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Current status and development VSC-based HVDC technologies in power system of Russian Federation

VSC based DC Transmission System and STATCOM

A.DROZDOV,
Technical director,Ph.D.
adroz@list.ru
Ltd. «SPC SAURUS ENERGO»
9, b.2, Artekovskay str., Moscow,
Russian Federation

A.KISELEV,
Chief Specialist, Ph.D.
akis.g.81@gmail.com
Ltd. «SPC SAURUS ENERGO»
9, b.2, Artekovskay str., Moscow
Russian Federation

O.SUSLOVA*
Chief Specialist, Ph.D.
suslova@ntcees.ru
JSC «STC UPS»
1, lit A, Kurchatov Str., Saint-Petersburg,
Russian Federation

At the end of August 2014 during the commissioning of Mogocha back-to-back VSC transmission test of one of two parallel VSC link was fulfilled. At the time when the back-to-back Mogocha interconnection was conceived, there were no electrical interconnections between the Far East and Siberia power grids. For the first time in the history Russian power system from Kaliningrad to Vladivostok has been fully connected and operated in "integrated" mode.

Mogocha back-to-back VSC was developed by a team of Russian scientists and engineers. This project embodies modern trends of VSC-based HVDC technologies, which are now widely used in the world. Full cycle of development (R&D), shipping, factory and system testing was fulfilled by Russian engineers.

Mogocha back-to-back VSC interconnects the Far East and Siberia power grids, nominal AC voltage 220 kV. Complete DC system, which is rated 240 MVA, consists of two parallel VSC links, nominal active power 200 MW. In the Mogocha VSC the IGBT valves are arranged in a three-phase three-level bridge, with converter transformer 220/38.5 kV.

Power link 220 kV Holbon - Mogocha - Skovorodino, interconnecting two power grids, is removed from the major power stations over a distance of 700 km and has a prevailing traction load of the Trans-Siberian Railway. Consequently, AC networks to which back-to-back VSC is connected, are characterized by low short-circuit ratio and significant deviations of electric power quality. The presence of the back-to-back VSC has stabilized voltage at each interconnection point without additional means of reactive power compensation.

A particularly important aspect is the possibility of voltage balancing. Electricity consumer with motor load, in particular oil pumping stations, located along power transit, have problems in operation of their equipment. Unbalanced and non-sinusoidal voltage leads to increased engine heating and wearing, interrupting the process at any tripping event. By using of voltage balancing algorithms in control system of back-to-back VSC Mogocha, it was possible to improve significantly the quality of voltage, which was noted by the main

consumers. Results of commissioning tests has shown good transient behavior of VCS during reclosure cycles, short-circuits in AC systems 220 kV, extremely unsymmetrical modes.

Next step in the development of the VSC-based HVDC technologies is creation of back-to-back VSC on the northern power link between the Far East and Siberia power grids at Substation 220 kV Hani. Power link is located along the Baikal-Amur Railway and the network parameters are similar to those at Mogocha. Thus, the preferred option is VSC back-to-back.

VSC HVDC options for interconnection of islanded or passive networks in the northern areas of Russia, where the cost of fuel delivery is very high, are considered.

In electrical networks of Moscow city there is a problem of limiting short-circuit current. One of the widely used measure for short-circuit currents limitation is power system sectionalizing, which may cause malfunctions of the power supply as showed blackout in 2005.One of the possible measures is power system sectionalizing with use of HVDC. In urban areas with lack of free territory design driver is substation overall dimension, which is key factor to select the modular multilevel VSC.