Underground cables in Europe: Overview

The European Association of Wire and Cable Manufacturers and National Associations

Presentation to RGI Workshop hosted by Amprion

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What are we actually talking about?

➢ "Technology Adoption" with all its challenges to our mindset, technology, legislative & regulatory frameworks, hick-ups and opportunities
What are we actually talking about?

Technology Adoption

➢ So where are we on underground cabling?
Where are we now on undergrounding?

Underground cable technology: Mature & fully available

- **High Voltage Alternate Current (HVAC)**
  - up to 400 kV (systems in operation)

- **High Voltage Direct Current (HVDC)**
  - up to 320 kV (systems in operation)
  - up to 600 kV (available technology)

➢ Now amplifying operational experience in networks
Where are we now on undergrounding?

1996 – 2015: Visionary technology adoption

- **4,691 km total AC land cable** length installed (EHV: 220 – 500 kV XLPE), of which:
  - **1,940 km** of 220 – 235 kV
  - **1,073 km** of 245 – 345 kV
  - **1,678 km** of 380 – 500 kV

- **Projects**
  - Abu Dhabi, Argentina, Austria, Bahrain, China, Denmark, France, Germany, India, Ireland, Italy, Japan, Mexico, The Netherlands, Portugal, Russia, Saudi Arabia, Spain, South Korea, Sweden, Switzerland, Taiwan, Tunisia, Turkey, UK, Ukraine, USA, ...

- **Types**
  - Connection to power plants and substations, city feeders, replacing overhead lines in areas of outstanding beauty, airport expansions, rural/tourist areas

- **8,000 km HVDC submarine cables** additionally installed globally until 2015 (JRC Study for European Commission

▶ **EHV XLPE cables have been in service for over 25 years**
Where are we now on undergrounding?

Today: Pragmatic roll out

- Case-by-case approach: Adapting to the specific conditions and requirements
- Projects feature different innovations, e.g. installation technologies, research, stakeholder engagement etc.

➢ Closely monitored from across the world: Innovators at work

380 kV AC Raesfeld Germany
- Total length: 181 km
- 3 sections underground
- Raesfeld: 7 km
- 380 kV, 2x1800 – 2300 MVA

380 kV AC Randstadt NL
- Total length: 85 km
- 20 km partial undergrounding
- HVAC 380kV, 2x2635 MVA

INELFE, Interconnector France-Spain
- Total Length: 65 km underground
- 8,5 km tunnel
- HVDC +/- 320kV; 2 GW

Nordlink, Interconnector Norway–Germany
- Offshore cable: 516 km
- Onshore: 53 km HVDC OHL (NO); 54 km HVDC cable (DE)
- HVDC +/- 500 kV, 1,4 GW
Where are we now on undergrounding?

Environmental implications: 2 dimensions need to be accounted for

**Construction**

- Major construction site
- Usually directly buried into the ground, surrounded by sand blending, can also be installed in tunnels, ducts or pipes
- Average laying depth: 1,60 m
- Average cable length: 700 – 1000 meters
- *Vegetation re-installed after 1-2 years*

**Operation**

- Will blend into open countryside, but will be visible if running through forests
- No limitation on cultivation apart from deeply routed trees
- No limitation on agriculture
- *Approx. 40 years lifetime*
Where are we now on undergrounding?

Public Acceptance: Cables key to deliver projects

At sea: Cable technology without alternative
   • Key technology for offshore windfarms and subsea interconnections

On land: Undergrounding may facilitate public acceptance
   • 32% of current grid projects across Europe are delayed
   • 15 years average delay to realise projects
   • Delays mainly due to “social resistance & lengthy permitting procedures”

➢ **It will be important to find the right balance between all available technologies**
Where are we now on undergrounding?

Underground & Submarine cables key technology for Europe’s electricity grids

2016 ENTSO-E TYNDP

- Some 40,000 km EHV power lines to be built/refurbished by 2030
- €150 billion of investment by 2030
- 48% of total distance to be covered by EHV underground and submarine cables

<table>
<thead>
<tr>
<th>2016 TYNDP</th>
<th>Km</th>
<th>% km</th>
<th>Projects</th>
<th>% projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overhead Line</td>
<td>21,230</td>
<td>52</td>
<td>199</td>
<td>68</td>
</tr>
<tr>
<td>Subsea Cabling (incl. some land parts)</td>
<td>18,075</td>
<td>44</td>
<td>54 subsea</td>
<td>24</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>14 mix subsea&amp;land cable</td>
<td></td>
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<tr>
<td>Land Cabling</td>
<td>1,511</td>
<td>4</td>
<td>11 land; 14 PUGC</td>
<td>8</td>
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<tr>
<td>Total</td>
<td>40,816</td>
<td>100</td>
<td>292</td>
<td>100</td>
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Europacable analysis shows demand of some 90,000 km of HV and EHV underground and submarine cables in Europe for the period 2016-2026
How do we move to the next level?

Technology Adoption

[Diagram showing the Geoffrey Moore Technology Adoption Lifecycle with categories: Tech Enthusiasts, Visionaries, Pragmatists, Conservatives, Skeptics]
How do we move to the next level?

“Go bold into the future” Tesla Motor Cars

1) Successful project implementation & operation
   - Complete current projects thoroughly, run them, learn from them
   - Establish close co-operation between industry and TSOs
   - Embark on further undergrounding projects

2) Respond to current & emerging challenges
   - Tackle challenges that emerge along the way
   - Address concerns voiced against undergrounding
   - Create fora for exchange of best practices

3) Adapt policy framework
   - Create compensation schemes
   - Create legislative and regulatory framework firmly managing and clearly defining the deployment of underground cabling

➢ Taking undergrounding from the “Pragmatists” to the “Conservatives”
Our conclusions

1) Building Europe’s future electricity networks is serious business
   - We can not afford to take risks: “The lights must stay on!”

2) Cable technology is fully available
   - Underground cabling is not a “disruptive technology”: Continuous evolution of EHV cable technology for over 100 years – and still moving forward...

3) Since 2005: “Europacable Concept of Partial Undergrounding“
   - Majority of new transmission lines will be built using overhead line technology (OHL)
   - For AC projects, partial undergrounding may complement OHL in sensitive areas
   - For DC projects, longer distances can be undergrounded

4) Delays are the greatest cost to society
   - We need a legislative framework that considers undergrounding from the outset of every project as a fully available technology option
   - We need clear, strict criteria to assess undergrounding option
   - We need to look at lifetime costs for the entire project, not cost of cable investment
   - We need to minimize delays
Our conclusions

5) European cable industry is ready

We have the experience, know-how and capacity to deliver Europe’s grids on time.
Thank you for your attention

Someday, archaeologists will find this and scratch their heads.

Free yourself from dependence on gasoline. With its 300 horsepower, emission-free motor, the Tesla Roadster proves that electric vehicles can be as exhilarating to drive as they are efficient to own. At last, someone has discovered the missing link between power and fuel efficiency.

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