EU Innovative electricity transmission grids
A technology roadmap

✓ About T&D Europe
  • EU Transmission grid vs. generation/consumption scenarios - T&D Europe view
  • Technology needs - Short term view
  • New technologies - Long term view
About T&D Europe

- T&D EUROPE is the European association of the electricity transmission and distribution equipment and services industry.

- The companies represented by T&D Europe account for a production worth over €25 billion, and employ over 200,000 people in Europe.
T&D Europe and some of its partners & stakeholders

Equipment Manufacturer, e.g.
- Europacable
- ESMIG

Business Europe
- Capiel

Politics and regulators, e.g.
- EU-Commission
- EU-Parliament
- EU-Council
- DG EN & Transp.
- EU Technology Platform Smart Grids

Grid operators/
User organizations, e.g.
- ETso
- UCTE
- ENTSO-E

* Belong to ORGALIME community
Objectives

• T&D Europe aims to promote and to defend the common interests of the European electricity transmission and distribution manufacturing industry towards and in cooperation with the EU institutions

• T&D Europe works in collaboration with European and international standardisation bodies, in order to establish a coherent system of worldwide standards and testing

• T&D Europe is committed to the supply of equipment, systems and services for electrical networks that are reliable and sustainable for the efficient transport and delivery of energy
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Increase of renewables EU scenarii

EU GHG emissions towards an 80% domestic reduction (100% =1990)
Under study - Source SRA2035 draft

Source: [IEA]
### EU-27

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<tbody>
<tr>
<td><strong>TOTAL SYSTEM</strong></td>
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<tr>
<td>Peak Demand (MW)</td>
<td>310,520</td>
<td>399,637</td>
<td>460,449</td>
<td>523,542</td>
<td>509,898</td>
<td>439,705</td>
<td>489,995</td>
<td>506,359</td>
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<tr>
<td>Total Demand (TWh)</td>
<td>1,841</td>
<td>2,343</td>
<td>2,844</td>
<td>3,161</td>
<td>3,173</td>
<td>2,764</td>
<td>3,072</td>
<td>2,755</td>
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<td>Date of Peak Demand (month of the year)</td>
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<td><strong>CONNECTED SYSTEM (</strong>)**</td>
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<tr>
<td>Peak Demand (MW)</td>
<td>309,866</td>
<td>398,377</td>
<td>457,025</td>
<td>516,976</td>
<td>502,932</td>
<td>433,083</td>
<td>485,690</td>
<td>500,845</td>
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<tr>
<td>Total Demand (TWh)</td>
<td>1,428</td>
<td>1,906</td>
<td>2,807</td>
<td>2,645</td>
<td>2,645</td>
<td>2,727</td>
<td>3,025</td>
<td>3,297</td>
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<tr>
<td>Date of Peak Demand (month of the year)</td>
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<tr>
<td>Use factor of Connected Peak Demand (h/a)</td>
<td>112,850</td>
<td>121,810</td>
<td>138,428</td>
<td>114,354</td>
<td>110,549</td>
<td>119,115</td>
<td>125,148</td>
<td>114,858</td>
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</table>
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Vision:
10 development demonstration projects for consortium T&D members in 2012 and launch in 2013

Examples:
- 2 HVDC on land
- HVDC/wind farm off shore,
- 2 cable and substation technology,
- 10 high voltage substations in cities,
- 5 next generation low loss efficiency products,
- 3 storage projects
Technology needs - Short term view
Technologies ready for demonstration <2013

• NCITs for AC and DC application
• Digital substations (digital communication between NCITs, protection system, switchgear)
• UHV (up to 1100kV) DC transmission based on LCC (line commutated)
• HV DC transmission based on VSC technology (voltage source)
• AC Fault current limiters
• UHV AC (up to 1200kV)
• WAMS
Solution: Renewable integration HVDC

**Scope of supply:**
- Offshore DC grid connection system
- Country: Germany
- Year: 2009

**Keywords:**
- German HVDC offshore platforms (i.e. Borvin)
- DC voltage: 150 kV
- Transmission capacity: 400 MW
- DC marine cable length = 125 km
- DC land cable = 75 km
- Weight: 4’800 tons
- 380 kV AC onshore connection to German grid
**Solution: Renewable integration HVAC**

**Scope of supply:**
- Offshore wind park incl. network connection
- Country: Germany
- Year: 2010

**Keywords:**
- German AC offshore platform
- Generation capacity: 12x5 MW = 60 MW
- AC marine cable connection
- Cable length = 45 km
- Water depth about 40 m
- 110 kV connection to German network
Solution: Compact underground substation

- Country: USA
- Client: City of Anaheim CA
- Scope: 8 x bays GIS type 8DN8 / 69 kV
  - 2 x 132/11 kV 50 MVA transformers
  - 20 x 12 kV panels

The substation is located under an existing park, in an exclusive residential area in Los Angeles, CA.
**Solution : Gas Insulated Lines**

**Issue :**

- Substitution of a 400kV overhead line adjacent to a new runway of the Frankfurt Airport
- Transmission of 2x1800MVA continuous power (length 1km)
- Long lifetime, no impact to the environment

**Solution :**

- Installation of a directly buried Gas Insulated Line (GIL)
- Special backfill material surround GIL tubes to enhance power rating
- GIL have passive/active corrosion protection, low EMF radiation

- 400kV GIL installed directly buried
- Power transmission is per system twice as high compared to a conventional cable solution
- Electromagnetic field radiation (EMF) is negligible
- High overload capability
- No external impact in case of internal failure (no explosion, no risk of fire)
- Can be operated like an overhead line (auto-reclose functionality)
Solution: Renewable integration in MV

Keywords:

- 43MWp - 600 000 Solar panels.
- 3 No. 30kV Grid Substations.
- 36 No. inverter stations including 500kW inverters and 36kV switchboards.
- 1 300km of solar cables, 30km of trenches, 8.5km of fence.
- 426 units array boxes.
- Monitoring system, security system (access control, cameras, lighting, IR).
- Performance Ratio Commitment.

Scope of supply:

- Solar farm Cellino San Marco
- Country: Italy - Puglia
- Year: 2010
Solution: MV Distribution Energy Management System

Keywords:
• Smart City Malaga (ENDESA).
• Platform test for Smart Grid technologies.
• 80 MV/LV Transformer Substations and 12,000 Customers.
• Advanced Meter Management (AMM).
• MV/LV Transformer Substation Automation.
• MV PLC and WiMax Communications.
• Distributed Generation.
• MV Electric Network Storage.
• Electric Vehicle.
• Power Flow Control.
• Control Center (Showroom).

Scope of supply:
- Smart City Malaga
- Country: Spain
- Year: 2009-2012
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Vision:
- Triple interconnection capability
- Develop a super grid (a “E HV1” from Milano to Amsterdam)
  - Use state of art HV
    - 800 kV, HVDC, FACTS, phase shifters, DC breakers.
  - All these solutions are developed in Europe

Means:
- Complement current 400 kV grid with additional overlay grid HVDC or AC.
- Possible use of 800 KV AC voltages also needs to be considered.
- Meshed grid/networks will require the use of DC circuit breakers with high power breaking capacity.
- Hybrid transmission consisting of HVAC 400KV and HVDC overlay network will require state of the art operation patterns.
Technology needs - Long term view

Vision:
• Triple interconnection capability
• Develop a super grid (a “E HV1” from Milano to Amsterdam)

Means:
• Interoperability of converter stations from different suppliers
• Management and monitoring of wide interstate areas with relative control systems will be required
• Address the potential problematic operations of managing such hybrid transmission systems, having the contribution of many volatile sources.
• Reliability of supply in the different phases of operations, with volatile sources, will have to be tested and supported by proper regulations.
Some examples:

- HV DC breakers
- Meshed HV DC grids
- Hybrid AC-DC grids
- Off-shore DC grids
- Large scale control systems, integrating flexible generation and storage resources
System Security, Observability and Blackout Prevention

Monitoring

Fault Records
Fault Protocols

Results
Operator Information
WAPCS

Met. Values
WAMS

Results
Operator Instructions
Operator-Training

Fault location,
Analysis & Information System
(SIMEAS-SAFIR)

Interpreter
Expert System

Phasor Data
Concentrator and Processor

Counter Measures
Expert System

Adaptive Settings
Expert System

Dynamic Security
Assessment

Protection Security
Assessment

Evaluation
locally

New WAMS
Components
Existing Components

Metered Values
of Relays / Recorders

Metered Values
of PMUs

Metered Values
of Transducers

IAP

State Estimation
Short-Circuit
Loadflow Contingency

Switching State
Dynamic Data
Protection Data

System
Forecasts

Met. Values
Results

1-10ms
20ms-200ms
1-5sec

Signal-Transmission Steps