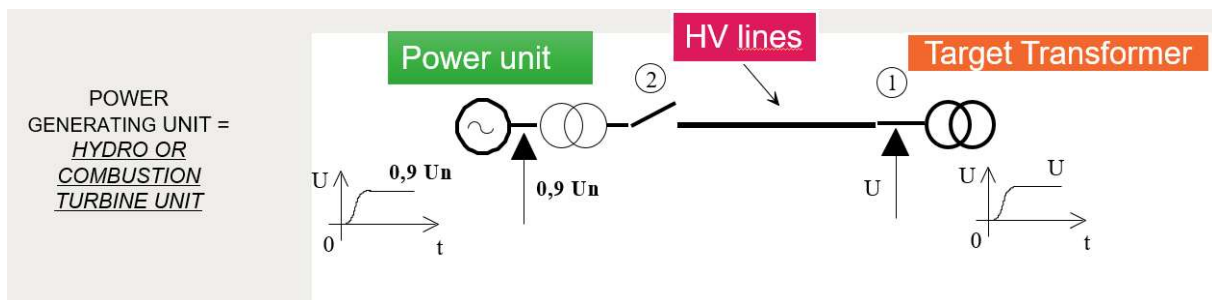


The main causes of TOV is the sudden switching of power transformers on a weak network. We meet this configuration on power system restoration studies and on site tests using black-start units.

As a matter of fact, a black start is the process of restoring an electric power station or a part of an electric grid to operation without relying on the external electric power transmission network to recover from a total or partial shutdown. In the absence of grid power, a so-called black start needs to be performed to bootstrap the power grid into operation.

To provide a black start, some power stations have small diesel generators, normally called the black start diesel generator (BSDG), which can be used to start larger generators (of several megawatts capacity), which in turn can be used to start the main power station generators. Often hydroelectric power plants are designated as the black-start sources to restore network interconnections. A hydroelectric station needs very little initial power for starting purposes (just enough to open the intake gates and provide excitation current to the generator field coils) and can put a large block of power on line very quickly to allow start-up of fossil fuel or nuclear stations.



Special sequences are used in order to avoid TOV during the test procedures.

- 1) The turbine-generator unit is brought to its rated rotational speed, without being excited or coupled,
- 2) We re-form the line up to including the transformers (all circuit-breakers are closed except for the unit circuit-breaker),
- 3) The unit circuit-breaker is closed on a “dead” network,
- 4) The excitation contactor of the power unit is closed: the generator output voltage will increase gradually - with the use of a ramp- from zero until it reaches the set-point value (usually $0.9 U_n$).