Work Stream Six Interim Report April 2014

Executive Summary

This interim report marks the half way point in the ambitious work stream 6 (WS6) programme of the smart grid forum (SGF). It sets out high level options through which customers can participate in smart grids alongside the roles and relationships industry parties will need between each other and with customers.

The options developed are not exhaustive but are intended to be broad ranging. They are designed to act as use cases to test against current regulatory and commercial frameworks in order to identify any gaps or where enablers may be required. We are not advocating any particular option or group of options. Many of the options for domestic customers will not be viable until the early 2020s once there is full roll out of smart meters and when the take up of low carbon technologies starts to drive the need for reinforcement of the low voltage networks. However, given the lead times to change industry arrangements we consider it is important to start thinking about these issues now.

In developing the options, we have leveraged the learning from the ongoing Low Carbon Network (LCN) Fund projects and held a series of focussed work shops to extract knowledge from these projects. We have also leveraged a number of other innovation studies and outputs from other groups looking at the commercial arrangements required for smart grids and, including the provision of demand side response (DSR).

We have developed nine generic options through which domestic customers could participate in a future smart grid. We concluded that each of these has a number of variants, whether the customer engagement is led by the supplier, a DNO or potentially a third party; whether the option is mandated or voluntary; and the different methods through which a customer can engage. This engagement could be facilitated through automation (either at the customer's premises or remotely).

We have also set out options through which industrial and commercial (I&C) customers[1] and Distributed Generation customers can engage. Many of these options are already being deployed by industry parties but there are questions over how they can work in a more efficient manner, particularly to allow the whole system benefits to be realised. Part of this is ensuring that dynamic demand response is visible within the wholesale market and this in an area the work stream and other parties are taking forward. Another aspect is around ensuring that there is consideration given to the design of interruptible contracts in the event that the network is reinforced in the future.

Some of these options, while potentially attractive to customers, would potentially only be useful to DNOs under very specific conditions, making it difficult for the DNOs to realise the benefits. Similarly, some of the options would provide opportunities for network operators but pose potential customer impact issues.

[1] Defined as those customers with an annual consumption above 55,000kWh

For example, some customers may be put off by the complexity of options involving parties they are unfamiliar with (such as DNOs and aggregators). Some customers may also be mistrustful of new, more complex tariff structures. It will be important (for all options) to carefully consider how customers are approached and informed about how they can engage with the smart grid. In particular, work is needed to ensure that customers are presented with simple, clear and understandable options.

Some options involve customers being compensated for allowing third parties (their DNO or supplier) to remotely control appliances during peak times or when the network is in danger of being overloaded. While customers would enter into these arrangements on a voluntary basis, many customers may be reluctant to allow a third party to control their appliances. For vulnerable customers, such as those who rely on electricity supply for medical equipment, this kind of arrangement would likely be unsuitable. We do not propose that any customer should be obliged to enter into an option which is not suitable for them.

In the next stage of work, we will look at how these customer impact issues can be addressed, in particular looking at the customer protection measures required to make the options viable. A specific sub-group of work stream six, chaired by Citizen Advice, has formed to look at these issues – the Customer Participation sub-group. This group's work will feed into the eventual recommendations of work stream six. We note that an important aspect of implementation of any of these options in future will be consideration of the customer impacts, drawing on learning from LCN Fund projects. In the next stage, we will also broaden the scope of work in order to fully examine commercial arrangements between all parties in the value chain and how to leverage the whole system benefits for customer. We will also continue to use emerging learning from the LCN Fund trials to test our options further and understand which methods of customer engagement are likely to yield the best response.

We will produce a final report in April 2015 which will set out the high level commercial arrangements for each option and highlight the gaps or challenges which need to be addressed. Where possible the report will identify the party best placed to take forward work to resolve the issues identified.

Introduction

Purpose of the report

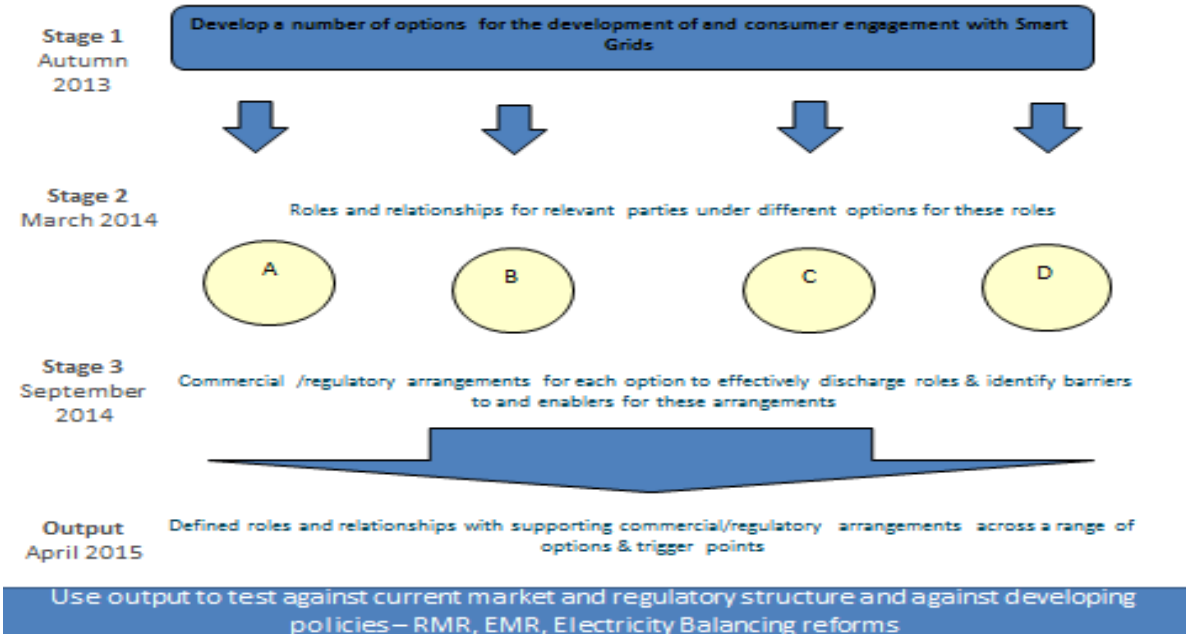
The purpose of this interim report is to update the SGF on the progress of the work stream now that the first two stages comprising the first half of a two-year work programme have been completed. WS6 will now begin to focus on the remaining stages of the existing programme which will build on the work undertaken to date. **The views expressed in this report are those of the work stream as a collective**. The organisations which have participated in the work stream and helped progress the work programme are set out in appendix 5.

Background

In August 2012, work stream six members submitted a report on the group's progress to the SGF. This focussed on identifying barriers to Distribution Network Operators (DNOs) using the smart grid solutions identified in work stream 3 within RIIO-ED1 business plans. The conclusion was that there were relatively few barriers, namely planning standards and charging methodologies which are in DNOs' power to amend. In completing this work the work stream identified some longer term issues which the SGF agreed were worthy of further investigation.

These issues included how DNOs could engage with customers to help them change their behaviour to help avoid reinforcement costs and assist with the running of a more efficient distribution system. Part of this involved assessing how to maximise the value

of the response in order to make the proposition financially appealing to customers. This requires investigating which party is best placed to engage with customers and what information sharing and commercial arrangements are required to reflect the cross party benefits of the response. Only through this might it be possible to have customers willing to actively engage with smart grids. With this in mind, in April 2013 the SGF approved the terms of reference which sought to investigate these broader issues. These terms of reference involve sequential stages outlined in the diagram below.



In progressing these, the work stream picks up a number of the next steps identified in its August 2012 report, including how a distribution system operator (DSO) role might evolve and unpicking how storage is treated in the regulatory framework. These next steps, along with current progress are attached as appendix 4.

Structure of the report

This interim report presents a set of potential options for customer engagement with smart grids which have been developed by the work stream. **Section 1** of the report outlines the approach which has been taken to the work and also the purpose underpinning it. **Section 2** comprises the majority of the report and describes each option developed, and the high level roles and relationships required to deliver each option most efficiently. Following these, we provide a brief assessment of each option. **Section 3** provides some emerging observations which have been made as the work has progressed. **Section 4** highlights the next steps that the group will be taking, in particular how it will progress the remainder of the work programme.

There are a number of **appendices** to the report. **Appendix 1** is the long list of options developed, including all the different variants of those options outlined in section 2. **Appendix 2** is a detailed paper assessing how battery storage fits within the current regulatory framework. **Appendix 3** describes the potential stages to move towards a DSO role, using LCN Fund projects as examples. Appendices 2 and 3 include some next steps which feed into section 4 of the main document. **Appendix 4** includes the next steps identified in the August 2012 report and highlights the progress that has been made. The final appendix comprises the names of all the organisations that have participated in the work stream and helped to progress the work programme.

Section 1: Approach taken

Main body of work

There is a huge volume of work being undertaken across the industry on smart grids. This includes demand side response, storage and other flexibility services. We've tried to use work stream 6 as a forum where this wider work can be shared and used as an input towards our deliverables. Indeed, work stream 6 activities and membership have some overlap with the work of other groups, for example, the DSR Network Forum under the Energy Networks Association. The DSR Network Forum is looking into how network companies can get the best value from DSR arrangements with industrial and commercial customers. Work stream 6 has provided an opportunity for the work of these groups to feed in to this report.

The first main deliverable was to develop a wide range of options in the form of practical examples of DSR products which DNOs (or suppliers) might offer to customers. Network customers entail a number of segments, as follows:

- demand – domestic premises, commercial and industrial premises
- generation – large generators up to 100MW[2] small generators of a few kW
- storage – a variety of technologies.

To develop the options, the group went through a three step process. First, we held a series of focussed workshops on the current customer facing LCN Fund or innovation projects. The workshops focussed on understanding the proposition (tariff, commercial arrangement etc.) which was being put to customers in the trial and how this could be used by industry parties to save costs and return these savings back to customers. We held separate workshops covering engagement with domestic customers, engagement with I&C customers and lastly engagement with distributed generation (DG) customers[3].

Following the workshops, we undertook a literature review of publications which had already looked at similar issues, particularly on how to engage customers and the means through which to do so. This included the Frontier Economics and Sustainability First literature review of major trials for DECC[4]. This paper highlighted a number of ongoing international studies. Building on the first two stages, the third stage was to collect information from work stream members on other international trials which may have relevance to our work.

This three stage process led to the creation of a number of different options. These options comprise of different tariffs or commercial arrangements which DNOs might want to offer to customers as part of a smart grid, some of which may be location-specific. Many of the options are dependent on data and communications which will be available once the smart meter roll out is complete. In developing the options, it was obvious that DNOs will not have a monopoly on such products. Suppliers might equally want to offer them. We have reflected this in our long list of options outlined in appendix 1.

[2] In England and Wales

[3] All slides and summary notes from each workshop are published on Ofgem's website: https://www.ofgem.gov.uk/electricity/distribution-networks/forums-seminars-and-working-groups/decc-ofgem-smart-grid-forum/work-stream-six?page=1#block-views-publications-and-updates-block

[4] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48552/5756-demand-side-response-in-the-domestic-sector-a-lit

The work stream spent some time refining the options that were created, trying to avoid duplication and ensure that there were clear differences of objective and purpose between each option. It was obvious that some options, particularly the mandated ones, are less likely to be acceptable to customers. While the work stream is not advocating these options, it did not want to remove them at this stage in the work. The idea behind generating so many options is to ensure a wide spectrum which we can use to undertake a robust test of the current commercial and regulatory framework in GB. To reflect some of the discussion and debate within the work steam, Section 2 includes a brief assessment of each of the options, highlighting their benefits and drawbacks.

Once the options had been defined, the work stream started to think about how each option might work in GB. This comprised of developing the high level roles required of, and the relationships between industry parties. The work stream has captured these roles and relationships in diagrams which are set out in the section below. The diagrams depict how five key aspects will work. These aspects are highlighted in the diagram on page 8 and have each been allocated a specific colour in the diagrams.

We plan to continue developing the options in the next stage of work from April onwards. This final stage will look at the commercial arrangements required between industry parties to support the high level roles and relationships. These next steps are discussed further in section 4.

Picking up the next steps in 2012 report

The work stream's August 2012 report set out a number of next steps. These are attached to this paper as appendix 4. Many of the next steps are being taken forward as part of the main body of work. Others are being progressed separately outside of work stream 6, albeit with the work stream monitoring progress. There were also some specific actions on the legal framework for storage and also the stages of the DSO role. While these are linked to the main body of work, we felt that they deserved a separate focus.

Storage

There has been and remains a debate over the status of storage in a legal framework which wasn't specifically designed with storage in mind. Ofgem took a number of actions in this area and has produced a paper relating to battery storage (see appendix 2). This paper summarises the regulatory and commercial issues surrounding battery storage. It tries to distinguish between legacy issues, which could be unintentional and others where perceived barriers may be necessary to protect customers' interests. Appendix 2 highlights a number of next steps to be pursued. Many of these next steps fit well with those outlined in section of this paper. For instance, establishing mechanisms to provide visibility of storage operation to all market participants and also enabling the whole system benefits to be realised.

Stages of a DSO role

The work stream has also produced a short paper in appendix 3 which describes the potential (evolutionary) stages of a DSO role. This paper outlines a path for moving from being a passive DNO to an active DSO. It uses aspects of LCN Fund and other innovation projects to illustrate different stages of this progression. It is designed to be an illustrative piece and also one which can be developed further in the last stage of the group's work assessing barriers and enablers. It is important that the DSO role is clearly defined and understood by all industry participants. This will help create a common understanding to inform discussions regarding roles, responsibilities and boundaries

between industry parties. Appendix 3 highlights some next steps which include defining the DSO role more fully and the trigger points for any future transition.

Matrices

To help the work stream progress some of its work, members developed a series of matrices designed to identify where there might be existing barriers to customers offering flexible products. Three separate matrices were produced to reflect the products and services which I&C customers, DG customers and storage customers can provide. These have helped identify existing commercial barriers which can get picked up in the next stage of the work programme. The matrices are published, alongside this document on working papers section of the work stream 6 website[5].

Early observations

While we are only half way through the work programme, a number of observations have been made and it is worth highlighting these now so that they can feed into ongoing policy development. These observations are outlined in section 3 below.

Section 2: Options for engagement with smart grids

This section describes the options that the work stream has developed through which industry parties can engage with customers. We have developed a different set of options for domestic, I&C and DG customers. These options are in the form of a tariff or commercial arrangements and could be offered by the DNO directly, in some cases via a supplier, or potentially via a third party (such as an aggregator). These may vary by time (eg Time of Use tariffs) or, potentially, location. Note that we have not fully considered the role of the system operator (SO), aggregators or other in offering these options directly to customers. As outlined in section 4, we will look at this as part of next year's work programme.

Throughout this section we provide an initial assessment of the options to reflect discussions within the work stream. We have also described (in the form of diagrams) the high level roles and relationships which are required to facilitate each option. These will form the basis of the commercial and regulatory arrangements which will be developed further in the next stage of work. The working paper section on the work stream 6 website[6] includes a roles and relationship diagram for each option, including its many variants outline in the table below. In this report, we have included one generic diagram for each option, so as to avoid repetition.

Guiding Principles

This report does not aim to provide an exhaustive list of options for customer engagement with smart grids. Rather, the report provides examples of arrangements to test against the regulatory and commercial framework. It does not preclude the development of other alternative options and arrangements.

The options described in this report are based on a certain number of assumptions and guiding principles. These include that:

- Consumers are willing to engage;

[5] https://www.ofgem.gov.uk/publications-and-updates/working-documents-work-stream-six
[6] https://www.ofgem.gov.uk/publications-and-updates/working-documents-work-stream-six

- The options are designed for a RIIO-ED2 environment where the smart meter roll-out has been completed and the take up of low carbon technologies is starting to drive reasonable levels of reinforcement at the lower voltage levels;
- All parties are free to engage with customers for demand side response.

Engagement with domestic customers

For each of the options described in this section, there are a number of variations which are worth discussing up front.

Supplier Vs DNO engagement

As already highlighted, the options could be offered to the customer by the supplier, or by the DNO. In GB, we have followed the principle of a supplier hub. We are not suggesting that this is reversed but we did want to examine whether a direct arrangement between a customer and a DNO is a feasible option which provides benefits in certain circumstances. One of these benefits may be that direct DNO engagement ensures that the full cost signal is visible to customers and provides them with an incentive to respond. There is always a risk that if the price signal goes via the supplier it could be smeared across a large customer base. However, we acknowledge that if the DNO is engaging directly with the customer this may require the DNO to develop and invest in a new systems and processes to engage with customers directly. This could duplicate the systems already in use by suppliers. The proliferation of parties in contact with the consumer could also lead to confusion or mixed messages and would therefore need to be carefully managed and presented to customers. If DNO engagement is via an intermediary or supplier, additional arrangements between the relevant parties may be required to enable the DNO tariff signal to be passed through.

Voluntary or Mandated

The options we have described could be voluntary or mandatory. We're not advocating a mandatory approach but recognise that some options, like product standards, will only work if they are mandatory. In addition, many changes to the DUoS methodology could be applied universally as part of a move towards greater cost reflectivity as opposed to socialisation.. The engagement from customers is likely to be less effective if an arrangement has been forced upon them. Conversely, mandating an option could result in a stronger response and one which is more reliable and predictable for a DNO, but this would come at a high cost of consumer detriment and may alienate them. It may be preferable to link a mandatory requirement to customers undertaking certain activities, such as purchasing a heat pump or electric vehicle, or as a requirement for access government subsidies. This would obviously require changes to GB or European legislation, as well as industry codes and licenses.

Methods of engaging with customers

Most of the options developed are designed to engage with the customer and to try and change their behaviour. To achieve this, we have set out three different methods. All of these methods rely on a price signal to provide an incentive to respond, however they differ in the means through which that response is delivered. The first method is to rely on active customer response to the price signal and involves no automation; the second allows customers to set parameters for their devices to be automated in response to the price signals; and the third allows an industry party to remotely control certain devices within pre-agreed boundaries in return for a lower bill or payments.

Active response to a price signal, **without automation** allows customers to remain firmly in control of their energy usage. For instance, refraining from certain energy intensive tasks during peak times. However this may make maximising savings more difficult. The timing of tariff changes or price signals may not always be at the forefront of customers' minds as they go about their lives e.g. putting the washing on, cooking or ironing.

Consequently, the **automation of devices at the premises** could help deliver a more certain response to industry and greater savings and provide more convenience to customers. Customers could actively choose the price or time when automation would apply and to which appliances it would apply to. Once set up, customers would not need to think about how they adapt their behaviour but could still save money on their bill. Because the customer would set (and be free to change) the parameters of the automation they would maintain control of their energy supply.

Remote automation of appliances may be a difficult message to put to customers as the concept implies that a third party takes control of customer appliances and will need to be fully tested with customers. However, this could also be done through customers choosing their own parameters. For instance, having an arrangement where their dishwasher will always be put on a cycle between 10pm and 6am but for an industry party to have control over exactly when the dishwasher is placed on a cycle. In many cases (as with the current radio teleswitching arrangements) customers may not notice that their appliance is controlled. However, it is highly likely that remote automation would need a consumer override, and regulation of this would need to be considered at a later stage. This might diminish the effectiveness of automation in creating a load shift, but would be in accordance with the principle that technology should help consumers to shift their load if they want to rather than forcing them to.

The pros and cons of these different methods of engaging with customers largely depend on the option (tariff or commercial arrangement) they are used in conjunction with. For instance, there might not be any need for automation alongside a fixed static time of use tariff which customers can learn to adjust their energy usage around. However, for dynamic or critical event options, where an industry party requires certainty of a response, automation or remote control could be the most attractive option.

Variants on options

In the table below we have 9 rows which summarise the options (tariffs or commercial arrangements) we have developed for engagement with domestic customers. These are described in more detail in the remainder of this section. In the columns we illustrate the different variations discussed above.

We have identified in red where some of the variations might not be appropriate for each option. For example the critical event arrangements require a fast response from customers and an arrangement without automation would be unlikely to deliver this. We also recognise that some of the options may not be suitable for vulnerable customers, for example if it could mean limiting supply (e.g. load limiting) in certain circumstances. Consideration would need to be given to customers' requirements when DNOs or other parties offer these arrangements. Cells highlighted in green indicate which of the variations are appropriate for each option, while grey cell reflect that some variations are not applicable to certain options.

Variants on Options

	Direct to customer via DNO or 3rd party	Via supplier		Mandated	Voluntary		Without automation	Automation at premises	Remote automation
1) Restructuring DUoS charges									
2) Two band DUoS capacity charge									
3) Critical event arrangements									
4) Dynamic DUoS tariff									
5) Load limiting									
6) Energy efficiency measures									
7) Demand reduction through information provision									
8) Mandated product standards with or without over-ride									
9) Community energy schemes									

There is a brief summary of each of the options considered for engagement with domestic customers below. For each option, this is followed by a diagram showing the roles of industry parties and the interactions required between them to make the option work in the most efficient way. The diagram below indicates the key elements we've tried to capture in the diagrams and the colour coding used. We also provide a brief assessment of each option based on five criteria which were developed by the working group; the customer impact of the option; the benefit the option can provide to industry parties; the impact the options will have on other market actors; and the viability of the option in terms of its technical and commercial feasibility. The diagrams also highlight some potential barriers. These are discussed in more detail in the emerging conclusions section.

Key Elements

= data flows to industry

= communications infrastructure / notifications

= billing flow

= payments to customer

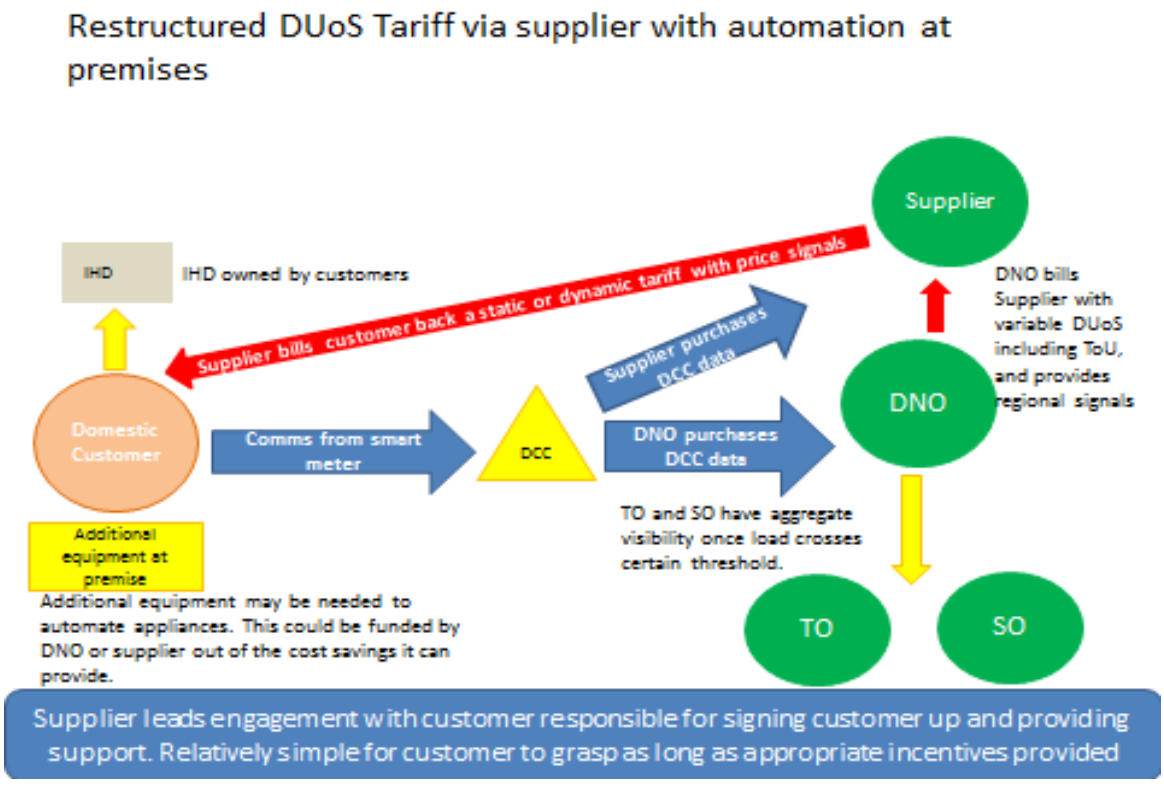
= chain of command (for remote automation)

Option 1: Restructuring of DUoS charge

Method and requirements
This option involves setting a differential DUoS unit charge (p/kWh) or a differential capacity charge (p/kVA) for peak times of the day to reflect the cost of peak network usage. This charge could either be billed to the supplier as per existing practice, or be billed directly from the DNO to the customer on a separate bill. The signal could be common across a DNO area or be location specific to recognise that there is more value in a response on certain parts of the network than in others. A location specific tariff might also be able to reflect that peak demand may be at a different time, depending on the location on the network. This option could be combined with either local or remote automation, and could be offered by either the DNO or a supplier. In order to bill for DUoS charges, the DNO would require smart meter data on total consumption in each time band.

Circumstances when option may be used
A restructured DUoS tariff could apply all year round but it's likely to have the largest cost differential during winter peak evenings to reflect that this is the time when the response has most value to the network.

Roles and relationships
The diagram below is based on a DUoS signal sent via the supplier. An alternative (as outlined in appendix 1 would be for the signal to go to the customer directly from the DNO.



Assessment
DNO and supplier billing systems would need to be highly complex if the DUoS charge was to vary in both price and time depending on location. Customers might also find this variation difficult to understand, particularly if reinforcement on a particular branch of the network reduces the price signal and consequently the customer's opportunity to save money. It is worth noting that change of supplier could make things complex. For example, systems may need to be able to cope with the complexity of regular changes

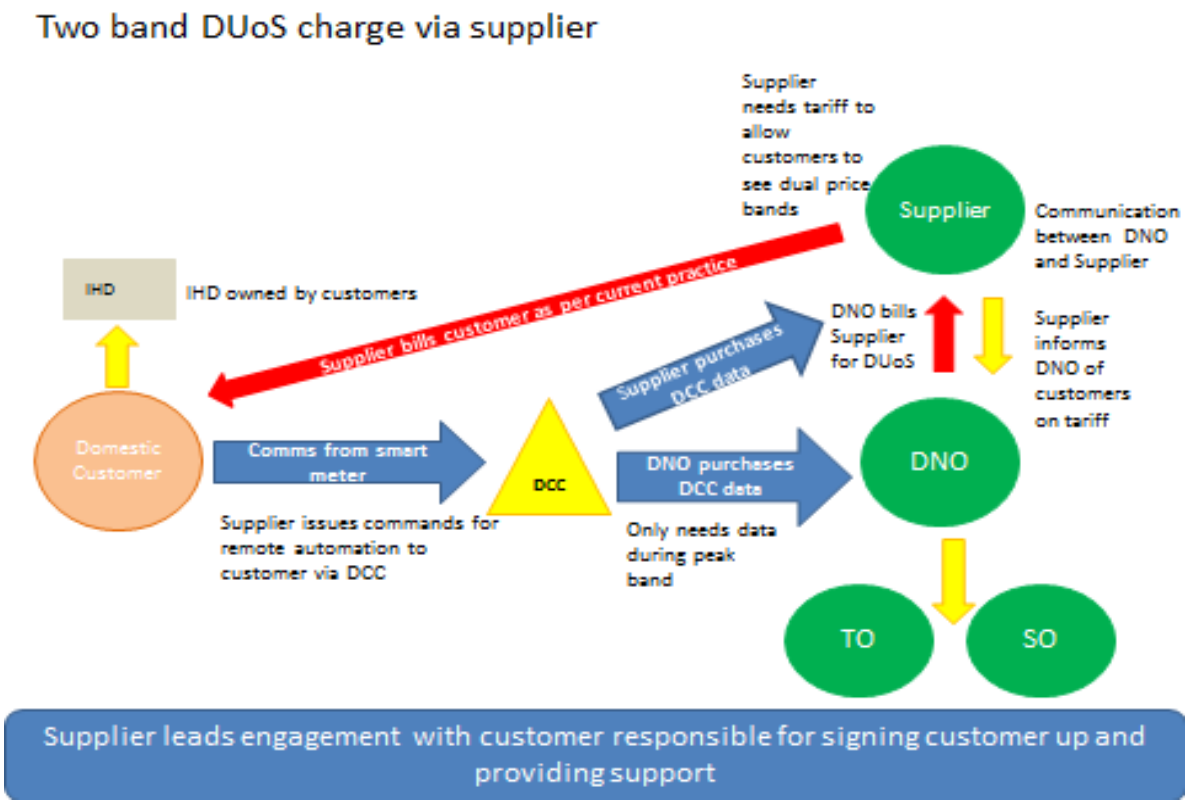
between variable DUoS/supply tariff combinations. In addition, increasing regional cost reflectivity could create a postcode lottery. In general, greater cost reflectivity could lead to cost reductions for customers who change behaviour to take advantage of the tariffs offered but also to cost increases for customers who do not (or cannot) adapt their behaviour. Ensuring that customers have the right information to choose the most suitable tariff for them will therefore be crucial.

Option 2: Two band DUoS capacity charge

Method and requirements
This option would set two bands of capacity charges (p/kVA) in the DUoS charge. Customers would be automatically placed on the lower band. If usage exceeds a capacity threshold within set peak times, the customer is moved onto the higher capacity charge for the duration of the peak period. This is designed to send a strong signal to incentivise customers to stay below the pre-determined threshold during peak times. The peak times will be set out upfront and may just be a single half hour period. The signal could be location specific to recognise that there is more value in a response on certain parts of the network than in others, and that the peak demand may be at a different time. This option could be combined with either local or remote automation, and could be offered either by the DNO or via a supplier. In order to bill for DUoS charges, the DNO would require smart meter data for total consumption in each time band.

Circumstances when option may be used
This could be used by DNOs to target specific peaks which might only occur on a handful of times at winter peak.

Roles and relationships
Again, the option below demonstrates this signal being sent via the supplier but it could also be sent directly to the customer from the DNO.



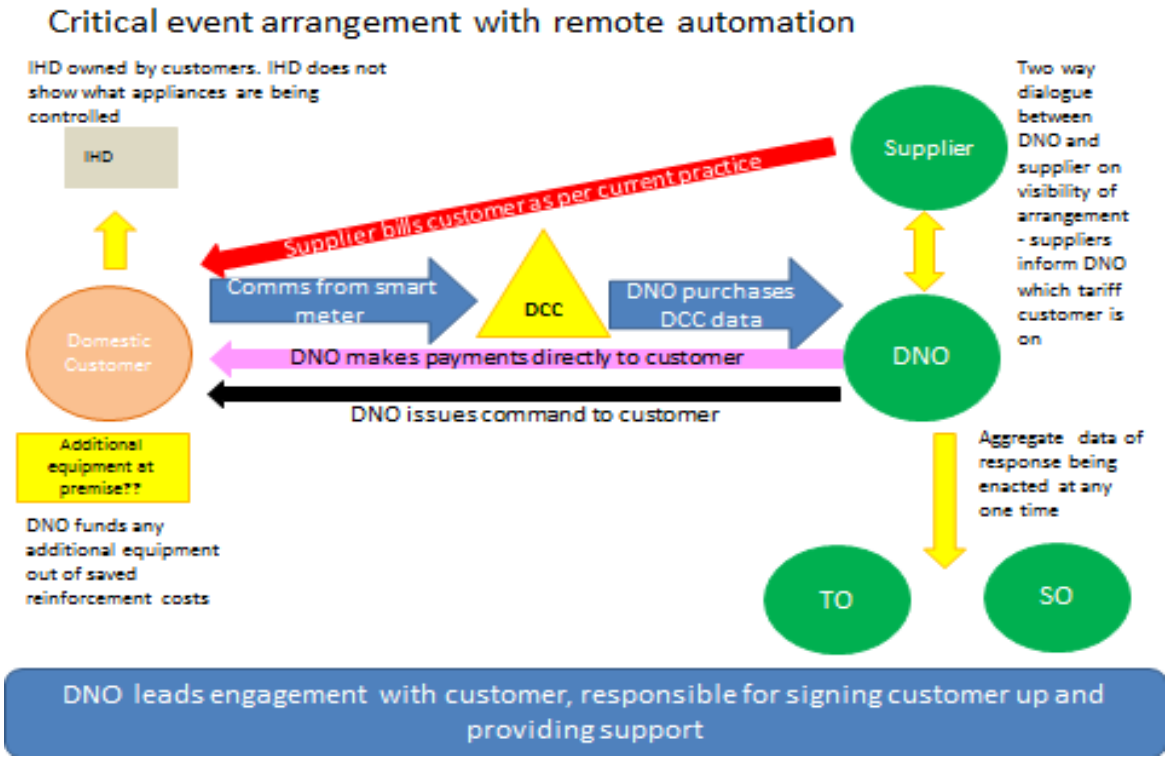
Assessment
The customer would require some form of in home display which is capable of illustrating their real time usage. Automation at the premises may be well suited to this option, since it might be difficult for customers to constantly monitor their usage during the peak time band. Automation of certain devices within the premises could ensure that customers never exceeded the threshold. This option could be particularly confusing to consumers, since it would involve not only the new concept of a DUoS charge but also of a capacity level as distinct from kWh usage. As mentioned above, careful consideration to the presentation of this type of option would be needed.

Option 3: Arrangement for response to critical event

Method and requirements
There may be certain times in the year when the DNO may need a response due to a network fault. Under this option, the DNO could have an arrangement in place with a customer to allow it to remotely control load in a critical event such as a fault. In return, the customer could either be placed on a slightly lower DUoS tariff or receive a rebate on their bill from the DNO. This option will only be possible with remote automation controlled by the DNO (either using the smart meter via the supplier or directly via some other means).

Circumstances when option may be used
This option could be used for post fault management, particularly on heavily loaded HV circuits which are likely to trip at peak time.

Roles and relationships
This depicts an arrangement directly between the DNO and the customer where the DNO provides a rebate directly to the customer outside of the supplier billing process.



Assessment
Customers may find this arrangement attractive until such time as it is called upon. It can often take a few hours to start to mitigate the impact of a large DNO fault, so customers may have restricted energy usage for a few hours at short notice. This tariff would likely be unsuitable for vulnerable customers because the supply restrictions would be unpredictable in timing and duration. There may also be a feasibility issue as the home access network (HAN) does not have a standard which covers 100% or premises. If this option was to be operated directly by the DNO, a modification to the SEC would be required. This is discussed in more detail in section 3 below[7].

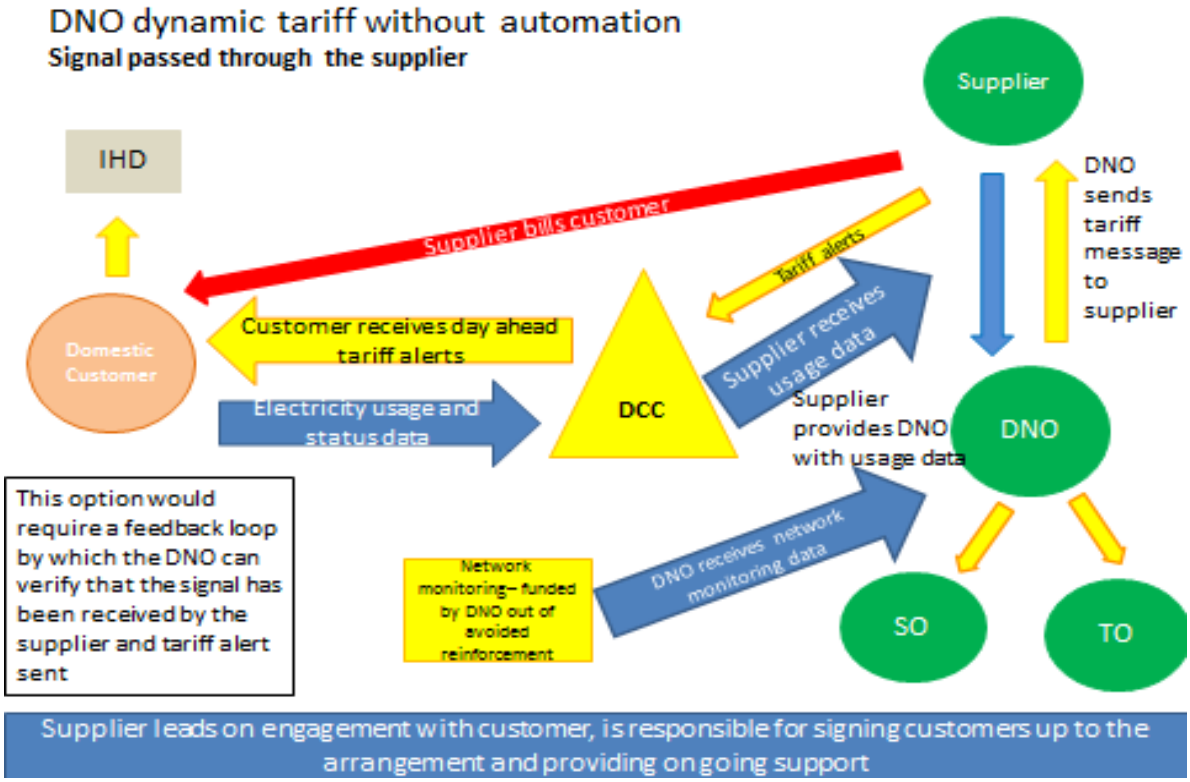
Option 4: Dynamic DUoS tariff

Method and requirements
This option involves providing a variable DUoS tariff which can fluctuate between pre-set points to reflect local network conditions. Customers could receive advanced notice (around a day ahead) of the expected price points for the next day. Either the peak price point and/or the time period will most likely be fixed (as too many variables would make the option unattractive to customers). This option could be combined with either local or remote automation, and could be offered either by the DNO or via a supplier. In order to bill for DUoS charges, the DNO would require half hourly smart meter data.

Circumstances where option may be used
This option could be used in situations where there is high localised generation i.e. wind or solar but low demand. Conversely, it could also be used at times of high demand but low local generation.

Roles and relationships
We have illustrated this example going via the supplier but it could equally go directly from the DNO.

[7] Although we note that new HANs are under development which should cover 95% of premises



Assessment
While specific aspects of the dynamic tariff will need to be fixed (such as price points or time bands) it is still a potentially complicated option for customers to understand and adapt their lifestyle around. Consequently this option may be well suited to automation at the premises (which a customer could pre-programme to respond to certain price points). Such automation is likely to provide more reliable and consistent benefits for customers, provided that the system is simple and understandable to customers. Full half hourly data may be required from smart meters in order to assess the level of response a customer had provided.

Option 5: Load limiting

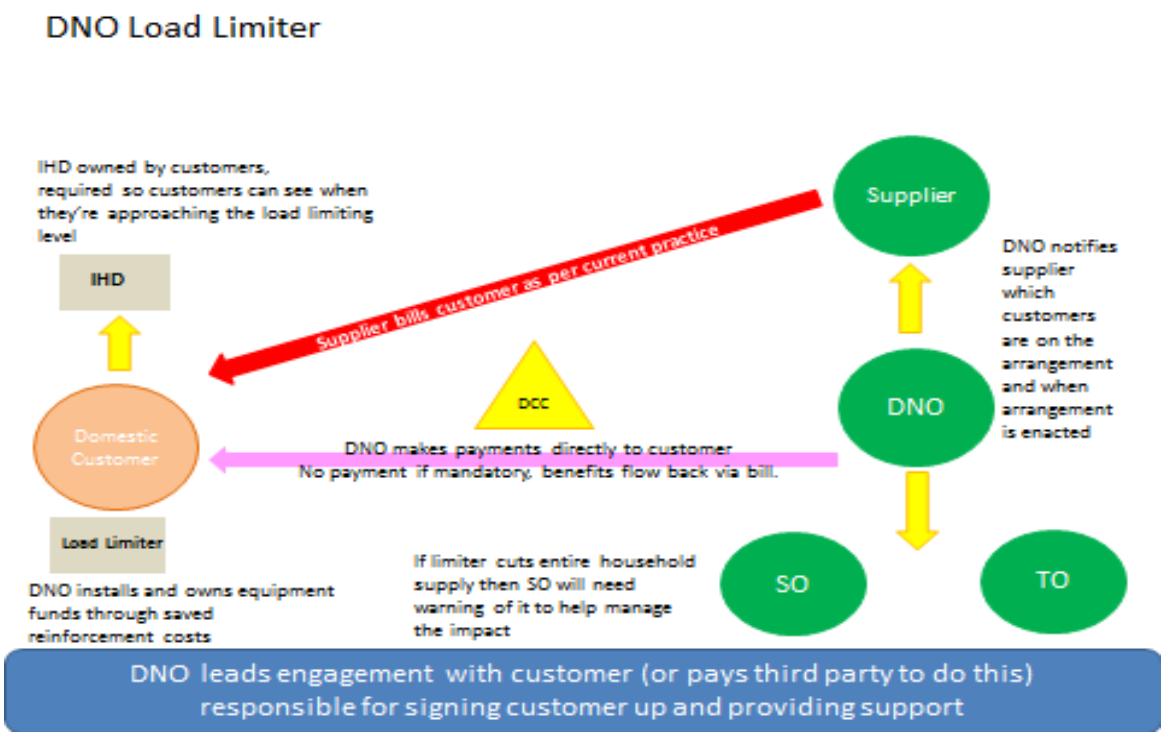
Method and requirements
Customers could have certain appliances (which use high volumes of electricity – such as electric vehicles) fitted with a load limiter in exchange for a lower distribution tariff or rebate on their bill. Equally, this could be fitted as a mandatory requirement if part of a deal when purchasing a heat pump or an electric vehicle (or applying for subsidies), in which case no payment would be made. The load limiter could restrict the usage of certain appliances, or even the entire household according to a capacity level agreed between the customer and the DNO. The load limiter could also be on a timer, so that it only applied in pre-defined peak times.

It is worth noting, a supplier-led variant (unrelated to dynamic response) would be to apply load limiting to customers on pre-payment meters who have run out of credit. It could be operated on a gradually increasing level, so that customers start with some capacity being restricted and the longer they go with no credit, the less capacity they are entitled to.

Circumstances where option may be used

This option is most likely to be used to provide a form of automated peak load reduction. Most DNO peak loads are likely to be at winter peak.

Roles and relationships
This describes the DNO led load limiter but the variant could be offered by suppliers.



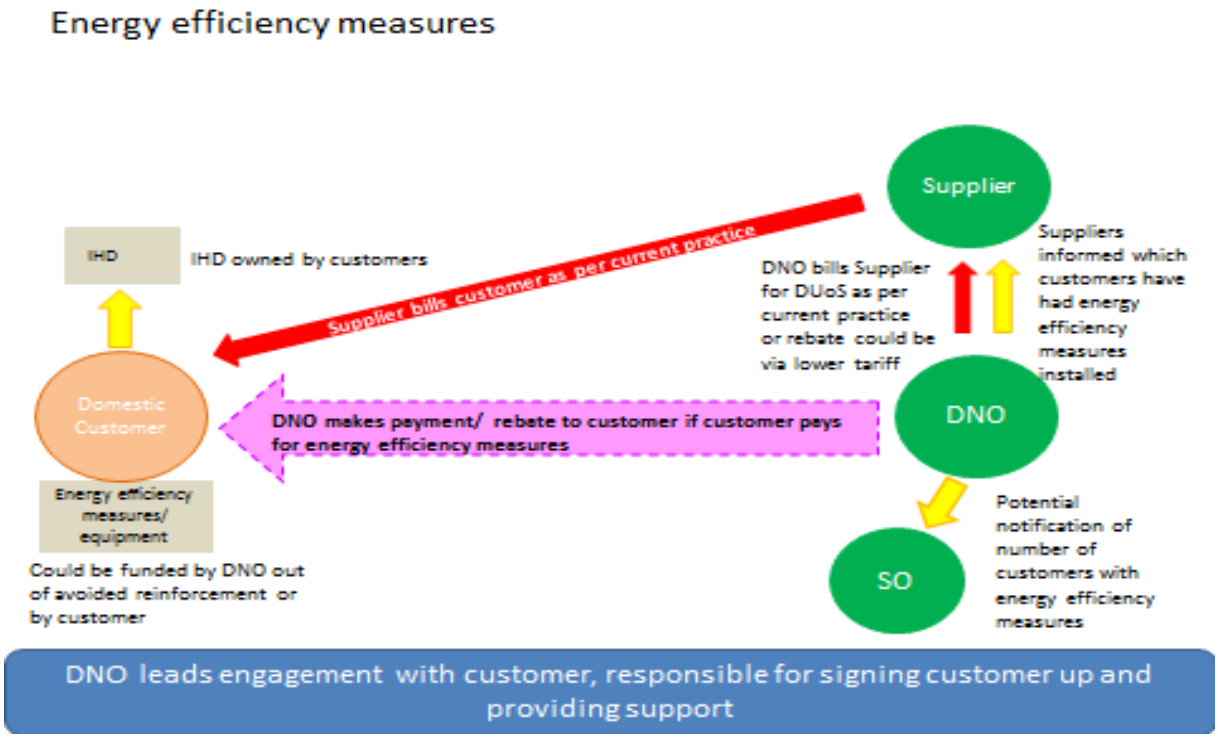
Assesment
This is likely to be unsuitable for vulnerable customers, particularly those who rely on electricity supply for medical equipment. There would also need to be recognition that the load limiting level will need to be set at different rates depending on the size of the premises. In addition, it may be impractical for a load limiter to cut off an entire household. Load limiting can be done through the smart meter functionality, but once triggered it requires the householder to manually reset their fuse at the meter. This could be inconvenient for customers if their meter is located somewhere which is difficult to access. However, load limiting would be very useful for DNOs as it would allow them to plan the network with the certainty that customers on this arrangement would not exceed a certain capacity. From the perspective of the system operator, it would be helpful to know when load limiters will be in operation and how many of them have been deployed.

Option 6: Deployment of energy efficiency measures

Method and requirements
For customers connected to branches of the network reaching full capacity, DNOs could offer customers who chose to install energy efficiency measures a rebate or a lower DUoS tariff to reflect the resulting network benefits. Alternatively the DNO could make a contribution to the cost of the energy efficiency measures to reflect the DNO benefits. The customer is likely to experience a permanent reduction in electricity usage and energy bill. The arrangement could be directly between the DNO and customer, or via a supplier. DNOs might employ third parties (including Green Deal companies) to recruit customers on their behalf.

Circumstances when option may be used
This option may provide a small amount of additional capacity on heavily loaded feeders. However, there is no certainty that this will coincide with local peak demand on the DNO network.

Roles and relationships
This diagram depicts the DNO leading the engagement and signing up customers but this could equally be undertaken by a third party.



Assessment
This could act as an additional incentive on customers to invest in energy efficiency measures. It would be more widely accessible than many of the other options, and could work in synergy with them because as well as reducing peak load, energy efficiency measures would make heating times more flexible. At present, the DNO benefits have yet to be fully tested and are not fully reflected. This is because the retro-fitting of energy efficiency measures is not notified to DNOs and not taken into account in their planning and design of the network. The option is only likely to have benefits where the customer uses electricity to heat their home. However, to deliver sufficient benefit to avoid reinforcement, a number of customers within a concentrated area may need to sign up this arrangement.

Option 7: Demand reduction through information provision

Method and requirements
Under this option a DNO may contribute towards a customer receiving energy management advice or equipment which can help customer manage their energy usage. For instance, equipment which can relay information to customers to help inform them when they are using a high volume of electricity. This will be particularly useful for DNOs if customers are also aware of the impact of peak usage on network constraints. No payment or tariff is provided but customers use the information provided to reduce their overall consumption and electricity bills. This reduction in load may have some network benefits if customers are able to reduce consumption at peak times. This option could

also take the simple form of red, amber, green lights on a smart meter's in home display, to highlight to customers their level of usage at any one time.

Circumstances when option may be used
As with option 6, it may provide some additional capacity on heavily loaded feeders but only if demand reduction coincides with local network peak.

Roles and relationships
This option is a relatively simple proposition and does not require the ongoing provision of data or billing arrangements between industry parties. Consequently, we have not included a roles and relationships diagram.

Assessment
The Irish smart meter trials[8] demonstrated that customers can respond well to information on their usage. It allows customers to stay in control of how they manage their energy usage but also understand when their usage is high. The main benefit is overall demand reduction as opposed to demand shifting. While this could help customers make savings on their bill, unless it is used in conjunction with a time of use tariff, customers may not receive the real value of that reduction at peak times. Furthermore, it may not provide the certainty of response which DNOs would require if they were to use this option as an alternative to reinforcing the network. Consequently, this may be an option which can be used alongside others.

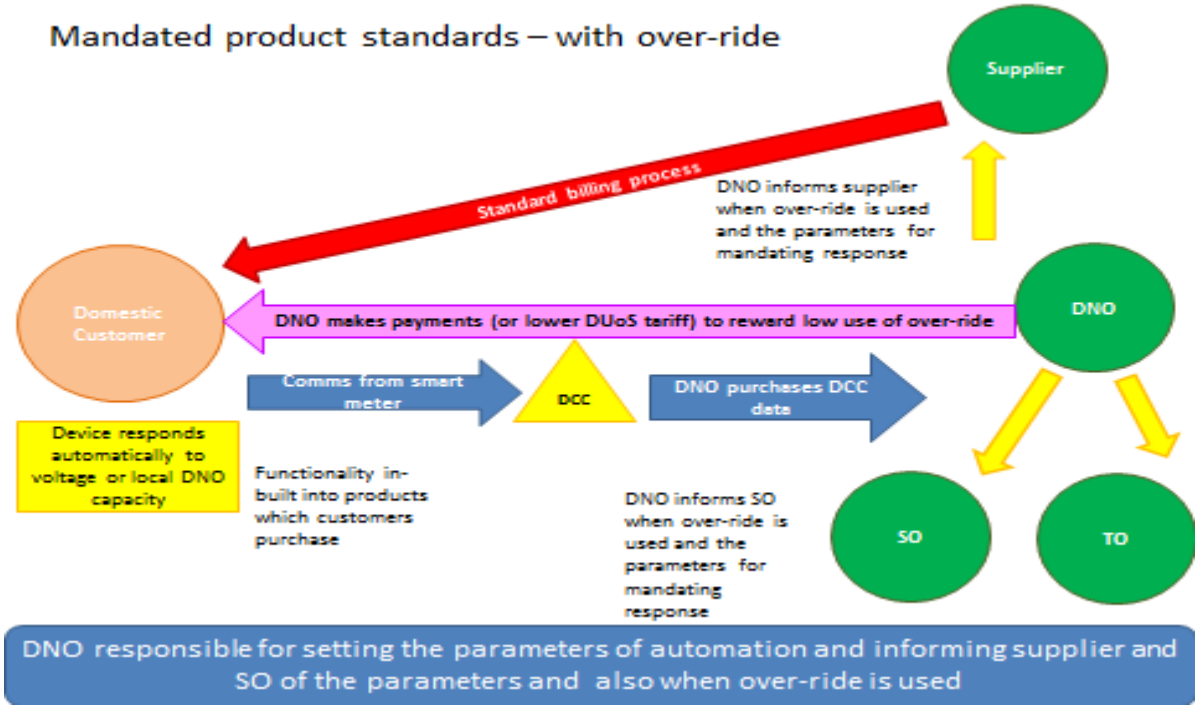
Option 8: Mandated product standards with or without over-ride

Method and requirements
Under this option certain products such as dishwashers, washing machines, electric vehicle chargers, or heat pumps could have demand response capability built in. This functionality would allow DNOs to adjust the electricity consumption of these appliances to help manage their network. For instance, the functionality could be used to adjust the electricity usage of appliances in order to keep voltage within certain parameters. Since the product standards would provide an automated response, there may be a need to have an over-ride function for customers. In order to encourage customers not to use the over-ride, they would need to receive payments for restricted use of it, or for not using it all. Consequently, DNOs will need to know when a customer has used the over-ride or not. This would require half-hourly smart meter data. The benefits of this option would flow back to customers through reductions in their bills. The option would require a change in product standards at EU level.

Circumstances when option may be used
This option could be used as part of an active network management system, set to respond to certain, pre-determined network conditions. This would be most likely to have DNO benefits either at winter peak, or as part of voltage control at times of high local generation output.

Roles and relationships
This diagram includes the over-ride functionality which requires greater granularity of data and payments made to customers to incentivise them not to use it.

[8] http://www.cer.ie/docs/000340/cer11080(a)(ii).pdf



Assessment

Careful thought would need to be given to the customer impact of this option. For example, the length of time over which customer's devices are switched on and off will be a factor in how willing customers are to accept this option. The standard frequency response functionality is of no use to DNOs. They are likely to require a longer duration of response (concentrated in particular areas) to help them manage voltage or capacity. Customers may find this duration of response (which could occur at short notice) overly intrusive. Careful thought also needs to be given to how this option would impact the system operator. European legislation may be required to mandate this functionality within certain products. Customers could receive the benefits through a trickle down affect in their bill, or in the form of payments for infrequent use of the over-ride function. Customers would need to fully understand the implications of load control and the costs associated with using an override. As discussed above, the use of such a mandated option would be a significant and likely controversial policy decision for legislators.

Option 9: Community schemes

Method and requirements

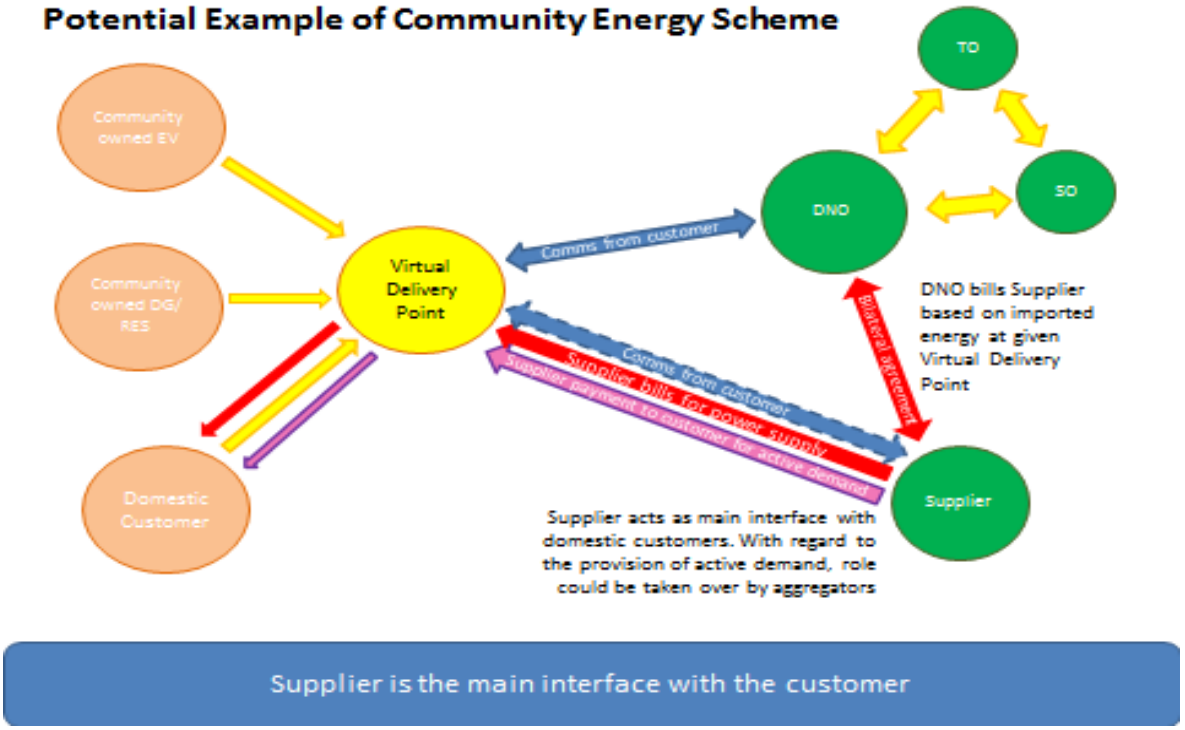
Community schemes could be used as an alternative form of engagement with domestic customers. It is possible that many of the options listed below may work at a community level where the small-scale benefit that each individual customer provides from participation in the DSR proposition could be aggregated into a larger sum. This sum could then be directed towards sources of value to the whole community affected by the network constraint and prepared to provide an appropriate response. Alternatively, this could be an option where the community has control over distributed generation. This would require a different form of engagement from DNOs. DNOs may need to think about how they could adapt some of the options above to suit this community generation model.

We have outlined a specific example below to illustrate one way in which a community energy scheme would work. We're aware that there could be many different models. The example below is based on a new build site which has community owned generation, community owned electric vehicle charging points and domestic customers with micro generation in the form of CHP. The community of third parties creates a virtual delivery

point. This is the entity which the supplier bills based on net import consumption. The virtual delivery point will then distribute the charges among the customers. There is also scope for suppliers (or potentially DNOs) to have a DSR arrangement in place with the virtual delivery point.

Circumstances when option may be used
This option would most likely be used at times of high local generation. It would encourage use of electricity, close to where it is generated in order to avoid thermal or voltage issues on the network.

Roles and relationships



Supplier is the main interface with the customer

The model above is just one example of how a community energy scheme could work. It is based largely on the ADDRESS project being trialled across a number of sites in Spain, France and Italy[9].

Assessment
These arrangements could work best at a community level for new build schemes and may be more difficult to introduce for existing domestic properties. Community energy would require motivated customers who were willing to engage. Research has indicated that customers like to try and be self-sufficient and that this could be a strong driver of behavioural change. In addition, the social aspect of being part of a community scheme may make customers more likely to engage. The increased self-sufficiency of the site could help reduce upstream network investment costs. Our example above might also require a methodology to be developed in order to accurately split costs between customers at the Virtual Delivery Point..

Engagement with industrial and commercial customers

[9] http://www.addressfp7.org/index.html?topic=project_vision Funded under the FP7 scheme.

This following section discusses options for engagement with Industrial and Commercial (I&C) customers. We have considered any customer who must have advanced metering from 2014 onwards to be an industrial and commercial customer. Typically these customers will have an annual consumption above 55,000kWh. At present these customers may be non-half hourly metered (profile class 5-8) or already be half hourly metered customers.

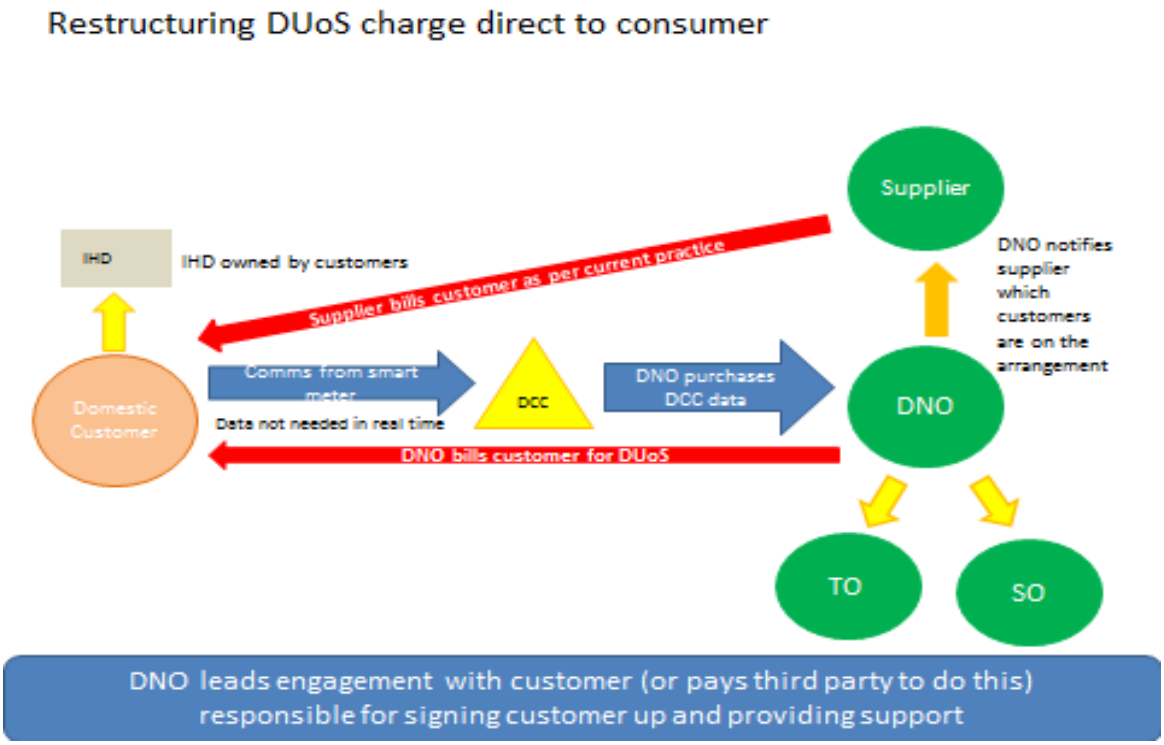
To facilitate automation, additional control equipment and potential communications infrastructure will be required. This could be funded by the DNO from avoided reinforcement costs, by the customer, or by a combination of the two. The options outlined below all have the DNO as responsible for the engagement (or using a third party). There are already a number of instances where DNOs have successfully engaged with I&C customers for demand response. Appendix 1 contains variants on these options which have the supplier leading the engagement with the customer.

Option 1: Restructuring of DUoS charge

Method and requirements
This option is to strengthen the locational element of the DUoS charge in the common distribution charging methodology (CDCM) and EHV distribution charging methodology (EDCM) to provide a more cost reflective signal of the impact of usage at peak on specific parts of the network. This could be done either through a unit charge or a more targeted, locational capacity charge on I&C customers at peak times. This charge could either follow existing practice and be billed to the supplier (to be passed on), or billed directly to the customer by the DNO. This option could be combined with either local or remote automation and could be offered either by the DNO or via a supplier.

Circumstances when option may be used
A restructured DUoS tariff could apply all year round but it's likely to have the largest cost differential during winter peak to reflect that this is the time when the response has most value to the network.

Roles and relationships



Assessment
This option could provide customers with the opportunity to plan their business around times of lower prices. The strength of the signal is likely to vary over time (due to new demand tipping the network closer to reinforcement or the DNO reinforcing the network). DNOs and potentially suppliers may need new billing systems to implement this option. These systems may need to manage additional granularity of data and deal with the same type of customers having varying locational charges.

Option 2: Availability and utilisation payment, or 'pay as you go' response payment

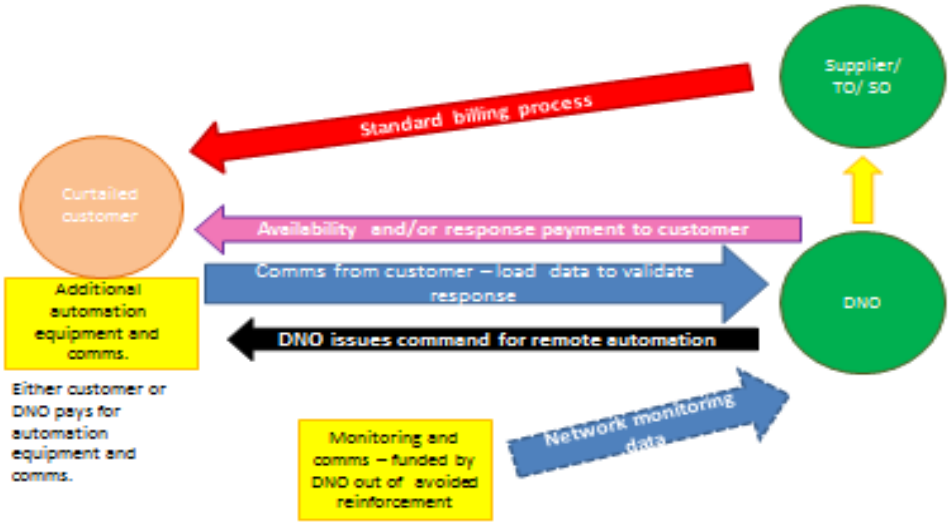
Method and requirements
Under this option, the customer agrees to turn down demand for a fixed period of time when called on to do so by the DNO. The response could be automated. The terms for the arrangement could be set out in a bilateral agreement between the customer and the DNO. The customer is paid an availability payment each month based on the MW they are willing to provide as a response. If called on to provide a response, the customer is paid an utilisation charge per kW/MW per half hour of response. If the customer is unable to respond, they may be subject to a penalty and/or claw back of availability payments.

Alternatively, the customer could simply be paid if called on to provide a response, with no availability payments. The necessary equipment could be paid for by the DNO, the customer or a combination. This option would require either local or remote automation.

Circumstances when option may be used
This option could either be used to target specific winter peaks which might only occur several times a year or it could be used as a post fault load reduction method. The latter would be particularly applicable on heavily loaded HV circuits where the restoration spans across a peak load period.

Roles and relationships
These are identical for both a 'pay as you go' arrangement and an 'availability and utilisation arrangement'. The only difference between the two is the trigger for payments to be made from the DNO to the customer.

I&C option: 'pay as you go' response/ availability and utilisation payment.



DNO leads engagement with customer (or pays third party to do this)

Assessment
To sign up to this option, the customer is likely to need a good level of certainty over the number of times they are likely to be called on for response and the income that can be generated. If the customer funds the additional communication and monitoring equipment then they will want certainty that the benefits they will receive outweigh this cost. The option can provide the DNO with some certainty as the response can be automated. By having equipment installed, the customer may be able to offer other services to other parties at little extra cost. If DNOs have a large number of customers on these arrangements, they may need new systems and staff to manage the engagement (or employ third parties to do this on their behalf). They may also need to inform the system operator of the aggregate level of response per half hourly period.

Engagement with distributed generation customers

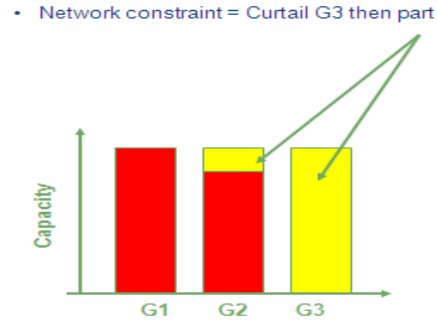
The following section describes options for engagement with distributed generation (DG) customers. There are many reasons for which DNOs may wish to engage with DG customers. Engagement could be beneficial not only in order to avoid network reinforcement, but also for system operation purposes, including voltage support or provision of reactive power. In certain circumstances generators may agree to enter into a non-firm connection agreement, whereby the upfront cost of connection is lower but the DNO may need to interrupt their generation at times of network constraint. A DG customer may agree to an interruptible contract to allow it to connect more quickly than would be the case if it waited for reinforcement to be undertaken to provide firm connection. There are a number of different ways in which these non-firm connection arrangements can work. These are discussed below.

It is important to note that there are financial support mechanisms in place for many types of DG customers, such as the renewable obligation. The options below do not include these financial support mechanisms as they are outside of the control of the DNO. Neither do the options discuss the level of payment which might be required to curtail generators.

Option 1: Last in first off

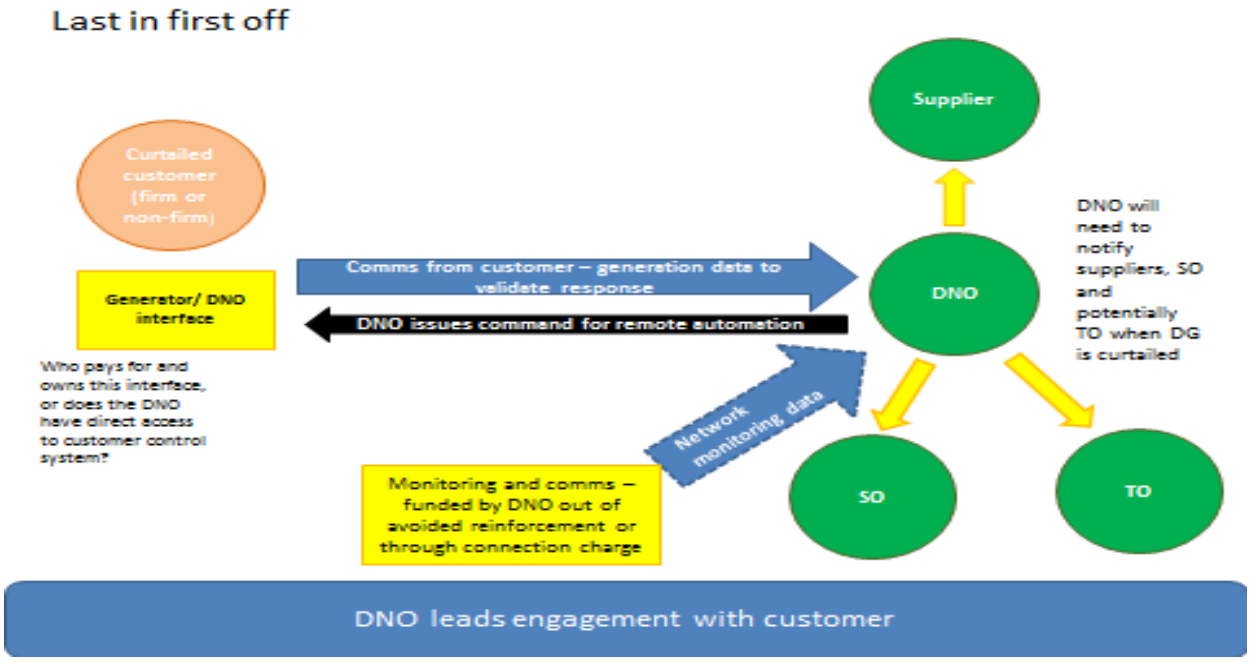
Method and requirements
This option involves the DNO offering a reduced connection charge in exchange for the generator agreeing a non-firm contract. The DNO curtails the output of generators on non-firm contracts in reverse order of their connection date. The most recent generator to connect to the network is curtailed first, followed by the next most recent connectee etc. The generators do not receive any payment from the DNO for curtailment as they signed up to a non-firm arrangement in return for a lower cost of connection. This is illustrated in the figure below where G2 is the second generator to connect and G3 the third.

Example of last in first off constraint management:



Circumstances when option may be used
This option would be used to facilitate the connection of distributed generation, on a constrained network, at the lowest cost. It would be enacted at times when the local generation exceeded capacity limits. This would likely to be a high wind period alongside low demand.

Roles and relationships

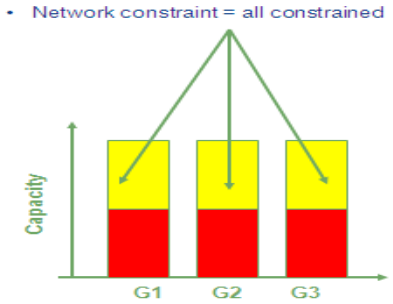


Assessment
The technical and commercial arrangements to support this option have been trialled and shown to be workable. The DG customer has certainty of its place in the connection queue and therefore a reasonable degree of certainty of the likely level of curtailment. However, for the first few customers in the queue, there is no incentive to contribute to any future network reinforcement. Consequently, new DG customers who wish to connect face a choice between a highly constrained connection arrangement (which becomes increasingly commercially unviable) or a significant upfront reinforcement cost (which previously connected generators could benefit from). This is likely to lead at a certain point to no new generators being able to connect. It may be that the constrained generator is lower-cost or more environmentally friendly than the non-constrained generation. This will impact overall costs and (with the assumption that DG is mainly renewable) may lead to higher carbon emissions in GB.

Option 2: Pro rata

Method and requirements
As with the last in first off, the DNO offers a reduced connection charge in exchange for the generator agreeing a non-firm contract. When necessary, the DNO curtails the output of generators on non-firm contracts by the same absolute amount. This is illustrated by the figure below.

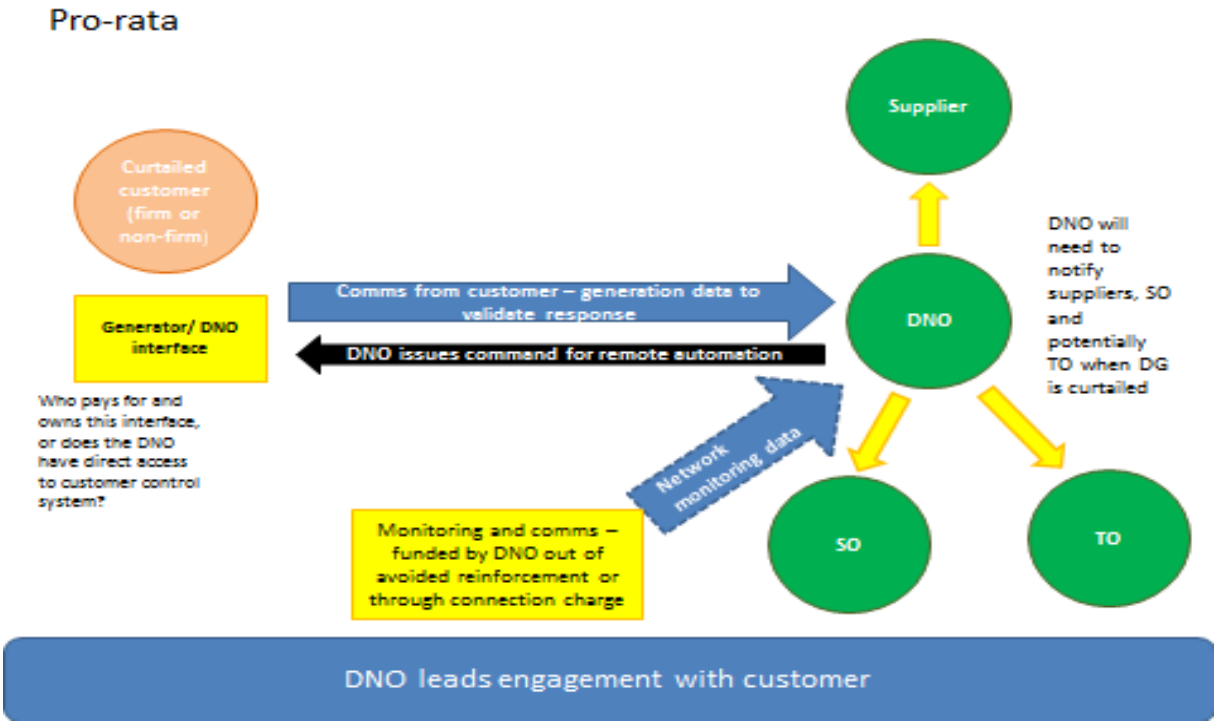
Example of pro rata constraint management



Alternatively, the generators on this arrangement could be curtailed in turn. The generators do not receive any payment from the DNO for curtailment as they were given a lower connection offer.

Circumstances when option may be used
This option would be used to facilitate the connection of distributed generation at the lowest cost. It would be enacted at times when the local generation exceeded capacity limits. This would likely to be a high wind period alongside low demand.

Roles and relationships



The roles and relationships for this option are identical to those for the last in first off option. The only difference between the two being how generators are selected for constraint.

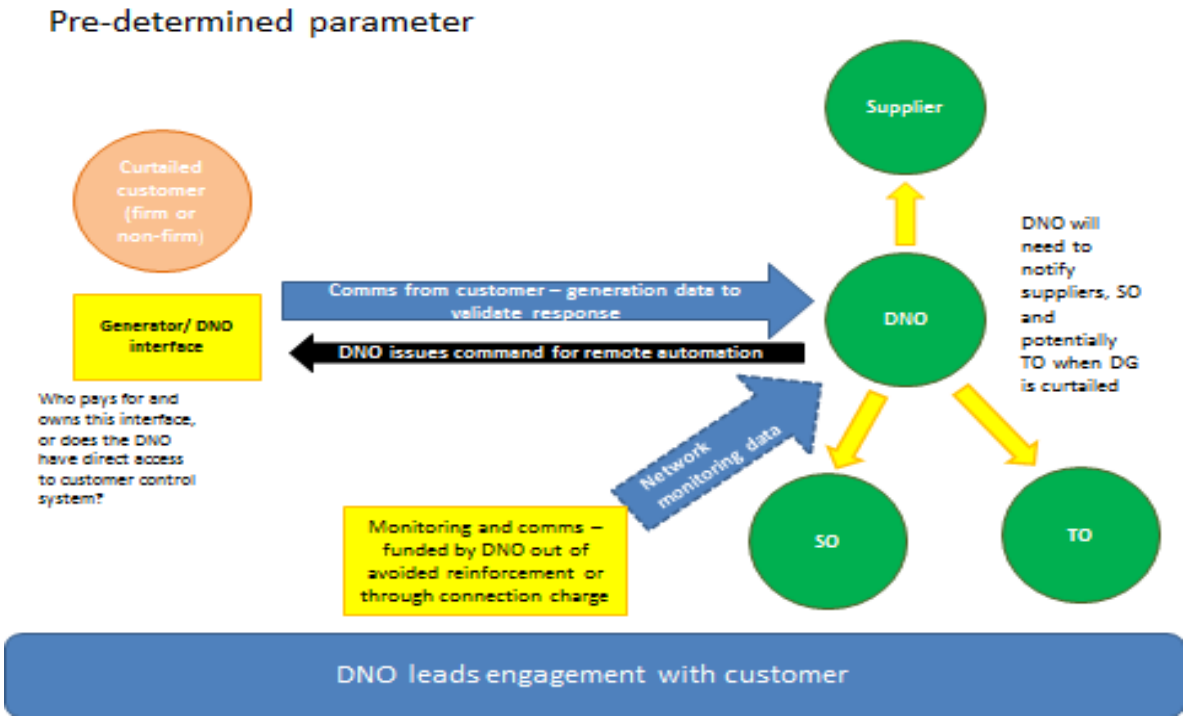
Assessment
This option would remove the 'cliff edge' at which it is not worth another generator connecting to the distribution network. However, generators already connected under a non-firm agreement face uncertainty over how often they will be curtailed as this depends on other generators who subsequently connect. By spreading the cost and risk, all generators have a stake in reinforcement. Once the curtailment costs are larger than the reinforcement costs, it makes economic sense for them all to contribute to the cost of reinforcement. Since each generator is curtailed in equal proportions, this option should not impact on the overall price or carbon content of generation. The technical and commercial arrangements for this option are currently being trialled. Commercially, it may be difficult for generators to commit to a contract where they will have no certainty over the volume of future interruptions they will face.

Option 3: Pre-determined parameter

Method and requirements
As with the previous two options, the DNO offers a reduced connection charge in exchange for the generator agreeing a non-firm contract. When necessary, the DNO curtails the output of generators on non-firm contracts in order according to a pre-agreed parameter (e.g. CO2 emissions, with highest emission generation curtailed first). The generators do not receive any payment from the DNO for curtailment as they were given a lower connection offer.

Circumstances when option may be used
This option would be used to facilitate the connection of distributed generation at the lowest cost. It would be enacted at times when the local generation exceeded capacity limits. This would likely to be a high wind period alongside low demand.

Roles and relationships



As with the pro rata option, the roles and relationships are identical to option 1. The key difference in the option is how generators are selected for constraint.

Assessment
While generators will know where they fall in the merit order against the DNO's parameters when they connect, they will not know how this may change with subsequent connectees. The DNO will have to collect information on how each generator performs against their parameters and keep this up to date. This option will place those generators who perform badly against the DNO's parameters at a distinct disadvantage. This could impact on overall costs, though it is possible that there will be a reduction in cost or carbon emissions.

Option 4: Upfront constraint auction

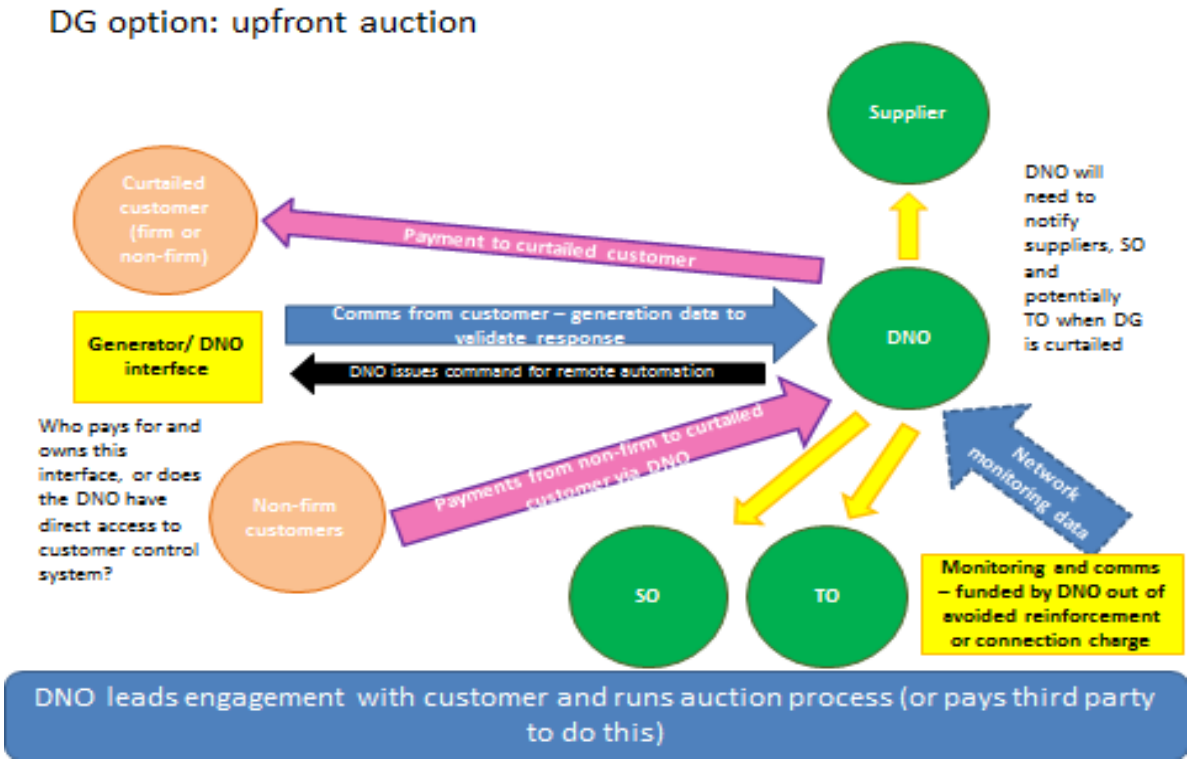
Method and requirements
Under this option, a market mechanism would provide the means through which to allocate constraints across generators. There are two variants.

Variant 1:
This option can be implemented in a situation where there are a number of generators who want to connect behind a constraint. All those generators are asked to place bids to the DNO on the price (per kW or MW) at which they are willing to be constrained. The DNO collects all bids and keeps a log of the price points. When the DNO needs to constrain a generator, they will constrain the one with the lowest bid first. The other generators, on flexible contracts, will then pay compensation to the constrained generator according to the price it quoted at auction. The DNO acts as a middle man transferring the funds between generators. Neither DUoS customers nor generators with firm capacity make any contribution to these payments.

Variant 2:
In this variant, the auction involves all generators who either wish to have a constrained connection or which have a firm connection agreement on the constrained branch of the network. In the event that a firm generator is the cheapest to constrain then it receives compensation from the new generators on constrained contracts. DUoS customers or those generators with firm capacity will never have to contribute towards the constraint payments made to other generators.

Circumstances when option may be used:
This option would be used to facilitate the connection of distributed generation at the lowest cost. It would be enacted at times when the local generation exceeded capacity limits. This would likely to be a high wind period alongside low demand.

Roles and relationships



Assessment
Once a customer has bid into the auction it will have certainty over the price they will be paid for curtailment or the price they will have to pay for firm capacity. However, a fixed curtailment price will not be able to reflect that at some times, a generator may be content for the DNO to curtail them at below their bid price. All curtailment payments (if applicable) are paid by generators so the DNO only has the role of coordinating the auction and potentially the payments. Competitive pressure between the generators should drive each generator to reveal the true cost of curtailment. DNOs will likely choose to curtail those generators with the lowest bids first, with those generators with the highest bids to be curtailed last.

This option would require DNOs to develop significant new skills (or some outsourcing of tasks), as well as significantly more complex commercial arrangements to support the auction and administer the process. Costs and benefits would need to be understood and considered. In addition, timescales for implementing this could also be significant.

Section 3: Emerging observations

While the work programme is not due to conclude until April next year, it has already made a number of observations which are worth noting, feeding into policy development and the future work programme.

1) Visibility of flexible arrangements for the wholesale market

Our roles and relationships diagrams raise questions concerning the visibility the system operator or other parties in the market require under the options. For example, Ofgem's electricity balancing significant code review (EBSCR) is looking to introduce reforms which will set the cash out price on the marginal cost of actions taken by the SO[10]. This may make balancing costs peakier and therefore increase the financial impact that DSR might have on parties in the wholesale market.

Work stream 6 has started to look into this issue and will continue to do so in the next phase of work. At present, indications are that only dynamic and unpredictable DSR, used by a DNO (or other parties) will cause an issue. Customers' response to other DSR products such as static tariffs can be built into supplier forecasting.

Some of our options such as dynamic or critical event tariffs, or some of the DG curtailment options, will require customers to provide a response, or have a response automated for them, at short notice. This is unpredictable and difficult for suppliers or generators to factor into their wholesale market position. In some cases, a response may be provided post gate closure, meaning that suppliers and generators can't factor it into their market position and that action is required by the SO.

With the move towards peakier balancing costs, there needs to be some formal mechanisms to ensure that parties have timely visibility of DSR actions, taken by DNOs, which impact them. Where these actions are taken post gate closure, the system operator will need some visibility of the aggregate level of demand response used by a DNO. Without this the SO will either be taking actions which aren't required, or risk taking insufficient action to balance the system. The work stream will look to undertake further work in this area and also link into work stream 7 which is investigating the technical challenges of system operation. The work stream will also look to leverage some of the work Elexon is undertaking in this area as it assesses how the balancing & settlement code (BSC) may need to adapt in a smart world.

2) DNO ownership of storage assets

The European third energy package (under the EU Directive 2009/72/EC) requires the unbundling of supply, generation and transportation of electricity. In GB, these activities have been legally unbundled for some time. In GB, a party requires a generation licence if they have an operational capacity of 50MW[11] or above. Traditionally it was considered that provided a single storage facility was below this threshold then DNOs could own and operate it.

As set out in more detail in appendix 2, our work has highlighted that the size of a storage facility is irrelevant when considering the DNO's role in operating it. If a DNO operates a storage device (particularly electricity storage) it will need to charge it (taking electricity off the network) and discharge it (placing electricity on the network) at different times. DNOs will either need to take the electricity when they charge the

[10] https://www.ofgem.gov.uk/electricity/wholesale-market/market-efficiency-review-and-reform/electricity-balancing-significant-code-review

[11] http://www.legislation.gov.uk/uksi/2001/3270/pdfs/uksi_20013270_en.pdf and http://www.legislation.gov.uk/uksi/2001/3270/contents/made

storage device and spill it when they discharge, or record the flows and pay the market price.

Taking and spilling electricity onto the system does not appear a feasible, long term solution. Consequently, if storage takes off at scale, it will need to be metered and the energy drawn to charge it recorded. Energy discharged will need to be declared to the market with an appropriate market price paid. In short, operating a storage facility and participating in the market can't be divorced.

There are strict rules surrounding how DNOs can use regulated assets to participate in a competitive market. It would not be fair or reasonable for regulated assets funded by distribution customers to be used to make excess profits in a competitive market, to the benefit of DNO shareholders. Consequently, it seems a reasonable expectation would be to separate the commercial participation in the market from DNO control.

There are ongoing LCNF projects which are investigating the commercial arrangements required to allow a third party operating the facility to provide services to DNO and non-DNO parties[12]. These will actively feed into the next stage of our work on commercial arrangements.

3) Sharing of risk within interruptible contracts with DG customers

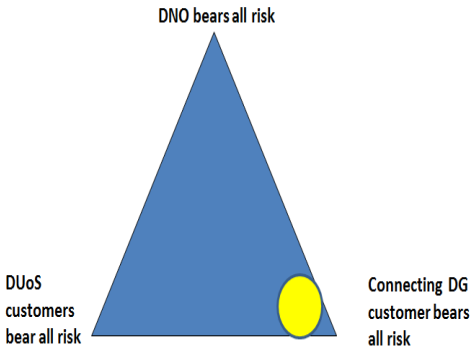
All of the engagement options for DG customers involve an arrangement whereby the DG customer has its output curtailed or interrupted. Any curtailment will obviously impact the revenues the DG customer can receive for its generation. Consequently, when considering whether to opt for an interruptible contract, DG customers want as much certainty on how many times they are interrupted and for how long. Without this certainty, DG projects may fail to secure the required investment as the future revenue streams would be uncertain.

At present, most interruptible contracts are designed to ensure that whenever the DNO's network faces a constraint, the DNO can curtail the generator. This places all the risk with the DG customer (as shown in diagram A). It would be helpful for DG customers if some of this risk could be shared with other parties. For instance, the DNO could offer a fixed number of hours it was allowed to constrain the generator for. If its network was constrained for more than this, it would have to look at alternative way to relieve that constraint, rather than curtail the generator. This is shown in diagram B below.

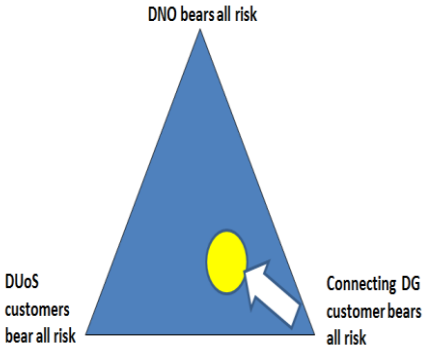
In diagram B, more risk is allocated to DUoS customers because if the DNO can't constrain the generator, then they have to take some other action. This is likely to involve payments to other customers (potentially to other generators to turn down). These will be funded by DUoS customers, hence why diagram B illustrates that DUoS customers take some risk. It may be appropriate for DNOs to take this extra risk on behalf of DUoS customers as this may still be a lower cost solution than undertaking reinforcement to provide a firm connection, as these lower costs will be shared between the generator and DUoS customers. DUoS customers could also benefit from having more local generation (reducing the transportation costs). However, further work is required to look into the merits of approaches which share some of the curtailment risk with DUoS customers.

[12] The Orkney storage park project: http://www.smarternetworks.org/Project.aspx?ProjectID=373 and also UKPN's Smarter Network Storage project: http://www.smarternetworks.org/Project.aspx?ProjectID=416

A – DG Customer takes all the risk



B– Risk partially shared with DUoS customers



4) Requiring constrained customers to contribute to reinforcement

The terms of connection agreements which allow DNOs to constrain a generator or demand customer, currently give little thought to what happens if the network is reinforced in the future. This is a likely scenario, particularly as there is a limit to the number of interruptible contracts which are viable in a certain part of the network. Therefore at some point, a future connectee may agree to a firm connection and pay for reinforcement.

Once the network has been reinforced, the DNO may not need to require any customers on an interruptible contact to be curtailed, for a period of time. Essentially, these customers now have a firm connection, even though they have not contributed to the costs of the reinforcement required to connect them. This seems unfair on the connecting customer who has paid its share of the reinforcement costs and also on DUoS customers who are picking up the remainder.

It does not seem appropriate for customers to be able to free-ride in this way. We consider that some thought needs to be given to the terms of interruptible contracts in order to explore how connectees can pay their share of the costs of future reinforcement from which they will benefit.

5) No DNO access to automated load control through the DCC

Under the current smart metering policy, DNOs will have to operate via a supplier if they wish to use the DCC infrastructure for direct load control of appliances. An alternative is to install separate control equipment and a parallel communications link. This could lead to duplicate systems being put in place. We understand that the current policy can be revisited if DNOs can demonstrate the benefits of having this functionality and can show that they have adequate security and data protection measures in place.

6) A more sophisticated in home display may be required

To allow customers to properly engage with some of the options, they may need real time information on their usage, as well as other information needed for customers to understand the impact of their behaviour on their bill.. Equally, customers might want to know when and which appliances are being remotely controlled. Thought may need to be given to how the functionality of the smart metering system, including the in home display lines up with some of the options industry may want to offer.

7) Appliances which customers are willing to automate

In order to control appliances via the smart meter infrastructure, there needs to be communication between the meter and the appliance (using the home area network – HAN). This could take a variety of forms one of which is through the consumer access device. However, there may not be visibility of the smart appliances registered on the CAD by the customer.

Without some transparency of the flexible load each household has available, industry parties may not be able to maximise the value of that flexibility and deliver full value back to customers.

8) The HAN does not have 100% coverage
It is already known that the HAN, which will link customer appliances to the smart meter, may not work in 100% of premises. In premises where there is no HAN coverage, many of the options listed above will not be available. This is particularly relevant to the options with remote automation. This may be an issue for DNOs who will require a concentration of customers providing a response at a specific location to deliver network benefits. We note that more advanced HANs are under development which can cover 95% of premises

Section 4: Next steps

This interim report marks the half-way point in the work programme for WS6. While we have made considerable progress, there is clearly still a lot to do in the next year. Below is a list of specific work areas which the group will undertake to help deliver the final two stages of work. Some of these are inter-related and will need to be progressed in series but others can be progressed in parallel.

Broadening the scope of work
We plan to broaden the scope of our work to more fully consider the perspectives of suppliers and the system operator and other players on the value chain. Some of our options in section 2 and appendix 1 already start to do this, particularly those which have suppliers as leading the consumer engagement. However, we have not given consideration to the products that the system operator might want to offer to customers. Consequently, a first step will be to check if there are any different products which suppliers or the system operator envisage offering to customers. Part of the work will involve assessing the impact which current or new policy developments have on the options. These are areas such as the electricity market reform (EMR), the retail market review (RMR) and the electricity balancing significant code review (EBSCR).

Part of the broader scope will involve the increasing involvement of Ofgem's Smarter Markets team in work stream 6. In December 2013 this team published a document entitled 'Creating the right environment for demand side response: next steps"[13]. This outlined how Ofgem intended to take work forward to create a 'framework' for demand side response. This framework will look to mitigate some of the current cross party impacts caused by lack of visibility of demand side response arrangements. There are clear synergies here with the work stream 6 programme. Consequently, Ofgem's smarter markets team indicated that they would leverage the work undertaken in work stream 6 as an input to their work and also use the work stream as the main stakeholder input to the project. This will be a crucial part of the broadening of the scope of work.

Reducing the number of options
We recognise that broadening the scope may leave us with an unworkable number of options. If this is the case, we will look to consolidate them. This consolidation will be aimed at avoiding repetition and removing any options which do not perform well against our assessment criteria (see section 1). This will provide the group with a more manageable set of options which can act as pathways to deliver DSR.

Develop a detailed understanding of current commercial arrangements

[13] https://www.ofgem.gov.uk/publications-and-updates/creating-right-environment-demand-side-response-next-steps

The rationale for developing our options is to have some practical examples to test against the current regulatory and commercial framework. The aim of this will be to identify where changes may be required. To facilitate this assessment, we will need a detailed map of current commercial arrangements, particularly the information flows between industry parties. This will be helpful in having a set of arrangements to contrast the options against.

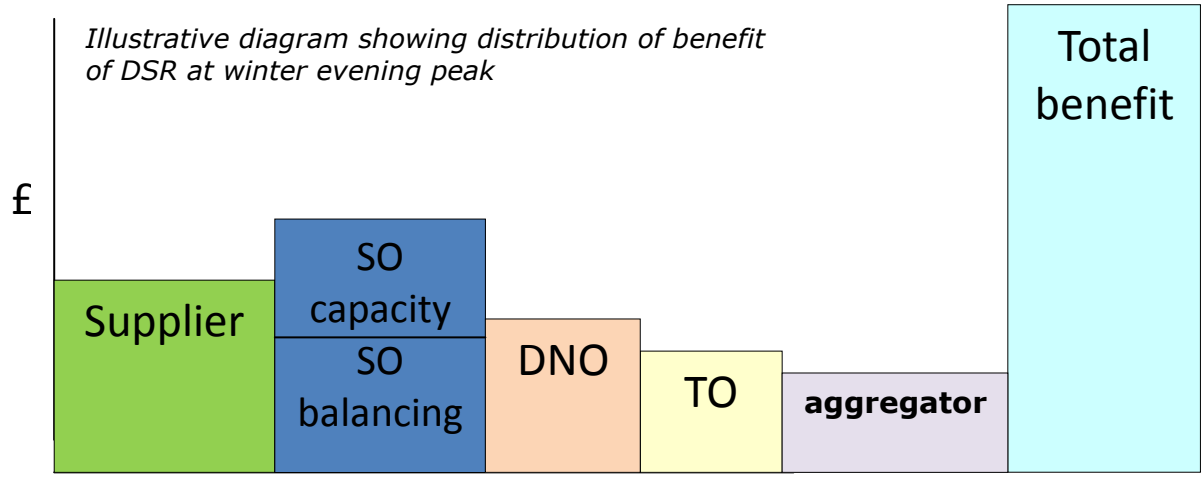
Incentivising customer behaviour

The work stream will use available learning from the LCN Fund trials and other innovation projects, to assess which of the options are likely to have the most significant impact on customer behaviour. A number of large scale, high profile, LCN Fund projects are due to be concluded in the next few months and we want to ensure that the learning on customer behaviour feeds directly into work stream 6. This learning will help in assessing the methods of engagement with customers, and what new regulatory protections will be needed in a DSR world. It should also contribute to our understanding of the likely distributional impact of the various options. Not only can this assessment feed into any work on reducing the number of options but it will also be an important input into understanding what level of benefits might be required to provide customers with an incentive to engage with the options.

Balancing the benefits of DSR

As part of our assessment of the commercial arrangements for DSR, we plan to examine how the benefits of DSR will be distributed between parties in the value chain, including different types of customers, both participants and non-participants in DSR. This will help to identify when DSR provided by one party can lead to benefits for another party. For instance, many of the options relevant to DNOs will seek to encourage customers to shift their consumption during winter peaks.

As indicated by the diagram below, at winter peak, it's likely that all parties in the value chain would benefit in customers shifting their demand outside of this period. This will be an important consideration because the commercial arrangements should allow all parties to have sufficient visibility of the response to allow them to maximise the benefits to customers. Only this will allow customers to realise the maximum benefits of flexible arrangements.



One the first tasks for the working group will be to take this work further and develop a number of scenarios to test the distribution of benefits across the value chain. In addition, we will examine how those benefits flow back to customers. For example, what proportion of costs are needed to pay for the enablers of the DSR, what proportion of the

benefits flow directly to the customers who provided the response and what proportion can go to the broader customer base.

This work will ensure that the commercial arrangements we develop for each option, maximise the value of the DSR for customers, ensuring that all options enable benefits to flow back to customers. .

Develop commercial and regulatory arrangements for each option
Many of the stages above will feed into the development of commercial arrangements for each option. These commercial arrangements will give effect to the roles and relationships depicted in the diagrams in section 2. Some of these arrangements might also require current regulations on consumer protection to be renewed or updated. It will also bring together the outputs of our work on the distribution of value and detailed understanding of current commercial arrangements. The development of these commercial arrangements will pick up the next steps identified in the separate storage paper outlined in appendix 2.

Impact of ongoing policy development
A final stage will be to assess how the commercial arrangements developed interact with ongoing policy reforms. This will help to highlight where those reforms can help or hinder the options industry parties might want to offer. As part of this assessment we expect to cover the electricity market reform (EMR), the retail market reform (RMR), the electricity balancing reforms, the Green Deal and the Government subsidy schemes such as the renewable heat incentive and the feed in tariff.

Building on emerging observations
In section 3 we have already set out a number of emerging observations on the barriers or challenges which might be associated with implementing the options we've developed. As we develop commercial arrangements and assess them against ongoing policy developments, we will look to add to these observations. For each observation we will look to set out how any barriers or challenges might be overcome and who is best placed to take these forward. Some of the emerging observations, such as visibility of DNO DSR in the wholesale market, will be addressed as we delve deeper into commercial arrangements which maximise the value of DSR.

The outputs from work stream will be taken forward by Ofgem and used as a key input to its policy work, both within the Distribution Policy and Smarter Markets teams.

Appendix 1: Long list of options with summary description

Domestic options

Option	Description
Restructuring DUoS charges via supplier	
1a) Restructuring the DUoS charge via supplier (without automation)	A DUoS charge to the supplier which includes either (i) a differential unit charge (kWh) or (ii) a differential capacity charge (kVa) for peak times
1b) Restructuring the DUoS charge via supplier with automation at the premises	As option 1a) above but where appliances within the premises are programmed to respond to the changes in price point and turn appliances down during peak price periods. The customer can set the parameters around this automation.
1c) Restructuring the DUoS charge via supplier with remote automation (supplier controlled)	As option 1a) except that the supplier is able to remotely control load at the customer's premises. DUoS charges would send a price signal to the supplier to reflect when DNO costs are high. Suppliers would take this into account when determining when to control customer load.
Restructuring DUoS charges direct to customer	
2a) Restructuring the DUoS charge direct to customer (without automation)	A DUoS charge with a differential unit or capacity charge which is sent directly to the customer either as a separate line in the supply bill or a completely different bill sent by the DNO directly.
2b) Restructuring the DUoS charge direct to customer with automation at the premises	As option 2a) but where appliances within the premises are programmed to respond to the changes in the DUoS price point and turn appliances down during peak price periods. The customer can set the parameters around this automation.
2c) Restructuring the DUoS charge direct to the customer with remote automation (DNO controlled)	As option 2a) except that the DNO is able to remotely control load at the customer's premises. There would be an arrangement between DNO and supplier in order for the remote automation to be done at times which were beneficial to the DNO.
Two band DUoS capacity charge via supplier	
3a) Two band DUoS capacity charge via supplier (without automation)	A restructured DUoS charge sent via the supplier with two bands of capacity charges. These are structured in such a way that customers are automatically placed on the lower (p/kVA) capacity band. If their usage exceeds a certain kVA threshold within agreed set peak times then they move onto the higher (p/kVA) capacity charge until they reduce usage below the threshold.
3b) Two band DUoS capacity charge via supplier with automation at the premises	As per option 3a but where appliances within the premises are programmed to ensure that the customer stays within the lower capacity band at all times. The

	customer can over-ride this but will pay the higher capacity band for the duration of the high price period.
3c) Two band DUoS capacity charge via supplier with remote automation (supplier controlled)	As option 3a) but where the supplier is able to remotely control equipment in the customer's home if they move onto the higher capacity band, in order to place them back below it.
Two band capacity charge direct to customer	
4a) Two band DUoS capacity charge direct to customer (without automation)	A restructured DUoS charge sent directly to the customer with two bands of capacity charges. These are structured in such a way that customers are automatically placed on the lower (p/kVA) capacity band. If their usages exceed a certain kVA threshold within agreed set peak times then they move onto the higher (p/kVA) capacity charge until they reduce usage below the threshold.
4b) Two band DUoS capacity charge direct to the customer with automation at the premises	As per option 4a but where appliances within the premise are programmed to ensure that the customer stays within the lower capacity band at all times.
4c) Two band DUoS capacity charge direct to the customer with remote automation (DNO controlled)	As option 4a) but where the DNO is able to remotely control equipment in the customer's home if they move onto the higher capacity band, in order to place them back below it.
Critical event arrangement	
5a) Critical event tariff with remote automation	Where a DNO has an arrangement in place with a customer to allow it to remotely control load in a critical event such as a large fault. The DNO would only call on this functionality rarely i.e. one every 2 to 5 years. In return, the customer could either be placed on a slightly lower DUoS tariff or receive a rebate on their bill from the DNO.
Dynamic tariffs via supplier	
6a) Dynamic tariff without automation via supplier	A variable DUoS tariff which can fluctuate between pre-set points to reflect local network conditions. The peak price point and/or its duration are fixed. Customers can receive advanced notice (around a day ahead) of the expected price points for the next day. Customers will try and reduce their consumption during the peak price periods
6b) Dynamic tariff with automation at the premises via supplier	As option 6a) but with appliances at the premise which are automated to respond to certain price points and reduce consumption. These price points could be set in advance by the customer in order to suit their specific circumstances.
6c) Dynamic tariff with remote automation (supplier controlled)	As option 6a) but where the supplier can remotely control customer appliances during peak price periods. The supplier would only be able to control appliances if certain parameters (pre-agreed with the customer) have been met.
Dynamic tariffs straight to customer	

7a) Dynamic tariff without automation direct to customer	A variable DUoS tariff which goes straight to the customer and which fluctuates between pre-set points to reflect local network conditions. The peak price point and/or its duration are fixed. Customers can receive advanced notice (around a day ahead) of the expected price points for the next day. Customers will try and reduce their consumption during the peak price periods
7b) Dynamic tariff direct to customer with automation at the premises	As option 7a) but with appliances at the premises which are automated to respond to certain price points and reduce consumption. These price points could be set in advance by the customer in order to suit their specific circumstances.
7c) Dynamic tariff direct to the customer with remote automation (DNO controlled)	As option 7a) but where the DNO can remotely control customer appliances during peak price periods. The DNO would only be able to control appliances if certain parameters (pre-agreed with the customer) have been met.
Load limiting	
8a) DNO Load limiting	Customers could voluntarily opt to have certain electricity intensive appliances fitted with a load limiter in exchange for a lower DUoS tariff or rebate on their bill. The load limiter would restrict the usage of certain appliances, or even the entire household according to a capacity level agreed with the DNO or at a time agreed with the customer and the DNO. The limiting would be in affect permanently.
8b) Supplier load limiting	The same as 8a) except operated by supplier and only in certain periods which are known in advance.
8c) Supplier load limiting – PPM customers	This would be load limiting for customers on PPM who had run out of credit. It could be operated on a gradually increasing level, so that customers start with some capacity being restricted and the longer they go with no credit, the less capacity they are entitled to.
Other options	
9) Deployment of energy efficiency measures	Where a customer installs energy efficiency measures such as loft insulation or LED lighting, a DNO would offer a rebate or a lower DUoS tariff.
10) Demand reduction through information provision	Energy management advice is provided by the DNO. Customers can use this information to help manage their electricity usage and understand when they are consuming at peak times. No payment or tariff is provided but customers use the information provided to reduce their overall consumption which may have some network benefits.
11) Community schemes	Communities could take ownership on operation of distributed generation, for instance, through community PV schemes. Church efficiency schemes, for example, could also seek to provide education to the local community on energy

	efficiency and reduction measures and could organise the purchase of energy efficiency materials, such as in bulk insulation. DNOs may need to think about how they could adapt some of the options above to suit this community generation model.
Mandated arrangements	
12a) Mandated product standards without over-ride	The EU or UK Government puts in place legislation which mandates that certain products must have demand response functionality built in as standard. This functionality would allow DNOs to adjust the consumption of these appliances to help manage their network. Note that to be of use for DNOs, this functionality needs to go beyond frequency response and involve adjusting appliances for longer periods of time.
12b) Mandated product standards with over-ride	As option 12a) above except with an over-ride function for customers. In order to encourage customers not to use the over-ride, they will receive payments for restricted use of it. Consequently, DNOs will need to know when a customer has used the over-ride or not.

Each of the options could also be made mandatory with through UK Government or EU legislation.

Industrial and commercial options

Option	Description
1) Restructuring of DUoS charges via supplier	Strengthen the locational element of the DUoS charge in the CDCM and EDCM to provide a more cost reflective signal of the impact of usage at peak on specific parts of the network. This DUoS charge is passed to the supplier and the supplier chooses how to recover those charges from customers.
2) Restructuring of DUoS charges via DNO	Strengthen the locational element of the DUoS charge in the CDCM and EDCM to provide a more cost reflective signal of the impact of usage at peak on specific parts of the network. This DUoS charge is passed directly from the DNO to customers. This assumes customers receive separate bills from the DNO (for DUoS charges) and supplier.
3i) Availability and utilisation payment	Customer agrees to turn down demand for a fixed period of time when called on to do so by the DNO. The response could be automated. The terms are set out in a bilateral agreement between the customer and the DNO. The customer is paid an availability payment each month based on the MW it is willing to provide as a response. If called on to provide a response, the customer is paid an utilisation charge per kW/MW per half hour of response. If the customer is unable to respond, they may be subject to a penalty and/or claw back of availability payments.
3ii) Pay as you go response payment	Customer agrees to turn down demand for a fixed period of time when called on to do so by the DNO. The response could be automated. The terms are set out in a bilateral agreement between the customer and the DNO. If called on to provide a response, the customer is paid an utilisation charge per kW/MW per half hour of response. If the customer is unable to respond, they may be subject to a penalty and/or claw back of availability payments.

Distributed generation options

Option	Description
1) Last in first out	DNO offers a reduced connection charge in exchange for the generator agreeing a non-firm contract. The DNO curtails the output of generators on non-firm contracts in reverse order of their connection date. The most recent to connect is curtailed first, followed by the next most recent connectee etc. The generators do not receive any payment from the DNO for curtailment as they were given a lower connection offer.
2) Pro-rata	DNO offers a reduced connection charge in exchange for the generator agreeing a non-firm contract. When necessary, the DNO curtails the output of generators on non-firm contracts by the same absolute amount or the same percentage of output. Alternatively, the generators take it in turns to be curtailed. The generators do not receive any payment from the DNO for curtailment as they were given a lower connection offer.
3a) Upfront auction (connecting generators bidding only)	To be used in a situation where there are a number of generators who want to connect behind a constraint. All those generators are asked to place bids to the DNO on the price (per kW or MW) at which they are willing to be constrained. The DNO collects all bids and keeps a log of the price points. When the DNO needs to constrain a generator, they will constrain the one with the lowest bid first. The other generators will then pay compensation to the constrained generator according to the price it quoted at auction. The DNO acts as a middle man transferring the funds between generators. Neither DUoS customers nor generators with firm capacity make any contribution to these payments.
3a) Upfront auction (all generators bidding)	As option 3a) but involving both generators who wish to connect to a constrained network and those generators already connected to that network which have firm capacity. The auction will involve all generators who either wish to have a constrained connection or which have a firm connection agreement on the constrained branch of the network. In the event that a firm generator is the cheapest to constrain

	then it receives compensation from the new generators on constrained contracts. DUoS customers or those generators with firm capacity will never have to contribute towards the constraint payments made to other generators.
3b) DNO parameters	DNO offers a reduced connection charge in exchange for the generator agreeing a non-firm contract. When necessary, the DNO curtails the output of generators on non-firm contracts in order according to a pre-agreed parameter (e.g. CO2 emissions, with highest emission generation curtailed first). The generators do not receive any payment from the DNO for curtailment as they were given a lower connection offer.

Appendix 2: Review of the potential for DNOs to utilise storage as a smart grid solution

Context

In order to meet our carbon reduction targets, the Department of Energy and Climate Change (DECC) has forecast that an increasing number of low carbon technologies will need to connect to the network in the future. These may be additional demand such as heat pumps and electric vehicles or additional distributed generation such as solar PV. In order to effectively and efficiently manage these changes to the network, Distribution Network Operators (DNOs) are incentivised under the price control to enter into innovative commercial arrangements or deploy new smart technologies if cheaper than conventional reinforcement.

One of the smart solutions considered by the Smart Grid Forum is storage. Work Stream 3 identified (battery) storage as a potential option for DNOs and it is included in the Transform model developed by that group. In its first phase of work, Work Stream 6 examined potential barriers to DNOs making use of smart grid solutions, including battery storage. This paper sets out the ways battery storage may be able to be used by DNOs, and examines the implications of the regulatory framework.

Models for storage operation

There are many different technologies that can be classed as storage. Each is best suited to providing certain services and being operated in certain ways. This paper is written from the perspective of using battery storage. Many of the observations and conclusions are relevant to any form of storage which takes electricity off the network, stores it as a different form of energy which can be converted back to electricity and (crucially) exported back onto the electricity system.

In general, there are two models through which DNOs can use storage. A DNO can either own and operate storage assets for network purposes or have commercial arrangements with a third party storage operator to procure network flexibility services. Both methods may be used to avoid reinforcement, and DNOs should have the opportunity to make use of storage where it is efficient to do so. Further detailed commercial models are set out in Annex 1.

Third party operation

In order to maximise revenues, storage operators often need to 'benefit stack' by providing a variety of services to different industry parties. In addition to agreeing a contract with a DNO, the storage operator may need to contract with the SO or other parties, as well as engaging in arbitrage. There are no regulatory barriers preventing third party storage operators offering services to DNOs or other parties.

In addition, there are no regulatory barriers preventing DNOs procuring services from third party storage operators. They are incentivised to do so if this is more efficient than conventional reinforcement. Low Carbon Networks Fund (LCNF) projects have identified novel contracts with storage providers for services to provide network benefits, including the following.[14]

- DNOs enter into contracts with third parties to provide services. Under this model, there are a variety of ownership structures that could be possible:

[14] See Annex 1 for the models considered by LCNF projects.

- the third party storage operator could own the storage asset;
- the DNO could own the land and rent it to a third party storage operator to build the asset; or
- the DNO could own the storage asset and lease the use of it to a third party operator.

- Increase the locational element of Distribution Use of System (DUoS) charges, providing credits to third party storage operators who locate where reinforcement can be avoided.

DNO operation

DNOs are able to own and operate storage assets for operational purposes. They are incentivised to do so if it is the cheapest way of managing the network. A DNO can invest in a storage asset either as a regulated asset and recover the costs of investment from DUoS charges, or as an unregulated asset and bear the cost of investment itself.

In order to prevent DNOs competing with third party storage operators and providers of flexibility more generally, European Commission Directive 2009/72/EC requires the activities of electricity distribution, transmission, generation and supply to be unbundled. DNOs are not able to have control over supply, the sale of electricity to wholesale or end customers, and therefore are not able to use storage to provide services to third parties. This may reduce the number of circumstances in which it is economically viable for DNOs to own and operate storage.

As the energy flows cannot be accounted for in the market if the DNO is operating the storage device, the DNO would have to 'steal' and 'spill' the electricity when charging and discharging respectively. This is not a suitable long term solution if storage is to be used at scale.

Implications of regulatory and commercial framework

Commercial arrangements

In order to maximise revenues, storage operators often must provide multiple services to the same or different parties. This requires the operator to enter into a number of contracts, which can be both complex and time consuming.

Some parties set out standardised contracts for procuring individual services to enable all potential providers to understand the terms. However, this is not always the case. Furthermore, storage operators may be able to offer multiple services to the same industry party (e.g. voltage and thermal constraint management services for a DNO). There are no standardised contracts for providing multiple services. Therefore, more time must be spent in negotiation with the various industry parties, and the level of uncertainty upfront is higher before contracts are agreed.

Storage assets may not be best suited to meet the technical requirements for providing some of the services industry parties wish to procure. For example, some types of storage can provide a response at very short notice compared with other technologies. However, there are limited opportunities to use storage in this way. This can mean that either these technologies are unable to offer these services or can do so only at sub-optimum efficiency.

However, industry parties are incentivised to procure the most effective and efficient services necessary. For example, the System Operator (SO) is incentivised to balance the system at lowest cost. The requirements on service providers should therefore be

those necessary to ensure it can cost efficiently and effectively meet this objective. It should be in the interest of the SO under the current regulatory framework to find new providers in order to increase competition and reduce costs.

Balancing and settlement

The operation of storage by a third party or a DNO, as with other forms of response, draws electricity off the network when charging at one point in time and exports it back to the network at another. This could change the amount of energy delivered to consumers in each settlement period. As use of storage may occur at very short notice, suppliers and the SO may not have visibility of it and therefore it will not be included in settlement. Therefore, it may appear as though suppliers have not matched demand with generation, potentially putting them and the system out of balance. Use of storage may also help put the system back into balance, but the benefit of this to the system will not be reflected to the storage operator and due to a lack of visibility, the SO may take unnecessary balancing actions.

If the system is put out of balance, the SO may have to take more actions at a higher cost than would otherwise be necessary. This increases the overall cost of balancing the system. This cost is recovered from customers via suppliers not from the storage operator. It will be important where possible for the SO (and potentially other parties) to be made aware in real time of the response that is being called upon and for storage operators to bear the costs they impose on the system where possible.

If profile data is used in settlement as opposed to actual data, the impact on each supplier's market position will not be recorded and the additional balancing costs will be spread across suppliers in proportion to their market share. If actual data is used, the impact of the use of storage on each supplier's market position will be recorded. Different suppliers may have been put in or out of balance by different amounts due to storage operators' actions. As the actual market position of suppliers will be recorded, the additional balancing costs will be spread across suppliers depending on how far out of balance they are. This will put unpredictable differential costs on suppliers, increasing the risk they face which could lead to customers paying a risk premium. Furthermore, it could lead to distortion of competition, either affecting small suppliers who are less able to absorb the risk or by disproportionately increasing costs for some suppliers.

While the impact of storage operation on balancing costs may be marginal at low levels of storage installation, it is likely to be unacceptable at scale.

Sharing and notification of response

If a storage operator is contracted to provide multiple services to different parties, there is a risk that one party will call on a service, leaving other parties unable to do so. There is currently no mechanism to share response and flexibility services between industry parties or inform parties once a response has been called on. This often means that storage operators cannot provide multiple services as each party wants exclusivity.

DNO revenue and investment limits

Charge Restriction Condition 15 of the Special Conditions of the Electricity Distribution Licence (CRC 15) sets out that revenue that a DNO makes from providing a service to a third party is shared between the DNO and distribution customers. The revenue sharing arrangements are necessary in order to ensure that distribution customers who pay for the costs of investments share in the benefits created by those investments. For instance, if the DNO is renting land or an asset to a third party, the rent received is shared. This provides an incentive for DNOs to enter into these arrangements as they are able to make a return. However, if by sharing the revenues with customers, the return to the DNO is too low in comparison with the risk, it could create a disincentive.

Changes to the sharing of revenues for the RIIO-ED1 price control should increase the incentive on DNOs by providing greater transparency and potentially allowing them to recover a higher proportion of revenues.

In order to ensure DNOs focus on the core business of operating the distribution network, Standard Licence Condition 29 (SLC 29) sets out limits on the level of investment in unregulated assets and the revenues generated from them. Analysis presented to Work Stream 6 undertaken by Northern Powergrid indicates that these limits would likely not pose a problem for the levels of storage installations expected in the foreseeable future.

Definition of storage in Electricity Act 1989 and European Commission Directive 2009/72/EC

The Electricity Act 1989 states that a licence is required to generate electricity. The Electricity (Class Exemptions from the Requirement for a Licence) Order 2001 provide an exemption for generation below 50MW. A DNO is not able to hold a generation licence and therefore each storage device operated by the DNO should be below this limit.

It is not clear whether storage is classified as generation under European Commission Directive 2009/72/EC. If it is, DNOs would not be able to operate storage assets, even only for network purposes. Correspondence with the Commission and experience of storage in other European Union countries indicates that storage should not be classified as generation. Furthermore, Terna, the Italian Transmission System Operator (TSO) is mandated by national law to install storage on the transmission network.

Next steps

The following next steps have been identified for Work Stream 6 to take forward under the next phase of work. Many of these are picked up in section 4 of the main paper, particularly is the assessment of current commercial arrangements and new commercial and regulatory arrangements for each option.

- Examine potential commercial arrangements to enable all parties to share services and be informed of the use of services by other parties where necessary.
- Examine the possibility for parties to set out standardised contracts for procuring single or multiple services.
- Examine how services can be provided and DNOs can 'spill' electricity without distorting settlement or increasing balancing costs.
- Examine the potential mechanisms for ensuring that additional balancing costs are borne by the storage operator rather than by suppliers.
- Identify potential models for operation of storage, develop assessment criteria, and undertake assessment.

The following next step has been identified for industry parties to take forward outside of Work Stream 6:

- Industry parties and potential service providers should continue to engage to establish whether storage and other new technologies are able to provide services.

Annex 1 – Summary of business models being trialled

DNO Merchant

This model involves full ownership and operation of storage by the DNO. Contracting needed would be direct between third parties and the DNO. Multiple applications could be provided. This is incompatible with the current regulatory framework. This is not physically being trialled by DNOs but learning from projects will help assess the viability of this model

DSO model

This model is the same as DNO Merchant but assumes a specific incentive on DNOs to operate sources of flexibility. This is incompatible with the current regulatory framework and is not physically being trialled.

DNO Contracted

In this model the storage is owned and operated by the DNO, with contracts for ancillary services and energy procurement put in place between the DNO and a third party (e.g. a supplier or aggregator). This third party has responsibility for the commercial operation of the storage and for contracting with other parties. A range of services can be provided in this model. The DNO may make payments to the third party for import, and the third party may make payments to the DNO for export. This model is being actively trialled.

A variant of this model is for the battery to be in a customer's premise.

Contracted Services

The storage is owned and operated by a third party, with capacity provided to the DNO as a customer. The DNO would enter into a contract with the energy storage provider who would also strike contracts with other customers such as National Grid. From the point of view of the DNO, the third party storage provider acts as any other provider of flexibility. Payments would be made by the DNO for network support based on availability and/or utilisation. This model is being actively trialled.

Charging Incentives

This model is to use strong locational signals in the Distribution Use of System (DUoS) charge to incentivise storage operators or other providers of flexibility to operate in areas of benefit to the DNO and to offer network support services. This is not physically being trialled.

DNO Capex

In this model, the DNO owns and operates the storage asset purely for network support purposes to manage constraints. No other contracts would be in place and the DNO would 'take' and 'spill' energy as necessary for operational purposes. This is being trialled and learning will help indicate whether this is a commercially viable business model. However, it is generally considered not to be a suitable long term solution at scale.

Shared use in domestic premises

In this model, the DNO owns a storage asset behind the meter in the customer's premise. The use of the storage is shared between the DNO and customer as in the DNO contracted model. The customer would sign up to a tariff to incentivise the use of the storage in a way that helps support the network. This model is being actively trialled.

Change of energy vector: power to gas

In this model, rather than converting electrical energy into another form to store before converting it back, the energy is used to create hydrogen. This therefore changes the energy vector. Although not strictly storage, it can be another form of flexibility. This model is being considered for trials.

Appendix 3: The potential move to a Distribution System Operator

Background

In the future, as penetration of low carbon technologies (LCTs) and distributed generation (DG) increases, the distribution network will become increasingly constrained. In order to ensure value for money, distribution network operators (DNOs) may need to take innovative and 'smart' approaches to manage this rather than investing in expensive conventional reinforcement. These smart approaches may involve striking commercial agreements with customers to encourage them to change their demand or generation profile, or the DNO actively managing the network. As the amount of active engagement with customers increases, this could lead to impacts (either beneficial or negative) on other industry parties. There may be a point at which it is most efficient for the DNO to have devolved responsibility for balancing the local network. This involves the DNO taking on a different role and new responsibilities such as co-ordinating numerous real-time local balancing schemes. In taking these responsibilities, the DNO would be taking the role of a Distribution System Operator (DSO). It is not clear if, or when this may happen, but it is unlikely to be necessary during the RIIO-ED1 price control period.

The work stream 6 (WS6) report of 2012[15] committed the group to examine the role of the DSO in more detail under its revised terms of reference. The group wished to answer the following broad questions:

- What might the evolution of a DSO role look like?
- What network conditions would trigger a move towards DNOs taking a DSO role?
- Should the move to a DSO role be incremental and gradual, or a co-ordinated 'big bang'?
- What are the challenges that face DNOs progressing towards taking a DSO role?

The remainder of this paper aims to answer some of these questions and set out next steps to identify potential changes in commercial or regulatory arrangements to mitigate the challenges.

The potential evolution of the DSO role

This section discusses potential stages in the move towards a DSO role. These stages are not necessarily sequential, and are not mutually exclusive. DNOs are incentivised to utilise the most efficient combination of tools in order to manage their network effectively, and should take the most appropriate role for doing so. Annex 1 of this paper sets out the current innovation trials being conducted by DNOs under the Low Carbon Networks Fund (LCNF) looking into how DNOs can utilise the different tools and take on the different roles discussed below.

1. Enhanced network monitoring and planning

In order to better understand what is happening on the network, DNOs may wish to collect data from smart meters or other network monitoring equipment that has not traditionally been deployed on the secondary network. This data can be used to improve planning processes and prediction of the impact of LCTs and DG on the network. This can release capacity on the network by providing visibility of actual usage levels as DNOs may often design the network conservatively to ensure resilience. This is more a case of using new tools rather than DNOs taking a new role. These tools are already beginning

[15] See https://www.ofgem.gov.uk/publications-and-updates/work-stream-6-report-august-2012

to be introduced as 'business-as-usual' (BAU) and can be developed and deployed incrementally.

The need to have better visibility could be driven by a concern about increasing penetration of LCTs and DG creating network constraints, or to allow new customers to connect at lowest cost by determining the spare network capacity available. Greater network visibility allows DNOs to deploy other tools and take on a more active role in managing the network as set out in the next stages of the evolution of a DSO.

2. Real time reconfiguration of the network

If a network constraint is reached on one part of the network adjacent to another which has unused capacity, the DNO can use automated real time network configuration to release this capacity where it is needed. New smart equipment may need to be installed on the network to allow the DNO to control power flows in this way, but it can avoid investment in conventional, more expensive assets, and increase overall network utilisation. Doing so requires the additional monitoring described in stage 1 above, as well as communications to remotely control the network reconfiguration. This is a new tool that DNOs can use, but does not in itself represent a new role.

The use of network reconfiguration is already BAU for fault recovery, and can be extended for use in normal operating conditions on an incremental basis. The primary drive for DNOs to undertake network reconfiguration will be a lack of capacity at particular points on the network due to excess demand or generation. This can lead to improved security of supply and quicker or cheaper connections as the customer will not need to pay for additional reinforcement.

3. Commercial arrangements to manage the network under fault conditions

DNOs are able to agree commercial arrangements with customers to provide flexibility services (e.g. demand side response – DSR) to provide additional capacity in the rare event of a network fault. Under normal operation, the network is usually run with sufficient spare capacity to manage high current flows when a fault occurs. However, as this capacity is only required in the case of a fault, it can be used at other times. It is therefore possible for DNOs to contract with a customer to agree to be cut off when there is a fault to release capacity to allow all other customers to be brought back on supply. This can therefore avoid investment in additional assets to create additional fault level capacity. Commercial arrangements can be implemented with or without smart network technologies to provide automated reconfiguration. This approach is beginning to be introduced into BAU and can be extended incrementally where efficient. As with the previous stage, this relies on additional monitoring under stage 1 and is a smart tool for DNOs to use rather than a change in their role.

The key drivers for making use of commercial arrangements for managing faults are either to avoid reinforcement if a fault level headroom constraint is identified, or to allow new customers to connect to the network more quickly and cheaply.

Other industry parties, notably the GB system operator (SO), suppliers and third parties (such as aggregators) may also want to have commercial flexibility arrangements with customers. To ensure maximum benefits for customers and minimum system costs, it would be necessary for all parties to have visibility of which customers have contracts and when they are called on to provide a response. There are not currently sufficient arrangements in place to ensure this level of visibility between parties. Work stream 6 proposes to examine potential visibility arrangements in the next stage of work.

4. Active network management to manage voltage or thermal constraints

This stage is essentially an extension of stage 3, using commercial arrangements (potentially combined with smart network technologies) to automatically manage voltage

or thermal constraints on the network in real time under normal network operation. This requires different commercial arrangements with customers as they may have to accept more frequent calls for a response. Having automated response from customers at times of constraint allows DNOs to avoid conventional network reinforcement and could increase utilisation of the existing assets. As with the previous stage, the DNO is using new tools but is undertaking its usual role.

The DNO may take this approach due to load or generation growth leading to a constraint or certain times of day or year, or to allow customers to connect more quickly or cheaply without the need for reinforcement. In the trials currently being undertaken by DNOs, it is often new customers who agree to these contracts in situations where the alternative – paying for reinforcement – is prohibitively expensive due to the level of network constraints. If the constraint is localised, it would be possible for the DNO to implement active network management for a particular part of the network. As more of the network becomes constrained, the area subject to this approach can be expanded incrementally.

Due to the need to contract with customers and the potential impact calling on response will have on energy use, industry parties will need to have the same level of visibility as in stage 3.

5. Distribution system balancing

As the need for active network management grows to cover a large proportion of the network, the potential impact on system balance is likely to grow. Each time a customer is called on to provide a response in real time, their energy use will change and this would need to be notified to the SO in order for it to take action to rebalance the system. There may come a point where the amount of actions taken by the DNO in aggregate has an impact on the SO's ability to balance the system such that it would be more efficient for the DNO to undertake a degree of balancing on their own network themselves. If this is the case, the DNO would be taking on a DSO role. This role would require DNOs to utilise the tools already discussed in preceding stages and to take responsibility for either advance scheduling of demand and generation based on forecasts, or procuring a certain degree of real-time response services, with the GB SO managing the residual imbalances.

While there are no regulatory arrangements that prevent the DNO taking on this role (as is done by SHEPD in Shetland), it is not clear whether the mechanisms currently exist to provide the correct incentives for DNOs to take this role. Arrangements could be developed to internalise the costs DNOs impose on the system through their actions. Such arrangements, or alternative approaches, will be examined by work stream 6 in the next phase of work. It will be necessary to consider whether these are sufficient to facilitate a move to a DSO role where efficient. The nature of these arrangements will determine the nature of the move to a DSO role, whether incremental or co-ordinated, and which party should be responsible for identifying the trigger point – i.e. when the benefits of this approach outweigh the costs.

Due to the multitude of actions a DSO could take, and the number of commercial arrangements they could have in place with customers, industry parties will require visibility as in stages 3 and 4.

Next steps

The following next steps have been identified:

- Consider options for arrangements to provide visibility of parties' contracts and actions
- Consider options for ensuring system-wide costs or benefits of actions are reflected and internalised by the relevant parties

- Qualitatively determine the benefits of an incremental or co-ordinated move to a DSO role in the light of visibility and cost-reflectivity arrangements
- Identify which party is best placed to take responsibility for identifying the trigger point for such a move.

The first two of these will be taken forward under the next phase of work, looking at how these arrangements may be developed to facilitate the use of DSR and flexibility by all parties. Once this is complete, the work stream proposes to return to the latter two issues.

Annex 1: List of innovation projects trialling each of the stages

1. *Enhanced network monitoring and planning*

Low Voltage Current Sensor Technology Evaluation	UKPN	http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-1-projects/low-voltage-current-sensor-technology-evaluation/
Distribution Network Visibility	UKPN	http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-1-projects/distribution-network-visibility/
Flexible Networks	SP	http://www.spenergynetworks.com/pages/flexible_networks_for_a_low_carbon_future.asp
VISOR	SP	http://www.smarternetworks.org/Project.aspx?ProjectID=1317
New Thames Valley Vision	SSE	http://www.thamesvalleyvision.co.uk/
LV Connected Storage	SSE	http://www.ssepd.co.uk/Innovation/Portfolio/LV_Batteries/
RPZ1 – 132kV	WPD	http://www.westernpower.co.uk/About-us/Innovation-Low-Carbon.aspx
LV Network Templates	WPD	http://www.westernpowerinnovation.co.uk/LV-Templates.aspx
FALCON	WPD	http://www.westernpowerinnovation.co.uk/Falcon.aspx
FLEXDGRID	WPD	http://www.westernpowerinnovation.co.uk/FlexDGrid.aspx
Smart Hooky	WPD	http://www.westernpowerinnovation.co.uk/Tier-1-Projects/Smart-Hooky.aspx
Early Learning	WPD	http://www.westernpowerinnovation.co.uk/Tier-1-Projects/Early-learning-of-LV-network-impacts-from-estate-P.aspx
Suburban PV Impact	WPD	http://www.westernpowerinnovation.co.uk/Tier-1-Projects/Photo-voltaic-impact-on-suburban-networks.aspx

2. *Real time reconfiguration of the network*

Smart Urban Low Voltage	UKPN	http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-1-projects/smart-urban-low-voltage-network/

Network		
FALCON	WPD	http://www.westernpowerinnovation.co.uk/Falcon.aspx
Isles of Scilly Smart Grid	WPD	http://www.westernpowerinnovation.co.uk/Tier-1-Projects/Network-Management-on-the-Isles-of-Scilly.aspx
Flexible Networks	SP	http://www.spenergynetworks.com/pages/flexible_networks_for_a_low_carbon_future.asp

3. *Commercial arrangements to manage the network under fault conditions*

Capacity to Customers	ENWL	http://www.enwl.co.uk/c2c
Isles of Scilly Smart Grid	WPD	http://www.westernpowerinnovation.co.uk/Tier-1-Projects/Network-Management-on-the-Isles-of-Scilly.aspx

4. *Active network management to manage voltage or thermal constraints*

Low Carbon Hub	WPD	http://www.westernpowerinnovation.co.uk/Lincolnshire-Low-Carbon-Hub.aspx
HV Voltage Control	WPD	http://www.westernpowerinnovation.co.uk/Tier-1-Projects/Voltage-Control-System-Demonstration-Project.aspx
CLNR	NPg	http://www.networkrevolution.co.uk/
GEMS	NPg	http://www.networkrevolution.co.uk/
ARC	SP	http://www.spenergynetworks.co.uk/pages/arc_accelerating_renewable_connections.asp
Flexible Urban Network - LV	UKPN	http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Flexible-Urban-Networks-Low-Voltage/
Flexible Plug and Play	UKPN	http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Flexible-Plug-and-Play-(FPP)/
Low Carbon London	UKPN	http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Low-Carbon-London-(LCL)/
Smarter Network Storage	UKPN	http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Smarter-Network-Storage-(SNS)/

Orkney RPZ	SSE	http://www.ssepd.co.uk/OrkneySmartGrid/
Orkney Energy Storage Park	SSE	http://www.ssepd.co.uk/Innovation/Portfolio/OrkneyPhase2/
New Thames Valley Vision	SSE	http://www.thamesvalleyvision.co.uk/
LV Connected Storage	SSE	http://www.ssepd.co.uk/Innovation/Portfolio/LV_Batteries/
My Electric Avenue	SSE	http://www.ssepd.co.uk/Innovation/Portfolio/

5. *Distribution system balancing*

NINES	SSE	http://www.ssepd.co.uk/Lerwick/NINES/

Appendix 4: Review of next steps from August 2012 report

Work Stream 6 – Next Steps				
Issue	**What's involved (*updates)***	**Updates**	**Owner**	**Status**
DSR				
Agree Timescales for revision of ER P2/6 - To get DNOs to set out defined timeline on how to take both issues forward and have working group established.	Two different amendments are required; one to recognise the contribution DSR can make to 'Group Demand'; the second is to start to define what contribution DSR can make based on probabilistic approach.	DNOs taking this forward through working group which will continue throughout 2015	DNOs	Ongoing
Consumer protection measures for DSR - To be able to cite adequate customer protection measures are in place for DNOs to engage with customers for DSR, either directly or through third parties. These may already exist, or may require developing.	Agree what, if any, protection measures we would want in place for different customer types and how these could be implemented.	On hold until smart grid engagement options are developed. Include lessons learnt around consumer protections in LCN Fund learning workshop. One of the key aspects to be set out for all the options developed.	WS6	Picked up in stages 3 and 4 of WS6
Right to withdraw from DSR contract - To have some firm principles in place on the treatment of those who withdraw from DSR arrangements and who will bear the cost in different circumstances.	Set out principles to enable customers to withdraw from contract whilst still ensuring that it is an attractive alternative to investment for DNOs.	Paper produced by WS6 in April 2013. Being refined by Charing working group. A DCUSA modification will be brought forward in April 2014.	Flexibility and Capacity charging group	Complete
Impact on IDNOs and ICPs - Demonstrate that DSR will not disadvantage IDNOS or ICPs.	Test impact of DSR arrangements on competitive markets.	Paper produced by WS6 in April 2013	WS6	Complete
Transparency of DSR arrangements for all industry parties - A mechanism to provide transparency of DSR arrangements.	Highlight that there could be value in greater transparency of DSR arrangements across the value chain.	This is covered in the roles and relationships but will require further detail in stage 3 of WS6	WS6	Ongoing
Receiving notification of the connection of new appliances - A robust process for notification of every type of low carbon technology which connects to existing domestic premises.	Monitor work of ENA working groups on heat pumps. OLEV considering how a notification process could work for electric vehicle charging points.	Process in place for heat pumps through MCS accreditation. A process still being developed for	ENA/ OLEV	Ongoing

		EV.		
Case for DNO access to disaggregated smart metering data - DNOs having the data available to operate smart grids, including dynamic time of use DSR through use of system charges.	WS6 report highlights that DNOs may need access to disaggregated smart metering data in order to send a universal DSR signal to customers.	DNOs free to make case to DECC and then Ofgem for access to data providing they outline adequate data protection measures	DNOs	Ongoing
Check that ED1 policies do not add new barriers - Confirmation that no new barriers have been added.	Create log of new policies/developments for ED1 and check impact on DSR strawman.	No barriers identified.	Ofgem	Completed
Electrical Storage				
Set out how storage is treated under current regulatory framework - Provide clarity on how DNOs can use storage and what barriers there are.	Consider questions around whether DNOs would be engaging in generation or supply if they operate storage. Consider treatment of investment costs and revenues from storage.	Covered in the storage section of this WS6 paper. To be undertaken by WS6.	WS6	Completed
Investigate whether DNO use of storage would lead to distortion of the market - Provide clarity on potential impacts on third parties of DNOs using storage.	Consider scope for and implications of regulated monopolies competing with third parties in offering services with storage.	Covered in the storage section of this WS6 paper. To be undertaken by WS6	WS6	Completed
Investigate potential high level ownership and operation models - Develop a variety of third party ownership models for different circumstances.	Developing some viable third party storage ownership models through which DNOs can access for constraint management.	Covered in the storage section of WS6 paper and to be developed in more detail alongside next phase of work.	WS6/ DNOs	Ongoing
Check that ED1 policies do not add new barriers - Confirmation that no new barriers have been added.	Create log of new policies/developments for ED1 and check impact on DSR strawman.	No barriers identified.	Ofgem	Completed
Charging issues				
Provide clarity on circumstances when DNOs can charge for connection of new appliances - Clarity and consistency on charging arrangements.	Set out a clear set of principles as to the circumstances when DNOs can charge for increasing load/generation including for appliances which fall below certain power quality thresholds.	DNOs raising a DCUSA mod in April 2014. This will be developed further by a working group and then submitted to Ofgem.	Flexibility & Capacity charging group	Ongoing
Impact of DSR on charging arrangements - To have a charging methodology in place which recognises that capacity can be created through DSR and includes an appropriate mechanism to charge for	Set out the principles of how charging arrangements will work when spare capacity is created through DSR. Identify which regulatory documents will need to change to implement these	DNOs raising a DCUSA mod in April 2014. This will be developed further by a working group and	Flexibility & Capacity charging	Ongoing

this capacity.	principles.	then submitted to Ofgem.	group	
Impact of strategic investment on charging arrangements - Clarity on whether DNOs can charge for capacity created through strategic investment which is subsequently used by customers and if so how.	Set out the principles of how charging arrangements will work when spare capacity is created through strategic investment. Identify which regulatory documents will need to change to implement these principles.	Decision made not to change regulations around strategic investment and charging boundary. Position clarified with DNOs at FCWG.	Ofgem	Completed
Electricity demand reduction				
Should DNOs proactively engage in electricity demand reduction - Clarity on whether this is something we're happy for DNOs to undertake.	Need to establish if this is a service which DNOs should be offering and if there are benefits in them doing so as opposed to other parties.	There is nothing to prevent DNO offering this service but we'd expect them to follow adequate customer protection process, or use 3rd parties.	Ofgem	Completed
Can DNOs use LCNF to trial electricity demand reduction measures - Revised LCNF criteria permit trialling of electricity demand reduction measures.	DNOs are providing examples of possible electricity demand reduction projects and we need to test them against LCNF eligibility criteria.	LCN Fund governance was updated in April 2013 to allow EDR trials.	Ofgem	Completed
Capturing system wide benefits of demand reduction - To have a mechanism in place to allow customers to receive the system wide benefits of demand reduction.	Demand reduction can provide benefits across the value chain but individual parties will only be able to provide reward for their share of the benefits	This falls under stages 2 and 3 of the WS6 programme	WS6	Ongoing
How should DNOs approach customers to provide electricity demand reduction measures and what protection measures do we need in place - To be able to cite adequate customer protection measures are in place for DNOs to engage with customers for demand reduction, either directly or through third parties. These may already exist, or may require developing.	If we consider that DNOs should approach customers directly, we will need to assess which licence conditions prevent them from undertaking work on the customer side of the meter and customer protection measures.	This is similar to the point above on customer protection measures and will be picked up further in stages 3 and 4 of WS6	WS6	Ongoing
Distribution System Operator				
Agree definition of DSO - A report which includes a broad definition of a DSO.	Include definition of DSO within WS6 report and flag that it is wider than *ad hoc* system balancing.	Included in the DSO role paper in this WS6 report	WS6	Completed
How to identify trigger points when DNOs move to a DSO model - Research and analysis into when a centralised DSO model starts to become economically viable.	Likely to be some cost benefit analysis on the penetration of renewable generation which would need to be in place before the economics of a centralised DSO model start to look viable.	Considered at high level in the DSO role paper in this report will be taken further in stage 4 of WS6	WS6	Ongoing

Who is responsible for monitoring trigger points and initiating changes to commercial arrangements going forward – Have clearly allocated roles and responsibilities amongst parties to monitor trigger points and responsibility for presenting the case for a DSO role.	Allocate some responsibility for monitoring any trigger points identified.	Considered at a high level in the DSO role paper in this report and will be picked up further in stage 4 of WS6	WS6	Ongoing
Integrated Energy Systems				
Examples of current projects which are ongoing to point to in our report - A report which includes some example projects to monitor.	Flag in WS6 report some current projects which might be useful to monitor.	Included in August 2012 report.	WS6	Completed

Appendix 5: Work stream 6 members

Apxgroup
BEAMA
British Gas
Consumer Focus
Cooperative Energy
DECC
E.On
EDF
Electralink
Electricity Storage Network
Element Energy
Elexon
eMeter
Energy Savings Trust
Engage Consulting
Electricity North West Ltd
Evolve Analytics
Good Energy
KiwiPower
Logica
Micropower Council
National Grid
Northern Powergrid
nPower
Ofgem
Office of Low Emissions Vehicles (OLEV)
UK Demand Response Association
RenewableUK
SmartGrid GB
SP Energy Networks
SSE Power Distribution
Sustainability First
UK Power Networks
Western Power Distribution