The New Frontier for Grids

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ELECTRIC ENERGY TRAVELS FROM ONE END OF A NATION TO ANOTHER AND BETWEEN INTERCONNECTED NATIONS. NETWORKS NEED TO RESPOND TO INCREASINGLY HIGH EFFICIENCY STANDARDS, AND SUSTAIN TRANSMISSION OF INCREASINGLY HEAVY POWER. GERMANY IS LEADING THE WAY IN EUROPE, BUT CHINA AND INDIA ARE THE TRUE FRONT-RUNNERS

Forecasts generally call for worldwide electricity demand to grow to nearly 32,000 TWh by 2035. The trend is to deliver bulk quantities of electric energy from renewables power generation plants that are typically far away from consumption centers and therefore need networks that can carry power across long distances.

In Asia, where four to six GW needs to be transmitted for over 3,000 km, the common choice is to increase ratings and achieve a voltage level greater than 1,000 kV (UHV AC and DC in China & India). In Europe, on the other hand, distances are shorter and/or there is less power to be delivered, so the preference is to maintain far lower voltage levels (HV & EHV: 400 kV AC and 5-600 kV DC).

A large amount of new T&D lines and substations will have to be installed over the next decade, while existing capacity will be upgraded, with utilities pushing component manufacturers to fulfill demand quickly. But speed cannot come at the expense of safety and reliability.
Major outages demand implementation of more stringent regulations in many countries, and these situations push utilities to rely on proof from testing as a way to demonstrate their due diligence in choosing equipment and technologies.

Transmission System Operators (TSOs) search for innovative solutions in developing the transmission grid and, as a result, it is likely that the application of extra and ultra high voltage AC and DC transmission systems will increase considerably over the coming years. But for now UHV projects per year are limited in numbers (3-5) compared to both terrestrial and submarine HV and EHV projects (40-80).
This creates a very different market situation, with a niche market for 800 to 1200 kV tests on equipment, while the most important market is in the HV – EHV sector (220-600 kV) for both AC and DC.
Recently a higher number of XLPE cable systems have also been introduced into HV networks, and more are planned for the future.

Improvements in T&D

The benefits of being able to transmit huge amounts of energy through overhead lines or cables cannot be overlooked. Bulck power generation centers are typically far away from consumption centers and there is an increasing need to carry power across long distances.

In Europe, Germany's energiewende, or energy switch, provides a perfect example of this new energy scenario. The biggest problems are going to be for the electricity network, which was designed to carry nuclear electricity from south to north and not renewable electricity from the coast.

Germany's nuclear power plants were built near its industrial centers, and electricity flowed locally or regionally. German network providers forecast that replacing them with offshore wind parks will require hundreds of km of overhead transmission lines to be built – 3,800 km by 2022; plus an additional 1,600 km of lines that have been mapped out but not yet built – for a cost up to 20€ billion over the next decade.

TRANSMISSION SYSTEM OPERATORS (TSOS) SEARCH FOR INNOVATIVE SOLUTIONS IN DEVELOPING THE TRANSMISSION GRID

While Germany is undoubtedly the most advanced country in this sense within the European panorama, the most avant-garde projects are being realized elsewhere in the world. Today China and India are the ones betting most heavily on these technologies, thanks to their strong economic growth and constant increases in energy consumption.
In August 2006 China's National Development & Reform Commission approved the realization of a 1,100 kV AC line with a transformational capacity of 6,000 MVA. Voltage is merely one of the records this line is setting: it is 650 km long, and several stretches of the infrastructure cross the Yellow and Hanjiang Rivers. In January 2009, just three years after it was approved the relevant UHC AC stations became operational.

Today India is aiming even higher, realizing various sections of 1,200 kV line. Once again, the need to realize a UHV line derives from a strong increase in energy consumption due to Indian economic growth, as well as distances between consumption centers and energy production facilities.
Realizing a project like this one will also allow India to achieve interconnection with neighboring countries as Nepal and Bhutan, both countries rich in hydroelectric resources. Therefore it comes as no surprise that powerful political and industrial interests have converged around the project.

| CESI's European testing platform for HVDC |

CESI has three testing platforms distributed across Europe (CESI Milano, Italy, FGH E&T Mannheim and IPH Berlin, Germany), and can boast almost 60 years of experience in developing the Italian Network system from 220 kV to a prototype 1000 kV experimental line in Suvereto, making it one of the main players in the testing market.

Overhead lines, components, cables and accessories can be tested in either FGH E&T or CESI.

In 2012 a UHVAC testing station of up to 1,200 kV was inaugurated.
This BINA project is the first interesting example in India of possible collaboration between public and private sectors in this sphere: the project will in fact involve several of the most important businesses in the sector on a national level.

The first section of 1,200 kV line may be the section between Wardha and Aurangabad in the Maharashtra, which are currently interconnected at 400 kV level. Forecasts call for initial operability in two to three years, as long as the tests conducted at the BINA center provide positive results.

THE CHOICE OF AC AND DC DEPENDS ON SPECIFIC PROJECT CONDITIONS, BUT NOWADAYS THE TREND IS TO COMBINE "AC AND DC" PECULIARITIES

AC - DC: alternative or complementary technology?
While the choice of AC and DC will depend on specific project conditions, nowadays the trend is to combine "AC and DC" peculiarities, like more collective expertise with equipment, possibly in order to connect loads at different intermediate points for AC systems compared to DC ones mainly point to point. HVDC system have for overhead line less environmental impact, and subsea cables links enjoy distinct technical advantages through DC solutions, not to mention the HVDC peculiarity that allows the interconnection of asynchronous AC systems (operating at different frequencies). Targeted planning may make it possible to create a DC transmission system in Europe, overlaying the existing 400 kV AC one, that can best take advantage of both technologies while guaranteeing consumers a level of service that is undoubtedly superior in terms of quality, safety and efficiency.

| First steps |

In the 1970s many countries were thinking far ahead, imagining the realization of UHVAC lines.

The first countries to initiate concrete projects were Russia and Japan.
In 1985, the Soviet Union brought an initial 500 km section of the line between Ekibastuz and Kokchetav to 1,100 kV.

In the meantime the project Enel1000 kV was worked out in Italy, with the development and testing, in CESI, of the various components, finalized in a 400/1000 kV GIS sub station and an innovative 1000 kV line, successfully operated for many years by ENEL

In Japan, research activities conducted by the Central Research Institute of Electric Power Industry (CRIEP) focused on this technology.
In 1993 the Tokyo Electric Power Company increased the carrying capacity of a 190 km section of line that connects the nuclear power plant on the Sea of Japan with the urban area to 1,100 kV.

Other lines were realized in 1999. Despite achieving a high level of technology, most of these networks continue to function at 550 kV.

Demand remains lower than expected, and the time has not yet come to take full advantage of those networks that have already been built.