality and availability when it comes to switching from pure consumers to prosumers. At the same time, the necessary grid expansion can be supported in a targeted manner and to the necessary extent.

**Thesis 12: Timely implementation of the energy transition can only succeed by ensuring the complete digital transformation of planning and approval processes**

Transforming the energy system requires enormous infrastructure investments, which are operationalized in various planning and approval processes. The underlying processes and interfaces must be digitalized to make the ambitious schedule possible with regard to approval law.

**Thesis 13: Cyber resilience will replace cybersecurity**

Viewing the digitalized energy system as an infrastructure that only requires adequate protection falls short of the mark. On the contrary, all stakeholders must understand that — given the complex nature of the system — complete protection is no longer feasible. The digital energy system of the future must therefore be able to deal with errors and faults.

**Thesis 14: Reliable energy networks require reliable communication networks**

Digital transformation means that energy networks and communication networks are increasingly interconnected. As a result, they depend directly on one another to ensure reliability. The requirements for a reliable energy supply must therefore also be derived from the communication infrastructures used for operation.

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