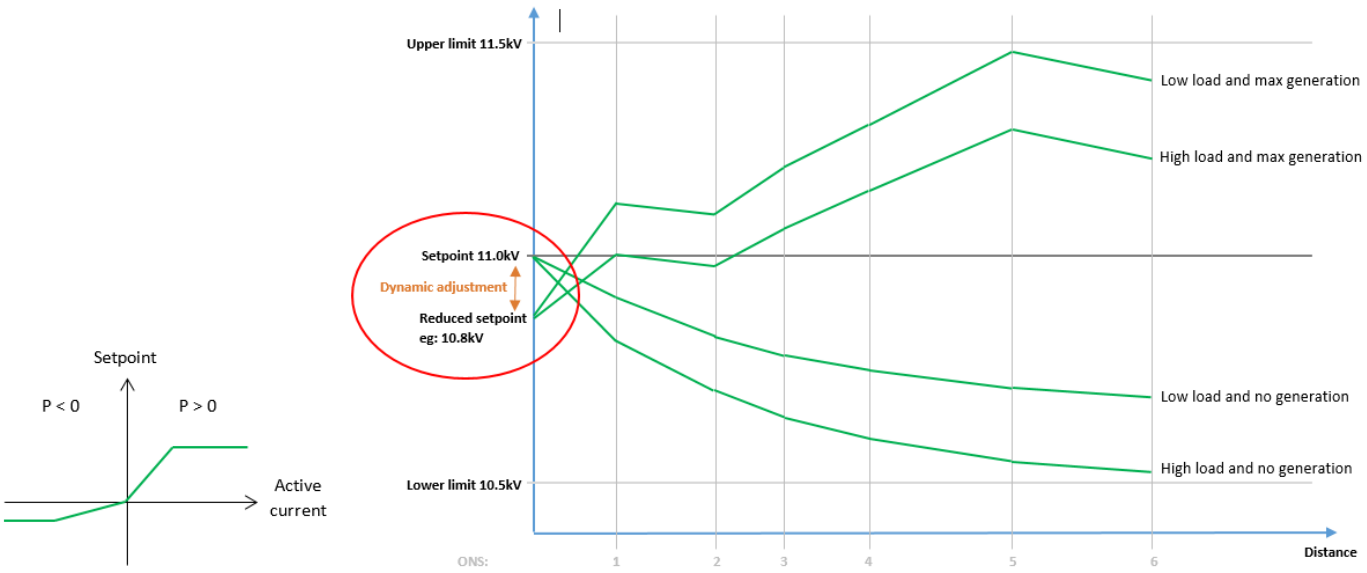
Reverse Power Flow

With increasing levels of distributed renewable energy being brought online, many Electrical Utilities are having to find effective ways to keep the distribution network stable while power is flowing in the reverse direction. The following is a brief discussion of some of the more common reverse power flow issues, and how the A.Eberle REG-D/DA can be used to solve them.

1. Negative Current Influence

When solar panels (PV cells) are added to the distribution grid in large quantities, the result can be that at certain times of the day, the amount of locally generated power can exceed the local load, resulting in a flow of power back towards the substation. A good example of this occurs in the middle of the day, when the sun is at its strongest, and not many people are at home.

The main aim in this situation, is to keep the distribution voltage within acceptable limits. If this is to be achieved at the substation, the REG-D/DA can be configured with one of the standard current influence programs, for example: Active Current Influence. Since a separate negative gradient and limit can be set for this program, the effect is like applying Line Drop Compensation (LDC) in reverse:



As the voltage on the distribution network rises, and the amount of Active Current increases in the reverse direction, the voltage setpoint is decreased at the substation transformer. When the transformer taps down to stay within the bandwidth of the reduced setpoint, the PV cells must carry more of the load, thereby keeping the distribution voltage to within acceptable limits. This approach has been shown to be effective on many networks worldwide, and is relatively simple to implement in the REG-D/DA, requiring only a load current measurement, and the configuration of an acceptable current influence gradient.

Wind turbines can be more demanding, sometimes producing reverse power flow together with positive VARs. To cope with this, the REG-D/DA can be configured to combine the effects of the Active Current influence program with those of the Reactive Current influence program.

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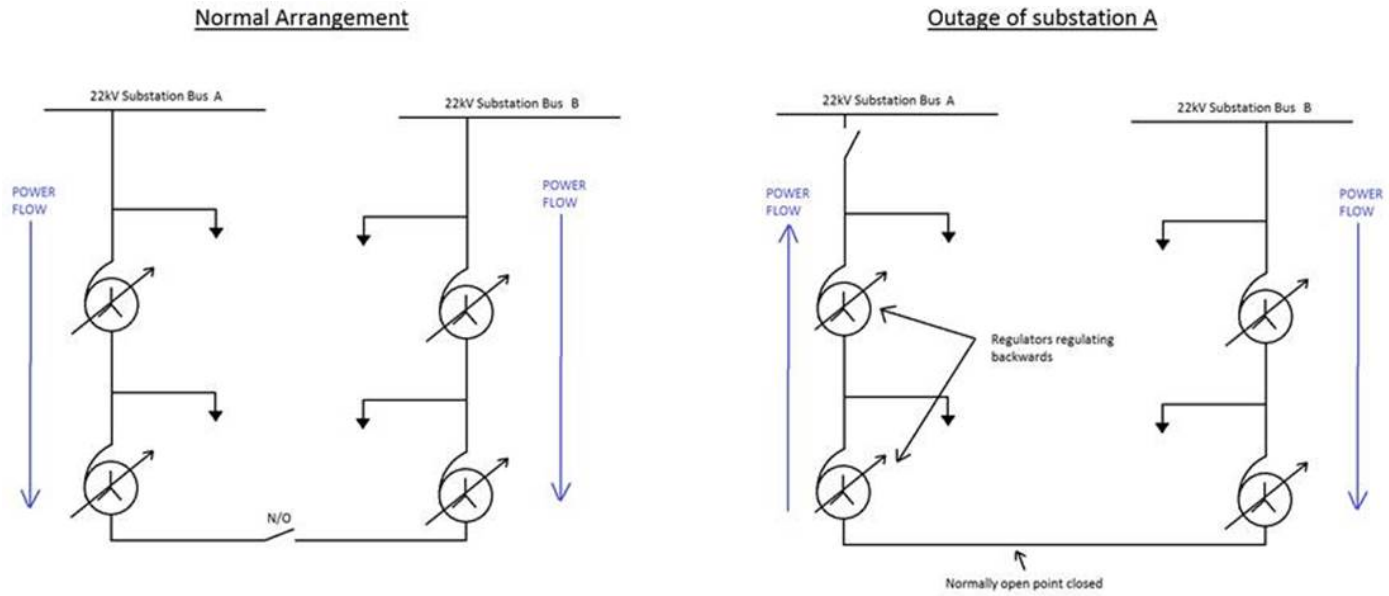
2. Blocking

If the downstream voltage source (eg: a generator or turbine) already has some form of voltage regulation, the best approach at the upstream transformer could be to simply block any further voltage regulation under reverse power flow conditions and let the generator do the regulation.

Such blocking is simple to achieve in the REG-D/DA, using only a single line of tried and tested background programming, (H-Code).

3. HV Regulation

Occasionally it is necessary to regulate the voltage on the upstream winding of the transformer during reverse power flow conditions. For example:



During an outage of Substation A, power must flow in reverse through the two transformers on the left, towards the distribution network. When this happens, the voltage on the Bus A side of the transformers should be monitored instead, and the functioning of the tap changers should be inverted. Achieving this with multiple controllers can be costly and complicated.

The REG-D/DA solves this by being able to monitor both sides of the transformer at the same time. To do this, the M9 option is equipped with a second VT/CT measurement set. When the power flow is reversed, H-Code automatically switches to the U2I2 measurement set and completely inverts the tap changer controls, including the tap up/down relay outputs, the tap changer limits and TPI monitoring. A time delay and hysteresis can also be added to the switching point if required.

Because separate VT and CT ratios are configured for U2 and I2, this solution is also applicable when trying to control the amount of locally generated renewable energy being pushed back into the HV network. Simply connect an HV VT to the REG-D/DA, configure the various options, and it does the rest.

The REG-D/DA: one box, many solutions.

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