Applications for smart secondary substations based on selected pilot projects

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Use cases for smart secondary substations
Drivers for automation solutions

Optimization of assets and grid operation
- Monitoring and analysis of distribution grid capacity
- Identification and management of congestions
- Optimized planning of operation tasks

Voltage control and optimization
- Coordinated voltage control in MV
- Voltage control in LV grids

Increase quality of supply
- Faster fault localization, isolation and restoration
- Documentation of quality

Required automation functions
- Measurement
- Fault detection
- Remote control
- Voltage regulation
- Communication
Stepwise approach for smart distribution grids
Analysis ➔ Monitoring ➔ Control

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<th>Control</th>
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- Evaluation of optimal deployment of grid automation
- Classification of LV grids with voltage problems
- Observation of voltage and evaluation for further upgrade
- Fault localization
- Optimized voltage control
- Management of congestions
- Fault isolation and restoration
Packages for stepwise automation
Modules for smart secondary substations

Secondary substation

MV

UPS
Remote control
Communication

LV

Measurement of non-electrical values

Primary equipment:

Load breaking switches with motor drive
Voltage regulator

Network control system
Case study RiesLing
Modular, scalable automation solution

Objectives

- Development and implementation of monitoring and automation equipment in secondary substations for safe, reliable and economical operation of distribution grids

Customers & partners

- EnBW ODR, EnBW REG, T-Systems

ABB’s response – Smart grid scope

- ABB remote control and measuring equipment for power monitoring, voltage control and fault detection
- Predictive network control
- Secure, surveilled communication

Benefits

- Modular, scalable solutions for secure, economical and predictive distribution grid operation
Case study RiesLing
Automation packages

Monitoring:
- Measurement of $I_{MV}$
- Measurement of $V_{LV}$, $I_{LV}$, $P_{LV}$, $Q_{LV}$
- Calculation or direct measurement of $V_{MV}$, $P_{MV}$, $Q_{MV}$
- Directional fault detection

Uninterruptible power supply:
- 15 minutes

Control option:
- Remote controllable load breaking switches

Voltage regulation option:
- Power electronic regulation PCS100 AVR

Uninterruptible power supply:
- 15 minutes
- 1 switching operation minimum
Case study RiesLing
Application examples
Case study RiesLing
MV calculation vs. direct sensor measurement

**Direct sensor measurement**
- Capacitive divider and rogowski coil
- Directional fault detection
- For new RMUs
- Retrofit of gas insulated RMUs

**Calculation of MV values**
- No direct MV measurement necessary
- Based on transformer model
- Directional fault detection
- Retrofit of secondary substations
Case study RiesLing
Results of MV calculation

Voltage [p.U.]

Time [h]

Deviation [%]

V measured
V calculated

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Case study RiesLing
Voltage control concepts

Voltage control
1. Setpoint from network control center
2. Based on solar radiation (not tested)
3. Based on distributed LV measurements, wide area regulation
4. Load flow dependent setpoint
Case study RiesLing  
Results of voltage control

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<th>Fixed setpoint</th>
<th>Wide area regulation</th>
<th>Load flow dependent setpoint</th>
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<td>Exploitation of voltage band</td>
<td>-</td>
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<td>Efforts</td>
<td>+</td>
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Optimized voltage control can enable a better exploitation of the available voltage bandwidth. 
Load flow dependent setpoint is best compromise between efforts and exploitation.
Smart Planning
Process for evaluation of „critical grids“

Classification of local grids → Monitoring in secondary substation → Installation of voltage regulator

Evaluation process is separated in three process phases in order to handle massproblems in low voltage

Only grids evaluated as critical reach the next process phase
Grid structure features:
- Local grid radius
- Number of residential units
- Number of residential connections
- Type of transformer
- Standard cable type
- Number of cable distribution units
- ...

- Classification based on simple grid structure features and current penetration of grid with photovoltaic

Classification of local grids

Monitoring in secondary substation

Installation of voltage regulator

- Critical area
- Uncritical area

Residential development

PV-penetration

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Determination of reference based on load flow calculation with NEPLAN® ⇒ „fingerprint“ of grid

- Upgrading the secondary substation with automation to an intelligent secondary substation and measuring of power and voltage
Grid with voltage range deviations:
⇒ voltage regulator or controllable distribution transformer and
⇒ continued monitoring of grid for possible voltage range deviations
Case study: Smart Area Aachen
Intelligent secondary substation

Objectives
- Increase distribution grid stability and observability while improving supply quality
- Development of long term cost effective distribution automation technology and products

Customers & partners
- Stadtwerke Aachen, FGH, TU Dortmund

ABB’s response – Smart grid scope
- Analysis of intelligent secondary substation use cases
- Identification & evaluation of secondary substation concepts and new voltage regulation algorithms
- Evaluation of new fault detection methods

Benefits
- Fully tested products and solutions for individual, scalable and economical distribution grid automation tasks, e.g. for measurement, voltage control and FDIR
Case study: Smart Area Aachen
Voltage observation for LV grids

Estimation of critical voltages in the LV grid without extensive ICT
Summary

Efficient automation of distribution grids with smart secondary substations requires:

- Integrated approach between planning and operation: analysis → monitoring → control
- Increased grid observability based on new measurement concepts
- New control and regulation options
- Modular solution packages adopted to use cases