Stevin / Nemo

Innovation

CIGRE
24.11.2016
Wouter Geladé

Agenda

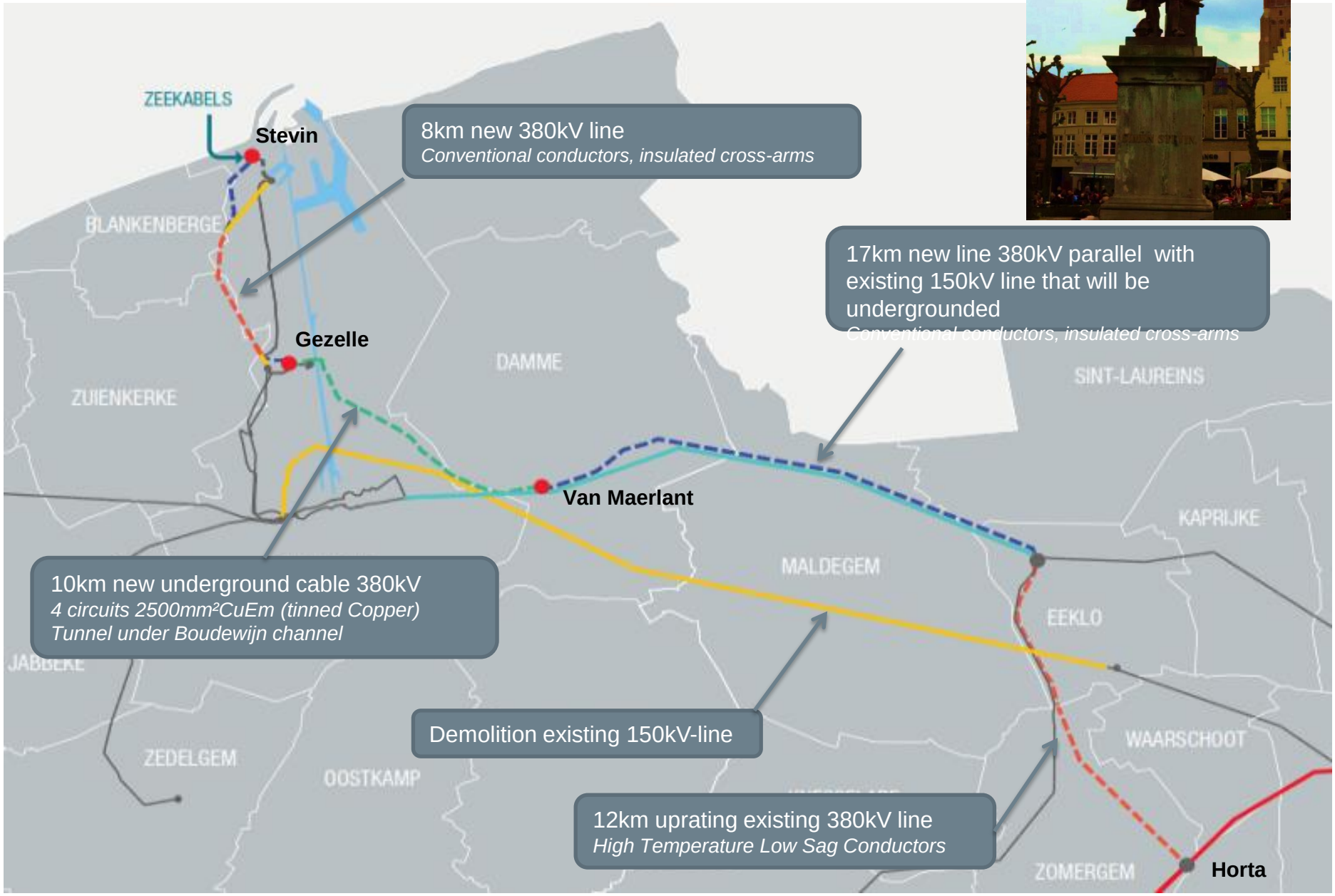
1. The Stevin Project
   1. General
   2. Stevin Overheadline
   3. Stevin Cable/Tunnel

2. The Nemo Project

3. Ampacimon

Stevin

Scope Stevin project

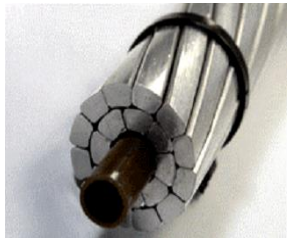


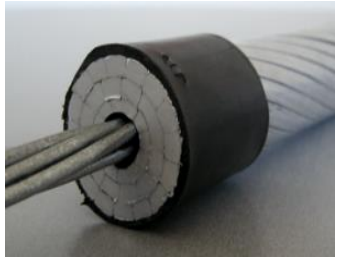
Stevin Overheadline

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**

http://www.inmr.com/project-belgian-tso-navigates-challenges-facing-new-power-infrastructure/?omhide=true&utm_source=INMR+WEEKLY+TECHNICAL+REVIEW&utm_campaign=951edee302-INMR_WTR_34_16_Monday_7_4_2016&utm_medium=email&utm_term=0_3d4b8a59df-951edee302-27670605

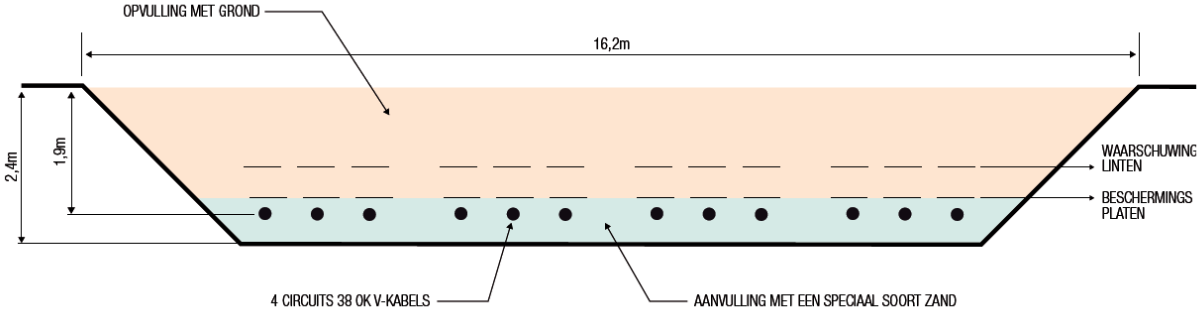
Stevin Cable/Tunnel

Cable 380kV

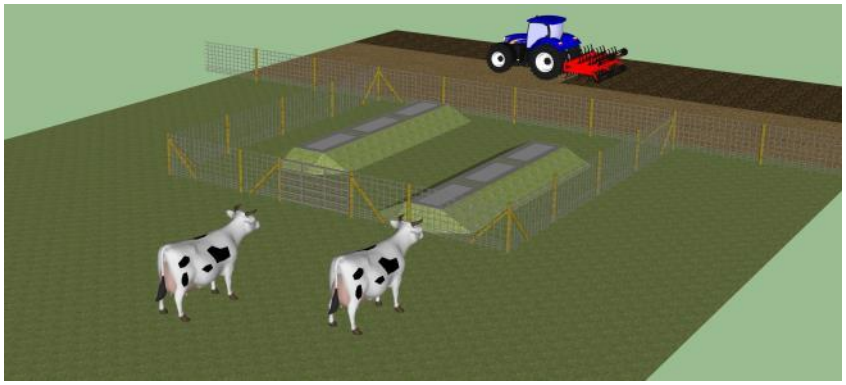
Van Maerlant (Vivenkappelle) – Gezelle (De Spie)

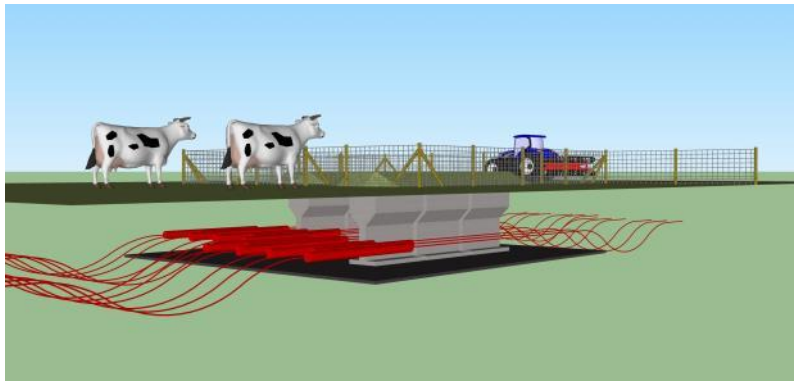
Length 10km with 4 Circuits 380kV => 4 x 3 x 2500mm²CuEm

- Cable Slot: +/- 16m
- Depth Cables: 2,4m
- 12 pieces of 800à900m



- 11 locations with cable glands– fencing 10m x 10m

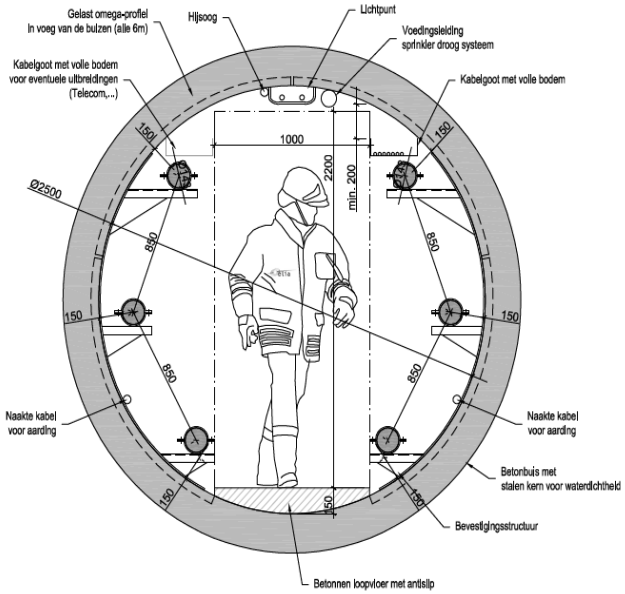


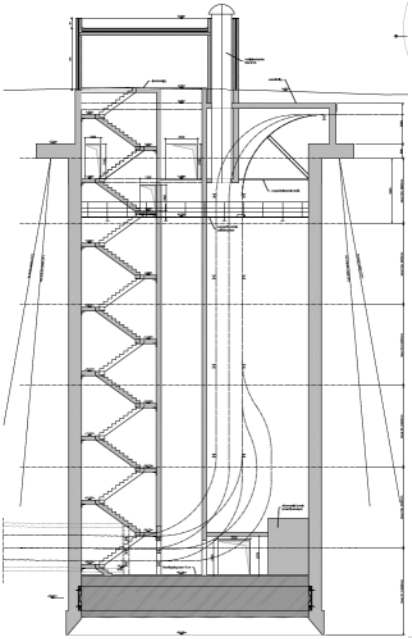


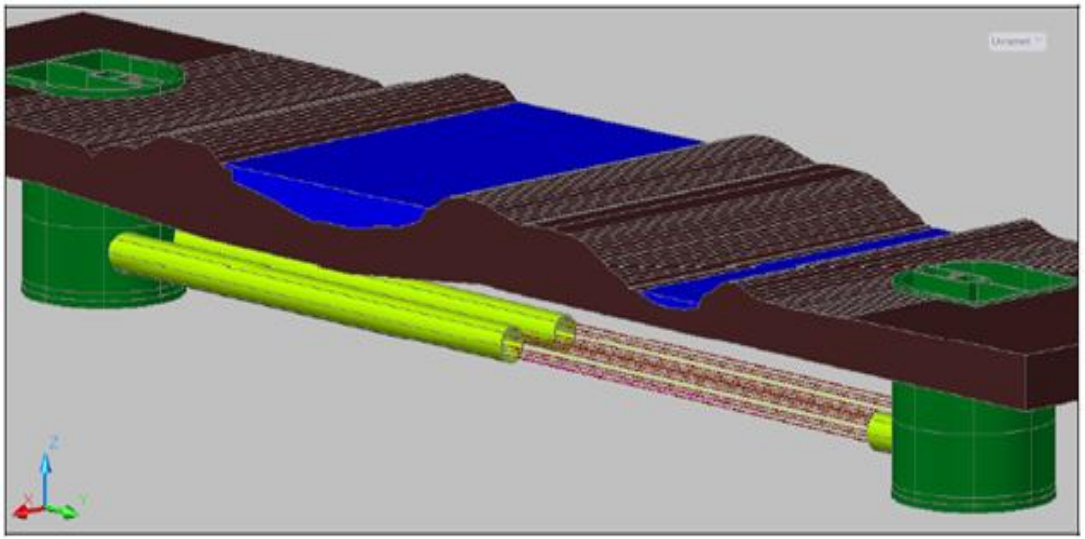
Cable 380kV
Tunnel under Boudewijn canal

Complex Civil Works

- 2 Tunnel shafts, Ø 14m, depth 32m
- 2 tunnel tube, Ø 2,5m, length 230m
- Cooling trough ventilation
- Accessibility - Safety procedures

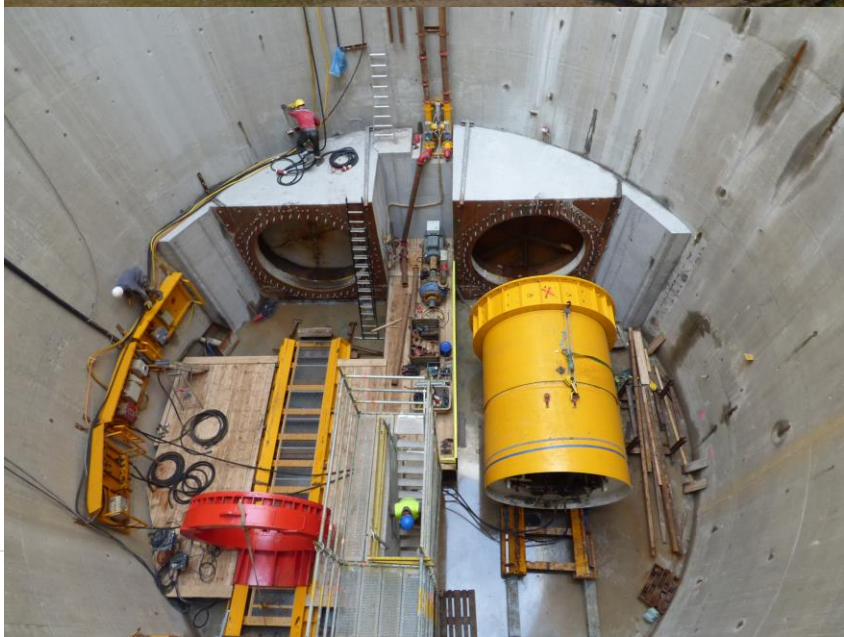






Tunnel - Uitvoeringsmethode

Tunnel…

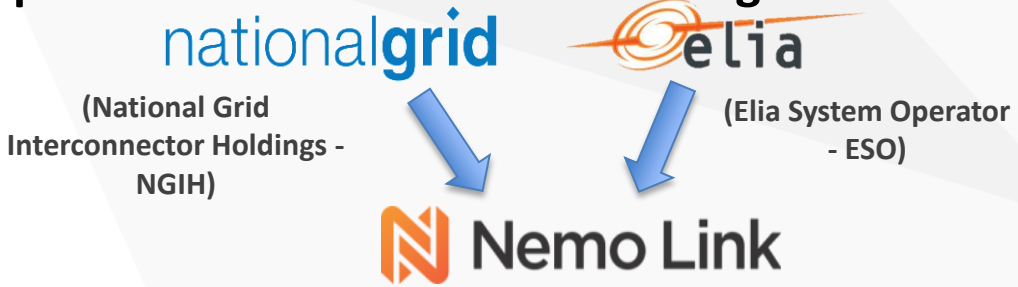


…en kabelwerken

NEMO

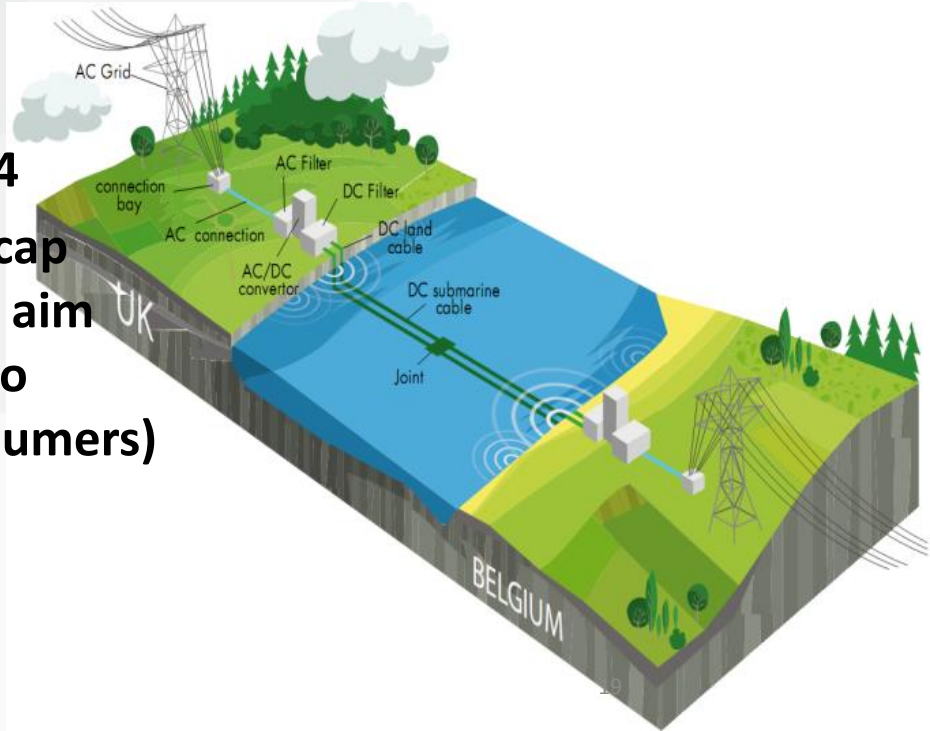
Project presentation

- 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

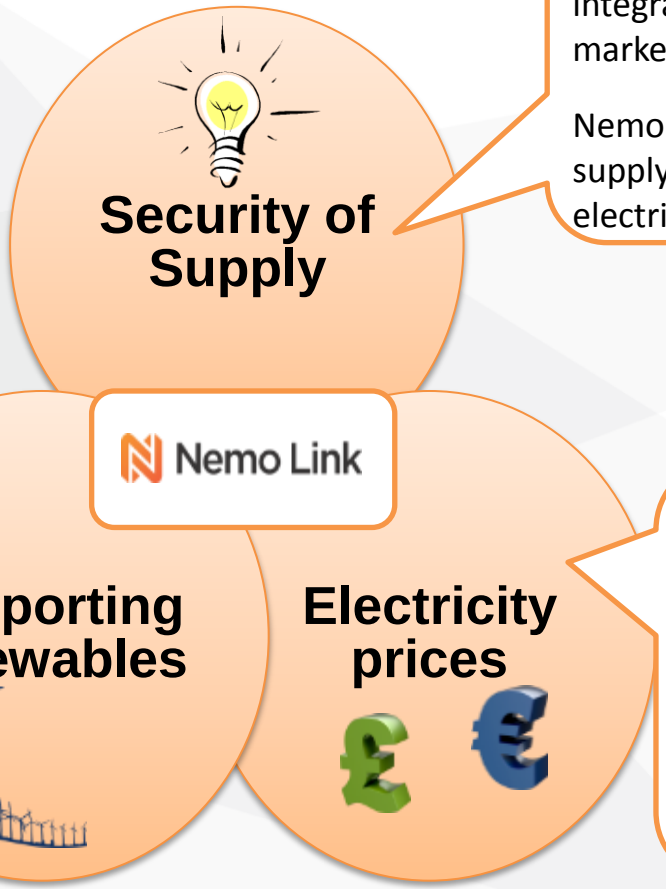
- Investment decision was taken on February 28th 2015
- UK-BE interconnector project (Nemo) already started in 2006
- Main challenge was to find a compromise between a merchant model (UK) and a fully regulated model (Belgium / Continental Europe)
- Ofgem/CREG held several public consultations & used 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

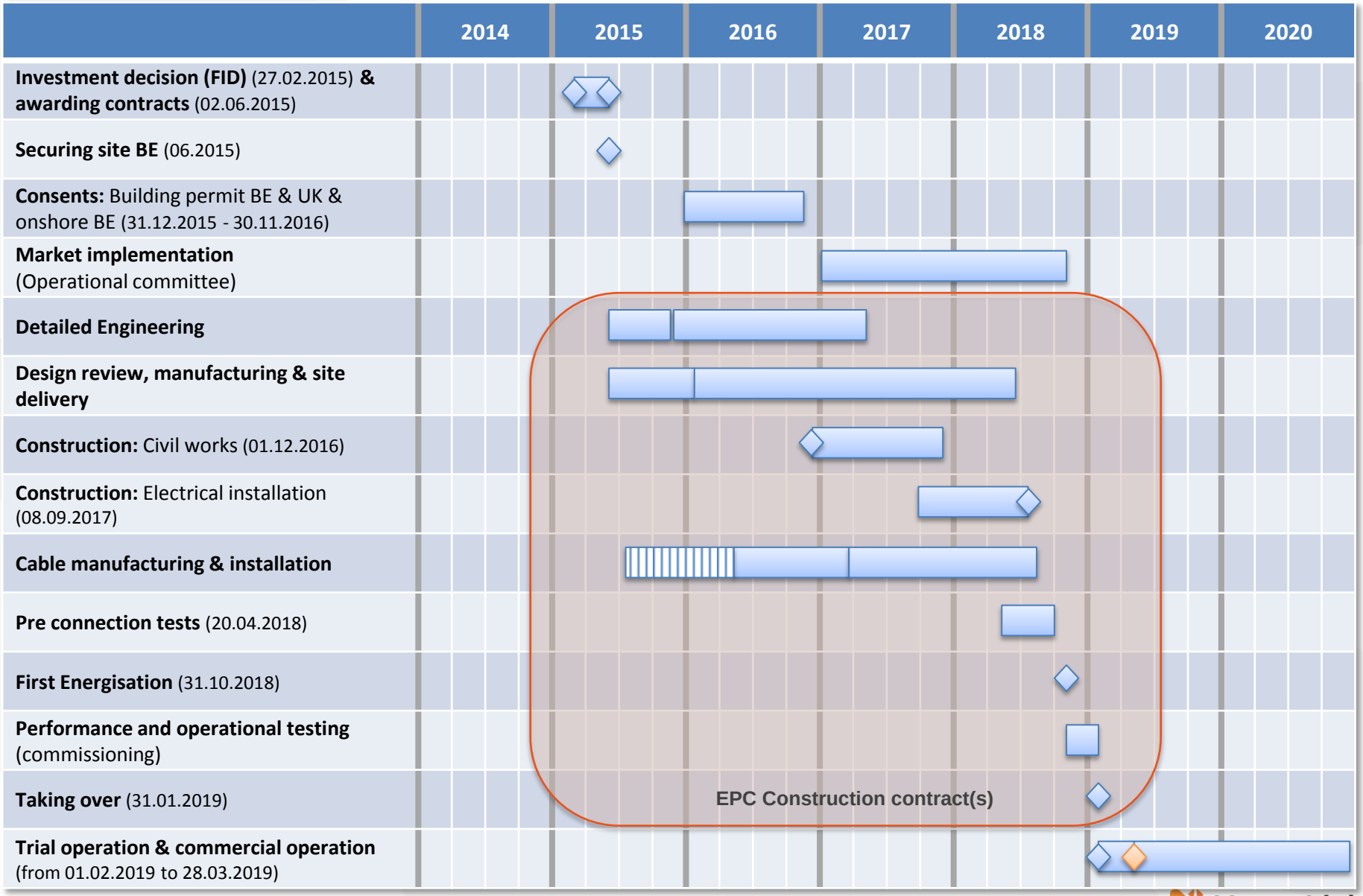
Nemo Link will increase security of supply and diversify BE and UK electricity supply

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

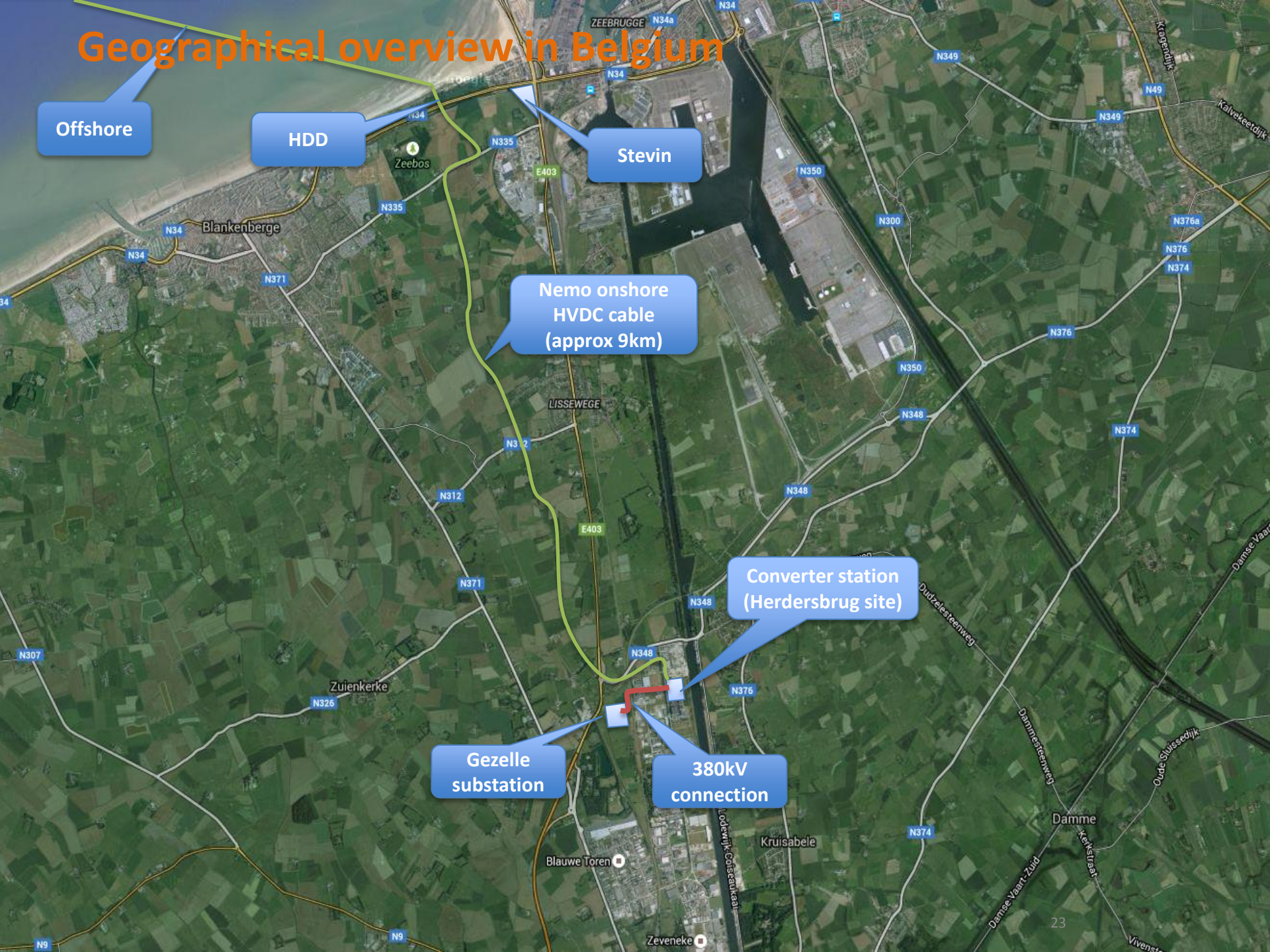


Nemo Link

Geography

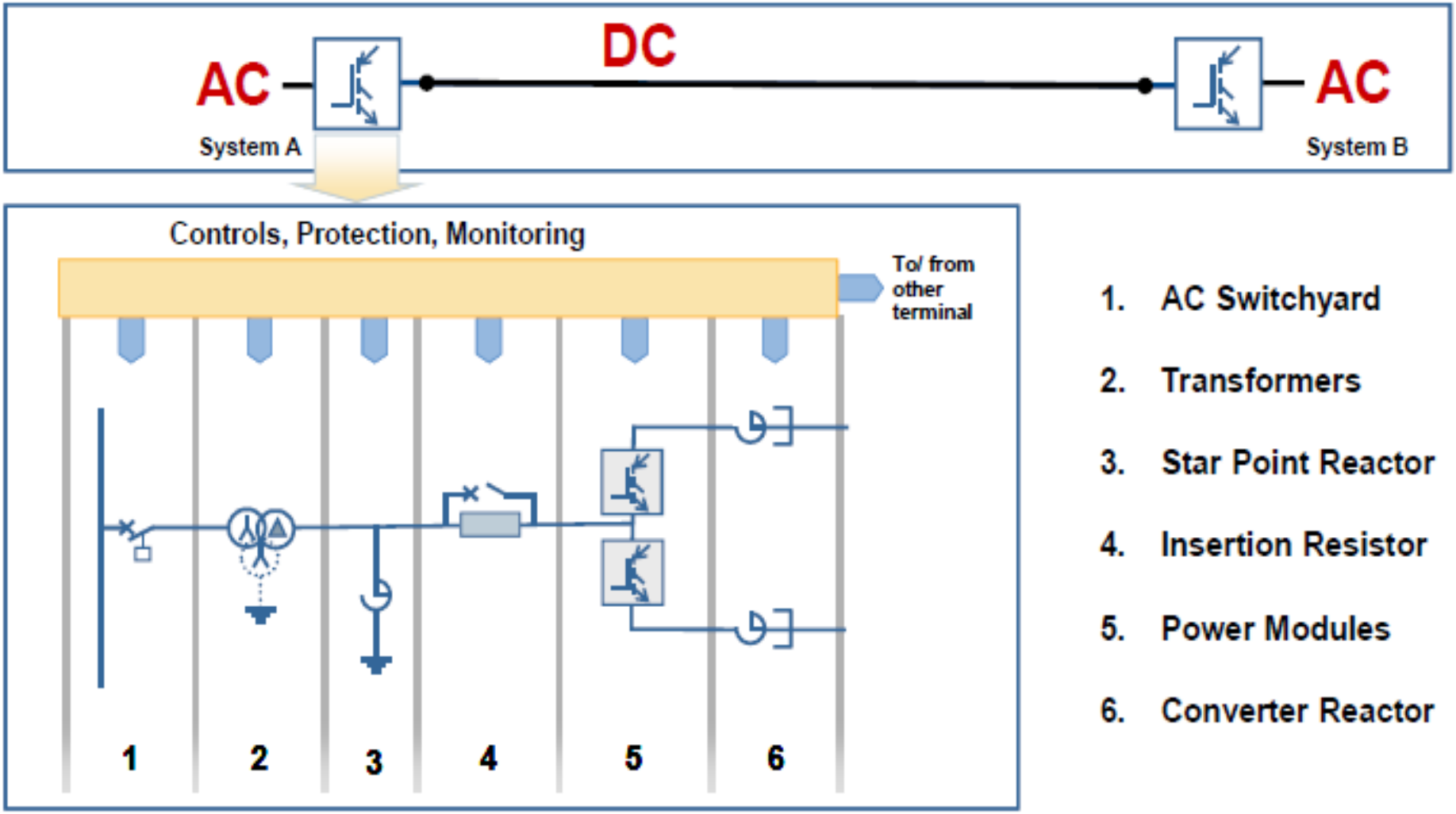
Nemo Link

Geographical overview in Belgium



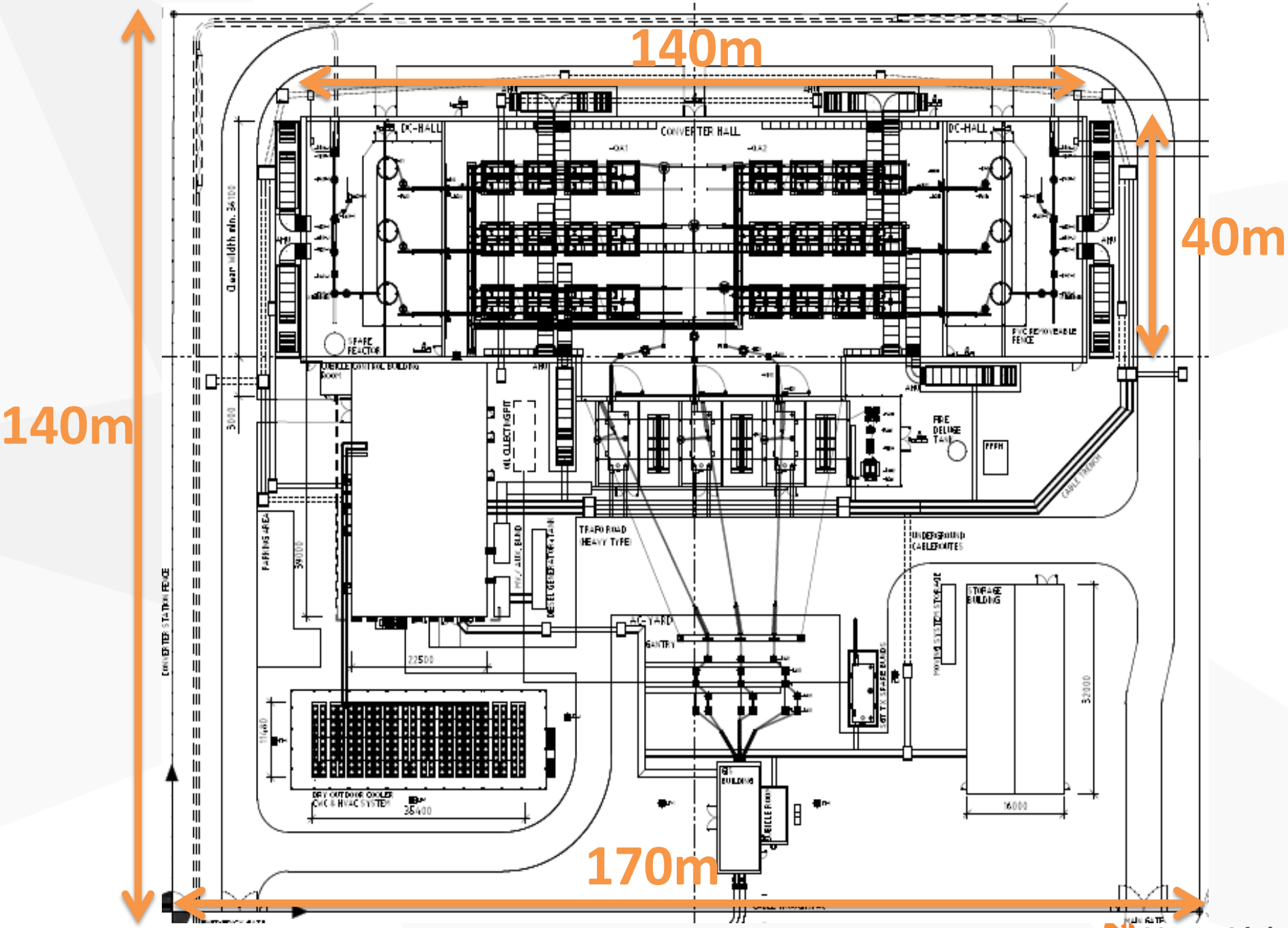
Technical

- **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 ±320Mvar
- **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: ±1% for each converter station**

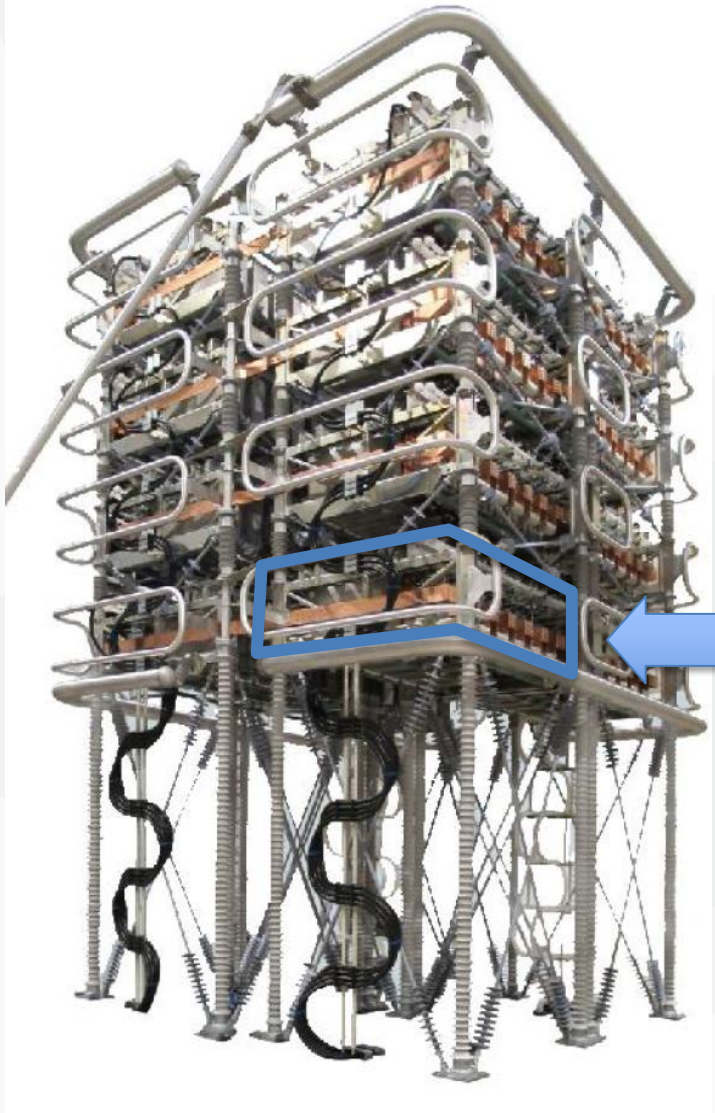


1. AC Switchyard
2. Transformers
3. Star Point Reactor
4. Insertion Resistor
5. Power Modules
6. Converter Reactor

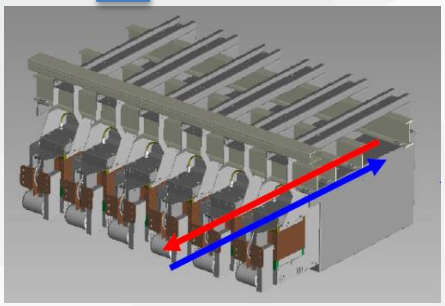
Nemo Link


140m
40m
140m
170m
CONVERTER HALL
DC-HALL
DC-HALL
SPARE REACTOR
FIRE DELUGE TANK
TRAFO ROAD (HEAVY TYPE)
UNDERGROUND CABLEROUTES
STORAGE BUILDING
DRY OUTDOOR COOLER CWC & HVAC SYSTEM
35400
22500
39000
32000
16000

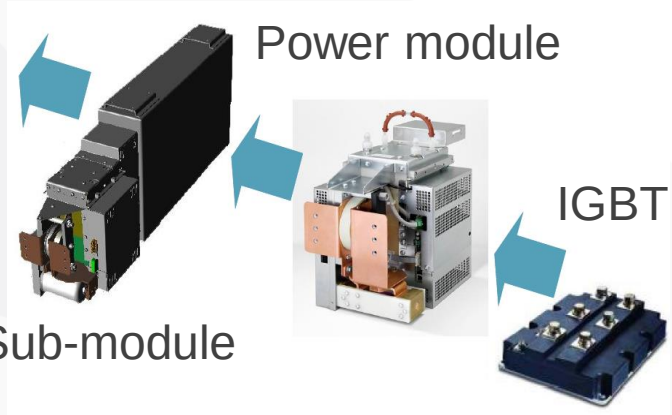
Nemo Link



Converter Tower

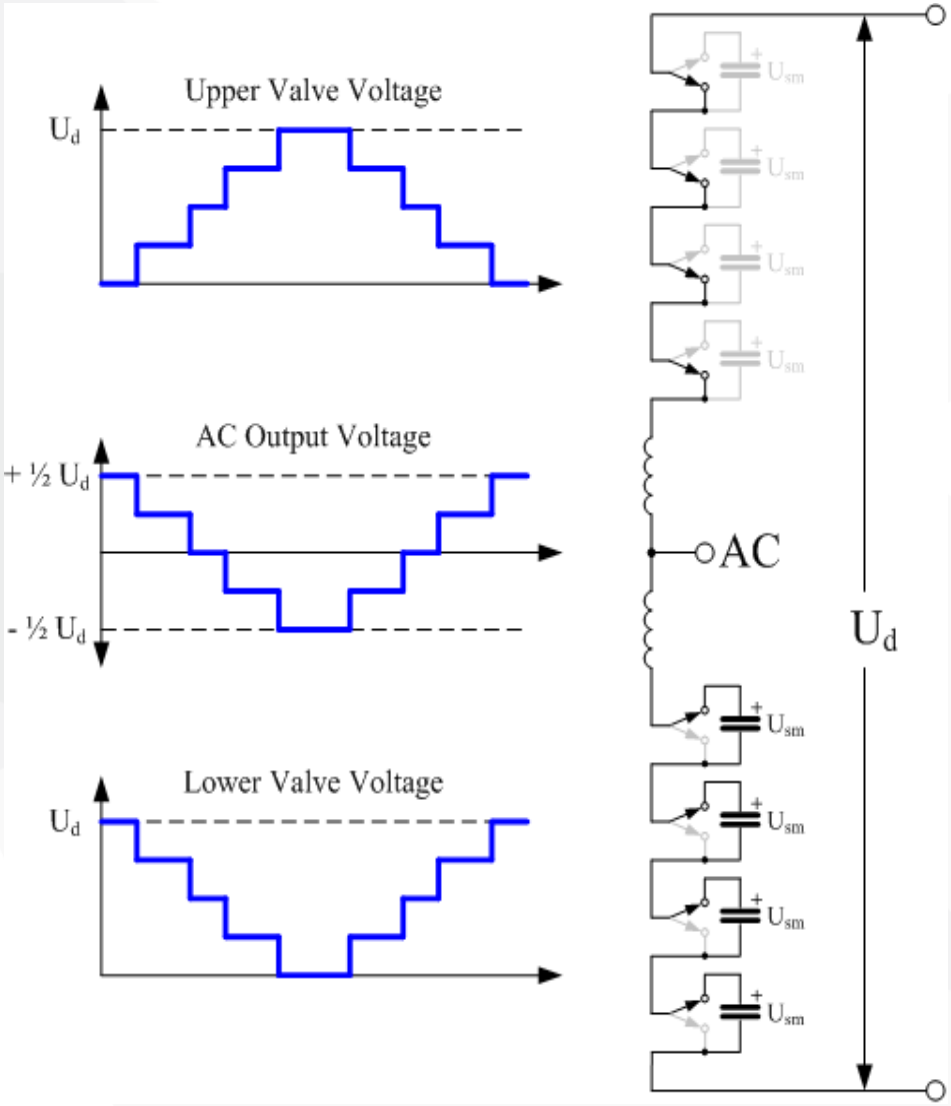


"6-pack"



Nemo Link

MMC Control



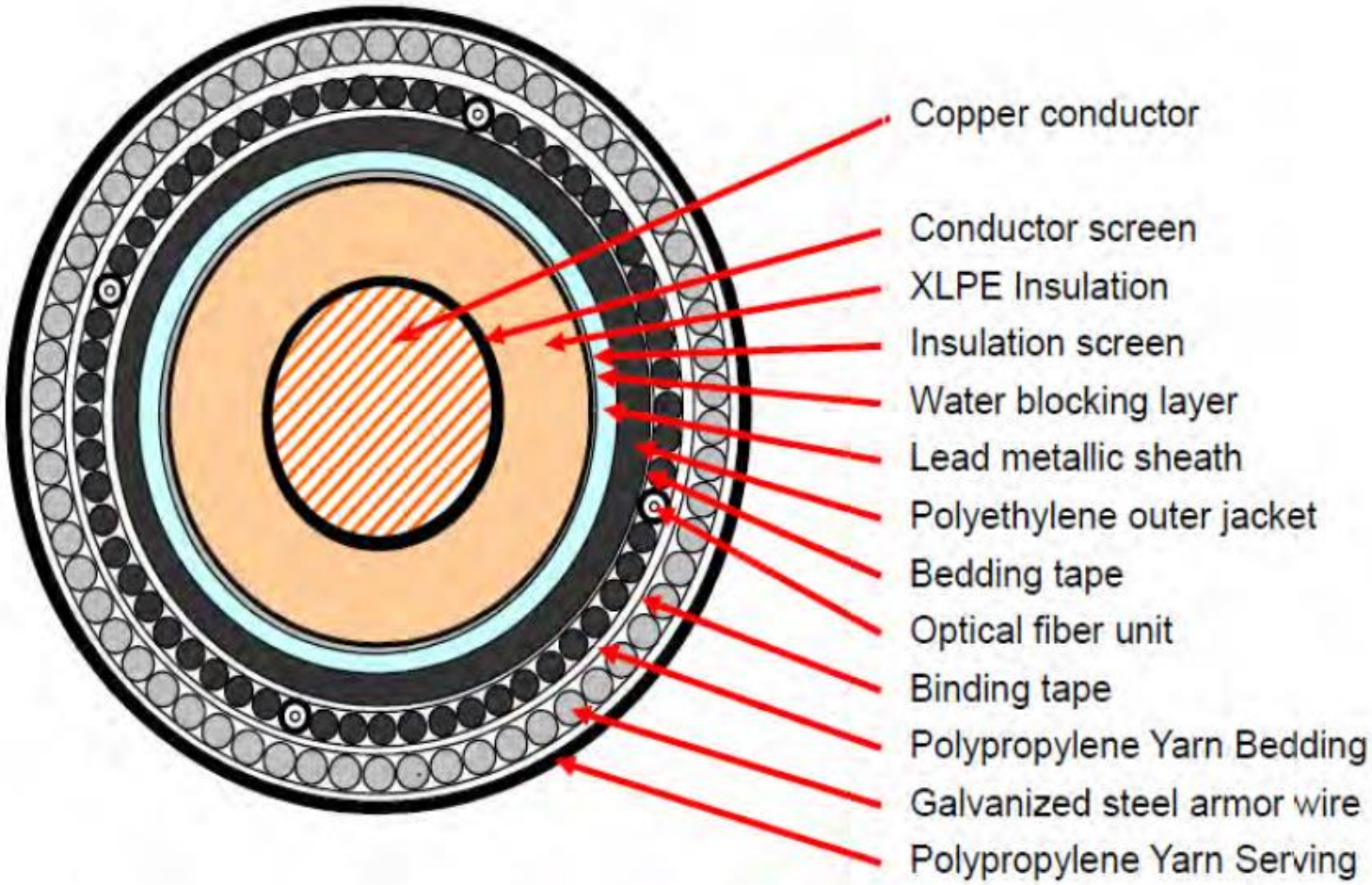
Nemo Link

Technical

- **HVDC cable**
  - XLPE (cross-linked polyethylene) cable
  - No metallic return
  - 130 km offshore route ⇨ 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

XLPE cable

HVDC cable cross section



HVDC cable bundling

Direct loading of cable on vessel

Nemo Link

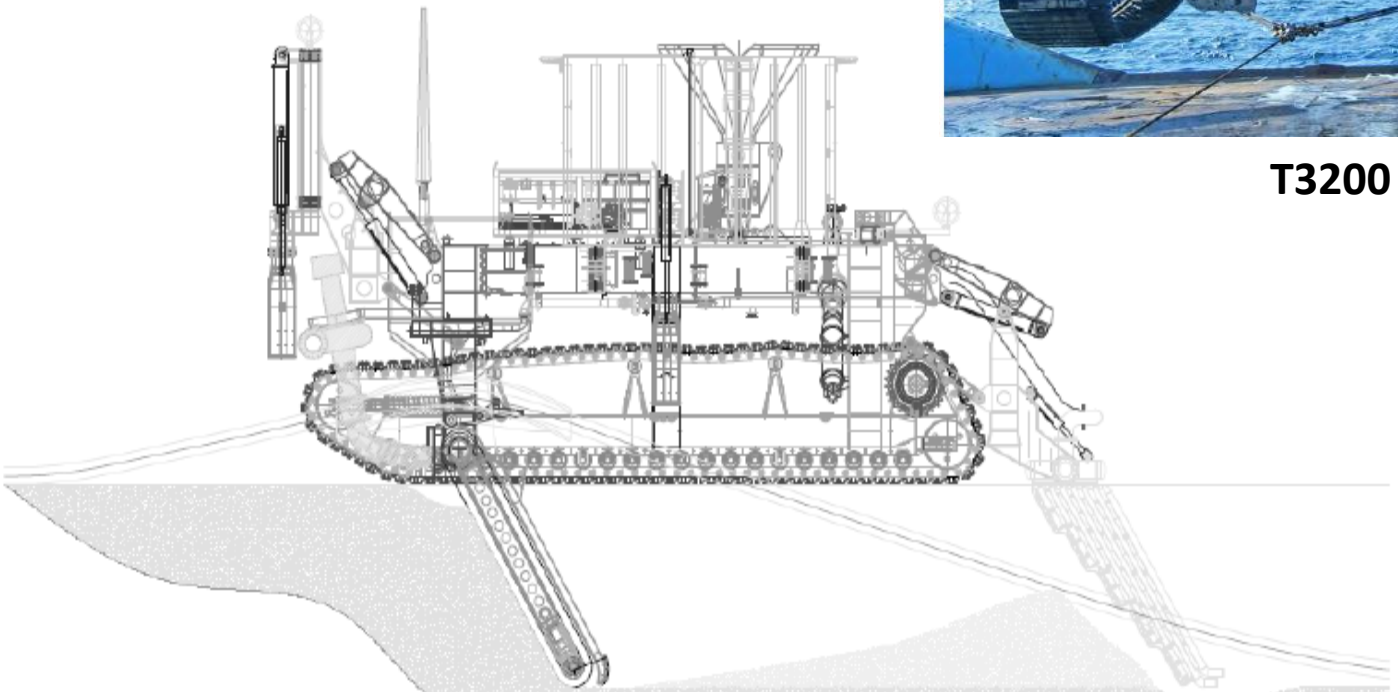
HVDC cable installation (Deep Ocean subcontractor)

Cable installation vessel

Vessel for cable trenching operations

HVDC cable installation

T3200 Trenching asset



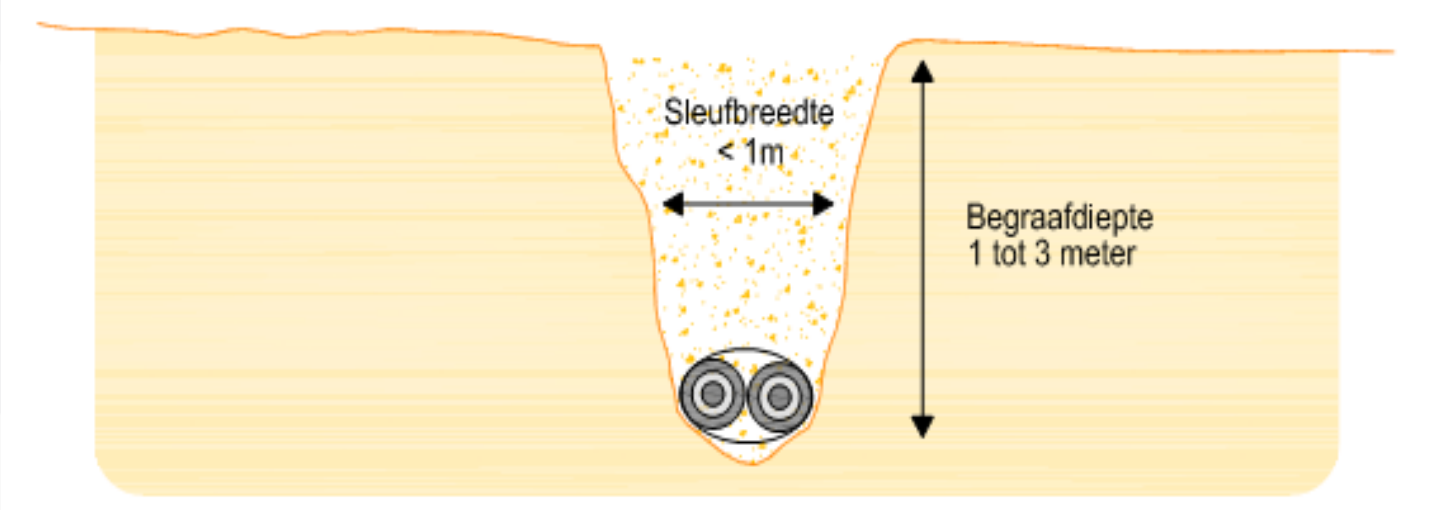
T3200 side view showing single cutter and jetting package deployed at rear

HVDC cable installation

T1000 Trenching asset

T2 trenching asset

Configuration of submarine cables

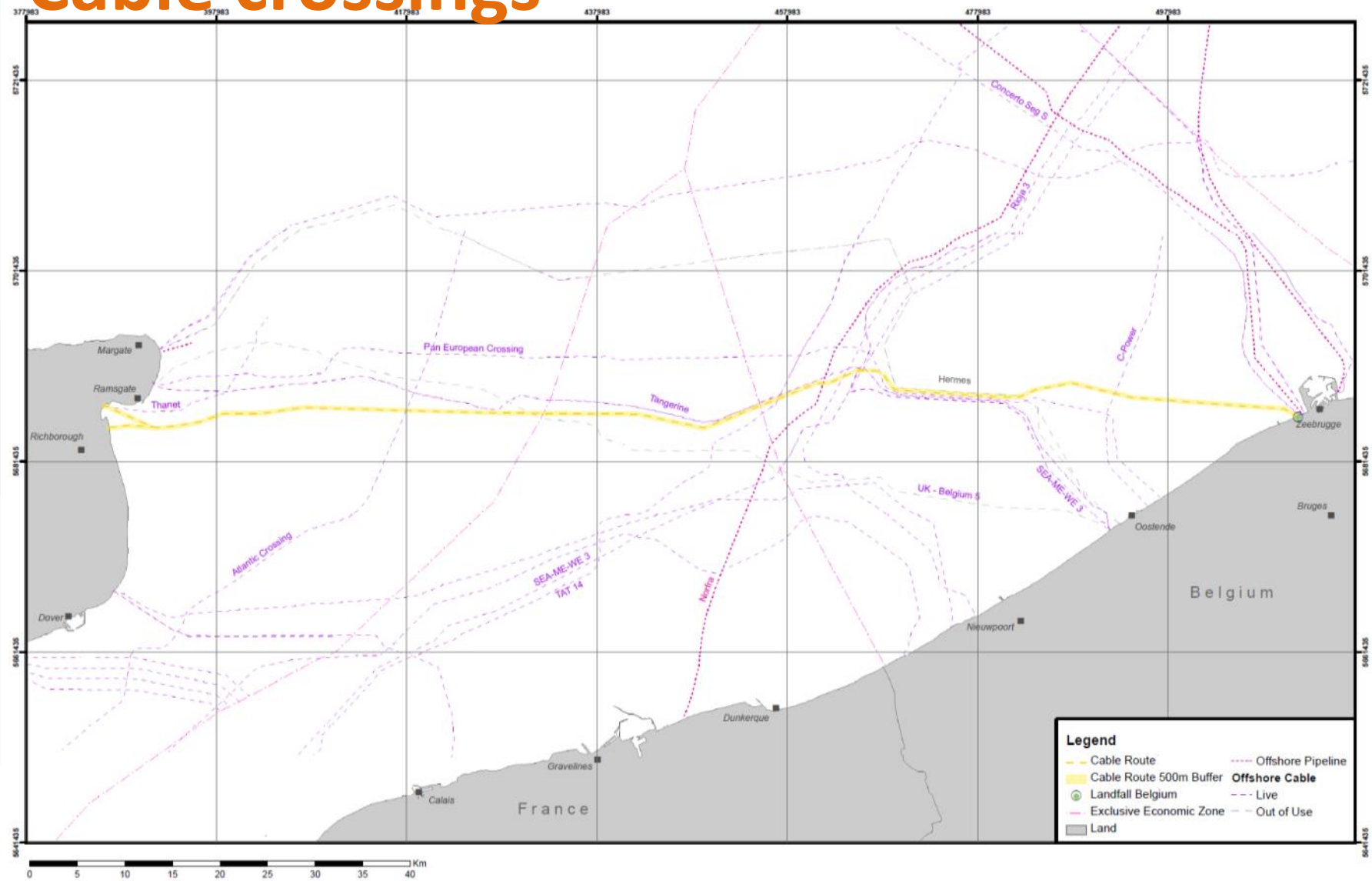


Base design

Burial depth depends on burial risk assessment (1.5-2m)

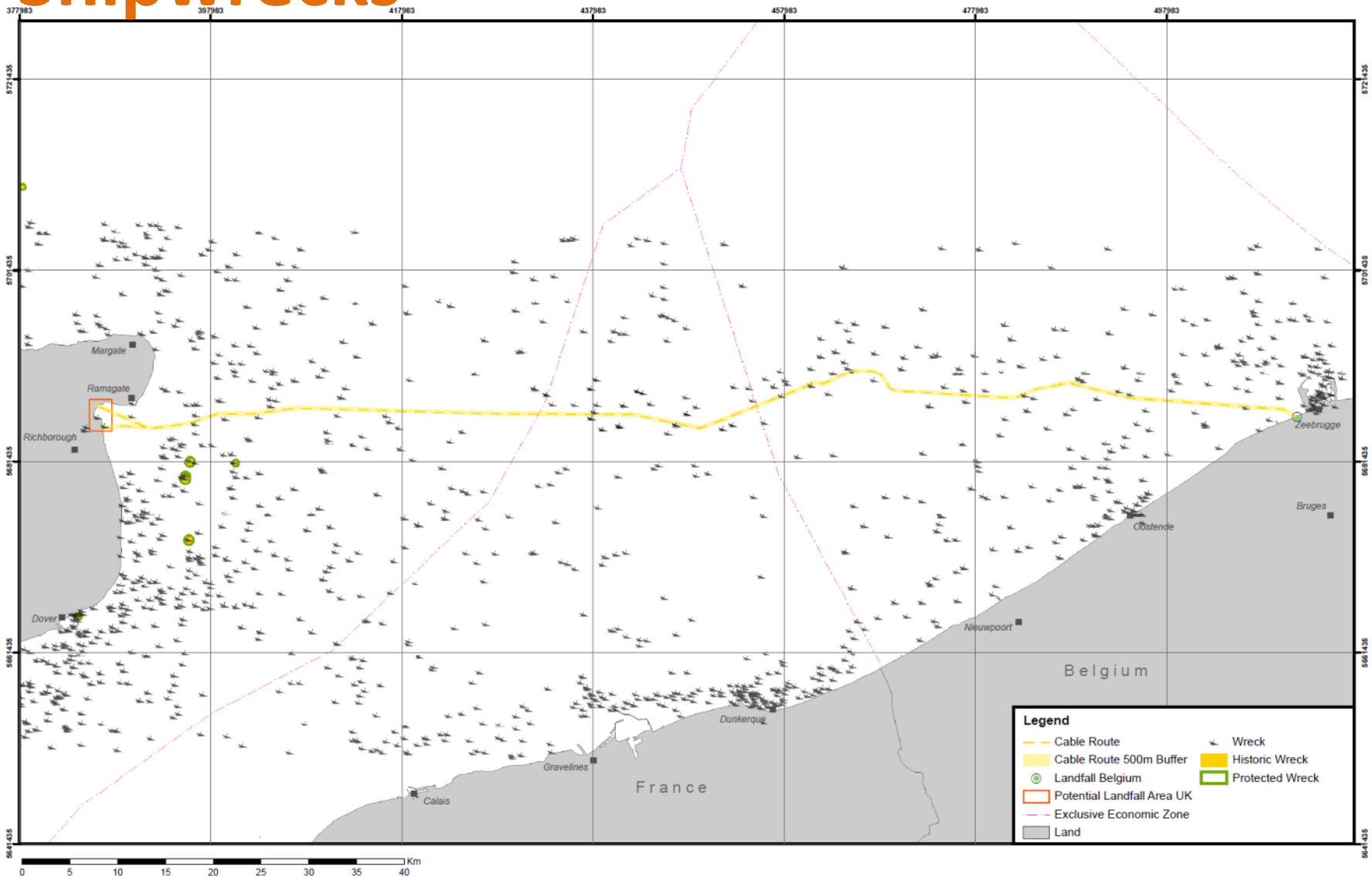
Nemo Link

Cable crossings



Nemo Link

Shipwrecks



Nemo Link

Innovations

First 400 kV XLPE cable installed worldwide

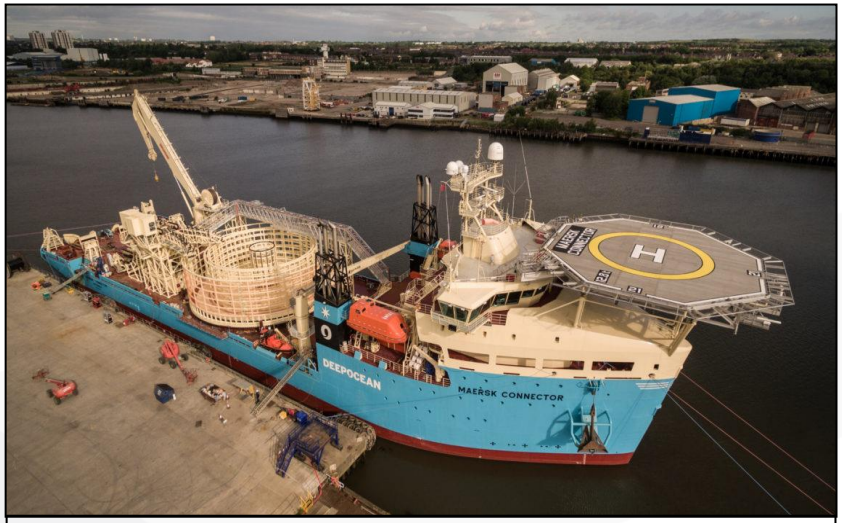
First 400 kV Siemens HVDC PLUS converter station worldwide

Innovations

Onshore cable in ducts

Limited footprint

Minimal installation nuisance

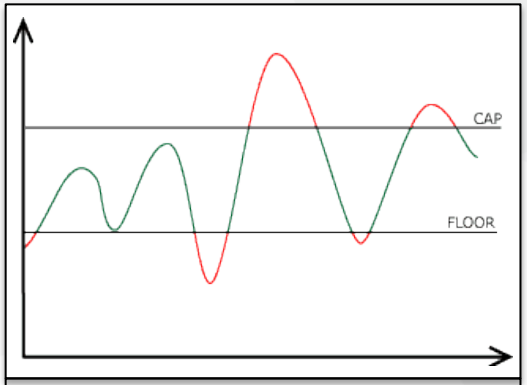


Maersk Connector

Brand new cable laying vessel (2016)

Beachable

Concentric carrousels (2x3500t)

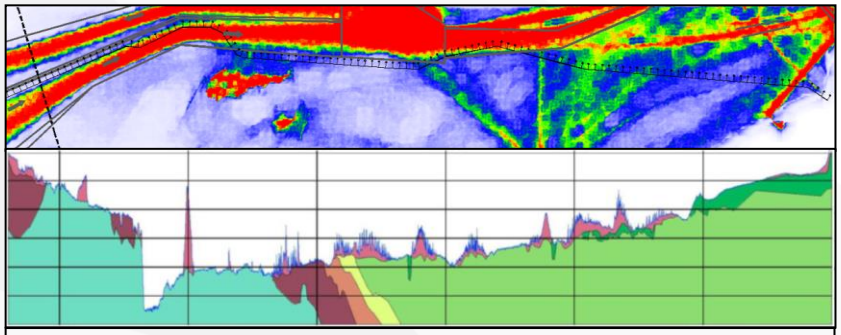


First project subject to Ofgem's cap & floor model

Sustainable design

Waste heat recovery

Loss minimisation



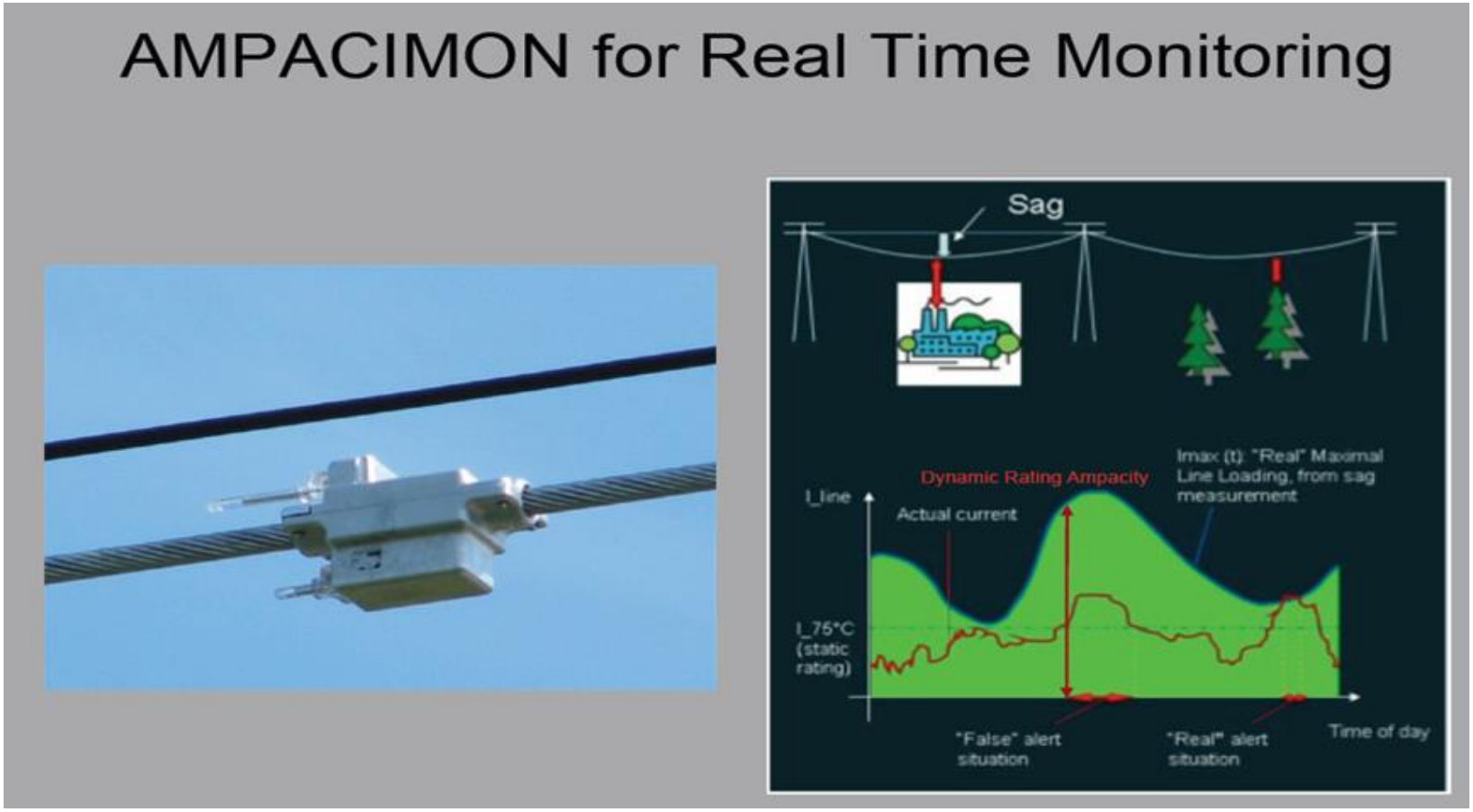
Burial Protection Index (BPI) concept

Combining seabed soil composition with cable threat assessment to determine burial depth

Nemo Link

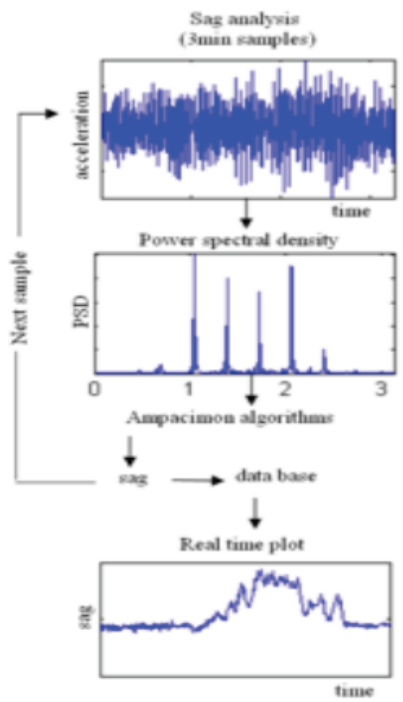
Ampacimon

Real time monitoring



Ampacimon : Measurement Principle

Vibration Analysis => Sag



Fréquence [Hz]	Indice [-]
0.274 ± 0.002	2
0.412 ±0.003	3
0.545 ± 0.002	4
0.686 ± 0.003	5
0.817 ± 0.004	6
1.09 ± 0.005	8
1.238 ± 0.002	9
1.370 ± 0.008	10
1.510 ± 0.008	11
1.771 ± 0.002	13
2.045 ± 0.004	15

Fundamental Frequency [Hz]	Sag [m]
$0.1367 \pm 4\ 10^{-4}$	16.40 ± 0.1

$$\left.\begin{aligned} f_k &= \frac{k}{2L}\sqrt{\frac{T}{m}} \\ s &= \frac{m\ g\ L^2}{8\ T} \end{aligned}\right\} \Rightarrow s = \frac{g}{32\ f_1^{\,2}}$$

No conductor data

No topological data

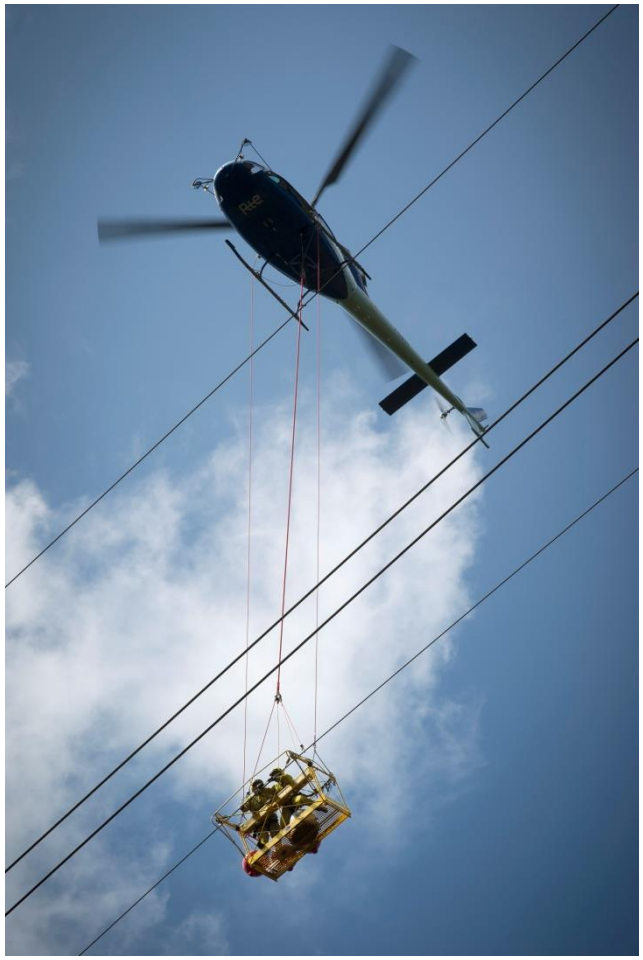
No sagging data

No weather data

= No Calibration !

Installation sensors Ampacimon

Line out of service



Line in service

Operational gain in Real time for entire year 2015

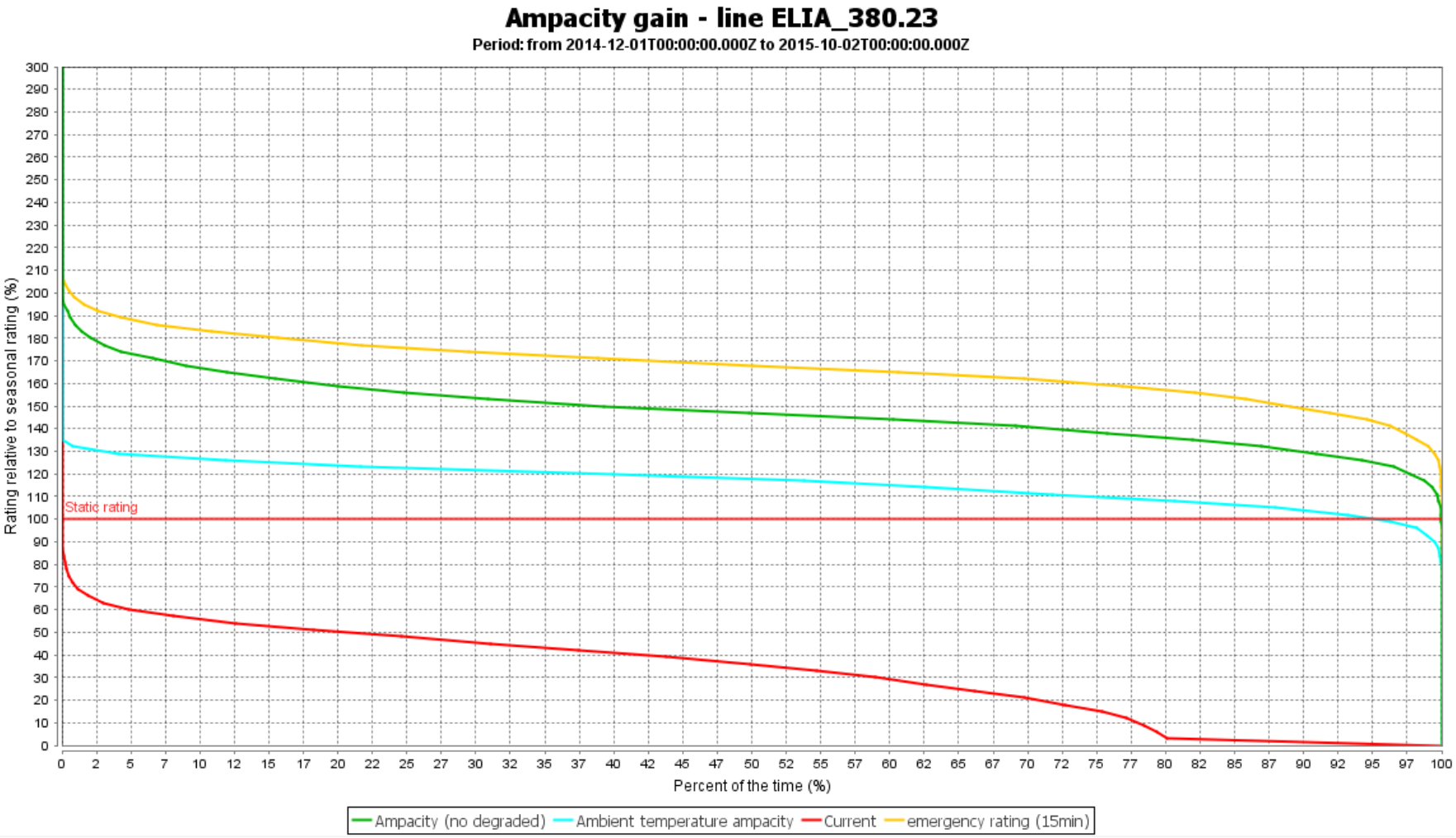
Line		Ampacity average gain	Ampacity gain P90	Ampacity gain P95
380.11.V	Herderen-Van Eyck	+ 43%	+ 30%	+ 25%
380.23	Meerhout-Van Eyck	+ 47%	+ 30%	+ 25%
380.25	Doel-Zandvliet	+ 106%	+ 74%	+ 68%
380.19	Achene-Lonny	+ 42%	+ 25%	+ 20%
380.80	Avelgem-Avelin	+ 44%	+ 27%	+ 22%

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’)

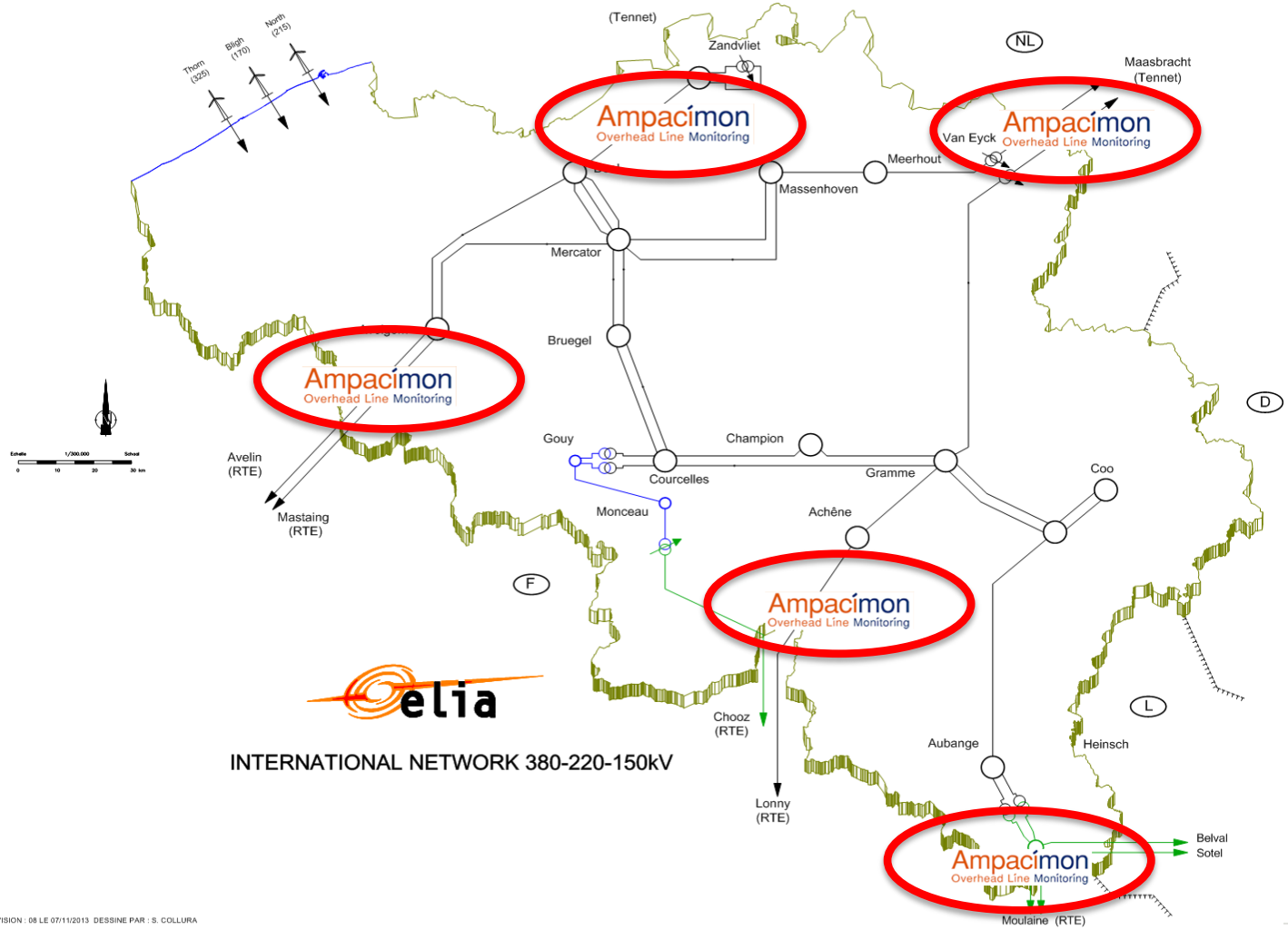


Forecast ampacity 48h
Confidence level P98

Line		Average Gain forecast 48h	Gain 90% of time forecast 48h	Gain 95% of time forecast 48h
380.11.V	Herderen-Van Eyck	+ 24%	+ 12%	+ 7%
380.23	Meerhout-Van Eyck	+ 29%	+ 15%	+ 11%
380.25	Doel-Zandvliet	+ 64%	+ 48%	+ 43%
380.19	Achene-Lonny	+ 26%	+ 12%	+ 8%
380.80	Avelgem-Avelin	+ 26%	+ 13%	+ 9%

Belgian border lines

DLR allows more imports



Many thanks for your attention!

First name, last name

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City, 19.11.2013