

Smart Metering Subgroup TOR(v): Load Control

Introduction

The aim of this paper is to develop an analysis to inform a future decision as to whether DNOs should have access to load control and other Smart Meter functionality. This includes:

- i. Benefits/Costs of DNOs having load control and other functionality
- ii. Technical feasibility of load control
- iii. How might DNOs get access to load control
- iv. Options for DNOs to use load control via the Consumer Access Device (CAD) and DCC – feasibility and comparison

This paper will focus only on options which are mutually beneficial to DNO and consumers.

Unless otherwise stated the scenarios refer to single element, single phase meters. For clarity, all meters will contain a load control switch (controlling all load). An Auxiliary Load Control Switch (controlling a proportion of load) is optional.

The following scenarios are assumed to be possible solutions where smart meters and smart metering infrastructure can assist in load control. Scenarios where smart meter infrastructure is not used are mentioned, but are considered out of scope for this paper.

Potential DNO load control scenarios

1a. Command & Control Demand Side Response – Normal Conditions

In this scenario, aggregated half hourly smart meter load profile information is used to inform DNO actions to manage the LV network. This may be in anticipation of (proactive) or as a result of (reactive) a localised constraint on the network. The resulting action in this scenario is to issue a command to the smart meter Auxiliary Load Control Switch (ALCS) or HAN Connected ALCS, where this is available, to reduce load. The ability to perform this ALCS action has historically been part of the contractual agreement between the Supplier and consumer.

For **proactive** command and control, the delay between identifying the need for action and the action taking place will be less time critical than for a reactive command and control. Time will be required to analyse load profile data and to predict the circumstances for a potential impact. An ALCS load control action can then be pre-configured to send to the meter.

For **reactive** command and control, the smart meter load profile analysis would need to take place in near real time. As the consumption profile measurement needed for analysis are half hourly averages, and it is probably unrealistic to assume this would be retrieved via individual DCC service requests every half hour, achieving a reactive solution via this route would be difficult.

In addition, if DNOs had direct access to the ALCS control commands a DCC delay of up to 60 seconds in issuing the command could ensue. If the ALCS control commands remain enacted via suppliers the delay could be significantly longer. Hence, there is significant concern as to whether the response would be timely enough to avoid the impact of the constraint in this scenario.

Note: Future options may allow us to exploit Home Energy Management Systems (HEMS) connected directly to a Consumer HAN. If HEMS receive an indication of a load control requirement directly via the DNO→ secure internet→Consumer HAN route i.e. the DNO communicating with the HEMS without using DCC/Smart Meter communications paths, then customer preferences for load control could be implemented. This would give more granularity than the "on/off" ALCS gives. However, it would be difficult for DNO to assess the total load under demand control i.e. the load control decision the HEMS has been configured to take, without setting up some sort of common HEMS services. Although a CAD system may well be feeding a HEMS with real time consumption/price information that may impact its response to a load control request, this option does not rely on this use of smart meter infrastructure and as such could be considered out of scope for this paper.

i. Benefits/Costs

Benefits to DNO would be from avoided reinforcement.

Benefits to customers would be improved service, more effective tariffs with ensuing reduction in energy costs.

Costs would be incurred from additional analysis tools and large volume data management.

Costs would be incurred if DCC/meter infrastructure were altered to support DNO access to critical ALCS control commands.

ii. Technical feasibility of load control

Processing discrete half hourly information will have both data volume and data privacy issues. However, constraints could be estimated with localised aggregations of smart meter profiles e.g. at a per feeder level, mitigating these issues. The analysis would take the following approximate form:

- Smart meter load profiles are collected from an area of the network over time
- These are used in offline time series analysis to predict the time and conditions under which constraints are likely to occur
- When these conditions are predicted to occur a load control command is pre-programmed to be sent or configured into the ALCS calendar
- In the alternative reactive solution, near real time analysis would focus on when the constraint was seen to occur and issue the ALCS command directly triggered by this event. As discussed above method, a reactive load control system is unlikely to respond in time to alleviate a constraint.

Although many DNO currently have the capability to carry out time series analysis in the LV domain, they do not generally do so for ongoing constraint monitoring.

Changes could be required to meter, GBCS and DUIS specifications for DNO to have access to a critical command in use by the supplier, such as the ALCS control command. An alternative mechanism could be for the system to remain as is and to formalise a mechanism for the DNO to request an ALCS control action by the supplier.

It should be noted that the load attached to an ALCS is only visible where twin element metering is configured in some form. There is a risk that such a configuration would not always be applied hence potentially precluding visibility of the ALCS controlled demand. Separate metering or identification (eg through a CAD) of the ALCS related load may be a future consideration for SMETS or GBCS functionality when multiple Low Carbon Technology (LCT) loads may be separately controlled by ALCS.

DNO do not currently have access to the ALCS descriptions i.e. description of load under control or the switching calendars which would assist in their estimation of load under control.

iii. How might DNOs get access to load control?

DNO would need to be given access to ALCS either directly or indirectly via the supplier (with the technical considerations mentioned previously). Indirect access would need to be automated and standardised across all suppliers to work effectively.

iv. Options for DNOs to use load control via the CAD and DCC – feasibility and comparison.

Direct access to ALCS can be achieved via DCC, with the technical and cost constraints mentioned if this access was also given to DNO in addition to suppliers

CAD could be used to pass a signal to a consumer HEMS to further reduce load. A possibility for future functionality is that CAD could pick up the Supplier/DCC issued price signal from the meter and take further more discrete load control actions. Again, the impact of this load control would be difficult for DNO to predict.

The other alternative is DNO access the HEMS directly via the Consumer HAN which is out of scope for this paper as it does not use Smart Meter infrastructure.

1b. Command & Control Demand Side Response with Third Parties – Normal Conditions

This scenario is essentially the same as scenario 1a but examines how bilateral agreements between DNO and third parties could develop to make use of load control functionality using the DCC infrastructure, via use of the CAD utility- or indeed the utility of such an agreement via any other load control route.

An aggregator is a company that acts as a collector of available consumer loads and distributed small-scale production, and offering these distributed energy resources to parties responsible for managing grid load. Aggregators could access the information and control facilities through the means described in

scenario 1a, or indeed via a variety of routes. Innovation, or indeed the means to achieve this end should not be proscribed in regulation at this moment. Multilateral agreements between a variety of parties – the consumer, DNOs, and aggregators should be formed on their commercial merits as technology and innovation allow.

These consumer load movements can be commercialised utilising a number of grid management mechanisms. The distribution of utility from these mechanisms would be according to the commercial agreements between parties involved in facilitating them. These mechanisms include:

STOR - The National Grid's Short Term Operating Reserve (STOR) programme is a service for the provision of additional active power from generation and/or demand reduction, and is tendered three times a year. Suppliers must: offer at least 3MW or more of generation or steady demand reduction (this can be from more than one site and is therefore often supplied by aggregator companies); deliver full MW within 240 minutes of receiving instructions from National Grid; and provide full MW for at least two hours when instructed. Payments are made on both an availability and utilisation basis. Smart metering technology is typically needed for demand side firms to take part.

FCDM - In the Frequency Control Demand Management (FCDM) scheme, the National Grid customers who provide the service are prepared for their demands to be interrupted for a 30 minute duration, where statistically interruptions are likely to occur between approximately ten to thirty times every year. An FCDM provider must provide the service within two seconds of instruction, deliver for minimum 30 minutes and deliver a minimum of 3MW.

DSBR - Having started in 2014, until 2016 National Grid will be offering businesses the opportunity to take part in its Demand Side Balancing Reserve (DSBR), which it hopes will open up demand response to a far wider range of businesses than those that currently participate in STOR. The minimum capacity offering is just 1MW, and the only technology required for plants to take part is a half-hourly meter. Messages about events in which firms can participate are sent by text, and the bulk of payment is made on utilisation, with no penalties if a firm decides not to participate.

Demand Side Response (DSR) - The final details of this DSR scheme must now be worked out following the passing of the Energy Act by Parliament in December. Set to run from 2016, with auctions beginning at the end of 2015, this scheme could simply be an extension of the DSBR or utilise more advanced smart metering and automated demand response.

Capacity Mechanism - From 2018 the DSR scheme will be rolled into a general Capacity Mechanism which, like STOR, also provides payments to generators that can turn on reserve generating plant at times of peak demand. (*Source: Process Engineering January 2015*)

The ability to interact with these markets will be dependent on the technologies and software developed by aggregator companies. Scale of operation is also relevant to a number of these mechanisms.

With regard to how aggregators or third parties could influence load control, all future options –such as those which may allow parties to exploit HEMS connected via CAD are an exciting possibility and in no way should be discouraged. As mentioned previously if HEMS receive an indication for load control – including to move a proportion of the load on an appliance or throughout the home, for example- directly via the DCC or CAD route then load control could be implemented. The party seeking to affect the load would have to have sufficient information about load requirements and be able to convey information in two directions. CADs can have a certain number of ‘trusted appliances’ attached to them which allow two way data, as well as further CADs which simply detail information. With regard to the data moving back and forth, it would be necessary to have consumers informed when load control was taking place, as well as for parties engaging with DSR to be aware when an important consumer need is being met- it is likely aggregators will need access to many systems to ensure there are sufficient units available to ‘turn down’ without directly compromising consumer utility.

There are a variety of commercial models which could serve to allow aggregators to work with DNOs to reduce demand on the grid.

Two examples are:

1. DNOs (or another party interested in DSR) could contract with an aggregator who has sold the principle to the end user. The capacity that the aggregator can shift is provided to the supplier in useful volumes, allowing DNOs to engage in DSR markets (through various balancing mechanisms – such as those outlined above).
2. A second option could see, for example an aggregator contract with a social landlord. The aggregator may provide, for example discounted heating units to the landlord- with the caveat they can engage in DSR markets. The aggregator then finances their own operations and the capital investment of reduced-price units via utilising DSR market capabilities. A DNO is an example of a party (of many) which could purchase DSR services from an aggregator.

It should be remembered that there will be an endless supply of ideas about how to commercialise aggregation services. Those which are marketed successfully will depend on the multilateral agreements formed between the parties involved and market conditions including risk and saleability. This paper does not seek to set out a comprehensive array of options which may be utilised.

It is also important to note that security of these third party arrangements may at some point need to be regulated.

2. ToU Tariff Demand Side Response – Normal Conditions

Trials have shown use of 1 hour/1 day ahead ToU tariffs have some impact on demand reduction. A recent example of the impact of ToU tariffs, reflecting both DNO and supplier signals, was demonstrated by UKPN's Low Carbon London project ¹

This solution could use historical smart meter load profiles, and other current information, such as weather forecasts, to predict demand in certain areas of the network at certain times. Customers are advised when "cheap" and "expensive" energy will be available during the day and can adjust their behaviour accordingly. Tariffs would need to be managed jointly by suppliers and DNO as they would need to track network constraints (potentially reflected in altered use of system charges) but not be offset by conflicting alterations to retail elements of the energy price.

i. Benefits/Costs of DNOs having load control and other functionality

Benefits to DNO would be from avoided reinforcement.

Benefits to customers would be improved service, more effective tariffs with ensuing reduction in energy costs.

Costs would be incurred from additional analysis tools, potential integration with suppliers (for ToU tariff setting) and large volume data management.

ii. Technical feasibility of load control

The above method relies on consumer behaviour to affect load and hence, the exact load reduction achievable in each incident will be indeterminate. As in scenario 1, DNOs would need to have new capabilities to analyse smart meter load profiles to identify local constraints (or alternative monitoring). If these profiles were premise specific then data privacy rules would apply. However, it may be argued that secondary substation level load information would be sufficient for this solution.

This solution would be much more feasible when home automation/HEMS are widely available as trials have shown limited response from consumers in some cases.

iii. How might DNOs get access to load control

Access to ALCS control is not required by the DNO but ToU tariffs would require liaison with suppliers, most likely via an industry forum rather than on a bilateral basis.

¹ [http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Low-Carbon-London-\(LCL\)/Project-Documents/LCL%20Learning%20Report%20-%20SR%20-%20Summary%20Report%20-%20DNO%20Guide%20to%20Future%20Smart%20Management%20of%20Distribution%20Networks.pdf](http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Low-Carbon-London-(LCL)/Project-Documents/LCL%20Learning%20Report%20-%20SR%20-%20Summary%20Report%20-%20DNO%20Guide%20to%20Future%20Smart%20Management%20of%20Distribution%20Networks.pdf)

iv. Options for DNOs to use load control via the CAD and DCC – feasibility and comparison.

DCC required for suppliers to change tariff on the meter. CAD could be used with HEMS to take auto actions or give visual display of change in tariff e.g. at an IHD or other consumer device.

3a. Load Limited Contracts – Load Managed Area

Smart Meters can currently support a load limit setting which can disconnect supply for a set period of time if the load limit is exceeded for a set amount of time. The functionality is currently under the control of suppliers and is currently intended to operate as below:

- a) The supplier receives an alert about the load limit being exceeded and the event is logged. This enables suppliers to offer, for example, a bonus if a consumer doesn't exceed a set load in a given month
- b) Alternatively, when the load limit is exceeded the supply goes off and the meter is immediately rearmed. The customer can immediately re-enable if they have reduced their load to below the threshold. In addition, there is a capability to set a restoration period after which the supply will automatically go from armed to enabled state (and the load limiting function will be turned off – so that the process is not immediately repeated).

New customers within a load managed area could be signed up on a load restricted contract effectively agreeing to a period of supply disconnect when load limits are exceeded. Existing customers could be asked to also sign up but would probably require some financial incentive/tariff that would need to be developed in conjunction with suppliers. Load limiting could also only be enabled (or disabled) during abnormal operating conditions.

i. Benefits/Costs of DNOs having load control and other functionality

Benefits to DNO would be from avoided reinforcement.

Benefits to customers would be improved service, more effective tariffs with ensuing reduction in energy costs.

Costs should be minimal as the meter functionality exists, though additional costs would be incurred if DNO were to be given direct access to load limit settings. Additional functionality with DNO systems may also be required to model the impact of load limiting based on smart meter settings. Instantaneous active power (kW) is the measure used to trigger a load limit action in the meter. Although a time period can be set during which active power measurement must exceed the threshold, the load limit function may help to avoid spikes rather than significantly reduce overall loading of the network.

Future meter functionality which allows load limiting based on kWh measurements may have a potential benefit. Alternatively, the use of meters in prepayment mode could be considered as a means to control load in this way, though this again is under the control of the supplier.

ii. Technical feasibility of load control

The above method relies on either liaison with the supplier or load limit control moving to the DNO. There may be a need to stagger the load limiting settings on smart meters if there was wide scale use i.e. if the supply can only be turned off

rather than reduced then no point all meters on particular a feeder hitting the load limit at same time, all switching off, then switching back on at same time.

As the load limit is to an extent self-governing once the smart meter is configured, there is a degree of uncertainty for the DNO in the response that will be achieved (hence previously mentioned need for additional analysis capabilities).

iii. How might DNOs get access to load control

Either via liaison with suppliers or transfer of control over load limit settings to DNO. Supplier liaison might be achieved through coordinated industry fora.

iv. Options for DNOs to use load control via the CAD and DCC – feasibility and comparison.

DCC can be used to configure load limit, currently a supplier responsibility. CAD could be used to inform user of load limit action or warning/provide timer to restoration. However, load limit information is not currently intended to be available directly from the smart meter to the CAD. If the CAD monitored power it may additionally allow the customer or HEMS to automatically take action to avoid triggering a load limit again.

3b. Load Limited Contracts - Radio Teleswitch Replacement

Currently the GB market supports dynamically switched tariffs via the Radio Teleswitch (RTS) and other switching mechanisms (such as timers at the meter). When the tariff is switched a load switch may also be used to activate load such as water and space heating to take advantage of cheaper tariffs. This system has been used for many years but will effectively be replaced during the smart meter rollout by functionality such as the ALCS in smart meters. DNO are working via DCUSA to retain visibility and some elements of control for these switching actions to avoid synchronised step changes in load.² With suppliers assuming full responsibility for all aspects of load control under SMS, DNOs and suppliers are working together to ensure the effective transition of services offered to existing RTS customers. This form of collaboration with DNO/suppliers could be replicated for some of the other scenarios mentioned in this paper.

4. Use of SM load control switches to mitigate the need for global demand control actions under ESEC and potentially Grid Code OC6

Smart Meters equipped with ALCS could be utilised to bring about a significant reduction in system demand under emergency network conditions.

Under the Electricity Supply Emergency Code (ESEC) the SO may require DNOs to apply global demand reductions which are implemented via voltage reduction and then rota disconnection.

The need for, frequency of and level of demand disconnection could be reduced over peak demand periods by use of the smart meter ALCS control switches to reduce related demand as a pre-cursor to actual demand disconnection.

² <http://www.dcusa.co.uk/Documents/DCP%20204%20Consultation.pdf>

i. Benefits/Costs of DNOs having load control and other functionality

Benefits to customers would be improved service.

Costs should be minimal, as DCC infrastructure exists for ALCS control actions, though as before costs would be incurred if non-suppliers were given access to these critical commands

ii. Technical feasibility of load control

To utilise the benefit reliably it would be necessary to have knowledge of the size of demand under ALCS control (as discussed previously).

iii. How might DNOs get access to load control

Currently would require liaison with suppliers who control the ALCS. However, there is a possibility access could be enabled for the DNO or SO dynamically when ESEC is activated – this would require significant smart meter system changes.

ESEC also does not envisage such use of smart meter demand controls. This could be changed to place the obligation on suppliers or enabled via the DNO or direct by the SO. A legal review of the application of ESEC would be required as existing powers may permit such use.

This issue has been considered separately by the SMSG.

iv. Options for DNOs to use load control via the CAD and DCC – feasibility and comparison.

DCC can be used to activate the ALCS, although only the supplier has this role currently.

CAD/IHD could be used to inform user of the action although this functionality is not currently in place.

5. Use of SM demand control to mitigate the number of customers remaining off supply during network fault events

Smart Meters equipped with ALCS could be utilised to bring about a reduction in network demand under emergency network conditions. During periods of severe network depletion N-2 etc, the NO may be unable to restore all customer supplies from the remaining network infrastructure. The ability to disconnect load under SM ALCS could; dependent upon the time of day and associated loading conditions, enable the DNO to restore more customer supplies hence potentially reducing CMLs and potential GS failures.

i. Benefits/Costs of DNOs having load control and other functionality

Benefits to DNO would be reduced CML.

Benefits to customers would be improved service.

Costs should be minimal, as DCC infrastructure exists to perform load control actions. Again, costs would be associated with changing access permission to these critical commands.

ii. Technical feasibility of load control

To utilise the benefit reliably it would be necessary to have knowledge of the size of demand under ALCS control.

iii. How might DNOs get access to load control

Currently would require liaison with suppliers who control load switch.

iv. Options for DNOs to use load control via the CAD and DCC – feasibility and comparison.

DCC can be used to configure ALCS, although only the supplier has access to this role currently. CAD/IHD could be used to inform user of the action although this functionality is not currently in place.

Other Smart Meter Data Use

This paper has focused primarily on the use of consumption for control load. Other measurements are available from smart meters

- Maximum demand – as mentioned, rather than using discrete half hourly consumption measurements in some cases the maximum demand over a certain time period will provide sufficient information to apply load control mechanisms
- Voltage – voltage profile information is also available as a half hourly measurement. However, there currently remains uncertainty as to how accurate these measurements will be. Hence, it remains uncertain how DNO will be able to use this information.

Recommendations

DNOs can obtain access through Suppliers to load control switches. This note recognises some of the challenges of this arrangement. It does not seek a change in the SEC to allow DNOs direct access to load control switches. However, it considers that this should be kept under review as SMs are rolled out and new commercial arrangements develop. If, in future, multiple stakeholders like Suppliers, TSO, or DNO access load control or load limiting functionality through SMs then some coordination between requests will be required. If load control is to be enacted via suppliers then it is imperative that a working practice is put in place to enable this.

This note recognises data aggregation (the ability of DNOs to obtain granular SM consumption data under its data privacy obligations) as a potential barrier. It is important that the approach agreed to data aggregation facilitates the best possible facility to enable future load control benefits. This issue is being investigated by the ENA SM Group.

Is unlikely that reactive solutions i.e. responding to a constraint which has occurred will be feasible. Proactive i.e. predictive, solutions are more feasible. However, proactive LV analysis for constraint identification (as described in scenario 1a) is not currently commonplace in DNO and hence, these processes will need to be developed.

The load under ALCS control is currently unclear to the DNO and other parties (as they are not separately metered) and hence, they should be provided with as much information as possible to help estimate this. This issue could be considered in two ways:

- 1) as a potential issue for any party seeking to make use of ALCS control, industry guidance could be developed on ALCS load estimation
- 2) future SMETS functionality to allow separate metering.

Working paper