Combined HTS Cable and Fault Current Limiter Project in Germany

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Combined HTS Cable and Fault Current Limiter Project in Germany

- Motivation
- Application Concept
- Case Study
- AmpaCity Project
- Summary
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
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Capacity of one transformer equals total load in each substation
Application Concept – Medium Voltage HTS Cables I

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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
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

Total Cost

- Investment Cost
- Operation Cost
  - Losses
  - Maintenance

Total Loss

- Power System Loss
  - No-load Loss
  - Load Loss
- Thermal Loss
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

![Bar chart showing total NPV in M€ for 110 kV, 10 kV conv., and 10 kV HTS with investment costs and NPV operating costs indicated separately. The bars for 110 kV, 10 kV conv., and 10 kV HTS have values of 103.2 M€, 87.7 M€, and 93.7 M€ respectively.]

**Total NPV in M€**

- 110 kV: 103.2 M€
- 10 kV conv.: 87.7 M€
- 10 kV HTS: 93.7 M€
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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

Project Partners and Roles
- RWE – Specification and Field Tests
- Nexans – HTS Cable and FCL
- KIT – HTS Material Tests and Characterization
AmpaCity Project – Three phase 40 MVA, 10 kV cable concept
AmpaCity Project – Three phase 40 MVA, 10 kV cable terminal
Approximately 1 km cable system length with one joint
Installation in Q4/2013, afterwards at least two year field test in grid
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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)