Stefan Kämpfer, ABB AG

Applications for smart secondary substations based on selected pilot projects

Content

- Use cases for smart secondary substations
- Modules and packages
- Case study RiesLing
  - Automation packages
  - MV monitoring
  - Optimized voltage control
- Smart planning process
- Case study Smart Area Aachen
  - Voltage observation in the LV grid
- Summary

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

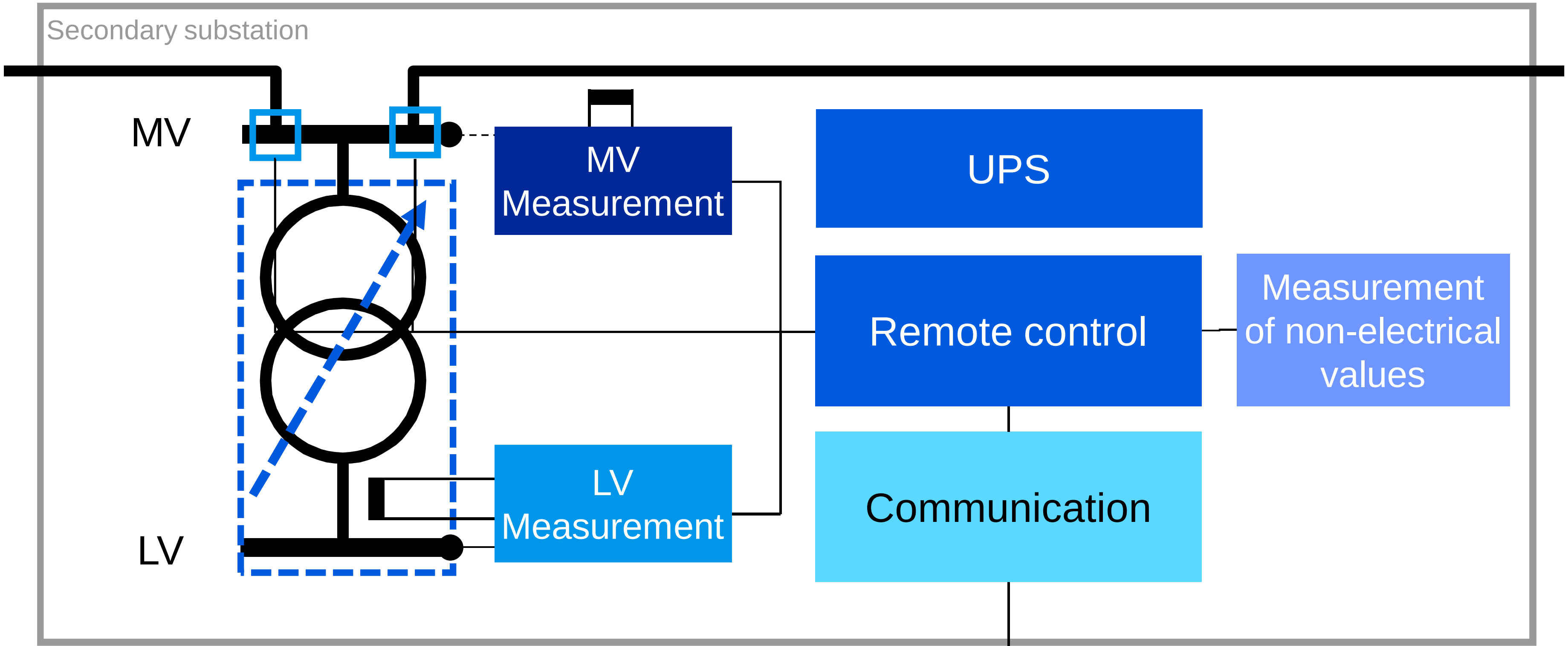
Required automation functions

- Measurement
- Fault detection
- Remote control
- Voltage regulation
- Communicat-ion

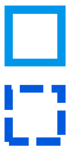
Stepwise approach for smart distribution grids
Analysis → Monitoring → Control

Analysis	Topology of MV grid Simple network structure features of LV grid	▪ Evaluation of optimal deployment of grid automation ▪ Classification of LV grids with voltage problems
Monitoring	Voltage and current measurements Fault detection	▪ Observation of voltage and evaluation for further upgrade ▪ Fault localization
Control	Voltage regulator Remote controlled switches	▪ Optimized voltage control ▪ Management of congestions ▪ Fault isolation and restoration

Packages for stepwise automation
Modules for smart secondary substations



Primary equipment:

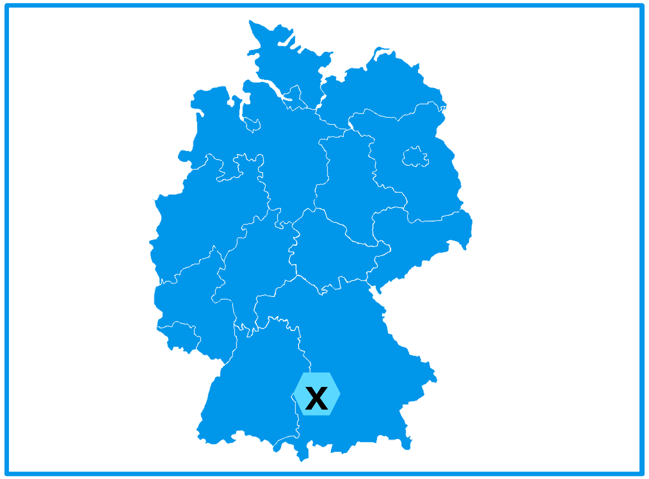


Load breaking switches with motor drive

Voltage regulator

Case study RiesLing
Modular, scalable automation solution

intelligent secondary substation in Wechingen



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

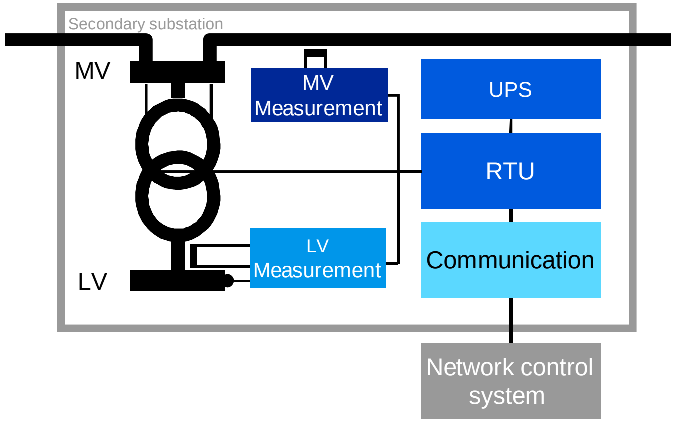
ABB's response – Smart grid scope

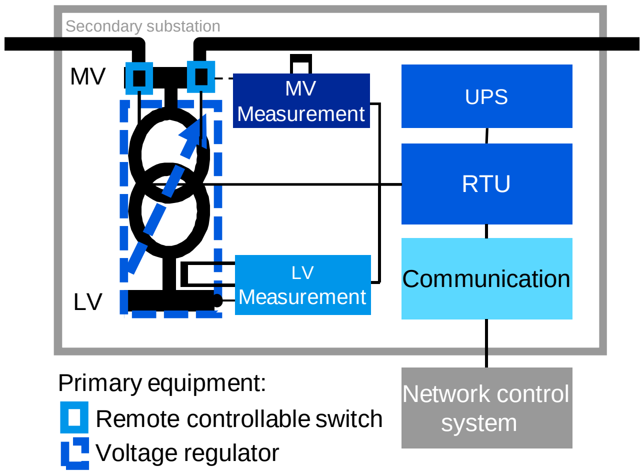
- ABB remote control and measuring equipment for power monitoring, voltage control and fault detection
- Predictive network control
- Secure, surveilled communication

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:

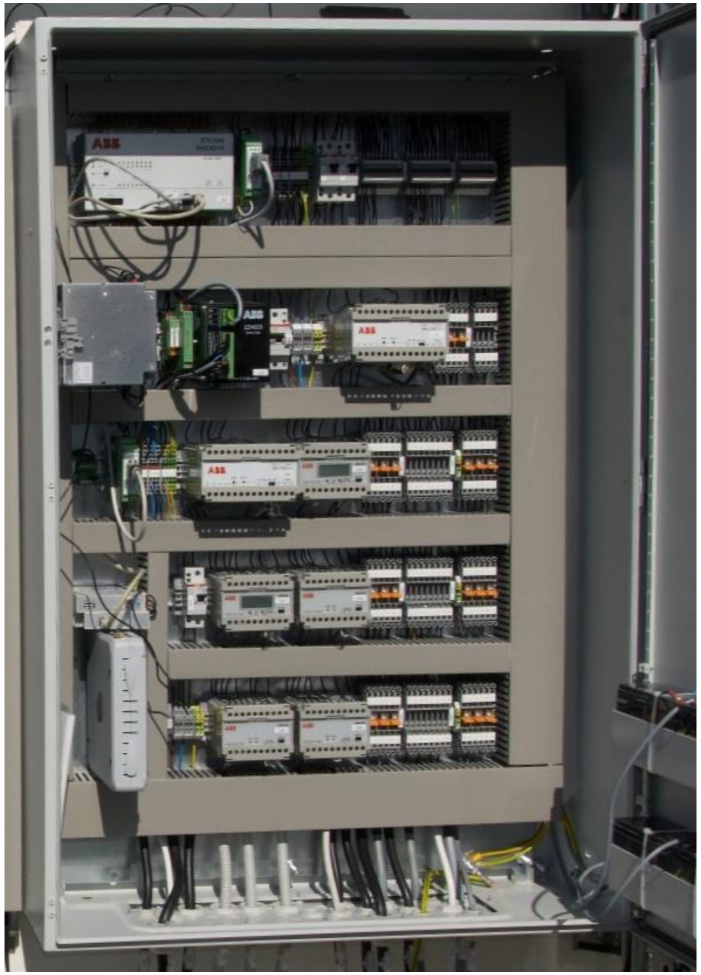
- Power electronic regulation PCS100 AVR

Uninterruptible power supply:

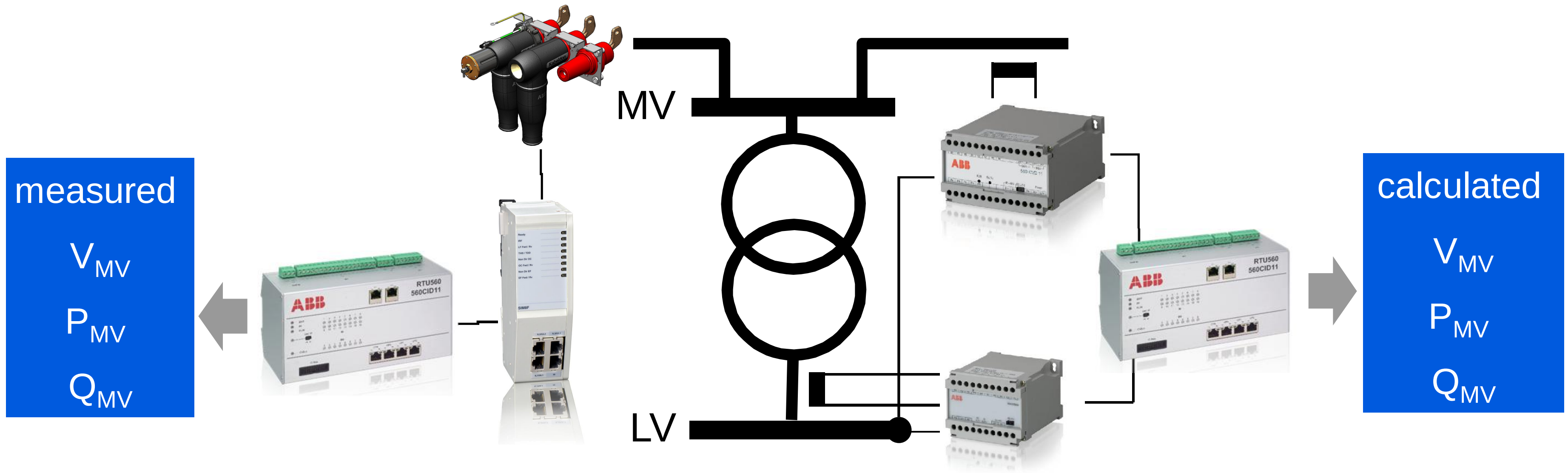
- 15 minutes
- 1 switching operation minimum

Case study RiesLing
Application examples



Case study RiesLing
MV calculation vs. direct sensor measurement



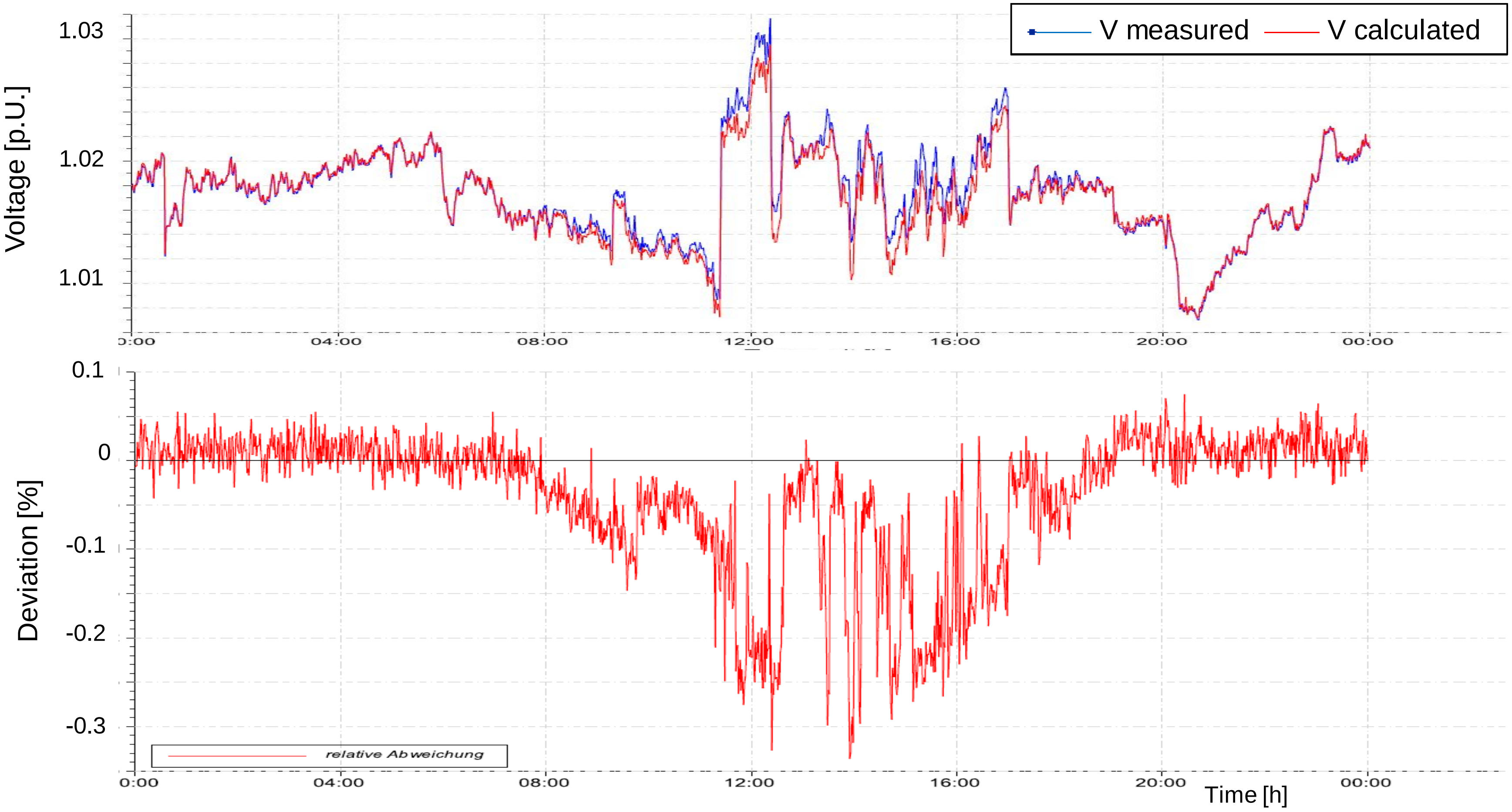
Direct sensor measurement

- Capacitve divider and rogowski coil
- Directional fault detection
- For new RMUs
- Retrofit of gas insulated RMUs

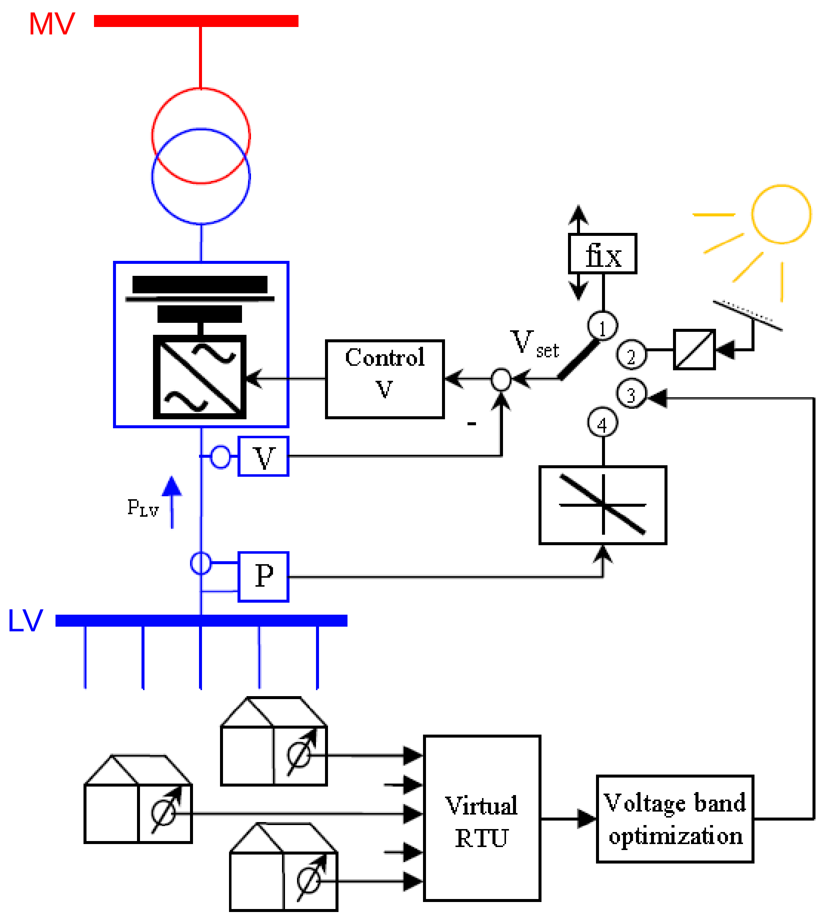
Calculation of MV values

- No direct MV measurement necessary
- Based on transformer model
- Directional fault detection
- Retrofit of secondary substations

Case study RiesLing
Results of MV calculation



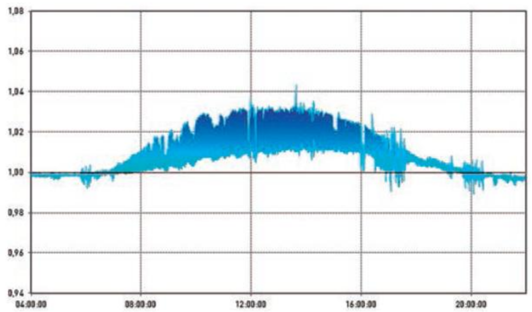
Case study RiesLing
Voltage control concepts

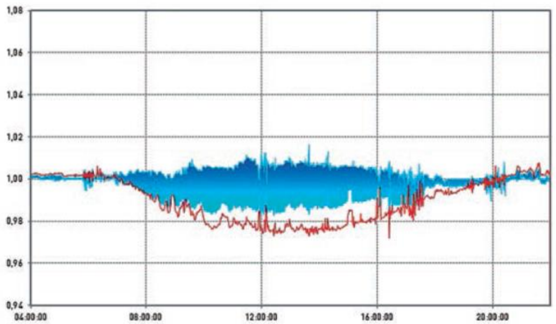


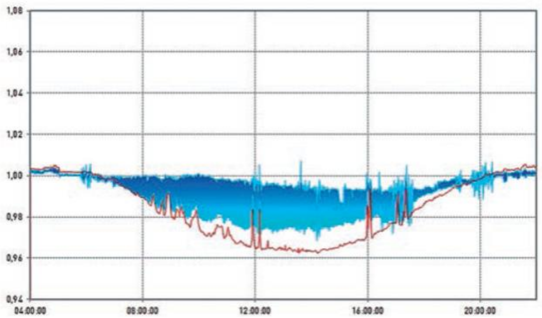
Voltage control

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







Fixed setpoint	Wide area regulation	Load flow dependent setpoint
	Exploitation of voltage band	
-	++	+
	Efforts	
+	-	o

Optimized voltage control can enable a better exploitation of the available voltage bandwidth

Load flow dependent setpoint is best compomise between efforts and exploitation

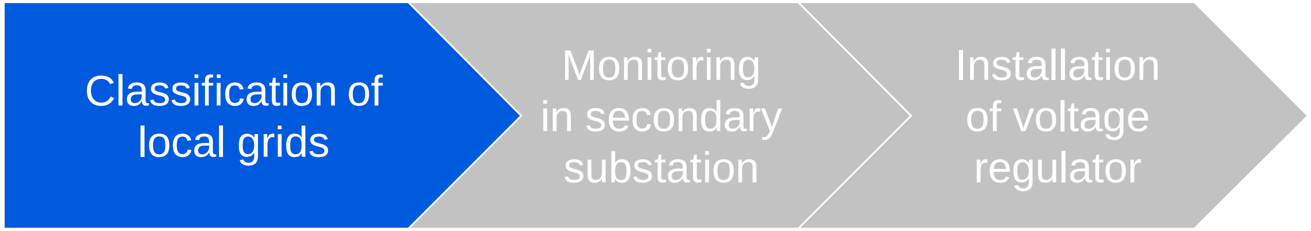
Smart Planning
Process for evaluation of „critical grids“

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

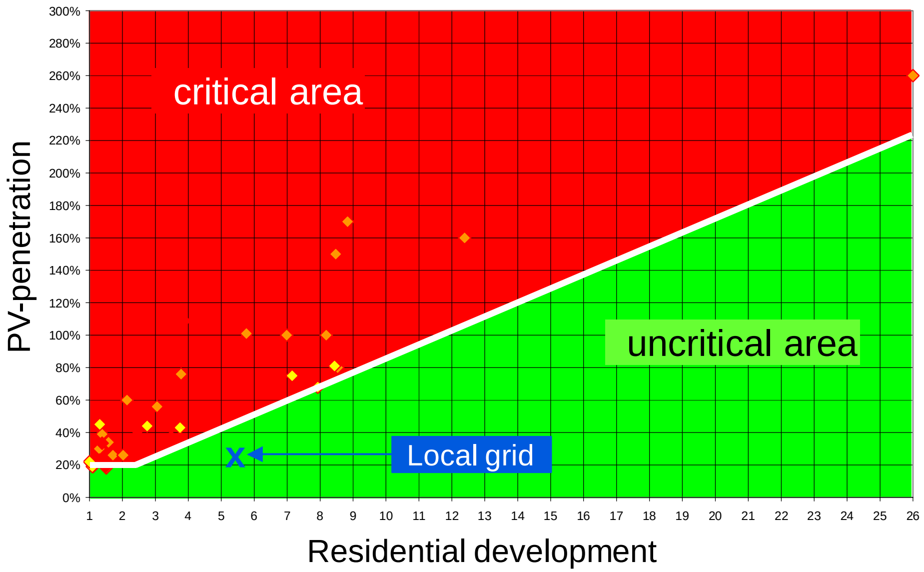
Only grids evaluated as critical reach the next process phase

Smart Planning
Step 1

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
- …



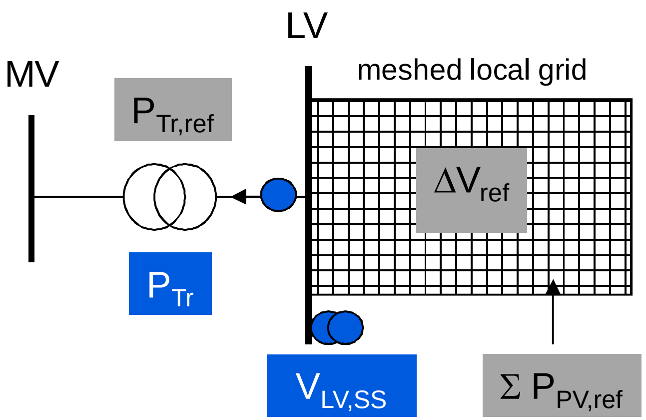
- Classification based on simple grid structure features and current penetration of grid with photovolatic



Smart Planning
Step 2

Local grid gets conspicuous in classification phase

- 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



Smart Planning
Step 3

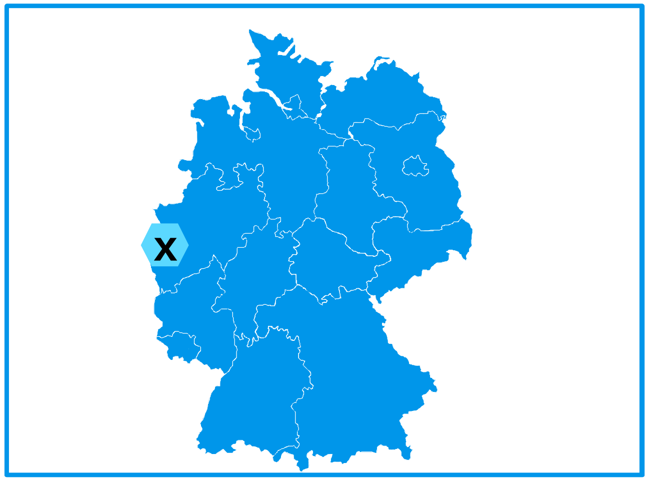
Classification of local grids → Monitoring in secondary substation → **Installation of voltage regulator**

- Grid with voltage range deviations:
  - ⇨ voltage regulator or controllable distribution transformer and
  - ⇨ continuated monitoring of grid for possible voltage range deviations

Case study: Smart Area Aachen
Intelligent secondary substation

smart area

Figure:
Automation package



Supported by:

Federal Ministry of Economics and Technology

on the basis of a decision by the German Bundestag

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

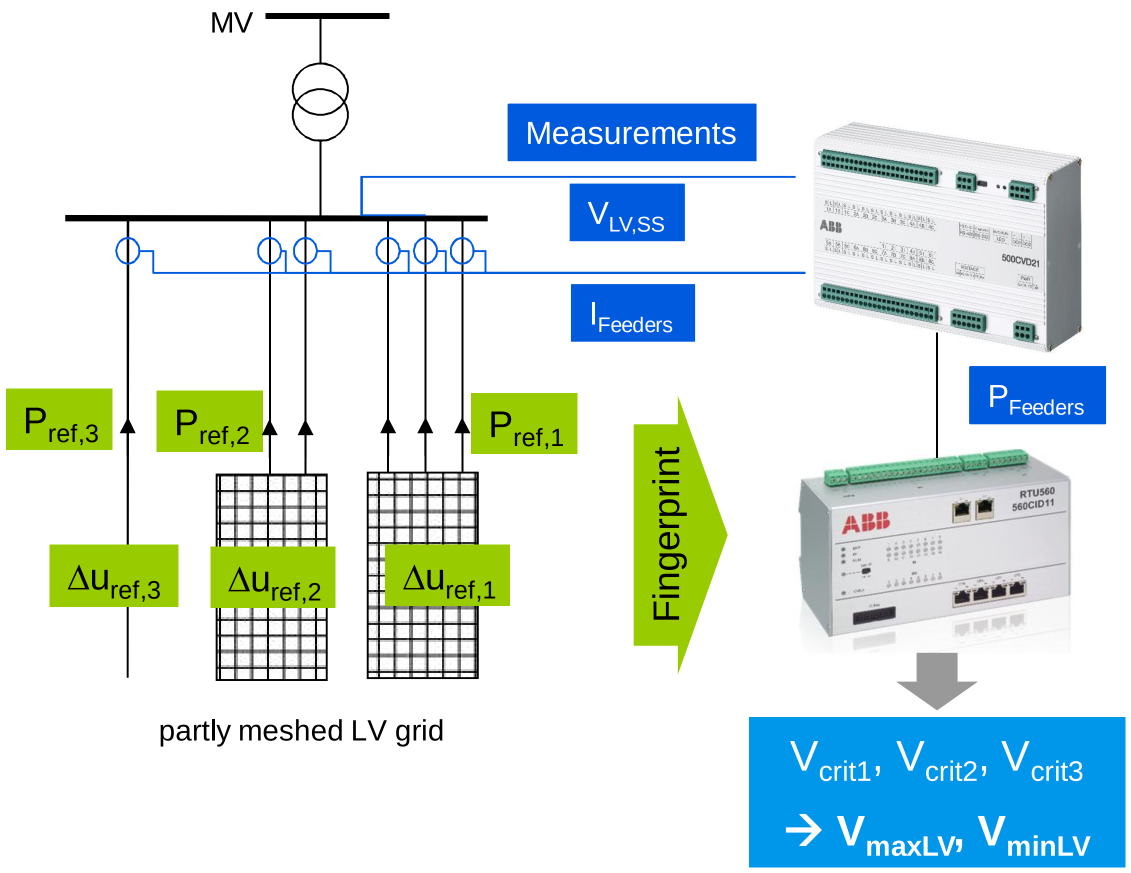
- Analysis of intelligent secondary substation use cases
- Identification & evaluation of secondary substation concepts and new voltage regulation algorithms
- Evaluation of new fault detection methods

Benefits

- Fully tested products and solutions for individual, scalable and economical distribution grid automation tasks, e.g. for measurement, voltage control and FDIR

ABB

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

Power and productivity
for a better world™

ABB