Stevin / Nemo

Innovation

CIGRE
24.11.2016
Wouter Geladé
Agenda

1. The Stevin Project
   1. General
   2. Stevin Overheadline
   3. Stevin Cable/Tunnel

2. The Nemo Project

3. Ampacimon
Stevin
Scope Stevin project

- **17km new line 380kV parallel with existing 150kV line that will be undergrounded**
  - Conventional conductors, insulated cross-arms

- **8km new 380kV line**
  - Conventional conductors, insulated cross-arms

- **10km new underground cable 380kV**
  - 4 circuits 2500mm²CuEm (tinned Copper)
  - Tunnel under Boudewijn channel

- **Demolition existing 150kV-line**

- **12km uprating existing 380kV line**
  - High Temperature Low Sag Conductors
Stevin Overheadline
Uprating between Horta and Eeklo (12.3km, 29 towers) from 1500 MVA to 2x3000 MVA

Uprating of existing line by reconductoring with HTLS conductors (ACCC and ACPR)

- Towers- and foundation reinforcements on line (22)
- New angle towers (7)
New line between Eeklo & Van Maerlant
(17.3km, 48 towers)

New 380kV line 3000 MVA with classic 4-bundle conductor
707 AAAC-2Z in parallel with the existing 150kV line

- Line tower with insulated cross-arms (compact configuration similar to a 150kV tower).
- Classic angle tower
First compact towers finished (part 2)
New line between Gezelle & Stevin (8.3km, 23 towers)
Uprating from 2 x 300 MVA to 2 x 3000 MVA

New 380kV line with classic 4-bundle conductor 707 AAAC-2Z

- Partial reuse of existing 150kV line corridor. The old line was completely undergrounded.
- Same towers as in part 2
Conclusion

The use of **compact towers** for new OHTL

+  

The use of **HTLS conductors** for existing lines allow elia to **double the transport capacity** while mitigating **the landscape impact**
Stevin Cable/Tunnel
Cable 380kV
Van Maerlant (Vivenkappelle) – Gezelle (De Spie)

Length 10km with 4 Circuits 380kV => 4 x 3 x 2500mm²CuEm

- Cable Slot: +/- 16m
- Depth Cables: 2,4m
- 12 pieces of 800à900m
- 11 locations with cable glands– fencing 10m x 10m
Complex Civil Works
- 2 Tunnel shafts, Ø 14m, depth 32m
- 2 tunnel tube, Ø 2,5m, length 230m
- Cooling trough ventilation
- Accessibility - Safety procedures
Tunnel - Uitvoeringsmethode
Tunnel...
…en kabelwerken
NEMO
National Grid and Elia are developing an electrical interconnector (1000 MW HVDC) between the UK (Richborough) and Belgium (Zeebrugge-Herdersbrug).

The interconnector will allow electricity to flow in either direction between the two countries.

It will collect congestion revenues through explicit and implicit capacity auctioning mechanisms.

Existing interconnectors between continental Europe and the UK are IFA (FR-UK) and BritNed (NL-UK).

Commercial operation is scheduled for Q1 2019.

Elia System Operator and NGIH are each having a 50% stake in Nemo Link.
Project presentation

• Investment decision was taken on February 28\textsuperscript{th} 2015
• UK-BE interconnector project (Nemo) already started in 2006
• Main challenge was to find a compromise between a merchant model (UK) and a fully regulated model (Belgium / Continental Europe)
• Ofgem/CREG held several public consultations & used several consultants in the past years
• A Final regulatory framework was published by Ofgem and CREG in 2014
• Nemo will be regulated through the ‘cap and floor’ regulatory regime with the aim that this project is self-financeable (no impact on the TSO tariffs for the consumers)
Project drivers

To meet climate change targets, UK and BE will increase renewable power generation

Nemo Link will provide an effective way to better manage the natural intermittent character of renewable generation

Crucial role of interconnectors in EU strategy for competitive and integrated European energy market

Nemo Link will increase security of supply and diversify BE and UK electricity supply

Greater opportunities for trade between UK and the Continent;

NemoLink will contribute to the realisation of the European copper plate & will increase the competition on the wholesale market in BE

The project is part of the European Commission list of Projects of Common Interest (PCI)
## Project timeline

<table>
<thead>
<tr>
<th>Event</th>
<th>Date Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment decision (FID) &amp; awarding contracts</td>
<td>27.02.2015 &amp; 02.06.2015</td>
</tr>
<tr>
<td>Securing site BE</td>
<td>06.2015</td>
</tr>
<tr>
<td>Market implementation (Operational committee)</td>
<td></td>
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<tr>
<td>Detailed Engineering</td>
<td></td>
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<tr>
<td>Design review, manufacturing &amp; site delivery</td>
<td></td>
</tr>
<tr>
<td>Construction: Civil works</td>
<td>01.12.2016</td>
</tr>
<tr>
<td>Construction: Electrical installation</td>
<td>08.09.2017</td>
</tr>
<tr>
<td>Cable manufacturing &amp; installation</td>
<td></td>
</tr>
<tr>
<td>Pre connection tests</td>
<td>20.04.2018</td>
</tr>
<tr>
<td>First Energisation</td>
<td>31.10.2018</td>
</tr>
<tr>
<td>Performance and operational testing (commissioning)</td>
<td></td>
</tr>
<tr>
<td>Taking over</td>
<td>31.01.2019</td>
</tr>
<tr>
<td>Trial operation &amp; commercial operation (from 01.02.2019 to 28.03.2019)</td>
<td></td>
</tr>
</tbody>
</table>
Geography
Geographical overview in Belgium

- Offshore
- HDD
- Stevin
- Nemo onshore HVDC cable (approx 9km)
- Converter station (Herdersbrug site)
- Gezelle substation
- 380kV connection
Technical

- **1000MW bi-directional rated power**
- **VSC technology (Voltage Source Converter)**
  - no polarity reversals (XLPE cables could be used)
  - Black start capabilities
  - Reactive power compensation capabilities $\pm 320$Mvar
- **Topology: symmetrical monopole**
  - High reliability (compared to bipolar solution)
  - Multilevel converter station (minimised harmonic distortion in AC grid)
  - Compact footprint (2.5 to 3ha)
- **Losses: $\pm 1\%$ for each converter station**
Controls, Protection, Monitoring

1. AC Switchyard
2. Transformers
3. Star Point Reactor
4. Insertion Resistor
5. Power Modules
6. Converter Reactor
MMC Control
Technical

- **HVDC cable**
  - XLPE (cross-linked polyethylene) cable
  - No metallic return
  - 130 km offshore route $\Rightarrow$ 260 km HVDC submarine cable
  - Approx 10km total onshore route
  - Water depth: max 60m
  - Burial depth: between 1 and 3m
  - Offshore cables bundled together (due to environmental restrictions)
  - DC Voltage: +/-400kV
  - Cable losses: ±1%
  - Soil conditions: BE to UK: sand, gravel, clay, chalk rock
HVDC cable cross section

- Copper conductor
- Conductor screen
- XLPE Insulation
- Insulation screen
- Water blocking layer
- Lead metallic sheath
- Polyethylene outer jacket
- Bedding tape
- Optical fiber unit
- Binding tape
- Polypropylene Yarn Bedding
- Galvanized steel armor wire
- Polypropylene Yarn Serving
HVDC cable bundling
Direct loading of cable on vessel
HVDC cable installation (Deep Ocean subcontractor)

Cable installation vessel

Vessel for cable trenching operations
HVDC cable installation

T3200 Trenching asset

T3200 side view showing single cutter and jetting package deployed at rear
HVDC cable installation

T2 trenching asset

T1000 Trenching asset
Configuration of submarine cables

Base design

Burial depth depends on burial risk assessment (1.5-2m)
Cable crossings
Shipwrecks
Innovations

First 400 kV XLPE cable installed worldwide

First 400 kV Siemens HVDC PLUS converter station worldwide
**Innovations**

**Onshore cable in ducts**
- Limited footprint
- Minimal installation nuisance

**Maersk Connector**
- Brand new cable laying vessel (2016)
- Beachable
- Concentric carrousels (2x3500t)

**First project subject to Ofgem’s cap & floor model**

**Sustainable design**
- Waste heat recovery
- Loss minimisation

**Burial Protection Index (BPI) concept**
- Combining seabed soil composition with cable threat assessment to determine burial depth
Ampacimon
Real time monitoring

AMPACIMON for Real Time Monitoring
Ampacimon: Measurement Principle

Vibration Analysis => Sag

No conductor data
No topological data
No sagging data
No weather data

= No Calibration!
Installation sensors Ampacimon

Line out of service

Line in service
## Operational gain in Real time for entire year 2015

<table>
<thead>
<tr>
<th>Line</th>
<th>Ampacity average gain</th>
<th>Ampacity gain P90</th>
<th>Ampacity gain P95</th>
</tr>
</thead>
<tbody>
<tr>
<td>380.11.V</td>
<td>+ 43%</td>
<td>+ 30%</td>
<td>+ 25%</td>
</tr>
<tr>
<td>Herderen-Van Eyck</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>380.23</td>
<td>+ 47%</td>
<td>+ 30%</td>
<td>+ 25%</td>
</tr>
<tr>
<td>Meerhout-Van Eyck</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>380.25</td>
<td>+ 106%</td>
<td>+ 74%</td>
<td>+ 68%</td>
</tr>
<tr>
<td>Doel-Zandvliet</td>
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<td></td>
<td></td>
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<tr>
<td>380.19</td>
<td>+ 42%</td>
<td>+ 25%</td>
<td>+ 20%</td>
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<tr>
<td>Achene-Lonny</td>
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<td></td>
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<tr>
<td>380.80</td>
<td>+ 44%</td>
<td>+ 27%</td>
<td>+ 22%</td>
</tr>
<tr>
<td>Avelgem-Avelin</td>
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</tbody>
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**In operation:**
Real time values are capped to 130% of the static seasonal rating
Innovations

• Temporary overload (15’)

• Forecast ampacity 2 days ahead
Temporary overload (15’)
## Forecast ampacity 48h

### Confidence level P98

<table>
<thead>
<tr>
<th>Line</th>
<th>Average Gain forecast 48h</th>
<th>Gain 90% of time forecast 48h</th>
<th>Gain 95% of time forecast 48h</th>
</tr>
</thead>
<tbody>
<tr>
<td>380.11.V</td>
<td>Herderen-Van Eyck</td>
<td>+ 24%</td>
<td>+ 12%</td>
</tr>
<tr>
<td>380.23</td>
<td>Meerhout-Van Eyck</td>
<td>+ 29%</td>
<td>+ 15%</td>
</tr>
<tr>
<td>380.25</td>
<td>Doel-Zandvliet</td>
<td>+ 64%</td>
<td>+ 48%</td>
</tr>
<tr>
<td>380.19</td>
<td>Achene-Lonny</td>
<td>+ 26%</td>
<td>+ 12%</td>
</tr>
<tr>
<td>380.80</td>
<td>Avelgem-Avelin</td>
<td>+ 26%</td>
<td>+ 13%</td>
</tr>
</tbody>
</table>
Belgian border lines

DLR allows more imports
Many thanks for your attention!

First name, last name

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City, 19.11.2013