The Smart Grid by Siemens

Constant energy in world of constant change

Dr. Bernd Koch
Infrastructure & Cities Sector, Smart Grid Division

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Renewable integration
Key challenges drive renewable integration

**Trends**

- Renewable generation in distribution grids
- Increasing electrical loads in LV distribution grids
- Aging and/or weak infrastructure

**Customer challenges**

- Overloads of distribution grids due to fluctuating renewable in-feed, e.g. share of world renewable generation to triple from 4% by 13% in 2030
- High cost for integration of renewable generation through grid extension
- Limited transparency on distribution grid
- Distribution grids are not designed for bidirectional energy

Source: 1) Energy Trends Study 2) U.S. 2002 CPI-weighted dollars 3) Brazil Regulator, Energy Trends Study
Changing in-feed patterns are challenging existing grid infrastructures

Weekly loading of a transformer station in the rural area of LEW Verteilnetz GmbH – 2003 and 2011

Load profile: 2003  Load profile: 2011

Source: LEW
The in-feed of power from distributed sources leads to entirely new challenges

- **High-voltage**: Voltage problems on the high-voltage level due to power in-feed from renewable sources
- **Medium-voltage RMU**: Voltage range deviations and thermal overloads due to refeed from several low-voltage lines
- **Low-voltage grid**: Voltage range deviations and thermal overloads due to power in-feed from renewable sources & power quality problems
  - Overload of local substation transformer
Smart Grid:
Measure, Analyze, Take Action

Measure
Using smart meters, IEDs

Analyze
Dynamic grid analysis

Take Action
Set points for storage, loads, generators, and trading

Current and planned portfolio for the integration of renewable generation
**Smart Market:**
*Driving new business models*

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<th>Demand Response</th>
<th>Virtual Power Plant</th>
<th>Renewable Integration</th>
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<tr>
<td>Avoid generation bottle-necks by controlling demand - dispatching of curtailable load as most economic power supply.</td>
<td>Integration of distributed generation, loads &amp; storage for economic optimization and trading power.</td>
<td>Integration of distributed generation, load &amp; storage into grid control centers for economic power supply &amp; grid stability.</td>
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<td>Additional revenue from selling curtailable load.</td>
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<td>The flexibility to generate, store, and shift energy; participation in various energy markets.</td>
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Demand Response offering benefits
Demand Response management systems can stabilize energy supply

Why is it relevant?

- High demand for power can lead to a critical peak load situation on the energy grid (blackouts)
- Utilities can prevent peak situations from escalating by shedding load
- Load is shed via customers that are signed up for a Demand Response program

How does an event-based and automated DR work?

- DRMS automatically reacts to an event signal by shedding load and switching off
- Process follows rules set by contract
- Rule set provides complete control while the automated system ensures real-time execution
- System performs verification of DR action and records credit with utility
  = Siemens generates income through the utility for providing a curtailable load

Participating in automated Demand Response stabilizes our energy supply

Source: Siemens
Demand Response offering benefits

### Multiple Demand Response Programs

- Create and manage multiple Demand Response programs
- Enroll customers in different programs
- Automated control of multiple programs for any customer segment

### Baseline Algorithms

- Multiple Baseline Calculations:
  - Different baselines for each DR program
  - Customized profiling available
- Enables customer consumption profiling
- Calculates baseline at substation down to single-meter granularity

### High Compatibility

- DRMS supports:
  - Manual and automated dispatch and load shedding
  - Existing load control programs
  - Open protocols and standards
Virtual Power Plants
Virtual Power Plants:
Technical structure and use cases

Load Forecast

- Biomass Power Plant
- Block-type Heating Power Plant
- PV Power Plants

Energy Exchange

- Load Balancing
- Aggregation of DER
- Tertiary Control Reserve
- Secondary Control Reserve

Scheduling

- Meteorological Service
- Flexible Loads

Renewable Generation Forecast

- Meter Reading
- Distributed Small Fuel Cell

Automatic Generation Control

- Wind Farms
- Distributed Loads

1 DER = Distributed Energy Resource

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Three main target groups for customers for Virtual Power Plants

**Use Case**

- Facilitate participation in energy trading/participate in markets for reserve capacity (day ahead and reserve markets)
- To optimize fleet management and ensure compliance with fleet schedule
- Economic optimization of energy costs

**Target customers**

- Aggregators and utilities
- Operators with larger generation units with
  - More than one generation source¹/converter² and/or
  - Different modalities of energy (e.g. electricity, heat)
- Industries and municipalities with their own
  - Generation source and/or
  - Load control
  - Storage³

¹Including Boilers, turbines, CHP, fuel cells, renewables ²Including compressors, chillers, electrolysis ³Including heat/cold storage, accumulators, e-cars
DEMS® for all use cases of Virtual Power Plants

- Energy contracts
- Production plan
- Operator inputs
- Process control
- Quality information
- Field information
- Energy counter

DEMS®

- Energy Data
  - Acquisition
  - Archiving
  - Reporting
  - Monitoring

- Supply Monitoring
  - Natural Gas
  - Electricity

- Load Forecast
  - Electricity
  - Steam
  - Natural Gas

- Optimization
  - Unit Commitment
  - Fuels
  - Contracts

- Optimize resource utilization
- Optimize short-term
- Purchasing on the market
- Optimize supply contracts

Energy cost savings

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Infrastructure & Cities Sector – Smart Grid Division
References & customer projects
Renewable integration – IRENE*
Dynamic grid stabilization

Challenge

- Enable existing grid for the integration of decentrally generated renewable energy as well as electric car infrastructure and energy storage

Solution

- Installation of a Microgrid manager in order to actively optimize energy generation and load management of electric cars and consumers
- Online tap-changing transformers
- Control interface for PV plants and other renewable generators to limit voltages and currents
- Stationary large scale batteries and control interface for e-car chargers

Benefits

- Simplification of power network operation through the use of intelligent components
- Limitation of raised voltage and over current problems by coordination of generation and consumption
- Keeping network extension to a minimum, thereby saving resources and reducing costs

*Integration Regenerativer Energien und Elektromobilität (FKZ 01ME11064)
Virtual Power Plant – E.ON headquarters in Malmö
Load balancing/Smart Building in a Smart Grid

**Challenge**

- E.ON Sverige partners with Siemens to find technical solutions to help Malmö City become Sweden’s most climate friendly city.
- Malmö City has partnered with its local energy supplier E.ON Sverige to address sustainability targets by setting-up a “climate contract”. Siemens provides a solution to bring local demand in line with the availability of renewable energy.

**Solution**

- Project that utilizes the flexibility of consumption in an E.ON office building
- Distributed energy management system (DEMS®) and building management system (Desigo®) optimize generation and load in new suburb of Hyllie according to the availability of renewable energy

**Benefits**

- Early teaming of Siemens with the local stakeholders and the strategic stakeholders at E.ON Innovative approach that embraces a generation to load value chain.
Stadtwerke München (SWM) – Virtual Power Plant in operation

**Challenge**

- To improve the reliability of planning and forecasting for decentralized power generation sources

**Solution**

- Integration of 6 unit-type cogeneration modules, 5 hydropower plants and a wind farm to form a virtual power plant
- Scope is the Distributed Energy Management System (DEMS),
- Automated deployment and trading schedule based on exact usage and generation forecasts

**Benefits**

- Opens up further marketing alternatives for small-scale, distributed energy sources
- Minimization of generation and operational costs through the optimization of distributed energy sources

**Project partner:** Stadtwerke München (SWM)

**Country:** Germany
Successfully implemented – today.
Virtual Power Plant – RWE: wind heating load balancing

**Challenge**

- To integrate the storage capacity of electrical heating systems into different energy markets, e.g. the market for minute reserve

**Solution**

- 50 households have been equipped with DER controllers.
  - Implementation of DEMS® as energy management system:
    - Front-end communication to the houses
    - Archiving of metered and measured data
    - Sending out set points to the heat controllers
    - Electricity consumption forecast

**Benefits**

- Economic usage of electrical heating as storage capacity avoiding investment in batteries

*DER = Distributed Energy Resource*
Virtual Power Plant – RWE ProVipp
Aggregation of generation + minute reserve market

Project partner: RWE
Country: Germany

Challenge

- To integrate multiple renewable energy resources
- To define various operation strategies
- To implement an optimal operation strategy for distributed generation

Solution

- Build up a virtual power plant, integrating small hydropower plants, combined heat and power units, and emergency generators based on DEMS®
- DER* controller for innovative communication with DEMS®

Benefits

- Allows market access for distributed energy resources
- Increases the economical benefit of distributed energy resources
- Provides regulating energy to reserve markets

*DER = Distributed Energy Resource
Virtual Power Plant: EcoGrid EU*
Prototype for European Smart Grid on the Island of Bornholm

**Requirements**

- To build and present a complete prototype of the future power system with more than 50% renewable energy
- Market integration and inclusion of electricity customers in the Smart Grids of the buildings of the future

**Scope**

- Testing and implementation of a virtual power plant including a 5-min tariff scheme
- Implementation based on the Decentralized Energy Management System (DEMS®), DER* controller and building/home automation systems

**Benefits**

- Balancing fluctuations in energy generation through the intelligent adaption of consumption using flexibility of loads, e.g. buildings
- Developing the island of Bornholm into an independent electrical island

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**Project partner:**
Consortium of 15 partners in 9 European countries

**Country:** Denmark

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