TenneT's HVDC Cable Projects in Germany and Quality Assurance

Dr. Roland Dongping Zhang

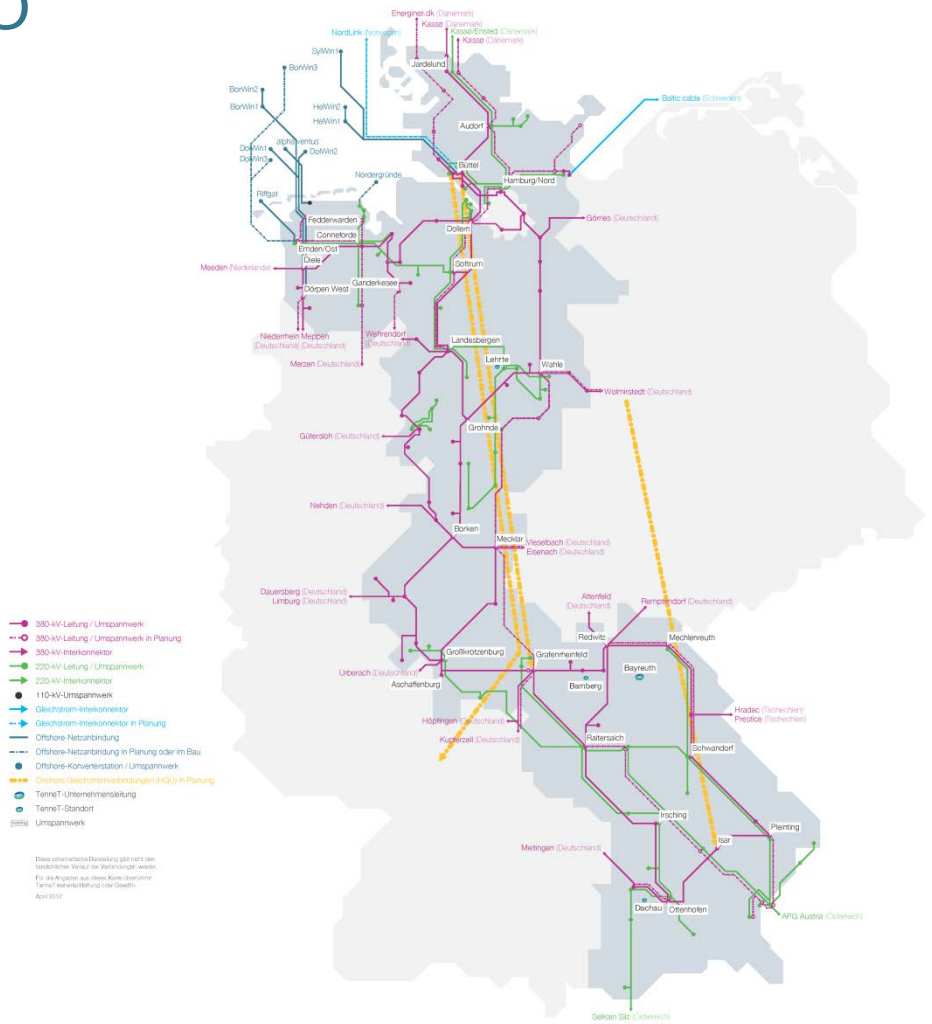
Agenda

- Introduction of TenneT
- TenneT's Cable Projects/HVDC Corridor Projects in Germany
- PQ Tests for 525kV DC Extruded Cables
- Quality Assuarance of HVDC Cables
- Summary

TenneT at a Glance

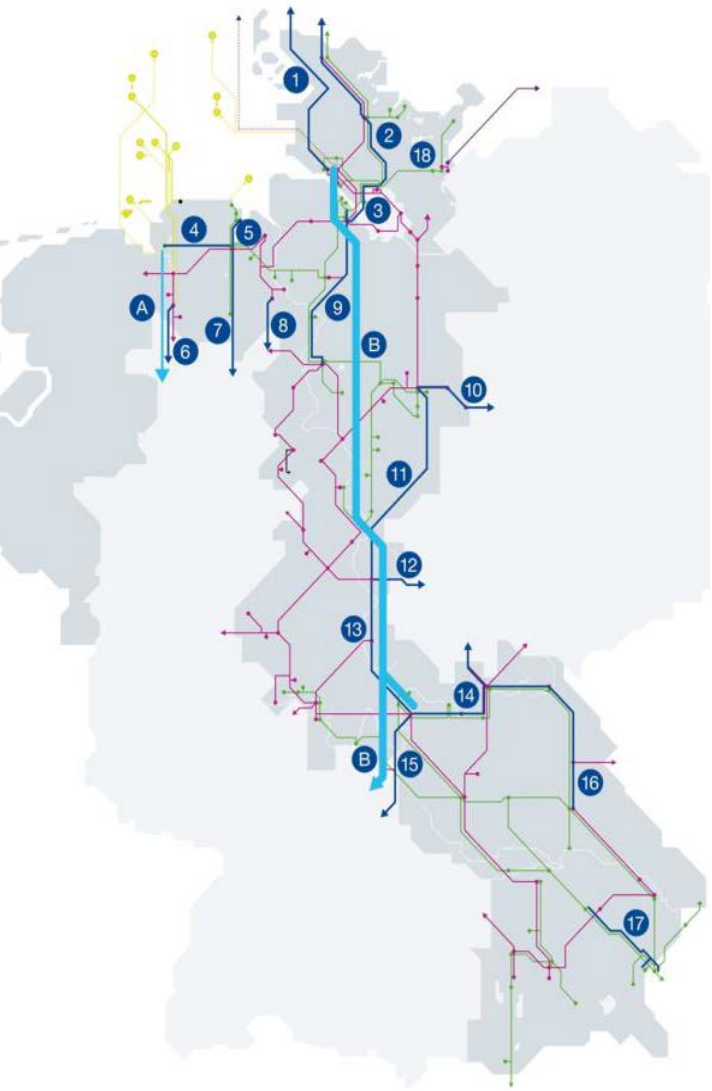
Europe's first cross-border TSO

- Headquartered in Arnhem (the Netherlands) and Bayreuth (Germany)
- Fully owned by the State of the Netherlands
- We maintain security of supply at an extremely high level of 99,9999 %.



Large Cable Projects

Stand: 15.06.2017



Project	Commis-sioning (GDP) *Year*	Route length *km*	Cable cores *No.*	Cable sections (plan) *km*
A120 Wahle - Mecklar	Q3 2021	218,5	12	21,7
A210 Emden/Ost – Conneforde	Q4 2021	63	24	16
A220 Wilhelmshaven – Conneforde	Q4 2020	34,2	12	9,2
A240 Conneforde-Cloppenburg-Merzen	Q4 2023	90	12	27
A250 Stade – Landesbergen Section 2-4	Q2 2023	160	12	23
A250 Bereich Stade Section 1			24	0
A260 Dörpen/West - Niederrhein	Q2 2019	31,3	12	3,1
A280 Ganderkesee - Wehrendorf	Q2 2021	60,7	12	12,5
A310 Ostküstenleitung	Q2 2022	132	12	12
A060 HGÜ Korr.D SuedOstLink 2 GW	Q4 2025	Approx. 262 (TenneT's resp.)	4	Approx. 262 (TenneT's resp.)
A100 HGÜ Korr. C SuedLink 2x2 GW	Q4 2025	Approx. 1130	4+2 / 8	Approx. 1130

→ app. 125 km route length of 380 kV XLPE AC cables
→ app. 1.400 km route length of HVDC cables

→ app. 1.525 km route length in the next decade

Offshore Grid Connections

Project	Capacity (MW)	Commissioning
Operational		
alpha ventus	62	2009
BorWin1	400	2010
BorWin2	800	2015
DolWin1	800	2015
DolWin2	916	2016
HelWin1	576	2015
HelWin2	690	2015
Riffgat	113	2014
SylWin1	864	2015
Under construction		
BorWin3	900	2019
DolWin3	900	2018
DolWin6	900	2023
Nordergründe	111	2017
Σ	**8,032**	
To be built by 2025		
DolWin5, BorWin5, SylWin2	**2,336**	
Assumption for transmission capacity SylWin2 536 MW As of spring 2017 (auction will be in spring 2018)		

SuedLink:
Cooperation with project partner TransnetBW

Co-financed by the European Union
Connecting Europe Facility

Overview of SuedLink

Status	worldwide largest DC high voltage cable project
legal	EU Project of Common Interest (PCI)
Capacity	2 x 2.000MW
Electric tension	525kV / 320kV
Converter	VSC-Technology
Cable length	ca. 700km x 4-6 cabels at 525kV / 700km x 8 cabels at 320kV
Special construction	Crossing of the river Elbe

Co-financed by the European Union
Connecting Europe Facility

SuedOstLink:

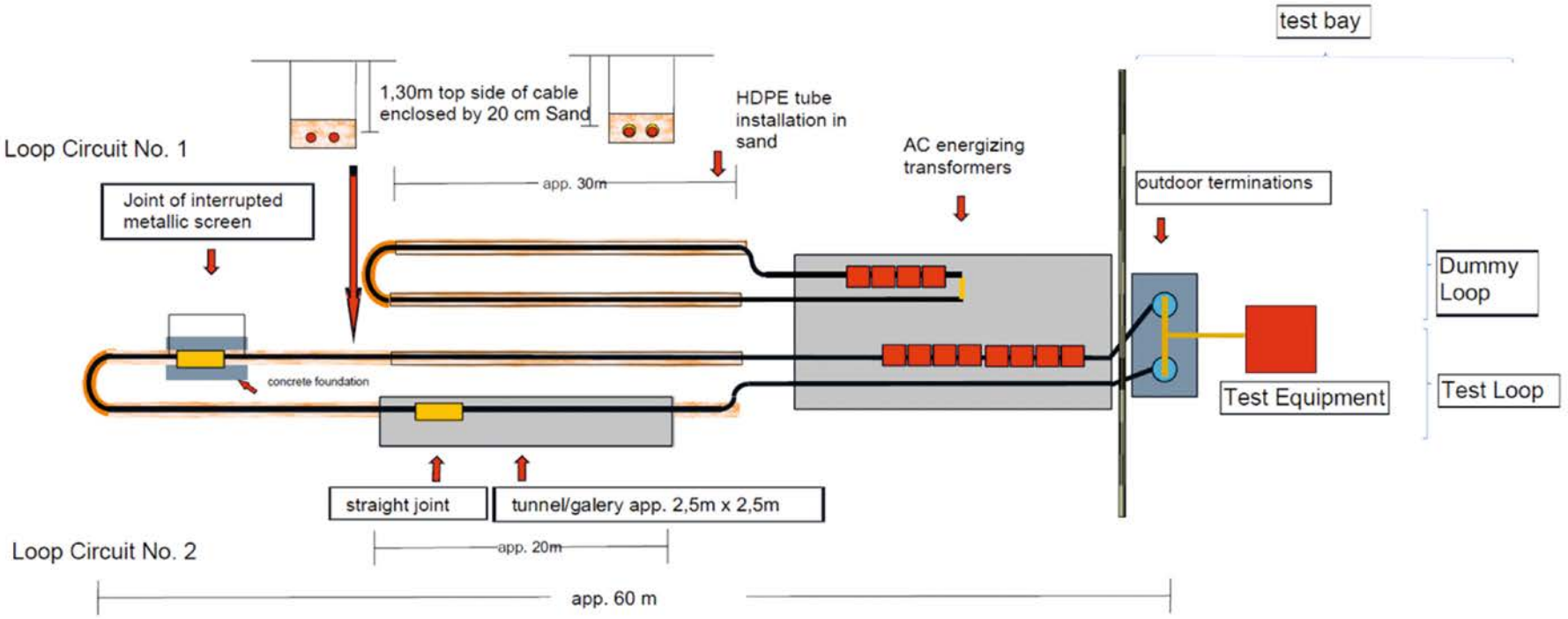
Safe power supply

Efficient underground cabling

SuedOstLink: project overview

- **DC high voltage technology**
- Priority **underground cabling**
- **Starting point**: Wolmirstedt in Saxony-Anhalt
- **Endpoint**: Landshut close to Munich
- Capacity: **2 GW** (525/320 kV)
- Converter: VSC-Technology
- Route length (linear distance): 580 km
- Route length in Bavaria (linear distance): 200 km
- Contracting Entities: (Wolmirstedt to state border Bavaria) **50Hertz Transmission GmbH** and **TenneT TSO GmbH (**state border Bavaria up to Isar)

PQ Test of 525 kV DC Cables



- cable length of rd. 150m, rd. 20m in the Tunnel and rd. 30m in the ducts (D_i=230mm)
- two joints and two outdoor terminations in the real operation condition
- With the dummy loop for temperature control

Projektpartner

Cable Manufacturers	Test Instituts	TSOs

Prysmian Group

SUMITOMO ELECTRIC

nkt cables

Nexans

CESI 1956 60 years 2016
Shaping a better energy future

STRI

50hertz

amprion

TenneT
Taking power further

TRANSNET BW

Projektmanagement by stresCon

PQ Test of 525 kV DC Cables

Q1/2017	Rewarding the contracts to test institutes
Q2/2017	FAT of cables and accessories, transportation and Installation in the test laboratories
Q3/2017	Start of PQ-Tests (Duration of rd. 12 Months)
Q4/2018	DC Impulse tests (Lightning and Switching) and visual inspection
Q1/2019	Reporting

Quality Assurance DC Cables

- **Verification of the qualification, design and tests**
  - What is a “substantial/significant” change for HVDC cables?
  - Can a qualification of one production line cover other lines in the same company?
  - What is about the difference btw. aluminum and copper cables, esp. with large cross-sections?

- **Assessment of QA/QC Systems**
  - Requirement vs. Reality
  - FME(C)A, a useful tool?

Quality Assurance DC Cables

- **Factory Tests**
- Tests frequency and scope
- Do successful tests mean good quality of cables?

- **Production supervision**
- suitable personal for the work
- process-oriented schedule

- **RCA by failures**
- singular or systematic?
- project time pressure vs. time need for detailed RCA

Quality Assurance DC Cables

- **Installation and After-Installation**
- Mechanical damages
- Real position of cables/HDD pipes
- Cable monitoring calibration
- Commissioning tests
- fingerprinting, sometime unuseable
- RCA by cable failure in the operation
- Repair strategy/concept

- **Trust is good, control is better!**
- **Confidence based on open communication!**

Summary

- More than 4,000 km cable installed or under construction incl. rd. 1200 accessories (AC, DC, Submarine, underground)
- rd. 4,000 km 525 kV or 8,000 km 320 kV HVDC extruded underground cables have been planed by TenneT till 2025 for the German corridor projects without considering the TenneT's offshore and interconnector projects
- Entirety of QA-measures are utmost necessary for a sustainable and reliable operation of TenneT's grid connection systems

Thank you very much
for your attention!