GE
Grid Solutions

What should it be? FACTS or HVDC?

When energy network managers around the world consider upgrading an inefficient or out-of-date alternating current transmission network, power electronics applications provide efficient solutions. This paper highlights considerations for evaluating and selecting the optimum solution.

Imagination at work

What Matters?

To determine the optimum solution, identifying what matters is a critical first step. Flexible Alternating Current Transmission Systems (FACTS) can improve a transmission system and High Voltage Direct Current (HVDC) solutions can upgrade a system. In addition, many variables need to be considered: resistive losses are important but the scheme's footprint, infrastructure costs and visual impact will also have major impacts.

It's Not Only a Question of Cost

It is worth comparing High Voltage Alternating Current (HVAC) solutions with or without FACTS, versus HVDC solutions. The overall purchasing and installation costs are to be considered carefully, but technical experts also look to appease the real estate manager, and are careful not to overlook the visual impact the transmission system will have on local residents.

Comparison Model

A transmission schemes comparison model has been designed to illustrate the options available using four different types of transmission schemes between a hydro power plant and a city.

In this model, the transmission scheme is carrying 6,000 MW of electricity for a distance of 1200 km. 500 kV AC is used as a baseline comparison.

Criteria taken into consideration include:

- Resistive losses
- Installed footprint (width of right-of-way)
- Visual impact
- Infrastructure costs

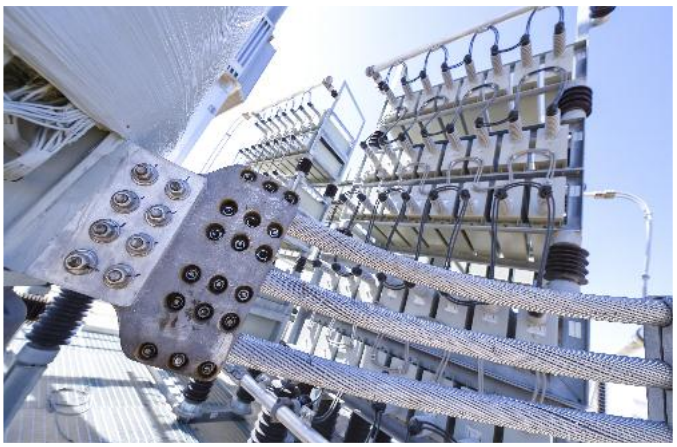
Comparison Model Results

Results of the consideration criteria in the transmission comparison model.

Transmission Type	Resistive Losses (%) (transmitting 6,000 MW)	Number of Overhead Line Sets	Right-of-Way (m)
500 kV AC	12.67	7	427
765 kV AC (with FSC)	10.61	2	150
±500 kV DC	7.62	2	100
±800 kV DC	4.96	1	50

FACTS Solution

The transmission of reactive power leads to significant voltage drops and current increases in the network, which can limit the transmission capacity of active power and increase losses. Increasing the active power capacity of an existing transmission line with fixed series capacitors (FSC) will improve the efficiency of the power plant, because it has to produce less reactive power and will also reduce the consumption of primary fuel. As a consequence, more active power can be transferred via the transmission lines.



Fixed Series Compensators Installed In The Kingdom of Saudi Arabia

Key Benefits

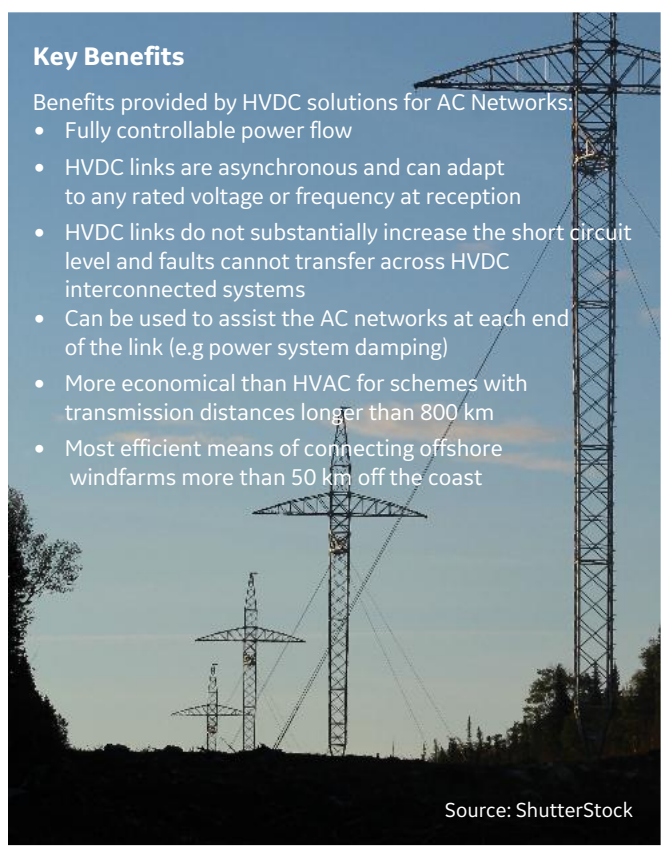
Benefits provided by FACTS solutions for AC networks:

- Increase power transmission capacity
- Improve power system transient and steady state stability
- Improve voltage profile of the lines and reduce voltage drops caused by loads
- Optimize power flow and allow load sharing between parallel lines
- Reduce transmission losses
- Reduce significantly the need for power generation or transfer line investments
- Save on dimensioning of power lines
- Maximize power transmission and minimize active and reactive power losses

HVDC Solution

±500 kV HVDC has important advantages in today's world that make it a superior choice for upgrading existing AC transmission systems or for building new power highways. One of the inherent challenges with AC networks is power control. When a HVDC link is embedded in an existing AC network (Line Commutated Converters or Voltage Source Converters), 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 inter-connected networks. The only way to interconnect two asynchronous AC systems is by using HVDC.

±800 kV HVDC is a highly efficient means to transport 600-800 kV energy over long distance lines or cables. Also, in a fixed corridor, HVDC provides increased transmission capacity. Large HVDC schemes (5,000 MW – 6,400 MW) are generally used to access remote hydro power resources, hence renewable energy with no CO_2 emissions. With ±800 kV UHVDC, transmission losses are under 5% and the width of the right-of-way is greatly reduced at only 50 meters. The physical footprint, infrastructure costs and visual impact are also greatly reduced compared to traditional 500 kV AC transmission systems.



Key Benefits

Benefits provided by HVDC solutions for AC Networks:

- Fully controllable power flow
- HVDC links are asynchronous and can adapt to any rated voltage or frequency at reception
- HVDC links do not substantially increase the short circuit level and faults cannot transfer across HVDC interconnected systems
- Can be used to assist the AC networks at each end of the link (e.g power system damping)
- More economical than HVAC for schemes with transmission distances longer than 800 km
- Most efficient means of connecting offshore windfarms more than 50 km off the coast

Source: ShutterStock

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Photography: HVDC Line installed in Canada. Source ShutterStock

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