

Recent Activities at Nexans in the field of Superconducting Systems



IEA Meeting – Kawasaki – July 4, 2017

Nexans
BRINGS ENERGY TO LIFE

Nexans superconducting cable references

Year (Commissioning)	Country	Customer	Location	Project	Cable Length	Voltage	Current
2008	USA	LIPA	New York	LIPA 1	610 m	138 kV	2400 A
2009	Spain	Endesa		Supercable	30 m	24 kV	3200 A
2012	USA	LIPA	New York	LIPA 2	610 m	138 kV	2400 A
2014	Germany	RWE	Essen	AmpaCity	1000 m	10 kV	2300 A
2016	USA	AMSC		ComEd Chicago	30 m	12 kV	3000 A



2008 Lipa 1

- World's first high voltage application
- In operation for 3 years



2014 AmpaCity Essen

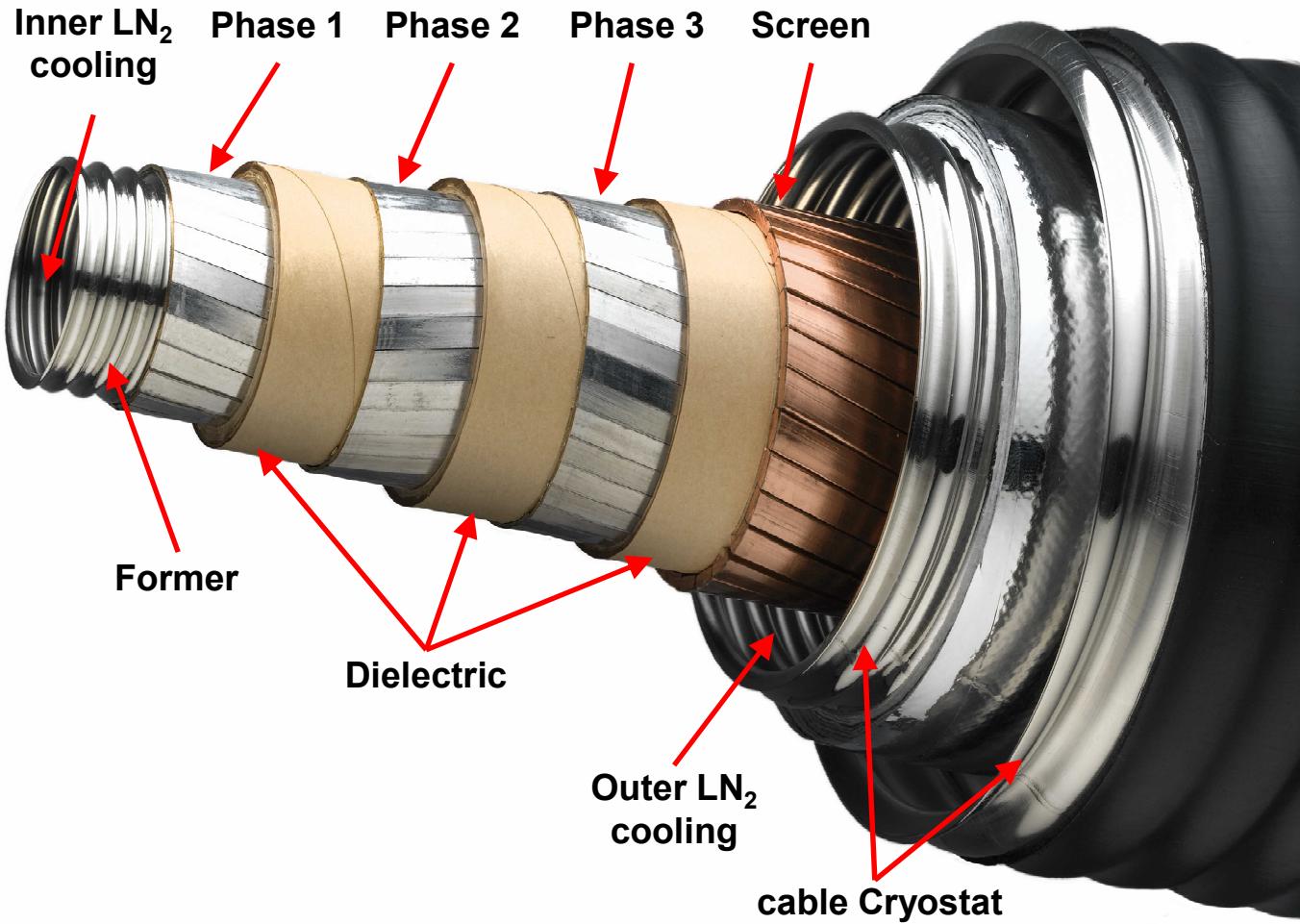
Moving high voltage out of the city center
World's first installation connecting 2 substations



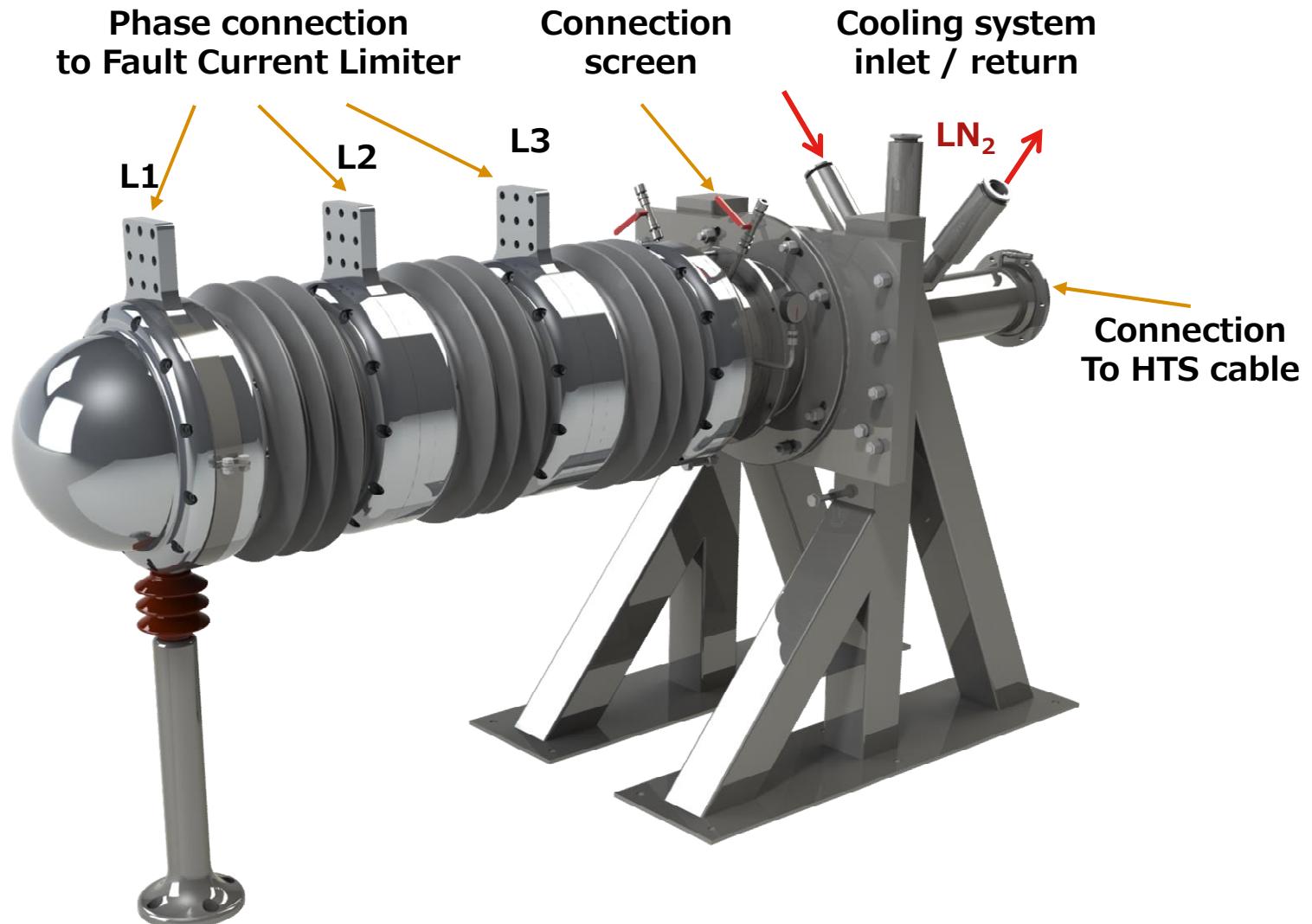
Superconducting cable system in the city center of Essen/Germany

In continuous operation since March 2014

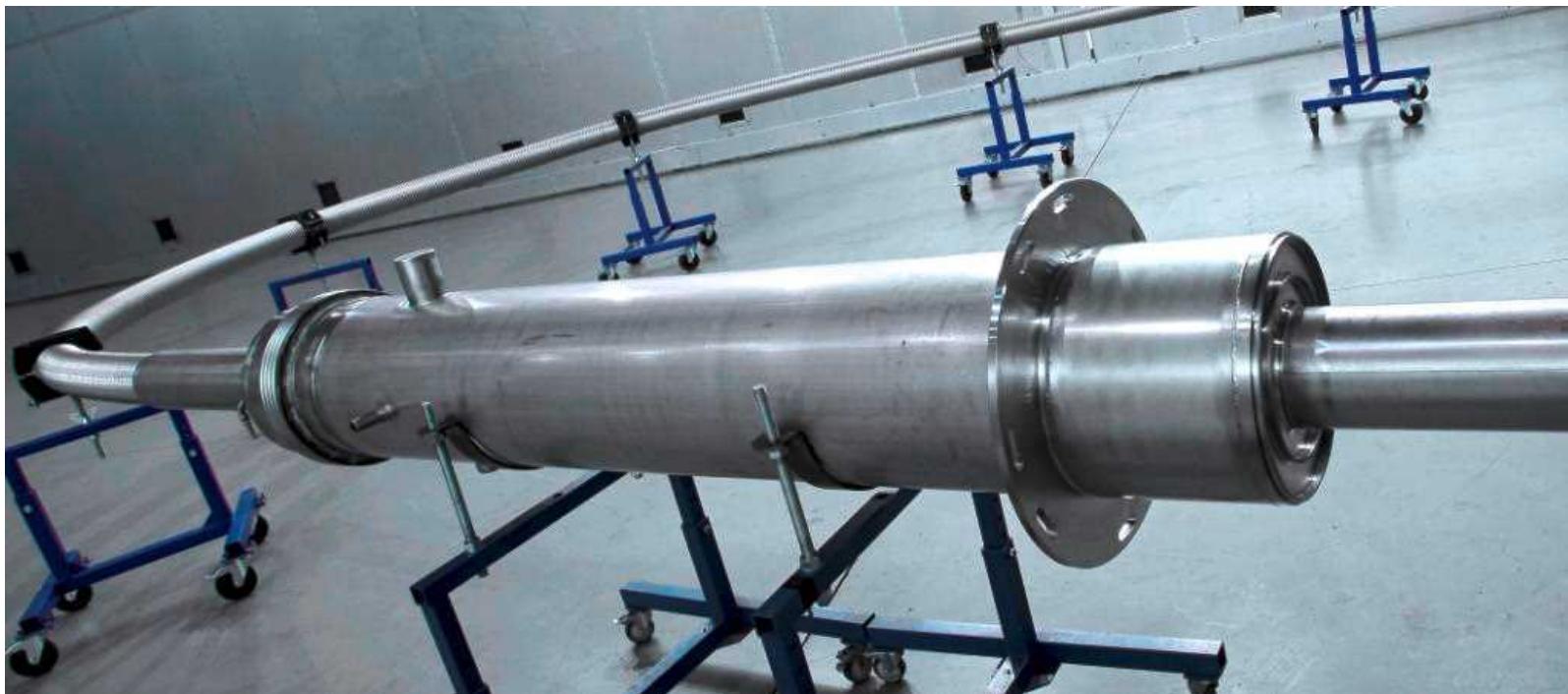
AmpaCity cable



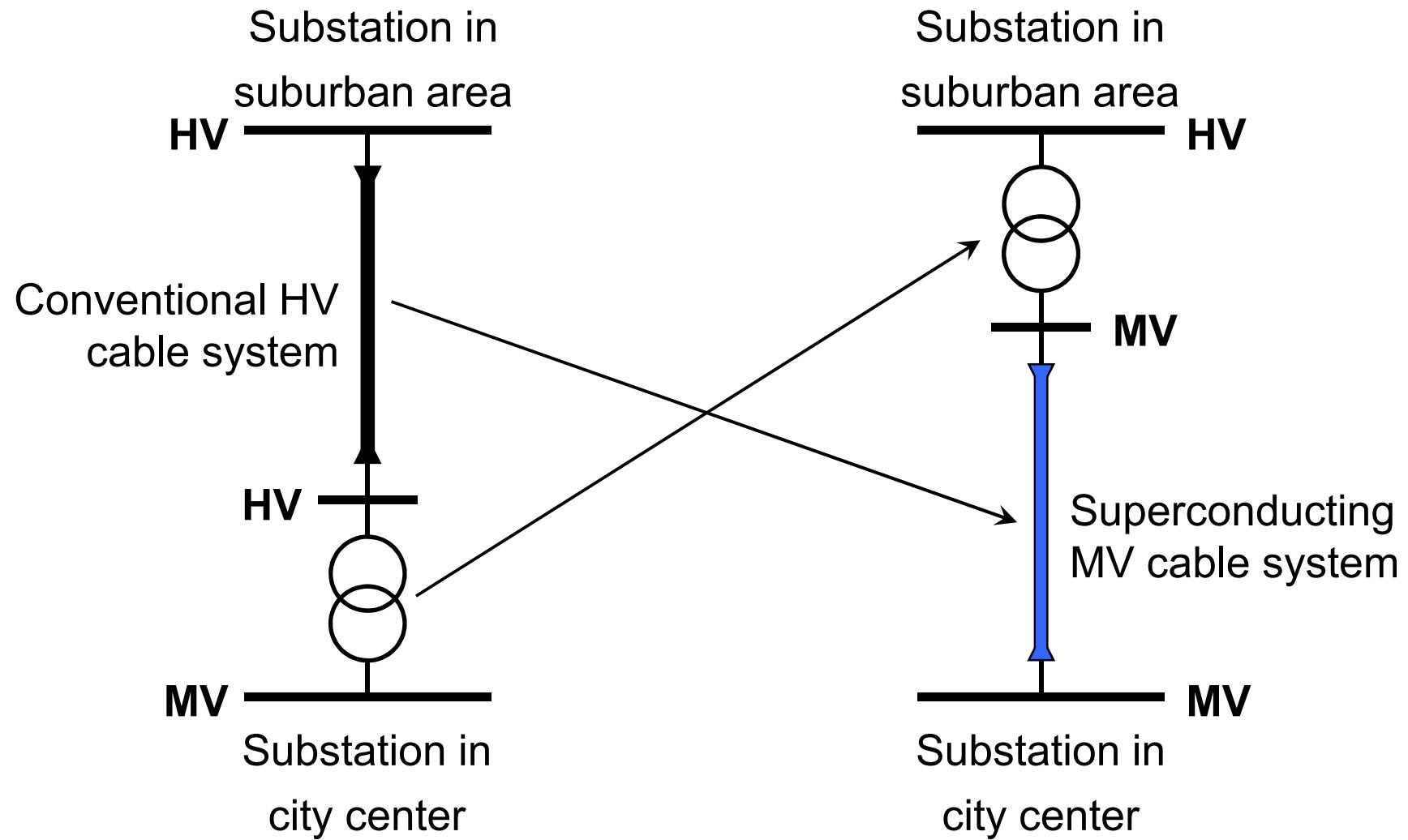
AmpaCity termination



AmpaCity joint



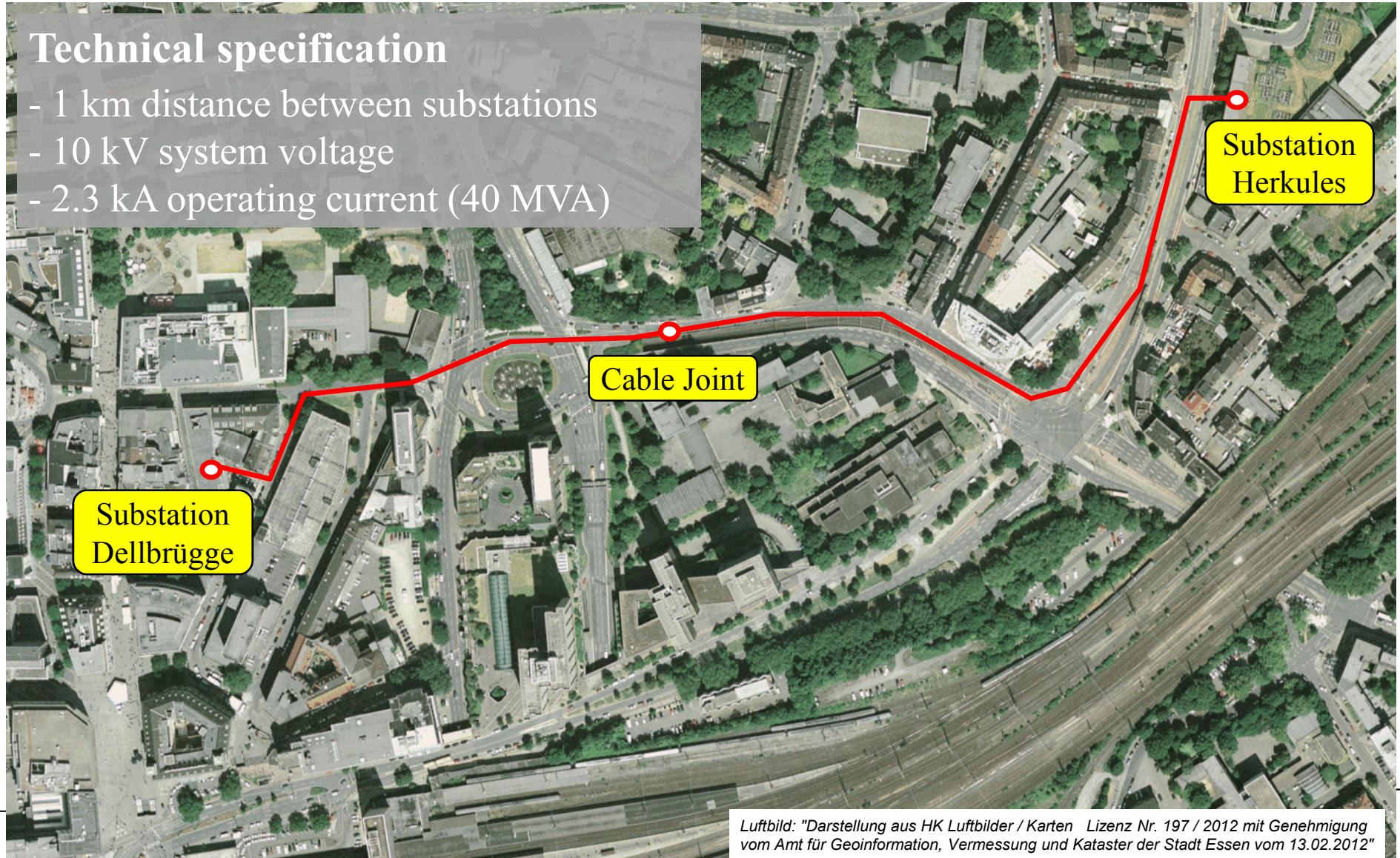
Rationale



Overview

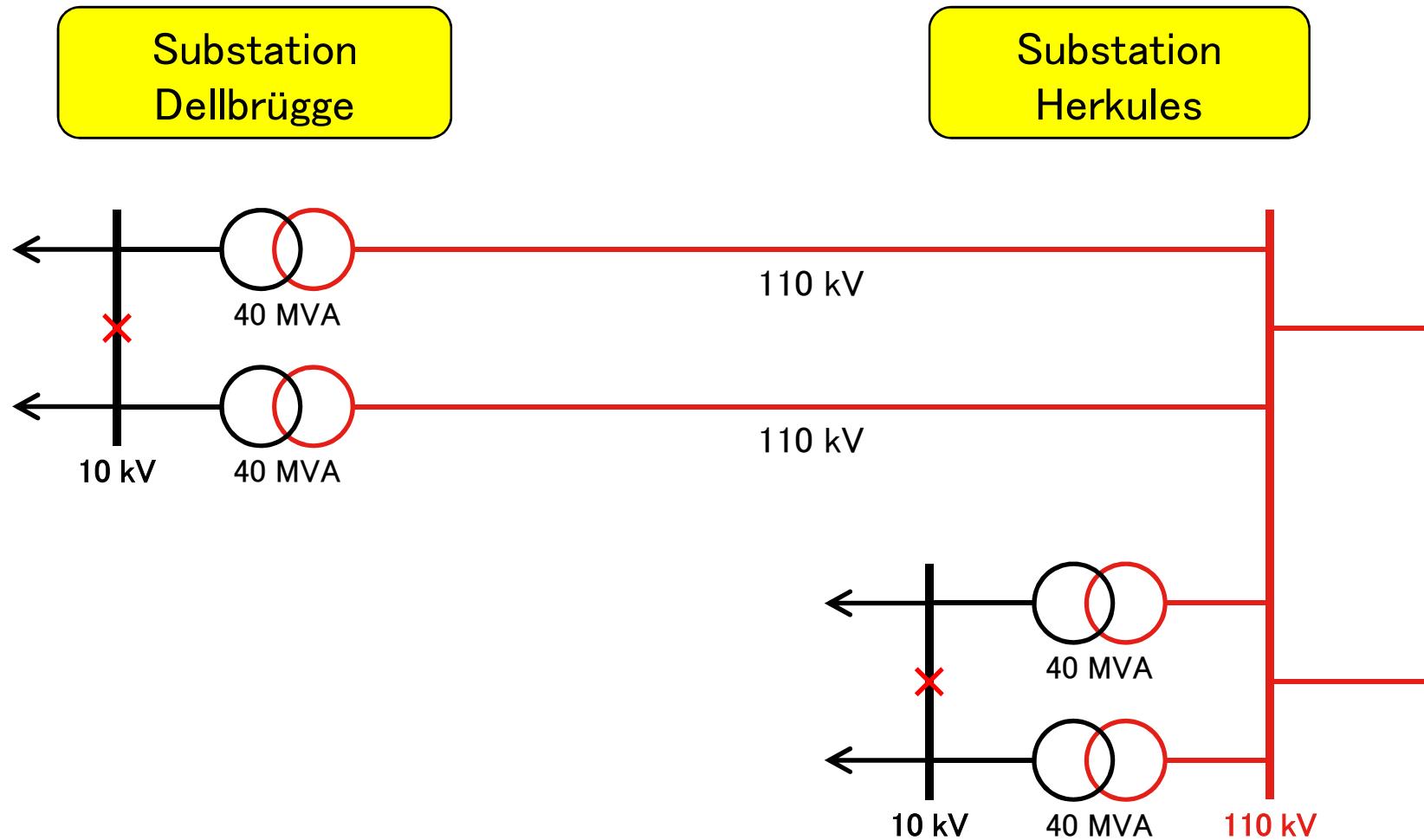
Technical specification

- 1 km distance between substations
- 10 kV system voltage
- 2.3 kA operating current (40 MVA)

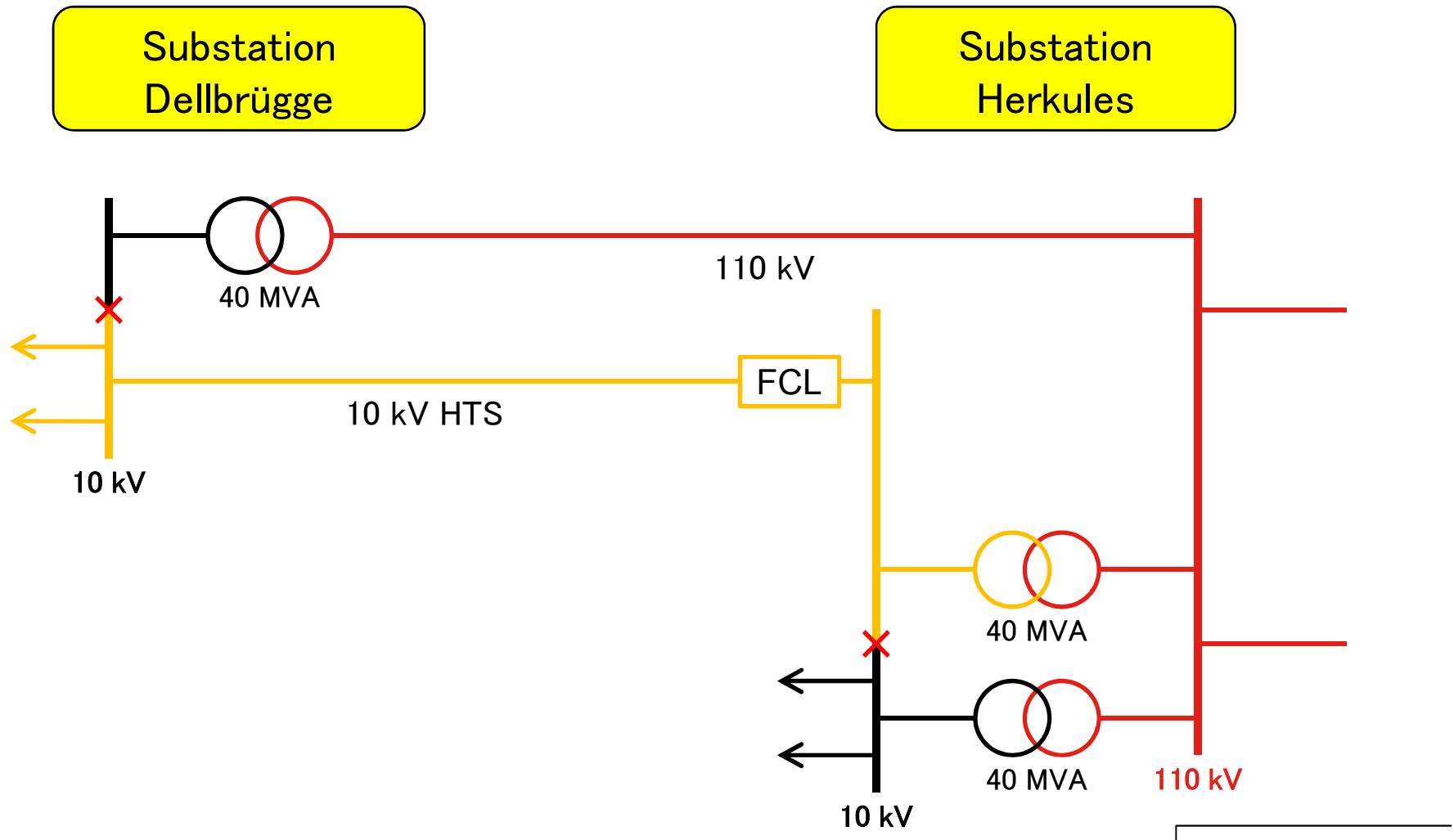


Luftbild: "Darstellung aus HK Luftbilder / Karten Lizenz Nr. 197 / 2012 mit Genehmigung vom Amt für Geoinformation, Vermessung und Kataster der Stadt Essen vom 13.02.2012"

Initial grid architecture



Final grid architecture



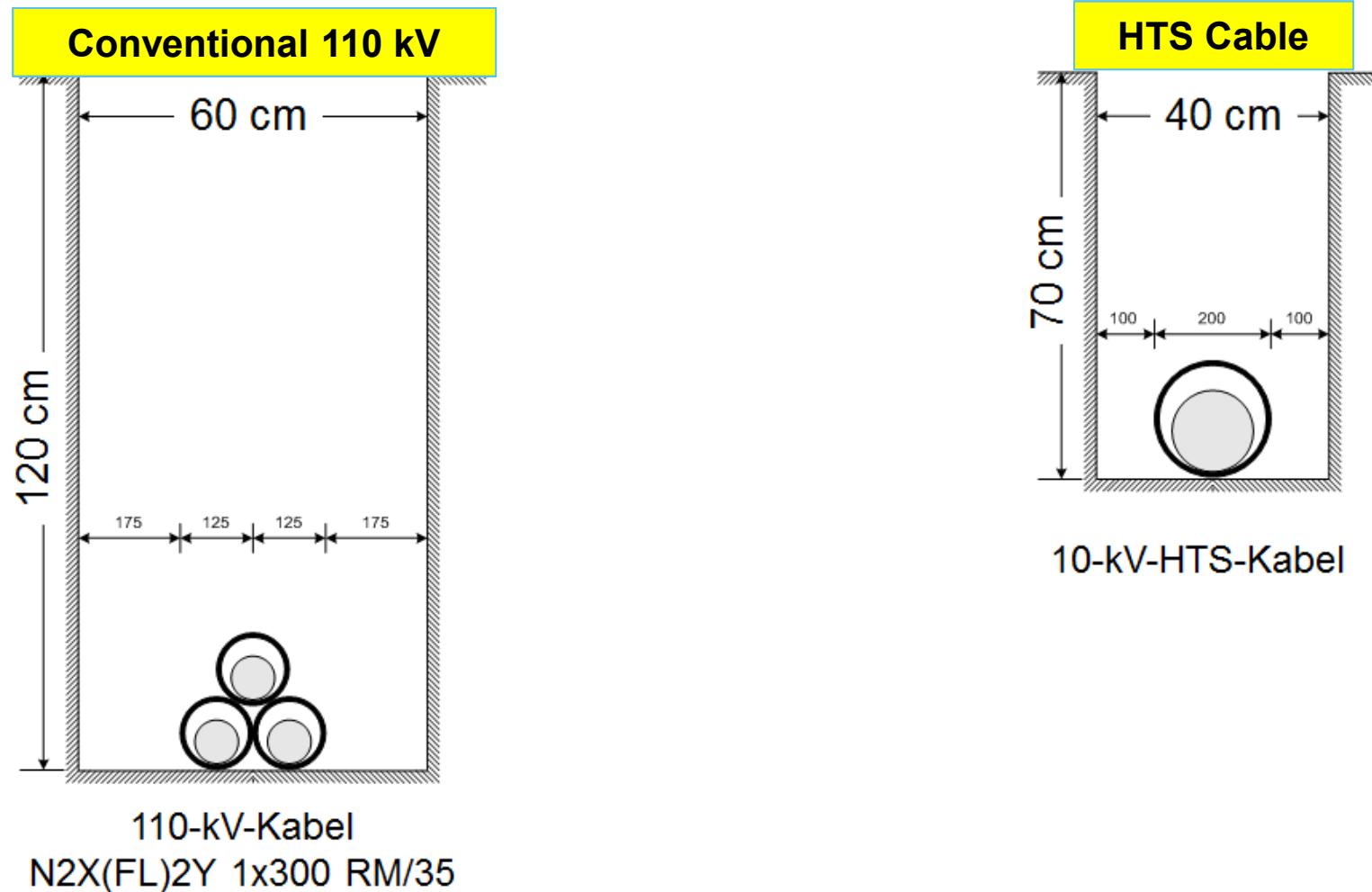
Moving transformers out of city center

110kV/10kV substation in city center



...just to be replaced by a small 10kV switchgear

Narrow cable track



Techno-economical study

2 Scenarios:

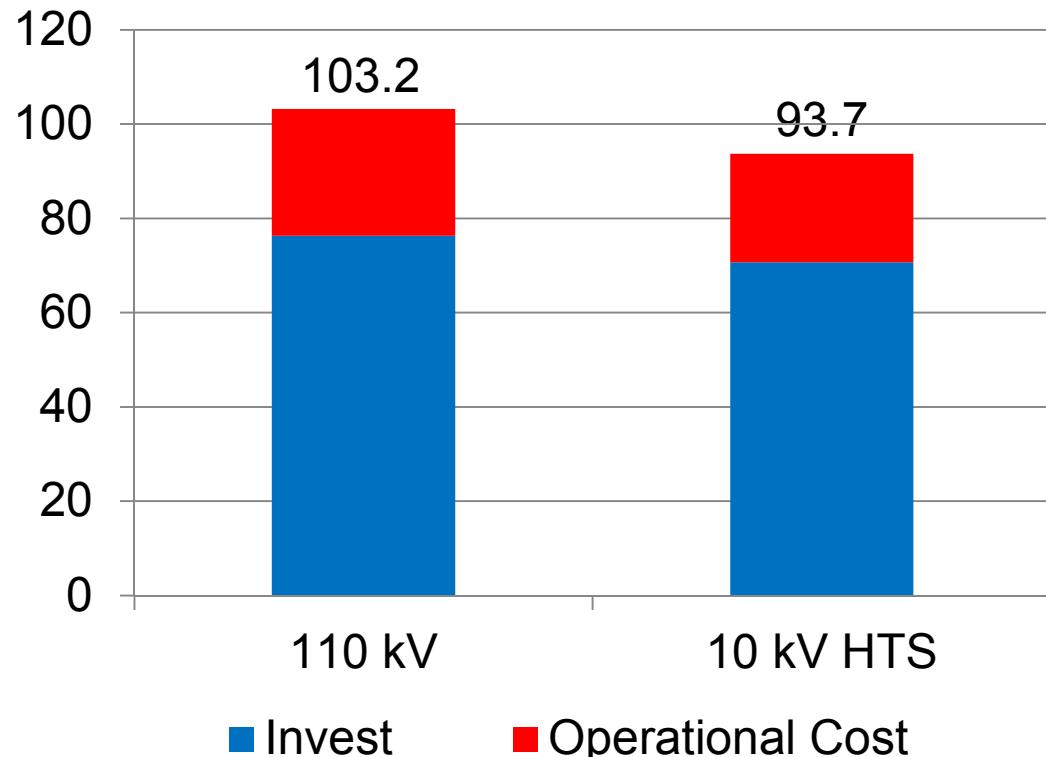
- 110 kV conventional
- 10 kV HTS

Total Cost

- Capex
- Operational Cost
(maintenance & losses)

Assumptions

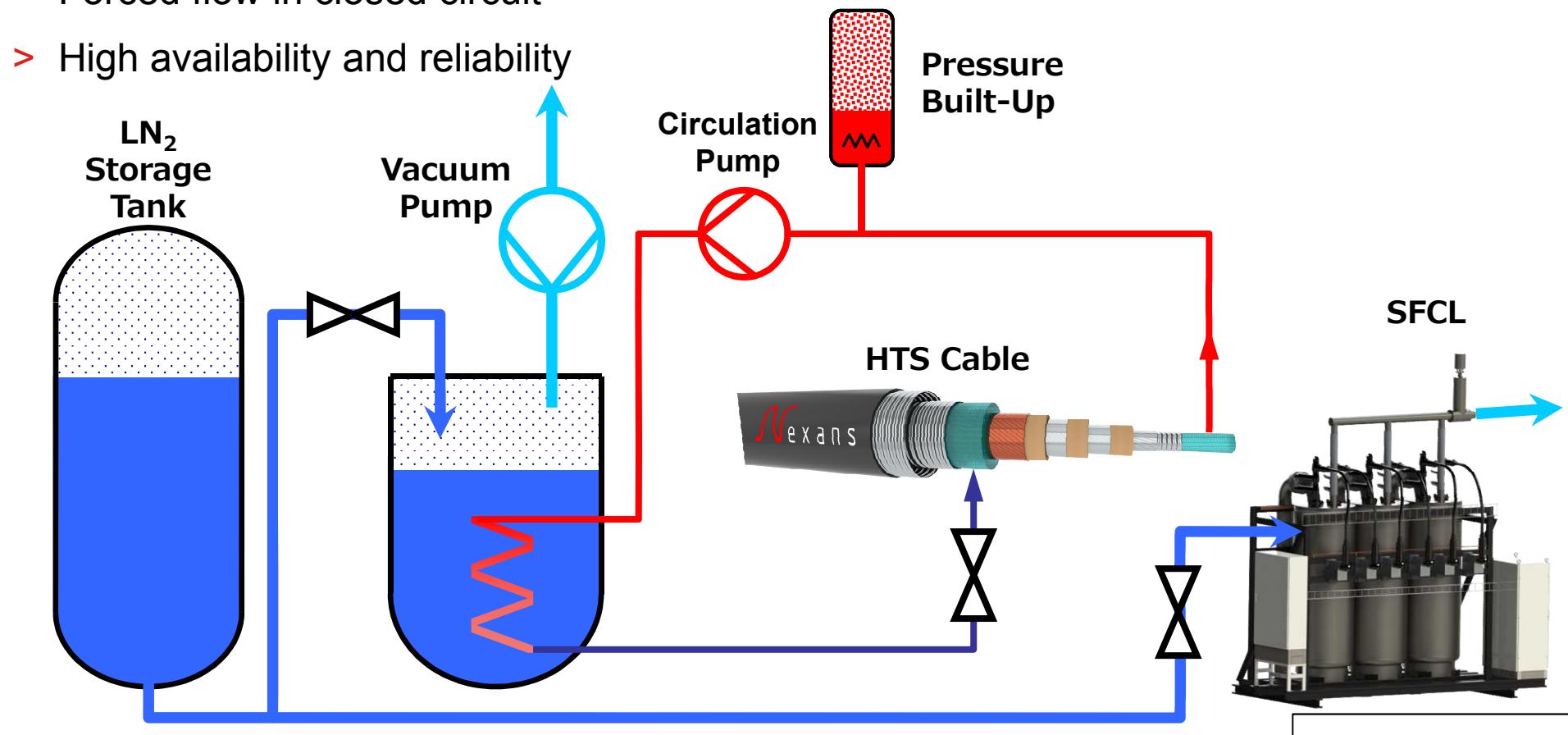
- 40-year operation



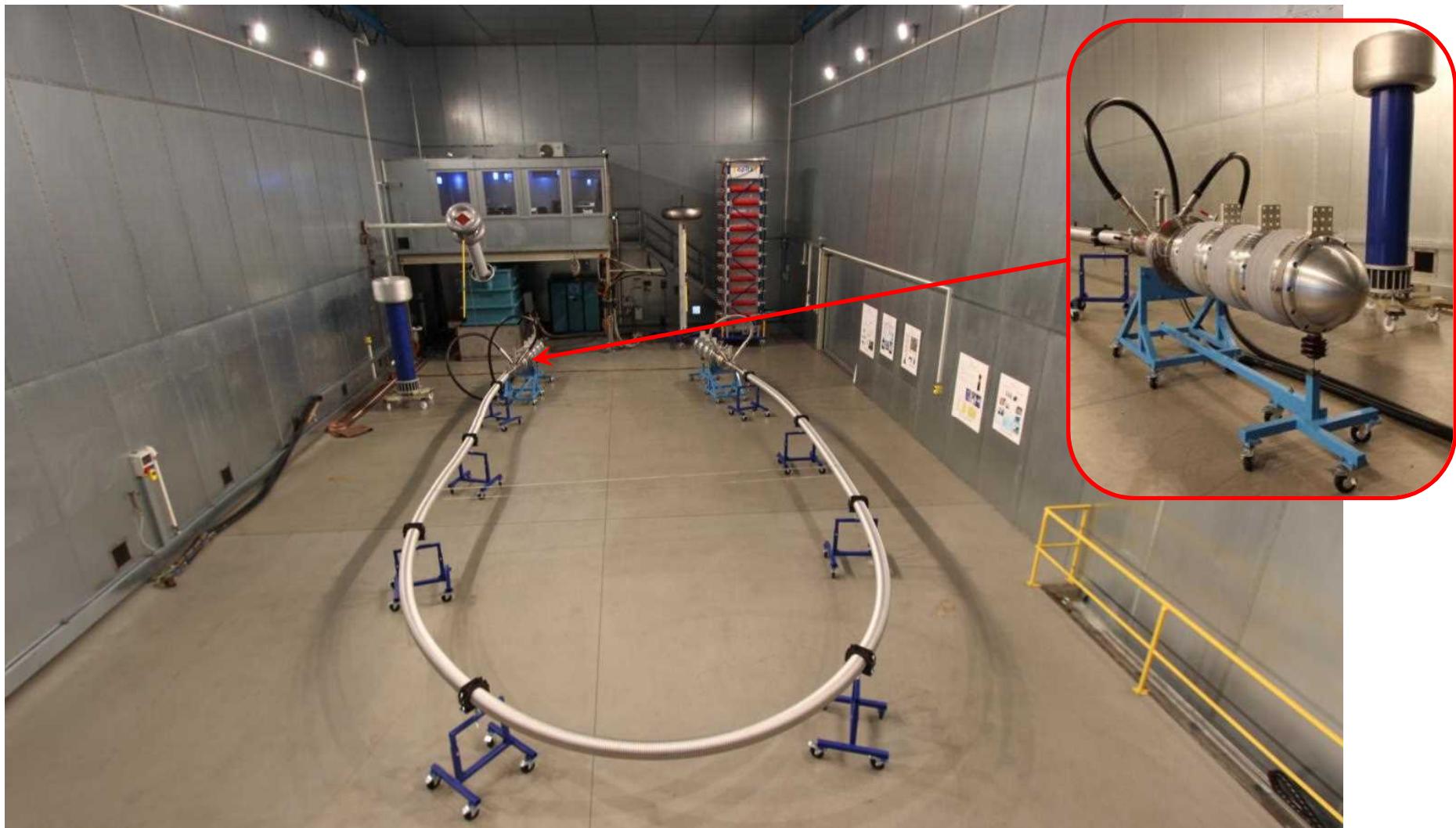
**Cost reduction, although benefits from space savings
are not taken into account in the calculation**

Cooling system

- > 4 kW cold power at 67 K
- > Subcooled pressurized nitrogen
- > Forced flow in closed circuit
- > High availability and reliability



Prototype qualification in Hanover



Nexans

FCL



NEXANS PROPRIETARY

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Drum loading in Hanover



Cable pulling



Thermal shrinkage management



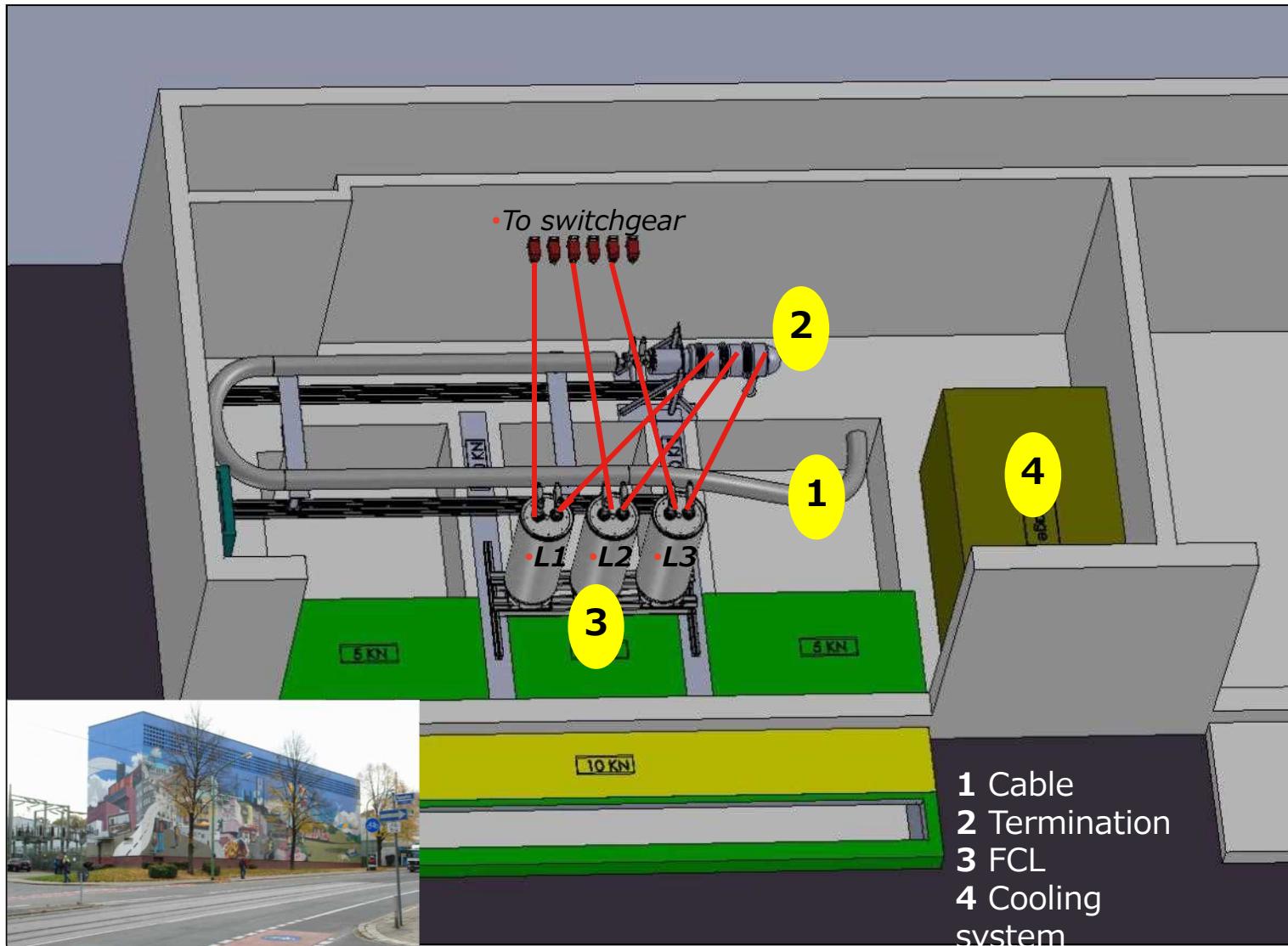
Joint installation



Installation in Dellbrügge substation



Installation in Herkules substation



Installation in Herkules substation



Installation in Herkules substation



Operational experience – Lessons learnt in Essen

> Balancing earth capacitance

- Compensation of unsymmetrical cable earth capacitances by installing capacitors



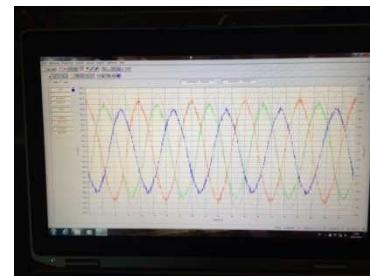
> Cooling system optimization

- Modification of vacuum pumps after freezing of humidity and other smaller optimizations



> Control system optimization

- Increase of response time after automatic reclosing for continuous operation after HV faults



System in continuous operation since commissioning – only a few minor optimizations of cooling and control system during operation

Project in Chicago for ComEd

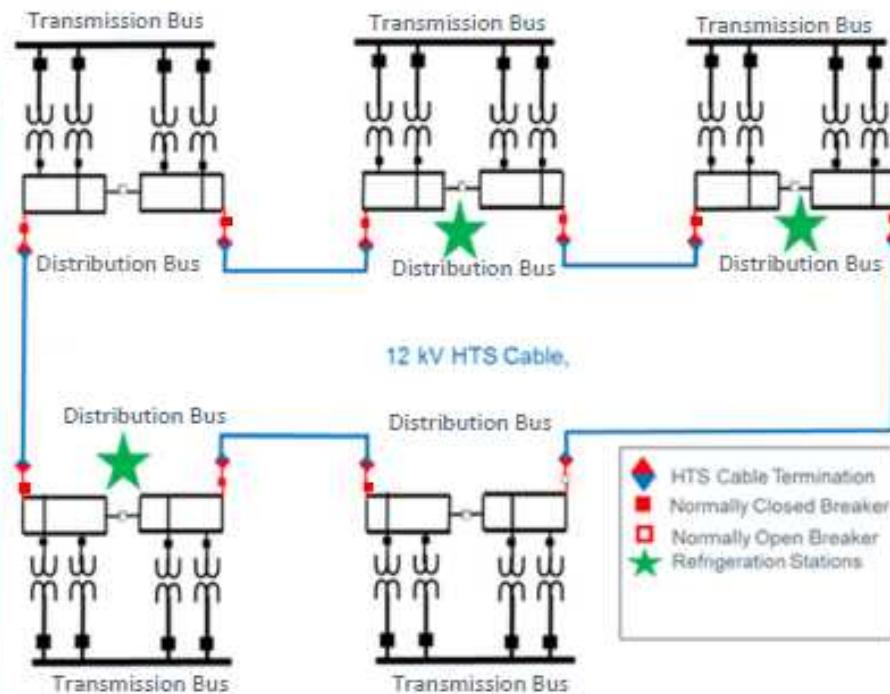
MV “Resilient Electric Grid” (REG) System

Distribution Networking

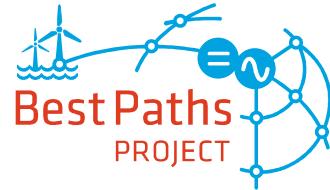


This REG system provides the utility:

- Increased reliability from N-2 to N-4
- Can serve load upon loss of all power supply to any substation
- Increased load serving capacity without installing new power transformers
- Provides Fault Current Limiting



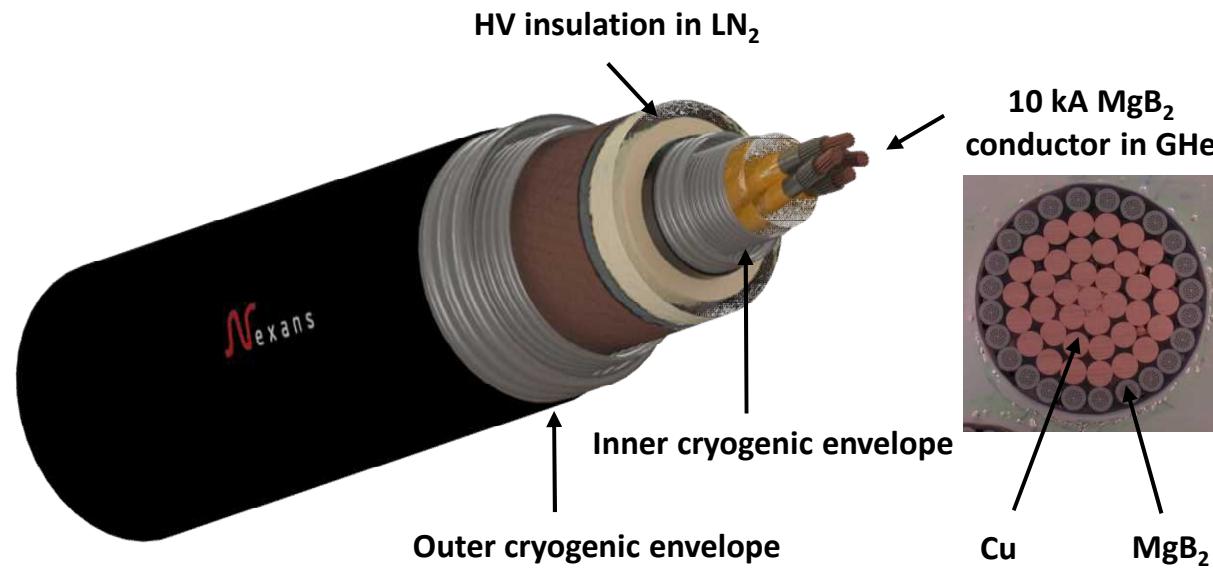
Nexans was selected as supplier for this project



European project Best Paths - Overview

High-power superconducting link

- Demonstrate full-scale 3 GW class HVDC superconducting cable system operating at 320 kV and 10 kA
- Validate the novel MgB₂ superconductor for high-power electricity transfer
- Provide guidance on technical aspects, economic viability, and environmental impact of this innovative technology



Future prospects of transmission grid development

FP7 eHighWay2050 results

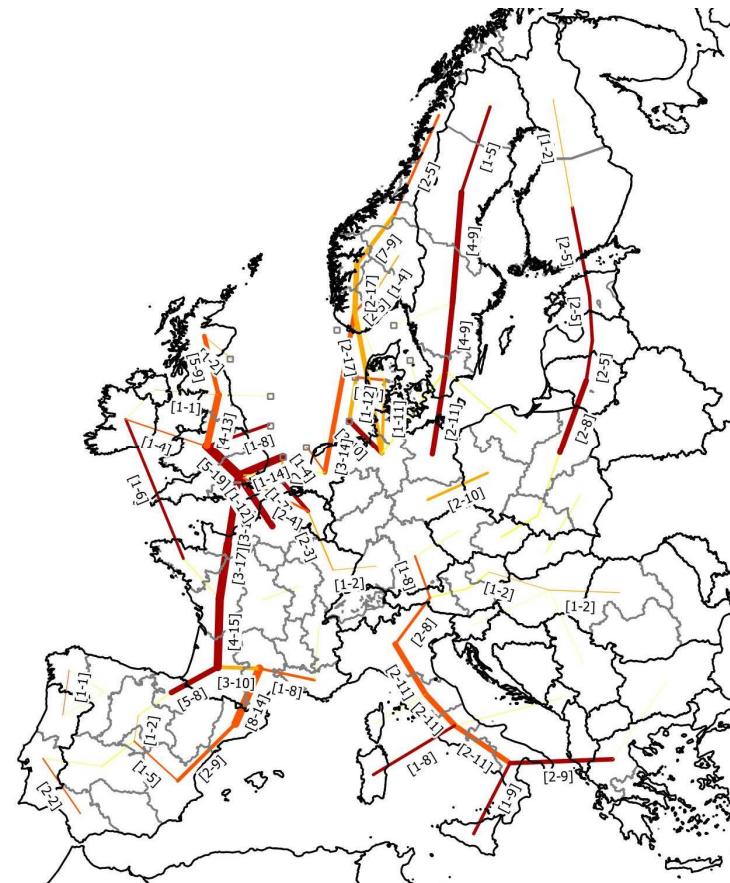
European **eHighWay2050** Project brings very useful input data

- New methodology to support grid planning
- Focusing on 2020 to 2050
- To ensure the reliable delivery of renewable electricity and pan-European market integration
- Five extreme energy mix scenarios considered

Whatever the scenario, 5 to 20 GW corridors are identified

- Major North-South corridors are necessary
- Connections of peninsulas and islands to continental Europe are critical

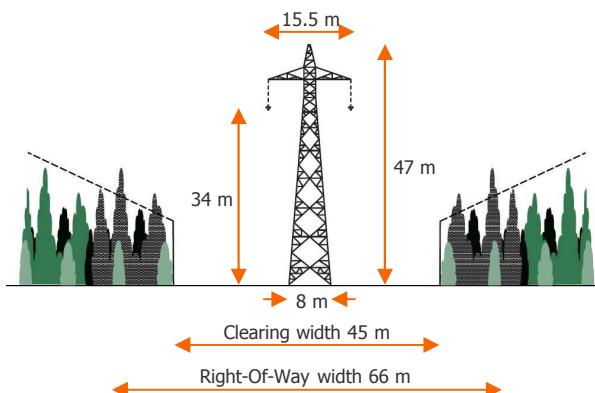
How to transmit more than 4 GW on long distance?



How to transmit bulk power 3-5 GW? (examples of corridors)



Nelson River DC line (Canada)
1600+1800 MVA (+2000 under construction)

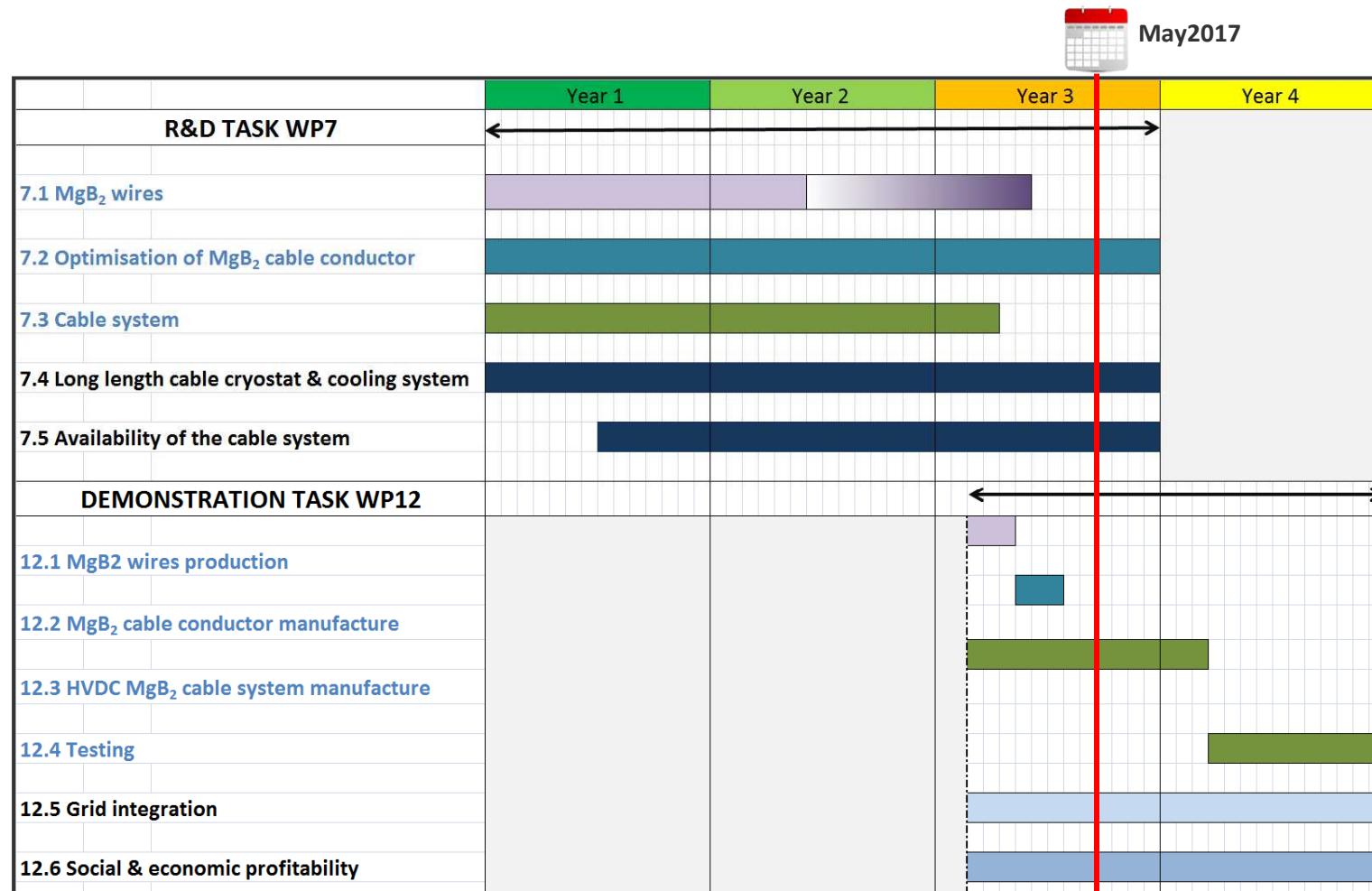


Raesfeld (380 kV AC, Germany)
2x 1800 MW



BEST PATHS stands for "BEyond State-of-the-art Technologies for rePowering Ac corridors and multi-Terminal Hvdc Systems". It is co-funded by the European Commission under the Seventh Framework Programme for Research, Technological Development and Demonstration under the grant agreement no. 612748.

Schedule: 2 Work Packages divided in 11 Key Tasks



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Nexans FCL references

Year (Commissioning)	Country	Customer	Location	Type / Project	Application	Voltage	Current
2009	Germany	Vattenfall	Boxberg	SFCL 12-800	Power Plant	12 kV	800 A
2009	UK	ASL	Bamber Bridge	SFCL 12-100	Distribution Grid	12 kV	100 A
2011	Germany	Vattenfall	Boxberg	SFCL 12-800 ENSYSTROB	Power Plant	12 kV	800 A
2012	UK	ASL	Ainsworth Lane	SFCL 12-400	Distribution Grid	12 kV	400 A
2013	Spain Slovacia	Endesa	Mallorca Kosice	SFCL 24-1000 ECCOFLOW	Distribution Grid	24 kV	1000 A
2014	Germany	RWE	Essen	SFCL 12-2400 AmpaCity	Distribution Grid	12 kV	2300 A
2015	UK	Western Power Distribution	Birmingham	SFCL 12-1600 WPD Chester St.	Distribution Grid	12 kV	1600 A
2015	UK	Western Power Distribution	Birmingham	SFCL 12-1050 WPD Bourneville	Distribution Grid	12 kV	1050 A



Conclusion

- **Nexans' Superconducting Systems ...**

- ... are in operation in real grids
- ... are cost effective solutions
- ... offer significant technical benefits

- **Nexans has a leading position
and gained greatest experience through several
successful projects**





Thank you for your attention !