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DISTRIBUTION CHALLENGES

Being aware of a problem and being able to take corrective action are two different things. Distribution networks are aware of the challenges posed by the growing market for ‘behind the meter’ generation. However, it appears nothing is being done about accommodating higher penetration of distributed generation, other than to impose rating limitations on consumer-generated power. Statements in general terms on the subject of smart networks of the future do not come to grips with the current rating of distribution networks and the limitations imposed on high distribution generation penetration levels. Problems at hand include:

- Substation voltage regulation
- Substation protection relay coordination
- Power quality (voltage, flicker, harmonics)
- Fringe of network problems

Solar photovoltaic (PV) generation, the single most important form of distributed generation, is shown below.

\[
\Delta V = V_1 - V_2 = R_{PL} + X_{QL} (P_L + X_Q L) / V
\]

Flicker-like effects are the result of rapidly changing weather conditions. Unbalance results from the unpredictable installation pattern of single-phase inverters, and fluctuation in their power output.

- Harmonics are an unattractive ‘feature’ of inverters.

CHARACTERISTICS OF ‘BEHIND THE METER’ DISTRIBUTION

Solar PV systems for ‘behind the meter’ generation.

GRID

OLTC

FEEDER

LOAD

DISTRIBUTION NETWORKS

VOLTAGE REGULATORS

Substations O/LTCs need to be controlled by more than just a voltage regulator. There is a good case to be made for monitoring (and responding) to changes in real and reactive power flow as well as direction, and values and sequencing of voltage and current phasors. In terms of control protocols, some form, although of an elementary nature, of neutral network current monitoring may be required. Learning ability will be important.

Notwithstanding the power flow into loads with resulting secondary ampacity limitations, the power factor is not a constant control.


different transformations. The reactive power available has an effect as well. If the solar PV inverter can be made to supply reactive power, QO, AV can be made to reduce by means of leading reactive power (+ QO) or to increase by providing lagging reactive power (+QO).

Smart meters, only partially deployed in the NEM jurisdictions, would in principle be able to function as DREDs. They are already used, in Victoria, for monitoring voltage at individual premises.

Flicker can be expected to increase because of the very drastic changes in apparent and reactive power, and grid transient giving rise to much higher fluctuation. At substation levels, Control system needs to be aware of any inrush levels in a circuit breaker as well as in connected equipment.

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Fig 1: A schematic representation of a feeder for distribution networks with voltage distribution control.