FACT SHEET:
SYSTEM STRENGTH

WHAT IS SYSTEM STRENGTH?

System strength is an inherent characteristic of any power system – it is a measure of the stability of a power system under all reasonably possible operating conditions. System strength is important as it can materially impact the way a power system operates.

System strength is usually measured by the available fault current at a given location or by the short circuit ratio. Higher fault current levels are typically found in a stronger power system, while lower fault current levels are representative of a weaker power system. A high fault level, or high currents following a fault, could be viewed as the generation on the grid responding strongly to the drop in voltage at the fault – trying to restore the situation. Similarly a high short circuit ratio at a point in the grid is a measure of the strength of the response to any faults in that area.

Fault currents vary around the grid both by location and by voltage level. The fault currents are higher in areas close to synchronous generation and lower further from generators. System strength reduces with increasing amounts of PEC[1] connected generation, along with the displacement of synchronous generation which contribute more to the fault current.

EXAMPLES OF GENERATION

- SYNCHRONOUS:
  Coal, gas, hydro.
- POWER ELECTRONIC CONVERTER (PEC) CONNECTED GENERATION:
  Large-scale wind and solar.

WHAT ARE THE CHARACTERISTICS OF STRONG AND WEAK SYSTEMS?

Power systems with a high quantity of on-line synchronous generation and very little PEC connected generation provide larger fault current and are categorised as strong systems. This is manifested by the ability of the power system to maintain stability in response to various types of disturbances.

Points of the power system with PEC connected generation which are distant from synchronous generation are more likely to be weaker. Low system strength generally leads to increased volatility of network voltages during system normal and disturbance conditions. Low system strength can also compromise the correct operation of protection systems, and result in PEC connected generation systems disconnecting during disturbances.

Some weak systems are easy to identify, for example, an isolated point in the system with no nearby synchronous generation. In other points in the system where there is multiple concentrated PEC connected generation, weak systems can only be identified through complex power system studies conducted by engineers using detailed models.

VOLTAGE MANAGEMENT IN STRONG AND WEAK SYSTEMS

Strong power systems exhibit better voltage control in response to small and large system disturbances. Weak systems are more susceptible to voltage instability or collapse.

[1] Power electronic converters include rectifiers and inverters which convert alternating current (ac) to direct current (dc) and dc to ac, respectively. Large scale wind generation is connected to the grid with complex converters whereas rooftop solar is connected to the grid with inverters.

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INCREASING CONNECTION OF PEC GENERATION

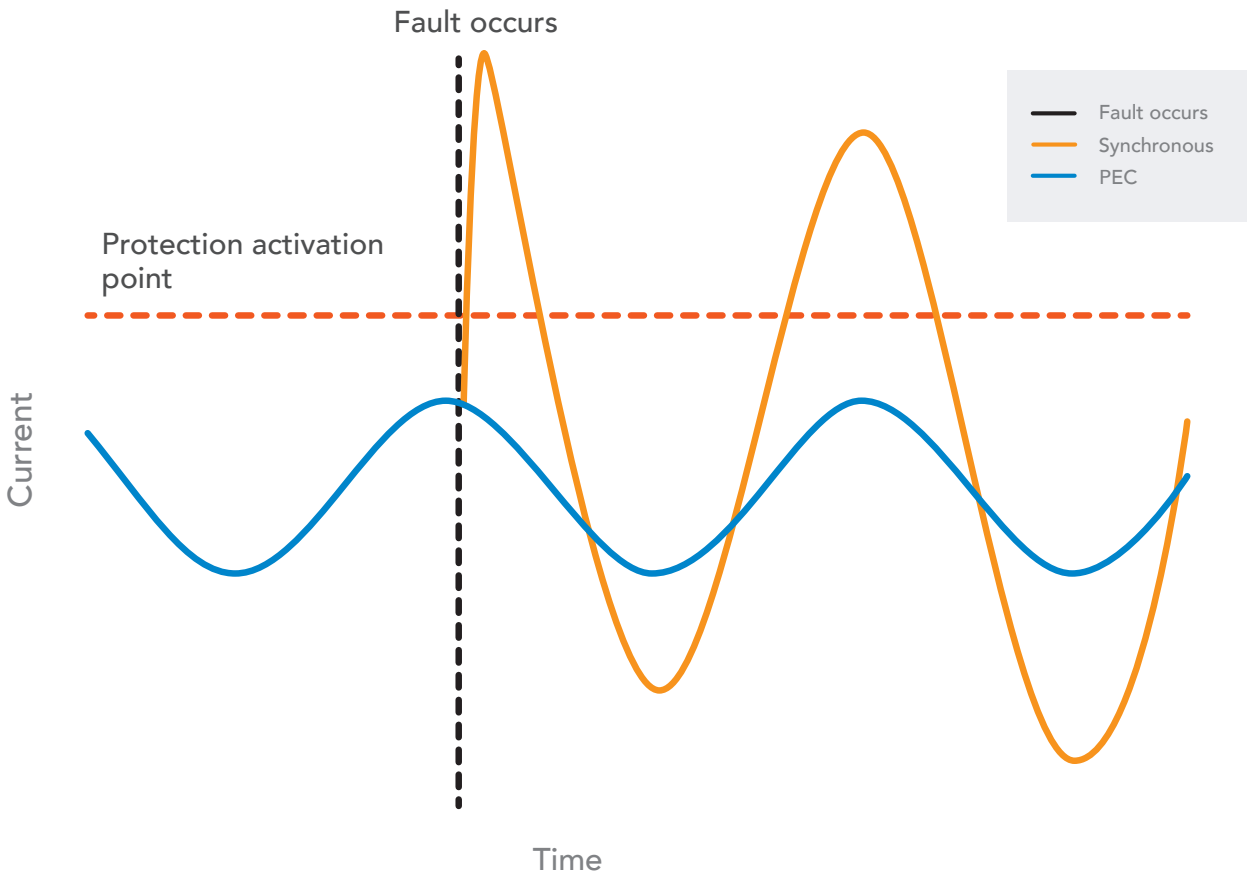
Generation that is interfaced to the network using PEC's requires a minimum system strength to remain stable and maintain continuous uninterrupted operation. Different types of converters use different strategies to match their output to the frequency of the system while maintaining voltage levels and power flows. In a weak AC system, these can fail to operate correctly through even relatively minor disturbances.

OPERATION OF PROTECTION EQUIPMENT IN WEAK SYSTEMS

While weak systems are not new to system operators, they are attracting greater attention following the rise of large scale PEC connected generation in the power system.

Protection equipment within power systems work to clear faults, prevent damage to network assets and mitigate risk to public safety. Protection equipment may be triggered when the current following a fault exceeds the protection activation point, or by the impedance[2] calculated from this current. Weak systems exhibit lower fault current relative to the strong networks. In a weak system, protective equipment which are programmed to activate on measured current or the ratio of measured voltage to current, could be susceptible to unintended operation or failure to operate.

Figure 1 – Current response from synchronous and PEC connected generation



[2] The effective resistance in a power system to alternating current (ac).

FURTHER INFORMATION

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