Increasing grid reliability with distribution automation

Smart grid planning for Croatian distribution grid

At a glance

The distribution system operator of Croatia Hrvatska elektroprivreda (HEP ODS) strives towards the implementation of a smart grid concept with an emphasis on distribution automation in order to reduce the supply unavailability in the network.

Siemens PTI delivered a "Grid Automation Planning" study to evaluate the integration of network automation functions up to the year 2032, including the following:

- Scenario planning with changing degrees of substation automation (standard and innovative solutions)
- Techno-economic assessment and comparison of variants to derive optimal solution
- Knowledge transfer to HEP ODS engineers

As a result, HEP ODS received an automation concept which will help them achieve the defined reliability targets and which can be used as a blueprint for other regional distribution grids in Croatia in the future.

Initial situation and challenge

Like most of European DSOs, as the sole distribution system operator in Croatia HEP ODS is facing diverse challenges regarding their electrical power supply which result from different developments in this sector over the last decades. Besides these challenges, HEP ODS set additional key business objectives which should be achieved in the future. Resulting from a high unavailability (System Average Interruption Duration Index, SAIDI) compared to Western networks and high values and spread of interruption frequency (System Average Interruption Frequency Index, SAIFI), HEP ODS is planning to implement a smart grid concept with an emphasis on distribution automation (DA) as well as smart network control and operation to benefit from these technologies in the long-term.

HEP ODS decided to perform a distribution network study for the region of Elektroistra Pula in the North-west region of Croatia (see Figure 1). The study focussed on the implementation of distribution automation and smart grid solutions to achieve the targeted objective of decreasing the unavailability of customer supply.

The distribution network mainly consists of a ring structure or a simple radial scheme for suppling areas with low customer density, especially in the 20-kV network, based on overhead lines. The current level of network automation allows the monitoring of the network state, but only with a low share of remote control and automation. This affects the quality of normal or maintenance regime management, leading to increased time for localization and liquidation of outages.

Figure 1: Distribution network of Elektroistra Pula region focused in the automation study.

The medium-voltage network shows high values and spread of interruption frequency (see Figure 2), whereas the recovery time in some network parts with radial structure is very high.

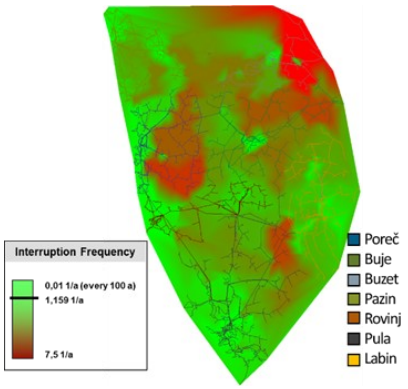

Figure 2: Calculated SAIFI values for each region in Elektroistra Pula.

"Defining the concept of further development of Distribution Automation (DA) is extremely important for the implementation of the Smart Grid concept in HEP ODS and the Republic of Croatia. The project team, in which experts from Siemens PTI from Germany, HEP ODS, Hrvoje Požar, the Croatian Energy Institute and Siemens Croatia worked together, fulfilled all the project goals. The importance of the developed methodology for defining the optimal number and location of MV network points that will be covered by DA in the distribution area of Elektroistra is especially in the fact that it is easily applicable to other distribution areas."

Anđelko Tunjić, Head of Service of Aset management and project Leader in HEP ODS, Zagreb, Croatia

The solution

HEP ODS, the Energy Institute Hrvoje Požar and Siemens conducted a distribution system planning study based on the expected load increase and planned integration of distributed generation (DG) by EIHP until 2032. The goal was to assess which network automation concepts and reinforcements will be needed in the distribution system over the next ten years (2020-2032). Based on the current reliability level, a target unavailability (SAIDI) of half of the present value was defined. Siemens PTI analyzed the current performance of the network in the Elektroistra Pula region using a synthetic network approach, which consists of four steps:

Phase 1: Derivation of a reference network as a representative feeder for the present network based on the network topology of the present grid (e.g. number of ring main units (RMU) per feeder, the distance between two RMU, cable density, number of short circuit breakers (CB), ...).

Phase 2: Re-assessment of the reference network with the results from the actual (present) network (plausibility check).

Phase 3: Derivation of a reference network as a representative feeder for the target network for the year 2032. Analysis with respect to the reliability index without any additional measures depending on the feeder length and the number of secondary substations on a feeder (see Figure 3).

Phase 4: Complementation of the reference network with a grid automation planning approach by developing variants which differ with respect to their degree of automation:

- Variant 1: Variation of number of circuit breakers
- Variant 2: Variation of number of smart RMU
- Variant 3: Smart RMU with circuit breakers in feeder center and variation of smart RMU

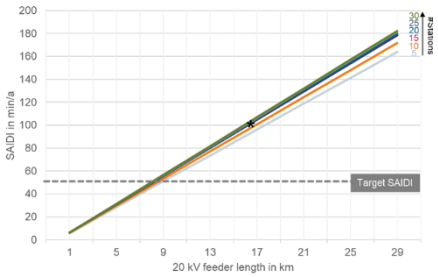

Figure 3: SAIDI depending on feeder length and number of secondary substations of a feeder.

Based on this reference network, the required measures to meet the targeted SAIDI value were derived for each variant. The findings were then applied to the target network by adding the automation equipment to the network model. Subsequently to the technical evaluation and the compilation of a bill of quantity for each variant, an economical evaluation of the investment costs was performed in order to derive a technically and economically optimal solution.

On top of the above-mentioned technical studies, the grid automation planning approach based on a synthetic network that was applied for the Elektroistra Pula region can be transferred to the basic network structure. Thus, it can also be applied to reduce supply unavailability in other regions. An extensive training program for HEP ODS engineers was set up, covering distribution automation planning practices and the application of the approach.

Key achievements

The main benefits of the distribution automation planning project for the Croatian distribution network included:

- transparency on the performance of the existing system showing its specific characteristics, weak points and limitations,
- identification of critical automation functions and development of optimized network structure for the year 2032 to achieve a 50% SAIDI reduction
- synthetic network planning approach allows application of automation concept to other distribution grids in Croatia
- know-how transfer and staff education in different forms

Published by
Siemens AG

Smart Infrastructure
Digital Grid
Humboldtstrasse 59
90459 Nuremberg

For the U.S. published by
Siemens Industry Inc.
100 Technology Drive
Alpharetta, GA 30005, United States

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