Combined HTS Cable and Fault Current Limiter Project in Germany

Mathias Noe, Institute for Technical Physics, KIT
Mark Stemmle, Nexans Germany
Frank Schmidt, Nexans Germany
Frank Merschel, RWE
Joachim Bock, Nexans SuperConductors

EPRI Superconductivity Conference, 12.-13. October 2011, Tallahassee, US

VORWEG GEHEN Nexans KIT Karlsruhe Institute of Technology

Combined HTS Cable and Fault Current Limiter Project in Germany

- Motivation
- Application Concept
- Case Study
- AmpaCity Project
- Summary

VORWEG GEHEN Nexans KIT Karlsruhe Institute of Technology

Background

Power supply within cities predominantly with cables

- Many quite old cables and substations
- Refurbishment / replacement in upcoming years
- Adaption of substations to new load requirements

High temperature superconductor systems (HTS cables in combination with HTS fault current limiters)

- Option for replacing conventional cables
- Enabling of new grid concepts

Combined HTS Cable and Fault Current Limiter Project in Germany

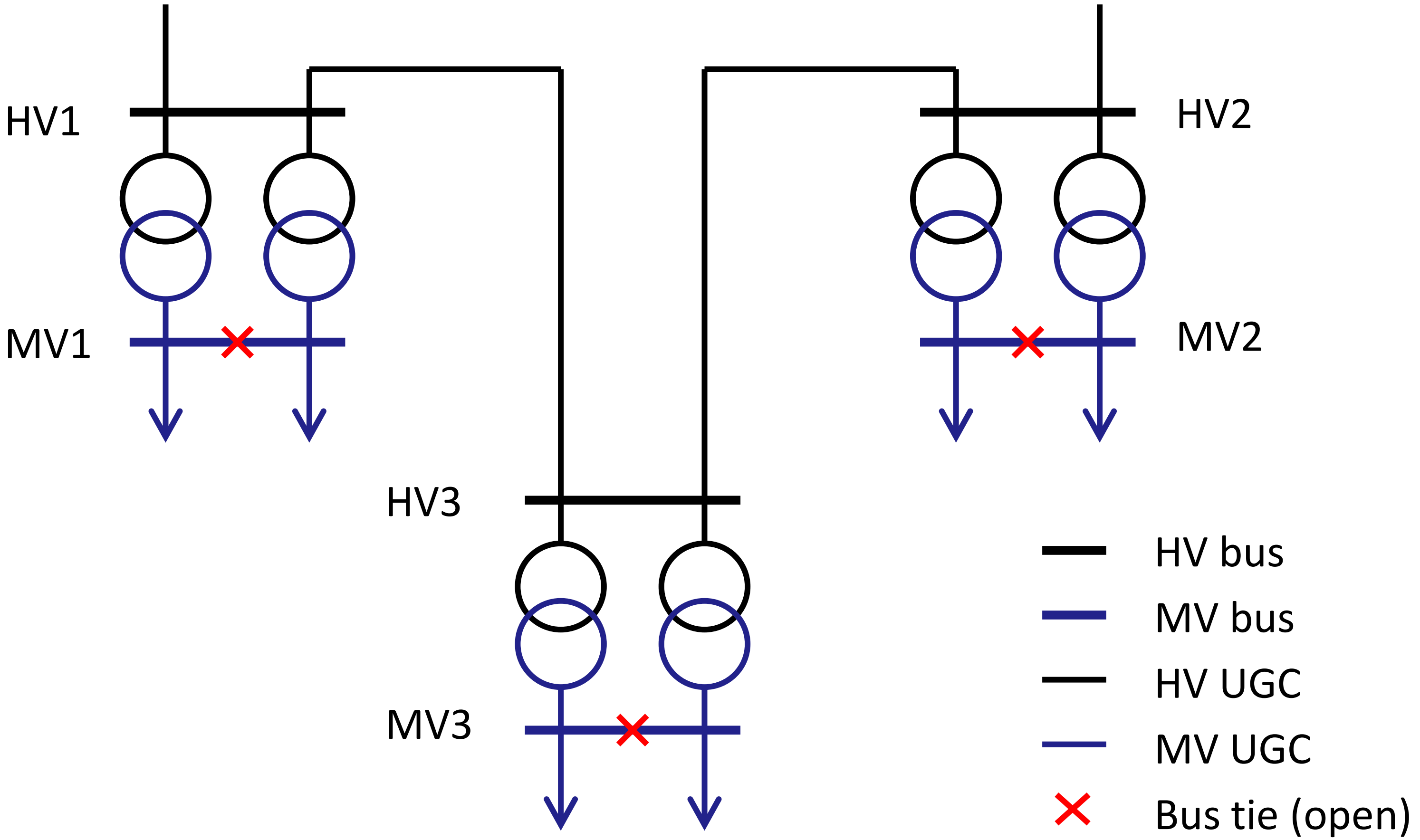
- Motivation
- **Application Concept**
- Case Study
- AmpaCity Project
- Summary

VORWEG GEHEN

Nexans

KIT Karlsruhe Institute of Technology

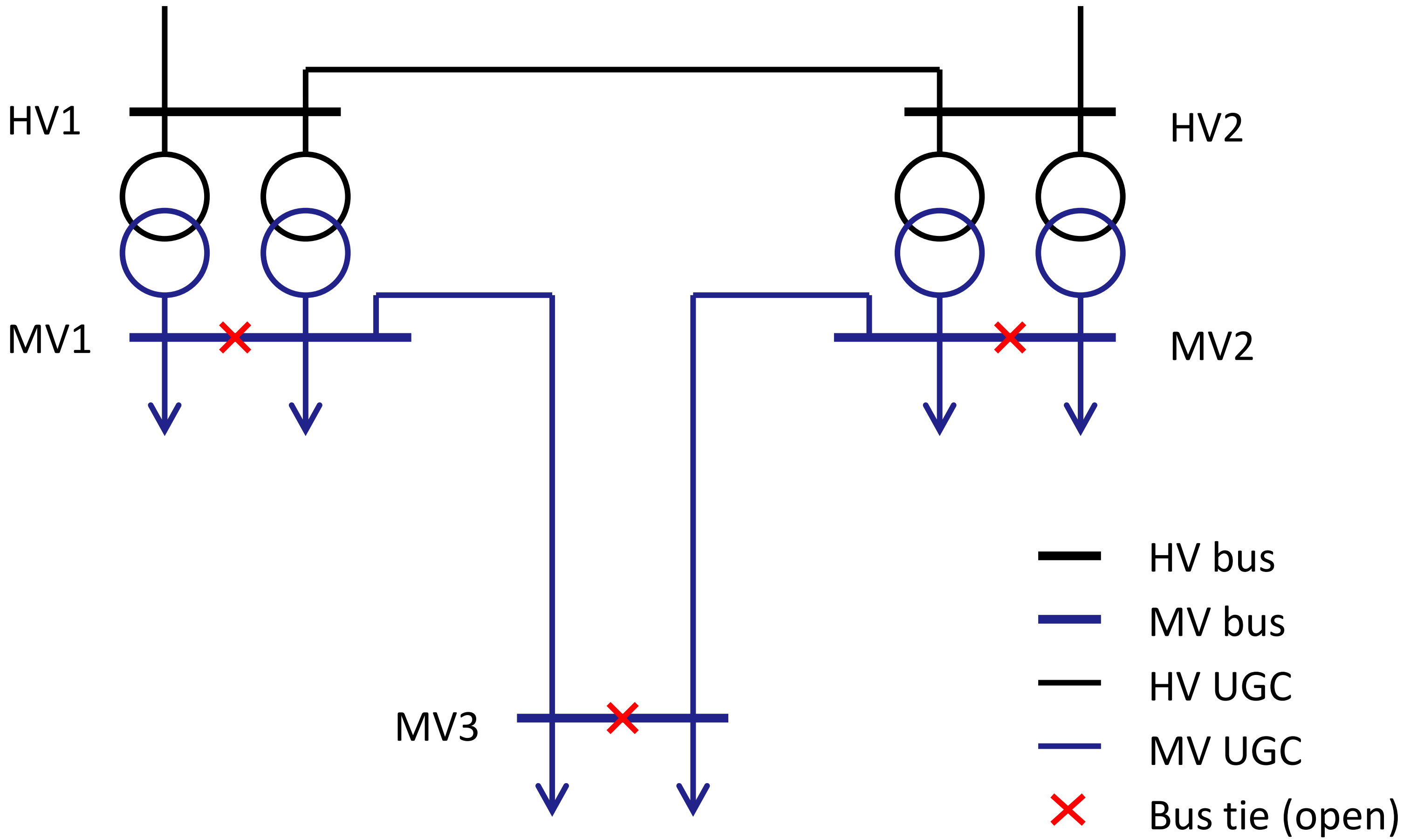
Application Concept – HV Cables



Capacity of one transformer equals total load in each substation

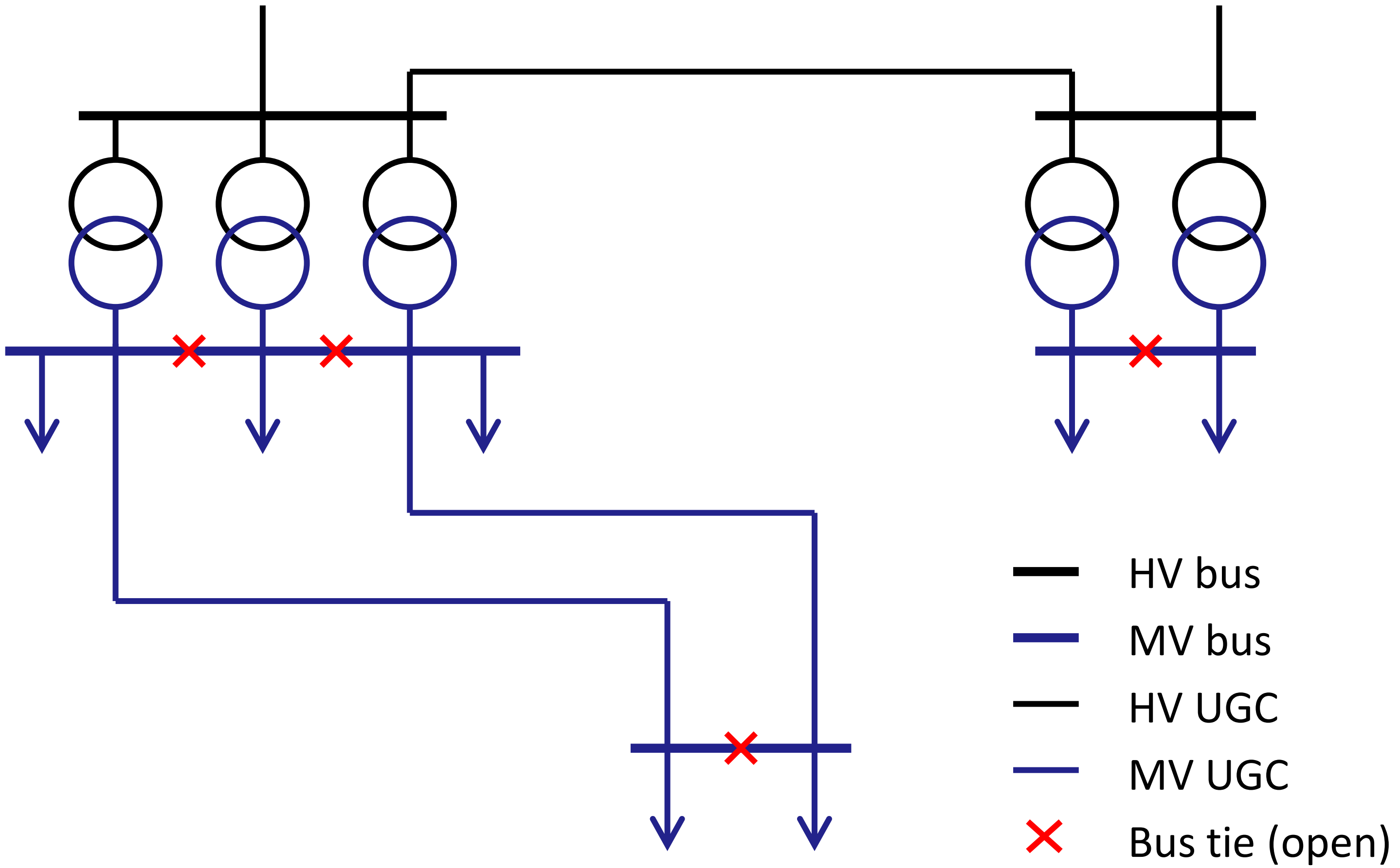
VORWEG GEHEN Nexans KIT Karlsruhe Institute of Technology

Application Concept – Medium Voltage HTS Cables I



Capacity of one transformer equals total load in each substation

Application Concept – Medium Voltage HTS Cables II



Capacity of one transformer equals total load in each substation

Combined HTS Cable and Fault Current Limiter Project in Germany

- Motivation
- Application Concept
- **Case Study**
- AmpaCity Project
- Summary

VORWEG GEHEN Nexans KIT Karlsruhe Institute of Technology

Case Study – RWE, Nexans, KIT, U Hannover

Contents

Applications and Specification

Cable Design

Operation Parameters

HTS Cables in the Grid

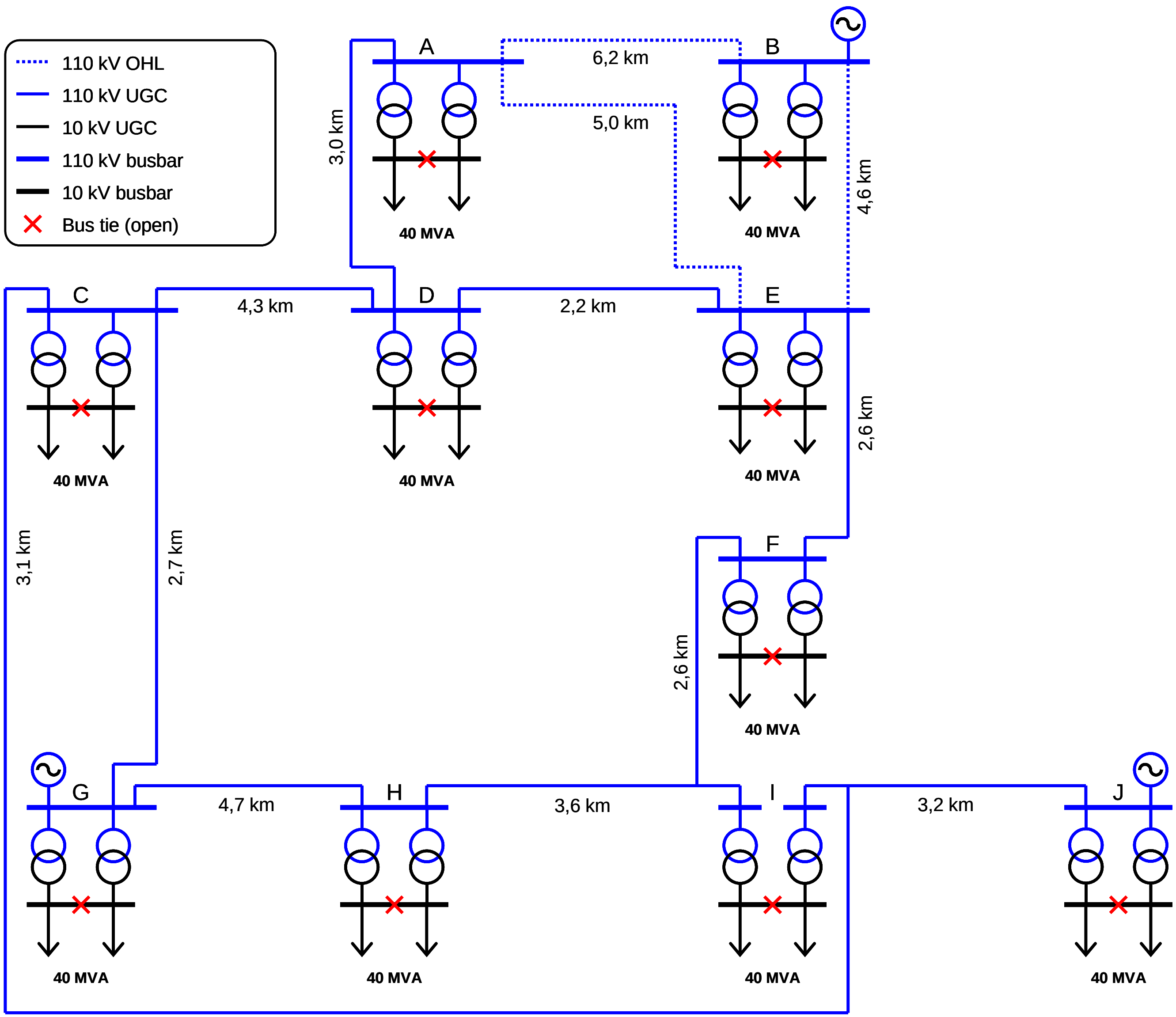
Economic Feasibility

State-of-the-art of HTS cable R&D

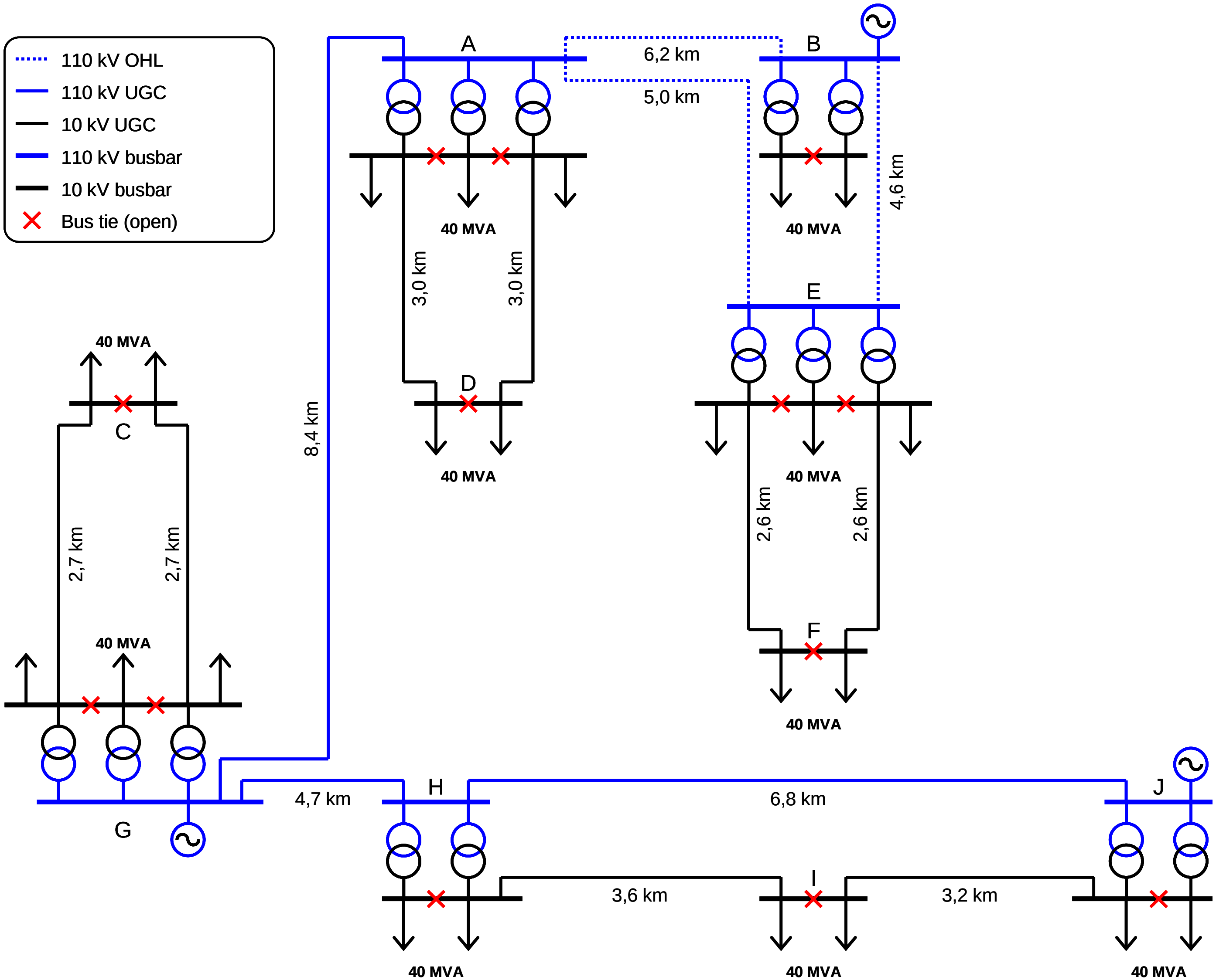
Tests

VORWEG GEHEN Nexans KIT Karlsruhe Institute of Technology

Case Study – Urban grid with HV cables



Case Study – Urban grid with MV-HTS cables

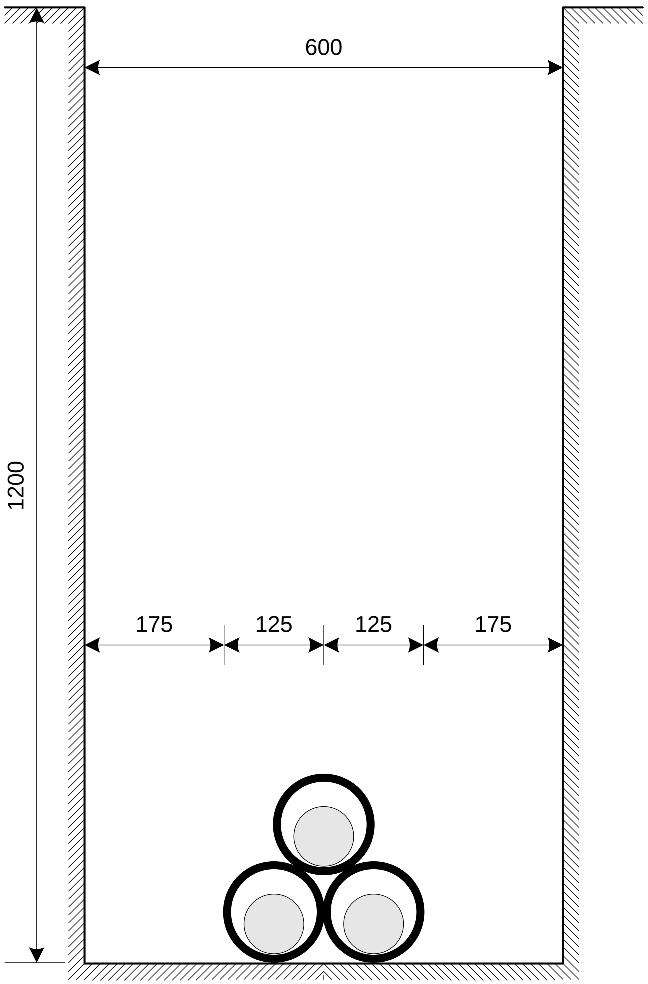


Case Study – Overall changes in the grid

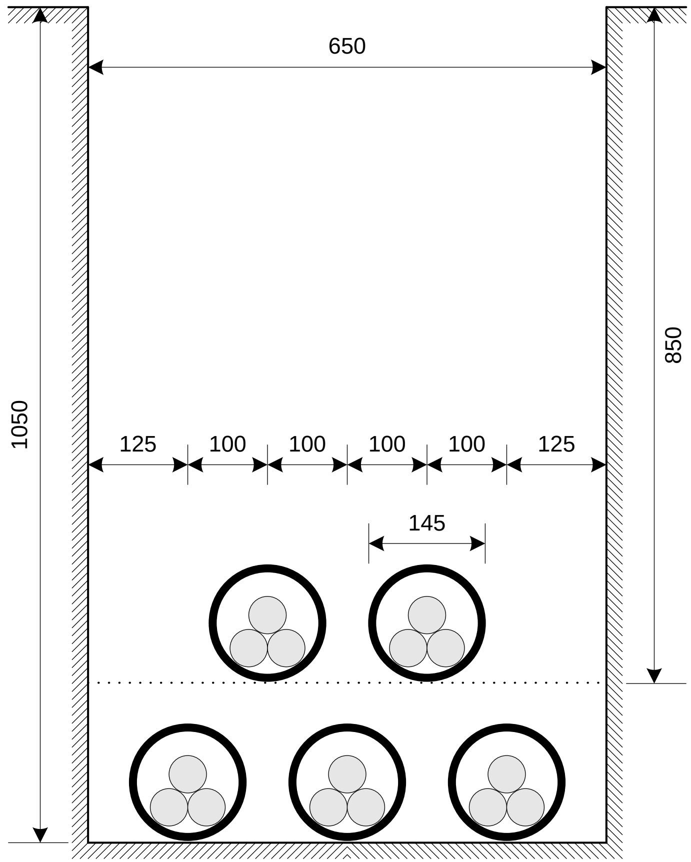
- Dispensable devices for new grid concept
  - 12.1 km of 110 kV cable systems
  - 12 x 110 kV cable switchgear
  - 5 x 40 MVA, 110/10 kV transformers
  - 5 x 110 kV transformer switchgear
  - 5 x 10 kV transformer switchgear
- Additionally required devices for new grid concept
  - 23.4 km of 10 kV HTS cable system
  - 16 x 10 kV cable switchgear
  - 3 x 10 kV bus ties

Case Study – Right of Way and Installation Space

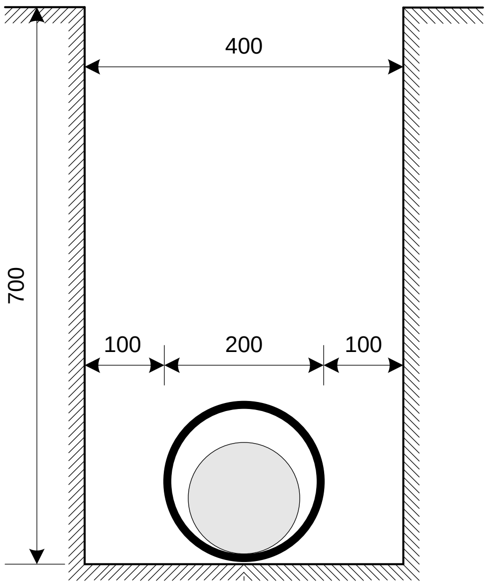
N2XS(FL)2Y 1 x 300 RM/35



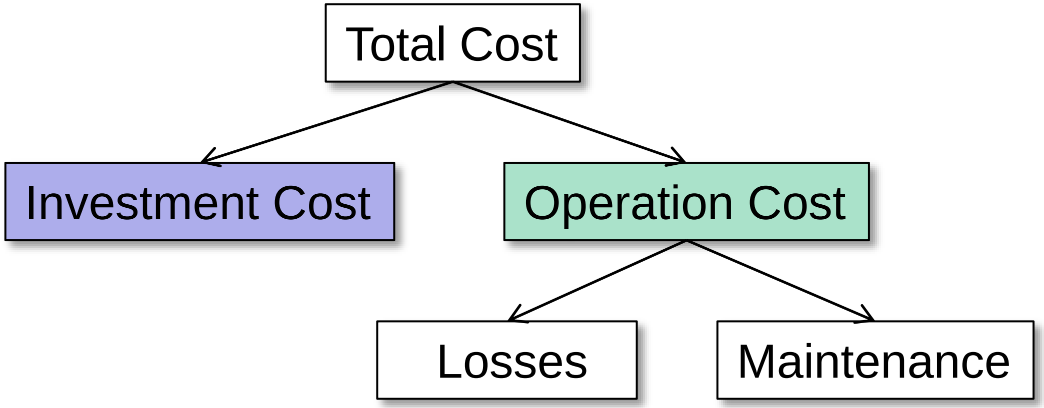
NA2XS2Y 1 x 630 RM/35

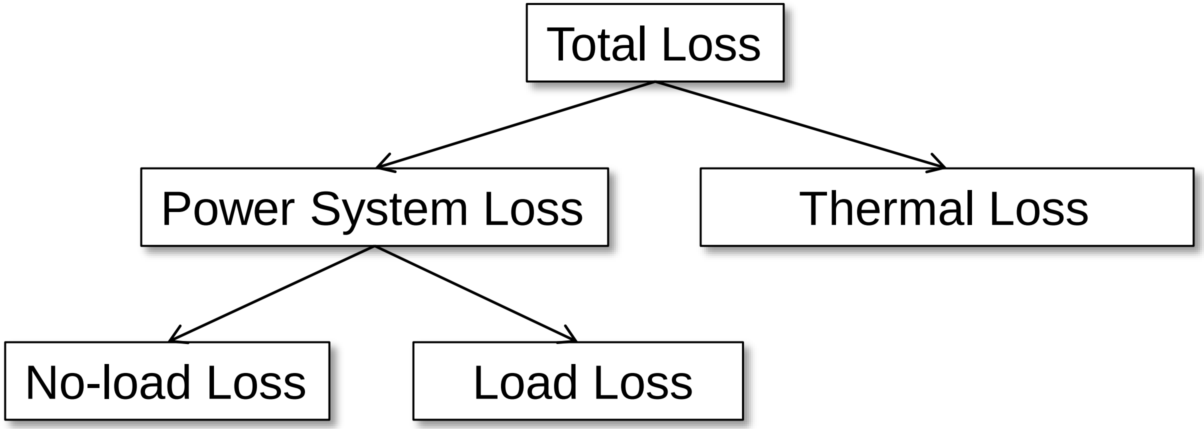


Nexans HTS 10/40



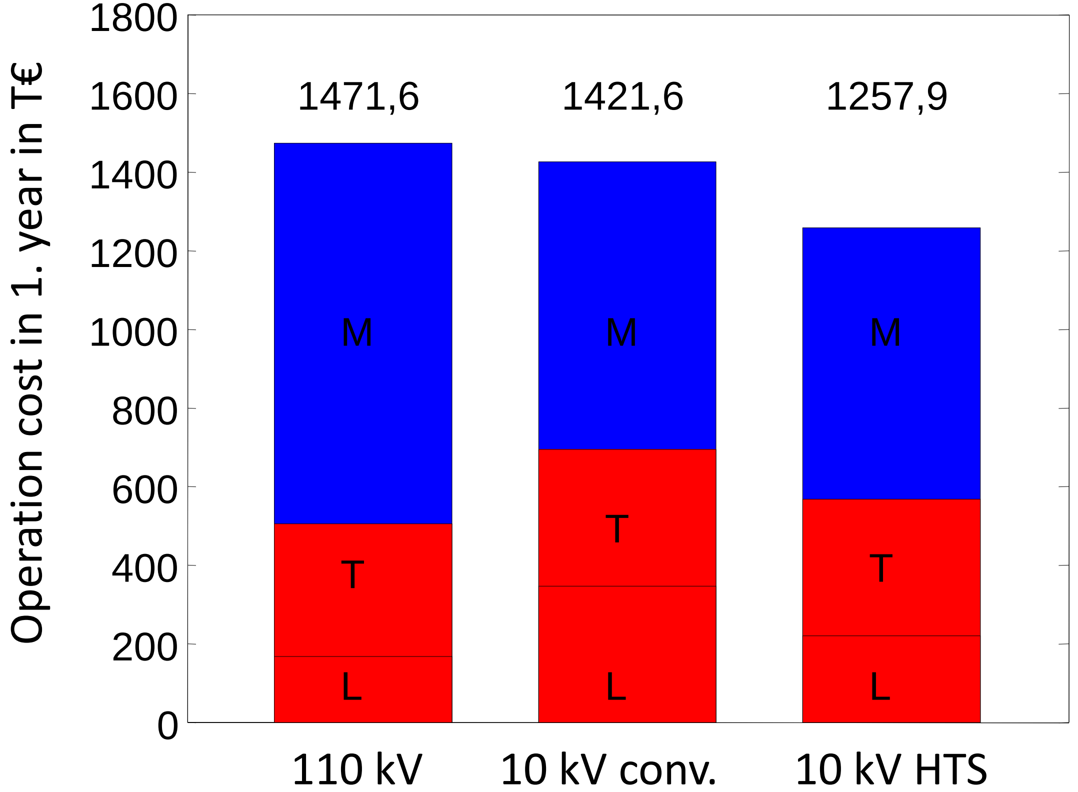
Case Study – Economic Feasibility





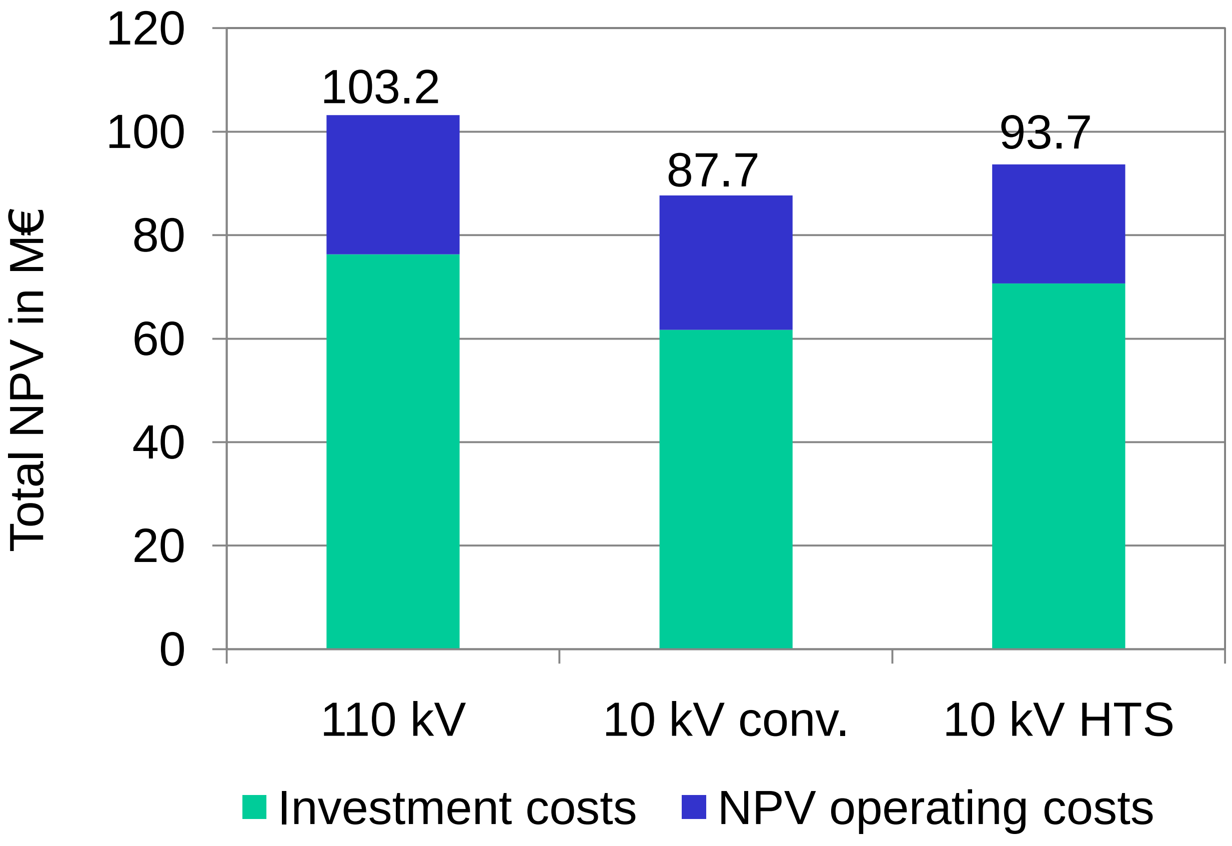
Case Study – Economic Feasibility

- Comparison of 3 different options based on NPV method
- Investment costs and operating costs (maintenance and losses)
- 40 years
- 2 % yearly increase
- 6.5 % interest rate
- 65 €/MWh



Case Study – Economic Feasibility

- Comparison of 3 different options based on NPV method
- Investment costs and operating costs (maintenance and losses)
- 40 years
- 2 % yearly increase
- 6.5 % interest rate
- 65 €/MWh



Combined HTS Cable and Fault Current Limiter Project in Germany

- Motivation
- Application Concept
- Case Study
- **AmpaCity Project**
- Summary

VORWEG GEHEN

AmpaCity Project

Project Objectives

Development and field test of a 1km long 40 MVA, 10 kV cable in combination with a resistive type SCFCL

Project Duration: 09/2011- 08/2015

Cable and SCFCL Installation in 2013

Supported by:

Federal Ministry of Economics and Technology

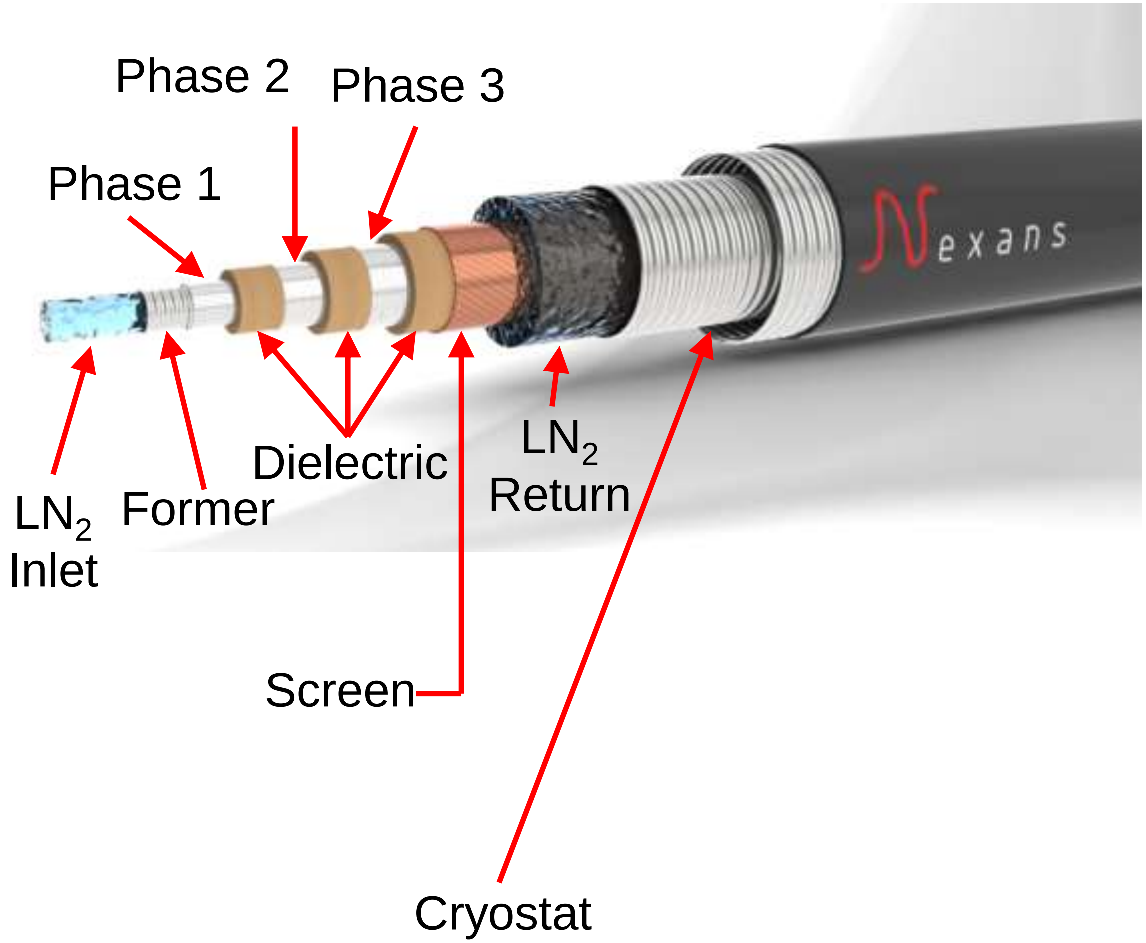
on the basis of a decision by the German Bundestag

Project Partners and Roles

- RWE – Specification and Field Tests
- Nexans – HTS Cable and FCL
- KIT – HTS Material Tests and Characterization

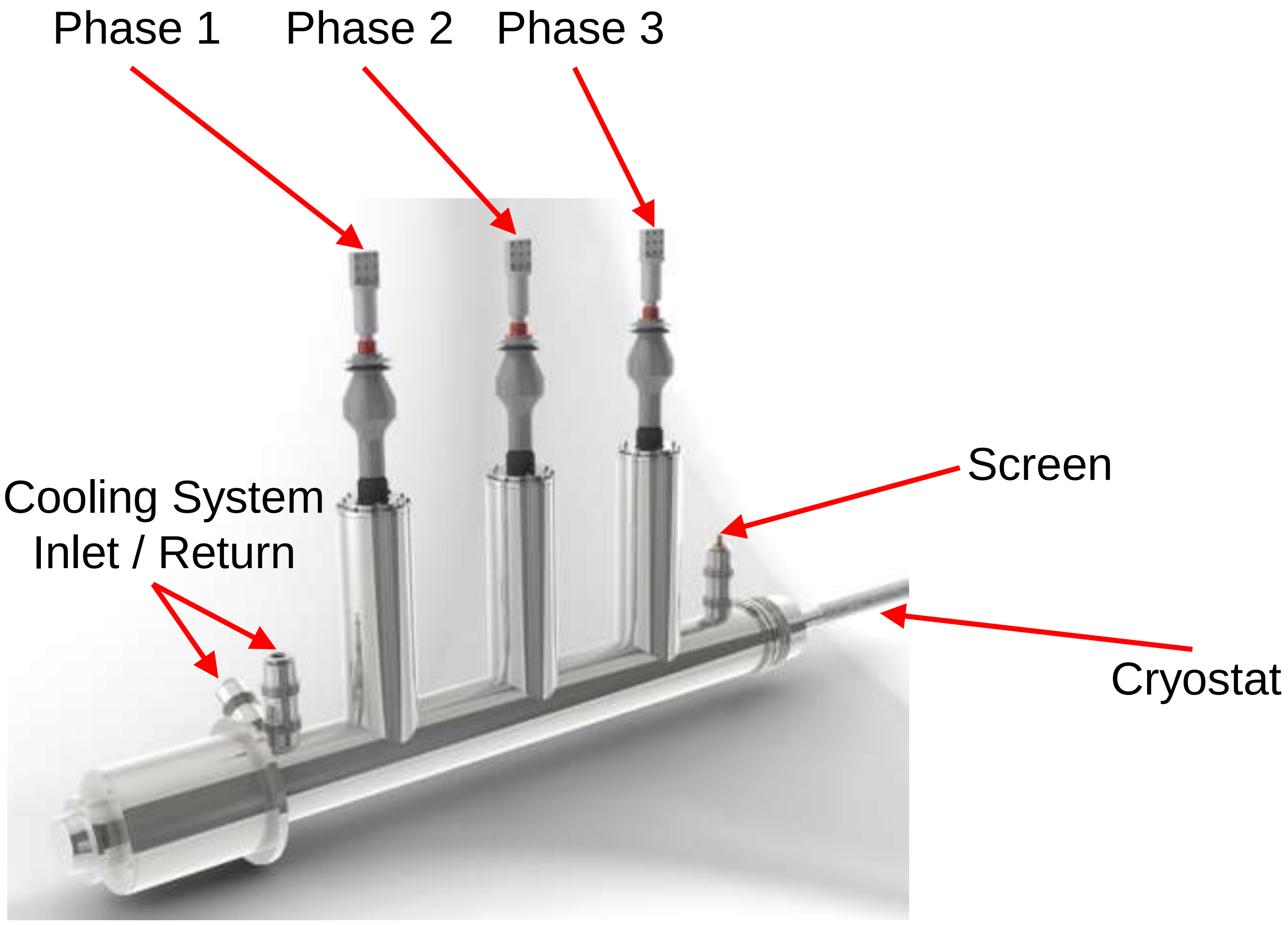
VORWEG GEHEN Nexans KIT Karlsruhe Institute of Technology

AmpaCity Project – Three phase 40 MVA, 10 kV cable concept



VORWEG GEHEN nexans KIT Karlsruhe Institute of Technology

AmpaCity Project – Three phase 40 MVA, 10 kV cable terminal

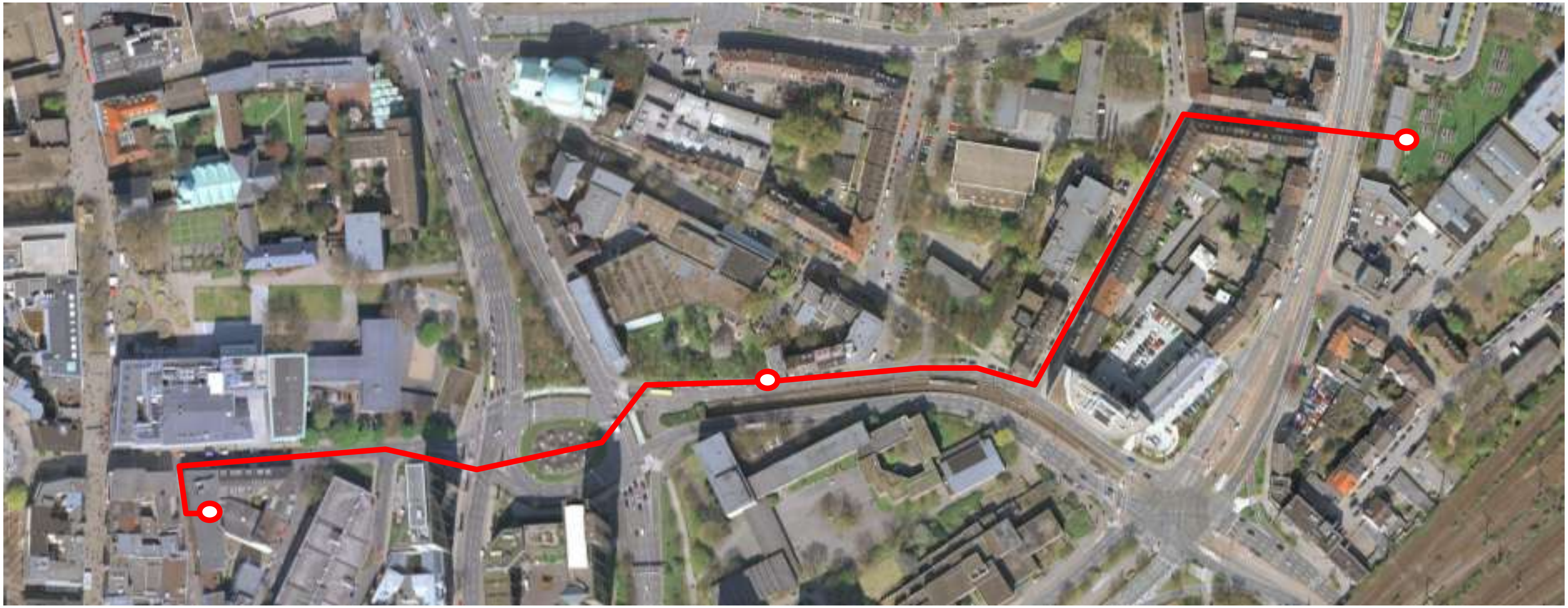


VORWEG GEHEN

Nexans

KIT Karlsruhe Institute of Technology

AmpaCity Project – Installation in Downtown Essen, Germany



- Approximately 1 km cable system length with one joint
- Installation in Q4/2013, afterwards at least two year field test in grid

VORWEG GEHEN Nexans KIT Karlsruhe Institute of Technology

Combined HTS Cable and Fault Current Limiter Project in Germany

- Motivation
- Application Concept
- Case Study
- AmpaCity Project
- **Summary**

VORWEG GEHEN Nexans KIT Karlsruhe Institute of Technology

Summary

HTS systems attractive alternatives to conventional systems

- Replacing HV cable systems with MV HTS cable systems
- Reduction of inner city transformer substations

Concentric HTS cable systems for MV applications

- Very good electromagnetic behavior
- Thermally independent from environment
- Small right of way and reduced installation costs

Enabling new grid concepts for urban area power supply

AmpaCity project in Germany started (HTS cable and SFCL)

VORWEG GEHEN Nexans KIT Karlsruhe Institute of Technology