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The Smart Grid Migration Path

Coping with a high amount of renewable generation and the introduction of new technologies in distribution grids

Distributed generation and the deployment of new technologies have a strong impact to the whole energy system

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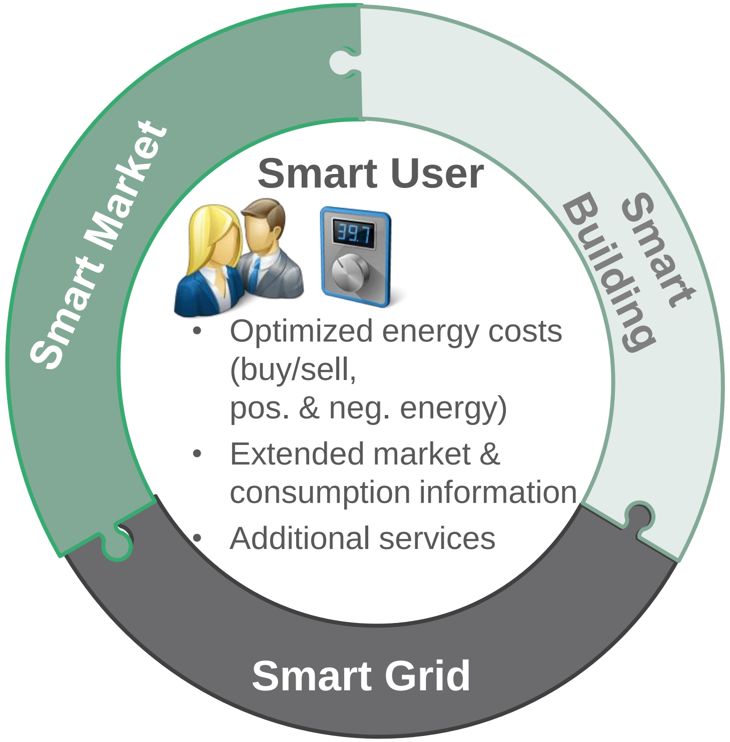
Smart Markets

- Production increasingly dependent on weather
- Demand for improved production and load forecasts
- Demand for short term energy pricing according to present production volume
- Demand for flexibilities to compensate forecast deviations



Smart Homes / Buildings

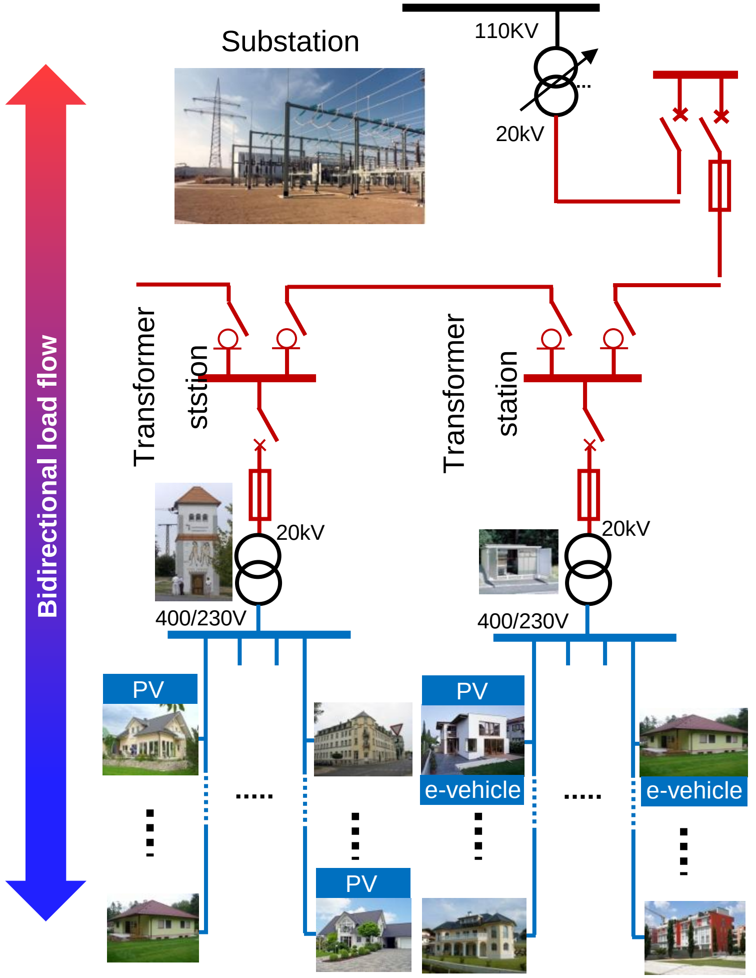
- Consumer → Prosumer
- Heat pumps + thermal storage
- Switchable loads (ripple control)
- Batteries
- First trends to energy autonomous buildings
- Future: Charging of e-vehicles
- Self optimizing buildings with an interface to market partners

Smart Grid as facilitator for smart markets (Vision for the future)

Provisioning of:

- information and forecasts
- a billing infrastructure for flexible Tariffs
- an infrastructure for Flexibility Management and Trading
- supply and power quality
- additional services for market partners

What are the challenges for distribution grids to cope with



Physical effects

- Distributed Generation → U problem (rural area), I problem (urban areas)
- Flexible Tariffs → “synchronized” consumption behavior
- Implemented protection concepts become obsolete
- Flexibility Trading & e-mobility → load problems combined with U/I challenges
- High amount of inverters connected to the grid → Grid stability

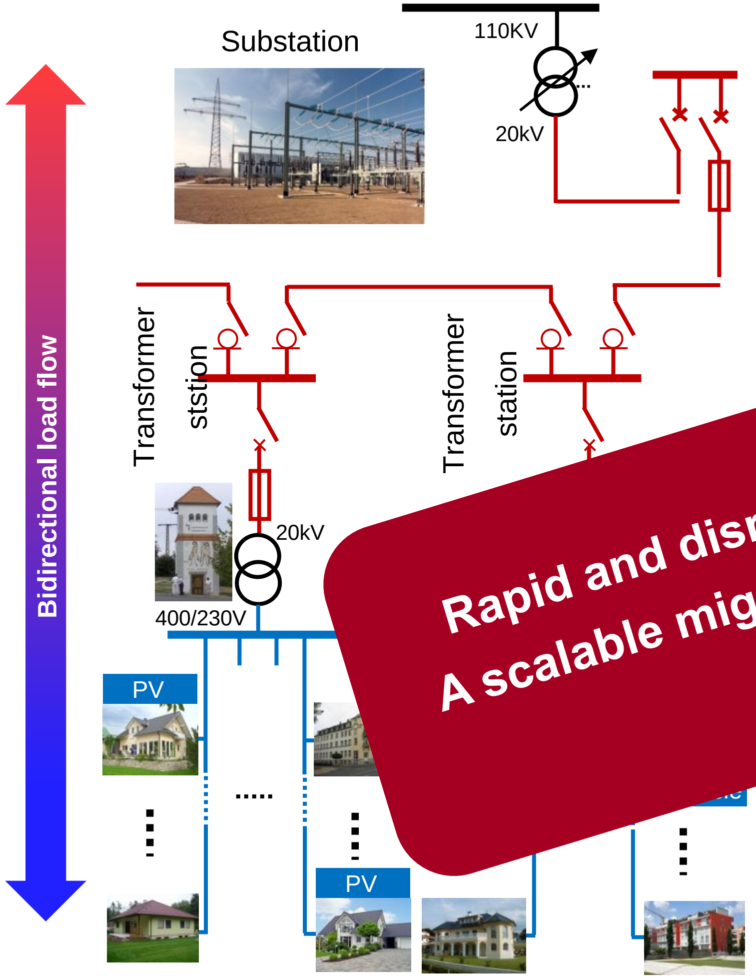
Challenges for distribution grid operators

- Which effect causes where problems in the LV/MV Grid → Lack of information
- Passive consumers become highly dynamic & active prosumers → Grid planning rules loose their validity
- Fast changing requirements increase capabilities of existing infrastructure

Strong demand to increase efficiency

- Efficient utilization of existing infrastructure, optimized grid operation
- Demand for more information to support efficiency of 3rd parties (TSO’s, Market partners, energy consumer)

What are the challenges for distribution grids to cope with



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Rapid and disruptive changes of distribution grids are not feasible
A scalable migration path in alignment with available technology and solutions is needed

Strong demand to increase efficiency

- Efficient utilization of existing infrastructure, optimized grid operation
- Demand for more information to support efficiency of 3rd parties (e.g. TSO's)

Three steps to migrate to a Smart Grid

Functional dependencies

Data provisioning & grid monitoring ➔ grid operation

Where does the infrastructure reach its limits?

- Continuous provisioning of grid operation data through distributed devices (sensors, meters) and load estimation
- Monitoring of faults and threshold violations
- Alarm generation
- Data provisioning for back office applications

Big data & business analytics ➔ back office grid optimization

„passive“ grid optimization, analysis of events and effects

- Migration of planning process from “worst case assumptions” to “real requirements” based on measured data
- Prosumer model based simulation of scenarios
- Risk analysis and deduction of a planning strategy
- IT supported planning processes (technical and commercial optimization)
- Event and process analysis (Business analytics)

Active grid management ➔distributed intelligent devices

„active“ grid optimization & asset protection

- Decentralized /centralized volt / var management (LV & MV)
- Load shedding to prevent overloads & tripping of protection devices
- Flexibility management systems (interaction with buildings and market partners)
- Load dependent grid configuration
- Automated fault isolation

The Smart Grid Migration Path has to be further developed
Grid specific optimization and research tasks

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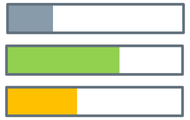
Data provisioning & grid monitoring ➔ grid operation

Where does the infrastructure reach its limits?

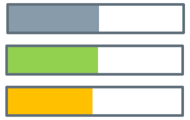
- *What is the optimal ratio between measured and estimated data?*
- *Which accuracy of measurement values is necessary?*
- *Acquisition of grid topology*
- *Contribution of Smart Meters*
- *Alarm generation and presentation (correlation of alarms of different grid layers)*
- *Which data can be provided / are necessary for back office applications*



Big data & business analytics ➔ back office grid optimization

„passive“ grid optimization, analysis of events and effects

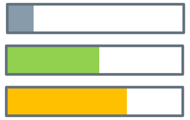
- *Validation of measurement values*
- *Substitution of missing measurement values*
- *Calibration of measurement values*
- *Deduction and validation of prosumer models*
- *Simulation and planning tools*
- *Fault analysis: Correlation of grid events and effects with other data (e.g., weather, asset data)*



Active grid management ➔distributed intelligent devices

„active“ grid optimization & asset protection

- *Robust and fault tolerant design of multi purpose control and regulation devices*
- *Plug and Play / Plug and Automate functionalities*
- *Flexibility management components*
- *To support and coordinate grid and market requirements*



Rough estimations

- Available solutions / required solutions
- Need for opimization related to the actual status
- Need for additional R&D

Recommendation how to start the migration process

Functional dependencies

Data provisioning & grid monitoring ➔ grid operation	Big data & business analytics ➔ back office grid optimization	Active grid management ➔ distributed intelligent devices

• Collection of all available Grid data in a central data base
• Improvement of topology data provisioning (LV and MV)
	• Implementation of a data warehouse and a business analytic environment
	• First implementation of simple analytic functions
		• Field tests of components and partial solutions:
		  • Validation of efficiency
		  • Impact on grid availability / stability
		  • Gain operation experience

Successive extension / optimization of operating processes
→ Deduction of general system requirements for process support

Successive enhancement of system functionality (grid specific and operation process specific)

Conclusio

1. Requirements for distribution grids are not static any more. They are fast changing
2. In order to ensure grid availability and Power Quality ***seamless and detailed grid data become essential.*** They are necessary to detect critical grid areas and to decide on mitigation solutions
3. To avoid overloads and to protect assets new intelligent solutions become necessary. They can help to reduce outage times, grant Power Quality and increase efficiency
4. The migration of a Distribution Grid to a Smart Distribution Grid is a evolutionary process. It requires a close cooperation between DSO's, Research Institutes and Industry in recursive cooperation scenarios
5. The first components and solutions to start the migration process are available

Thank you for your attention

Contacts

Alexander Schenk
EM TI TDI

Ruthnergasse 3
1210 Vienna
Austria

E-mail:
alexander.schenk@siemens.com

Andreas Lugmaier
CT RTC NEC

Siemensstrasse 90
1210 Vienna
Austria

E-Mail
andreas.lugmaier@siemens.com

Dr. Alfred Einfalt
CT RTC NEC

Siemensstrasse 90
1210 Vienna
Austria

E-Mail
alfred.einfalt@siemens.com