The Role of Information Flow and Power Flow in the Smart Grid Concept

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What is a “Smart Grid”?

Do we need a “Smart Grid”?

Key drivers towards a “Smarter Grid”

Some Technical Challenges for Distribution Grids

Conclusions

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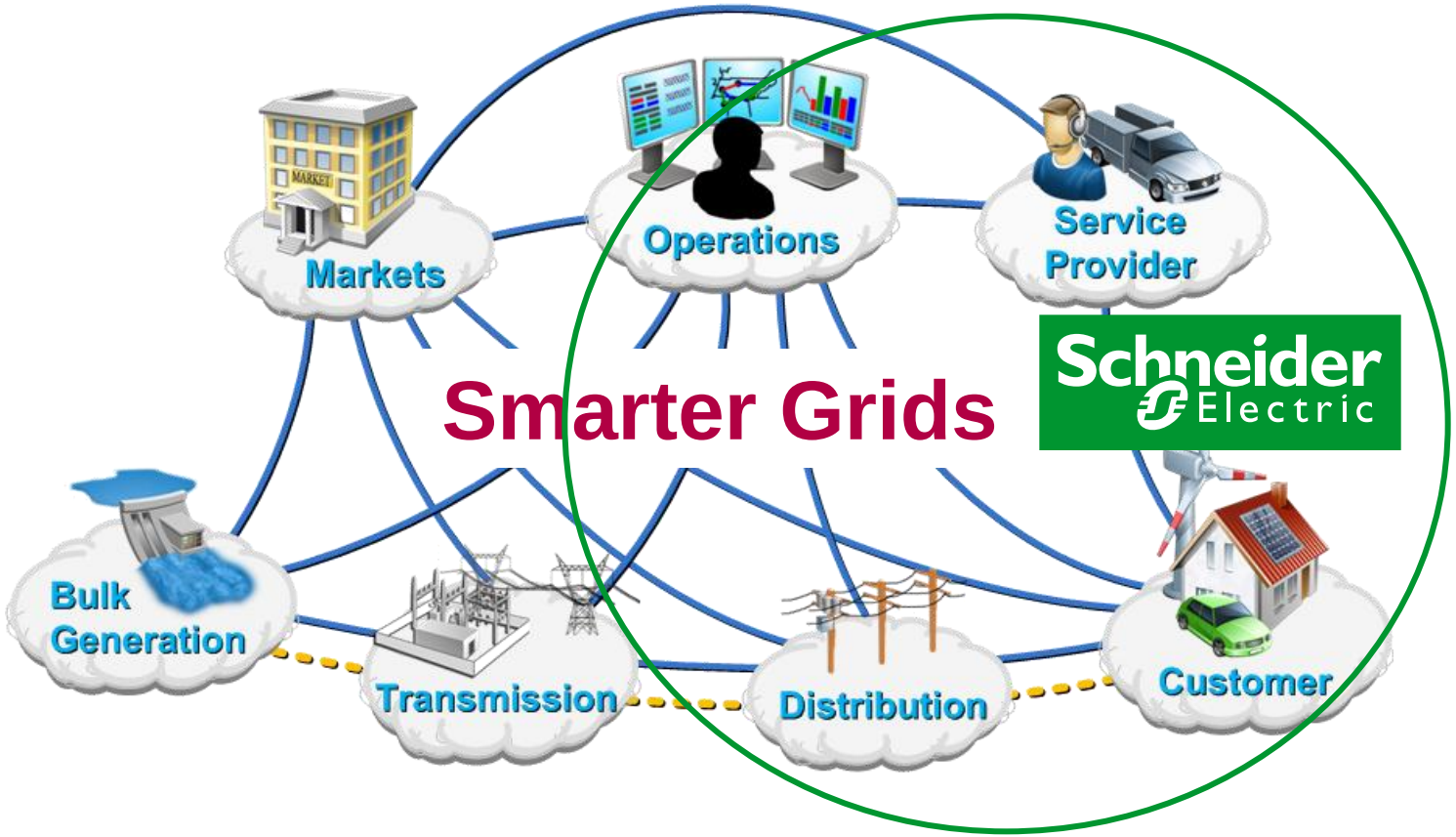
What is a “Smart Grid”?

- ***standards-based IP networks***
- ***optimize communications***
- ***GIS Data and Processes***
- ***Existing WAN/LAN Networks***
- ***Energy Delivery Network Topology***
- ***Integration Architecture***
- ***Legacy IT Systems***
- ***value chain integration***
- ***exponential increase in information flow***

Smart Grid is about Active Energy Management

"A Smart Grid is an electricity network that can intelligently integrate all **Active *Energy* Management** actions from smart users connected to it".



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Do we really need Smart Grids?

by Marco C. Janssen

The buzz word of our time is “Smart Grids”. It seems that suddenly everything has to become “Smart”.
When I look at this it makes me start to think…

On the one hand I strongly believe that a combination of all the available information existing today within so-called islands of automation, can lead to better and even simpler solutions.

On the other hand I also believe that it is wise to think before we act. We should remember that automation for the sake of automating has never led to cost effective solutions.

We should never forget to ask at least one important question.
“Why are we doing this?”

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Key Factors are Pushing Grids to Change

- Structural growing electricity consumption
  - Population growth
  - Growing needs like future need for charging EV
- Climate change and Green sensibility
  - Pressure on CO_2 emissions reduction, Green products
  - Resulting increasing cost of energy
- Evolution of the electricity market
  - Unbundling & deregulation of the electricity market
  - A lot of intermittent renewable energy sources (global and local)
- Users' expectations
  - Increasing need for better grid's reliability and quality
  - Search for better economic performance
  - Willingness to pro-actively manage their energy

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A Short GRID History

- Simple switching devices

In the 50‘s

From simple grid to higher complexity and disturbances

- Switching devices with fast actuation
  - direct protection relays
  - Local operation

In the 70‘s

From local operated grid to centralized grids

- Switching devices with associated intelligence
  - numerical protection relays
  - Remote operation

Now

From centralized grids to agile, autonomous grid management, Smarter Grids

SMART GRID Challenges

Additional capacity without Network re-building

- Utilization of all available capacities, monitored in real world conditions
- Detection of theft by matching primary and secondary import / export loads

Bi – Directional current flow and switching

- Challenging MV products and users operational practices
- Load break switches can not work bi-directional under full load
- Circuit Breakers will handle currents in either direction in a non-hierarchic grid
- Monitoring of outgoing cables, do not earth if live
- New motorized mechanisms with intelligent control and interlocking

Easy connection of new generation

- Extendable AIS and GIS Switchgear
- PnP Cable Connections up to 40.5 kV
- Adaptive network protection
- Local Generation at LV and MV Level: non-hierarchical power flow

What's about Smarter Hardware?

Ambition: Provide innovative smart grid-ready products and solutions, enabling our customers to increase the efficiency, reliability and environment-friendliness of their networks.

Customer-centric solutions

- Limit Electricity Theft
- Increased Efficiency from Reduced Losses
- Easy Connection and Integration of DG
- Reduced bottlenecks in T&D networks
- Operate the system close to it's limits
- Reduce constraints and wear on equipment

COORDINATED ADAPTIVE T&D Networks

Solution: Local Intelligence

- Key enabler for bi-directional power flow in the SMART Distribution Grid
- Self-adaptive Network Design Approach WITHOUT network communication layer

Technology:

- Highly Meshed and Expandable Distribution Grids
- Fast Circuit Breaker for Controlled Switching
- Power flow control by NCIT and Smart Controller

Requirements:

- Prediction of Power Flow Transients in complete Distribution Grids
- Dynamically controlled electronic drives for breakers and switches
- Non Conventional Instrument Transformers designed for real-time load control (I, U or ρ)
- Intelligent Control Unit

Fault Current Limitation

Growing electricity demand PLUS strong growth of decentralized power generation result in needed capacity upgrades and higher stressed grids

- Increased # of power surges or “fault currents” that arise from short circuits
- Increased levels of fault currents beyond existing circuit-breaker’s rating

Fault Current Limiters are needed for:

- Protection of grid infrastructure becomes more complex and necessary for improved Power Quality
- Avoid over-dimensioning of equipment
- Extend existing grid equipment’s life time

Necessary Features of FCLs:

- Self activation
- Fast self recovery
- Lowest losses in service

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Smart Grid Challenges

Information versus Power Flow:

- Information Technologies will help to manage complex systems like distribution grids.
- To enable all economical and ecological benefits from Information and Communication Technologies, we need to develop the next generation of power equipment, dealing with the demand of volatile power flow.

Technology:

- Local Intelligence will allow self adaptive solutions.
- Current Limitation will become an important role in smarter grids.

Requirements:

- To understand the impact of new hardware and smart control algorithms, we need to increase the knowledge of transient processes in Distribution grids.

… and

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