Demand Control OC6

Industry Technical Code Group

Background

1. The Grid Code obligations relating to Demand Control are documented in OC6.5. OC6.5.3 specifies the functional requirements of the scheme:

   OC6.5.3
   (a) Whether a National Electricity Transmission System Warning – High **Risk of Demand Reduction** or **National Electricity Transmission System Warning** - **Demand Control Imminent** has been issued or not:-

   (i) provided the instruction relates to not more than 20 per cent of its total **Demand** (measured at the time the **Demand** reduction is required); and

   (ii) if less than that, is in four integral multiples of between four and six per cent, each **Network Operator** will abide by the instructions of **NGET** with regard to **Demand** reduction under OC6.5 without delay.

   (b) The **Demand** reduction must be achieved within the **Network Operator's System** as far as possible uniformly across all **Grid Supply Points** (unless otherwise specified in the **National Electricity Transmission System Warning - High Risk of Demand Reduction)** either by **Customer** voltage reduction or by **Demand Disconnection**, as soon as possible but in any event no longer than five minutes from the instruction being given by **NGET**.

2. Key points to draw out from these requirements are:
   - The demand reduction is a percentage of the demand at the time of the instruction
   - The requirement is to reduce demand; voltage control is a method of achieving demand reduction as is demand disconnection
   - There is some flexibility (4-6%) in the size of each block
   - The demand reduction should be uniformly applied
   - The demand reduction needs to be implemented within 5 minutes
   - There is a need to consider time for the Control Engineer to receive and interpret and respond to the instruction from NGET and initiate the SCADA switching sequence.

3. Most DNOs plan to achieve the Grid Code requirements by a combination of voltage reduction and demand disconnection. There are two key factors associated with this requirement i.e. the demand reduction achieved and the implementation time.

Voltage Reduction – Demand Reduction

4. The historic expectation was that a 3% voltage reduction would achieve a demand reduction of approximately 5% and that a further 3% voltage reduction would deliver a total demand reduction of 10%. Due to this expectation the standard industry approach is typically for voltage reduction to form the first two stages of demand control, thus providing a reduction in the demand on the transmission system whilst continuing to maintain supplies to all customers. This functionality is generally hardwired in to the voltage control schemes installed in approximately 3000 DNO primary substations (e.g. 66/11, 33/11 and 33/6kV substation).

5. Following the Black Start Exercise Phoenix, questions were raised about the effectiveness of voltage reduction given that distribution networks now supply an increasing population of non linear loads i.e. where the demand does not reduce

with the supplied voltage. Two Network Operators conducted limited tests on their live network during the summer and autumn of 2008 to attempt to establish the effectiveness of voltage reduction.

6. Tests were undertaken on three types of primary site; predominately domestic customers, commercial customers and finally large industrial customers.

7. The tests confirmed that voltage reduction will have an impact on the demand but as expected the results differ across the different types of customers. For a 3% voltage reduction instruction the resultant demand reduction ranged from 2.57% to 5.09%. In most cases the demand reduction was sustained for the period of the test, but a slight recovery in demand was observed at times.

Voltage reduction %	**Demand reduction %**
3.47	2.57
2.63	4.46
4.3	4.34
3.03	3.29
2.02	5
4.35	32.9[1]
2.68	2.67
3.57	3.73
2.64	5.09

8. The results show that the demand reduction associated with a 3% voltage reduction is variable and could be as low as 2.6%; it might be more reasonable to assume from an operational management perspective that a 3% voltage reduction is more likely to result in a 3% demand reduction rather than the 5% that has been historically assumed.

Voltage Reduction – Implementation time

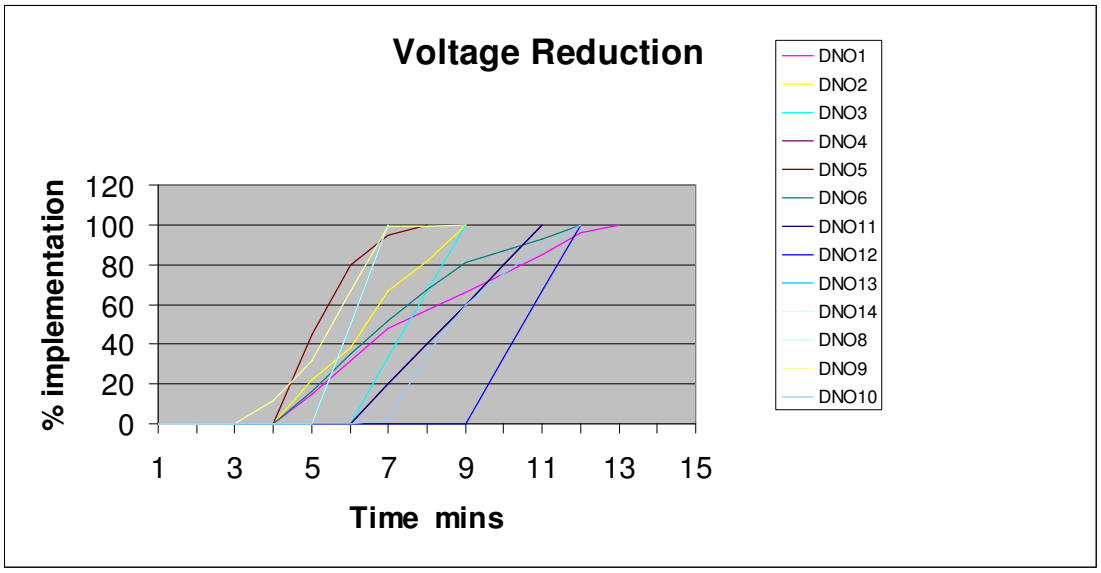
9. As part of the investigation of the 27 May 2008 incident DNOs were asked to provide information to Ofgem relating to the implementation time of the demand reduction scheme. This information provided indicated that the voltage reduction might take longer that the 5 minutes which is specified in Grid Code OC6.5. As a result of this finding DNOs carried out a further assessment of the time taken to implement a voltage reduction stage.

10. This assessment took into account the time taken for the voltage reduction instruction to propagate through their SCADA systems, the time taken for the voltage control scheme to respond and the time taken for the tap changer to progress through a tap change cycle.

11. The following graph summarises the responses from DNOs. The graph illustrates that a single voltage reduction could take up to 13 minutes to implement[2].

[1] Abnormal demand resulted in the high demand reduction

[2] These times include an additional two minute period for receiving an instruction from NGET and initiating the voltage reduction process. It is not clear if all the DNO responses already include for this activity, and it may be that some DNO voltage reduction schemes could be completed two minutes earlier than indicated in this graph.



12. The implementation time is influenced by several factors including:

- The time taken for the Control Engineers to respond to the NGET instruction.
  The time for SCADA systems to convey the instruction from the Control Rooms to the substations. These timescales are largely influence by the architecture of the SCADA and associated communications infrastructure.
  The time for the tap change relay and tap changer to respond to the instruction. This timescale is governed by the basic design of the voltage control scheme in each of substations.

Voltage Reduction – summary

13. The results of investigations carried out by DNOs provide a degree of transparency of the performance of the voltage reduction schemes which have been in place for many years. This additional transparency has identified that there is likely to be a technical non compliance with the Grid Code OC6.5 in terms of the demand reduction delivered by voltage reduction the timescale of delivery.

14. The systems that deliver voltage reduction form an intrinsic part of DNO SCADA and individual substation based systems.

Options

15. There are a range of options for addressing the potential technical compliance with Grid Code OC6.5 which are considered briefly below:

16. Option 1
Reflect the likely performance of the voltage reduction schemes currently employed in terms of the demand reduction likely to be achieved and the implementation time in an amended version of the Grid Code.

17. Option 2
Improve the performance of the voltage reduction schemes currently employed by DNOs by increasing the speed of operation. This could require extensive changes to SCADA systems and changes to substation voltage control schemes. Assuming that there was a need to update the voltage control scheme in 3000 substations this could cost £90m (based at a cost of £30k per substation). Updating the voltage control scheme might deliver an increased implementation time of between 1 – 2 minutes. Changing the substation voltage control scheme would not improve the propagation time through SCADA. More detailed studies would be required to establish if it would be possible to reduce the SCADA propagation times and, if feasible, the associated costs.

Enhancing SCADA and substation equipment would not address the magnitude of the demand reduction achieved.

18. Option 3
There is provision in OC6.5 for DNOs to deliver the prescribed Demand Control using demand disconnection rather than voltage reduction. It would be possible to comply with OC6.5 as currently drafted by using demand disconnection only. Where there is a requirement is for a relatively modest demand reduction on the transmission system, the present voltage reduction scheme can deliver material benefits without disconnecting or having a significant impact on customers.

Recommendation

19. The Grid Code Review Panel is invited to:

- Note the additional transparency on the effectiveness of the voltage reduction schemes used by most DNOs to deliver Demand Control as required by OC6.5.
- Recognise that there are customer benefits from delivering some degree of demand control via voltage reduction rather than relying solely on demand disconnection.
- Consider the acceptability of changing OC6.5 as proposed in Appendix 1 recognising the Demand Control facilities that are generally provided by DNOs.

Appendix 1

Potential changes to the Grid Code to implement Option 1

The Grid Code obligations relating to Demand Control are documented in OC6.5. OC6.5.3 specifies the functional requirements of the scheme:

> OC6.5.3
> (a) Whether a National Electricity Transmission System Warning – High **Risk of Demand Reduction** or **National Electricity Transmission System Warning** - **Demand Control Imminent** has been issued or not:-
>
> (i) provided the instruction relates to not more than 20 per cent of its total **Demand** (measured at the time the **Demand** reduction is required); and
>
> (ii) if less than that, is in four integral multiples of demand disconnection each of which is between four and six per cent, each **Network Operator** will abide by the instructions of **NGET** with regard to **Demand** reduction under OC6.5 without delay~~.~~ or
>
> (iii) if less than that, is in two voltage reduction stages each of which being 3%, followed by two integral multiples of demand disconnection each of which is between four and six per cent, each **Network Operator** will abide by the instructions of **NGET** with regard to **Demand** reduction under OC6.5 without delay.
>
> (b) The **Demand** reduction must be achieved within the **Network Operator's System** as far as possible uniformly across all **Grid Supply Points** (unless otherwise specified in the **National Electricity Transmission System Warning - High Risk of Demand Reduction)** either by **Customer** voltage reduction or by **Demand Disconnection**~~as soon as possible but in any event no longer than five minutes from the instruction being given by **NGET**.~~
>
> (i) **Demand Control** initiated by voltage reduction shall be initiated as soon as possible but in any event no longer than 2 minutes from the instruction being received from **NGET,** and completed within 15 minutes of the instruction being received from **NGET**.
>
> **(ii) Demand Control** initiated by **Demand Disconnection** shall be implemented as soon as possible but in any event no longer than five minutes from the instruction being given by **NGET**.