Cluster Methodology Review

Call for Evidence

05 October 2020

Contents

EXECUTIVE SUMMARY

The NIE Networks Statement of Charges[1] for Connection to the Northern Ireland Electricity Networks distribution system (the 'SoCC') sets out a methodology, in Appendix 2, for the connection of generation sites within a defined area to a cluster substation (the 'cluster methodology'). The cluster methodology has been a major success in facilitating the connection of renewable generation in Northern Ireland, and a major contributor towards the early achievement of the 2020 40% target. This target was in fact exceeded ahead of time, as 44% of electricity consumed for the 12 month period ending 30 June 2019 came from renewable sources[2].

Five clusters were commissioned between 2012 and 2018, enabling approximately 500MW of renewables to be connected. In addition, two clusters enabling around 180MW of further renewable connections are at different stages of the development process. When these are completed, cluster connected generation will represent approximately a third of all renewables connected in NI.

The cluster methodology has provided significant capacity, technical and environmental benefits for the connection of renewable generation in Northern Ireland. In the light of future targets, such as the proposed new Energy Strategy for Northern Ireland and the existing commitment for the UK to bring all greenhouse gas emissions to net zero by 2050, it is appropriate that the cluster methodology is reviewed so that assets are utilised efficiently to facilitate the delivery of these targets. By carrying out this review of the cluster methodology, NIE Networks is acting to comply with the Electricity (NI) Order 1992[3], Article 12(1), 'It shall be the duty of an electricity distributor to develop and maintain an efficient, coordinated and economical system of electricity distribution'.

NIE Networks consider that, following the experience gained from connecting renewable generation to cluster infrastructure, there are issues relating to present cluster matters to be resolved. Due to the direction of travel of the whole energy system, including the electrification of heat and transport, it is also prudent to consider future cluster matters such as connecting large customer and network demand into cluster infrastructure.

Many of the reasons for connecting generation into a cluster substation are also applicable for the connection of demand. This approach reduces distribution overhead line lengths and hence minimises any resulting environmental impact, and utilising adjacent cluster infrastructure to support the distribution network may be the most cost effective solution to relieve network constraints. It could be considered environmentally and commercially unsustainable to maintain a policy that requires the planning of 33 kV reinforcement infrastructure to by-pass a local cluster substation and connect to a more remote traditional 110 kV substation. The concept of connecting network demand into cluster sites may be helpful to efficiently develop capacity on the distribution network in rural areas for the future electrification of heat and transport in the drive to meet Net Zero carbon targets.

NIE Networks invite interested parties to respond to this Call for Evidence (CfE). The responses to this CfE will be analysed by NIE Networks and will be used in the development of a subsequent consultation document setting out a proposal for implementing the changes to improve the present cluster methodology and optimise existing cluster sites.

[1] https://www.nienetworks.co.uk/statementofcharges
[2] https://www.economy-ni.gov.uk/news/40-electricity-consumption-renewable-sources-by-2020-achieved-ahead-schedule
[3] https://www.legislation.gov.uk/nisi/1992/231/contents

1. INTRODUCTION

This document is the first step in collaborating with key stakeholders on updating the current NIE Networks cluster methodology. NIE Networks are keen to ensure that all stakeholders have every possible opportunity to input into these proposed changes.

This CfE seeks to gather evidence on aspects of the existing cluster methodology and future considerations, including the connection of large customer and network demand into clusters. The responses to this CfE will help with the development of a subsequent consultation document which will outline how NIE Networks plan to overcome the issues raised in this document and utilise existing network assets more efficiently by updating its cluster methodology.

2. CLUSTER BACKGROUND

The introduction of the Northern Ireland Renewables Obligation (NIRO) in April 2005 provided financial incentives for renewable generation. When this was coupled with the Northern Ireland Assembly's stated intention (in 2010) to achieve 40% of electricity consumption from renewables by 2020[4], it was clear that more sophisticated arrangements were required both technically and commercially to enable high volumes of renewable generation to connect within reasonable timelines and in a manner more sustainable for the environment.

Renewable generation projects, in particular wind, have tended to locate in the same areas of high average wind speed in order to maximise their investment case. However such locations are often remote from existing grid connection points. This presented major challenges for NIE Networks in two key areas:

- The planning and development of a power system that meets the needs of developers is always demanding. Where the project timescales, both for network and generation developments, are uncertain and where the future generation capacity requirements are not finalised it is particularly complex.

- It became clear to NIE Networks through discussions with the planning authorities that the connection of all proposed wind farms to the distribution system using lengthy individual overhead lines was unlikely to be possible (particularly for lines to run in parallel to overhead lines already constructed) as to do so would create an unacceptable detrimental effect on the environment.

The purpose of the cluster methodology was to improve access to the network for remote renewable generation, by extending the 110 kV transmission system, in the form of a 110/33 kV substation (referred to as a cluster substation), to a point more central to these groups of renewable generation projects. This enabled a more efficient connection arrangement with a reduced environmental impact by decreasing the aggregated length of overhead network required.

The cluster methodology was consulted on in detail, with endorsement from the Utility Regulator (UR), from March 2010 through May 2013, at which point the detailed cluster methodology and charging arrangements were introduced into the NIE Networks Statement of Charges for Connection to the Northern Ireland Electricity Networks distribution system (SoCC) as Appendix 2 and section 7 respectively[5].

2.1 Approved Charging Methodology

As stated in section 7 of the SoCC each generation developer pays in proportion to their share of the connection generation capacity. Therefore, each developer would pay in full for its unique connection assets

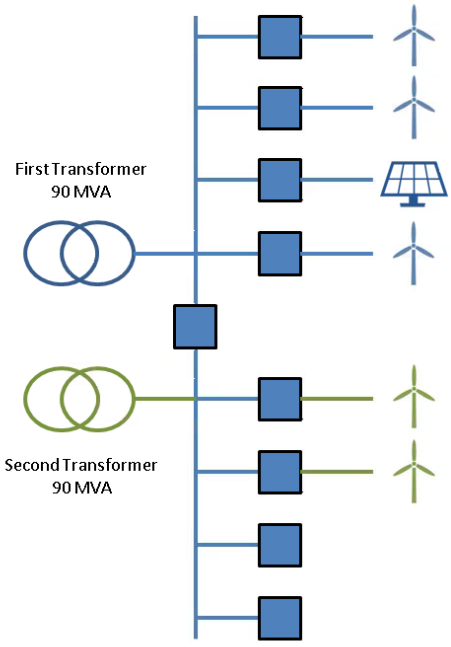
[4] https://www.economy-ni.gov.uk/sites/default/files/publications/deti/sef%202010.pdf
[5] https://www.nienetworks.co.uk/statementofcharges

and would pay for a share of the joint assets, based on the fraction of the total connection capacity. In other words, if the connection capacity was, 90 MW, and the generator to connect had a capacity of 31MW, then it would pay 31/90th of the cost of the cluster infrastructure.

Notably, using this mechanism it is possible that some of the costs of the shared assets would not be recovered from the developers as it would require the volume of generation connected to equal the connection capacity. This balance is recovered through use of system charges and is ultimately borne by Northern Ireland customers. To mitigate against the risk that the cluster is only minimally utilised, a threshold of 56 MW is used as the minimum combined weighted Maximum Export Capacity (MEC) needed to justify a cluster.

Where the capacity of the first transformer is fully utilised and a second transformer is installed then the hybrid concept is applied. The first to connect would pay the full cost of the sole-use assets and the full cost of the assets, which may be shared at some point in the future e.g. the second transformer. Charging principles for all connections will be considered in a full connection charging review which will involve a full consultation process; however it falls outside the scope of this CfE and subsequent consultation.

This charging methodology is shown in Figure 1. Note that all diagrams used in this document are for illustrative purposes only.



Connection Size (MVA)	Remaining Cluster Generation Capacity (MVA)	Note
25	65	Charged for 25/90th of Cluster (plus unique connection costs)
20	45	Charged for 20/90th of Cluster (plus unique connection costs)
25	20	Charged for 25/90th of Cluster (plus unique connection costs)
20	0	Charged for 20/90th of Cluster (plus unique connection costs)
First transformer capacity is now fully subscribed and funded by generation connections		
30	60	Charged for unique connection and full cost of the 2nd transformer
15	45	Charged for unique connection cost.
Spare		
Spare		

Order of Connection

FIGURE 1 - CLUSTER CHARGING METHODOLOGY

2.2 Benefits and Success of Clusters

The cluster methodology has been a major success in enabling the high levels of renewable generation connected to and committed to connect in Northern Ireland, and a major contributor towards the early achievement of the 2020 40% target. This target was in fact exceeded ahead of time, as 44% of electricity consumption for the 12 month period ending 30 June 2019 came from renewable sources[6].

Five clusters were commissioned between 2012 and 2018, enabling approximately 500MW of renewables to be connected. In addition, two clusters enabling around 180MW of further renewable connections are at different stages of the development process. When these are completed, cluster connections will represent approximately a third of all renewables connected in NI.

Without the cluster methodology, it is unlikely that the 2020 target would have been met due to a number of logistical and technical constraints. Not only does the cluster methodology provide much more robust technical control of both active and reactive power, but it has also enabled efficient connections of 24 large scale[7] projects.

The cluster methodology has provided benefits in the following areas:

- Capacity – a greater volume of renewable generation has been able to connect to the network. It has created large volumes of generation capacity in areas of the country where it was previously limited.
- Technical – improved power flow, voltage management and communications control from a central point. It has provided more efficient control of generation onto the Distribution and Transmission systems.
- Environmental – the aggregated length of overhead lines has been greatly reduced by extending the 110 kV network, therefore shortening the 33 kV lines connecting the renewable generation to the network. This philosophy is demonstrated in Figure 2 below.
- Constraint Reduction – the creation of capacity at clusters has bypassed potential constraints at existing 110/33 kV Bulk Supply Points (BSPs).

[6] https://www.economy-ni.gov.uk/news/40-electricity-consumption-renewable-sources-by-2020-achieved-ahead-schedule

[7] NIE Networks defines large scale as greater than or equal to 5MW

- Advancing Infrastructure – The funding arrangement agreed with the UR has enabled work to commence in advance of applicant funding, therefore putting downward pressure on connection timescales.

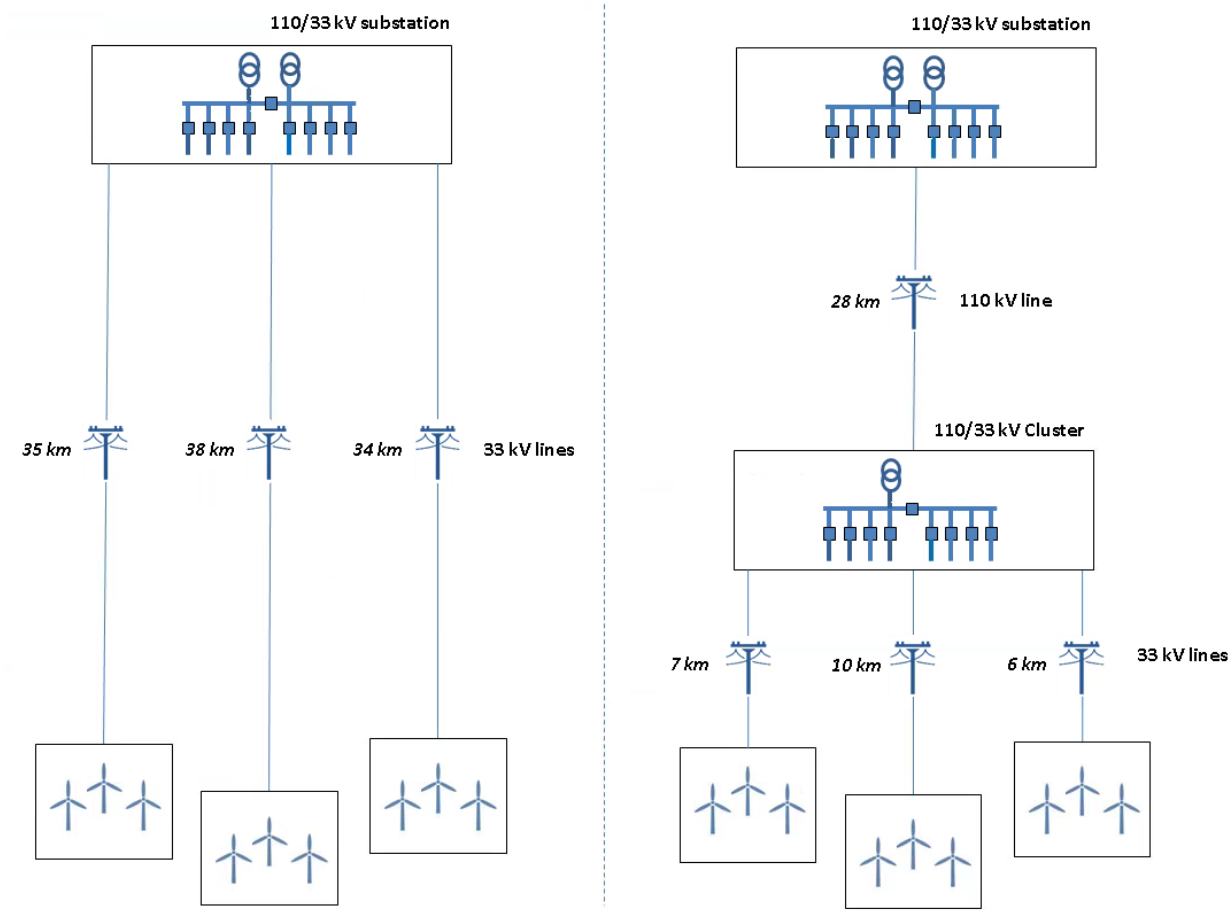


FIGURE 2 - THE ENVIRONMENTAL BENEFIT OF CLUSTERS

The creation of cluster substations has been very successful in facilitating greater connections of renewable generation and has been a major contributor to the whole system drive towards a low carbon future. It marked an innovative approach to overcoming capacity, environmental and technical problems and the cluster methodology will continue to be utilised to deliver these benefits and meet future renewable generation targets.

3. WHY A CALL FOR EVIDENCE

The cluster methodology has provided significant capacity, technical and environmental benefits for the connection of renewable generation in Northern Ireland. In the light of future targets, such as the anticipated new Energy Strategy for Northern Ireland and the existing commitment for the UK to bring all greenhouse gas emissions to net zero by 2050, it is appropriate that the cluster methodology is reviewed so that assets are utilised efficiently to facilitate the delivery of these targets. By carrying out this review of the cluster methodology, NIE Networks is acting to comply with the Electricity (NI) Order 1992, Article 12(1), 'It shall be the duty of an electricity distributor to develop and maintain an efficient, coordinated and economical system of electricity distribution'.

NIE Networks consider that, following the experience gained from connecting renewable generation to cluster infrastructure, there are issues relating to present cluster matters to be resolved. Due to the direction of travel of the whole energy system, including the electrification of heat and transport, it is also prudent to consider future cluster matters such as connecting large customer and network demand into cluster infrastructure.

NIE Networks is seeking evidence from stakeholders regarding the proposed changes to the cluster methodology, including the opening up of clusters to accept demand connections. The current cluster methodology has been successful in helping to facilitate large volumes of renewable generation to the network and assist in Northern Ireland achieving ambitious clean energy targets. The success of this was in part due to the successful engagement between NIE Networks and its stakeholders to create a robust and suitable cluster methodology.

Responses from stakeholders to this CfE will help with the development of a subsequent consultation document which will outline how NIE Networks plan to overcome the issues raised in this document and utilise assets more efficiently by updating its cluster methodology.

4. PRESENT CLUSTER MATTERS

4.1 Standardisation of Capacity Allocation

The current NIE Networks' charging arrangements for Authorised Generators connecting to the network as part of a generator cluster makes some explicit assumptions about the use of MW and MVA, and in other places uses the terms interchangeably.

NIE Networks' SoCC states the proportion of the cost of the cluster infrastructure that will be charged to each authorised generator connecting to the first transformer will be assessed on the basis of the MVA of capacity installed, or to be installed. The example that follows calculates this proportion of cost based on MW installed or to be installed, omitting the reactive power element of the connection.

The NIE Networks Distribution Code requires all Type C Power Generating Facility(s)[8] to be capable of operating at its Registered Capacity in a stable manner as a minimum within the power factor range 0.95 absorbing to 0.95 producing. This would mean a generator with a 10MW Registered Capacity must (as a minimum) be capable of providing ±3.3MVAr equating to a MVA capacity installed or to be installed of 10.5MVA. NIE Networks propose updating the Statement of Connection Charges to reflect that MVA will be calculated based on a 0.95 power factor, and update the charging examples to align with this.

The initial design of a cluster is based on a 90MVA transformer with the associated switchgear, lines etc. Generally speaking, the limiting factor in how much generation can be connected will be the rating of the transformer. Therefore when this rating is reached a second transformer is required.

Question 1 – Do you agree that the MVA capacity installed or to be installed should be calculated based on a 0.95 power factor requirement as per the NIE Networks Distribution Code?

Question 2 - In order to accurately reflect the technical aspects discussed above, do you agree the NIE Networks' SoCC text and examples should reflect the statement in 7.8 of the SOCC; the proportion of the cost of the cluster infrastructure that will be charged to each authorised generator connecting to the first transformer will be assessed on the basis of the MVA of capacity installed, or to be installed? If not, please explain why.

[8] Type C Power Generating Facility(s) means Power Generating Facility(s) with a Registered Capacity between 5 MW and 10 MW.

4.2 Cluster Designation

The existing NIE Networks cluster methodology was approved by the Utility Regulator in 2013 when planning matters in Northern Ireland were managed by the NI Planning Service. However, since then the responsibility for planning has been decentralised and is now a matter for local councils. The previous centralised process for renewable planning applications allowed for close coordination between the NI Planning Service and NIE Networks, which allowed us to better plan and coordinate the development of the electricity network based on the single strategic view of renewable projects in progress. Since planning powers have been devolved to local councils, this central strategic view no longer exists, leading to a risk of a more ad-hoc and less strategic approach to renewable projects and associated infrastructure. It also leads to inconsistency across councils regarding the approval of planning permission for renewable generation projects.

The probabilistic approach used by NIE Networks to anticipate the amount of generation in an area and to determine if it meets the threshold to designate a cluster assumes a consistent approach to planning matters across Northern Ireland. Weighting factors are applied to the generator MEC based on which stage of the planning process it is in: Early Stage, EIA Commenced, Submitted to Planning Service or PAC, Withdrawn from Planning and Consented. The current weighting factors for each stage are shown in Table 1 below.

Stage	Weighting Factor
Consented	1.0
Submitted to Planning or PAC	0.8
Applied for Grid Connection	0.8
EIA Commenced	0.0
EIA Commenced with Generator in an AONB or similar	0.0
Withdrawn from Planning	0.0
Early Stage	0.0

TABLE 1 - WEIGHTING FACTORS

At present a threshold of 56 MVA is used as the minimum combined weighted MEC needed to justify a cluster. This is based on the typical capacity of 33 kV overhead lines (28 MVA) and the need to reduce aggregated overhead line lengths. Currently this MVA value is calculated based on an assumed unity power factor i.e. 1MW = 1MVA. Based on the technical reasons discussed in section 4.1 NIE Networks believe the MVA value should be calculated based on a 0.95 power factor.

Question 3 – Do you believe the current approach for cluster designation remains fit for purpose i.e. weighted capacity calculation based on planning permission status or do you believe an alternative approach should be considered? Please provide reasons behind your opinion and propose alternatives if appropriate.

Question 4 - Do you agree cluster designation should be based on 56 MVA assuming a 0.95 power factor? If not, please explain why.

4.3 Timing

The NIE Networks' Statement of Connection Charges acknowledges that a connection offered to a generator via a designated cluster may take longer to deliver than an individual 33 kV connection to an existing constructed main substation. This can be due to a number of factors, including the need to obtain legal and regulatory consents for the cluster substation. The time required to complete substation design, line surveys, legalities and procurement of the equipment can be considerably longer for a clustered arrangement than with a direct connection to an existing node.

Accordingly the Timing section of Appendix 2 of the Statement of Connection Charges makes provision for a single generator to be offered a direct connection to an existing node where that generator may be delayed by the implementation of a cluster approach compared with the timing for an individual 33 kV connection to an existing node. An applicant who would otherwise be offered a connection via a cluster must currently meet three conditions before they can be considered for a direct connection to an existing node. These are:

a) The applicant is the "first in the queue" for connection to that particular cluster, measured by the date of application,

b) A connection via a cluster would result in severe delay – defined as 18 months or more – in comparison with a direction connection, and

c) Providing a direct connection to that applicant would not result in the cluster falling below the 56 MW threshold for designation.

The Timing provision within the cluster methodology was developed prior to NIE Networks having experience of the cluster process from designation to construction and energisation. Since the cluster methodology has been in place, five clusters were commissioned between 2012 and 2018, enabling approximately 500MW of renewables to be connected. In addition, two clusters enabling around 180MW of further renewable connections are at different stages of the development process. When these are completed, cluster connected generation will represent approximately a third of all renewables connected in NI. This practical experience has shown that the time taken from pre-construction to completion of a cluster can range between 4 years and 8 years.

NIE Networks experience is that the Timing provision in its current form does not reflect the length of time required to develop and construct a cluster and is unclear as to the point in time at which each of the three conditions must be assessed. Arguably an ongoing assessment of connection options for the first in the queue is required each time there is a change in the connection queue. This continual process results in the potential for multiple changes to connection offers and connection costs prior to applicants being connected and opens a loop of continual analysis for NIE Networks which can be time consuming but ultimately nugatory if connection to a cluster is preferred by the first in the queue. This can result in a lack of certainty for NIE Networks and generators. Where the Timing provision is applied this can then have a knock on effect on other applicants in the connection queue.

Based on this practical experience, and in order to maintain a Timing provision that can be implemented with certainty, NIE Networks proposes amending the Statement of Connection Charges so that the Timing provision will only be applied if the following conditions are met:

a) The applicant is the "first in the queue" for connection to a designated or approved cluster and has suffered or will suffer a Delay in being connected to that cluster. In this context 'Delay' shall mean that connection shall not occur within a period of 24 months commencing on the estimated date of connection stated in the connection offer issued to the applicant by NIE Networks.

b) The first in the queue has applied for and paid NIE Networks for a feasibility study to be undertaken within 3 months to determine if a direct connection to an existing node is technically acceptable; and

c) Where a direct connection to an existing node is technically acceptable, offering a direct connection to an existing node to the first in the queue would not result in the cluster falling below the 56MVA threshold for designation should the offer for the direct connection to an existing node be accepted.

Question 5 - Do you agree that the Timing provision currently provided for does not reflect cluster experience and can not be applied with certainty for both NIE Networks and generators? If not, please explain why.

Question 6 – Do you agree with the proposal for amending the SoCC? If not, please explain why.

Question 7 – Do you have any other comments or suggestions with regard to the future use of the Timing provision?

4.4 Technical Assessment – Geographic Extent of a Cluster

When determining the amount of generation capacity that is likely to connect to a potential cluster substation NIE Networks carries out an assessment of all generation anticipated in an area. The current cluster methodology limits this area to approximately 310 km^2 based on a 10 km radius from the potential cluster substation location. This radius was originally based on a 12 km maximum length of 33 kV 200 mm^2 aluminium overhead line that, when fully loaded, maintains the 33 kV voltage at the generator within statutory limits. The radius is reduced to 10 km to allow for the route length being generally around 20% greater than the direct distance from the source to the generator.

The current cluster methodology also allows for this radius to be extended when it is technically acceptable to do so. The radius is based upon average conditions and engineering principles and judgement are to be applied to refine any particular case. For example, it might be possible to use a 15 km 33 kV overhead line to connect a generator where the voltage rise at the generator remains within the upper statutory limit.

Developments in NIE Networks' connection policy including development of long cable connections and design means this 10 km limit can be extended in many scenarios, whilst maintaining the 33 kV voltage at the generator within statutory limits, based on factors such as generator size, technical specification and connection method i.e. overhead line or underground cable.

The inclusion of a radius is to act as a guide for NIE Networks when carrying out technical assessments to designate a cluster and for generators to understand the likely geographical extent of the cluster area.

Question 8 – Do you agree with the benefits of including a radius but also allowing for engineering judgement to be applied ensuring optimised connection methods are offered?

Question 9 – Do you think the 10 km radius should be updated taking account of improvements in NIE Networks' connection policy and design? If yes, please provide suggestions.

4.5 Definitions

NIE Networks recognises that there may be a requirement to include new definitions and/or update existing definitions within the SoCC as part of this proposed cluster Methodology update.

The need for these new and/or modified definitions will be dependant on the scale of the overall update, as proposed within this document. Therefore it is not possible to propose any specific changes at this time.

Question 10 – Do you agree that new and/or updated definitions may be required? If you have any specific concerns about new or existing definitions please provide information here.

5. FUTURE CLUSTER MATTERS – CONNECTING LARGE CUSTOMER AND NETWORK DEMAND

The present cluster methodology was intended solely to facilitate the connection of renewable generation into cluster sites. NIE Networks now consider that network reinforcement costs to meet increases in demand, in particular associated with facilitating the future electrification of heat and transport to meet carbon reduction targets in more rural communities, can be minimised by utilising the existing cluster infrastructure.

This section seeks to outline the reasons, benefits and considerations associated with connecting demand into cluster substations.

5.1 Drivers for Change

Many of the justifications for connecting generation into a cluster are also applicable for the connection of demand. This approach can reduce overhead line lengths and hence minimises environmental impact, and a cluster connection may be the most cost effective solution to resolving network constraints in terms of the contribution required from the NI customer. It could be considered environmentally and commercially unsustainable to maintain a policy that requires the planning of 33 kV reinforcement infrastructure to by-pass a local cluster substation and connect to a more remote traditional 110 kV substation. In this situation, by making use of an existing technically feasible asset it is probable that the delivery time of any network reinforcement or large demand customer connection projects will be reduced.

Northern Ireland is expected to see considerable growth in demand due to the electrification of heat and transport. It is expected that this increase in load will utilise existing demand capacity at all voltage levels, leading to network congestion as the volume of these new Low Carbon Technologies (LCTs) increases. Whilst the connection of LCTs are currently modest, it is expected that over the next decade there will be a large increase in the number connecting, as demonstrated by government announcements, e.g. no new diesel or petrol vehicles to be sold in the UK after 2040. NIE Networks are preparing for this increase by modelling the projected uptake of LCTs in order to better understand the scale of the impact they will have on the network and to plan for the subsequent investment which will be required.

In order to reduce the amount of conventional reinforcement (new lines, cables and transformers) required and ultimately place downward pressure on customer bills, NIE Networks are seeking to implement smart and market-based solutions[9] to unlock further capacity on the network. With this context in mind, it is important that NIE Networks continue to consider how all network assets can be used as efficiently as possible to deliver customer and network benefits. This therefore drives a need for NIE Networks to investigate the potential for using constructed cluster infrastructure for the connection of demand. It is worth noting that at other 110/33 kV substations (BSPs) the connection of both demand and generation is normal practice.

The regulatory environment and, in particular the requirement to meet overall standards of performance, provides a strong external influence towards the development of networks which deliver continuously improving performance. While such improvement would, clearly, be a laudable objective it must be set within the context that income for the funding of capital expenditure is subject to regulation. Electricity (NI) Order 1992, Article 12(1) states, ‘It shall be the duty of an electricity distributor to develop and maintain an efficient, coordinated and economical system of electricity distribution’. Therefore, it is an obligation on NIE Networks that existing assets are used in the most efficient and economical way.

[9] https://www.nienetworks.co.uk/future-networks/level2/our-innovation-projects

5.2 Benefits of Change

The connection of demand into clusters could provide a number of benefits to generators, demand customers and the wider NI customer base, as described below.

5.2.1 Benefits to Generators

1. Better Redundancy

   Clusters are currently a means of connecting generation, and therefore in accordance with the Distribution System Security and Planning Standards (DSSPS) they do not have any requirement to have a level of redundancy (discussed further in section 5.3). The addition of demand to clusters would benefit the existing generators at that cluster by reducing the constraint during an outage condition of the existing 110 kV line and transformer and increasing the security of their connection.

2. Improved Power Quality

   The requirement for redundancy will result in the addition of a second 110/33 kV transformer and 110 kV circuit where a cluster initially has a single transformer and 110 kV circuit, which will reduce the impedance of this section of the network and will consequently increase fault level. Among other benefits, this will help to reduce the impact of generator harmonic current emissions and voltage step changes, making it easier for future generation schemes to remain within the relevant statutory limits and potentially avoiding the need for a costly mitigating solution.

3. Additional Generation Capacity Released

   Under current arrangements (demand is not connected into clusters), the release of additional generation capacity at a cluster substation would require the reinforcement costs to be borne by the generation connection which triggers the need for a second transformer. The DSSPS requirement for a second 110/33 kV transformer and 110 kV circuit following the connection of demand to a cluster will consequently provide additional transformer capacity which can then be utilised by subsequent generation connections, without incurring the cost of the second transformer. Scenarios illustrating this benefit are outlined in Section 5.4.1.

5.2.2 Benefits to Large Demand Customers

1. Releases Large Volumes of Demand Capacity

   With 5 clusters already constructed (with 2 more in progress), the opening of clusters to demand would represent a release of previously unavailable capacity. As clusters are often located in remote locations (driven by the location of wind farms) the alternative connection option would be advantageous to a large demand customer seeking a connection in such regions. NIE Networks currently signpost where such capacity is available through an interactive capacity map[10] to assist generation and demand customers with the planning process for large connections. The release of this demand capacity would provide further alternatives for large demand customers seeking a connection to the network.

2. May Reduce Costs and Timescales of Projects

   The possibility of connecting a large demand customer into a constructed cluster will provide alternative options for a network connection. This alternative may represent the most cost effective connection by potentially reducing the length of overhead line or underground cable routes, or by preventing the need for costly network reinforcement to facilitate the connection.

[10] https://www.nienetworks.co.uk/connections/capacity-map

A key factor for the establishment of clusters was that the advancement of such infrastructure would put downward pressure on connection timescales for generation customers. In certain situations, the timescale for a demand customer to connect to the network could also be reduced because of the ability for a nearby cluster to accept demand connections.

5.2.3 Benefits to the Northern Ireland Customer

1. Efficient Use of Assets

   Under the Electricity (NI) Order 1992, NIE Networks has an obligation to develop and maintain an efficient, coordinated and economical system of electricity distribution which has the long-term ability to meet reasonable demands for the distribution of electricity. It is therefore vital that NIE Networks continue to consider how assets can be used as efficiently as possible to deliver customer and network benefits. The potential to connect network demand into clusters would increase the efficiency of future network design and would ensure the minimising of network charges borne by the NI customer. This improved efficiency would also reduce electrical losses on the network, reducing the impact of Distribution Loss Adjustment Factors (DLAFs) on network charges.

2. Environmental Conservation

   NIE Networks' Environmental Statement[11] states that it will aim to mitigate the impact of its activities on the environment. Accordingly, NIE Networks will always consider the impact of its activities on the environment. If NIE Networks determines an environmental assessment is needed to support a decision an environmental assessment will be carried out by environmental and planning specialists. This was a key factor in the establishment of clusters, as the aggregated length of overhead lines has been greatly reduced by extending the 110 kV network, therefore shortening the 33 kV lines connecting the renewable generation to the network. The same concept can apply to demand connections as a cluster may represent the geographically closest point of connection. The opening up of clusters to demand would prevent the undesirable scenario where a demand connection would be required to bypass a cluster site and connect elsewhere, adding avoidable overhead line lengths to the NI landscape.

Question 11– Do you agree that connecting network and large customer demand using constructed cluster infrastructure would be an efficient, coordinated and economical use of the network? If not, please state why.

Question 12 – Do you agree that the SoCC should be updated to reflect that connecting network and large customer demand using constructed cluster infrastructure would be an efficient, coordinated and economical use of the network? If not, please state why.

Question 13 – Do you agree that the connection of demand into clusters would provide benefits to generation customers, large demand customers and the overall NI customer base? If not, please provide reasons why.

5.3 Demand Redundancy Requirements

At the time of writing, cluster substations solely facilitate the connection of renewable generation and consequently are not required to have any level of redundancy, meaning that some clusters are operational with a single 110/33 kV transformer supplied by a single 110 kV circuit. Therefore, under a single outage of the 110 kV line or the 110/33 kV transformer, all generation connected to that cluster will be constrained to zero export.

[11] https://www.nienetworks.co.uk/documents/environment/environmental-statement-oct-15.aspx

NIE Networks is governed by statute and by licence in respect of the manner in which it plans, operates and maintains its electrical network. NIE Networks' minimum security of supply planning obligations is defined by Engineering Recommendation (EREC) P2 (NI) of the Distribution System Security and Planning Standards[12]. According to EREC P2, a level of redundancy is required for demand. The recommendations which are appropriate in this context are:

- If the Group Demand is over 1MW and up to 8MW, then following a circuit outage the Group Demand minus 1MW must be met within 3 hours.
- If the Group demand is over 8MW and up to 24MW, then following a circuit outage the Group Demand minus 8MW must be met within 15 minutes and Group demand within 3hrs.
- If the Group demand is over 24MW and up to 60MW, then following a circuit outage 2/3 of the Group Demand must be met within 15 minutes and Group demand within 3hrs.

P2 also recommends that for Group Demand greater than 8MW, then "Under normal situations, Group Demand will normally be supplied by at least two normally closed circuits or by one circuit with supervisory or automatic switching of alternative circuits." Therefore, to provide appropriate redundancy it is necessary that any cluster substation that is selected to supply demand will need at least two 110/33 kV transformers fed from multiple 110 kV circuits.

Due to the nature of cluster substations, there is currently limited scope for taking advantage of the contribution of adjacent 33 kV networks in order to delay additional reinforcement in the consideration of 110/33 kV substation security. It is also worth noting that the addition of this redundancy provides an advantage to generators, by reducing the constraint during an outage condition and increasing the security of their connection.

5.3.1 Redundancy Requirements for Storage

Electricity storage is seen as a key aspect of the future energy system. Its ability to decouple demand and generation can provide wide ranging benefits such as renewable energy curtailment and constraint reduction. Storage schemes share similarities with generation assets but when compared against traditional generating schemes important differences arise.

Primarily, storage requires both an import and an export capability. Although storage is often considered as a generation asset, it does not provide a net export of energy and therefore relies entirely on its import to provide an export. In EREC P2, the demand required by a storage unit is included in the overall Group Demand, and therefore a level of redundancy is required for connections where the Maximum Import Capacity (MIC) of the storage unit is over 1 MW.

Therefore, the presence of demand requirements for a storage scheme means that EREC P2 applies and consequentially it is necessary that any cluster substation with storage connected will need at least two 110/33 kV transformers fed from multiple 110 kV circuits.

5.4 Network and Large Customer Demand Connection Charges

Unlike for generation, there is currently no demand-specific charging methodology for clusters. Therefore, under current arrangements the charging which would apply to any demand which would connect to a cluster would be according to NIE Networks SoCC and would mirror the principles for how demand is charged across the network.

[12] https://www.nienetworks.co.uk/distribution-code

5.4.1 Demand Charging for a Constructed Cluster

This section seeks to present the implications of connecting demand into a Constructed[13] cluster. It is worth noting that NIE Networks would consider the applicability of other charging arrangements should clusters be opened up to accept demand connections. Charging principles for all connections will be considered in a full connection charging review which will involve a full consultation process; however it falls outside the scope of this CfE and subsequent consultation. However, for the purpose of this CfE, it was considered appropriate to present how this would currently be achieved according to the existing SoCC. This approach was used in order to clearly outline the implications of connecting network and large customer demand into clusters.

Key points when the SoCC is applied to demand connections to a cluster are:

- The first demand customer is required to pay for their connection assets, including any necessary redundancy infrastructure. Subsequent demand customers will then be charged for their unique connection assets.

- Network reinforcement is funded (including redundancy infrastructure if not already present) through the use of system charges borne by the NI customer.

- Generators seeking to connect are still charged according to the cluster charging methodology. In the case where an additional transformer has been added for demand redundancy (and funded by the first demand customer or through system charges), any generator seeking to connect to make use of this additional transformer generation capacity will not be charged any proportion of the transformer cost and will only be charged for their unique connection assets. Note that this only applies when the initial generation capacity of the cluster is fully subscribed.

The following scenarios seek to describe how these charges would be applied to demand. All 3 scenarios consider a cluster substation with a single 90 MVA transformer and 110 kV transmission circuit, with 65 MVA of generation already connected. This is shown in Figure 3.

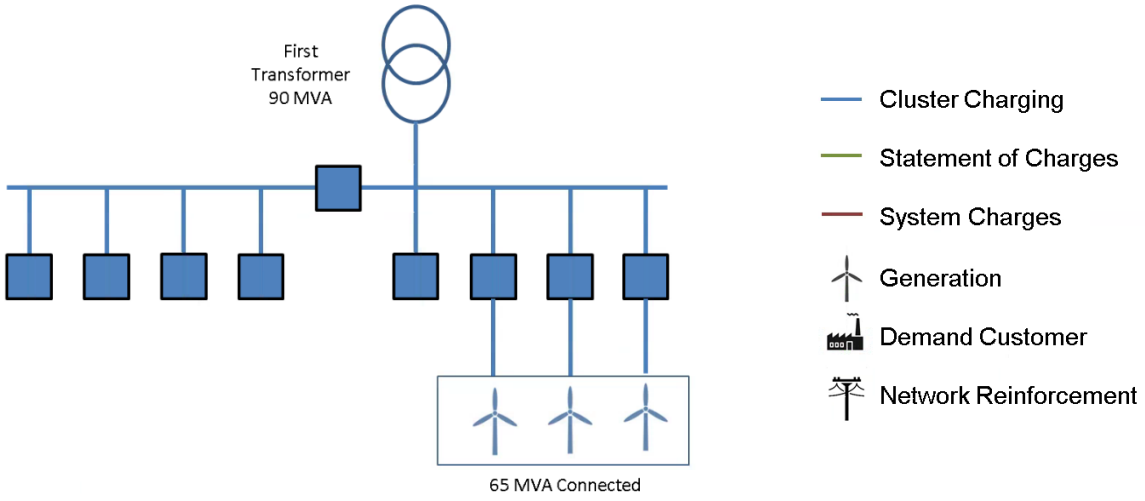
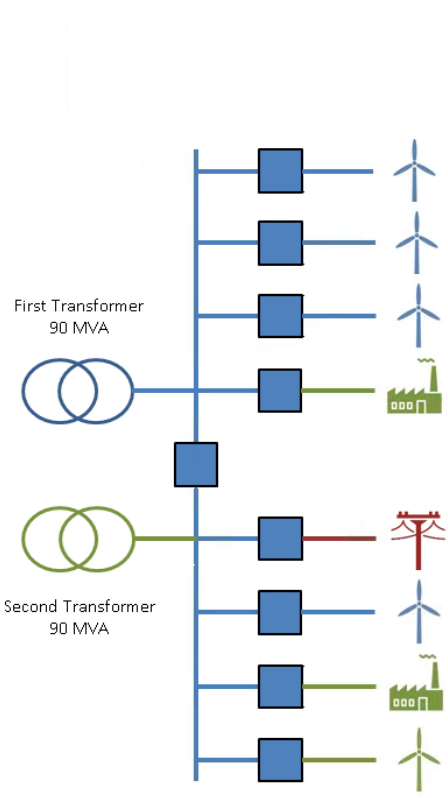


FIGURE 3 - INITIAL CLUSTER SCENARIO AND KEY

[13] *Constructed Generation Cluster Infrastructure* means existing Network Infrastructure including, as appropriate, civil works, electrical lines and cables, electrical plant, meters, telemetry and data processing equipment which has been previously been approved by the Authority as being required for the purposes of connecting a Generation Cluster to the network.

5.4.1.1 Scenario 1

In the first scenario, which is shown below in Figure 4, the need for a second transformer (required due to EREC P2) is driven by a demand customer.



Connection Size (MVA)	Remaining Cluster Generation Capacity (MVA)	Remaining Cluster Demand Capacity (MVA)	Note
25	65	0	
20	45	0	
20	25	0	
15	115	75	Second transformer funded by 1st Demand Customer
30	115	45	
25	90	45	Connection still pays 25/90th of initial infrastructure to ensure cost recovery
15	90	30	
20	70	30	Pays for unique connection assets only

Order of Connection

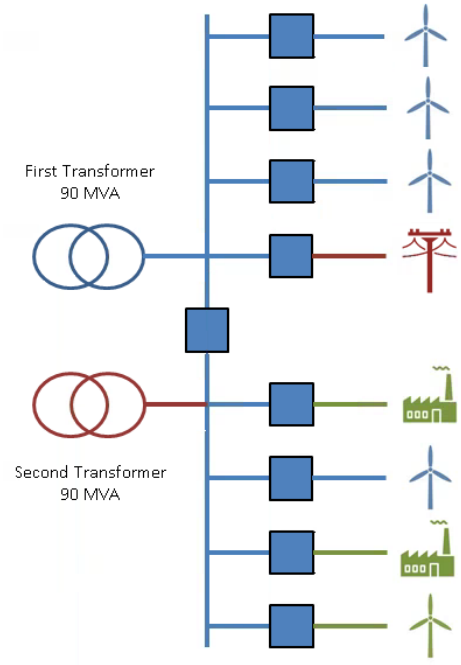
FIGURE 4 - SCENARIO 1

In this scenario the demand customer incurs the full redundancy costs as well as their unique connection costs. In order to ensure the cost of the cluster is fully recovered, the next generator to connect is still charged according to the cluster charging methodology. Once this cost is fully recovered (90/90th now paid), any generator wishing to connect would only be charged for their unique connection assets.

Note that in line with EREC P2 and NIE Networks' design policy, a total transformer capacity of 180 MVA would only represent a demand capacity of 90 MVA.

5.4.1.2 Scenario 2

In the second scenario, which can be seen below in Figure 5, the second transformer (required due to EREC P2) is driven by a need for network reinforcement.



Connection Size (MVA)	Remaining Cluster Generation Capacity (MVA)	Remaining Cluster Demand Capacity (MVA)	Note
25	65	0	
20	45	0	
20	25	0	
30	115	60	Second transformer funded through System Charges
20	115	40	Pays for unique connection assets only
25	90	40	Connection still pays 25/90th of initial infrastructure to ensure cost recovery
15	90	25	Pays for unique connection assets only
20	70	25	Pays for unique connection assets only

Order of Connection

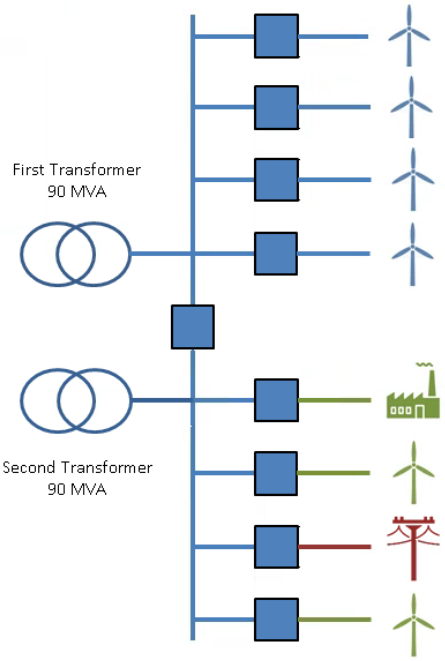
FIGURE 5 - SCENARIO 2

In this scenario the cost associated with the network reinforcement work, including the additional transformer and transmission infrastructure, is recovered through system charges which are borne by the NI customer. As before, generation connections will still be charged according to the cluster charging methodology until the cost for the initial cluster infrastructure is fully recovered.

It is worth noting that the connection of demand into clusters and the subsequent increase of demand capacity will have the positive affect of reducing network reinforcement costs and therefore reducing the financial impact of such projects on NI customers.

5.4.1.3 Scenario 3

In the third scenario, which is shown in Figure 6, the second transformer (required due a transformer generation capacity constraint) is driven by a generator seeking to connect.



Connection Size (MVA)	Remaining Cluster Generation Capacity (MVA)	Remaining Cluster Demand Firm Capacity (MVA)	Note
25	65	0	
20	45	0	
20	25	0	
30	85	90	Pays for 2nd transformer
20	85	70	Pays for unique connection assets only
25	60	70	Pays for unique connection assets only
25	60	45	Reinforcement assets funded through system charges
20	40	45	Pays for unique connection assets only

Order of Connection

FIGURE 6 - SCENARIO 3

In this scenario, the second transformer is funded using the cluster methodology for second transformer charging. In this example, as the initial infrastructure has not yet been fully recovered the 30 MVA generator would pay for 25/90th of the original cluster infrastructure plus the entire cost of the second transformer. Any demand or generation customers who subsequently connect are charged for their unique connection assets only.

Question 14 – Having seen the scenarios above, do you agree with using the existing SoCC to charge demand connections to a cluster? If not, please provide alternative proposals.

5.4.2 Cluster Designation Considerations

Currently, the designation[14] of a cluster substation begins with an assessment of all generation anticipated in an area of about 310 km^2 or a 10 km radius. This radius is based on a 12 km maximum length of 33 kV 200 mm^2 aluminium overhead line that, when fully loaded, maintains the 33 kV voltage at the generator within statutory limits. The radius is reduced to 10 km to allow for the route length being generally around 20% greater than the direct distance from the source to the generator. The radius is based upon average conditions and engineering principles and judgement are to be applied to refine any particular case, e.g. it might be possible to use a longer

[14] *Designated Generation Cluster Infrastructure* means Network Infrastructure including, as appropriate, civil works, electrical lines and cables, electrical plant, meters, telemetry and data processing equipment proposed by NIE Networks as being required for the purposes of connecting a Generation Cluster to the network, prior to its approval for such purpose by the Authority.

33 kV overhead line to connect a generator where the voltage rise at the generator remains within the upper statutory limit.

Based on the typical capacity of 33 kV overhead lines (28 MVA) and the need to reduce aggregated overhead line lengths, the threshold for a cluster to be considered is 56 MVA of proposed generation connections. It is worth noting that each generation site's MEC is weighted (as discussed in Section 4.2) according to the development stage of the generation project to take account of uncertainty of a project being completed. Therefore if the combined weighted MECs of generation sites within the designated area are above 56 MVA then a cluster substation will be considered and NIE Networks will carry out further analysis.

A demand customer seeking to connect to the network is offered the Least Cost Technically Acceptable (LCTA) connection. In order for this offer to be considered technically acceptable, it has to provide a connection to network infrastructure which currently exists. Similarly for network reinforcement projects, an expenditure allowance is provided for reinforcement works for the subsequent regulatory period. The reinforcement work to alleviate any identified network deficiencies cannot be based on speculative assets, and therefore speculative costings, due to the mitigation proposal taking account of assets which do not currently exist.

It is NIE Networks view that, as neither demand customer connections nor network reinforcement can be designed to connect to infrastructure which is not yet operational (which is the case for an approved or designated cluster), it follows that the connection of network or large customer demand should not be considered in the designation of a cluster site.

Question 15 – Do you agree that demand should not be considered as part of the designation of a cluster site? If not, please provide reasons why.

5.5 Allowable Connection Voltage

Where a 33 kV circuit, due to being constructed during the time of rural electrification, contains directly connected 33/0.4 kV or 33/0.23 kV transformers it is classified as a 33 kV distribution circuit and can be considered under certain circumstances as the LCTA solution for an LV connection. However, 33 kV circuits which do not have distribution transformers historically connected are designed in order to maximise network performance and capacity. This type of circuit is classed as sub-transmission circuit and therefore the connection of distribution transformers is not permitted.

It is important to mitigate against the risk that cluster infrastructure is only minimally utilised. For this reason, a threshold for connected generation was introduced to ensure that the infrastructure is not used inefficiently. It is important to ensure that any connection of demand also respects this principle and does not represent inefficient use of the assets.

For these reasons, it is NIE Network's view that the connection of distribution transformers to a 33 kV circuit of a cluster substation should not be permitted. Consequently, it follows that only 33 kV (EHV) customers and 33 kV circuits used for network reinforcement, including the connection of Primary (33/11 kV) substations, are permitted to directly connect to the cluster infrastructure.

Question 16 – Do you agree that in order to ensure the efficient use of assets, all direct customer connections to a cluster should be restricted to 33 kV connections? If not, please provide reasons why.

5.6 33 kV Busbar Voltage Considerations

Cluster substations differ from traditional 110/33 kV arrangements (BSPs) in that the voltage at the 33 kV busbar is designed to be 1.0pu, as opposed to BSPs where it is designed to be 1.03pu. Limiting the source voltage to 1.0pu is to provide extra headroom for voltage rise on the 33 kV circuits connecting the generators to the cluster substation, ensuring that upper voltage limits are not exceeded and thereby maximizing the amount of renewable generation that can be connected to a cluster substation. The opposite applies for BSP sites that

are normally designed to supply load whereby the source voltage is maximized to allow for the network voltage drop caused by remote demand connections. This allows the most efficient use of assets that are primarily designed to supply electrical demand. Consequently, increasing the source voltage to maximise demand capacity would compromise generation capacity.

It is NIE Networks' view that, as the primary function of a cluster substation is to maximize the capacity for renewable generation connections, it is therefore required that any connection of demand into a cluster substation should be designed in such a way that it does not compromise this arrangement meaning the 33kV busbar voltage remains at 1.0pu for cluster substations

Question 17 – Do you agree that in order to continue facilitating high levels of renewable generation any connection of demand into a cluster should be designed in order to maintain this current 33 kV busbar voltage concession? If not, please provide evidence why.

5.7 Transmission/Distribution Interactions

At present, when a cluster is designated and approved by the Utility Regulator, NIE Networks applies to the System Operator for Northern Ireland (SONI) for a 90MVA MEC on the transmission network. SONI carries out a technical assessment of the transmission system and provides NIE Networks with an offer.

Based on the proposals for cluster substations to facilitate the connection of demand, NIE Networks would have to apply to SONI for an associated Maximum Import Capacity (MIC). As per EREC P2 (discussed in section 5.4.1.1) a transformer capacity of 180 MVA provides a demand capacity of 90 MVA, allowing for full redundancy.

The NIE Networks' SoCC states in section 7.11 that in circumstances where an Authorised Generator makes an application for connection which has the effect of increasing the electrical capacity required from the Designated Generation Cluster Infrastructure or Approved Generation Cluster Infrastructure or Constructed Generation Cluster Infrastructure above the capacity of the First Transformer and therefore necessitates the installation of a second transformer or a third transformer (where the capacity of a second transformer is exceeded by the connection application) or triggers the need for further transmission reinforcement then that Authorised Generator shall be required to pay for the full cost of the second transformer or the third transformer or further transmission reinforcement (as the case may be) and associated works notwithstanding that the transformer and / or further reinforcement may subsequently become a shared asset. The SoCC also makes provisions for interactive offers.

Question 18 – If the need for a second (or third) transformer arises, should NIE Networks apply to SONI for an additional 90 MVA MEC and 90 MVA MIC or apply incrementally each time the need arises for an increased MEC/MIC?

6. NEXT STEPS AND HOW TO RESPOND

6.1 Next Steps

This CfE is the first step in collaborating with key stakeholders on updating the NIE Networks cluster methodology. NIE Networks are keen to ensure that all stakeholders have every possible opportunity to input into these proposed changes. The responses to this CfE will be analysed by NIE Networks and will be used in the development of a subsequent consultation document setting out a proposal for implementing the changes to improve the current cluster methodology and to connect network reinforcement and large customer demand into clusters.

An indicative timeframe for the process is provided below in Table 2. Please note that these timescales will be kept under review and are subject to change as the scope of the consultation paper will be largely dependent on the responses and input of stakeholders.

Key Milestones	Dates
Call for Evidence Released	5th October 2020
Call for Evidence Closed	13th November 2020
Publication of Consultation Paper	Q2 2021

TABLE 2 - PROPOSED TIMELINE

6.2 How to Respond

NIE Networks invite interested parties to respond to this Call for Evidence. Whilst NIE Networks welcome all comments they particularly welcome comments on the questions that are embedded within this document. A summary of these questions is included below. Responses should be sent electronically to Carl.Hashim@nienetworks.co.uk by 5pm on Friday 13th November 2020.

NIE Networks will handle all information in accordance with the NIE Networks Privacy Statement (http://www.nienetworks.co.uk/privacy).

Please note that it is intended to publish all responses to this paper on the NIE Networks website (www.nienetworks.co.uk). Respondents who wish that their response remains confidential should highlight this when submitting their response.

NIE Networks may share responses with UR. Respondents should be aware that as UR is a public body and non-ministerial government department, the UR is required to comply with the Freedom of Information Act (FOIA)[15].

7. SUMMARY OF QUESTIONS

7.1 Present Cluster Matters

Question 1 – Do you agree that the MVA capacity installed or to be installed should be calculated based on a 0.95 power factor requirement as per the NIE Networks Distribution Code?

Question 2 - In order to accurately reflect the technical aspects discussed above, do you agree the NIE Networks' SoCC text and examples should reflect the statement in 7.8 of the SoCC; the proportion of the cost of the cluster infrastructure that will be charged to each authorised generator connecting to the first transformer will be assessed on the basis of the MVA of capacity installed, or to be installed? If not, please explain why.

Question 3 – Do you believe the current approach for cluster designation remains fit for purpose i.e. weighted capacity calculation based on planning permission status or do you believe an alternative approach should be considered? Please provide reasons behind your opinion and propose alternatives if appropriate.

[15] The effect of FOIA may be that information contained in CfE responses that is shared with UR is required to be put into the public domain. Hence it is possible that all responses made to this CfE that may be shared with UR will be discoverable under FOIA, even if respondents ask for the responses to be treated as confidential. It is therefore important that respondents take account of this and in particular, if asking that the responses are treated as confidential.

Question 4 - Do you agree cluster designation should be based on 56 MVA assuming a 0.95 power factor? If not, please explain why.

Question 5 - Do you agree that the Timing provision currently provided for does not reflect cluster experience and can not be applied with certainty for both NIE Networks and generators? If not, please explain why.

Question 6 – Do you agree with the proposal for amending the SoCC? If not, please explain why.

Question 7 – Do you have any other comments or suggestions with regard to the future use of the Timing provision?

Question 8 – Do you agree with the benefits of including a radius but also allowing for engineering judgement to be applied ensuring optimised connection methods are offered?

Question 9 – Do you think the 10 km radius should be updated taking account of improvements in NIE Networks' connection policy and design? If yes, please provide suggestions.

Question 10 – Do you agree that new and/or updated definitions may be required? If you have any specific concerns about new or existing definitions please provide information here.

7.2 Future Cluster Matters

Question 11 – Do you agree that connecting network and large customer demand using constructed cluster infrastructure would be an efficient, coordinated and economical use of the network? If not, please state why.

Question 12 – Do you agree that the SoCC should be updated to reflect that connecting network and large customer demand using constructed cluster infrastructure would be an efficient, coordinated and economical use of the network? If not, please state why.

Question 13– Do you agree that the connection of demand into clusters would provide benefits to generation customers, large demand customers and the overall NI customer base? If not, please provide reasons why.

Question 14 – Having seen the scenarios above, do you agree with using the existing SoCC to charge demand connections to a cluster? If not, please provide alternative proposals.

Question 15 – Do you agree that demand should not be considered as part of the designation of a cluster site? If not, please provide reasons why.

Question 16 – Do you agree that in order to ensure the efficient use of assets, all direct customer connections to a cluster should be restricted to 33 kV connections? If not, please provide reasons why.

Question 17 – Do you agree that in order to continue facilitating high levels of renewable generation any connection of demand into a cluster should be designed in order to maintain this current 33 kV busbar voltage concession? If not, please provide evidence why.

Question 18 – If the need for a second (or third) transformer arises, should NIE Networks apply to SONI for an additional 90 MVA MEC and 90 MVA MIC or apply incrementally each time the need arises for an increased MEC/MIC?