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TECHNICAL NOTE

Client:	Grid Code Review Panel
Project:	GCRP meeting 20th September 2007
Subject:	Despatch of Reactive Power from Embedded Generation
Issue Date:	06 September 2007

	Name	Date	Signature
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1 Introduction

The paper is a result of discussions at the Grid Code Review Panel meeting on 17th May 2007 regarding concerns raised about the despatch of reactive power from generators connected to distribution networks.

A presentation of the paper will be made at the Grid Code Review Panel meeting on 20th September.

2 Background

Reactive power capabilities of grid code compliant generators are specified in the connection conditions.

For most power stations with synchronous machines the requirements are met by those machines without the need to install extra plant to deliver the requirements.

For many novel generators / power park modules, the capabilities required are not met by the basic generation plant and additional plant needs to be installed to meet the requirements.

Steady state capability for reactive power must be distinguished from dynamic capabilities which are required to ride through low voltage events and faults, and deliver dynamic voltage control. With power park modules the capabilities for each requirement may be provided by different specific plant and equipment.

The control of voltage on distribution networks is the responsibility of the distribution network operator. This control is normally delivered by transformer tap changers and occasionally by mechanically switched capacitors or in line voltage regulators (1:1 transformers). The voltage on each section of network is normally controlled at one point, i.e. the source busbar connecting the transformer infeeds from the higher voltage network. For interconnected networks negative reactance compounding of tap change controllers provides control of voltage and acceptable sharing of reactive power.

Dynamic voltage changes are not specifically controlled, but limited by specifying the voltage step changes allowable due to generator or demand fluctuations e.g. voltage step changes and voltage flicker.

When generators connect to distribution networks, the power factor, or power factor range, is specified in the connection agreement with the DNO. The power factor range and requirements are calculated so that the operation of the generator will not result in steady state voltage changes which could result in customers connected to that network experiencing voltages outside statutory limits. Many distribution networks were designed to accommodate only unidirectional power flows from higher to lower voltages. Therefore the capability of such a network to manage reverse power flows without reaching voltage limits is severely limited. Connection of generation to distribution networks has always required tight regulation of allowable reactive power ranges and in some cases some form of voltage control.

3 Issues arising

The principal issue arising is that if despatch of reactive power, or operation at a range of power factors specified for transmission network requirements by the grid code, is controlled by the system operator, the voltage on the distribution network will be affected potentially resulting in:

- Loss of control of voltage by DNO.
- Customers experiencing voltage outside statutory limits.
- Embedded generators tripping on voltage limits.

Additional issues are:

- Potential conflict between grid code requirement and DNO connection agreement.
- The cost effectiveness of connection conditions where plant is installed but cannot be operated and is therefore a stranded asset.

4 Related issues

The following related issues arise.

- There are currently no charges or rewards for the transfer of reactive power across the TO/ DNO boundary. We understand that this position is currently under review. It would be appropriate to review the despatch of reactive power on generation embedded in distribution networks in conjunction with this overall issue.
- Despatch of reactive power by generation can contribute to minimising costs for transmission / system operators. In the case of synchronous machines this is probably the most cost effective way of providing the reactive requirements on the transmission system. In the case of some Novel Technologies, these reactive capabilities do not always come inherently with the generator / machine and therefore additional equipment has to be purchased to provide the capability.
- If embedded generators with grid code requirements are to operate to their full connection condition requirements, most will have to change their connection arrangements, adding a massive cost to their connection charges to enable the reactive capability to be delivered. This cost will ultimately be passed through by the market to electricity customers. It is highly unlikely that this will result in the most cost effective delivery of reactive power control on the transmission system.
- Whether reactive power is a Transmission Owner or System Operator issue.