Offshore Grid

Already taking shape
TenneT - The company

TenneT – Two TSOs, One Company

- Europe’s first cross-border grid operator for electricity
- In the Netherlands and Germany
- 14 interconnectors to 10 surrounding TSO’s in BE, DE, GB, NO, DK, SE, CZ, AT
- Top five grid operator in Europe
- Statutory mandate grid expansion and safe operation on- and offshore
- 21,000 km high-voltage lines
- 41 million end-users
- 99.9976% security of supply
## TenneT

### First cross border TSO in Europe

<table>
<thead>
<tr>
<th>Category</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staff</td>
<td>2,813</td>
</tr>
<tr>
<td>EBIT</td>
<td>725 (EUR million)</td>
</tr>
<tr>
<td>Assets</td>
<td>13.645 (EUR billion)</td>
</tr>
<tr>
<td>Investments 2014-2023</td>
<td>20 (EUR billion)</td>
</tr>
<tr>
<td>Total grid length</td>
<td>21,000 km</td>
</tr>
<tr>
<td>End users</td>
<td>41 million</td>
</tr>
<tr>
<td>Sub stations</td>
<td>445</td>
</tr>
<tr>
<td>Interconnectors</td>
<td>14</td>
</tr>
<tr>
<td>Grid availability</td>
<td>99.99%</td>
</tr>
</tbody>
</table>

- Investments: 13.3% of EU total (150 bn.)
- End users: 7.7% of EU total (532 mln.)

*Figures as of December 31st 2014*
Reasons of interconnections

In general since years

- Facilitating integration of renewable energy
- Enhancing security of supply in Northwest Europe
- Creating a strong interconnected European electricity grid and enhancing the level playing field and increasing social welfare

North Sea Interconnections

In operation:
- NorNed 700MW, since 2008
- BritNed 1000MW, since 2011

Under construction:
- NordLink 1400MW, commissioning in 2019
Planned

New approach added with the COBRAcable project

- Similar benefits as other interconnectors
- In addition anticipatory investments for connection of offshore windpark

COBRAcable

- Joint project Energienet.DK / TenneT
- Project of Common Interest and Recovery Grant
- 700MW
- Commissioning in: 2019
Technical concept

1. Existing electricity grid (alternating current)
2. High-voltage substation (alternating current)
3. Converter station VSC technology (alternating current / direct current ±320kV)
4. Onshore cable (direct current ≈ 25km bi-pole XLPE)
5. Subsea cable (direct current ≈ 300km bi-pole XLPE)
Prepared for connection OWF
Next developments

German Offshore Gridplan (O-NEP)

- In operation: 4.3 GW
- 2016: Dolwin2, Nordergrunde
- 2017: Dolwin3,
- 2019: Borwin3

\[ \sum = 7.1 \text{ GW} \]

- 2024: additional 1.8 GW foreseen
Next developments

Offshore Grid

Dutch Offshore Gridplan

- 2019–2023, 700MW/year
  \[ \sum = 3.5 \text{ GW} \]
- Short distance to shore makes AC-grid connections possible
- Standardized approach
- Concept makes OWF platform obsolete
- Important contribution to 40% LCOE reduction
Electrifying the North Sea
Future requirements

Affordable and a realistic North Sea Grid

<table>
<thead>
<tr>
<th>topics</th>
<th>options</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Future benefits of interconnectors.</td>
<td>Balanced with investments in storage</td>
</tr>
<tr>
<td>• Functionality expectations; meshed, radial, redundant, etc.</td>
<td>“New” proven technical components</td>
</tr>
<tr>
<td>• Framework for financeability and social welfare distribution</td>
<td>many</td>
</tr>
</tbody>
</table>

From our leading role as an Offshore TSO, TenneT is committed to use the acquired knowledge and experience together with partners to address these topics. E.g. in PROgress on Meshed HVDC Offshore Transmission Networks, a Horizon2020 LCE5 proposal.
Conclusion

We have started building the “meshed” offshore grid with point to point connections!
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TenneT is Europe’s first cross-border grid operator for electricity. With about 21,000 kilometres of (extra) high-voltage lines and 36 million end-users in the Netherlands and Germany, we rank among the top five grid operators in Europe. Our focus is to develop a North-west European energy market and to integrate renewable energy.

Taking power further

www.tennet.eu