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Converter technology: reactive power

SC.C4 Power System Technical Performance

PS1: Q4: is there an increased risk of the impact of GICs in addition to other known impacts?

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Converter technologies may mitigate risks.

- Reactive power Q in the PQS power triangle was proposed in 1910 [1].
  - Defined only for sinusoidal signals in 1-phase and balanced 3-phase [IEV]. Not defined for distortion as caused by GIC half-wave saturation of transformers.
  - Effects of GICs typically modelled by increase in or Q-loss [10415, 10944].
- What is Q; how is it measured?
  - The orthogonal component Q is not physical power; given unit: var.
  - Alternative extra components (e.g. unbalance, scatter) of residual non-active power give $S^2=P^2+Q^2+D^2$.
  - Measurement not defined; left to the meter manufacturers. NEMA (in 2011) showed reactive power meters differed widely.
  - Equation $Q_{LOSS}= V_{pu}.k.I_{GIC}$ (and how k is measured) needs more consideration.

General Power Theory [2020] offers alternative compensation.

- For systems with any number of wires, unbalance, v-i displacement, distortion
  - GPT defines a relative efficiency of delivery and how it is affected by harmonics and/or unbalance. Orthogonal Q only approximates physical performance.
  - C4-415 (in 2020) introduced GPT for GICs.
  - Recent papers apply GPT to non-linear unbalanced loads, and compensation of GICs; another paper is in review.
  - Q-loss during GICs, and Q during a transient, have unknown uncertainty.
- Converter technologies are not constrained to 120° phase angles of machines, nor to balanced inverter outputs and an orthogonal reference frame.
  - Power electronics, and novel analytics offer new solutions to power system problems.