First UHV DC – A quantum leap towards tomorrow’s Supergrids

First 800-kV Yunnan-Guangdong UHV DC Project, China is up and running by 5000 MW

On 18th June 2010, Siemens Energy and the utility China Southern Power Grid have put into operation the second pole of the world-record HVDC system Yunnan-Guangdong Project. In December 2009, the link had also set the world record for first DC operation ever at the voltage level of 800 kV DC. Since that date, first pole named Pole 2 has operated at nominal power of 2500 MW without any interruptions. Now the transmission capacity has been doubled to 5000 MW. With one pole operating at plus 800 kV and the other at minus 800 kV, the voltage difference between the poles reaches the world record of 1600 kV DC. This project sets a new milestone in power transmission history. It has overcome several technical limitations in HVDC transmission. This huge success opens new opportunities and paves the way to future Supergrids for Bulk Power Transmission that will play a major role in a global energy system of tomorrow.

UHV DC within Supergrids for reliability
Climate change, the progressing worldwide urbanization and the trend towards megacities with more than 10 million inhabitants poses new challenges on national and international power transmission systems. One of the most important factors for the economic dynamics of megacities is an effective infrastructure, based on a reliable and efficient power supply. However, an important development in the power supply of megacities is the outsourcing of power generation to close or more distant surrounding areas and the integration of power from renewable sources. From an operator’s point of view, transmission networks and distribution systems will have to bridge increasingly longer distances, while at the same time facing the problems presented by volatile infeeds. As far as the customers are concerned, efficiency and reliability of supply play an important role, particularly in the face of increasing energy prices and almost incalculable safety risks during power blackouts. From an operator’s point of view, transmission networks and distribution systems will have to bridge increasingly longer distances, while at the same time facing the problems presented by volatile infeeds. As far as the
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**UHV DC within Supergrids for efficiency**

Electric power is the only solution to overcome the threat of global climate change, as it enables the use of green energy from renewable sources. However, renewable energy sources are usually located far away from the load centers. At the same time, demanding economic objectives must be met in transporting and distributing green energy. This is where the latest UHV DC technology comes in. Compared to the equivalent 800-kV AC solution, DC transmission is much more efficient, which makes it the ideal solution for long-haul transmission as well as system upgrades in existing grids to stabilize parallel AC systems. With DC, overhead line losses are typically 30 to 40 percent lower compared to AC transmission.

For the 1,400-kilometer Yunnan-Guangdong line this means, that overhead line losses drop from 13 percent in AC transmission to less than five percent with DC technology. The project’s new 800 kV UHV level presents advantages even over other (lower) DC voltage transmission systems: Compared to the established 600 kV level the overhead line loss reduction is 44 percent – and a staggering 60 percent for the 500-kV DC- level “standard”.China plans a number future 800-kV Bulk Power DC transmission projects to bridge the 2,000 to 3,000 kilometers between power generation in the mountains and consumption in the industrialized mega-cities close to the coast. With UHV DC technology, China will construct over 20 of high-power DC energy highways superimposed on its AC grid. The UHV DC Yunnan-Guangdong project is world’s first at present, and has been presented with the Asia Award for its contribution to environment-compatible power supply. The project helps to conserve approximately 33 megatons of CO2 annually by use of hydro power compared to the current Chinese energy mix.

**Fig. 3: Yunnan – Guangdong: Substation**

**Fig. 4: Asian Power Award 2009 for Yunnan-Guangdong**
First UHV DC - Far ahead in just 2.5 years
The Yunnan-Guangdong UHV DC Project was developed and implemented in a mere two and a half years. Operation at the record-breaking full capacity of 5,000 MW began after only 3 years in June 2010. Perhaps this success was due in part to the fact that the testing transmission capacity was raised to 2,600 MW, as 2,500 is deemed to be a somewhat unlucky number in China. Regardless of the cause, the project is a huge success in every respect. Due to the required insulation clearance distances, each project station covers an area of almost 240,000 square meters, the equivalent of 24 soccer pitches. In addition, the extraordinary dimensions of the equipment placed special demands on their technical as well as mechanical design, not to mention on transportation along the 1,400-kilometer transmission line.
Supergrids for green energy
These supergrids are especially suitable for future projects like DESERTEC, SEATEC, and Transgreen, which will be using power from renewable sources to overcome limitations in the generation of conventional power from fossil resources.

While the DESERTEC concept strives to bring deserts in northern Africa and existing technology into service to improve global security of power supply, SEATEC aims at erecting a sea based supergrid in the North Sea to connect large wind farms and Scandinavian hydro power stations to the European grids. To achieve this, SEATEC employs a multiterminal concept to transmit wind power to its destination in one of the nine littoral states participating in the project. Alternatively, power can be stored in Scandinavian pump storage lakes in times of low energy consumption and be generated to support times of peak demands or lower infeed from the wind farms – thanks to the supergrid’s high capacity.

Further south, French initiative Transgreen plans to build a supergrid across the Mediterranean Sea to help transmit the DESERTEC power to Europe. All of these initiatives have a common denominator: they are all backed by energy efficient UHV DC power transmission – and Siemens holds a stake in each of them.

Supergrids consisting of powerful UHV AC and DC transmission lines will be the most efficient solutions for these problems and enable countries to build bulk power transmission corridors to their load centers. At the same time, these technologies lay the foundation for a global power grid that will be able to transport vast amounts of energy to megacities all over the world with minimum losses and therefore most economically.

Siemens Energy is one of the leading companies for power solutions in the world. The Siemens portfolio spans the entire energy conversion chain, from generation through transmission to distribution. Siemens has earned a special reputation in realizing large-scale energy projects all over the world, backed by unique technological expertise and financial resources that allow for intensive research and development of groundbreaking new technologies like UHV DC transmission.