How to smarten up the grid?
Drivers for a Smart Grid

Balancing
- Generation
- Load
- Renewables
- Prosumers

Load shifting
- Peak demand
- Shaved peak demand

Reliability

Efficiency
Paradigm shift in power grids:
The new age of electricity

- 'Generation follows load'
  - Fossil energy sources

- 'Load follows generation'
  - Renewable energy sources

20th Century: Unsustainable energy system
End of 21st Century: Sustainable energy system
The Siemens Smart Grid Compass creates a framework for implementation of Smart Grids.

### Compass Dimensions

- **Objectives**: What am I trying to achieve? Business objectives an organization wishes to achieve.

- **Business Capabilities**: How can I do this? Different ways an organization can execute a different activity depending on the extent of their smart grid implementation.

- **Technologies**: What do I need? Different smart grid technologies.

Utilizing the dimensions above the compass model closes the gap between technologies and business value.
Turning the entire energy conversion chain into a smart infrastructure

- Decentralized energy management system
- Condition monitoring/asset management
- Energy Management System
- Power generation management
- Power transmission
- Communications solutions
- Distribution Management System
- Smart metering
- Smart substation automation
- Distribution automation
- Demand Response
- Building automation
The benefits of power generation management

Power Generation ready for the Smart Grid:

- Contribution to security of supply
- Improved profitability
- Maintained environmental performance
  under significantly more challenging conditions

achieved by
- minimizing complexity in plant operation
- maximizing flexibility through process optimization
- leveraging all available information
High flexibility through SPPA-P3000 process optimization solutions - without unexpected adverse effects

- **High availability**
- **Longer Life time**

**High efficiency**
- Low Loss Start
- Combustion Optimizer
- Sootblower Optimizer
- Temperature Optimizer
- Low Throttling
- Best Point

**High flexibility**
- Fast Start
- Fast Ramp
- Frequency Control
- Dispatch Control
- Minimum Load Reduction
- Maximum Load Plus

**Low emissions**
- NO\textsubscript{x} Reduction
- CO\textsubscript{2} Reduction
- LOI*) Reduction

*LOI: loss on ignition – i.e. the share of unburned material in the ash
Reference examples proof customer benefits

**Franken power plant**
- Peak load service capability
  - Number of start-ups per year increased from approx. 20 to 170
  - While reducing start-up costs and time by 25 to 40% and improving rated efficiency by 0.33%

**Ninghai power station**
- Load ramps
  - Load ramps significantly improved to gradients of 4%/min
  - While maintaining temperature deviations restricted to the extraordinarily low level of +/- 2K

**New Harquahala power station**
- Availability and predictability
  - Starting reliability improved from 67% to 87%
  - While avoiding more then 5 trips per year and achieving significant service cost reduction due to reduced stress

**US-utility headquarter**
- Boosting fleet profitability
  - All data sources integrated to monitor, analyze and optimize the fleet’s 19 plants
  - Efficiency improved by 1.5 to 2% (depending on fuel type)
  - Availability increased by 0.5%
The benefits of HVDC and FACTS

- Reduction in transmission losses – increase in system security
- Reduction in CO$_2$ emissions through grid access of large wind, hydro, and solar power plants
- Bulk power transmission in the gigawatt range over distances of 1,000 kilometers and more
- Increase in power quality on the various voltage levels
- Increase in system stability
Trans bay cable project, USA: Security of power supply for San Francisco area with HVDC PLUS

- Energy exchange by sea cable
- No increase in short-circuit power

Transmission constraints before TBC

Transmission constraints after TBC

Elimination of transmission bottlenecks

Dynamic voltage support

P = 400 MW
Q = +/- 170-300 MVAr

2010
Power system visualization for improved situational awareness

- Voltage Magnitude contour
- Line Loading Contour
- Power flow direction and amount
- Reactive power reserves
The benefits of communications solutions

- Minimum downtime and optimized life cycle costs through online monitoring and control of all grid assets
- Integration of smart meters and distributed generation, and development of new business models, through extension of the communication networks down to the end customer
- Reliable basis through ruggedized Ethernet- and IP components complying with utility standards
Enabling interaction

One-stop communication solutions for utilities and retailers include:

- IP solutions
- SDH/PDH solutions
- Powerline carrier and teleprotection equipment
- Wireless solutions
- Optimized solutions for medium and low voltage applications
- Live line installation

End to End Communication Network Solutions are the basis to build a Smart Grid for Power Utilities
Communication network solutions for a Smart Grid
Reference examples

First installation of a Siemens power line carrier system in 1929

- IP solutions
- SDH/PDH solutions
- Power line carrier and teleprotection equipment
- Wireless solutions
- Optimized solutions for medium and low-voltage applications
- Live Line Installation

More than 50,000 communication systems sold
The benefits of substation automation

- Over 50 percent time savings in engineering and commissioning
- Minimized wiring and documentation effort
- Fast start-up and minimal downtime
- Improved monitoring
- Improved operational safety
Substation automation: typical configuration

Vendor-independent device integration via IEC 61850 process bus

Digital instrument transformer data via IEC61850-9-2

IEC 61850 (Ethernet)

Protection & Control

Communication to other substations*

*in standardization work
The benefits of condition monitoring and asset management

- Reduced life cycle costs
- Maximized component life
- Optimized performance
- Minimized downtime
- Avoidance of possible penalties
- Environmental benefits
- Documentation of responsible handling
- Easy implementation
- Optimized allocation of OPEX and CAPEX
- Controlled risks
- Effort-optimized regulatory compliance
- Long-term knowledge protection
- Simplified growth

Accessibility

Flexibility

Profitability

Reliability
Ongoing in-depth analyses of asset condition
The benefits of a decentralized energy management system

- Synergies through pooling of distributed energy resources
- Remarkable economical and ecological benefits
- New market opportunities for distributed energy resources
- Optimal integration into distribution networks

Accessibility
Reliability
Flexibility
Profitability
### Distributed energy resources and storage

#### From
Central generation, decentralized consumption

#### To
Integration of **distributed energy resources (DER) and storage** by virtual power plants

#### Virtual power plants – main features:
- Energy management system for monitoring, planning, and optimization of DER
- Forecasting system for load and generation of wind power and photovoltaic plants
- Energy data management for collection and retrieval of required information, e.g., loads, contractual data
- Front-end for communication with distributed power units
As a Windows-based system, DEMS provides …

- Energy forecasts
- Forecast of regenerative production
- Cost-optimal planning and management of distributed generation
- Consideration of topological restrictions in the grid management
- Analysis and assessment of individual energy purchase and sales contracts

DEMS (Decentralized Energy Management System)

- Energy forecast
- Forecast of regenerative production
- Production optimization
- Demand optimization

SCADA (Supervisory Control and Data Acquisition)
- Process coupling
- Communication

User interface
- Reports
- Storage
The Benefits of Demand Response

- Use of available renewable energy resources in an optimal way
- Development of new business models and additional services
- Grid investments can be avoided or postponed
- Increase of comfort for customers, e.g. decrease of costs, use of „green“ energy
Demand Response:
- Balancing of generation and consumption through active load management
- Integration of renewables
- Maximum use of CO2 free energy
- Mitigation of "negative" impacts on the grid through load shifting and peak demand shaving
- Integration of new loads like electric cars into the network operation
- Optimization of system operation costs

Generation follows load

For traditional energy systems there is always sufficient controllable supply
And uncontrollable consumption

Available supply
Peak Demand

And the consumption needs to be flexible
Customer Demand

Renewable supply capacity is uncontrollable - Storage and energy Management become key to network balancing

Available supply
Supply

Load follows generation, while renewable energy resources are used with maximum benefit
Demand Response – Emulator tool

- Tested with 100,000 statistical users
- Interfacing also with TSO and Power Marketer.
- Communications and Power analysis.

Real Iberdrola Alava province (Spectrum data: topology, year consumption; weather, generation and OMEL prices forecast).
The benefits of distribution management

- Reduction of outage occurrences and durations by applying advanced fault location and network reconfiguration algorithms
- Minimization of losses through improved monitoring
- Optimization of utilizing assets by management of demand and distributed generation
- Reduction of maintenance costs by online condition monitoring.
Our Solution Spectrum Power DMS

Enables a smart, self-healing grid.

- Spectrum Power
- Geospatial Information System
- Disturbance Information
- Database
- Google
- Maps on request
- Web-System
- Spectrum Power Map-Portal

Our Solution Spectrum Power DMS

Enables a smart, self-healing grid.
Smart distribution is marked by an optimal interaction between various tools of your IT infrastructure.

A Service Oriented Architecture (SOA) replaces direct tight coupling by adapters and middleware.

- Less cost & less risk with modernization of components and integration of new components
- Vendor-independence
- More freedom to choose
- Low-threshold start
- Gradual approach to modernization by service-enabling existing legacy applications one-by-one
- Legacy applications may be changed out at a later date more simply because they have standard interfaces.
ONCOR states: “Enabling Smart Grid technologies also include “back office” IT systems that support integration of data from these various intelligent devices, leading to actionable information”
The benefits of distribution automation

- Minimized wiring and documentation effort
- High reliability through simplicity
- Improved monitoring
- Improved operational safety
- Data and site security
Distribution automation in practice: Reference examples

RMU-automation

Pole top automation

DA and metering
The benefits of smart metering

- Significant improvement of customer processes and services
- Transparent process that allows customers to monitor their energy use and improve consumption decisions
- Comprehensive solution for smart metering and distribution network automation
The complete smart metering solution

How it works

- Home automation networks allow consumers to make choices around consumption
- Internet energy information services
- EnergyIP GUI
- Power line carrier
- GPRS
- Communications
- Gas, electricity, water, and heat

Utility integration bus

- Meter data management
- CIM

Smart metering back office
- Meter data management (MDM) interface to the enterprise
- Interface adapters/Web services APIs
- EnergyIP Message Bus
- EnergyIP application modules
- Metered usage data repository

Retailer, Industry & Utility

Work management
GIS system
Demand response management
Outage management system
Control system
Billing

Smart meter systems and services management
EnergyIP smart meter & meters rendering adapters
EnergyIP application modules

The benefits of building automation

- Reduced energy costs for building operators and increased network performance for utilities
  - Operation of power plants and grid at maximum efficiency levels
  - Easy integration of distributed generation
  - Optimal usage of renewable energy
  - Advantages on the energy exchange

Through active participation of buildings in Smart Grids enabled by
- Metering concepts and enhanced forecasting
- Active management of power generation and load profiles of buildings
- New, innovative contract and financing models

Profitability

Flexibility

Reliability

Accessibility
Integration of automated buildings into the Smart Grid

Our building management solutions and services are ready to:
- Communicate with the Smart Grid, improve forecasting
- And enable variable tariffs and net schedules
- Enable optimized building performance through:
  - Optimal scheduling of power generation and loads in buildings
  - Optimal energy efficiency and sustainability
  - Maximum productivity of occupants and building related processes
  - Reduction of operational costs
Building automation:
Reference examples along the building life cycle

Design and build

Sierra Nevada College (US)
- LEED platinum building
- 60% energy savings\(^1\)
- 65% water savings\(^2\)
- 7% higher upfront cost pay back in 15 years

Borås Schools (Sweden)
- 30% saved on district heat within 2 years
- 8% saved on electrical power
- 22% saved on water consumption
- Annual carbon dioxide reduction of 824,000 kg
- Payback time of only a few months

Renew and revitalize

University of Arts Berlin (DE)
- Green building partner status for customer
- Financing for modernization of HVAC equipment
- 28% energy savings
- Annual carbon dioxide reduction of 1,180 tons

1) savings over ASHRAE 90.1
2) savings over traditional automation systems
How smart is your grid?

Thanks for your attention
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