Innovative technologies ready for the Supergrid

Electricity Forum, Ljubljana 16 May 2013

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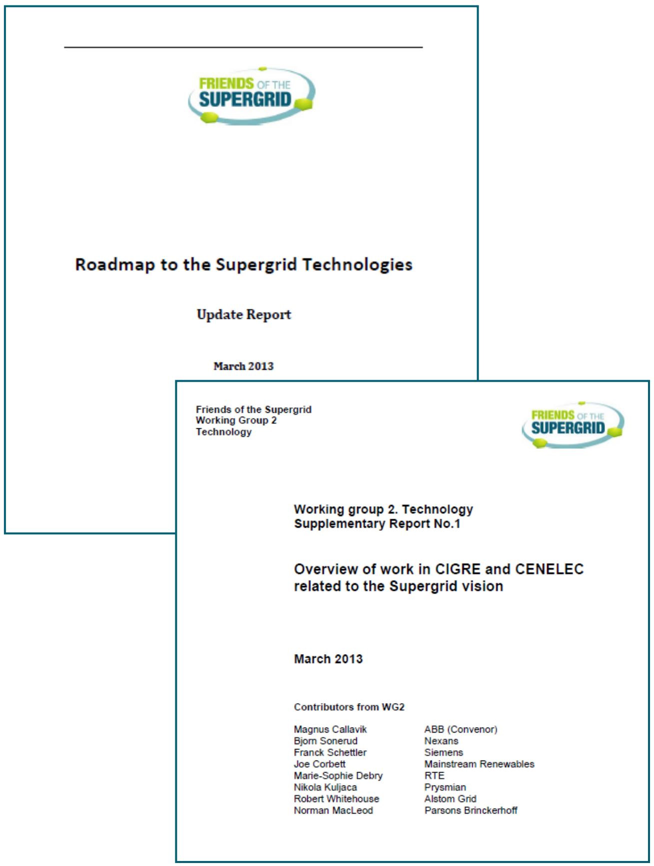
Roadmap to Supergrid Technologies Updates 2013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Roadmap to the Supergrid Technologies

Update Report

March 2013

Friends of the Supergrid
Working Group 2
Technology

FRIENDS OF THE SUPERGRID

Working group 2. Technology
Supplementary Report No.1

Overview of work in CIGRE and CENELEC related to the Supergrid vision

March 2013

Contributors from WG2

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"1st Roadmap Technology" Report in March 2012

1. Applications for Supergrid
2. Network Technologies for Supergrid
3. Scenarios for the Development of Supergrid

Roadmap update March 2013 (*106 pp*)

1. Recent developments in line with the scenario
2. New Sections on
   - Energy storage
   - Supergrid control
   - Relation Microgrid and Supergrid
3. Supplementary report on work in CIGRE & CENELEC (*25 pp*)

Read it – appreciate your comments and suggestions!

Phases for Developing Supergrid

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Today – 2015
(Supergrid Preparation Phase)

- Renewable energy starts replacing older coal fired power plants and nuclear (e.g. Germany)
- Large scale wind parks become connected (500...1,000 MW) near shore using AC; far shore using DC
- **The existing transmission system reaches its limits, planning is underway for system strengthening and expansion**

Studies (examples):
Offshore Grid, Climate Foundation 2050 Road Map, North Seas Countries Offshore Grid, 2050 Electricity Highways, German NEP

2015 – 2020
(Supergrid Phase 1)

- Further development of far shore bulk power wind parks (some 1,000 MW)
- Phasing out of coal fired and nuclear power plants continues in some MS
- **Balancing generation and load calls for stronger system integration on a European level**
- To achieve the required flexibility of power flows and facilitate power trading, offshore wind parks are connected to one another and tapped into cross country links
- A common European Grid Code is developed providing a basis for pan-continental system planning

After 2020
(Supergrid Phase 2)

- **The system integration process is continued leading to a European wide overlay grid.**
- The overlay grid, mainly based on DC, is built to interconnect wind parks and pumped hydro storages in the North as well as large scale solar power plants in the South with the European load centres.
- Trans-continental power transmission is planned to connect to the solar power plants in the African desserts or to Eastern Europe and even Asia.

Recent Key Developments
Technical landmarks during 2012

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- DC current interruption enable planning of the HVDC Supergrid now. Building blocks
  - Hybrid HVDC Breaker and Half bridges
  - Full bridge with fast switches
- Capacity increase in cable factories, ships, production and engineering facilities are announced
  - Gearing up for anticipated larger future volumes
- The number of interconnection and embedded HVDC links in construction increases rapidly with higher power ratings
  - E.g. South-West link SE, EWIP IR-UK, INELFE FR-ES, Western link UK
- FOSG technology members spend every year around 4% of their turnover on R&D: large part on transmission

Why now. Key success factors

- Large-scale utilization of renewable energies on an European level and a common electricity market require European transmission system integration (system planning & construction, regulation, operation)

- Technology is not a show-stopper. Large-scale utilization of renewable energy will lead to development of the competitive supply chains in the field of HVDC and offshore grids

- Funding schemes are an important contribution to drive the development of innovative transmission solutions, which are a key factor for the European industry
  - Europe accommodates the market leaders in HVDC
  - Europe has a large installed base
  - Europe experience a rapid development of production facilities

Development Roadmap.
Key achievements ticked in “year 1”

2012 – 2015
(Supergrid Preparation Phase)

√ **Increased power ratings for VSC (1,000 MW at 320 kV DC)**

√ **Demonstrators for DC side fault clearing (e.g. DC Circuit Breakers)**

√ **MI-PPL 600kV (1.1GW per cable) developed and higher voltages in development**

√ **Standardization work for HVDC grids in CIGRÈ, CENELEC started**

√ **AC GIL in operation**

- DC 320 kV cables with extruded insulation in operation at different onshore and offshore projects (500 MW per cable)
- DC cables with extruded insulation >320 kV developed
- MI >500 kV cable developed

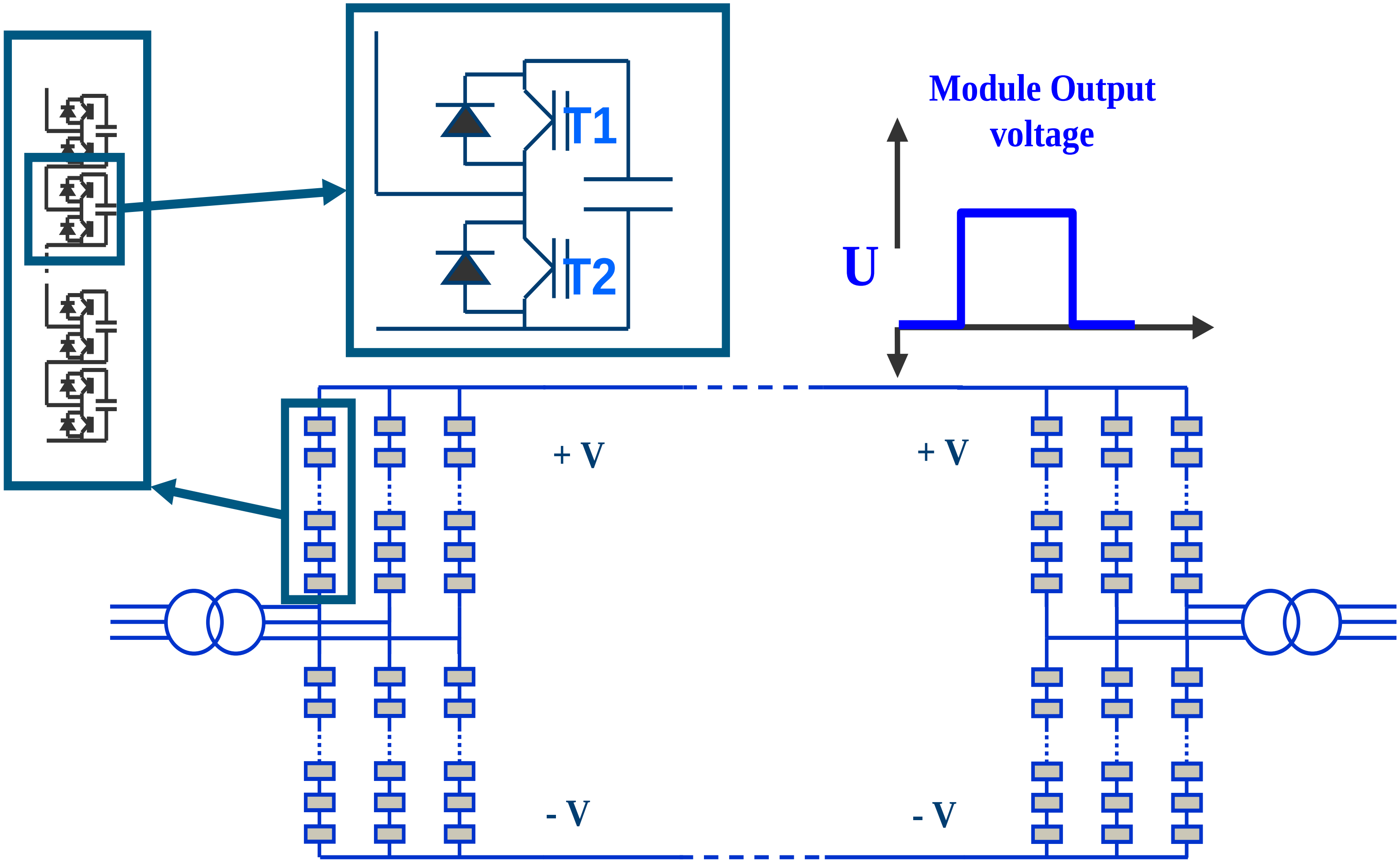
2015 – 2020
(Supergrid Phase 1)

- DC cables with extruded insulation >320 kV in operation
- MI-PPL 600kV cable in operation
- MI >500kV in operation
- Development of new extruded insulation compounds for HVDC cables
- System for fast selective fault detection in HVDC networks
- DC side selective fault clearing and system reconfiguration
- Hierarchical control architecture for integrated AC and DC Grid in Europe
- Demonstrators for DC/DC Converter

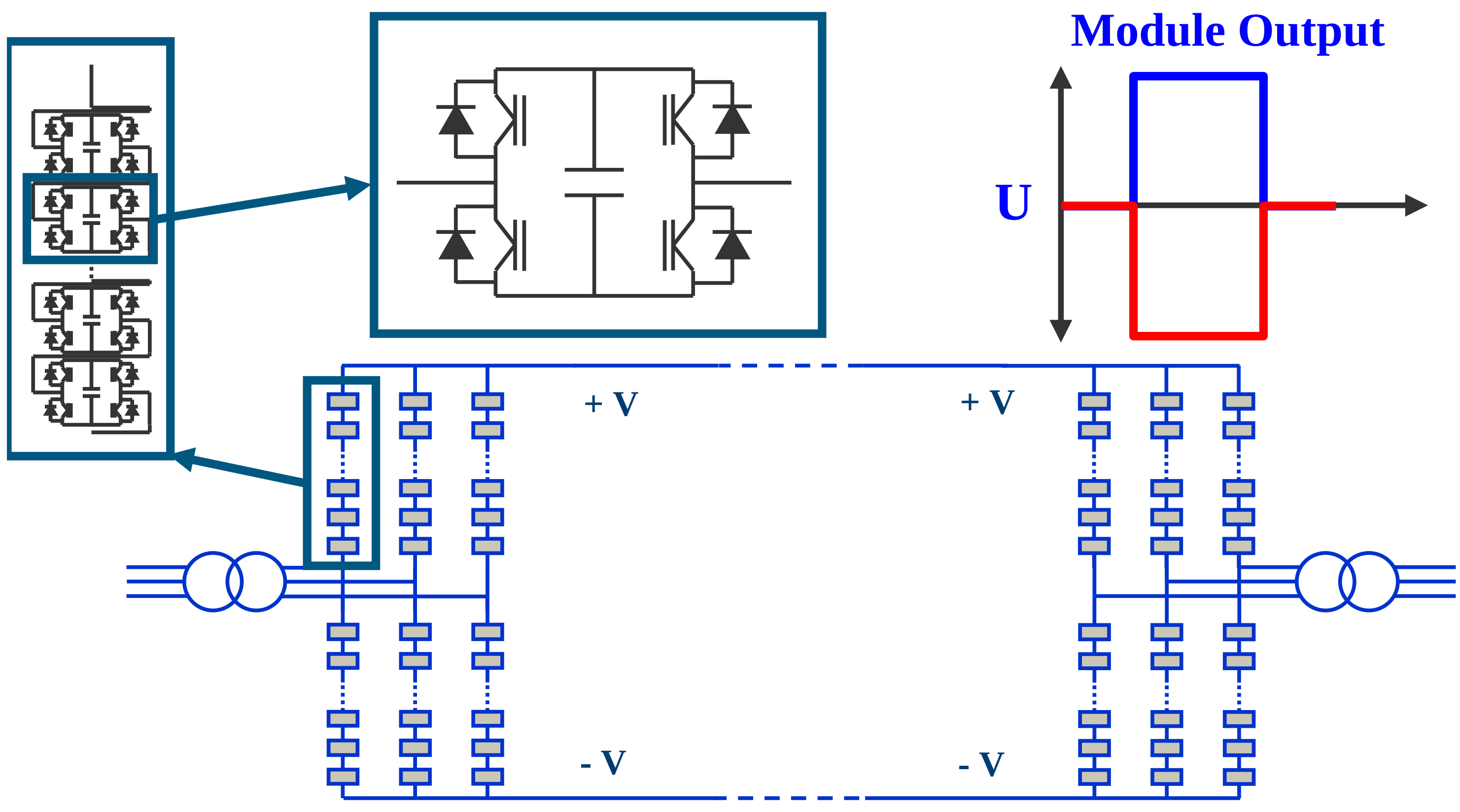
After 2020
(Supergrid Phase 2)

- Further Development of MI and MI-PPL Cables
- HVDC cables with new extruded insulation compounds in operation
- Superconducting cables
- DC GIL
- DC/DC converter

Half bridge VSC: Technology used in >20 projects in operation or construction

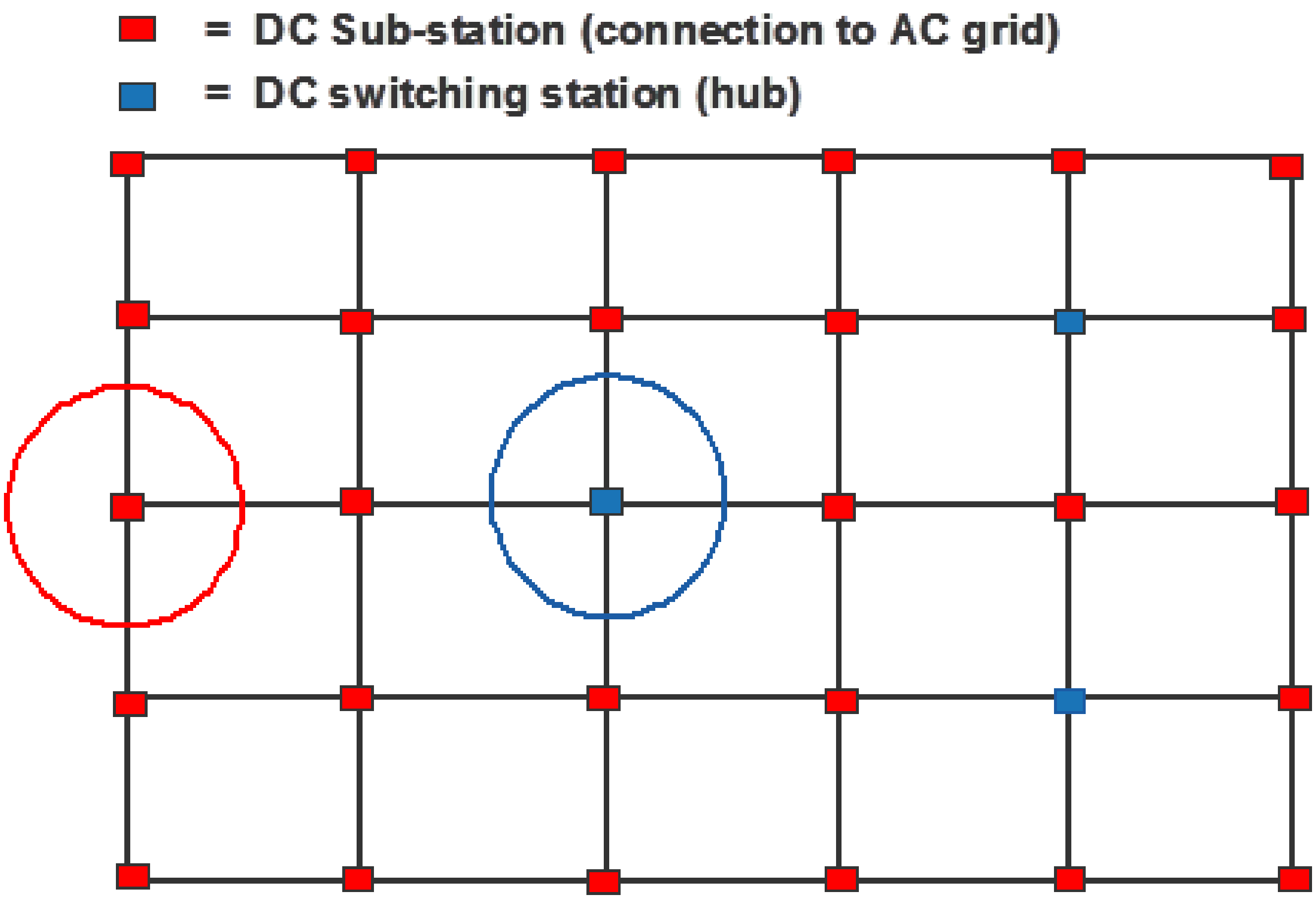


Full Bridge VSC: Alternative approach for blocking DC faults by the converter



Meshed HVDC Grid system

Here breakers are needed to isolate faults on the DC side from the remaining healthy parts



In a future power network with a high density of DC converter station it is logical to connect them also on the DC side to have a combined AC and DC transmission grid

The Hybrid HVDC Breaker

Announced in Nov 2012


MIT Technology Review

10 BREAKTHROUGH TECHNOLOGIES 2013

Supergrids

A high-power circuit breaker could finally make DC power grids practical.

By Kevin Bullis on April 23, 2013

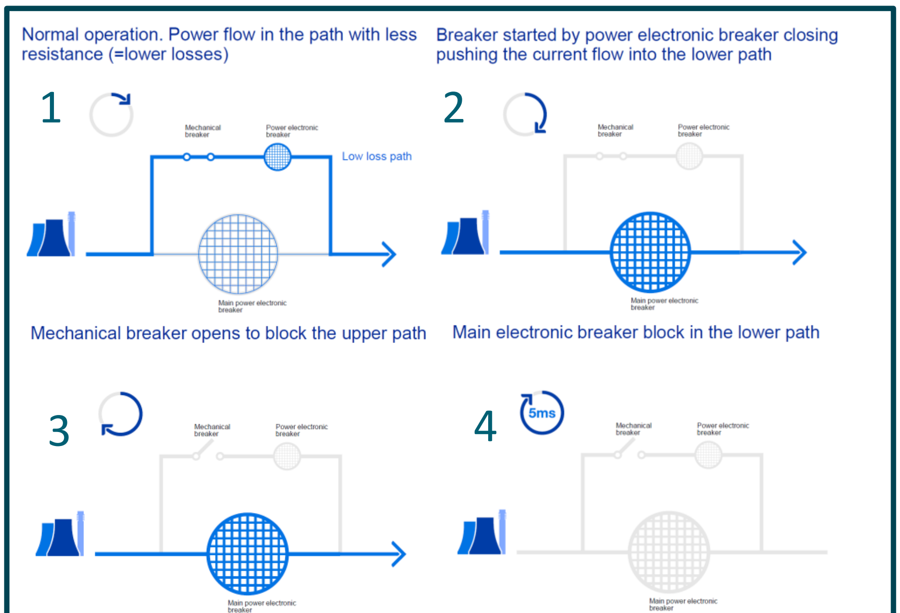


Image by ABB

- Selected by *MIT Technology Review* as one of ten breakthrough technologies 2012. “The high power breaker makes the HVDC power grids practical. ... The Supergrid is a key to sustainable economic growth”
- The Hybrid path enables a dramatic reduction in losses and operation below 5 millisecond
- Also available as a pure semi-conductor design with breaking operation below 1 millisecond, but with higher losses

DC Breaker model

Several manufacturers have reported successful HVDC breaker tests results

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Image by Alstom

Full Bridge Converters -

Most Powerful and Flexible Solutions for Transmission

Main Features:

- Inherent DC turn-off capability
- Independent DC Voltage control for:
  - Load flow control in extended DC Grids
  - DC fault current control
  - Unlimited number of fast and smooth DC Voltage recoveries after faults
- Broad experience in 74 Industrial and Energy applications in operation or in project execution (April 2013)

Full Bridge MMC as already used for power frequency conversion and reactive power compensation in Industry and Energy applications. (Image by Siemens)

Material for downloading at www.FriendsoftheSupergrid.eu

- Roadmap to the Supergrid technologies revision 2013
- Supplementary report #1 on Activities at CIGRE & CENELEC
- This presentation

Thank you for the attention!

The Friends of the Supergrid

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3E

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