Complete Offering in Clean Energy & Transportation Infrastructures

**Products & Services**

**Power**
- Nuclear, thermal & Renewable
- Carbon Capture & Storage
- Automation

**Grid**
- HVDC
- Network management
- Substations

**Transport**
- Rolling Stock
- Infrastructure & systems
- Systems & Services

**Transversal Technologies**
- Power Electronic Converters
- Automation & Embedded Controls
- Energy & Asset Management Software
Alstom Grid’s technologies and solutions are at the heart of the Smart & Super Grid

Alstom Grid is N°1 leader in Network Management Solutions

New applications deployed for Smart Grid network management

On-line stability  Renewable integration  Integrated DMS  Eco-Cities
Electric Utility Evolution

Classic

- Vertically integrated
- Cost-based operation
- Physical infrastructure

Competition

- Open grid access
- Genco divestiture
- Wholesale electric mrkt

Smart-Grid

- Distributed intelligence
- Customer choices
- New energy eco-system
- Micro-grid

1980 1990 2000 2010
SmartGrid: supply to end use

- Operate CCGT between 9am and 4pm at 80% and standby for Grid services.
- Wind generation forecast: 25MW.
- Tomorrow's weather: Sunny & warm.
- Charge hybrid cars with solar panels.
- Buy 150kW green energy balance to market for Air Cond.
- Day Ahead Price at 60 Euros/MWh & 20 Euro/Carbon ton.

Source: Alstom
Key Drivers for Smart Grids

1. Maximize CO2 free energy and reduce environmental impacts
   E.g.: Europe over 50% of generation investment until 2020 is in renewable energy
   - Enable renewable grid connection and improve thermal generation flexibility
   - Maximize dispatch of intermittent renewable generation (wind, solar)
   - Integrate distributed generation, eco-buildings and electric vehicles
   - Develop new energy storage capabilities

2. Improve energy efficiency across the value chain
   E.g.: USA, $4.6Bn federal investment in smart grid technology deployment
   - Optimize real-time CO2 free energy delivery to end-users
   - Maximize energy flow in constrained and aging grids
   - Enable end-users dynamic participation to the market (“prosumers”)
   - Integrate smart metering and demand side information integration

3. Increase Grid Reliability and Stability
   E.g.: Annual costs of power interruptions to US electric consumers: $79Bn
   - Estimate Grid Asset condition through real-time and react accordingly
   - Prevent transmission blackouts and minimize outages in distribution
   - Monitor Grid stability / oscillations and implement Defense plans/Grid self healing
Driver 2. Improving system wide energy efficiency

Managing demand response could help decrease peak consumption from 5 to 20%!

Smart homes can monitor, control and adjust local consumption... and generation!

Consumers become pro-sumers contributing to green energy generation

Electric vehicles will call for new network infrastructure and load management systems
The Grid of the 21st century: towards a two-way flow of energy and information

From a traditional top-down network...

- Centralized generation

... to a meshed network with two-way flow of energy and information

- Centralized + Distributed generation
  - Renewable Energy
  - Energy Storage
  - Prosumers
  - Smarter Homes
  - Electric Vehicles
  - Micro Grid
Today's AC Grids
Future: Hydrid AC/DC Grids
New requirements for Distributed Energy Balancing at City Scale
High Level Smart Grids Roadmap

Stage 1: Improved Grid Stability
- Grid Online stability monitoring
- Generation Asset Monitoring
- Renewable generation connection & integration

Stage 2: Improved Flexible Generation
- Automation & IT for Flexible Generation
- Large Wind Direct Drives & Solar Inverters
- Integration of new Storage capability

Stage 3: Active T&D Grids
- Dispatch into Distribution Grid
- On-Line Asset Monitoring
- Wide Area Protection & Power electronics integration into Defense Plans

Stage 4: Demand Side Management
- New End User Energy Management
- Virtual Power Plant for Energy Positive Buildings
- Sustainability management in Smart cities

New End User Flexibility
Refined Grid Control Strategies
Improved Bulk Resource Flexibility
Improved Grid Stability

2008 09 10 11 12 13 14 15 16 17 18 19 20
Partnerships: development of an ecosystem of partners to leverage Smart Grid synergies

- Strategic Customers and Users Community
- End-user solutions
- Joint Innovation
- Channel to Market
- Portfolio Completion
- Software & Technology
Typical demonstrations currently developed in Europe

- Example: TWENTIES EC project
  Objective: prepare European networks for a massive wind penetration (26 partners, led by Red Electrica de Espana)

- Integrate intermittent generation
  - DEMO: Services by wind farms
  - DEMO: Flexible demand

- Prepare offshore grids roll-out
  - DEMO: DC breaker
  - DEMO: Storm control for wind farm

- Make grids flexible
  - DEMO: WAMS and advanced operational tools
  - DEMO: Novel FACTS and network management

Alstom Grid involved with a budget of nearly 3 million EUR
Grid stability improvement

• Example: NCG, China

Customer challenge
- Prevent transmission blackouts in the context of extreme load conditions

Solution
- e-terra On-line Stability integrated with NCG Energy Management System
Distributed generation management

Example: Energinet.dk

Customer challenge

- Manage large portfolio of intermittent and distributed generation units

Solution

- e-terra Renewable Desk integrated in Energinet control center
• Smart “Grid” can deliver **real-time monitoring and control** of electricity generation, transmission, distribution and demand (C&I, residential)

• Smart Grid is about **optimisation of energy dispatch**, and not only about smart meters

• All **four elements** (electricity generation management, transmission, distribution and demand) **need to be addressed**

• SmartGrid is likely to expand through eco city clusters

• **Standards** are key

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Help to achieve 20/20/20
Clean Power Today!