How to smarten up the grid?
Evolución del precio del petróleo
Paradigm shift
New “Energy Age” arrives
Growing demand for electrical power until 2030

Expected increase in power generation: EU 27

(in TWh)

+25%

Expected increase in power generation: worldwide

(in TWh)

+75%

Source: Eurostat, IEA, VGB

Source: IEA

Water, wind, biomass, solar
Nuclear power
Coal
Gas
Oil

Water, wind, biomass, solar
Nuclear power
Coal
Gas
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Paradigm shift -
Growing electrification is leading to a power matrix
New sector: Meeting the dynamic growth of cities and infrastructure investments

Starting October 1, 2011

- Rail Systems
- Mobility & Logistics
- Low and Medium Voltage
- Smart Grid
- Building Technologies
- Osram
Smart grid helps managing the challenges of the New Energy Age
Turning the entire energy conversion chain into a smart infrastructure

- Decentralized energy management system
- Condition monitoring/asset management
- Energy Management System
- Power generation management
- Communications solutions
- Power transmission
- Distribution Management System
- Distribution automation
- Smart substation automation
- Smart metering
- Building automation
- Demand Response
- Siemens S.A.
Improve generation business performance under challenging market requirements
Power Generation Management Solutions

From

Scheduled generation with predefined load cycles.

To

High operational flexibility of power plants without restriction of reliability.

Changing general business conditions - the new energy mix new grid demands

Significantly increased complexity

Increase operational flexibility

Manage the information load

Contribute to security of supply

Ensure and improve profitability

Maintain environmental performance

High operational flexibility of power plants without restriction of reliability.
Manage data load from grid and plant to provide relevant and reliable decision-making information.
Transmission solutions
for secure, sustainable, and efficient power supply
European Power Grid has reached its limits.

### Power trading in the European power grid

- **2000 MW**
- **2350 MW**
- **2575 MW**
- **2700 MW**
- **2200 MW**
- **3200 MW**
- **3400 MW**
- **3650 MW**
- **800 MW**
- **1200 MW**

### Requirements
- Integrate renewable energies
- Cross-border power exchanges and trading
- Increase grid stability
- Minimize generation and load fluctuations
- Optimize power plant capacity utilization
- Increase grid reliability

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Source: ENTSO-E (European Network of Transmission System Operators for Electricity), Eurostat

*Guarantee power supplies*
HVDC and FACTS

From

Congestion, bottlenecks, and blackouts

To

Security, sustainability, and efficiency of power supply

What’s necessary:
- Control of power flow
- Avoidance loop flows and overloads
- System interconnections with HVDC (Firewall)
- Use of integrated AC/DC systems with FACTS & HVDC
- Support of voltage recovery after system faults
- Reduction in Transmission losses (HVDC)
- Use of bulk power energy highways with HVDC & FACTS
## E T PS (Power Transmission Solutions)
### HVDC Project “Cometa” and HVDC Plus “Inelfe”

<table>
<thead>
<tr>
<th>Customer</th>
<th>Customer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red Eléctrica de España (REE)</td>
<td>Inelfe (RTE and REE)</td>
</tr>
<tr>
<td><strong>Locations</strong></td>
<td><strong>Locations</strong></td>
</tr>
<tr>
<td>Santa Ponça (Mallorca)</td>
<td>Baixas (France)</td>
</tr>
<tr>
<td>Morvedre (Sagunto - Valencia)</td>
<td>Santa Llogaia (Spain)</td>
</tr>
<tr>
<td><strong>Status</strong></td>
<td><strong>Status</strong></td>
</tr>
<tr>
<td>Project in execution</td>
<td>Project will start on Jan’11</td>
</tr>
<tr>
<td>Planned to be working on Jan’12</td>
<td>Planned to be working on Dec’13</td>
</tr>
<tr>
<td><strong>Technology</strong></td>
<td><strong>Technology</strong></td>
</tr>
<tr>
<td>HVDC Long Submarine Transmission</td>
<td>HVDC PLUS Underground cable</td>
</tr>
<tr>
<td><strong>Power Rating</strong></td>
<td><strong>Power Rating</strong></td>
</tr>
<tr>
<td>2 x 200 MW / ± 250 kV DC</td>
<td>2 x 1000 MW / ± 320 kV DC</td>
</tr>
<tr>
<td><strong>Distance</strong></td>
<td><strong>Distance</strong></td>
</tr>
<tr>
<td>Approx. 250 Km.</td>
<td>Approx. 60 Km.</td>
</tr>
</tbody>
</table>

### Benefits for society

**Environmental - Reduction in CO2:**
1.2 million tons p.a. (52 %)

by using Energy-Mix from the Mainland versus local Supply with a new Oil-fired Power Plant on the Island
(Based on International Energy Agency information)

**Energy Transmission Network without losses:**
Sustainability in Transmission

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**HVDC PLUS a Siemens Innovation**

**Technology Innovation:**

**Space Saving**

by using HVDC PLUS and VSC Technology, system compact and adaptable station in fields where shortage of space is a criterion.

**Cometa**

HVDC "Classic" (LCC) based on Thyristor Technology

**INELFE**

HVDC PLUS (VSC) based on IGBT Technology
Transmission solutions
for secure, sustainable, and efficient power supply

Smarten up your power transmission
Why EMS?

- Alert the operator right in advance before critical situations can occur.
- Reduce critical time needed for analyzing faults in the grid and finding the correct alleviating response.
- Increase grid reliability
- Balance generating units with consumption in consideration of the capacity of the transmission network.

Energy management system ensures
1. reliability of supply
2. efficiency in using generation resources under more stringent environmental restrictions
3. reduction of transmission losses

- Innovative Voltage Stability Analysis (VSA)
- Intelligent Alarm Processors (IAP)
- Optimal Power Flow (OPF)
- Week-/Day-Ahead Unit Commitment/ Hydro Scheduling, Security Constrained Unit Commitment
Communications solutions that provide the basis for smart applications
Communication network solutions

From

Heterogeneous communication networks limited in capacity and bandwidth

To

Homogeneous Smart Grid communication network with IP/Ethernet connectivity between all components

What’s necessary?

- Sufficient bandwidth from end to end
- IP/Ethernet capable devices
- Flexible backbone and access communication network solution
- Network extension down to RMUs and consumers
- Interfaces and protocols based on energy industry standards
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
Streamlined processes for improved, flexible workflow and reliable substation management
Substation automation

From

Complex, personal intensive engineering and operating

To

Smart substation automation

What’s necessary?

- Standard intelligent process interfaces (Process bus IEC 61850)
- Standard communication and processes inside the station and among stations (horizontal and vertical integration)
- Digital system, online information, and intelligent applications
- Digital protection devices and components for online network analyses
Integrated solutions for highest economic efficiency

Smarten up your grid assets
Condition monitoring and asset management

From

Primary equipment condition not well known and not integrated in overall grid asset management strategy

To

Condition monitoring for better asset performance and grid asset management for advanced asset management

ISCM – Integrated Substation Condition Monitoring
- Information on the ageing or health condition of primary devices in operation
- Provided by special sensors and/or derived from data typically available
- Using your familiar RTU, communication, and HMI structure

GAMS – Grid Asset Management Suite
- Balancing economic and technical aspects for an efficient grid management approach
- 360° view for optimization of asset management
- New maintenance and investment strategies
Seamless integration of energy resources into the grid
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
Distributed Energy Resources (DER) and storage: Reference example of DEMS

Virtual power plant KonWerl (Germany)

- 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
Smarten up your consumption
**Demand Response**

**Generation follows load**

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
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</thead>
<tbody>
<tr>
<td><strong>Generation follows load</strong></td>
<td><strong>Load follows generation</strong>, while renewable energy resources are used with maximum benefit</td>
</tr>
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</table>

For traditional energy systems there is always sufficient controllable supply and uncontrollable consumption. Renewable supply capacity is uncontrollable - Storage and energy management become key to network balancing.

<table>
<thead>
<tr>
<th>Available supply</th>
<th>Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Demand</td>
<td></td>
</tr>
<tr>
<td>Available supply</td>
<td></td>
</tr>
</tbody>
</table>

And the consumption needs to be flexible.

**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
Smart management of electric distribution grids
Distribution Management

**From**
- No monitoring, control and automation
- No communication
- No auxiliary power supply and motor-operated mechanism
- No active integration in control Center (manual updates)

**To**
- Automation of distribution substations
- Communication in distribution networks
- Decentralized, intelligent application
- Self-healing capabilities
- Online condition monitoring
Our Solution Spectrum Power DMS

Enables a smart, self-healing grid.

Spectrum Power

Disturbance Information

Database

Google

Maps on request

Geospatial Information System

Geographical Information

Spectrum Power Map-Portal

Web-System

Maps on request

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Web-System
Flexible and reliable distribution automation
Distribution automation characteristics

**Today’s standard**
- No monitoring, control, and automation
- No communication
- No auxiliary power supply and motor-operated mechanism
- No active integration in control center (manual updates)

**Evolution**
- Automation of distribution substations
- Communication in distribution networks
- Decentralized, intelligent application
- Distribution management system
- Harmonized networks and tasks

**Smart distribution automation**
- Self-healing automation functions
- Intelligent applications
- Online information (operational and non-op.), e.g., power quality system
Infusing intelligence into the last mile
Smart metering

From
Unmanaged “take-it-as-it-comes” consumption

To
Smart metering and load management

AMIS
Automated Metering and Information System

EnergyIP
Meter Data Management System
Smart metering characteristics

**With regard to your customer**
- Monthly meter reading – higher transparency
- Flexible tariffs

**With regard to your business**
- Increased efficiency of metering business
- High-volume, multi-purpose data platform for real-time and offline data service
- Chance for additional services

**With regard to legal aspects**
- Platform for the “energy efficiency directive”
- Fulfillment of legal requirements
- Equal legal access provided to all market participants at required access rates

Smart metering and load management
Making buildings part of the Smart Grid
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
How smart is your grid?