ENHANCING THE ASSET MANAGEMENT PROCESS FOR NEW DEMANDS OF DECENTRALIZED ENERGY INTEGRATION

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ABSTRACT

The „Energiewende“ in Germany and resulting legal requirements lead to a dynamic increase of decentralized energy generation and the essential network integration. The power distribution system represents the central hub between decentralized energy resources and load customers. German distribution system operators are obliged to immediate network extension in order to take up the decentralized energy in total and to ensure the complete network integration. The resulting demands for distribution system operators are dealing with even more than technical issues and will be discussed in the following.

INTRODUCTION

The quality of supply was developed and continued through several decades and has been one of the main performance indices of electrical distribution grids to date.

The defined demands result from the main tasks of a distribution system operator, from the technical capability of the grid to serve the customers and from the actual high quality of supply. Several external regulatory mechanisms like incentive regulation in Germany increase the pressure on the expenditure as well as the in-house expected return on investment. The herefore acquired know-how has to cover the financial aspects similarly to the technical needs.

DEMANDS TO FUTURE GRID STRUCTURES

The increasing of decentralized energy resources, which can be observed since several years, will become even faster in Germany due to the „Energiewende“ throughout the next years. First of all the development of wind energy and solar power has to be mentioned. Future topics show up in first pilot technology applications. These are customer oriented control and information systems on the consumption side as well as the predicted expansion of electro-mobility.

The integration of a significant increasing amount of small and middle decentralized energy resources causes already a reversed power flow in rural areas. With the integration of decentralized energy resources the ensurance of the given voltage range in medium- and low-voltage grids is associated.

Decentralized energy resources are typically located in rural areas and out of load centers, therefore the actual distribution grids have to be developed to regional transportation grids. Better prediction of the provided decentralized energy, the network load and the balancing between the fluctuating power flows are additional tasks.

The customer behavior will be determined more and more by an active control of loads, supported by new informational monitoring and control systems. A substitution of conventional energy resources by heat pumps and also by upcoming electro-mobility is observed.

The previously described regulatory pressure on the revenue side of a grid operator will show up in sinking budgets for the grid, in case economically oriented margins are assumed.

This effect can only be compensated in a very little scope by using innovative concepts and new equipment, because their efficiency is not yet given. Furthermore external financial trigger points for technical innovations are rarely set, e.g. by incentive regulation. Therefore the classical grid expansion will be most likely the way to choose.

The aging network structures generate an additional facet of this demand portfolio. Besides the described functional demands the aging factor represents a main driver of necessary financial budgets. Furthermore these competitive demands have to be considered against the background of a constant high level of network capacity and supply reliability.

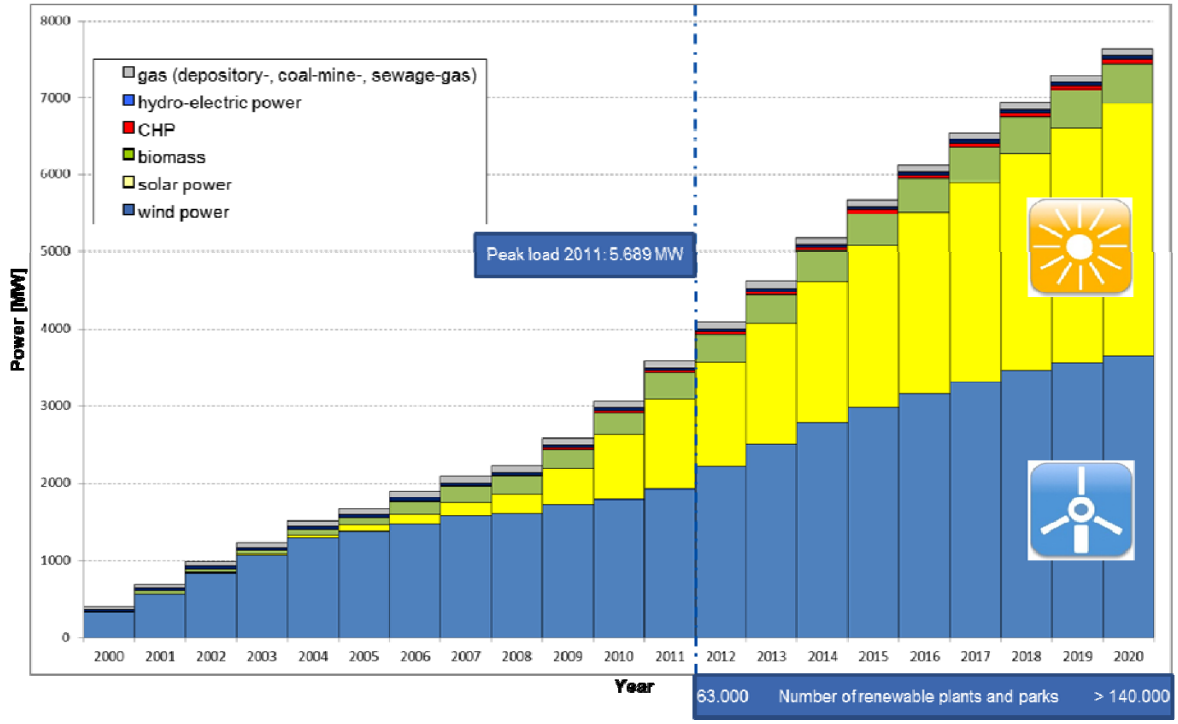

Fig. 1: Prognosis of the installed power and the number of decentralized energy resources (Case study of a German distribution system operator)

Increasing decentralized energy resources

The system and grid integration of decentralized forms of energy is one of the essential challenges of European network operators today. The classical hierarchically structured and historically grown grid structures are replaced or adapted in the long run to accommodate the decentralized generation. Besides the great number of single decentralized energy resources and large decentralized energy resources parks the respective composition of the different forms of energy will play a decisive role. In the area of a large distribution system operator in Germany the installed power of decentralized energy resources will be more than doubled. While the number of decentralized energy resources will increase from 63.000 at the end of 2011 to more than 140.000 in the year 2020 (fig. 1).

Considering the increasing dynamic in the field of network connections the classical grid expansion by conventional equipment is often associated with time problems due to typical realization periods. Also the economical aspect of this classical approach has to be scrutinized. At the moment technical alternatives are examined intensively under technical and economic aspects. These alternatives are for example a higher intelligence in lower voltage levels or monitoring systems to optimize the utilization of the existing grid infrastructure.

These new technical opportunities have to be integrated in the existing portfolio of grid expansion and have to be understood as an enhancement of the set of tools in the planning process. In the role of an active control function the asset management has to transfer the new or still existing requirements of the grid operation to the future grid structure (fig. 2).

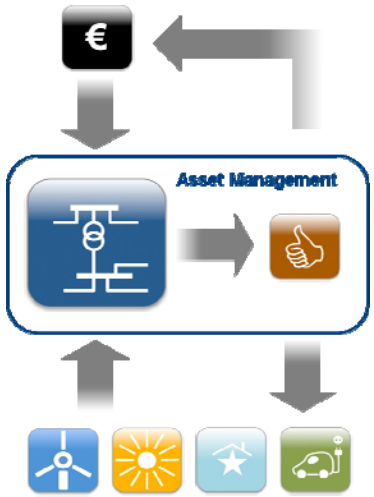

Fig. 2: Asset management as an active control role

The increasing intelligence of a “smart” approach has to be reflected in both the process and the tools of the future asset manager. Within the scope of this asset management control cycle new technical approaches will be developed and evaluated. This extension of the planning toolbox will have an impact on the financial side as well as on the described demands towards the network business.

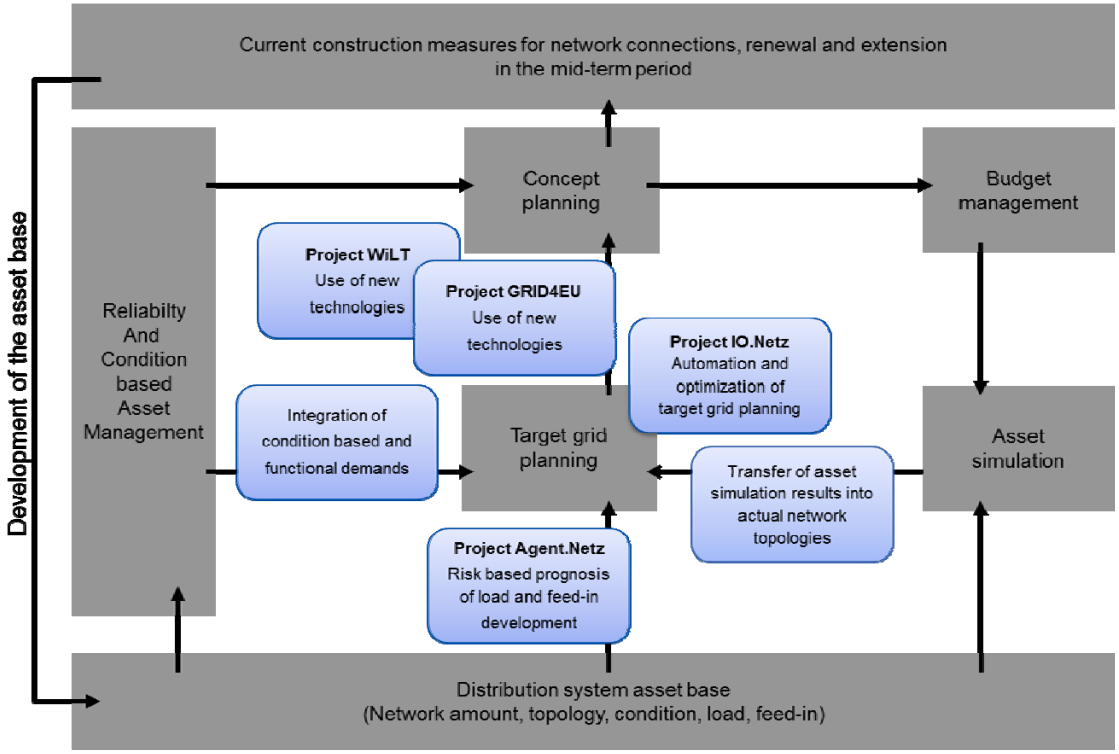

Fig. 3: Current projects in the scope of the planning process

CURRENT PROJECTS

Within the scope of this paper current projects and activities are presented dealing with the increasing demands of integrating decentralized energy resources in the distribution network. These tasks are an essential part of the asset management and network planning process. Figure 3 shows their integration in the current planning process.

Enhancing the intelligence of distribution systems by new technologies

The enhancement of „network intelligence“ is driven by an extended automation of medium-voltage networks as well as a weather condition based adaption of transmission capacities of high-voltage overhead lines:

- In the context of a EU wide R&D project [1] cost efficient approaches are investigated to enhance the degree of automation and data monitoring of the medium-voltage level. These economical alternatives are implemented to reduce or to support the conventional network extension measures.
  The focus will be on higher workloads of existing assets, an automated failure detection and the resulting development of “self-healing” network structures.
  A second key idea of this approach is the principle that regional tasks need regional decisions. Therefore the implementation of a full-size medium-voltage SCADA system may be only regionally developed or even completely avoided. The installed autonomous agents act locally and contact their supervisory central instance only from case to case.

- In general the transfer capacity extension of existing high-voltage networks is linked with a number of construction measures on the same level as a complete renewal. The network integration of decentralized energy, especially wind energy, is usually connected with weather conditions which differ from standard (worst-case) conditions. The related higher transfer capacities of existing overhead lines can be used by means of a focused weather condition monitoring system.

Increased integration of network planning process steps

The essential integration of both condition based and functional driven network planning demands is a basic issue for the network integration of decentralized energy resources [2]. Further optimization potential is given at the interface between asset strategy and operational target grid planning [3]. A basic approach is the transfer of network-independent strategic goals into the network-oriented view of the following process steps.

Automation and optimization of target grid planning

The increasing complexity of the network planning task leads to more and more extensive planning scenarios and therefore to a significant increase of the necessary planning time expenditure. In this case a large number of planning process steps are suitable for a higher degree of automation concerning methods and content. In the context of a R&D project granted by BMWi [4] existing strategic optimization tools [5] are adapted to the actual issues of target grid planning [6].

The future target grid structure which is in line with load and feed-in demands is the starting point of this planning problem and has to be identified initially. This structure serves as the target for strategic asset management measures as well as for the mid-term oriented tactical network expansion and reconstruction.

Due to the complexity of the so far manually implemented scenario simulation a new approach is needed to create the measures for network expansion, reconstruction and compensational construction in a more manageable way.

These days the development effort of a complete target grid structure including a basis strategy covers several weeks. Therefore the achievement of an optimally adjusted strategy is not possible due to the minor number of possible scenario variations.

The development of an "optimum strategy" is based on the simulation of different transition paths from the existing network structure to the future target grid structure. This simulation uses different representative load and feed-in scenarios.

Based on the simulation results an optimum transition strategy will be determined by means of a robust and multi-criteria based optimization. This method regards the competitive factors capital costs and supply reliability as well as regulatory specifications, operational resource constraints and financial parameters.

Risk based prognosis of load and DER development in distribution systems

In general the basic prognosis of load and decentralized energy resources development is linked with a number of risks and constraints which have to be considered in the context of the complete planning process. Another R&D project funded by FIT Ziel2 [7] develops a multi-agent-based approach allowing a probability-based model of the complete supply task of distribution systems.

This approach is chosen to define individual functions and interdependencies of all grid- and market-participants, represented by specific agents. Due to connections and interactions of technical and economical agents, the complex interrelations and influences can be simulated. Key drivers of grid extension necessity, even economic and regulatory influences, can be modeled in a comprehensible and transparent way.

Different aggregation levels enable the development of central agents, e. g. the Energy market or the offering dependent central power supply, as well as modeling the behavior of single network nodes representing single decentralized energy resources or storage facilities. Finally the simulation serves as an intelligent method to design and to use an adequate network infrastructure.

SUMMARY

New demands in terms of a dynamic increasing number of decentralized energy resources or an active demand side management have to be integrated into the business model of modern distribution system operators and will lead to new network structures in the long term.
A simple answer in terms of the operation of new "smart" technology will not be enough. Furthermore planning and operation processes also need to be adapted to these new demands.
The integration of decentralized energy resources in distribution networks is more than a technical question and requires a holistic integrative approach on different levels.

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