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Paper Title	Progress of Electric Power Grid Interconnection in Japan and Development of its Applications
Authors	Dr. Hiroji Ota Chubu Electric Power Company, Inc., Japan
Correspondence Address	1, Toshin-Cho, Higashiku, Nagoya 461-8680, JAPAN Tel. + 81-52-951-8211

ABSTRACT

The aim of this document, which describes grid interconnection technology in Japan, is to serve the purpose of the forum by promoting further advances of technological developments in Central America.

The arc of Japan's four main islands and Costa Rica's location in Central America, have many topographical and other similarities relevant to the power grid. Central America has a longitudinal grid formed by the electric power grids of six countries – similarly, Japan has a longitudinal grid formed by nine regional grids. While interconnected operations have been maintained in Japan for some time, Japan's present coordinated grid operations are the result of much progress over the years.

An interconnected electric power grid may yield some advantages (sharing of back-up power, an economical transportation of power, etc), however, there are some problems in interconnected power system operations that must be solved:

- 1) Amplified fault current from short circuits or grounding faults.
- 2) To maintain the frequency of the interconnected grid it is necessary to allocate responsibility to each system and to develop control methods. Voltage issues, which can be handled on a local scale, are quite similar to those for frequency.
- 3) Large-scale, spread type incidents such as the recent power failure in North America.

The grid voltage was increased to 275 kV, and then to 500 kV; transmission lines connected longitudinally now span numerous utilities in Japan. The technological problems accompanying the grid interconnection have been resolved in the following manner.

- 1) Current-limiting reactors or large circuit breakers on high voltage lines were installed to control the short circuit
- 2) Utilities shared the responsibility of maintaining a balance between supply and demand. Cooperation of Flat Frequency Control (FFC) and Tie line Bias Control (TBC) equipment was ensured in order to monitor the balance and control frequency on the grid.
- 3) An automatic voltage and reactive power adjustment device was developed; it was also decided by the utilities to interconnect based on maximum voltage.

There were two large-scale cascading power failures in the past: in June 1965 in Japan and in November 1965 in North America; studies of both events helped develop the following certain prevention measures against the spread of power failures on interconnected grids.

- 1) Grid structure to prevent fault spreading
- 2) Prompt actions against primary faults
- 3) Distinct conditions and the operations of interconnections
- 4) Application of System Stabilizing Technologies

Presently nine electric power utilities are interconnected in Japan with "coordinated operations". Operating parameters of the power flow, frequency limitations and other parameters of the interconnected grid are determined and managed by the Central Electric Power Council. As an important step towards streamlined operations, a watchdog function capable of handling a coordinated operation area should be established to maintain, regulate and supervise the interconnected grid.