

# Design of distributed energy systems

## Development of holistic supply and network concepts

### At a glance

Siemens Power Technologies International (Siemens PTI) is a world leader in distribution and industrial system analysis having performed extensive studies in key energy supply disciplines. Siemens PTI has provided services to a diverse client base that includes electric power utilities, as well as industrial customers around the globe. Key services provided by Siemens PTI include:

- Techno-economical optimization of energy supply and network tariff,
- Overall technical analysis of grid integration and connection,
- System expansion planning and simplification of your network,
- System reliability and power quality assessment,
- Integration studies of new loads, drives and storage systems,
- Dynamic behavior of power systems with dispersed generation units.

### The challenge

The ongoing transformation of the energy system leads to more heterogeneous and dynamic systems with multiple actors and multi-layered energy, information, and money flows. With an

increasing share of decentralized and smaller units, more and more energy is generated and consumed locally towards areas that are supplied in so called Decentralized Energy Systems (DES) and microgrids. These systems can be operated autonomously and/or in islanded mode, but also as part of a larger grid.



Figure 1: Distributed energy system

These systems are increasingly recognized as a key concept of future energy supply systems, complementing the conventional centralized energy supply system. They are also put forward as building blocks towards smarter and more resilient grids with increased integration of renewable sources. Additionally, DES and microgrids enable more prosumers (prosumers produce and consume energy) to join the power market as environmental awareness of today's consumers increases.

### Our solution

Siemens PTI provides independent technical consulting services for the industrial and distribution power sectors worldwide. We offer a unique combination of industry leading expertise and software that can successfully deliver on our customer's vision in different development phases, including:

- A global organization that is actively defining and implementing integrated planning solutions and evolving our industry leading, integrated power systems software, PSS®SINCAL in design, modeling and analysis,
- A thorough understanding of the process and alignment with the need for enhanced planning capabilities,
- A project team that will share and apply its experience and expertise gained from our end-to-end services and world class product functionality for integrated planning processes,
- A field-proven process to jointly develop the requirements and roadmaps of similar nature with a long history of successful implementations,
- A highly efficient organization that is able to quickly implement changes to meet needed timelines and provide long-term consulting services and enhancement to maximize our customer's return on their investments.

### Design of DES

Siemens PTI can support clients with comprehensive analyses to design a new distributed energy system or develop their network towards more efficient, resilient and independent supply systems.

## System definition and scenario development

The assessment of the current situation starts with an analysis of the framework conditions, which influence and determine the energy system, as well as an identification of the affected stakeholder. Especially political target locations and the supporting mechanism for renewable energy sources are key impact factors as they induce and influence the business models around decentralized generation and the trend towards autonomous supply.

Together with our customers, a stakeholder analysis is conducted to ensure that all affected stakeholders (e.g. households, SMEs, government, regulator, DSO, etc.) are identified and considered in the following analyses.

Based on the stakeholder analysis, the electricity demand and its major energy users are further evaluated. Depending on the development and project type (greenfield/brownfield) either actual and/or forecasted consumption data (e.g. yearly consumption, load profiles) is used and energy consumers are divided into certain user groups and consumption clusters.

If applicable, an assessment of the current generation mix and network will be conducted. In cooperation with the local utility/DSO and based on the available information (e.g. single line diagrams, installed capacities, etc.), the share of distributed energy resources (DER) and the current network topology are evaluated to identify existing constraints and prepare possible measures.

### Generation analysis

The generation analysis starts with a description of different DER applicable (e.g. PV, wind, combined heat and power units etc).

Based on the scenario description, the generation portfolio is simulated and evaluated. Starting from already installed capacities of thermal power units and DER (if applicable), the sizing and operation of additional resources and assets like storage systems are simulated and optimized, depending on the available potential of renewable sources like PV and wind. The simulations deliver detailed information about the operation of the available generation resources, like fuel consumption or number of starts and stops of thermal power units, number of cycles of battery storage units or the

share of renewable energy sources to the total energy consumption of the DES.

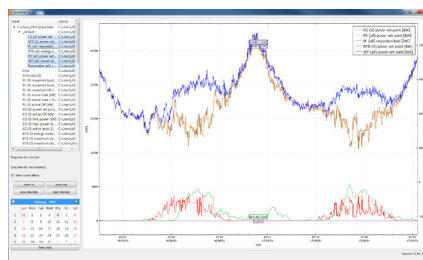


Figure 2: Dispatch simulation of DES

In addition, the simulation delivers financial results considering the capital and operational expenditures of the selected generation structure on the basis of the specific composition and interaction of different generation resources. In consequence, financial Key Performance Indicators (KPIs), like Levelized Cost of Electricity (LCoE), Return on Investment (RoI) or Net Present Value (NPV), can be derived for the evaluated scenarios.

### Network Analysis

After the generation analysis, the analysis of different network development concepts is the core task of strategic network analysis. In order to prepare a comparison of the different scenarios, a detailed technical and economical analysis of each of these scenarios is required. Various technical network calculations and economic evaluations will be performed, such as:

- Power flow calculation
- Short-circuit current calculation
- Network analysis and optimization
- Reliability and contingencies
- Protection coordination and Island operation strategies
- Dynamic analysis and stability
- Economic analysis, assessing, the required CAPEX and OPEX

Contradictory factors often influence the criteria used for planning. As the trade-off depends on many factors which are different in each network, there are no ready-made solutions to define planning criteria. The experience of the network planner is very important to reach satisfying results.

### Scenario comparison and decision making

The technical planning criteria and approach form the basis of an economical analysis of different supply scenarios. Alternative solutions are compared

for different generation capacities, network and price developments, and conventional vs. renewable (including storage) supply, as well as connection to the main grid. Performing a first allocation of the measures and related investments over the considered time period enables first perceptions of future cost structure and revenue streams. After evaluation of the different options, they are compared to select the optimal solution considering short, medium and long-term perspective. This therefore enables decision-makers to select and implement investments on a reasonable basis.

### How you can benefit

With our consulting services, we can provide expert advice to help our clients in:

- Evaluating the technical feasibility of DES under consideration of economical expectations with an integrated approach
- Developing an optimal, flexible and transparent roadmap
- Ensuring system availability and increase system resilience with optimized network concepts,
- Supporting decision makers to ensure profitable business development based on technical resilience

With our industry leading expertise and software, we offer a broad spectrum of studies that are based on a thorough understanding of processes and align with the need for enhanced planning capabilities, allowing us to provide concrete improvements our customer's performance.

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