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HVDC: Back to the Future

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THERE ARE ABOUT 80 HVDC PROJECTS THAT ARE EXPECTED TO BE COMPLETED BY 2020, A TRUE BOOM WITH IMPORTANT ENVIRONMENTAL REPERCUSSIONS

The future began in Gotland in 1950.
It is here, between this island 90 kilometres off the coast of Sweden and the mainland, that the first direct current connection for the transmission of electricity was made. Though limited in size and power, the project has had enormous resonance. In fact, the prototype developed by ABB showed the world that transmitting energy in HVDC is possible. The technology is there and it works.

Since then it took almost fifty years of research and studies far from the spotlight to refine the technology and materials to the point that HVDC is not only feasible and ever more reliable, but also economically viable.

The break-even point was reached in the late 1990s. Since then, experimental projects and significant investments continued and the technology made substantial leaps forward thanks to the increasing number of concrete projects and the competitive market that was being created. There are about 80 projects using HVDC that are expected to be completed by 2020, a true boom with important environmental repercussions.
The Future will defenitely include HVDC.

HVDC: the reasons for its success

Most of the projects in the pipeline have a common fundamental characteristic: the need to link areas that are very far apart, separated, for example, by the sea as in the case of Gotland. At one end of the network there is an area with a major source of energy. At the opposite end is an area with a big need for that energy, such as densely populated urban areas with very high rates of energy consumption.

When compared to a traditional alternating current network, HVDC makes it possible to carry a higher amount of energy while greatly reducing the losses. Overall, efficiency and performance are much higher. These characteristics make it clear why this technology is ideal for infrastructure projects many developing countries have rolled out to ensure their people have access to modern forms of energy, that can speed up development and growth.

While this is certainly the main reason HVDC has become one of the technologies of future reference, there are other advantages that should not be forgotten.

For example, compared with alternating current, HVDC improves a network's safety. HVDC makes it possible to isolate the section of the network where a malfunction occurs, limiting, if not preventing entirely, the danger that a black-out spreads.

HVDC MAKES IT POSSIBLE TO CARRY HIGHER AMOUNTS OF ENERGY, WHILE REDUCING THE LOSSES

There are positive aspects also on the environmental front. The same amount of energy can be carried in smaller right-of-way and overhead lines. This translates into a smaller direct impact on the ecosystem of the territory crossed by the lines. The overall optimisation of the production process, transmission and distribution also allows for a significant reduction of CO_2 emissions. In addition, since there are no sine waves there are no magnetic fields. Very often, long distance HVDC interconnection projects are linked to energy produced from renewable sources. Without this technology it would be impossible to contemplate realising the projects that aim to exploit the massive solar energy in North Africa or the wind in Northern Europe.

Thanks to all these characteristics, the acceptance of HVDC is higher than other technologies and the permitting process is easier and faster.
Finally, if we want to look at this technology from a political point of view, the introduction of a HVDC system is a prerequisite for a progressive integration of electricity markets and the creation of a single market.

THIS TECHNOLOGY IS IDEAL FOR INFRASTRUCTURE PROJECTS MANY DEVELOPING COUNTRIES HAVE ROLLED OUT TO ENSURE THEIR PEOPLE HAVE ACCESS TO MODERN FORMS OF ENERGY

In Europe, as well as in Latin America and the Middle East, the benefits of interconnections that cross national borders are becoming more evident. Often, however, different countries have networks that work with different voltages or frequencies, making integration complex. The use of HVDC makes it possible to overcome these differences without having to modify the parameters of the different systems.

Worldwide Investment in Transmission System

€ 6/8 billion per year until 2020

	Germany	China	Brazil	Middle East
electricity grid	**35,085 km**	**962,000 km**	**104,929 km**	**89,835 km**
Installed (transformer capacity)	**152.24 GW**	**3,538 GW**	**219.9 GW**	**310.8 GW**

Sources: **elaboration based on the Transmission Global Report 2011**

A cutting-edge technology becomes the norm

As we have seen, there are many solid reasons to believe in and invest in the development of HVDC.

Today though the world is still crisscrossed by a dense network in alternating current. While the recent development of direct current has been rapid, it remains a niche technology adopted above all to connect isolated areas or different countries. If direct current is going to become the standard in the future there must be a gradual standardisation of the technologies it uses.

THE GOAL OF GETTING DIRECT CURRENT ACCEPTED IN THE MAINSTREAM WOULD BE FACILITATED BY THE ESTABLISHMENT OF INDEPENDENT LABORATORIES

It is in fact the designation of internationally recognised regulatory parameters that open the way for a technology to jump from being in the avant-garde to being widely embraced. This is exactly what happened in the past with alternating current. The goal of getting direct current accepted in the mainstream would be facilitated by the establishment of independent and authoritative laboratories that could test new components developed by those working in the industry. To date the only recognised independent organisation that aims to define key norms for HVDC is the CIGRE (Conféderation Internationale Grand Réseaux Electriques), though its findings are non-binding pre-standard recommendations.

Yet it is absolutely fundamental, for utilities that must make huge investments to build out infrastructural projects, to be able to obtain the certification of an impartial institution that outlines the real capabilities of products billed as meeting the specific needs of a project. This is precisely the goal CESI has set for itself – to be a partner that utilities can turn to as they choose which technologies, systems and models are best for them as they build out infrastructure projects.

This is a daunting task for laboratories considering the breadth of factors that must be confronted during testing.

Each project is a new challenge. From time to time, for example, the various elements – above all the cables – are subjected to different environmental and climatic conditions. In general, the bar for the level of voltage seems to always be rising – today it is from ± 600 kV / ± 800 kV. In underwater projects, maximum attention must be paid to the pressure and mechanical stress, while at the same time the cables' response to the different temperatures they are expected to be subjected to must be tested.

In a situation always in rapid evolution, the key factor is precisely the correct definition of the methodology and specifications used in the tests. This is a role that can only be played by accredited and independent laboratories, which in time accumulate a sufficient amount of experience regarding very different products in specific test conditions. CESI, which has more than 50 years of experience testing high voltage parts, has what it takes to be the market leader in HVDC testing.