Transmission & Distribution of Electricity – The Challenge

Peter Vaessen

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The digital dilemma

- Data tsunami
- Networking/Sensors → functionality
- New equipment and players
- Security risk?
Acting on aging assets

- Grey wave from the 1970-ties
- Less money available
- Different component life cycles
- Maintenance / Replacement ?
European Power System

- 495 million people served
- 3500 TWh/year

- 760 GW installed capacity
- 250,000 km HV network
- Approx. 6,000,000 km MV & LV network

- Largest business sector (capital)
- Largest man-made system

- Approximately 1500 € investment per EU citizen
Increased bulk transmission

Physical energy flows 2008

50GW wind in the North?

30GW sun in the south?

DC links and interconnections

Source: Nexans
Wind at sea impact

- Ready for large scale deployment
- AC and DC solutions
- Grid operation effects
- Sea-grid?
Doing more with less

- Dynamic rating needs sensors & rules
- Overhead → underground
- Public voice = CAVE
- Use existing right of way

赢轨
An internet-like distribution grid

Central & local intelligence
Integration of new applications
Real-time information & active participation
Central & local sources
Smart (power) electronics
Solar Power up

- Exponential growth
- Prices drop fast from 5 to 2.5€/Wp in 2 year
- Grid parity: 2015?
E-mobility (storage) a growing force

- Means of decoupling generation & demand
- Controllability issue
- Slow take off …or not?

Opel Ampera
PowerMatching City - Full Concept Smart Grid Solution
(partners: KEMA, ECN, HUMIQ, RWE/Essent)

Intermittent Renewable Energy Sources

Smart Appliances for Demand Response

Smart Hybrid Heat Pumps

Smart Charged Electric Vehicles

mCHP for Flexible Power
The pyramid Challenge (Netherlands)
Process information challenge

**Asset Management**
- Data need
- Trends, Analyses Aggregation

**Market Facilitation**
- Measurements
- Feed-in
- Billing
- Energy saving

**Operation**
- Measuring information
- Grid information
- Power Quality
- HV-MV-LV

**Component Control**
- Micro CHP
- Wind turbine
- Configuration (switching)
- Measurements
- Power Quality
- Voltage control
- Protection

<table>
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<tr>
<th>Response time</th>
<th>Information</th>
<th>Data size</th>
<th>Control parameters</th>
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Even more challenges

Feeder voltage profile

Customer profile

Voltage at connection point

Scenario / Prediction
Thank you for your attention