Integration of RES in MV / LV grids

Experiences from Field tests and current projects

IEA DSM Task XVII Workshop
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Content

- MV grid
  - DG DemoNet - experiences from field trials
- LV grid
  - ISOLVES / Smart LV Grid

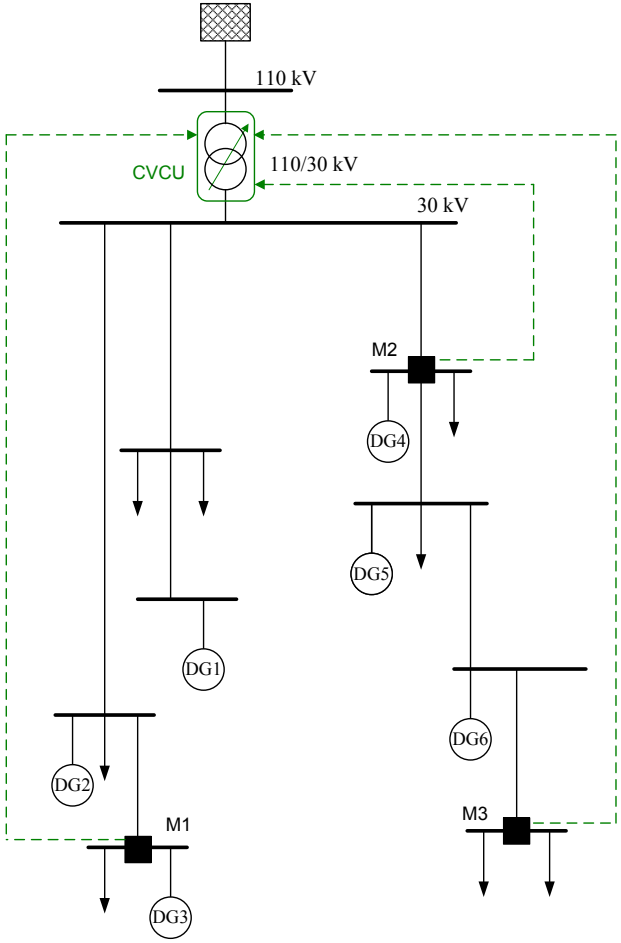
DG DemoNet

Keeping voltage limits by integration of distributed generation (DG)

DG DemoNet (1)

Distributed control (level control)

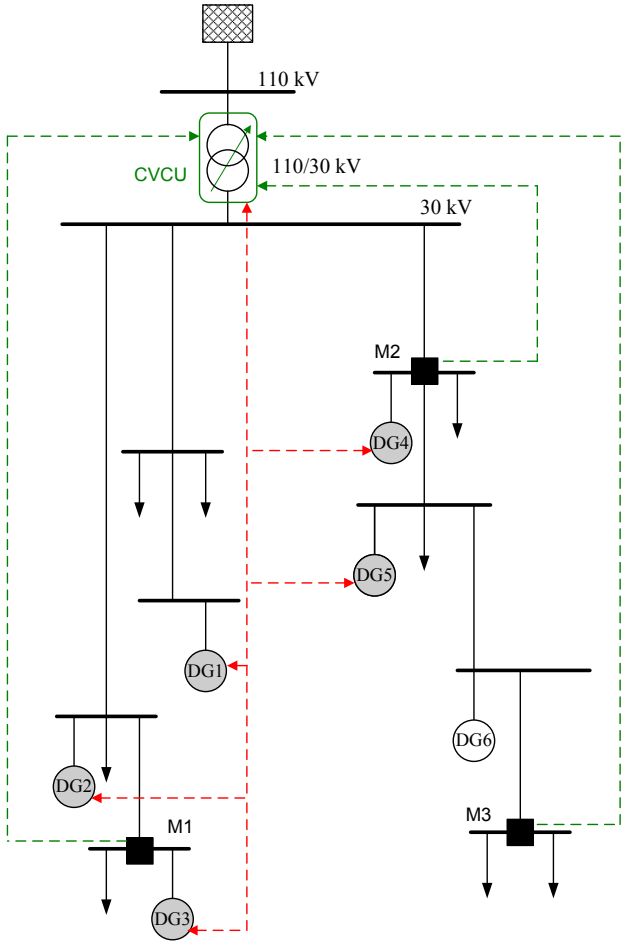
- **Control of tap changer** according to **voltage measurements** from the grid (critical nodes)
- Information about the grid state is required **→ICT necessary**



DG DemoNet (2)

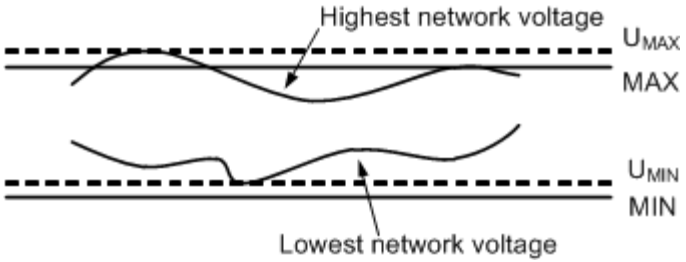
Coordinated control (level + range control)

- **Control of tap changer** according to **voltage measurements** from the grid (critical nodes)
- **Control of reactive power (Q)** and as a last measurement **reactive power (P)**
- Impact of Q/P on the critical nodes (voltage sensitivity) are in a linearised model – the **contribution matrix**
- **Local controller** (in case of failure)
- Information about the grid state is required **→ICT necessary**

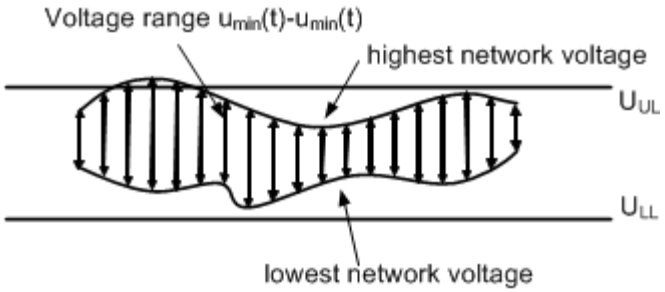


DG DemoNet – controller concept

- The following indicators are used:
  - **over voltage**
  - **voltage band**
  - **lower voltage**

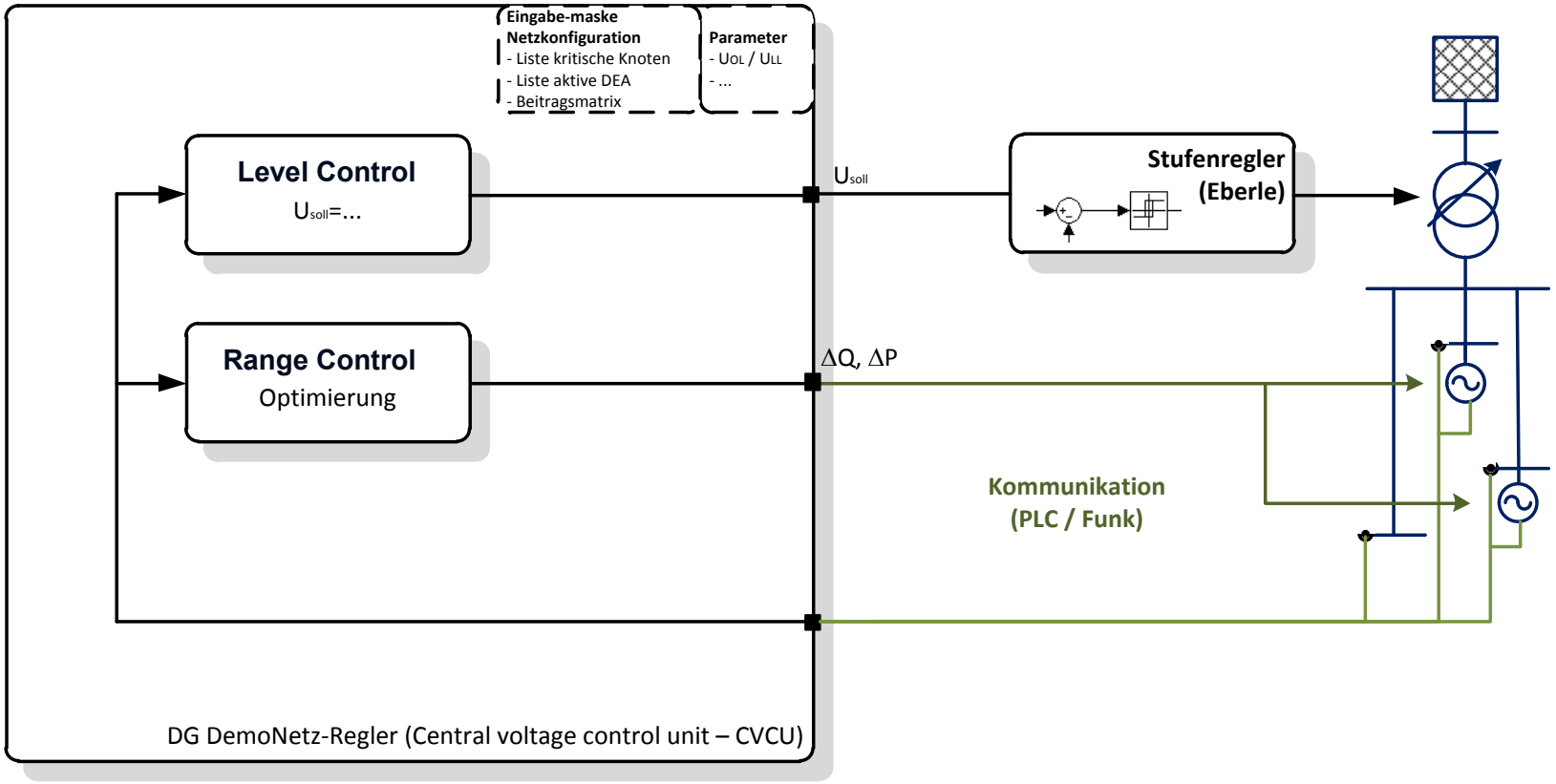


  - **range**: distance between highest and lowest voltage measurement



- Two separate controllers:
  - **level control**: tap changer position at the substation
  - **range control**: control of Q(P) at the distributed generator (if the range is greater than the voltage band)

DG DemoNet – controller design

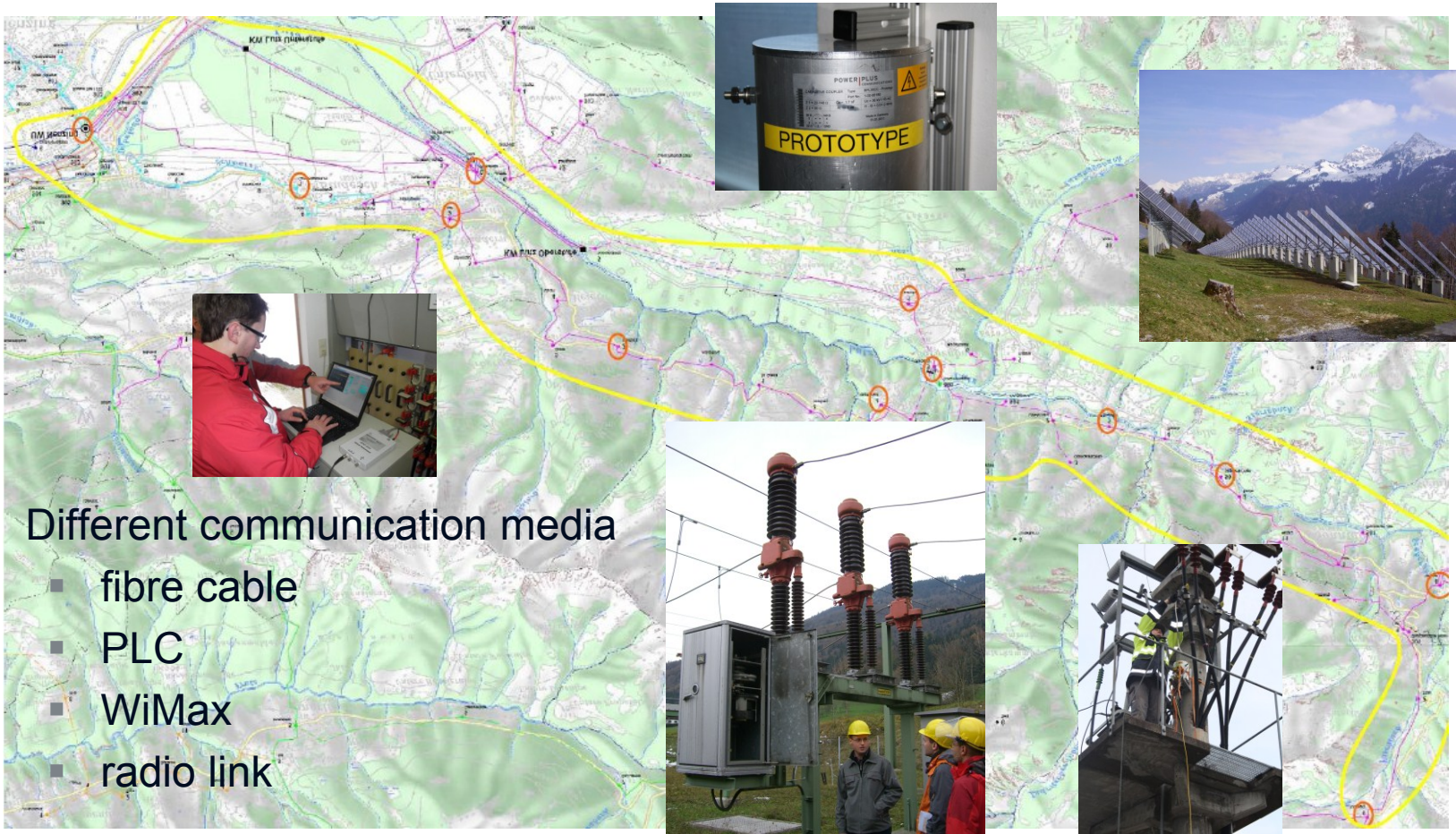


Field tests

Open loop and closed loop tests

Communication

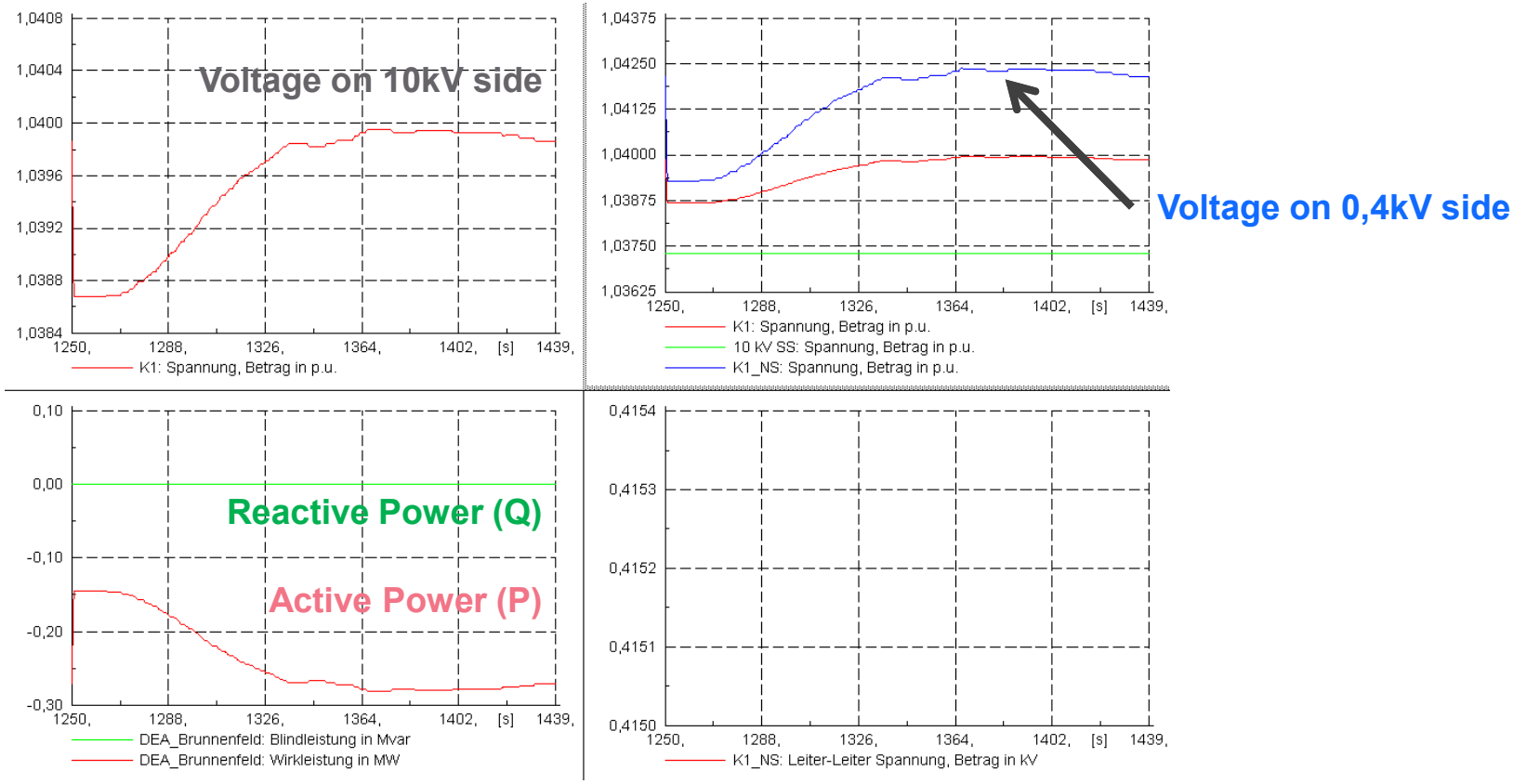
- Großes Walsertal



- Different communication media
  - fibre cable
  - PLC
  - WiMax
  - radio link

Field test DG Brunnenfeld (Substation Bürs)

- Without range control



Field test DG Brunnenfeld (Substation Bürs)

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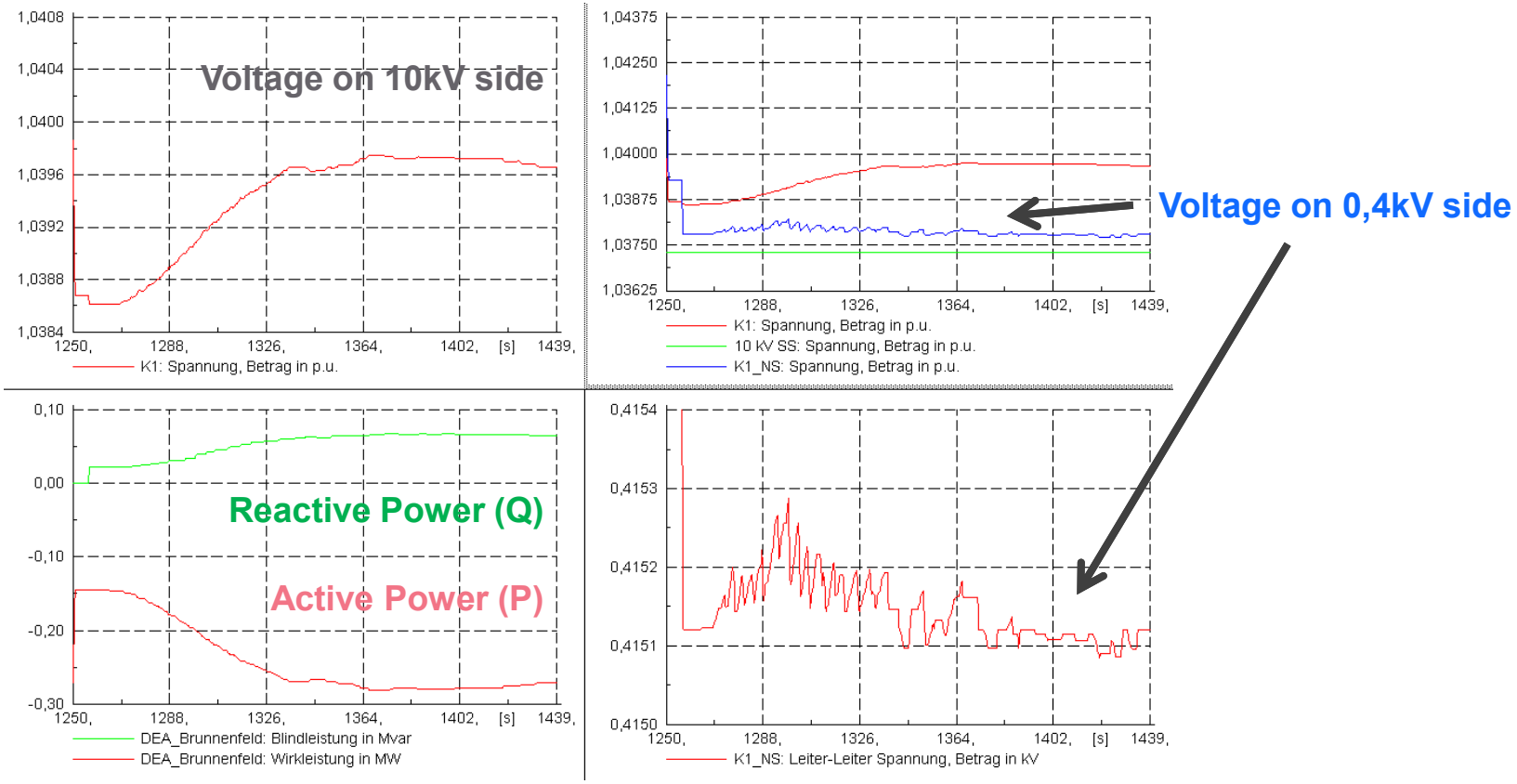
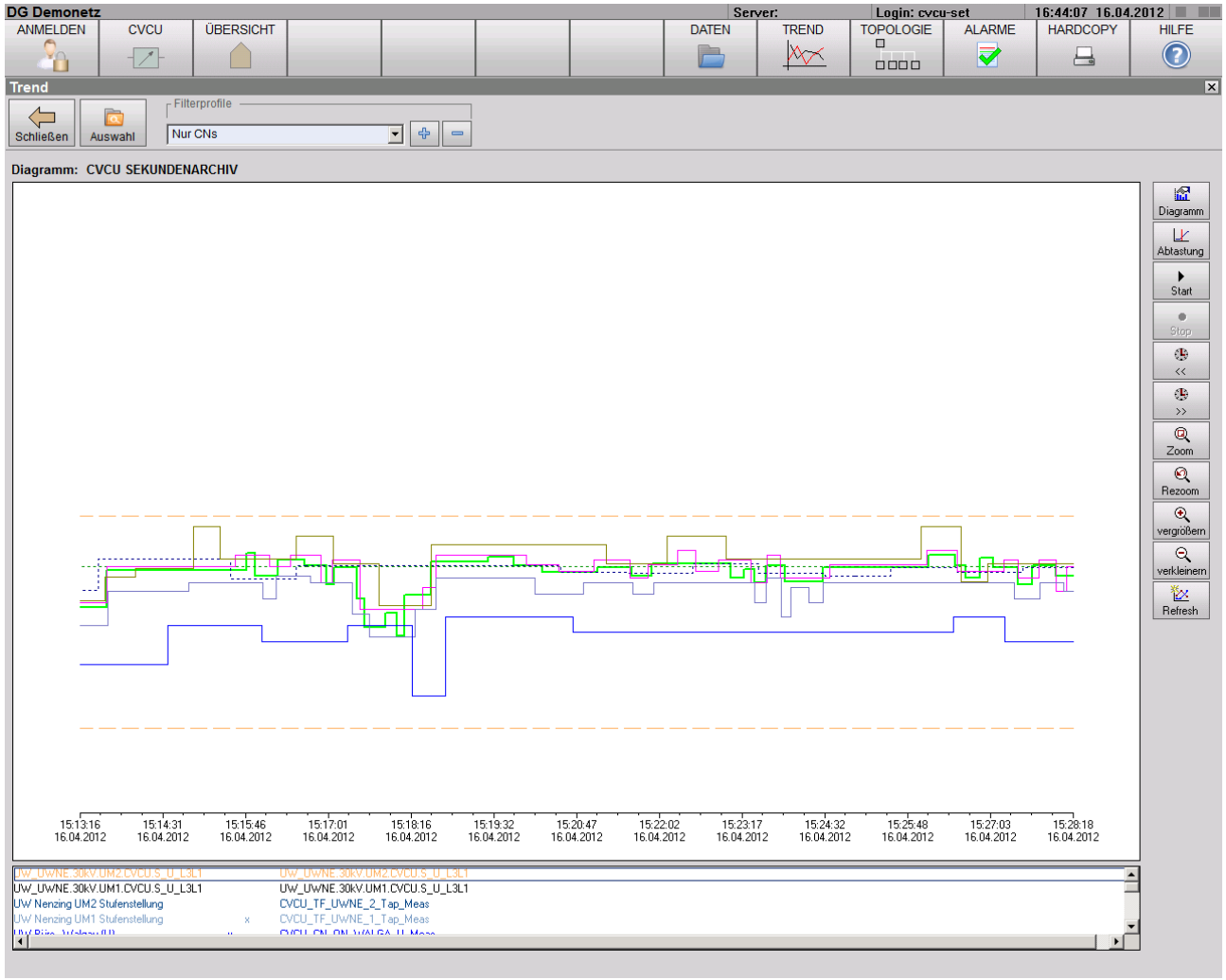
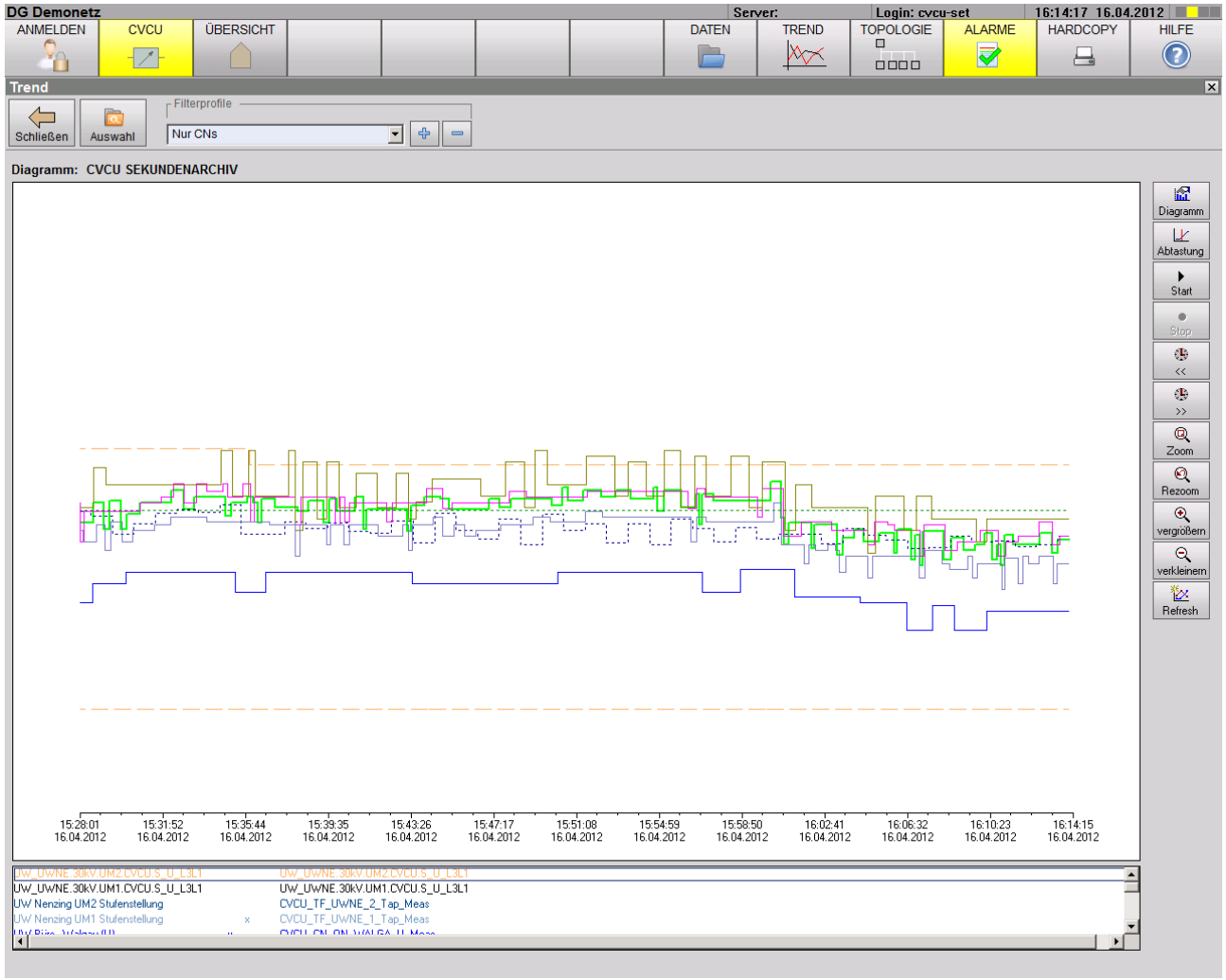


Closed loop operation (1)

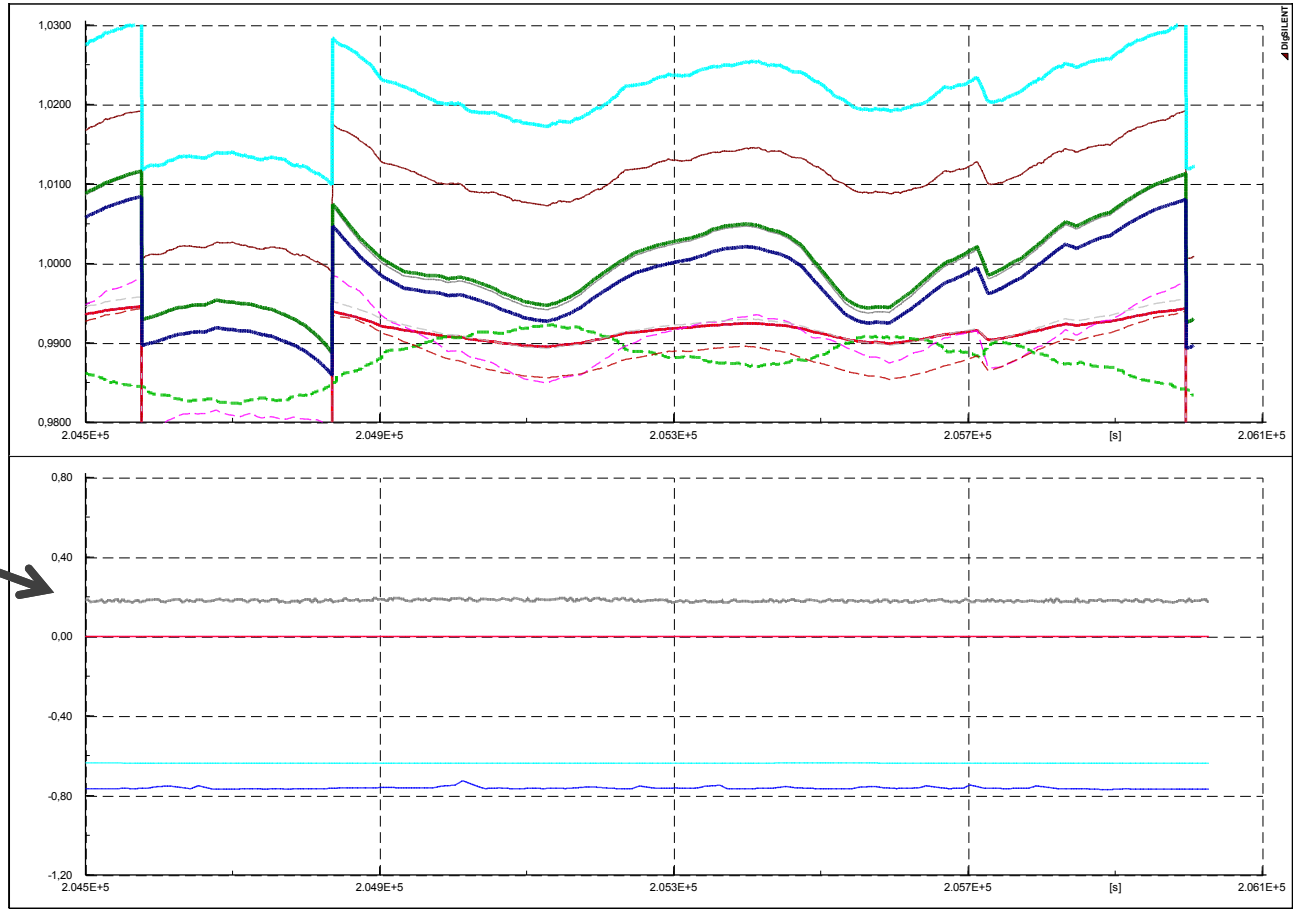


Closed Loop operation (2)



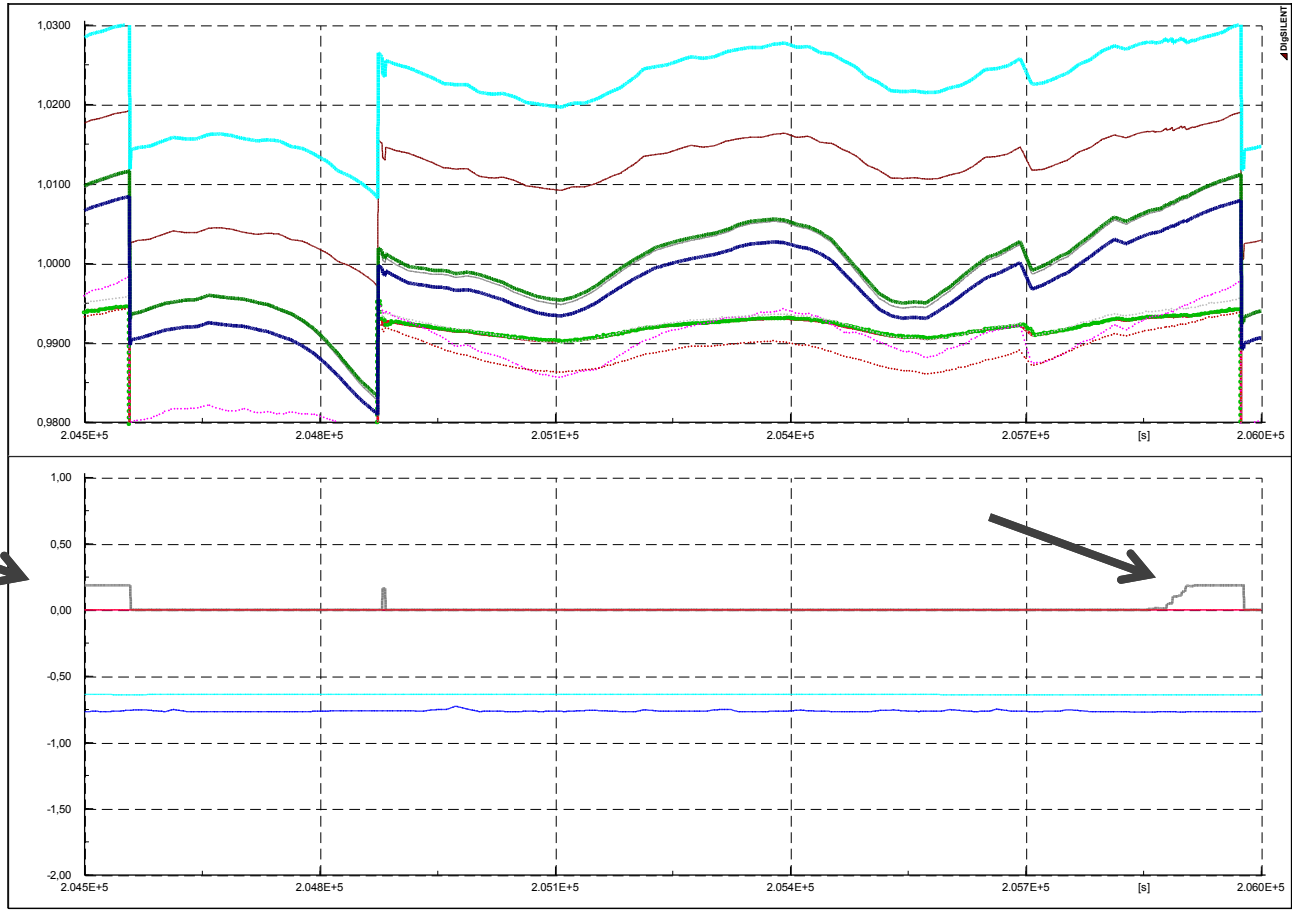
Control strategy: Effective voltage band (independent)

- Range control tries to keep voltages within EVB with Q from the DG



Control strategy: Full voltage band (cooperative)

- Range control only activates Q when voltage limits are to get violated

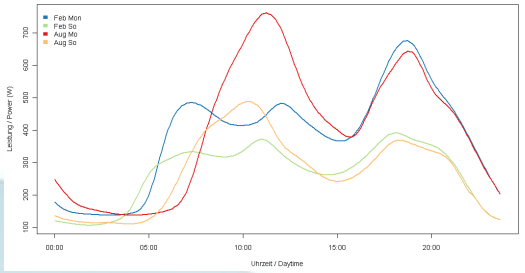


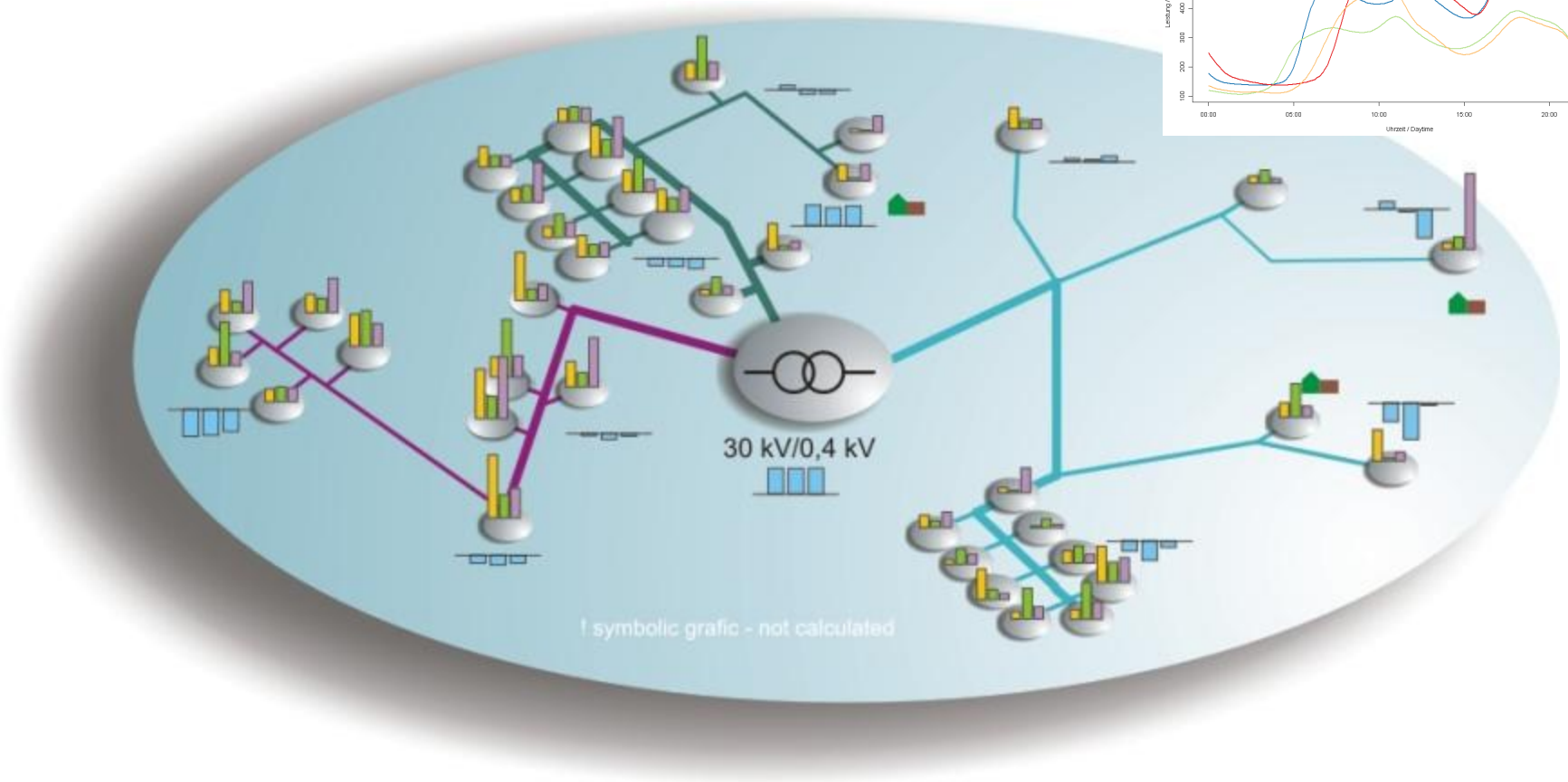
Low Voltage Distribution Networks

Status quo in planning and operation

Low Voltage Networks

Current state of operation and planning methods

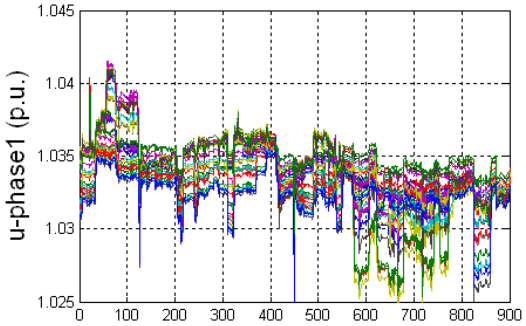


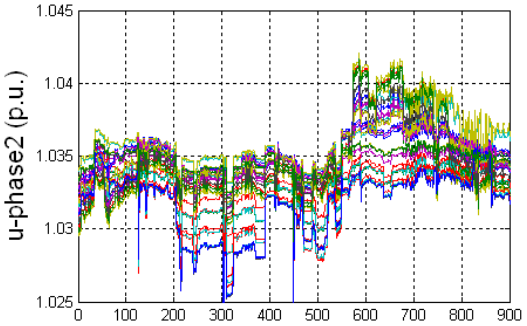


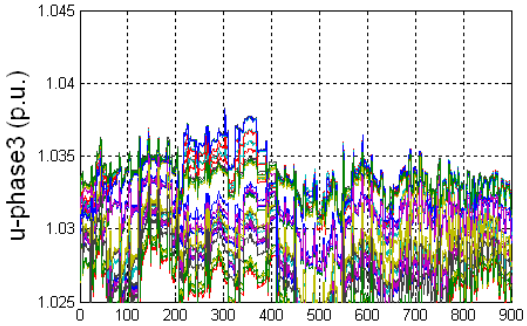
Low Voltage Networks

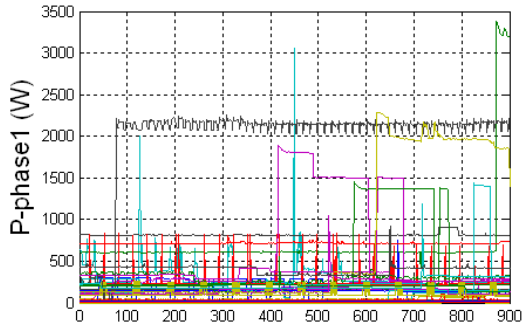
Real voltage and power profiles

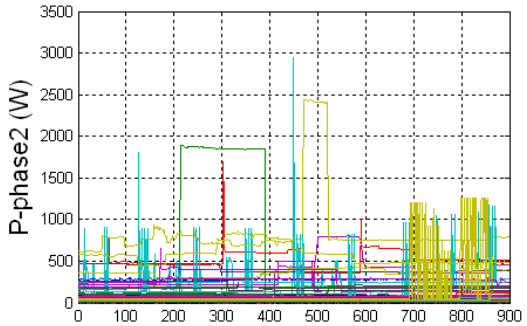
- 900 1-sec RMS values of voltages and powers of all nodes

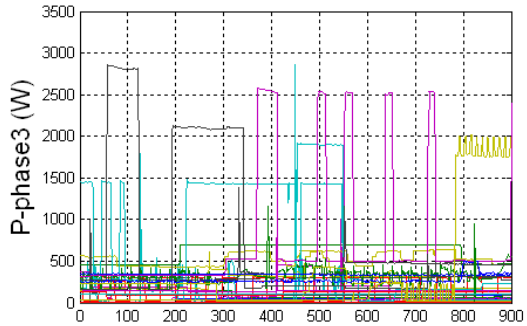








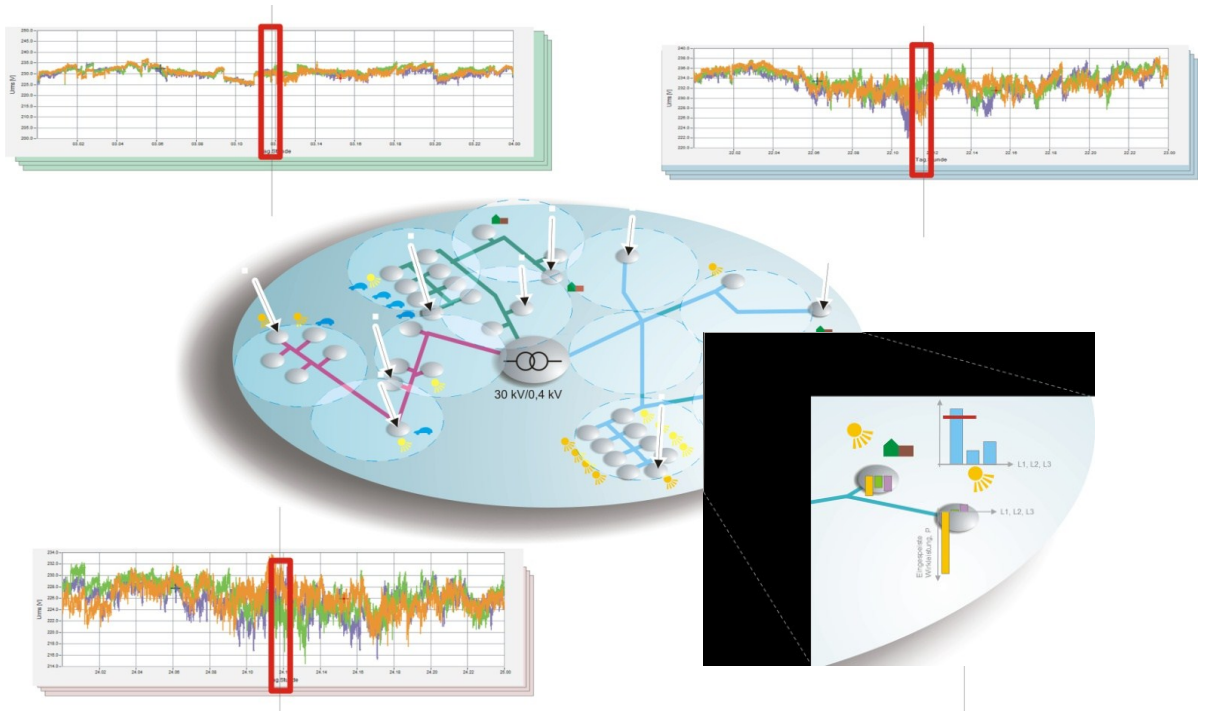




PSSA Method

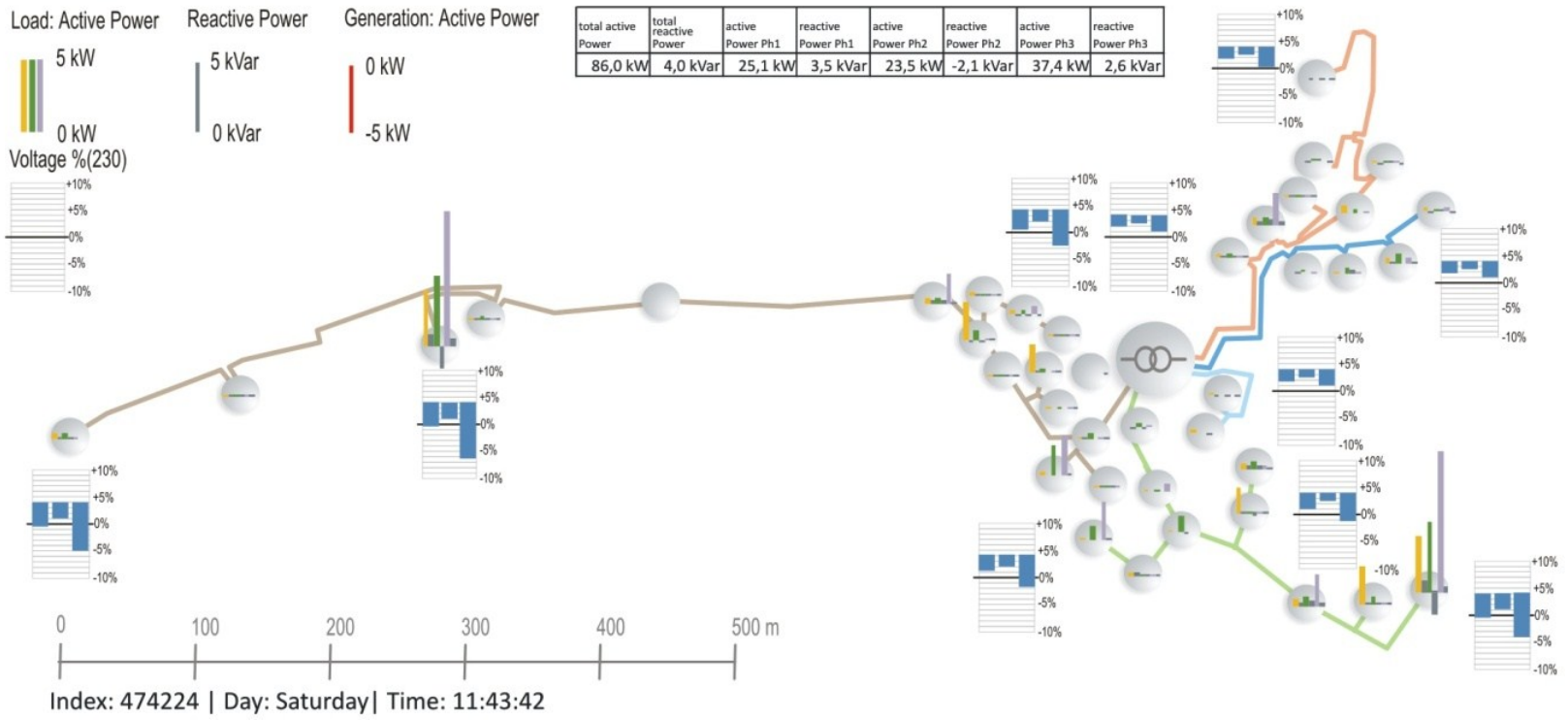
Power SnapShot Analysis

- **Synchronized measurements** per meter (1 sec-RMS)
  - 3x voltages, 3x current, 3x active and 3x reactive power
- **Trigger suggestions** sent to dataconcentrator, where triggers are selected



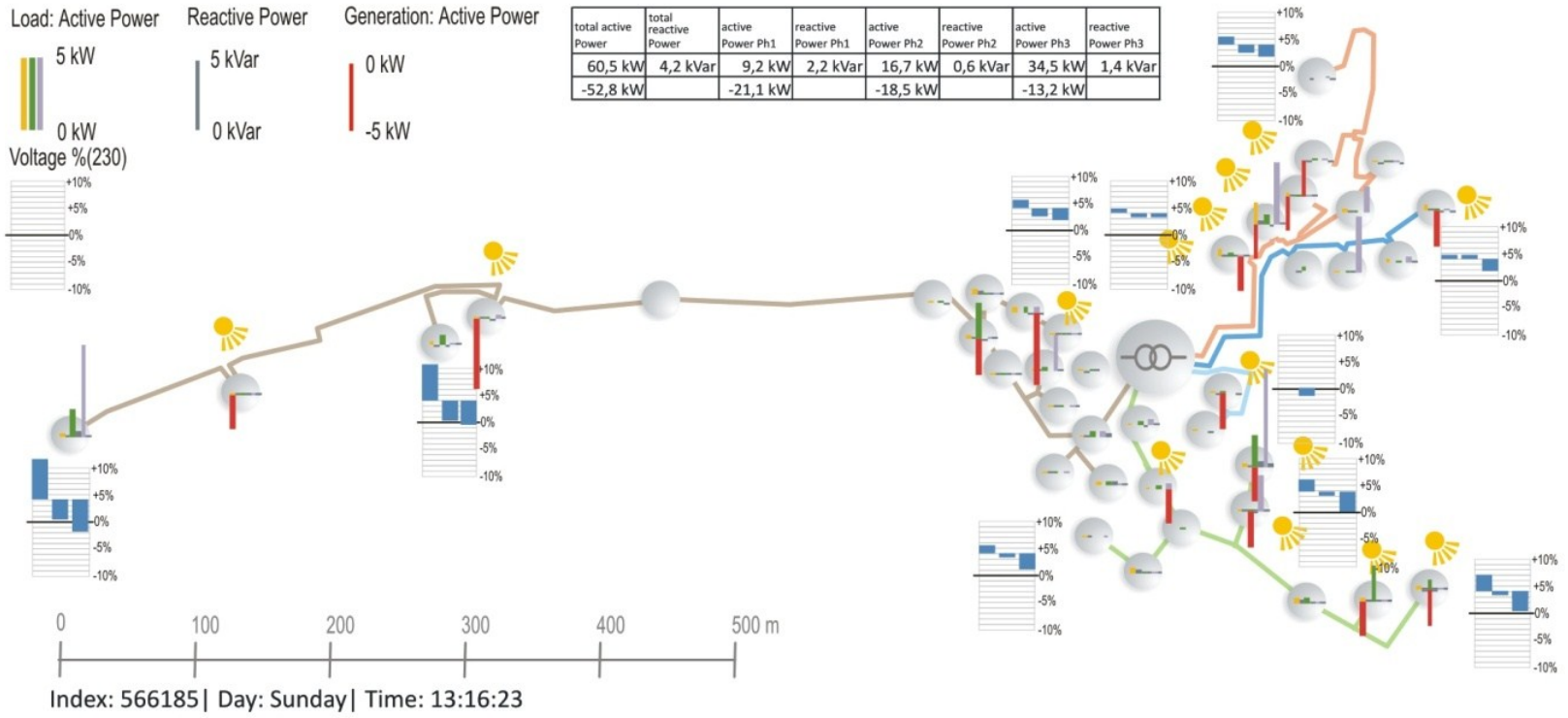
Simulation of Szenarios

- Power SnapShot



Scenarios with PV

- Power Snap Shot with additional single phase PV

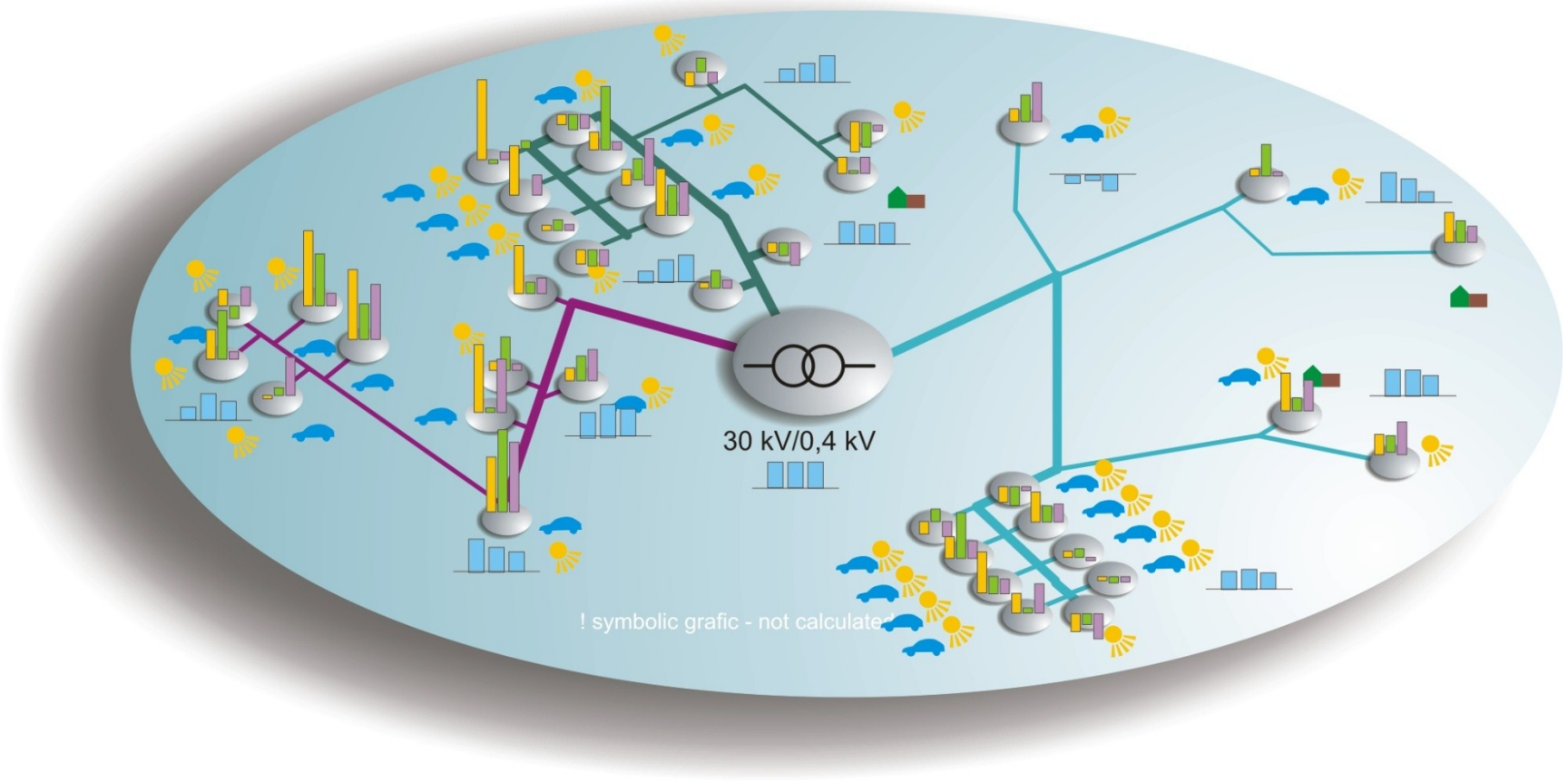


total active Power	total reactive Power	active Power Ph1	reactive Power Ph1	active Power Ph2	reactive Power Ph2	active Power Ph3	reactive Power Ph3
60,5 kW	4,2 kVar	9,2 kW	2,2 kVar	16,7 kW	0,6 kVar	34,5 kW	1,4 kVar
-52,8 kW		-21,1 kW		-18,5 kW		-13,2 kW	

Towards a ‚Smart LV Grid‘

PV und Electric Vehicles are the main drivers for a Smart LV Grid

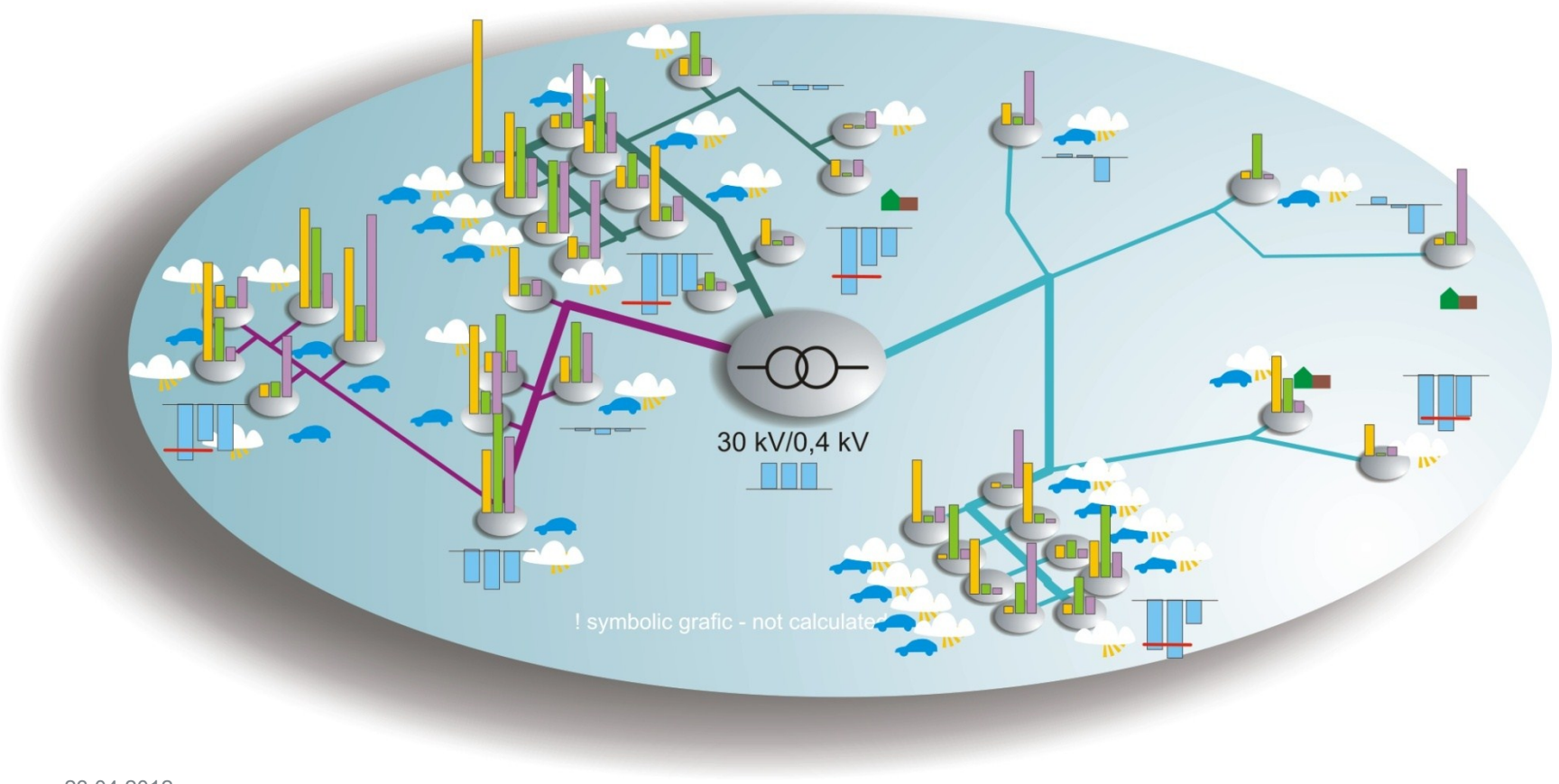
- PV and EV



Towards a ‚Smart LV Grid‘

PV und Electric Vehicles are the main drivers for a Smart LV Grid

- No PV



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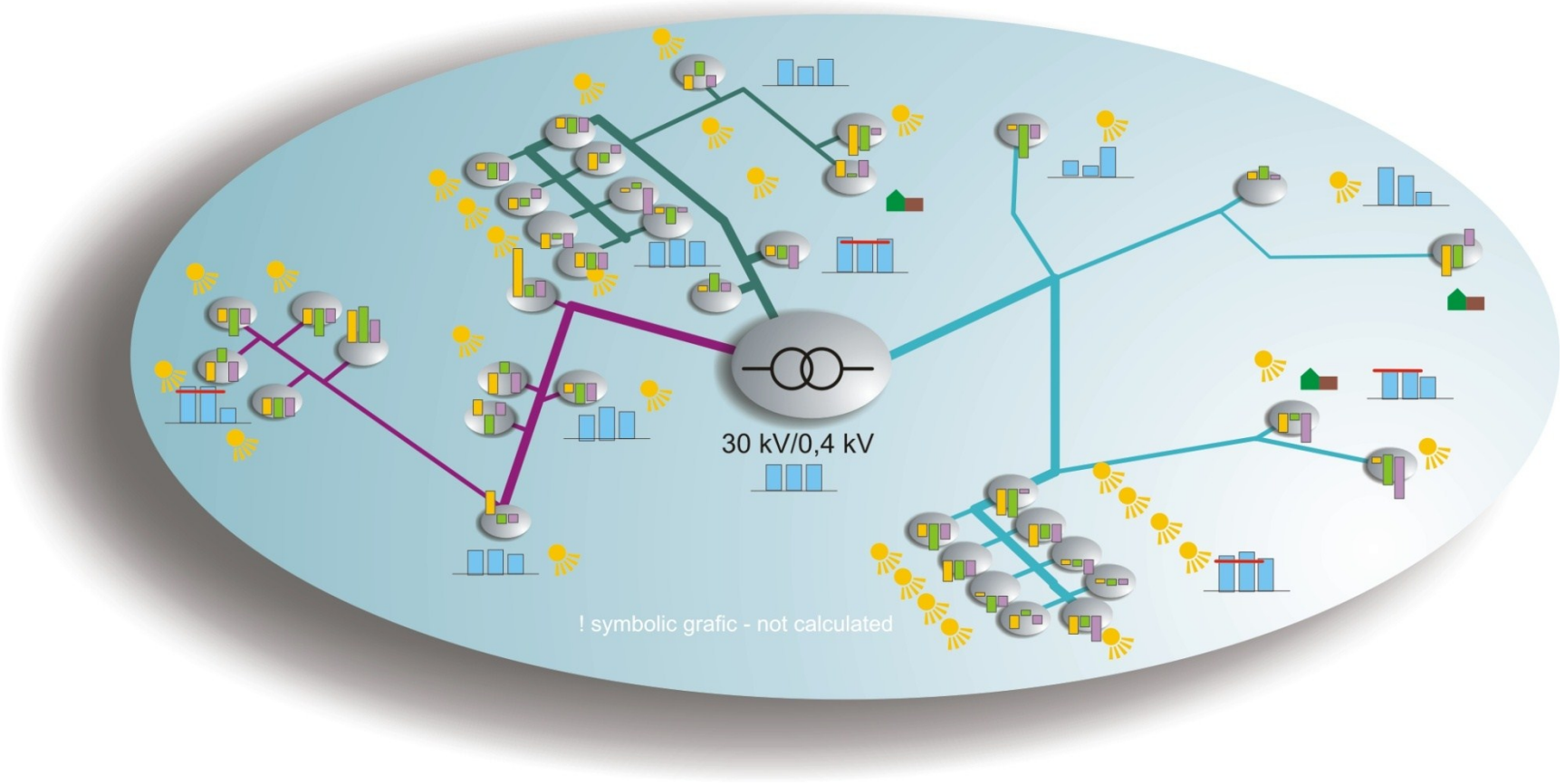

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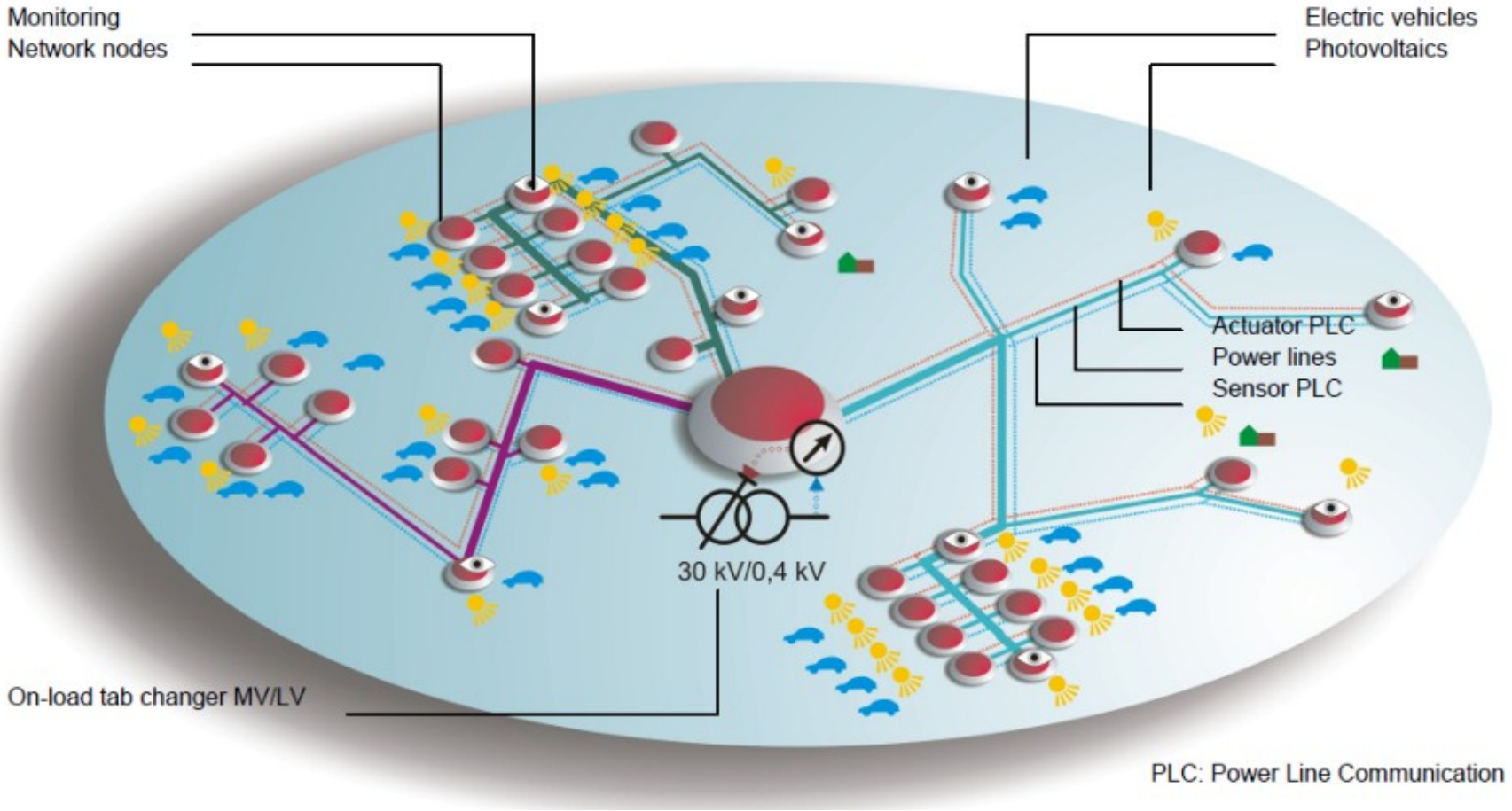

Conclusion and Outlook

Integration of DER

- DG: Integration with Volt/Var Control
- DR: Smart LV Grid → Controllable Charging of Evs
- B2G: Shifting load by utilizing the thermal storage of the building

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