



Active Distribution Network Management in Europe

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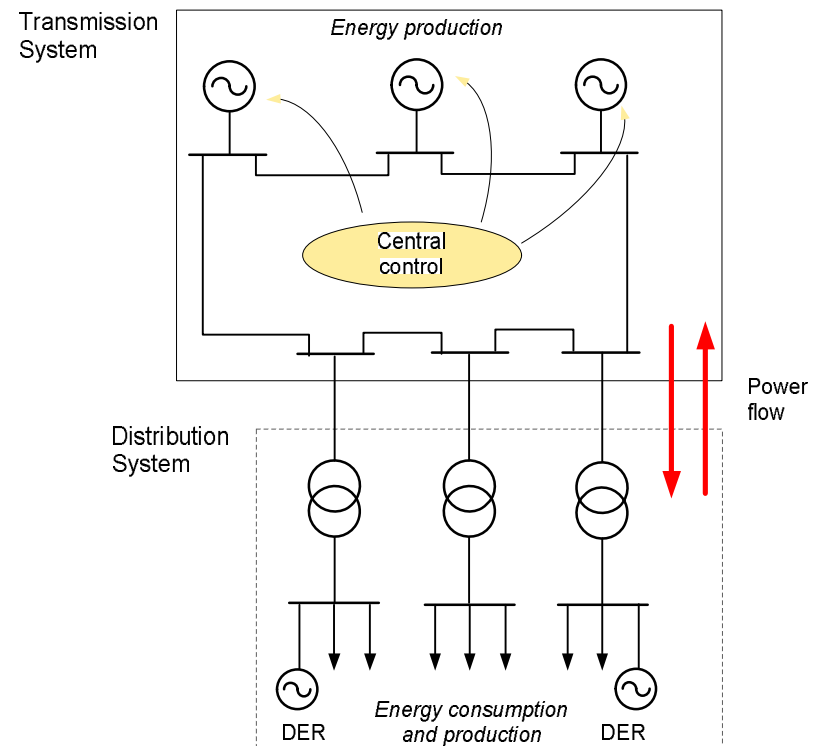
GDF SVEZ



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Starting Point

- Centrally controlled transmission system forms the backbone of the system
 - Energy sources connected also in the distribution system
 - Bi-directional power flow
 - distribution system is an energy exchange system
- Development of two power production areas
- Influence of DER on systems depends on its share



Impact of DER on System Operation

- Impact on network operation depends on DER penetration
 - small DER share causes local problems
 - unsuitable voltage profile
 - malfunction of protection operation
 - lower power quality
 - large DER share may cause systemic problems
 - worsen network stability
 - uncontrolled reactive power flows
 - impact on power reserves

- Main problem: large number of uncontrolled sources

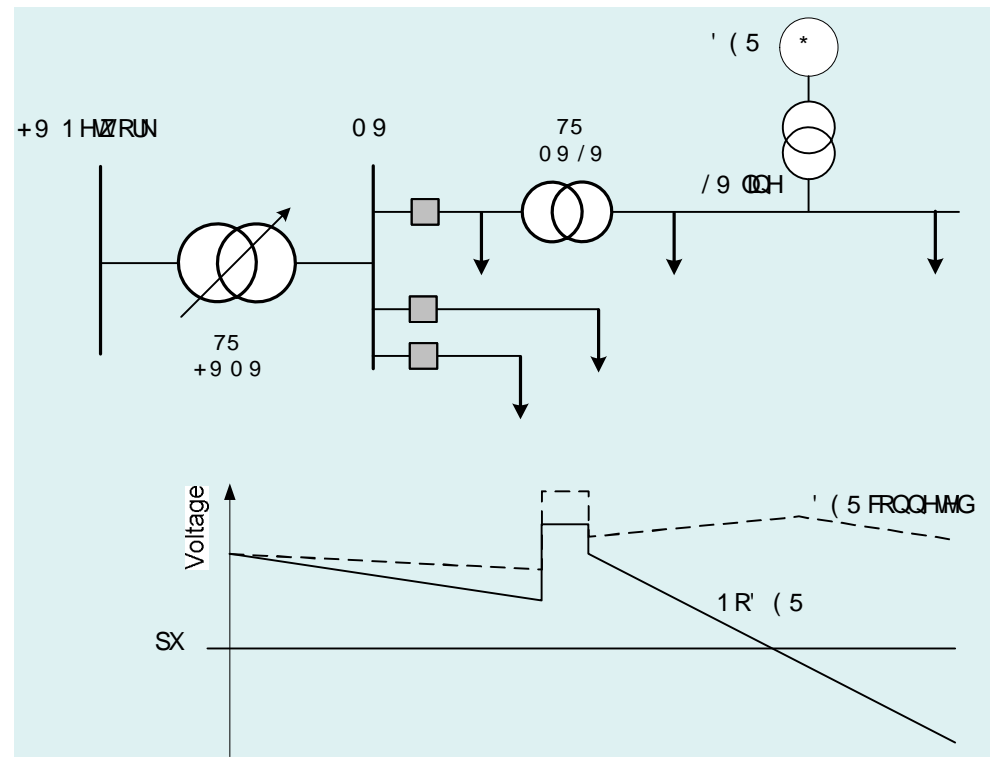
Impact on Voltage Profile

- Worst-case scenarios
 - low consumption, high DER generation
 - high consumption, low DER generation

- Difficult to control the network voltage profile only with the HV/MV transformer

- Solutions

- advanced transformer voltage regulation
- voltage regulation with DER
- active compensators



Impact on Power Quality and Power Reserves

■ Impact on power quality

- Transient voltage variations
 - e.g. connection or disconnection of DER
- Flicker
 - especially wind turbines
- Harmonics
 - e.g. from power converters

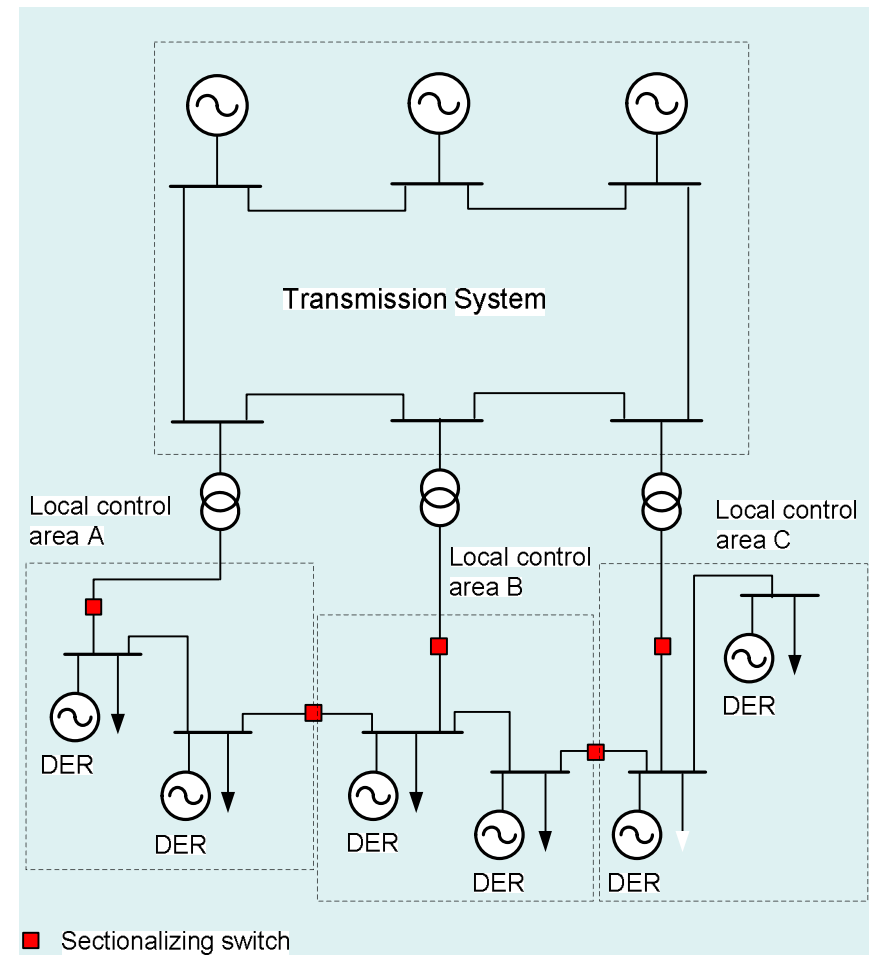
■ Impact on reserve capacity

- DER often an intermittent source (wind, water levels, sun...)
 - e.g. wind power changes with the 3rd power of wind speed
- power reserves needed for production/consumption balancing
 - reserves based on fossil fuels

$$P = \frac{1}{2} C_p r V^3 A \text{ (W)}$$

Active Network Concept

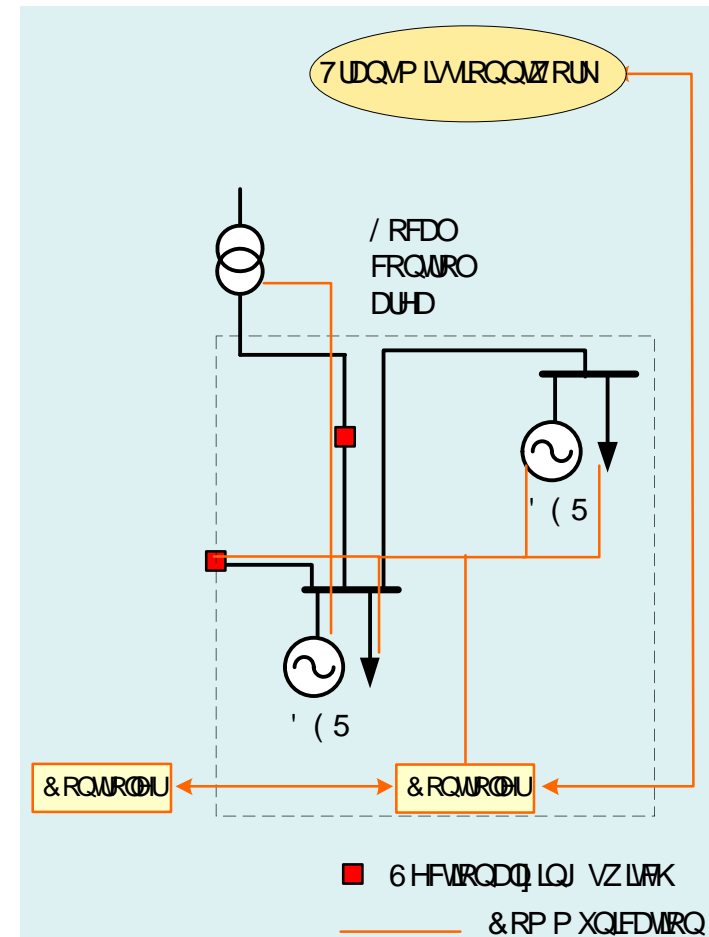
- Network divided into local control areas
 - MV and NN network with DER, storage and controllable loads
- A local control area is an energy exchange system
 - normally operates connected to the main network
 - possibility of islanded operation
 - enables power flow control
 - frequency regulation
 - voltage regulation



Active Networks Control

- Efficient ICT are essential
 - coordination of: network equipment, sources, loads...

- Network control concepts
 - central control
 - peer-to-peer control
 - combination
 - sources autonomous to some extent
 - central controller for optimization of operation



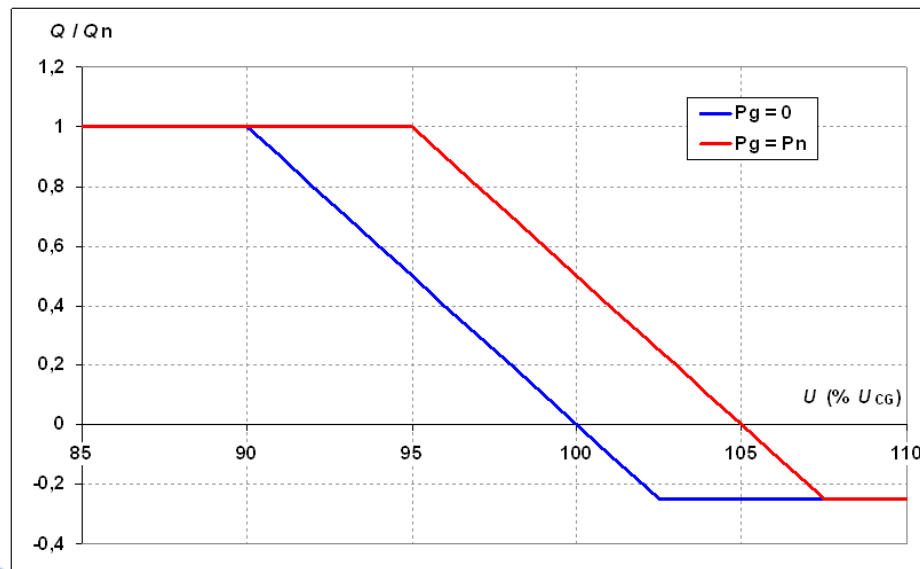
Key Technologies – Controllable DER and Loads, Electricity Storage

■ Controllable DER

- normal operation: maximisation of revenues
- emergency operation: maintain system stability

■ Electricity storage

- enable production and consumption balancing

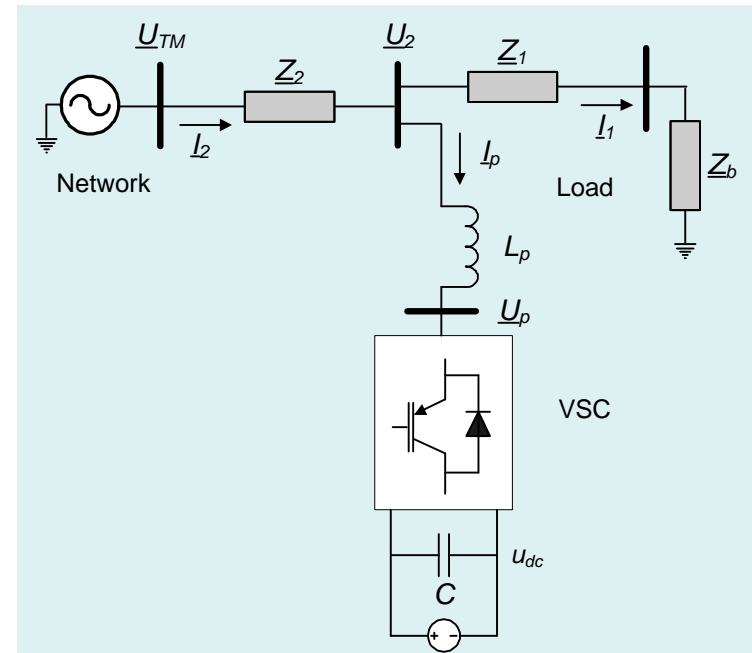


VRB, 5 kW, 10 kWh



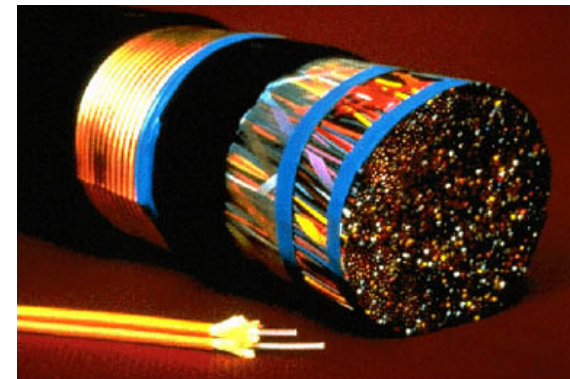
Key Technologies – Power Electronics Equipment

- Technologies
 - network reconfiguration devices
 - compensators
 - converters for connection of DER
 - all based on power semiconductor switches
- Active compensators, active filters
 - based on voltage source converters
 - reactive power compensation, voltage control, harmonics compensation...
- Converters for connection of DER
 - can incorporate the functionality of active compensators



Key Technologies – ICT

- Information and communication technologies
 - a technology which involves acquiring, storing, processing and distributing information by electronic means
- Widespread communication between controllable devices and control units
 - generation and load control
 - network reconfiguration
 - control of active compensators
 - monitoring
 - prediction of consumption, production and prices
- Communications media
 - power line carrier
 - landlines (telephone cable, optics)
 - wireless (radio, GSM)



Monitoring and Forecasting

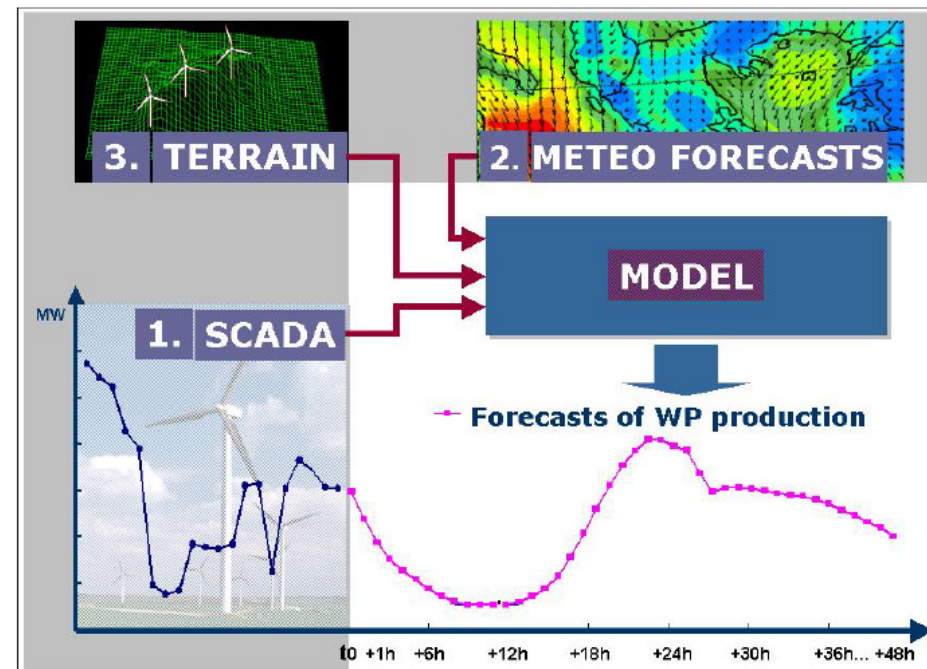
■ Measurements of network parameters

- stand-alone equipment
- integrated equipment
- large number of sources
- estimation of actual conditions

■ Forecasting of

- production
- consumption
- electricity prices
- essential for system stability

Source: Anemos project



Future Development of Power Networks

- Two energy production areas are emerging
 - production in large power plants in the transmission network
 - DER in distribution networks
 - The transmission network still represents the back-bone of the system
- The evolution of power systems will be gradual
 - substation automation
 - controllable DER
 - feeder automation
 - controllable loads



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Contact

THANK YOU FOR YOUR ATTENTION!

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