

# Optimization of power system structure and operation

Economical solutions for high quality power supply

## At a glance

The implementation of quality regulation requires the joint consideration of economical aspects and system reliability during the planning and operation of distribution grids.

Siemens Power Technologies International (Siemens PTI) provides methods for determining the economically optimum quality of supply. Therefore, detailed reliability calculations are combined with modeling and analysis of operational processes of utilities in the PSS®SINCAL software or other simulation software to answer central questions of quality regulation, such as:

- What is the most cost-effective way to reach or maintain a pre-defined level of quality?
- What is the optimal composition of staff organization (OPEX), as well as system assets (CAPEX) to reach this goal?
- How does this affect workforce management and investment strategies?

## The challenge

Investments in power systems or the adjustment of operating structures have a direct impact on annual operating costs and quality of supply.

Changes in quality of supply have a direct impact on the profit of system operators, depending on the regulatory framework schemes. The correlations between quality of supply, and operational and system-related measures, are often very complex, such that the efficiency of measures can only be derived by analytic evaluations.



Figure 1: Economic analysis based on technical evaluations

## Our solution

Siemens PTI has developed a model which allows an integrated calculation of the correlations between assets, system operation and quality of supply to assess the costs for system-related and operational activities (Figure 2).

The comprehensive reliability calculation determines the complex effects of failures and necessary remedial actions on customers based on failure models of electrical equipment.

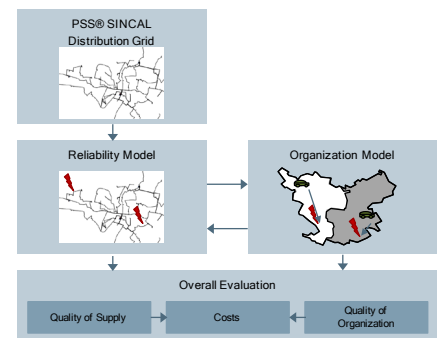


Figure 2: Overview of the model

The organizational model incorporates all resources and the organizational structure of the utility, including number of employees during working time and on-call service, their qualifications and responsibilities. Furthermore, the operational decision-making process is simulated. The influence of restructuring the power system, as well as the impact of changes in number and location of employees on the quality of supply can be investigated.

## Application example

In a distribution network (20 kV, 350 km cable, 50 km of overhead lines, 4 transformer substations), 80,000 customers are supplied via open ring structures. The remedial actions are performed by 12 employees in three service zones and three employees during on-call service hours (Figure 3)

In the initial design of the power system and its operation, customers are facing different quality levels, depending on the substation they are connected to:

- The structures of the medium-voltage systems differ significantly with respect to length, equipment types, switching options, etc.

- The specific employee density (employee per components) varies in the service zones.
- The transportation infrastructure, and thus the travelling times of the employees, differs in each service zone.

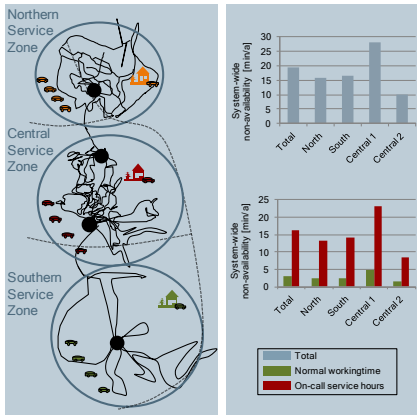


Figure 3: Investigated power system area

### Adjustment of power system structure and operation

In order to influence the quality of supply from a long-term perspective, three measures are examined:

- Replacement of overhead lines by cables,
- Implementation of remotely controlled switches at suitable locations in the power system,
- Improvement of the power system structure (reduction of central stations and cables).

Besides these long-term adjustments to the system structure, changes in the operating structure are also considered:

- Aggregation of operating areas,
- Adjustment of the number of available employees during on-call service hours (nights and weekend).

Figure 4 shows the impact of the related measures on the reliability of supply

in connection with the adjustment of the operating structure.

The results allow for a detailed analysis and quantification of the individual measures in terms of their impact on the quality of supply:

- The aggregation of service zones leads to marginal changes of non-availability.
- The variation of the number of employees during normal working time has no significant effect on the reliability of supply, as planned activities generally bind more employees than failure events, and thus are decisive for the number of employees during normal working time.
- The reduction of the number of employees during on-call service hours has significant influence on the reliability of supply.
- Remotely controlled switches and cabling of overhead lines prove to be effective in reducing the non-availability.
- The streamlining of the system structure increases the non-availability of supply. This can be compensated by changes in the organizational structure.

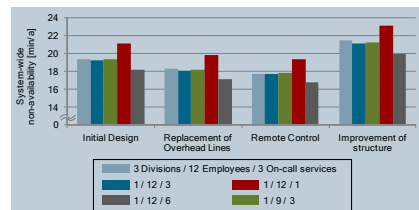


Figure 4: Non-availability of variants of the power system and organization

### Duration until arrival on site

Using the duration until arrival on failure site, the quality of the power system organization is quantified. As the operator is in charge of a safe operation

of the power system, the organizational quality has to be included in management decisions. As an example, Figure 5 shows that in particular the number of employees during on-call service hours determines the share of failure sites which can be reached by an employee within 45 minutes.

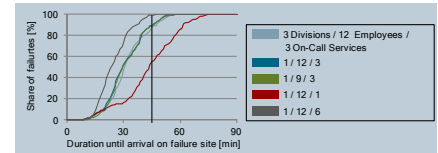


Figure 5: Duration until arrival on site in initial power system design

### How you can benefit

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

- Evaluating the optimal composition of operational and capital expenditures based on the boundary conditions specified,
- Ensuring system availability with optimized network concepts and workforce management,
- Developing concrete mitigation measures to increase system reliability.

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 to our customers' performance.

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Energy Management Division  
Freyeslebenstrasse 1  
91058 Erlangen, Germany

For more information, please contact:  
power-technologies.energy@siemens.com

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