

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

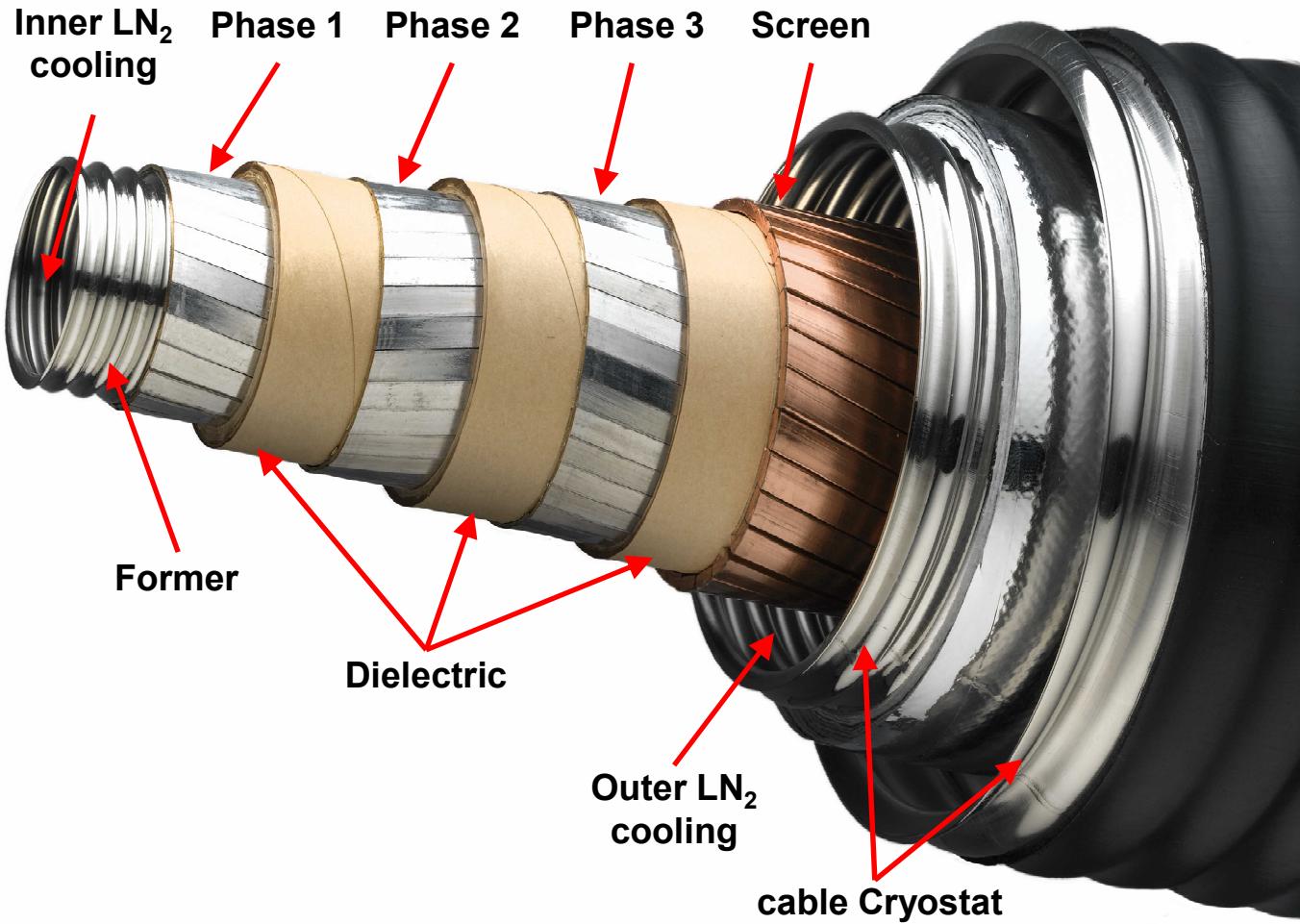
Moving high voltage out of the city center
World's first installation connecting 2 substations



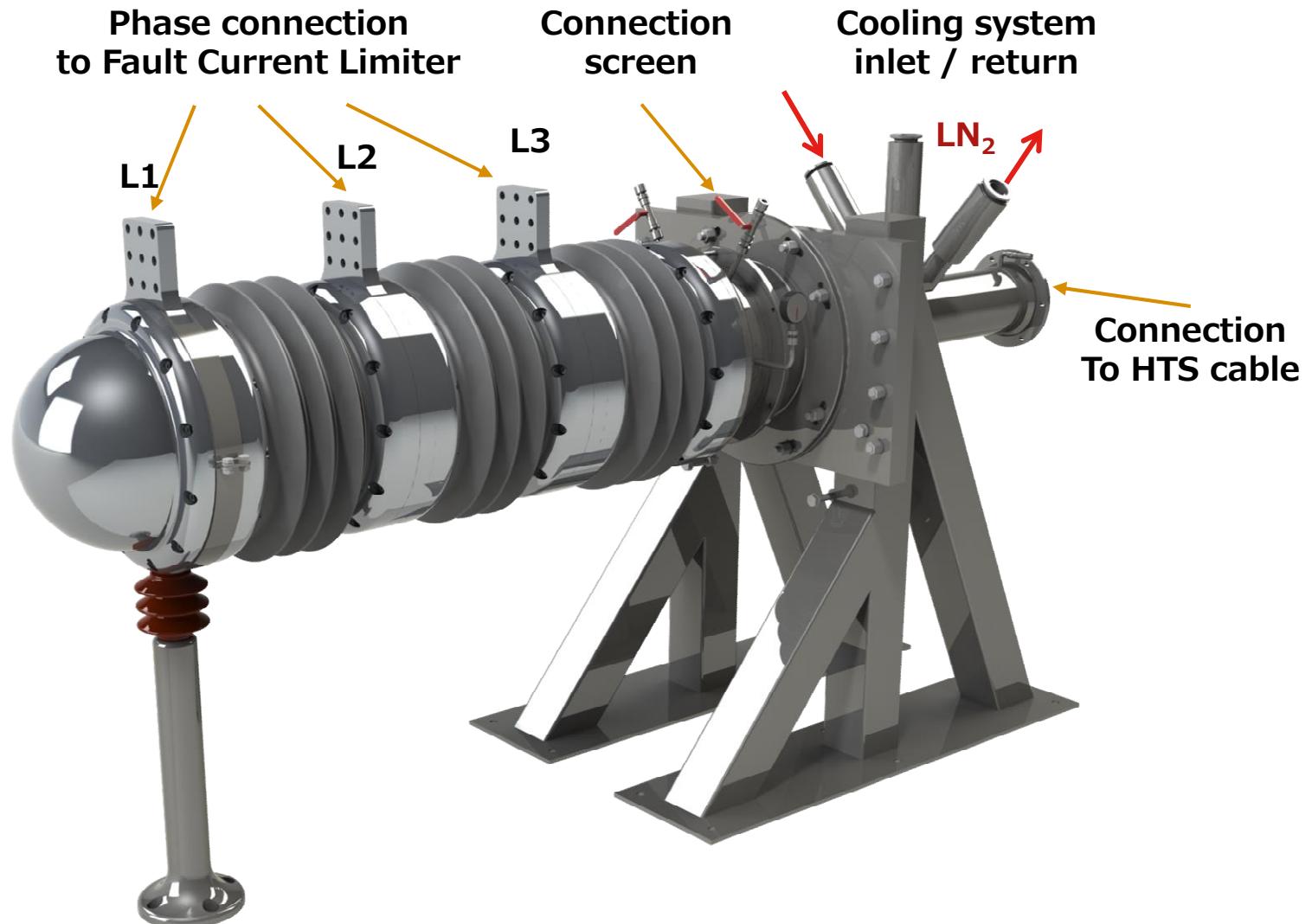
Superconducting cable system in the city center of Essen/Germany

In continuous operation since March 2014

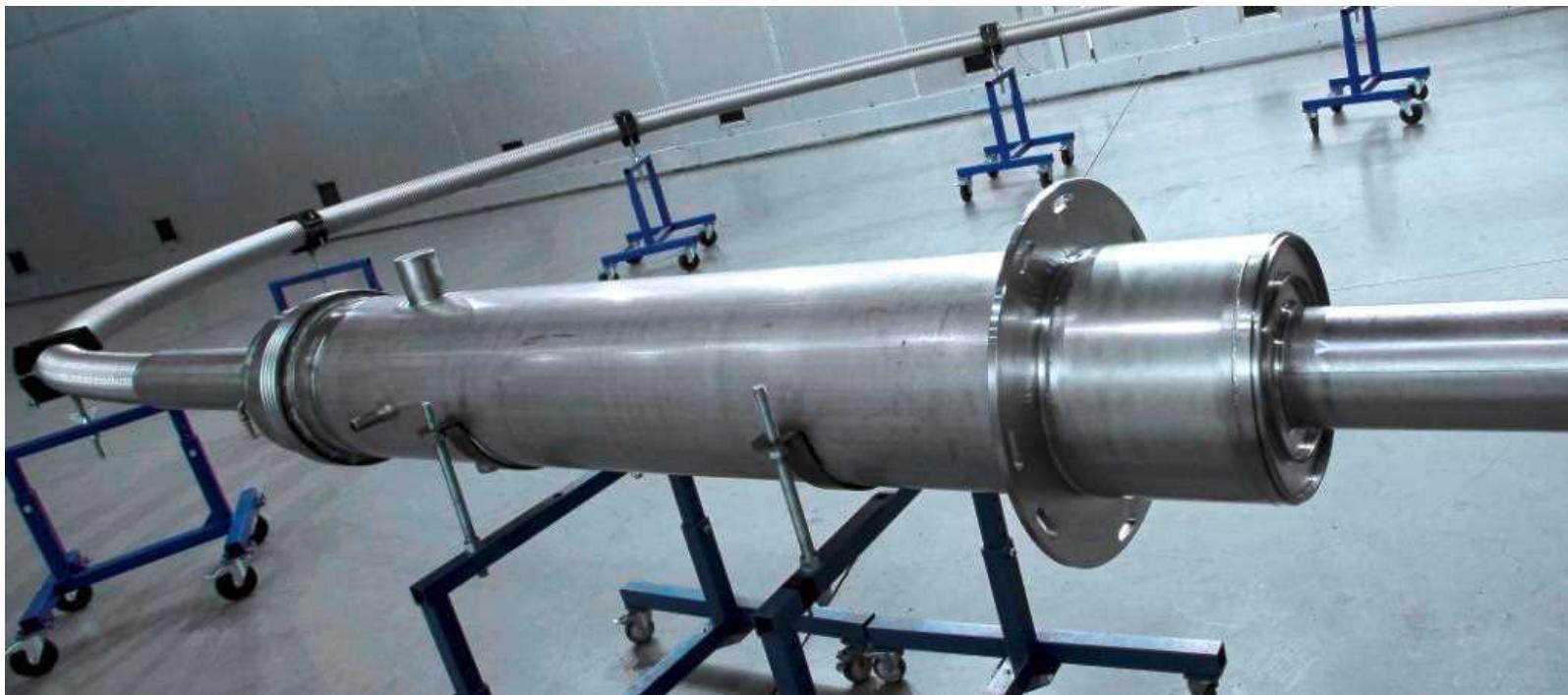
AmpaCity cable



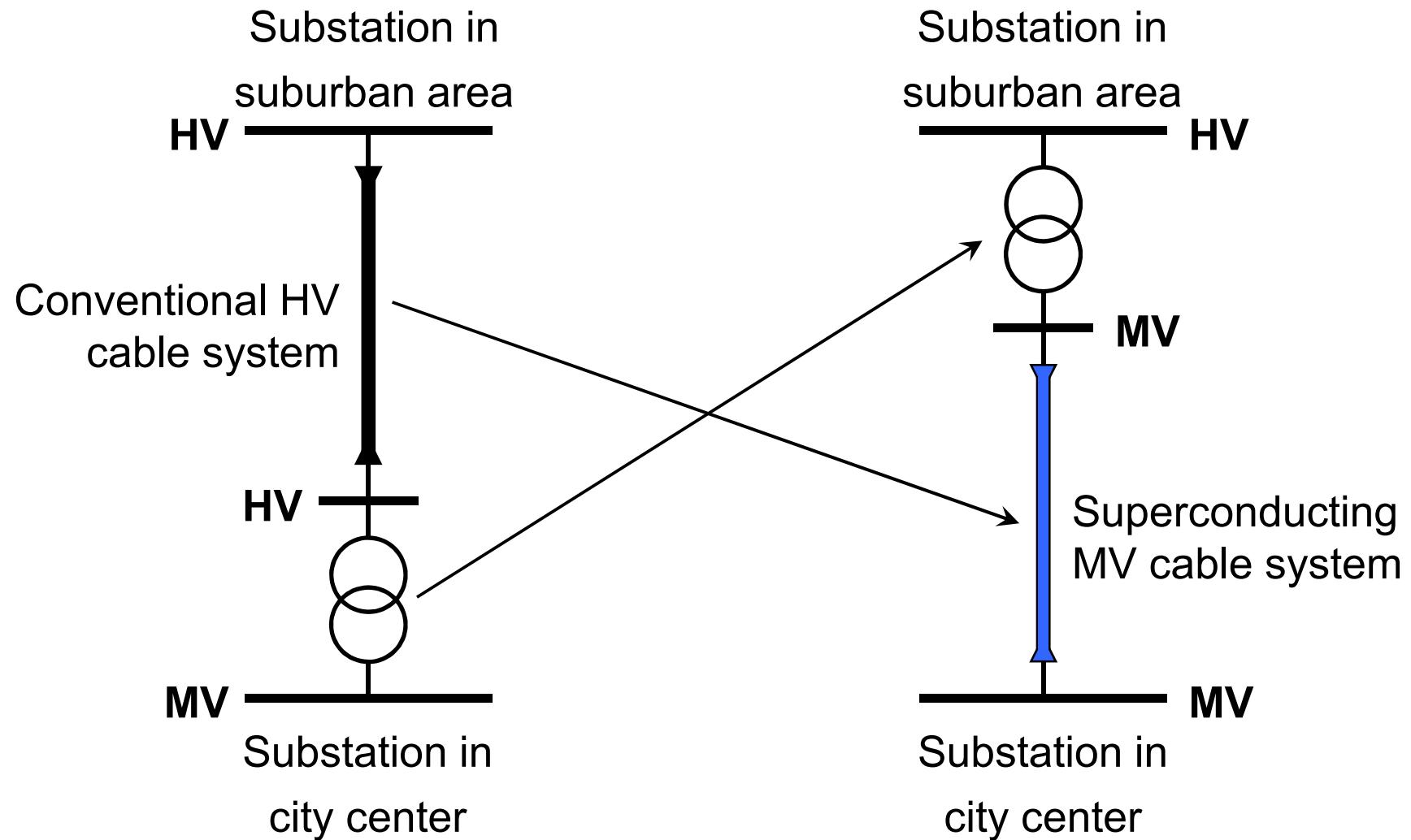
AmpaCity termination



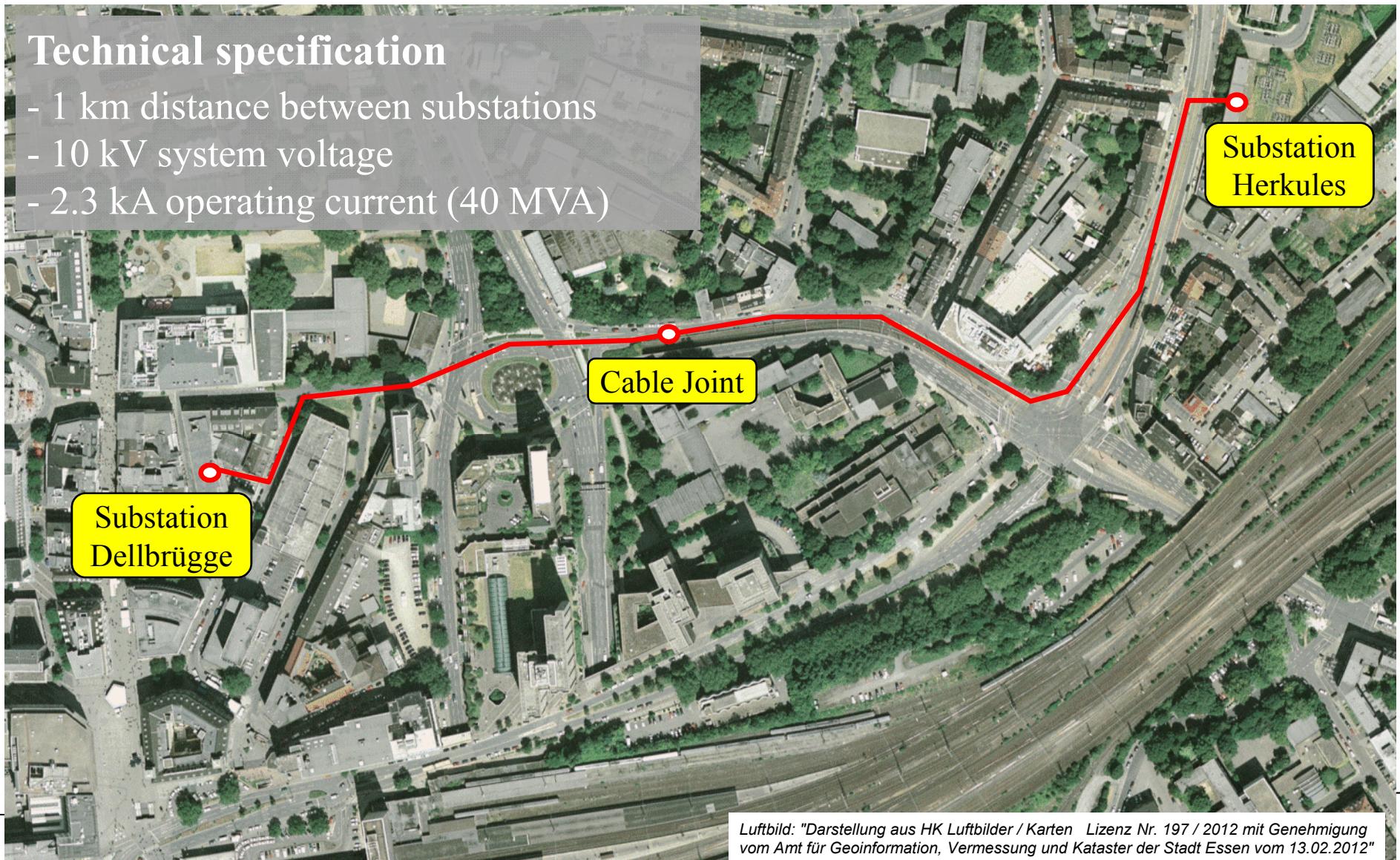
AmpaCity joint



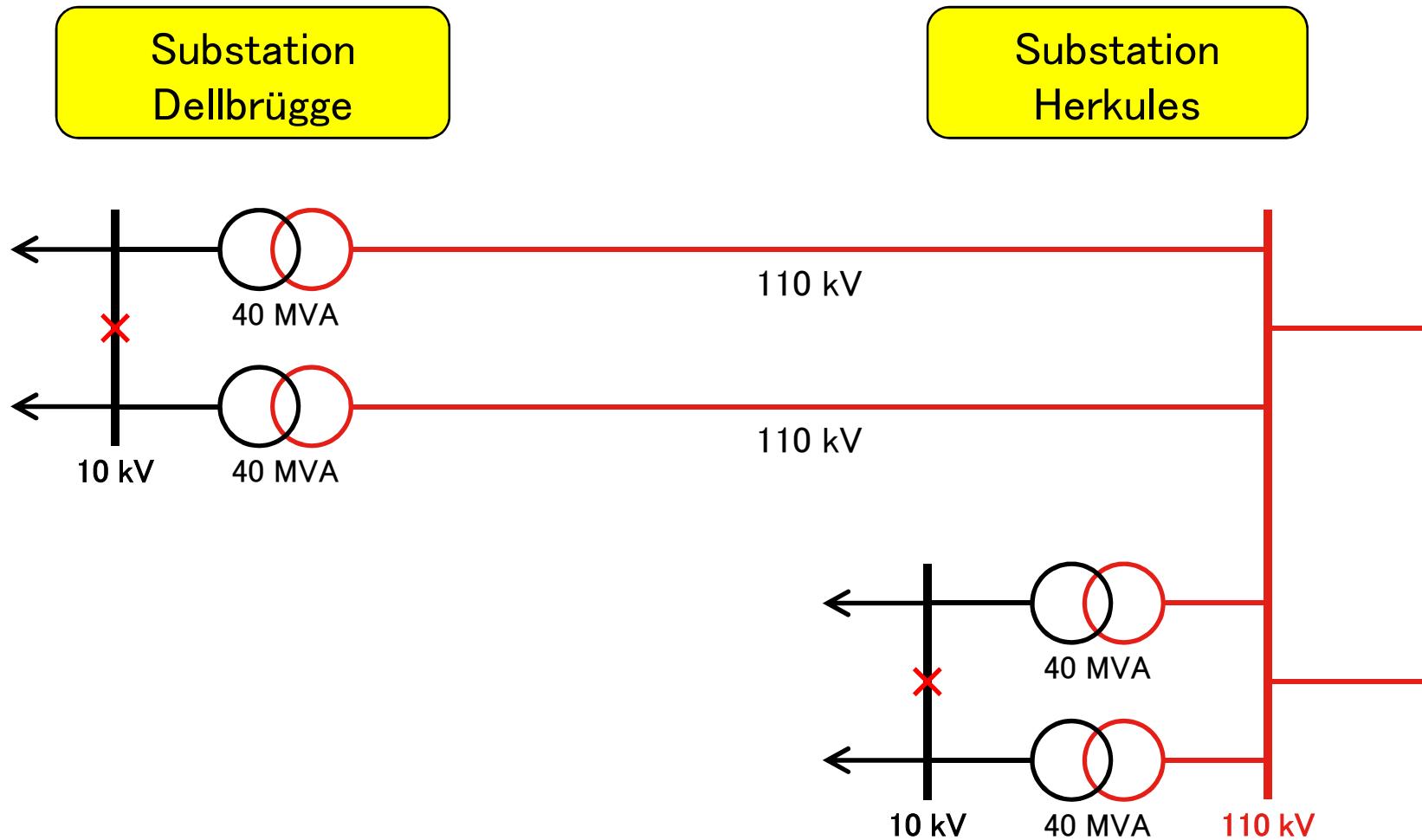
Rationale



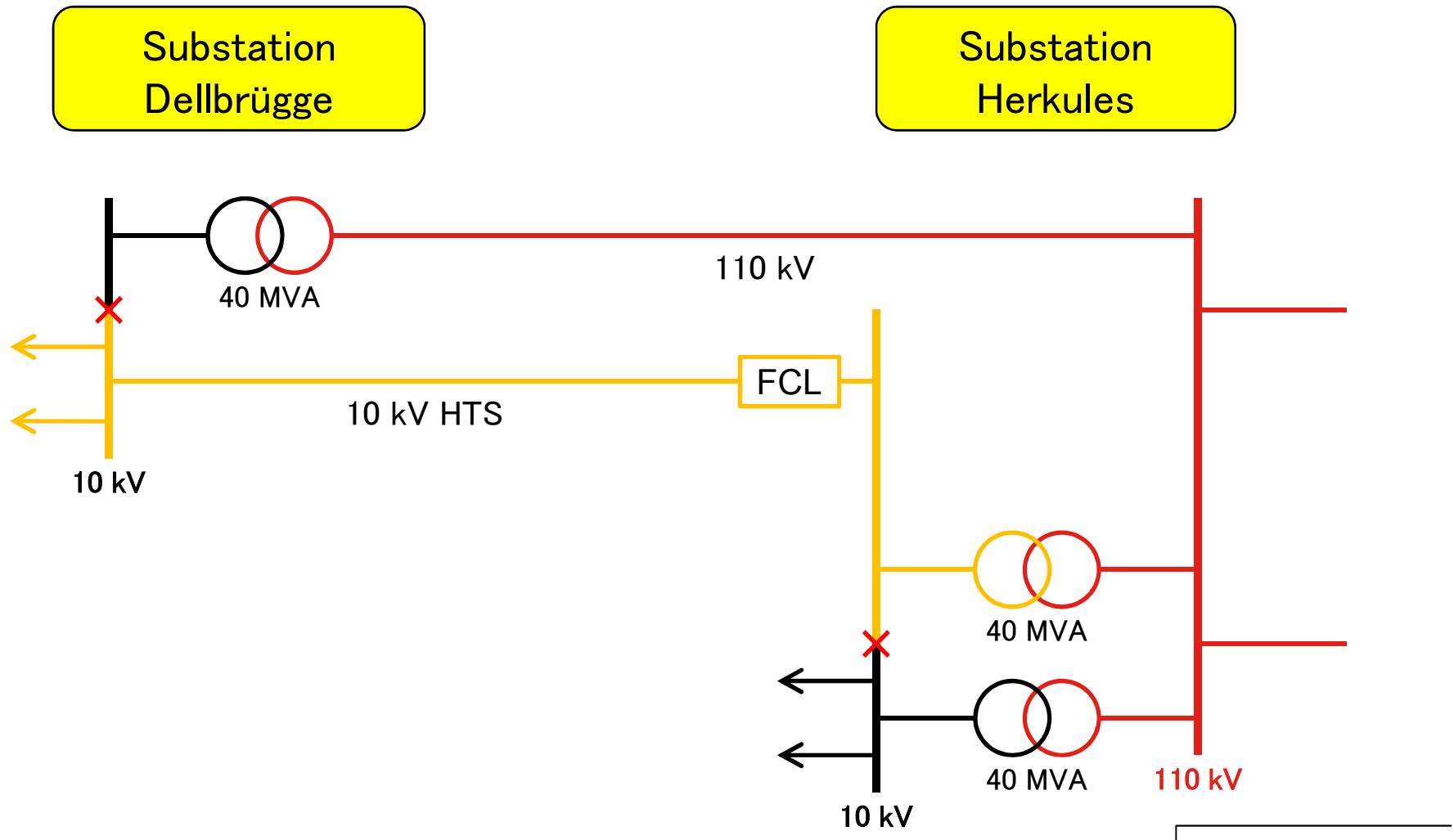
Overview



Initial grid architecture



Final grid architecture



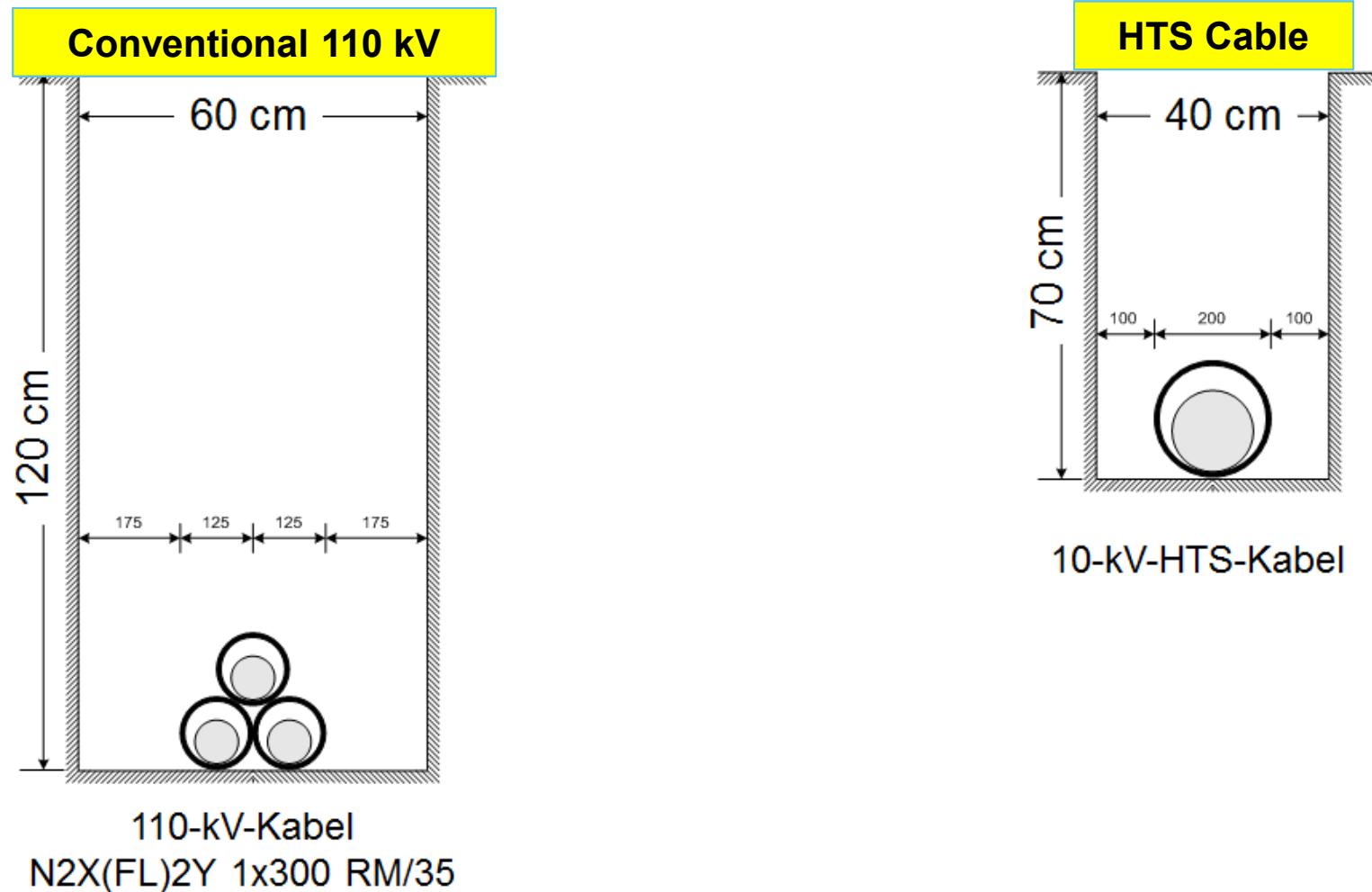
Moving transformers out of city center

110kV/10kV substation in city center



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

Narrow cable track



Techno-economical study

2 Scenarios:

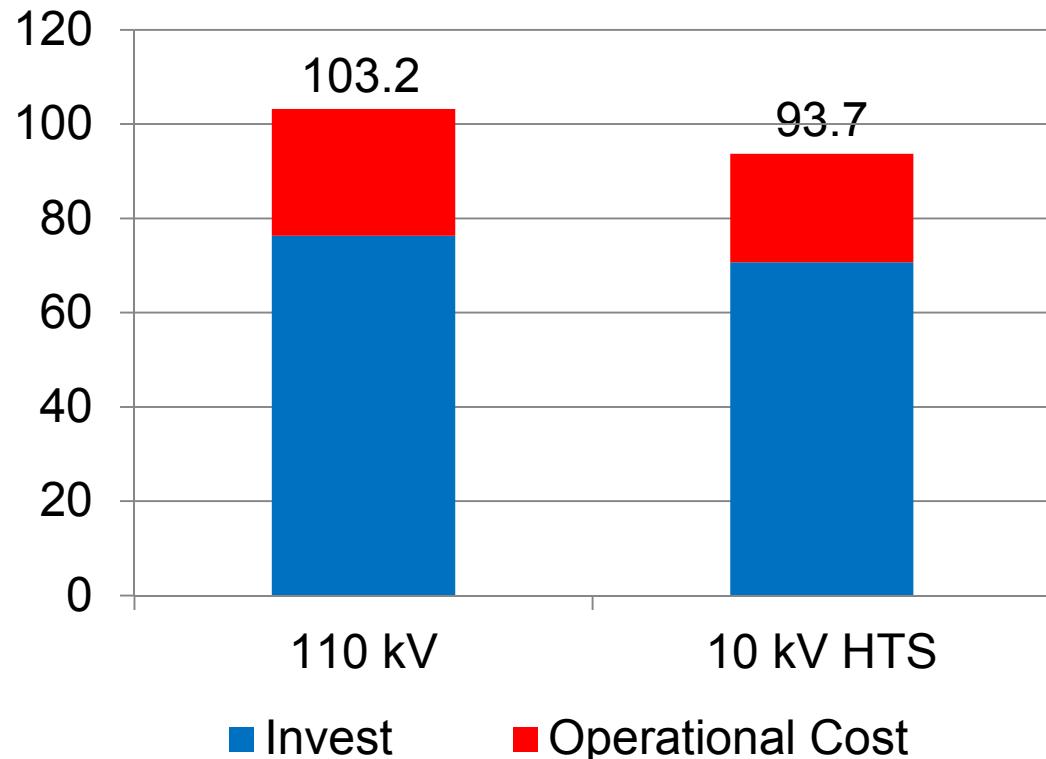
- 110 kV conventional
- 10 kV HTS

Total Cost

- Capex
- Operational Cost
(maintenance & losses)

Assumptions

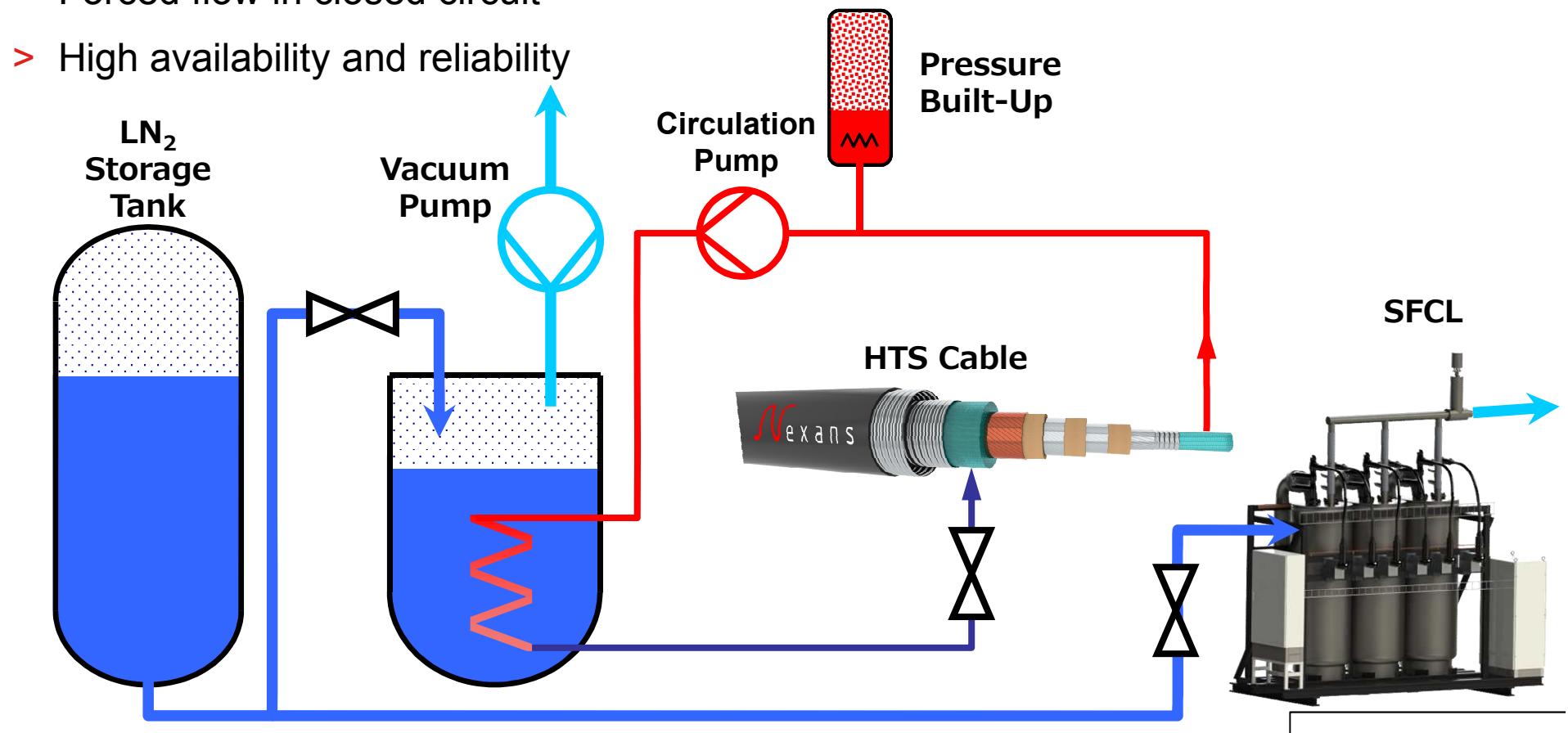
- 40-year operation



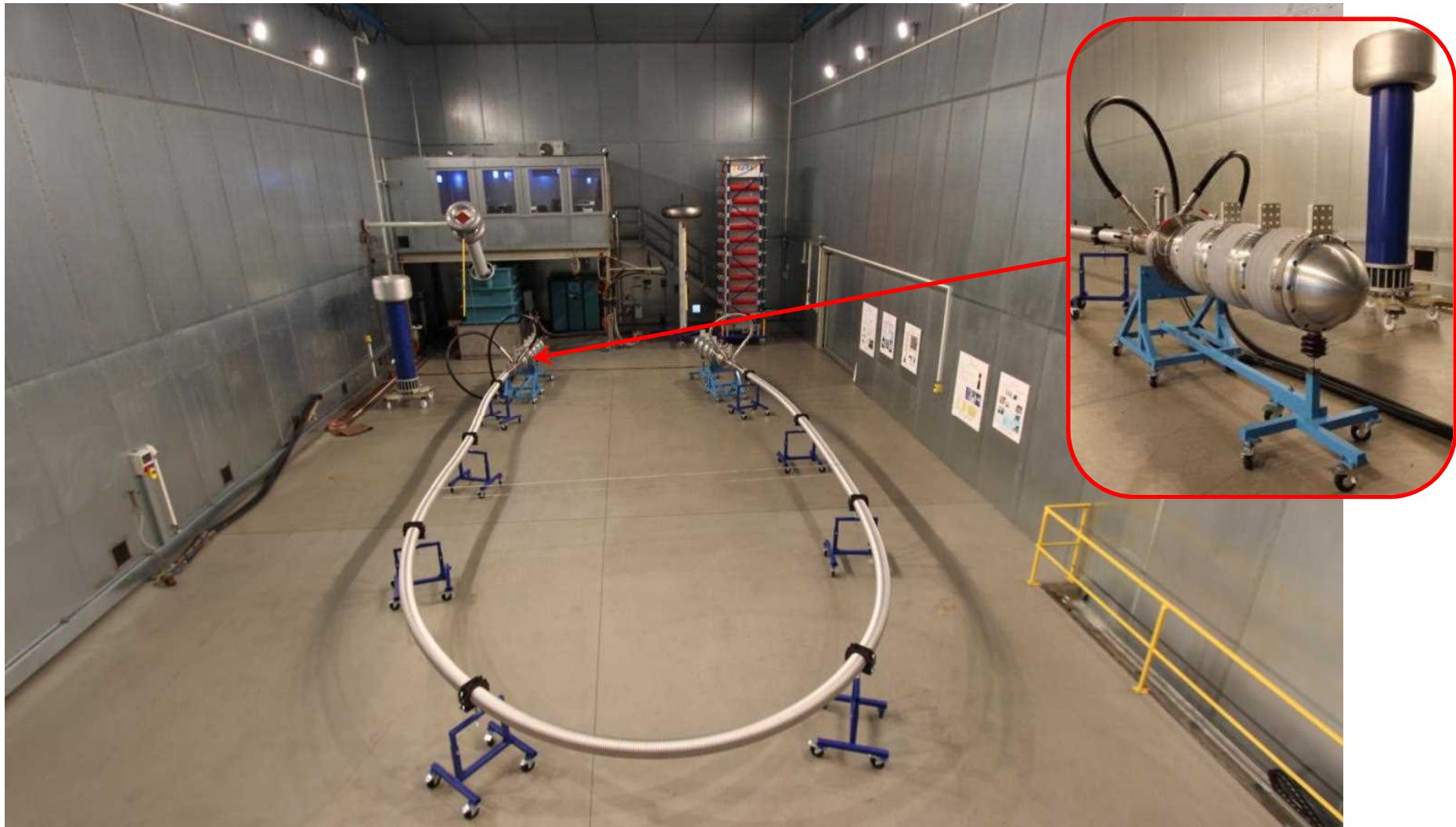
**Cost reduction, although benefits from space savings
are not taken into account in the calculation**

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



FCL



NEXANS PROPRIETARY

Nexans

Drum loading in Hanover



Cable pulling



Thermal shrinkage management



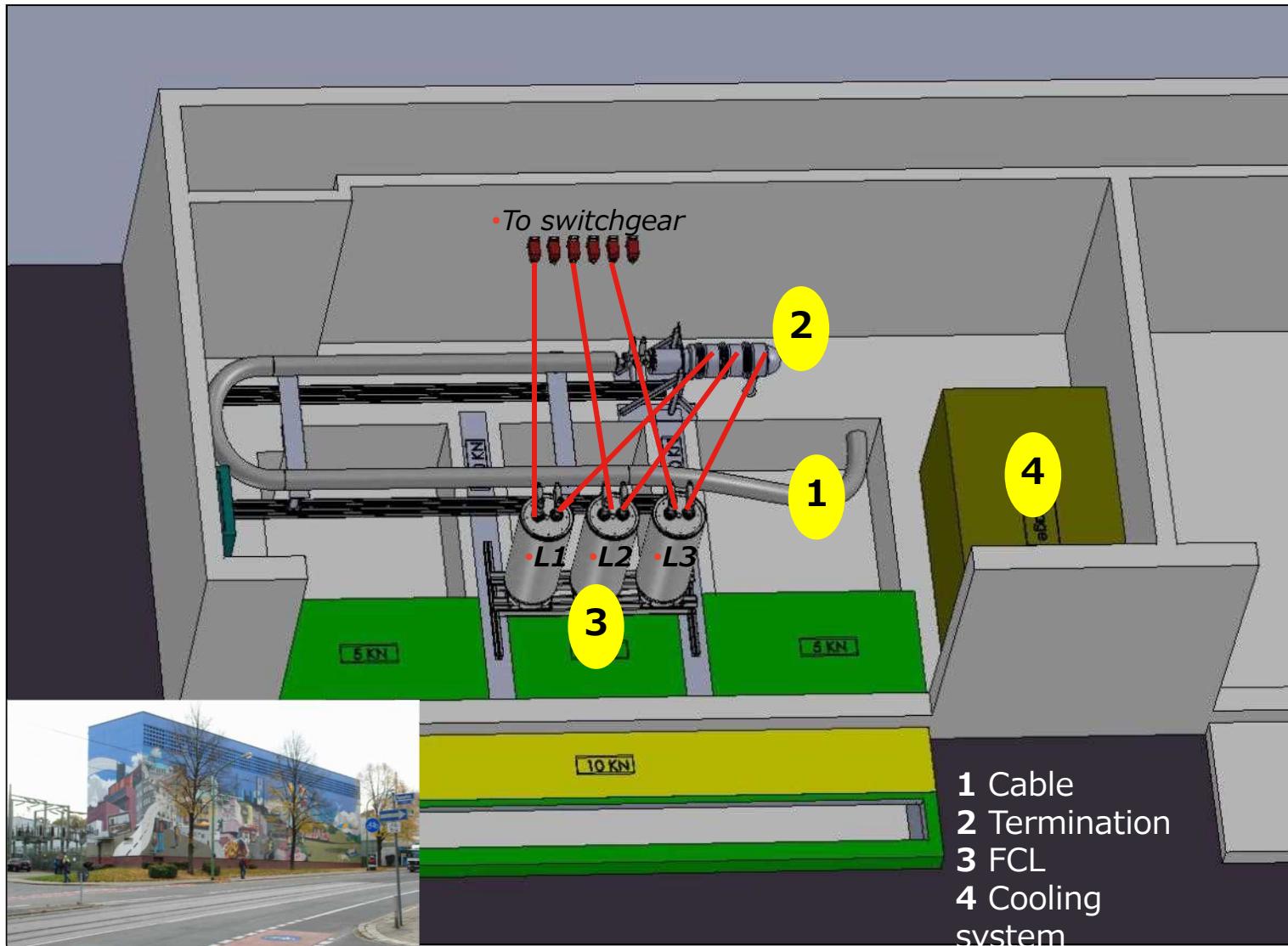
Joint installation



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



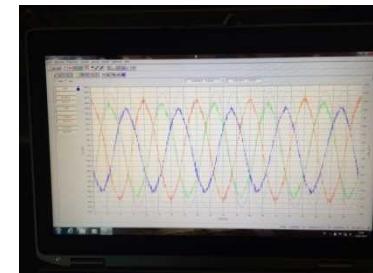
> Cooling system optimization

- 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

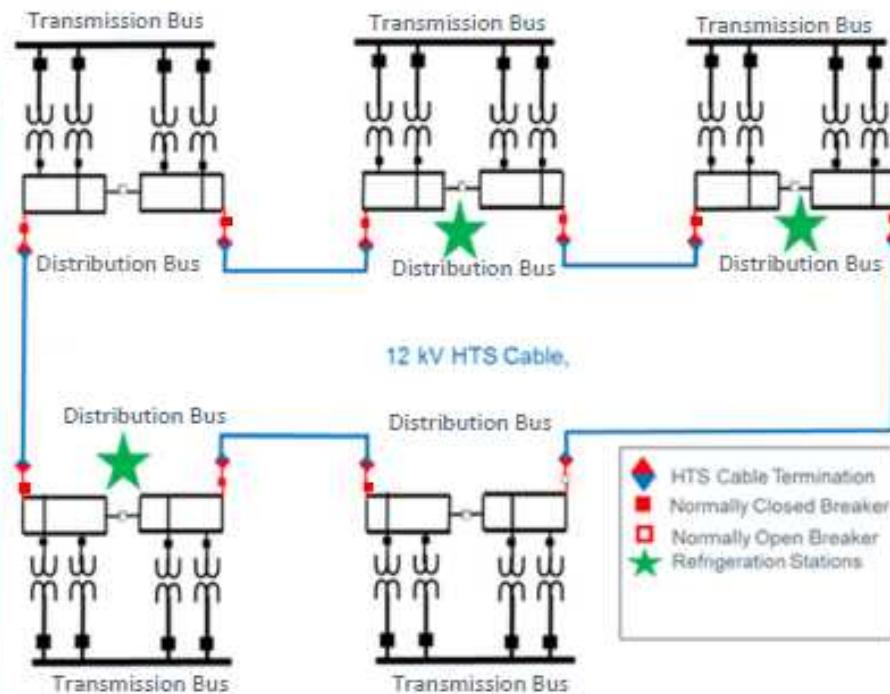
MV “Resilient Electric Grid” (REG) System

Distribution Networking

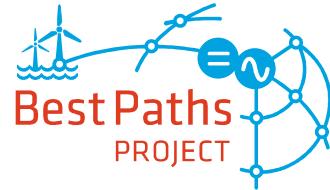


This REG system provides the utility:

- 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



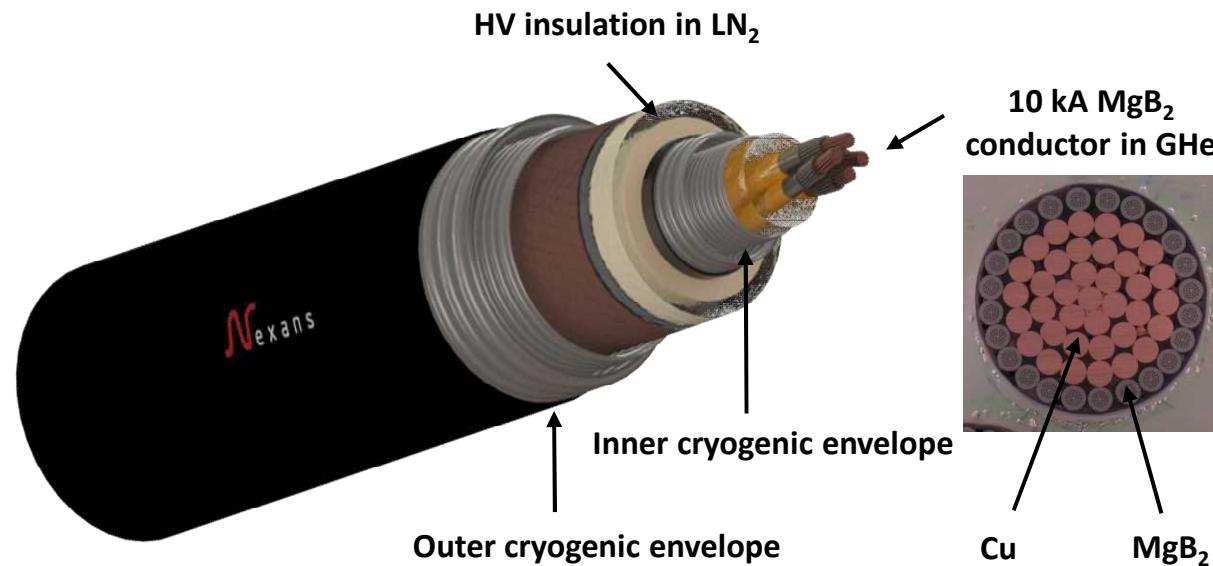
Nexans was selected as supplier for this project



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

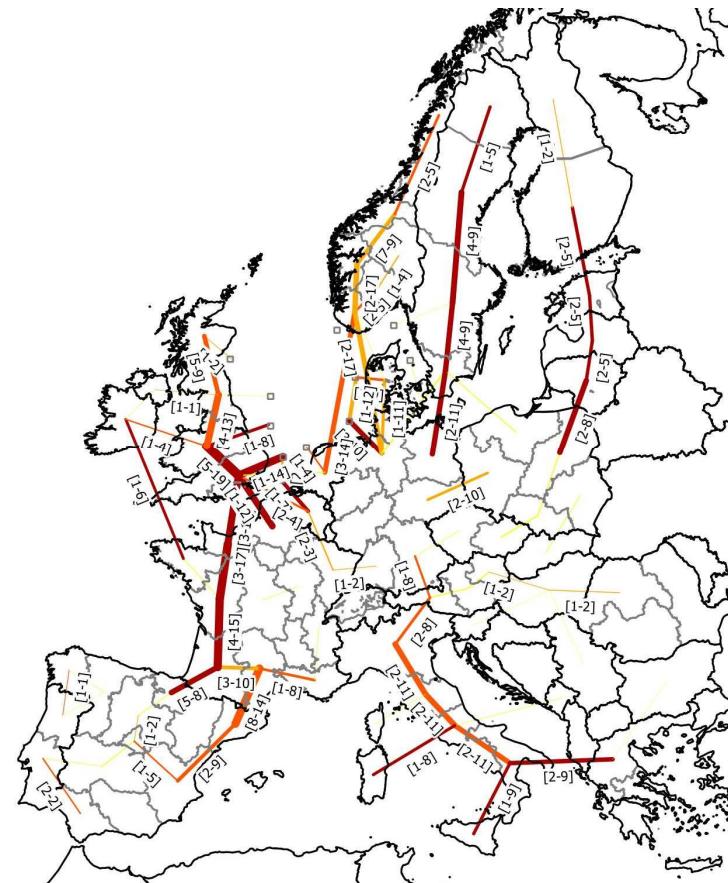
European **eHighWay2050** Project brings very useful input data

- 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

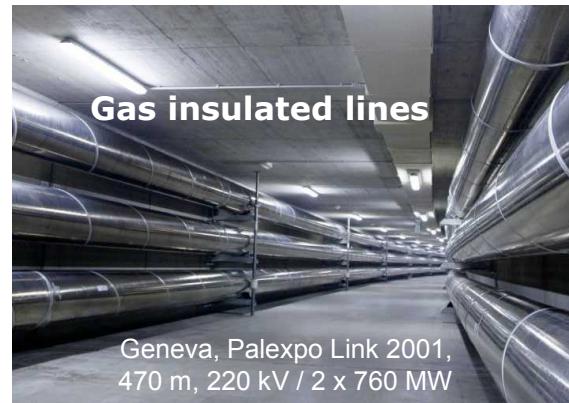
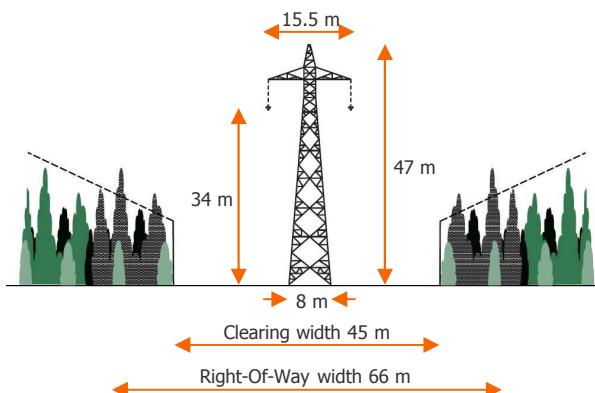
How to transmit more than 4 GW on long distance?



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



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

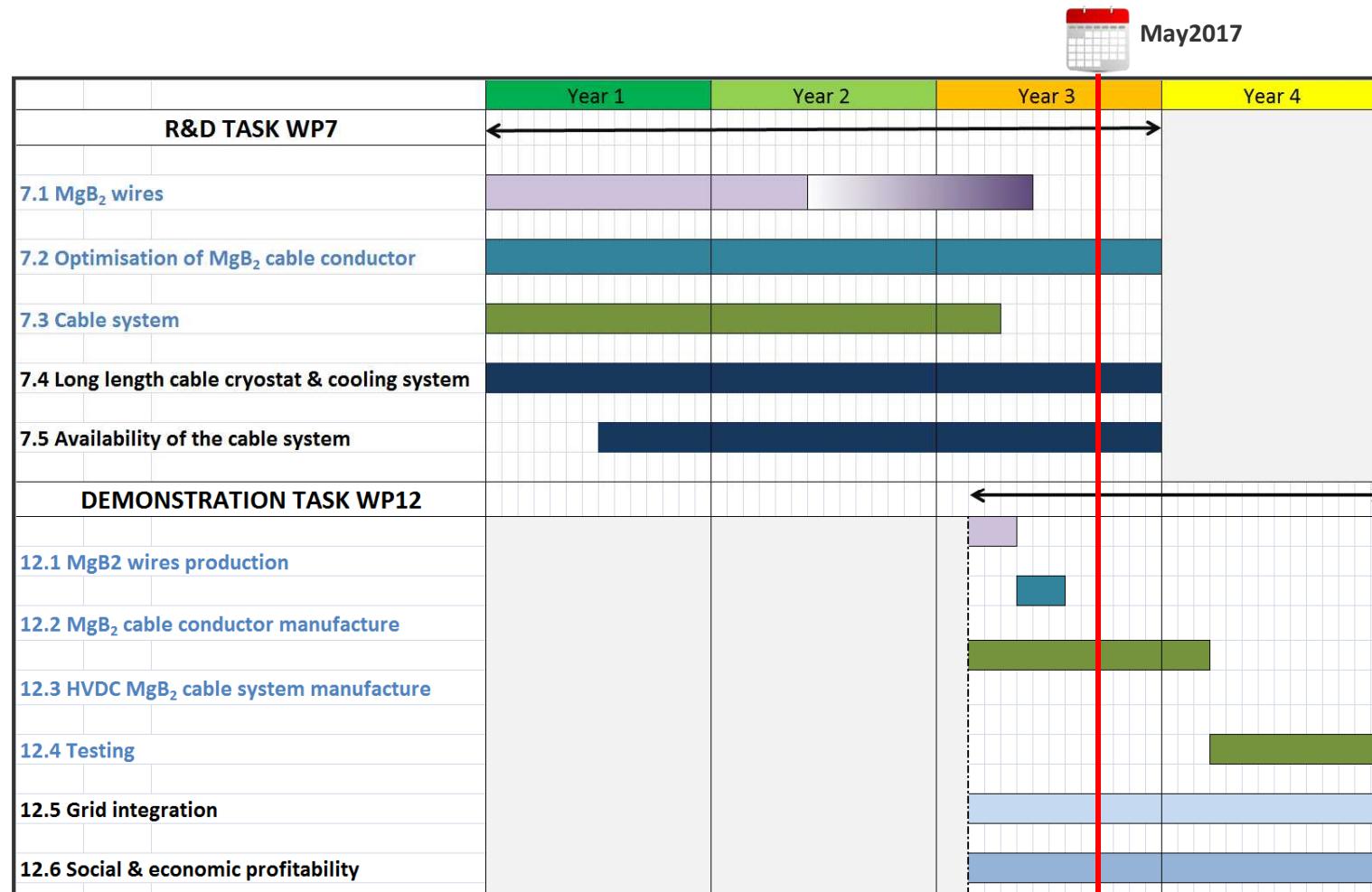


Raesfeld (380 kV AC, Germany)
2x 1800 MW



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 !