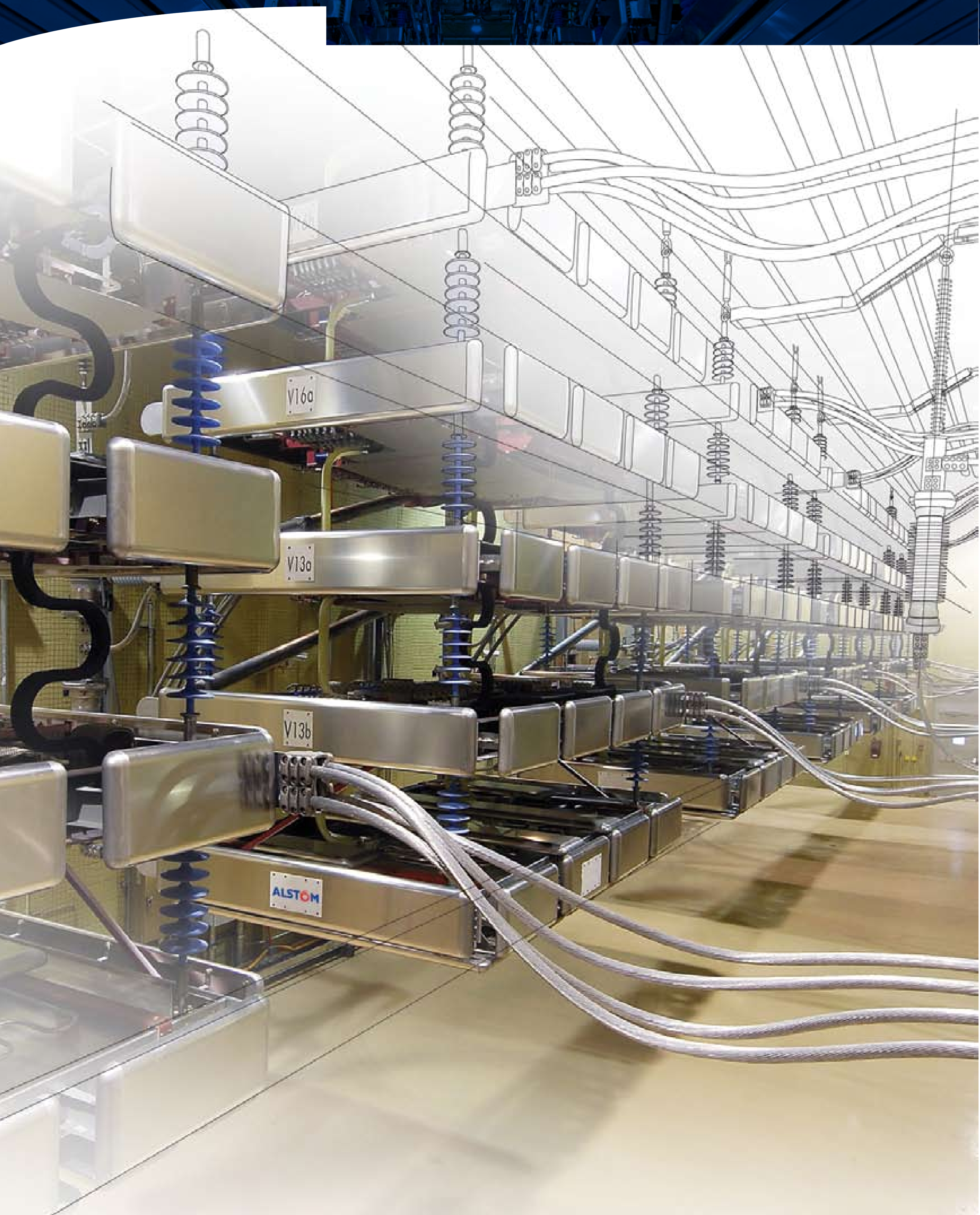
Effective HVDC solutions

up to 800 kV

GRID

we are shaping the future

ALSTOM



EFFECTIVE HVDC-LCC SOLUTIONS

Innovation and efficiency

High Voltage Direct Current is all about making existing power grids efficient. In a world consumed by cost-cutting yet obliged to improve environmental impact, HVDC is the answer to one of the biggest challenges faced by energy managers: move more power, more efficiently, with the lowest losses possible.

Staying ahead of the curve

With land costs becoming more and more expensive and new right-of-way access permits nearly impossible to obtain, the only choice for many utilities is to restructure their grid systems. Utility managers will have to look ahead to the future and anticipate their needs for the next 20 to 50 years.

Taking advantage of new technological advances for energy transmission, the use of HVDC systems up to 800 kV offer a giant step forward in increasing grid capacity without restructuring or building an entire new network.

Global expertise based on decades of experience

Alstom Grid is a major supplier of turnkey HVDC solutions for efficient power transmission worldwide. We offer complete project management—from network analysis and design, to commissioning and even operation—for any type of HVDC connection. Our project management teams handle all your needs including feasibility studies and economic evaluation, all equipment procurement, civil works, and overhead or submarine cables.

Alstom Grid - Architects of your engery-efficient future

Expert HVDC design engineers create the most optimised solutions for your network based on your present needs and in anticipation of future growth. All HVDC solutions are based on a project-by-project assessment, whether it's for long distance power transmission, energy trading between independent networks or connection between asynchronous grid structures.

At the forefront of HVDC innovation

Continuous improvement is at the heart of all Alstom Grid research and development projects. Driven by our global HVDC Competency Centre in Stafford, UK, and our Ultra High Voltage test laboratories in China, our engineering teams around the world bring unparalleled experience to your projects.

In cooperation with major teaching universities, utility owners and industry partners, we are constantly investing in future technological advances to create new, innovative processes. Our goal: to make your network safer, more efficient and more profitable.

Alstom Grid's fields of expertise From evaluation to operation:

- Network analysis
- Feasibility studies
- Design and engineering
- Turnkey project management
- Managed energy trading
- HVDC and FACTS schemes
- HVDC converter transformers
- Full digital control based on high performance controller
- Power electronics based on thyristor valves of up to 150 mm, 8.5 kV thyristors
- Installation, commissioning and testing
- Training and maintenance

WHY HVDC?

Al Fadhili, Saudi Arabia GCCIA HVDC interconnection

HVDC has important advantages in today's energy business world that make it a superior choice for upgrading existing AC transmission systems or for building new power highways.

From generation point to end-user, HVDC is more energy efficient over long distances. Because HVDC has lower losses than AC transmission, it means producing less energy and less CO2.

More power per tower—By running Direct Current (DC) instead of Alternating Current (AC) across the same towers and lines, it is possible to transmit up to three times more megawatts in the same right-of-way. When the acquisition of new ROW permits becomes impossible in highly populated areas, HVDC is not just an option: it's the ideal solution!

HVDC = Greater Controllability

One of the inherent challenges with AC networks is power control. When an HVDC link is embedded in an existing AC network, it allows the transmitted power to be 'dialled up' and even modulated in response to inter-area power oscillations. HVDC dramatically improves power flow controllability in the interconnected networks. The only way to interconnect two asynchronous AC systems is by using HVDC. Dynamic reserve power sharing becomes possible across two AC networks with different frequencies when HVDC converter substations are added to the system—which means cutting standby power consumption in half. HVDC is a firewall against faults. In a cascading AC fault, an HVDC interconnection stops the propagation.

Sellindge, UK: France UK submarine interconnection

Technical HVDC advantages:

- The HVDC power flow is fully controllable, fast and accurate. The operator or automatic controller determines how much power flows via the link.
- An HVDC link is asynchronous and can adapt to any rated voltage or frequency at reception. The HVDC link can be used to assist the AC networks at each end of the link (e.g power system damping).
- HVDC links do not increase the systems short circuit level and faults can not transfer across HVDC interconnected systems.
- HVDC can transport energy economically and efficiently over long distance than AC lines or cables and, in a fixed corridor, HVDC provides increased tranmission capacity.
- Large HVDC schemes (5000 MW – 6400 MW) are used to access remote hydro power resources, hence renewable energy with no CO2 emissions.
- HVDC is more economical than HVAC for schemes with transmission distances longer than 700 km.

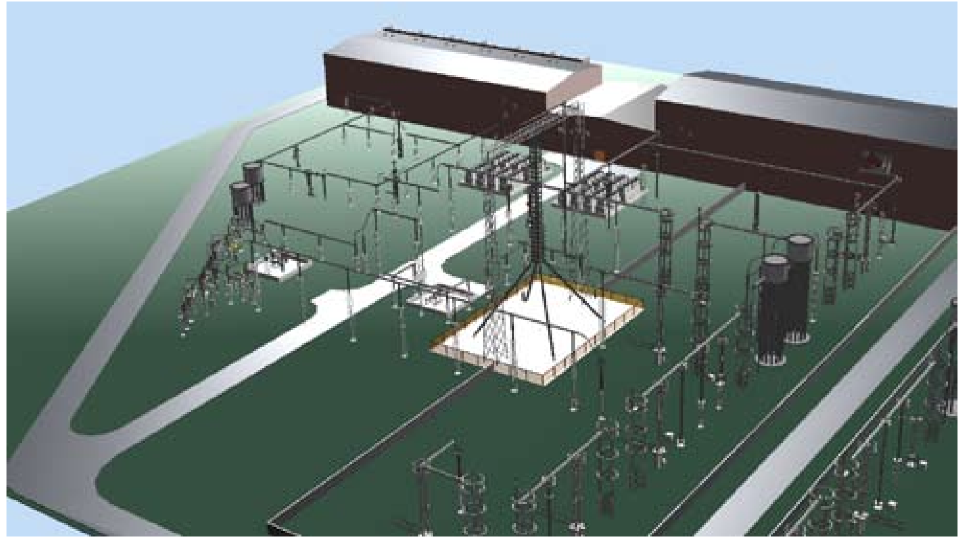
Our technology allows you to efficiently control your network.

EXPERTISE THAT GOES BEYOND STATE-OF-THE-ART

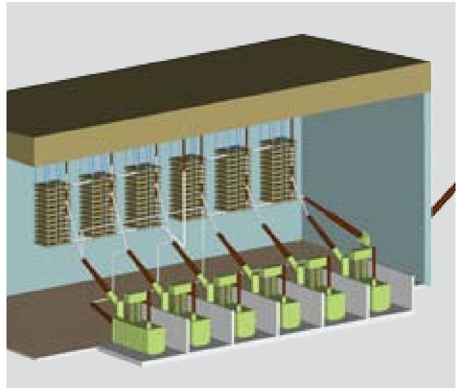
Alstom Grid is staying ahead of the curve. We have refined our best products and systems and successfully tested our equipment to 800 kV. With over a half-century of HVDC experience to build on, combined with investments to support the new designs and testing techniques necessary to make Ultra High Voltage DC transmission a reality, our expertise will help our customers around the world to unclog their grids and reduce transmission costs while delivering a reliable energy to end-users.

The land requirement for 800 kV UHVDC is reduced by two compared with standard HVDC transmission, reduced by four for UHVAC transmission and by five for conventional AC transmission.

Regardless of the source (hydro, thermal or nuclear) UHVDC presents efficient and cost effective transmission of very high levels of remotely generated power over very long distances to the load centres.



800 kV 3D Model



Upper voltage valve hall 400 to 800 kV

UHVDC advantages

- 800 kV DC reduces overall transmission losses
- The right-of-way land requirement for an ±800 kV, 6400 MW UHVDC scheme is about half that required for 2 off 500 kV parallel HVDC or about one fifth of that required for 5 off ±500 kV parallel HVAC alternatives.

INNOVATIVE SOLUTIONS

The H400 thyristor valve for 800 kV

Thyristor valves are the heart of any HVDC installation. The latest version of Alstom Grid's HVDC thyristor valve is the H400. These high power density valves use series-connected, fully protected thyristors, each having a diameter of 150 mm (6 inches). The thyristor valves are controlled by Alstom Grid's industry leading Series V digital control and protection system, offering fully redundant operation, including monitoring and alarm capabilities. Due to the higher 800 kV DC voltages, new corona shields have been built and tested in our HVDC Competency Centre's design and test laboratories in Stafford, UK.

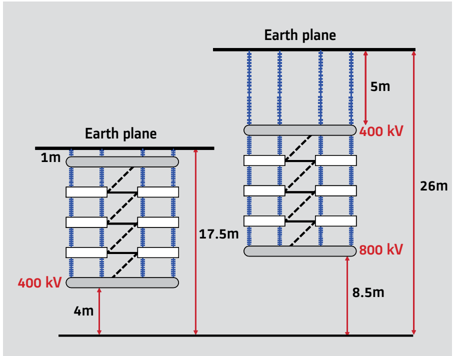
Alstom Grid has existing experience with series connected converters for voltages up to 500 kV DC. For 800 kV, switched blocks of equal sizes are recommended – allowing for common transformer designs, maybe with different valve winding bushings – which would be more economical and more useful to the operator (spare parts, etc). Such a topology also enables a scheme to be built in two stages, if required.

Alstom Grid UHVDC technology choice: 2 x 12 pulse series connected converters per pole

The fundamental transformer frequency rating of approximately 320 MVA permits transport to generation end without difficulty. Valve design would be common throughout and voltage ratings within current expertise. The maximum bypass switch voltage is 400 kV and a converter trip removes only 1600 MW in a bipole with a rating of 6400 MW.

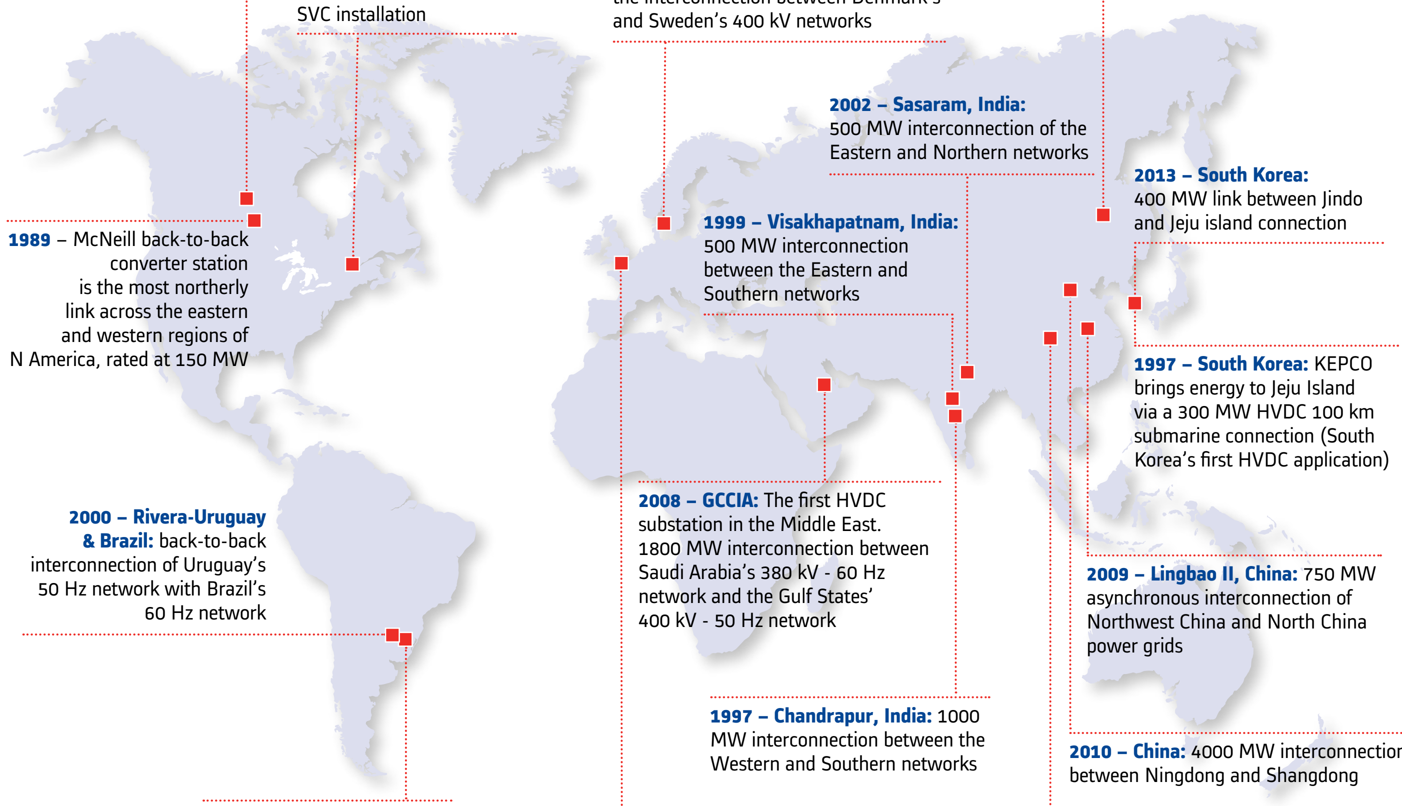
UHVDC valve hall design

The valve hall will house valves split into two complimentary sections. The lower section will manage 0-400 kV and the upper section, 400 kV-800 kV.



Lindome Sweden : converter substation part of the Konti-Skan HVDC interconnection between Denmark and Sweden

ALSTOM GRID: A GLOBAL REFERENCE FOR HVDC SOLUTIONS



1993 – From Mercury Arc to state-of-the-art thyristors, Canada's Manitoba Hydro upgrades their Nelson River 334 MW HVDC transmission project with long-term partner Alstom Grid

2009 – China: in cooperation with CEPRI for the supply of HVDC valves for the 750 MW Sino-Russian interconnection

2008 – Hydro-Quebec's 300 MW transformable AC transmission line deicer and SVC installation

2006 – Konti-Skan: first turnkey project utilizing H400 thyristor valves for the interconnection between Denmark's and Sweden's 400 kV networks

2002 – Sasaram, India: 500 MW interconnection of the Eastern and Northern networks

2013 – South Korea: 400 MW link between Jindo and Jeju island connection

1989 – McNeill back-to-back converter station is the most northerly link across the eastern and western regions of N America, rated at 150 MW

1999 – Visakhapatnam, India: 500 MW interconnection between the Eastern and Southern networks

1997 – South Korea: KEPCO brings energy to Jeju Island via a 300 MW HVDC 100 km submarine connection (South Korea's first HVDC application)

2000 – Rivera-Uruguay & Brazil: back-to-back interconnection of Uruguay's 50 Hz network with Brazil's 60 Hz network

2008 – GCCIA: The first HVDC substation in the Middle East. 1800 MW interconnection between Saudi Arabia's 380 kV - 60 Hz network and the Gulf States' 400 kV - 50 Hz network

2009 – Lingbao II, China: 750 MW asynchronous interconnection of Northwest China and North China power grids

1997 – Chandrapur, India: 1000 MW interconnection between the Western and Southern networks

2010 – China: 4000 MW interconnection between Ningdong and Shangdong

2011 – Melo-Uruguay & Brazil: 500 MW back-to-back interconnection of Uruguay's 50 Hz network with Brazil's 60 Hz network.

2013 – Rio Madeira, Brazil: this 600 kV point-to-point interconnection will be the world's longest HVDC transmission scheme (2,375 km)

2010 – China: 3000 MW interconnection between the Three Gorges Dam and Shanghai

2011 – IFA 2000: renovation and upgrade of the France - UK 2000 MW interconnection, the world's highest rated submarine HVDC link

In The Future

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South Korea: 400 MW link between Jindo and Jeju island connection

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