The Ghunan transmission control center in action.

Bringing secure, efficient transmission services to the Gulf

The high rate of business development and improvement in the standard of living in the Gulf region come with a price: a sharp increase in energy consumption. A landmark project interconnects grids and facilitates power exchange to meet rising demand without excess generation.

Many Gulf countries find their power grids inadequate to meet the growing demand. In 2001, six states—Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates—founded the Gulf Cooperation Council Interconnection Authority (GCCIA) to address their collective electricity needs.

The GCCIA promotes reliable, competitive and sustainable electrical transmission services for its member states. To do this, it established a set of challenging objectives, including goals to:

• link the electrical power networks in member states;

• reduce the electrical generation reserve;
• improve economic efficiency of the power systems;
• exchange electrical power.

The first major effort to meet these objectives was the creation of the GCCIA Project, a regionally integrated electricity market where member states can exchange power as needed in an economical and environmentally sound way. It links the electrical power networks of all member states. On completion, no country will need to be energy self-sufficient because each will be able to draw power from the others to handle a sudden change in load balance.

The GCCIA Project consists of three phases:

• Phase I, energized in July 2009, connecting the north grid states to each other: Kuwait, Saudi Arabia, Bahrain and Qatar;
• Phase II, scheduled to be energized in 2010, to link the south grid nations of the United Arab Emirates and Oman to each other;
• Phase III, planned to be energized in 2011, to tie the north grid and south grid together.

AREVA T&D provided key components of Phase I, including the first Middle East installation of HVDC back-to-back stations for power sharing.

Innovative solution

The AREVA T&D solution is an 1,800 MW HVDC back-to-back link configured as three separate 600 MW stations, 70 percent of which are AREVA T&D components. Each station can operate autonomously or in coordination with the others.

At the heart of the HVDC installation is AREVA T&D's H400 thyristor valve. These greater power density valves use series-connected, fully protected thyristors, each with an 8.5 kV rating and 125 mm diameter. AREVA T&D's industry-leading Series V digital system controls and protects the thyristors by offering fully redundant operation, including monitoring and alarm capabilities.

AREVA T&D also delivered a full end-to-end interconnection system on a turnkey basis, integrating the Energy Management System hosted in the Load

HVDC substation in the Middle East.

> "Member states can exchange power as needed in an economical and environmentally sound way."

Dispatch Center (built in the desert), the control and protection system for seven substations, the telecommunications system on the 400 kV network, as well as the interconnection with the national utilities in each of the six countries.

Back-to-back HVDC for system control

HVDC systems are ideally suited for applications where AC transmission is not economical or possible because of distance or asynchronous frequencies. The second condition necessitates an HVDC connection here as Saudi Arabia's network operates at 380 kV 60 Hz while its neighbors' grids operate at 50 Hz. In addition, having an HVDC connection, overall system fault level increase remains fully under control, thus eliminating the need for replacing existing equipment.

"Above all," explains Someswar Chakravorty, AREVA T&D Systems Engineering Director for Power Electronics Systems, "our back-to-back HVDC technology provides the means to control the exchange of power rapidly, accurately and with flexibility. The AREVA T&D 3 x 600 MW back-to-back stations respond in milliseconds to deliver the right amount of power in response to a generation deficit in any network in the group. This correlates directly to lower costs and environmental impacts, because each of the individual grids does not need to be self sufficient in surplus power capacity to cope with generation deficit conditions in the region."

Minimum spinning reserve = maximum savings

The secret? Efficient use of the spinning reserve of the entire network. Spinning reserve is the unused capacity that a system operator must have to cope with

Thyristor valves for HVDC applications.

a sudden increase in load or loss of generation. Generators synchronized to the grid provide the spinning reserve.

To maintain the integrity of their networks, grid operators must have enough spinning reserve to replace the loss of their largest generating unit. Operating and maintaining spinning reserve is expensive, because it represents additional generators running at low power, like a car engine idling.

The key to successful spinning reserve management is a unique control function developed by AREVA T&D, called Dynamic Reserve Power Sharing (DRPS).

Dynamic innovation

"Dynamic" means the DRPS system is very fast: the response times are in terms of milliseconds. Moreover, even if the station is disconnected and off-line, it can be brought into action within one second. This indicates that the DRPS system is also very efficient; because the system operates so quickly, it can stay turned off most of the time, and be turned on only when needed.

The DRPS controller monitors several key parameters, including local power bus voltage changes, frequency, frequency change rate and voltage change rate. When it detects a power deficit, it calculates and predicts the amount of power flow needed in the right direction and acts accordingly.

The DRPS system is being used for the first time in the world in the GCCIA Project.

"The DRPS system is being used for the first time in the world in the GCCIA Project."

Future opportunities

When fully operational in two years' time, the GCCIA Project will benefit member states in measurable ways:

- Bring down operating cost by using the most economic generation unit in the interconnected system;
- Reduce generating capacity in each system as a result of sharing power reserve;
- Defer or eliminate the need for new power plants;
- Help to avoid power shortages and cuts;
- Reduce emissions;
- Increase overall system reliability;
- Create an opportunity to trade energy regionally and internationally. ●

TO KNOW MORE @ somesvar.chakravorty@areva-td.com

> MORE

> Noaman Al Adhami

ENERGY CONSUMPTION IN THE MIDDLE EAST

Energy demand in the Middle East shows no slowdown in the short or long term. The IEA estimates that, over the next 20 years, energy consumption in the region will increase slightly below the growth rate in Asia, but over three times the pace in the West.

Energy-intensive consumer lifestyles and infrastructure markets are driving the Gulf Cooperation Council (GCC) countries to add 59 GW of new power by 2015, which means almost doubling their current generation capacity. To provide this level of power with minimal environmental impact, GCC members are turning to more efficient electricity transmission.

"Key to a solution is the 3 x 600 MW HVDC converter station that AREVA T&D is building in Saudi Arabia for the GCCIA project," explains Noaman Al-Adhami, AREVA T&D Regional Marketing Manager in Dubai. "It enables Dynamic Reserve Power Sharing to interconnect the power systems in the GCC quickly, efficiently and safely. Energized in July 2009, Phase I of the project is the first step toward enabling all six GCC nations to meet their current and future energy requirements without straining the resources of any single country."