Smart Grid Project in Vrchlabi: Automated Distribution Network

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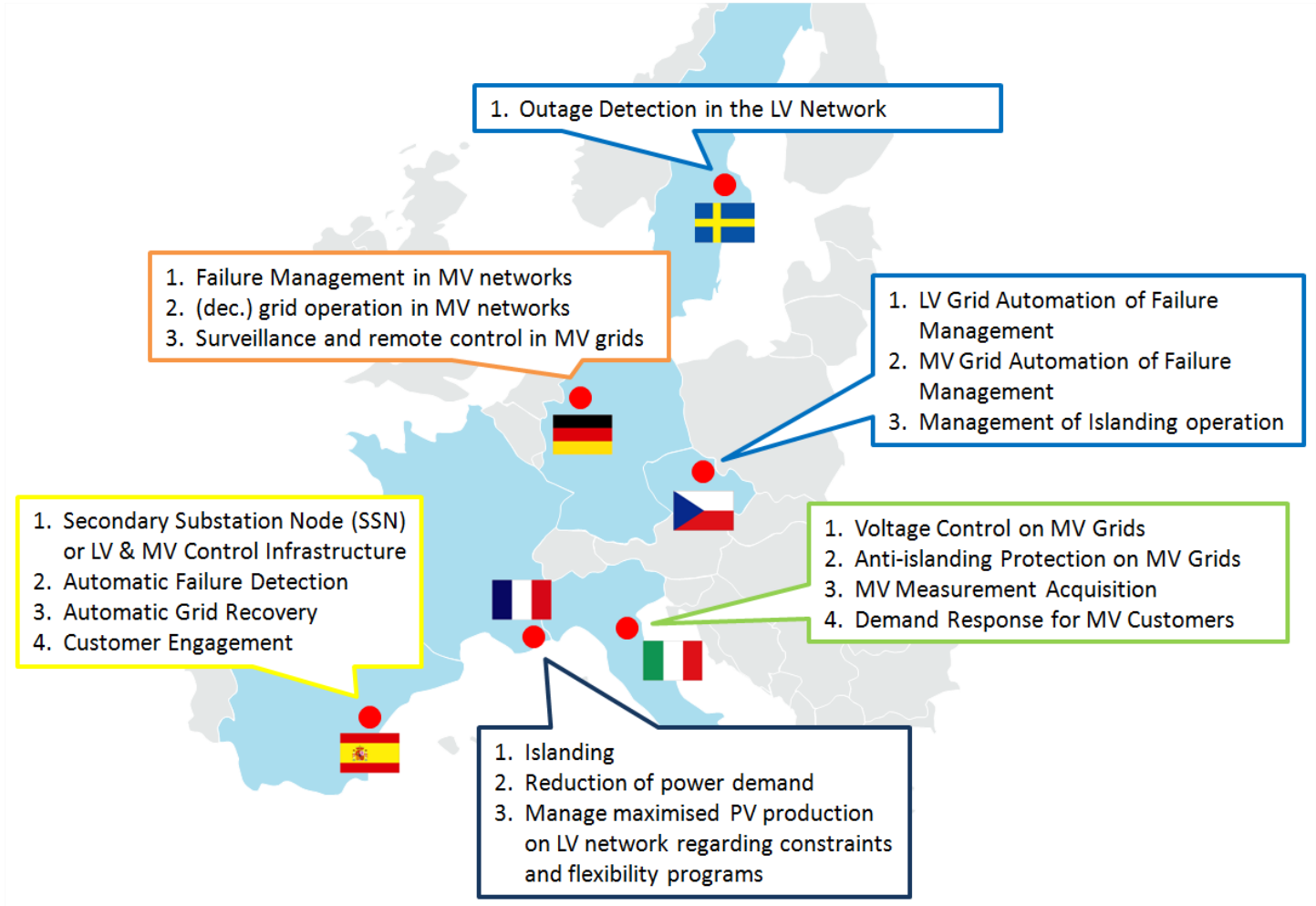
GRID4EU
INNOVATION FOR ENERGY NETWORKS

DEMO5 within GRID4EU (Smart Region in Vrchlabí)



Project tasks and goals

- **TASKS**

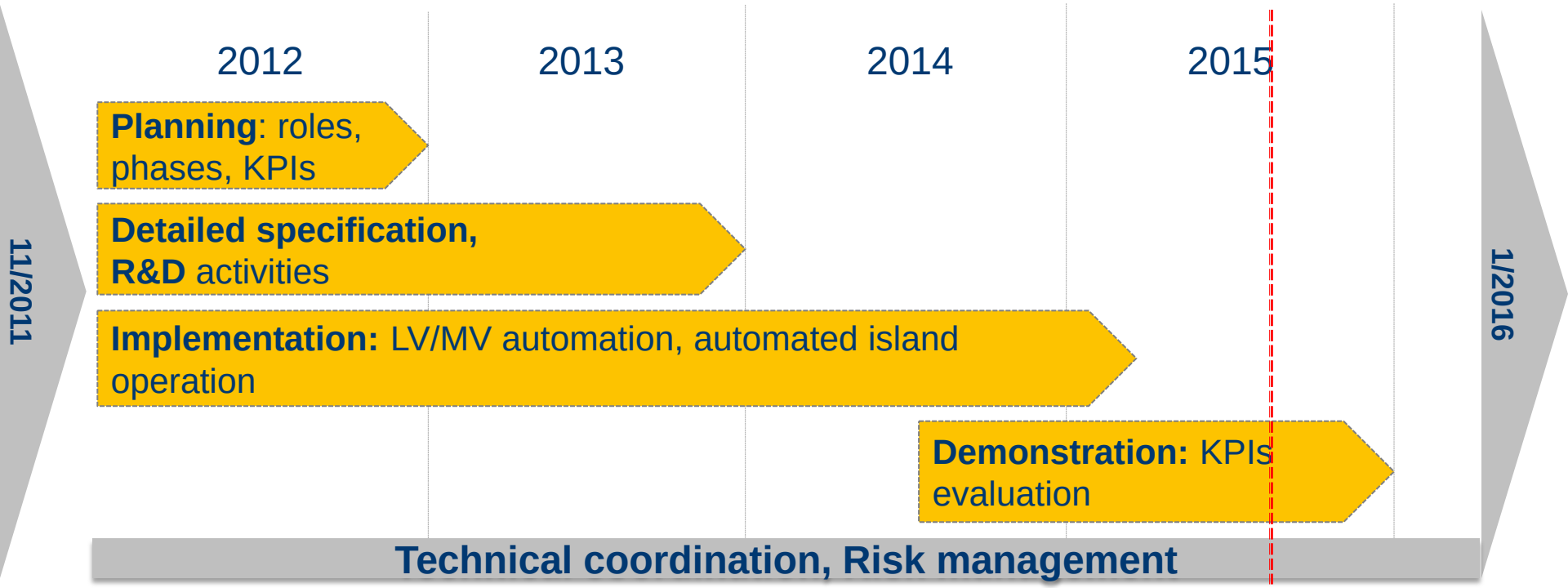
The project aims to test functions which are not usual so far within CEZ Distribuce area

The overall goal is to increase the quality and reliability of power supply

- **Main goals**
  - Automated failure management of LV network
  - Automated failure management of MV network
  - Automated island operation with CHP

- **Drivers**
  - To ensure (future) reliability of distribution network and quality of power supply
  - To reduce grid losses
  - To reduce time of electricity outages

Project progress



- **Time schedule**
- 2015 – operation of all functionalities, project result + evaluation (KPIs)

Automated failure management of LV network

- **Description:** automation of failures isolation between two DTSs - interconnected topology of distribution network

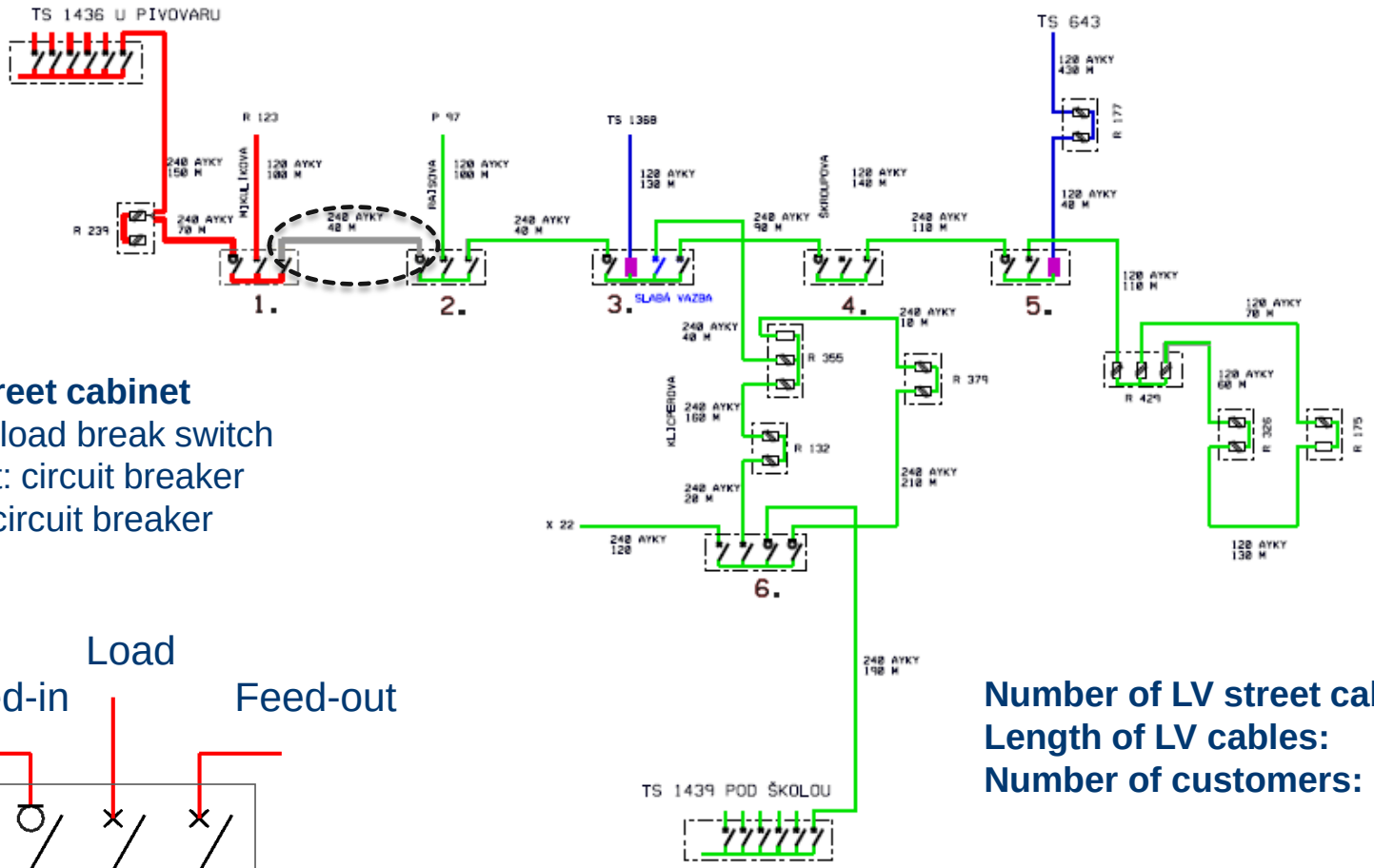
- **Implementation:** replacement of fuses in LV network (MV/LV substations, LV street cabinets) with remote controlled equipment enabling measuring, information transfer, remote and autonomous control

- **Communication:** Wi-MAX

Former equipment

New equipment

Automated failure management of LV network



LV Street cabinet
input: load break switch
output: circuit breaker
load: circuit breaker

Number of LV street cabinets: 6
Length of LV cables: 4km
Number of customers: 64

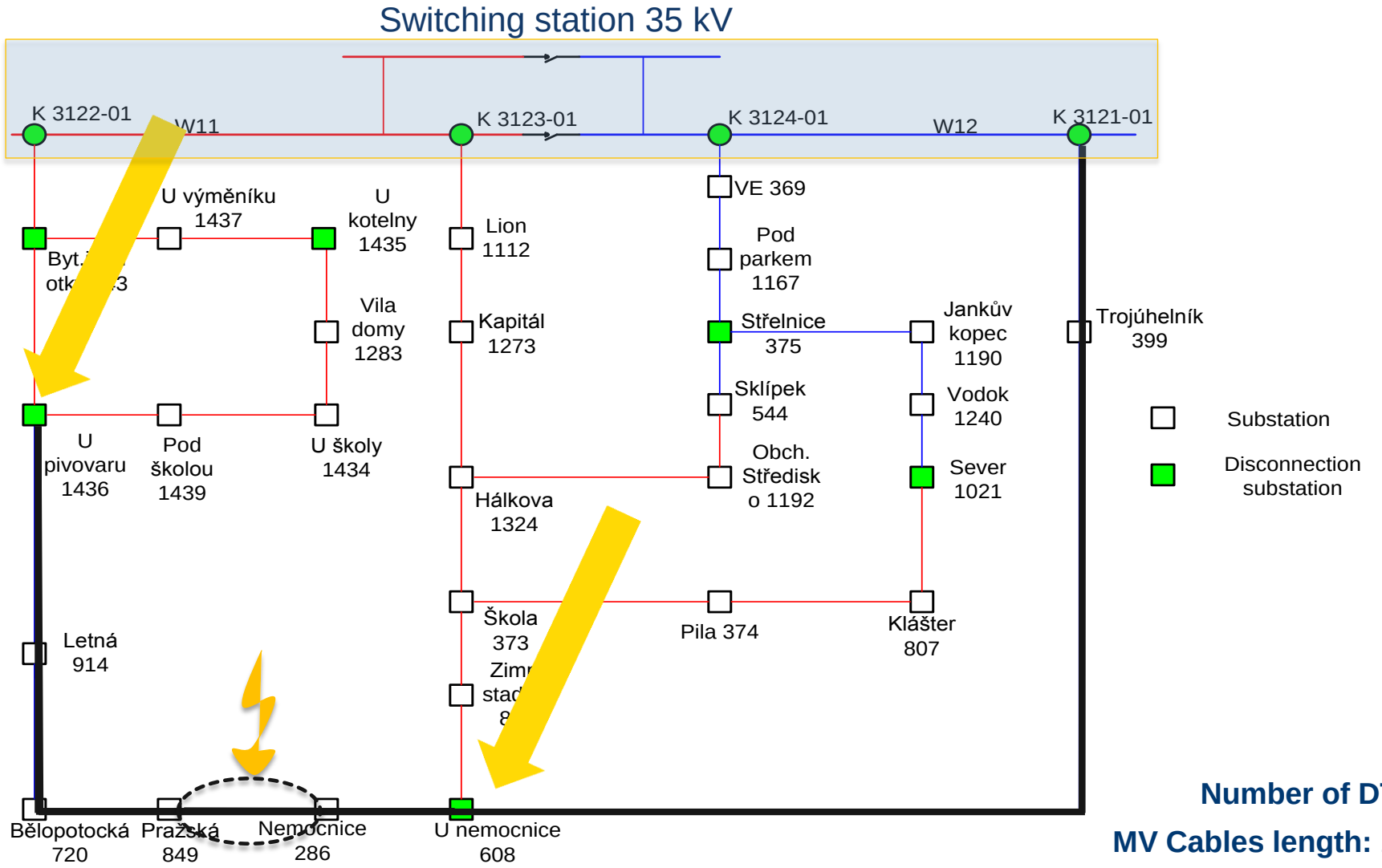
Automated failure management of MV network

- **Description:** automated failure isolation in municipal MV network (operated in a loop)
- **Implementation:** selected MV/LV substations enable to disconnect the section in order to isolate the failure first = disconnection points, these are equipped with switches, protections and RTUs, other DTSs are fitted with a RTUs and directional fault current indicators allowing fault localization of failure between the two closest MV/LV substations and thus significantly reduce affected area in the second step
- **Communication:** fiber optic, Wi-MAX, GPRS

Former equipment

New equipment

Automated failure management of MV network



Number of DTSs: 28

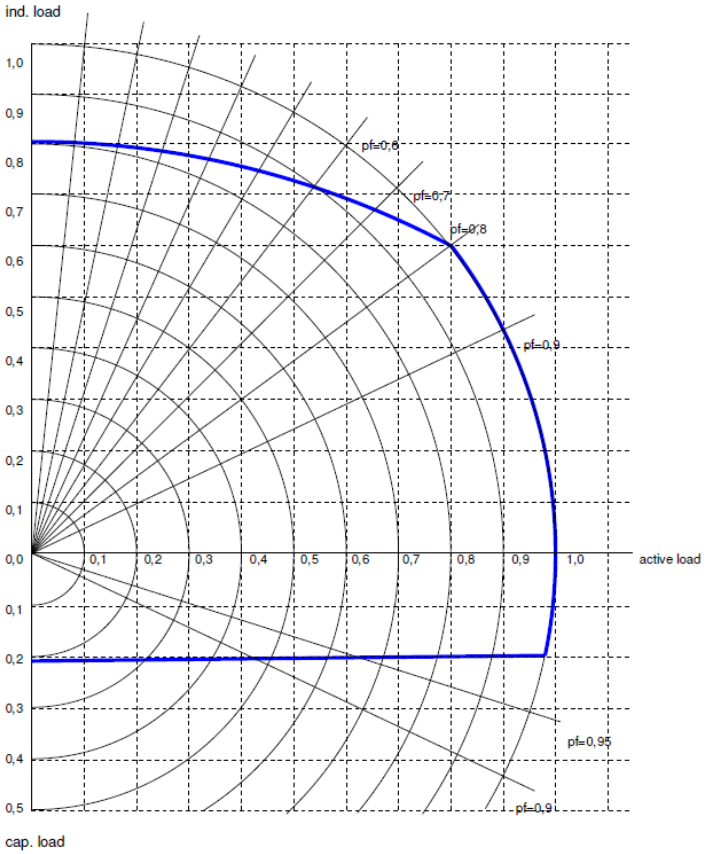
MV Cables length: 12,9 km

Number of customers: 4895

Island operation with CHP

- **Description:** fully autonomous island operation of the predefined part of the MV distribution network (7 MV/LV substations)
- **Implementation:** there is balance, disconnection and synchronization automatics installed in order to ensure appropriate performance of island operation, fast disconnection of islanding area from the rest of MV network is provided by disconnection points, balance of load and power supply of the island area is secured by the regulation of the CHP generator, by additional watt load (water boiler) and also each of the MV/LV substation‘s LV feeder is controlled by remote controlled circuit breakers
- **Communication:** fiber optic (GOOSE messages - IEC 61850)

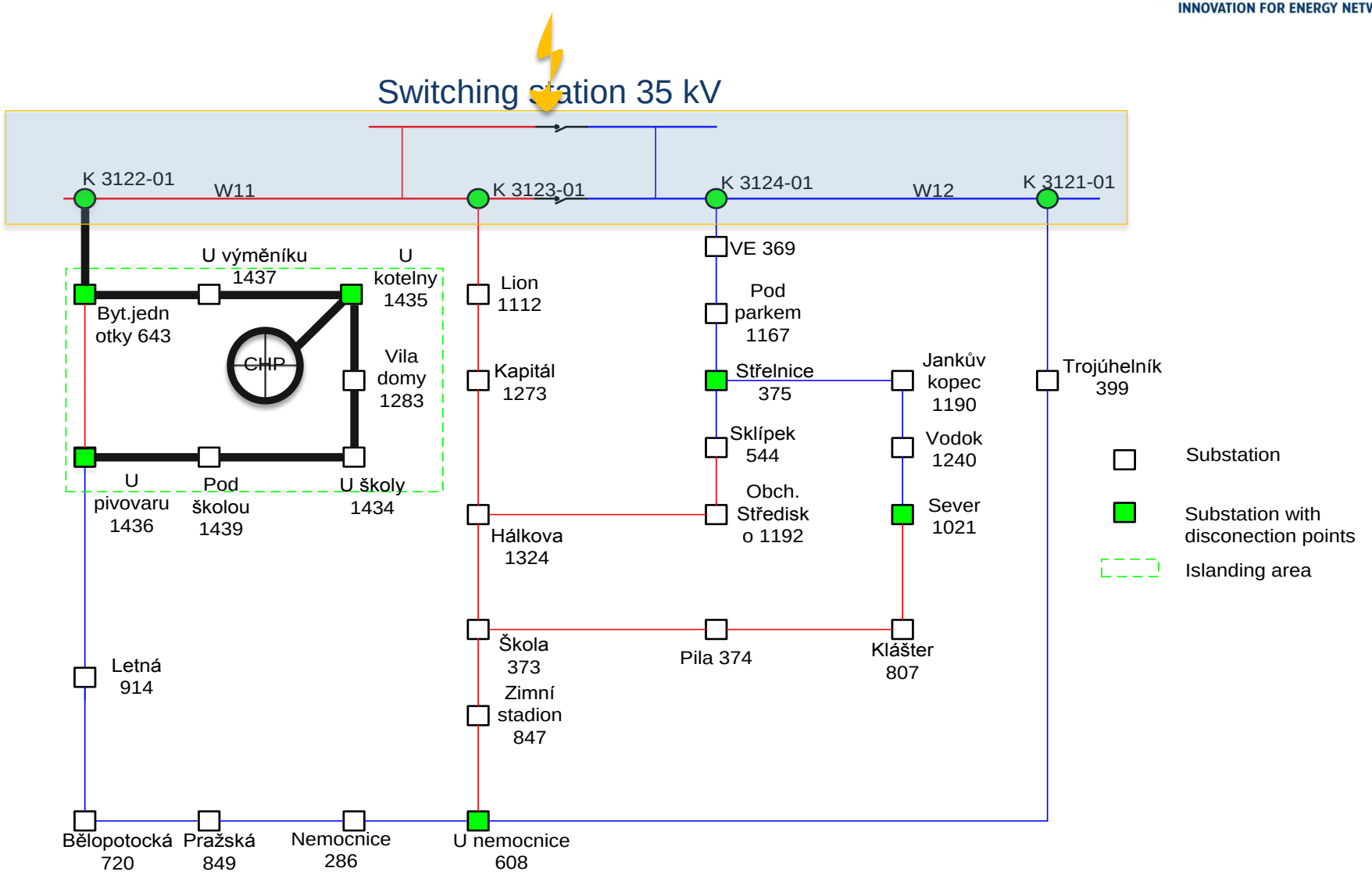
Island operation with CHP



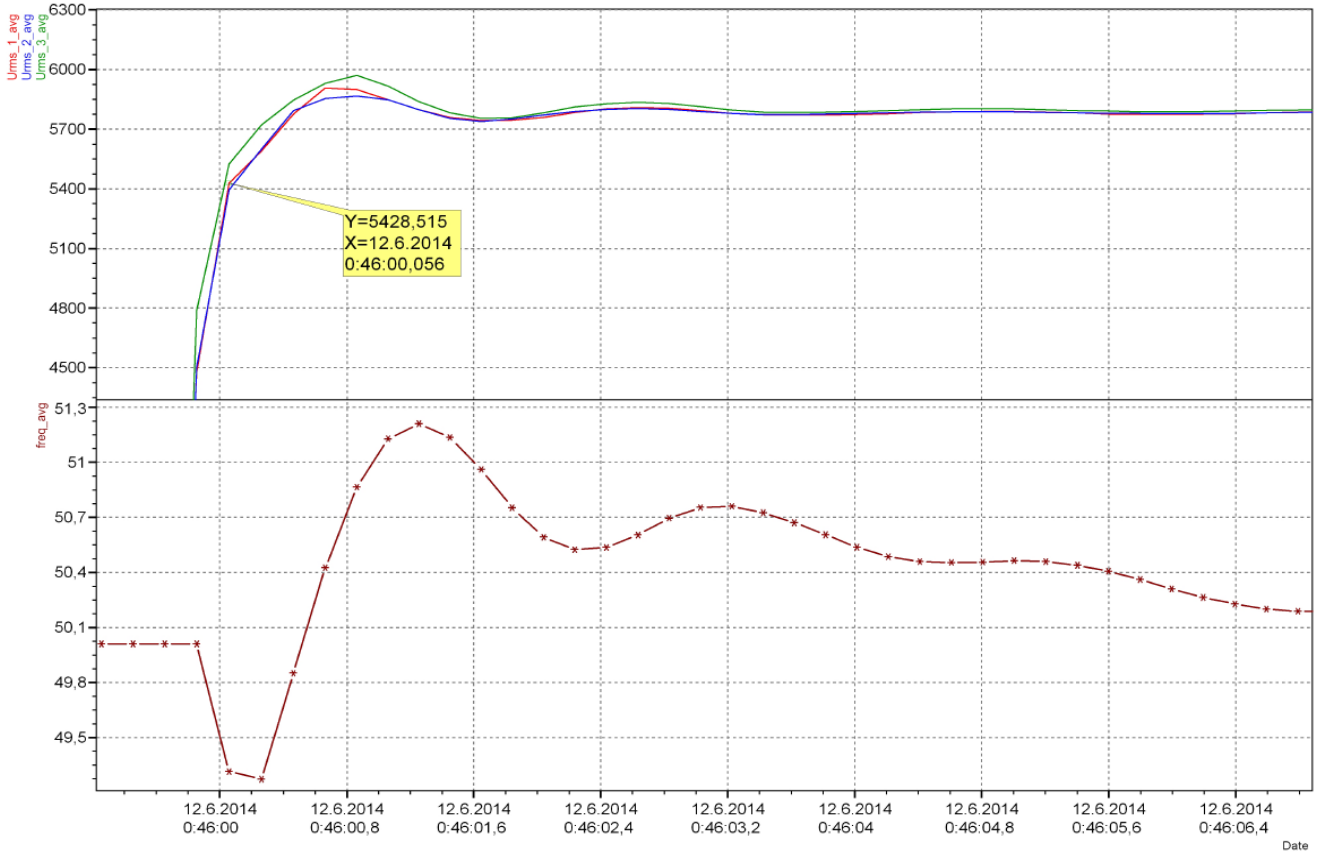
Load measurement	P [kW]	Q [kVAr]
summer maximum	950	240
summer minimum	350	80
winter maximum	1270	270
winter minimum	500	80

- Load measurement of max and min P and Q in the IO area preceded IO tests
- Synchronous generator used in CHP unit (1,6 MW) is suitable for IO

Island operation with CHP

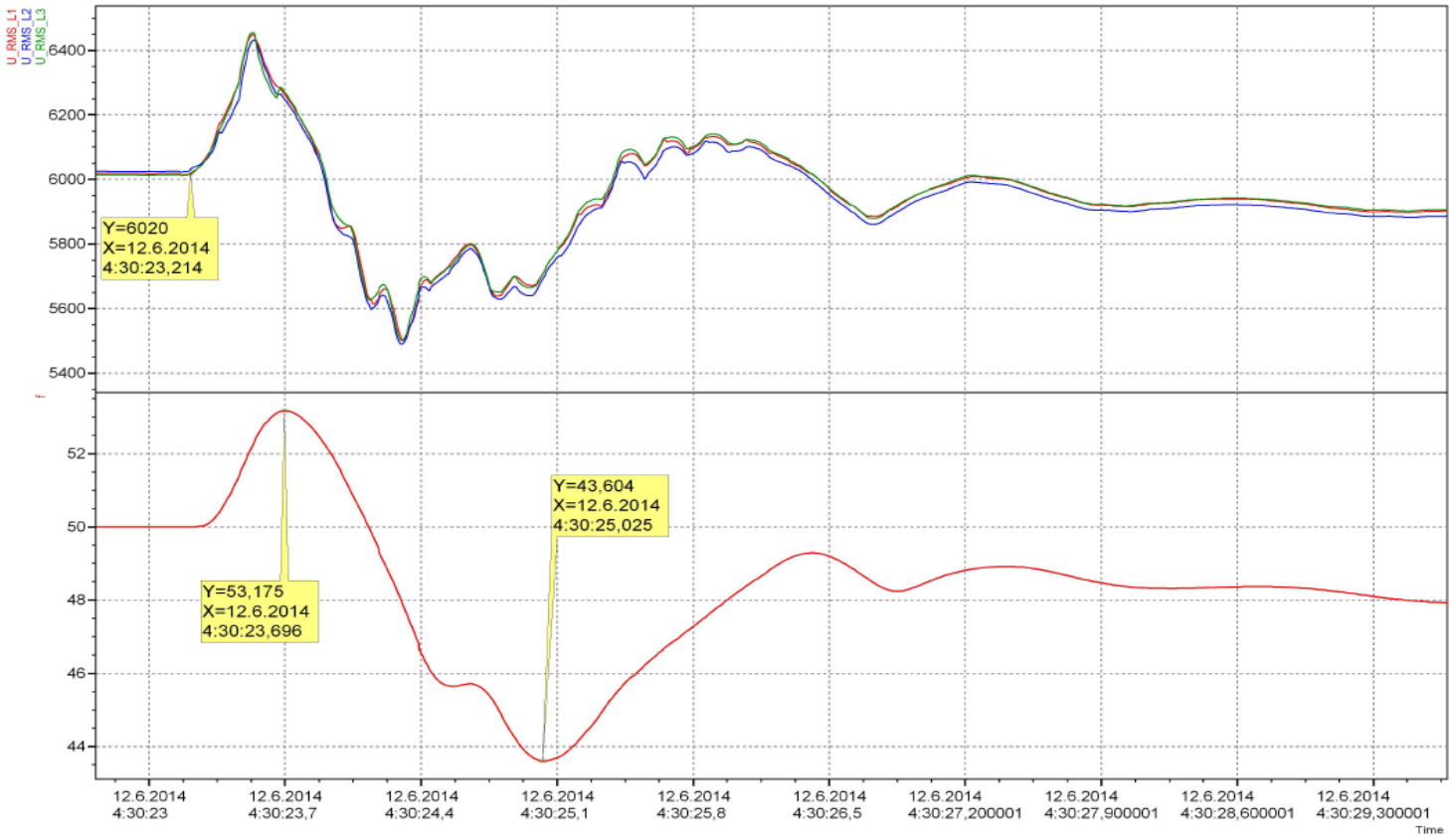


Black start of island operation: test on 10kV level



- Real successful black start of island operation in Smart Region Vrchlabí
- EN 50160 standard was fulfilled (for IO - wider range of V and f tolerance)

Switch to island operation: test on 10kV level



- Real successful switch to island operation in Smart Region Vrchlabí
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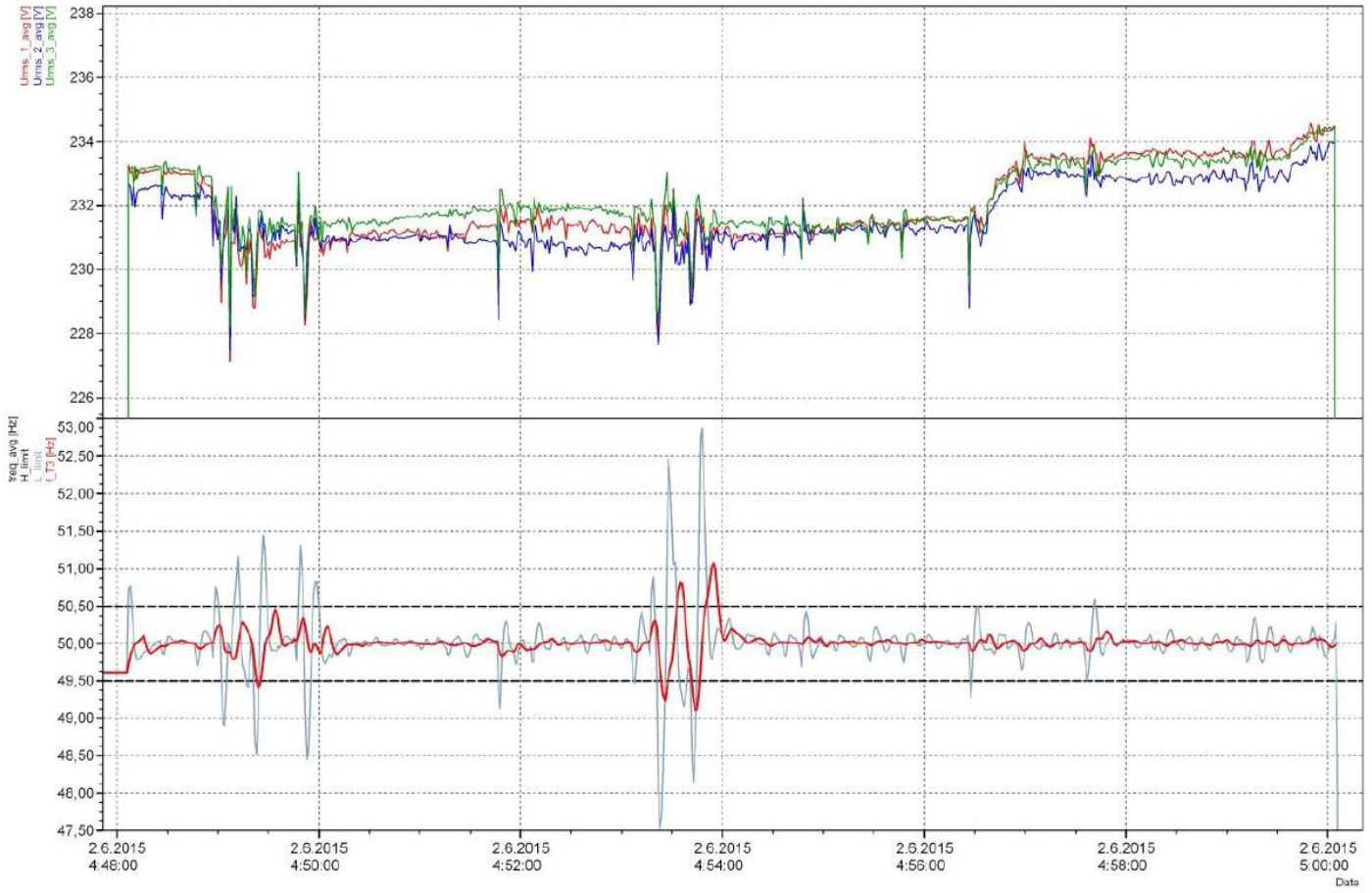
Black start of island operation: test on 35kV level



- Real successful black start of island operation in Smart Region Vrchlabí
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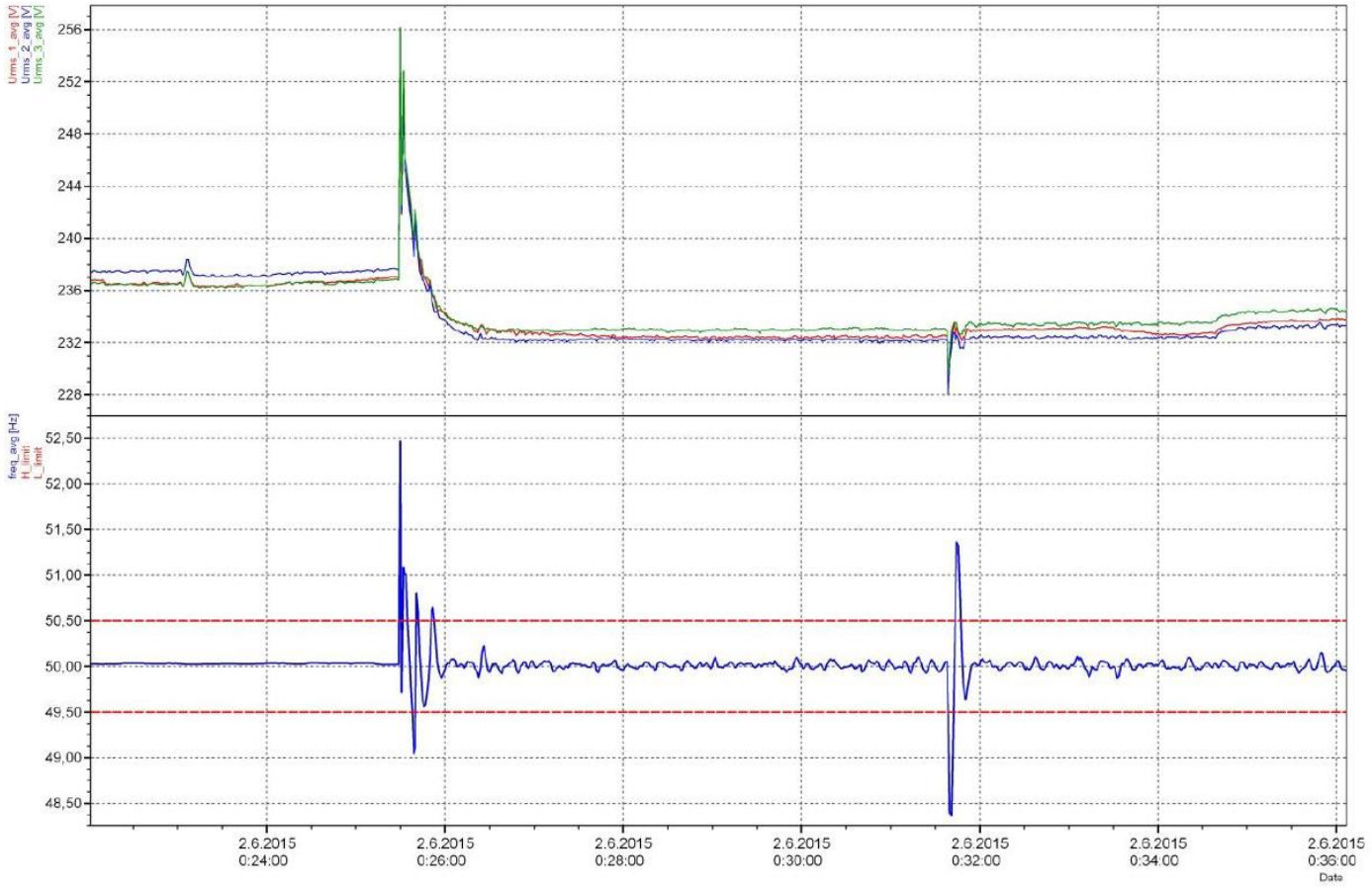
Switch to island operation: test on 35kV level



- Real successful switch to island operation in Smart Region Vrchlabí
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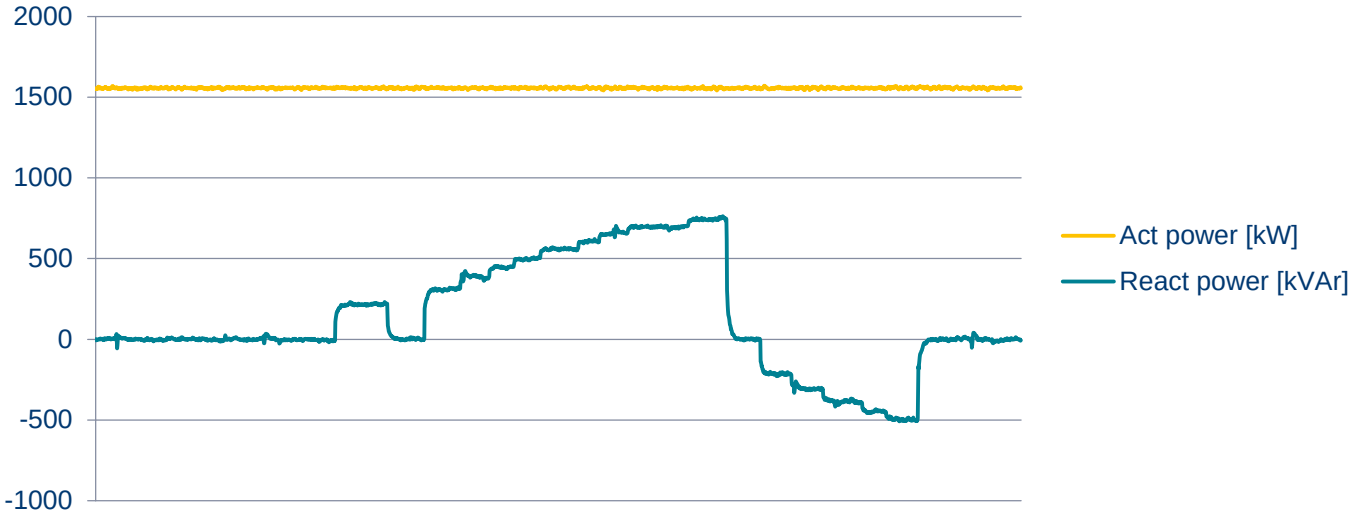
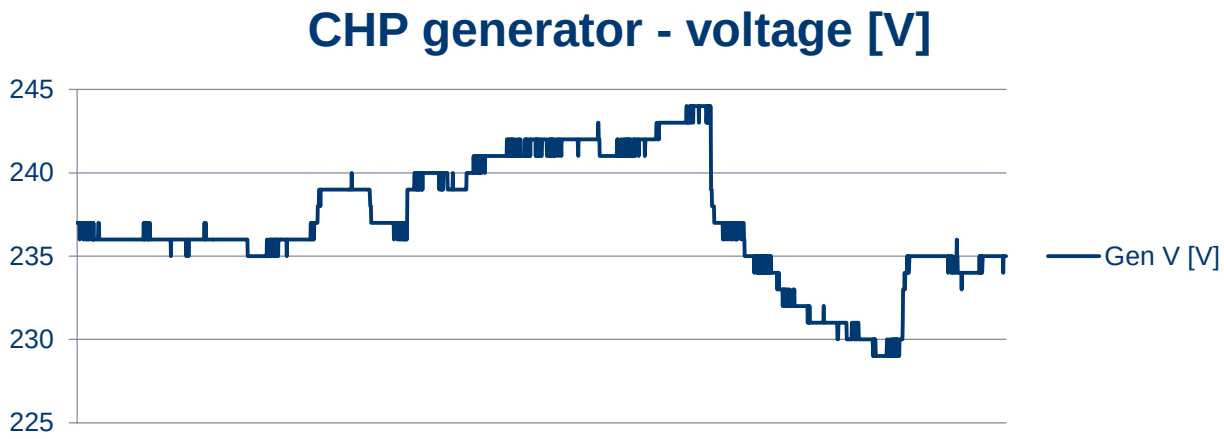
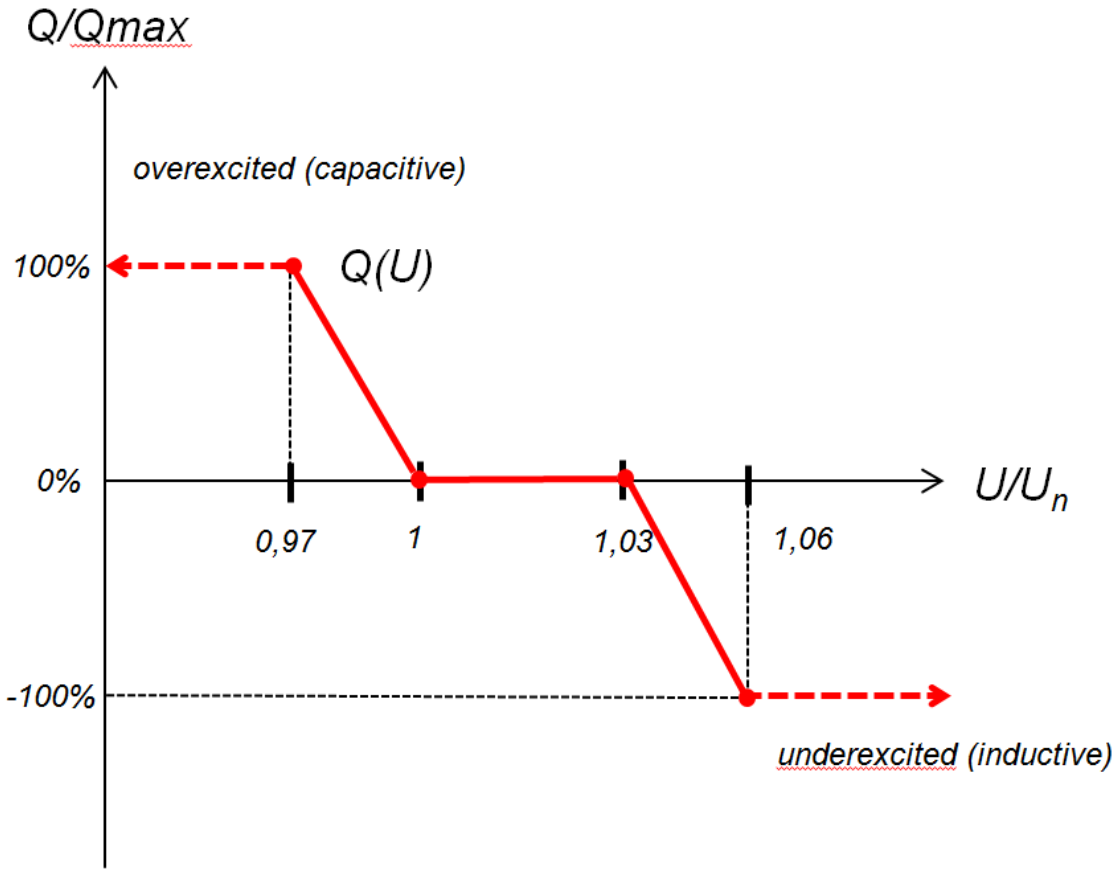
Volt/var control with CHP unit



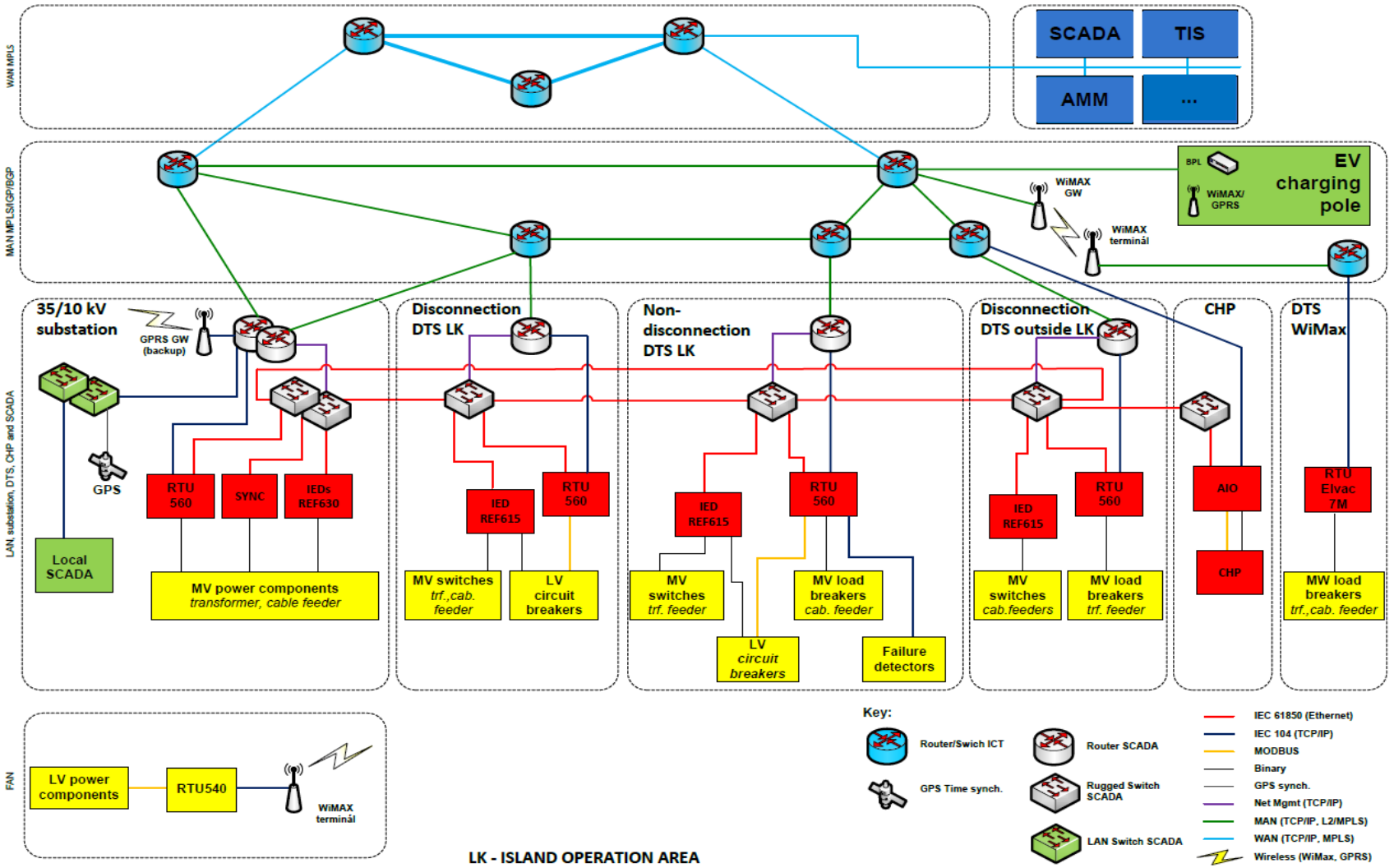


Volt/var control with PV inverters

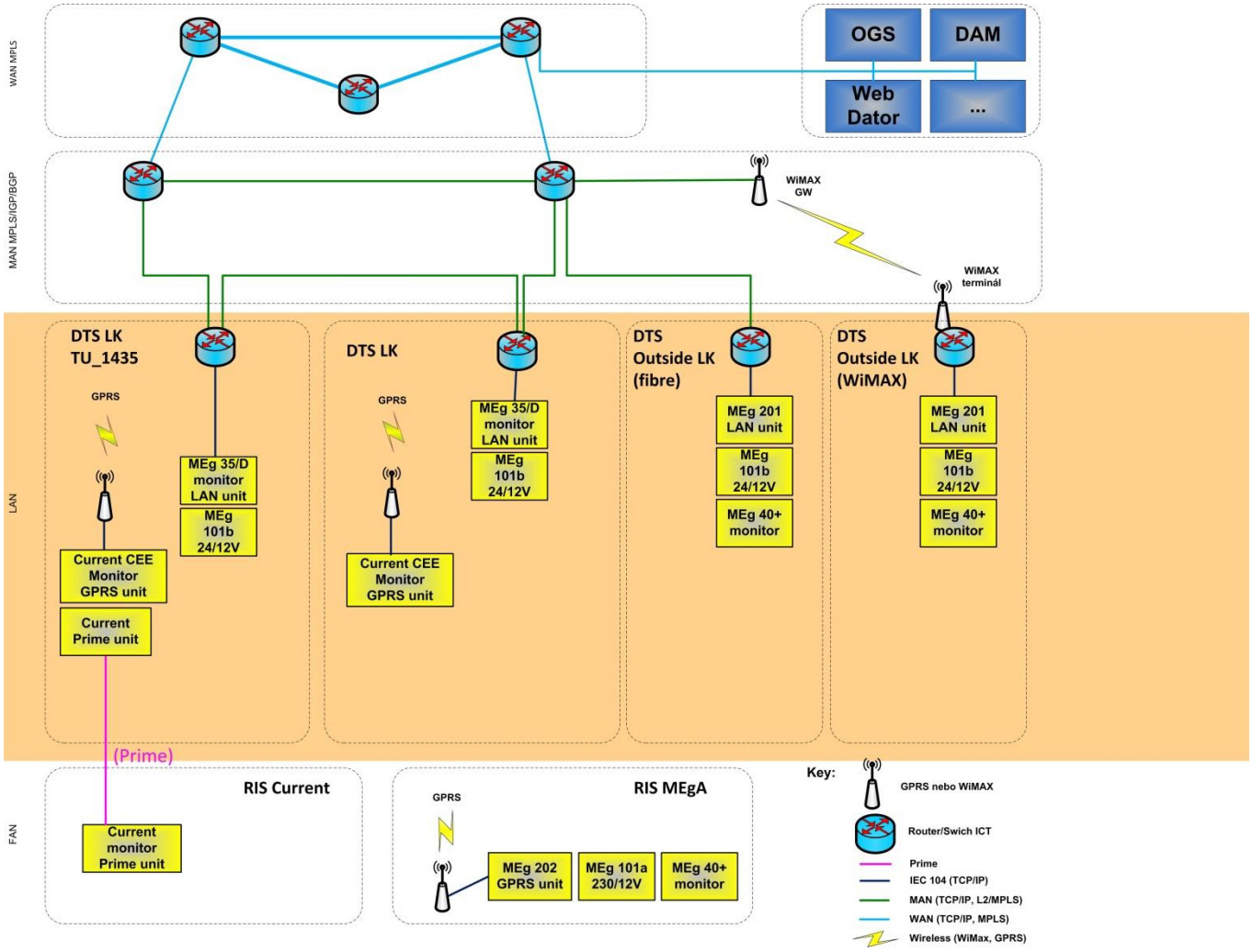


- Autonomous function Q(U) is defined in standard EN 50438 ed.2
- Two customers with ”smart” Fronius inverters agreed with testing
- Function Q(U) contributes for better voltage stability in LV network

Communication topology



Communication topology – power quality measurement



Power quality measurement devices

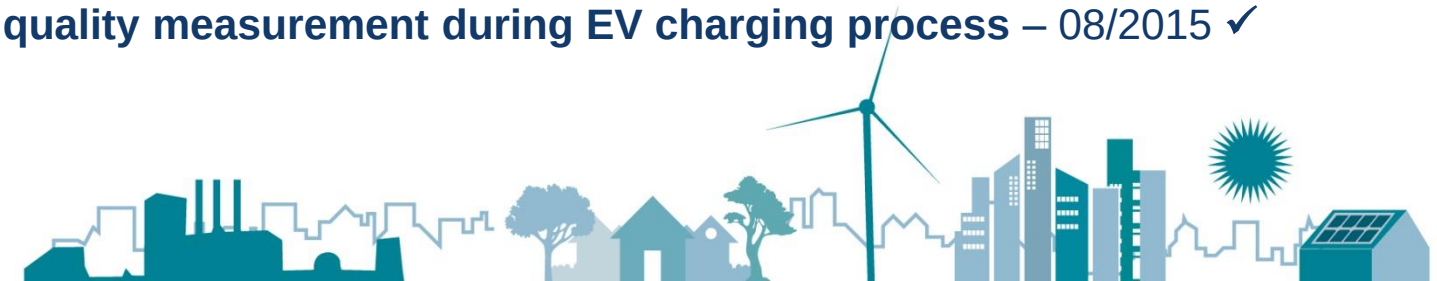
- PQ measurement devices: MEg and Ormazabal Current units
- Measured and evaluated values: V, I, f, S, P, Q, THD

EV charging infrastructure

- 1 x fast charging station (up to 50 kW) + 2 normal charging station (up to 22 kW)
- Power quality measurement and evaluation according to EN 50160 standard

Demo 5 - What was done

- **Implementation of DEMO5 innovative solutions** – all equipment physically installed ✓
- **Implementation of communication infrastructure** – all equipment physically installed ✓
- **Island operation (demonstration)** – successfully tested 06/2014 and 6/2015 ✓
- **Automated failure management of LV network (demonstration)** – successfully tested in 09/2014 ✓
- **Automated failure management of MV network (demonstration)** – successfully tested in 04/2015 ✓
- **Switching station reconstruction** – finalized in 12/2014 ✓
- **Power quality measurement during EV charging process** – 08/2015 ✓



Future use and lessons learned

- **LV automation –** we don't expect wide scale deployment because of expected CBA
- **MV automation** – in specific cases could reduce significantly SAIDI, SAIFI and have positive CBA (deployment depends also on regulation rules)
- **Island operation** – could be demanded and financed by cities or stakeholders who need backup power for critical infrastructure in case of long term blackouts – for example result from Prague theoretical exercise Blackout 2014
- **Power quality measurement** – wide scale deployment could help with better identification of problems in LV or MV distribution networks (for example THD) caused also by consumer or avoid unnecessary expenses on distribution network reconstructions
- **Power quality measurement of EV charging process** – check of influence will help in future for better EV infrastructure implementation (evaluation according to EN 50160)
- **Volt/var control –** is necessary for better DER integration into distribution networks

The end

Thank you very much for your attention

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