Application of Clause 5.4 of EirGrid's Connection Charging Methodology Statement in a harmonics context

Consultation Paper

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Introduction

EirGrid plc is dedicated to the provision of transmission and market services for the benefit of electricity consumers. It is a state-owned commercial company. It puts in place the grid infrastructure needed to support competition in energy, to promote economic growth, to facilitate renewable energy and to provide essential services.

EirGrid holds licences as independent electricity Transmission System Operator (**TSO**) and Market Operator (**MO**) in the wholesale trading system in Ireland, and is the owner of System Operator Northern Ireland (**SONI** Ltd), the licensed TSO and market operator in Northern Ireland. The Single Electricity Market Operator (**SEMO**) is part of the EirGrid Group and operates the Single Electricity Market on the island of Ireland.

Purpose and structure of this paper

This paper considers the interpretation of Clause 5.4 of EirGrid's Connection Charging Methodology Statement (**CMS**) in the context of harmonics issues arising from customer[1] requests for underground cable connections and seeks industry and customer views on the most appropriate methods of allocating the costs of works that EirGrid is required to undertake in order to mitigate the effects of harmonics on the system in those circumstances. This paper is structured as follows -

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1. Background

Connection charging refers to the methodology for charging for the shallow cost of connections to the transmission system. The policy framework governing connection charging is outlined in the following regulated documents:

- EirGrid's Transmission Connection Charging Methodology Statement, 14 March 2008; and
- Joint TSO/DSO Group Processing Approach Charging and Rebating Principles paper, 17 June 2010.

[1] The CMS and this paper apply to both Generation and Demand customers. Additionally, for the purposes of this paper, it is assumed that all current and future DSO customers are/will be Grid Code compliant at their Transmission System Connection Point i.e. no harmonics mitigation at the transmission level is required.

EirGrid interprets and applies the high level principles set out in these documents in preparing connection offers and charging customers for connection to the transmission system.

This paper explores the practical application of the following Clause 5.4 of the CMS as it relates to charging for System Assets:

> *"Where an **Applicant** requests a connection offer on the basis of a design which is more expensive than the **[LCC]** connection then the Applicant will be required to pay the estimated cost of providing both the **Connection Assets** and additional **System Assets**, if any, required by the **Applicant**'s preference."*

In general, connection charging policy is concerned with Connection Assets which can be clearly assigned to individual customers (or subgroups in the case of group processing). It is based on the concept of the Least Cost Chargeable (**LCC**)[2] connection method which is the application of charges for Connection Assets as defined in Clause 4.1 of the CMS (see Appendix 1 attached). Any assets that are not Connection Assets, as defined in the CMS, are System Assets and the costs associated with these System Assets are usually recovered via Transmission Use of System (**TUoS**) charges.

EirGrid may offer a customer a System Operator Preferred Connection Method (**SOPCM**), if this is to the overall benefit of the system, with the customer connection charge capped at the cost of the LCC. Connecting parties also have the option of requesting an alternative connection method to that specified by the TSO, a Customer Preferred Connection Method (**CPCM**). However any incremental cost of this CPCM (cost of Connection Assets and/or System Assets) above the LCC will be to the account of the customer in accordance with Clause 5.4 of the CMS (quoted above).

Recently, power quality studies routinely conducted by EirGrid when assessing connection methods have indicated increasing levels of harmonics in some parts of the transmission system. In some situations, CPCMs are causing harmonics in excess of the allowable limits

[2] Previously referred to as Least Cost Technically Acceptable (LCTA) per Clause 5 of the CMS and changed to LCC via Section 2.1 of Joint SO Group Processing Approach Charging and Rebating Principles Paper 2010

and additional equipment will need to be installed to bring the harmonic levels back to an acceptable level. This harmonics mitigation equipment may, depending on the circumstances, be classified as a System Asset or a Connection Asset, as defined in the CMS, the relevant extracts from which are detailed in Appendix 1 of this document.

Since this issue has come to light, EirGrid thought it prudent to include a holding statement in connection offers issued to customers, stating that this issue is being considered by EirGrid and CER, that a consultation may be imminent and that a customer may, on conclusion of that consultation, be liable for additional charges associated with harmonics mitigation in certain circumstances.

EirGrid is mindful of the uncertainty that this emerging harmonics issue is creating for customers, particularly those who may be currently considering requesting underground cable as part of their connection method. The purpose of this consultation process is to determine the appropriate mechanism for allocating the cost of installing harmonics mitigation equipment on the transmission system. This consultation paper seeks to gather the views of industry and customers on different options for applying the charging principles in order to inform both EirGrid and CER when making a final decision on the allocation of these costs.

It should be noted that the nature of harmonic disturbances on the grid means that any guidance that EirGrid publishes in future will not be able to be entirely prescriptive and that the application of connection charging policy for harmonics mitigation will always take into account the particular circumstances of each connection.

2. What are harmonics

Harmonics are signals or waves that occur at a frequency that is an integer multiple of the fundamental 50 Hz sinusoidal voltage waveform. The net effect of these harmonics is that they combine with the voltage (or current) waveform and are superimposed onto it, thereby

inflicting a distortion. This means that the smooth sinusoidal aspect of the 50Hz voltage (or current) waveform is deformed.

High voltage underground cable connections can introduce power-frequency resonance points to the system. Any harmonic currents injected at these resonance points will be amplified and result in greater distortion to the system voltage waveform.

The increasing use of power electronics and converters is injecting more harmonic currents onto the system. The addition of more underground cables onto the network can exacerbate the problem by amplifying any harmonic injections present.

There are prescribed limits on the level of harmonics permissible on the system. These prescribed limits are pre-determined by IEC standards and are referenced in the Grid Code. The information note "Harmonic Issues and their impact on Customer Connections", available at http://www.eirgrid.com/media/AnInformationNoteOnHarmonicIssuesv1.0.pdf provides more details on this issue.

Assets required to mitigate harmonics are not always easily attributable to individual connections. There is an existing level of harmonic distortion on the system which comes from many sources, including: demand customers using arc furnaces, DC motor controllers, saturated ferromagnetic transformers etc. and existing generators. This existing background level of harmonics can be heightened by underground cable connections on the grid. Contemporaneous underground cable connections in the same geographic area (but not necessarily in the same subgroup or group processing "Area") can exacerbate these levels. The issue does not always manifest itself at the point of connection to the system but at the meshed point and beyond. For example, a customer's underground cable may not cause harmonic levels at the connection point to be exceeded but it may drive harmonic levels at the point of connection to the meshed transmission system above permitted limits.

3. What are the charging issues

Clause 5.4 of the CMS outlines that customers must pay the incremental cost of any customer requested changes to the connection method. The inclusion of "System Assets" in this clause raises a broader issue – what happens when a customer requests a connection that causes problems on a deeper portion of the system that would not exist if the request was not made.

One of the principal objectives of transmission charging policy is to ensure fair and non-discriminatory transmission cost recovery. The reference in Clause 5.4 of the CMS to System Assets reflects this intent – the cost of customer requests that are above LCC requirements should not be borne, or subsidised, by the TUoS customer.

The addition of underground cables in weaker parts of the transmission system can drive the need for significant investment in harmonics mitigation. Underground cable connections rarely form part of the LCC connection method and are generally installed at the request of the customer, with the consent of the TSO[3]. In certain cases charging a customer for an asset to mitigate harmonics can be clear cut e.g. the asset is required by the customer for connection and is not driven by any other connecting parties. In this case the asset would be defined as shallow and the customer would be charged for the filter bank or other appropriate solution.

It could be the case, however, that a number of connections in the same geographic area drive the need for a harmonics mitigation solution at the meshed connection point or deeper within the transmission system. As these connections are not exclusively driving the harmonics problem on an individual basis, the harmonics mitigation solution is classified as a System Asset. It would be inequitable if customers did not pay for a System Asset which they were driving through choice. Therefore, in accordance with Clause 5.4 of the CMS, EirGrid is proposing that in these instances, these customers should pay for the System Assets that are needed as a result of the customers' choices.

[3] It is the sole responsibility of the TSO to specify the connection method.

Similarly, it may be viewed as inequitable for a jointly caused harmonics problem to be charged only to one customer. For example, if two customers connect via underground cable in the same region at similar times, each causing similar harmonics issues but the second customer's connection brings harmonic levels over the limits, it may be viewed as inequitable for one customer to be required to pay the whole cost of harmonics mitigation in those circumstances.

The practical application of Clause 5.4 of the CMS should ensure that customers factor system costs that are caused by their connection preferences into their investment decisions. Customers should receive clear cost signals where their decisions have impacts on the system.

It is worth noting that in cases where an overhead line is determined by the TSO to be an unfeasible connection method, e.g. if planning permission cannot be obtained for the overhead line, then the LCC will be reviewed. If an LCC connection method is reclassified as underground cable then any System Assets driven by this LCC connection method will be charged to the account of TUoS, per charging policy as set out in the CMS.

4. Charging options and analysis

The following charging options have been identified:

- Charge customers for the actual solution implemented
- Charge customers on a Least Cost basis
- Apply a "harmonics levy" and
- Recover the cost of harmonics mitigation via TUoS tariffs

In addition to comments on the above charging options, EirGrid welcomes comment on alternative charging methods which stakeholders consider would be preferable and the supporting reasoning for this view.

Each of the above charging options has been considered against the following connection charging policy objectives[4]:

- Cost recovery
- Protecting the interests of the TUoS customer
- Policy is clear and transparent; and
- Does not unduly discriminate.

EirGrid would be interested in any views that stakeholders have as to how the proposed charging options meet or do not meet the above relevant charging policy objectives.

4.1. Charge customers for the actual solution implemented

Applying this approach, if a customer requests an underground cable as part of their connection method and this drives particular harmonics mitigation equipment, as determined by the TSO in carrying out any necessary studies, the actual solution implemented would be charged in its entirety to the customer, on the basis of out-turn cost. The solution may be for example a filter bank or other system reinforcements deeper in the transmission network. The harmonics mitigation solution required would be determined by the TSO using best engineering judgement and balancing technical, operational and cost considerations.

It may be the case that a number of parties in a subgroup, or in a wider geographic area, request influencing underground cables at a similar time thus forming part of the TSO's studies in aggregate, resulting in an optimised solution. In such instances a mechanism would have to be developed to share the cost of the optimised solution between the parties driving the harmonics levels.

[4] As outlined in the policy documentation referenced in Section 1 of this paper.

The benefit of this approach is that it would be entirely cost reflective and would protect the TUoS customer from any subsidisation of non-LCC CPCM's. The approach would be reasonably straightforward to apply in the case of a single customer request.

One of the main problems with this approach, highlighted by recent harmonics findings, is that if a harmonics problem is driven by a number of different connections and the solution involves a range of connections, it would be very difficult to assign causation to individual connections and therefore apportion the appropriate share of any optimised solution on an individual basis. This option would likely require additional power quality studies to estimate causation and associated charges on a per connection basis, to estimate the extent to which individual customers or subgroups are contributing to the need for optimised solutions. This would introduce significant additional complexity to the application of connection charging policy.

In order to ensure that this approach was applied in a consistent manner, the methodology and the data sets for studying harmonics for members of a group would have to be consistent, which would be difficult given the staggered nature of underground cable requests. Creating an underground cable request process to ensure that the costing of such requests was based on the appropriate data would likely require a window/deadline date for requesting underground cable connections on a subgroup or geographical basis. Defining the appropriate geographical boundary within which other customers should be put on notice of another customer's request for underground cable to support any such underground cable request process would also be problematic. This approach could impose undue inflexibility and delays on customers.

Consistent with the principle that TUoS should not pick up any elements of the costs associated with non-LCC customer driven works, where a subgroup has requested the works, in the event that one or more parties within a subgroup falls away during the implementation phase, the costs that these parties would have shared would not be subsidised by TUoS (as happens for LCC connections) but would in fact be payable by the remaining connecting customers who had also requested the change in connection method. This could create significant risk and financial uncertainty for connecting parties.

To the extent that a solution reduces the harmonic levels at a node or in an area significantly and therefore mitigates potential future harmonic problems at that node/in that area, it could be interpreted that the solution future-proofs the area and/or other connections in the area and this raises the question as to whether rebates should be administered if future customers request underground cable connections that do not form part of their LCC.

EirGrid would have significant concerns about developing and administering a mechanism for calculating rebates. Harmonics are a deep network issue and therefore every time any change was being made to the network (for example a new customer connection, a change in sectionalising, an addition or removal of a network component etc.) it would be necessary to test if that change would on its own have required a harmonic mitigation device if EirGrid removed all customer funded harmonic mitigation devices. Given the multitude of harmonic mitigation devices likely to be required across the network and the multitude of network changes that are made over any given rebating period (50 years) the ability to carry out this test for every unique network change is virtually impossible. A simple rebating process could be implemented whereby the cost of a harmonic mitigation device which was driven by a CPCM asset is "attached" to the cost of the CPCM asset and any new customers who utilise that CPCM asset would rebate the cost of the CPCM including the cost of the harmonic mitigation device.

On balance, while the option of having customers paying for the actual solution implemented would protect the interests of the TUoS customer, it would be difficult to implement in a fair and consistent manner and may create unnecessary connection delays.

4.2. Charge customers on a Least Cost basis

This solution would result in customers being charged for a "Least Cost" solution at the point of connection to the meshed transmission system where it is found that the connection exceeds harmonic levels at that point. This may, for example, be a filter bank for which a standard charge could be developed. The TSO could optimise system works

independent of the charging process and costs recovered from connecting parties would be put towards the cost of mitigating harmonics on the system. The standard charges would be designed to ensure that on average they covered the TSO's costs and therefore did not put any burden on the TUoS Customer. Periodic adjustments would be made to the standard charges over time, as part of the TSO's standard charge review.

Based on current information, it is estimated that the cost of a fully installed 110kV filter bank would be in the region of ~ €3m and a fully installed 220kV/110kV transformer would be ~ €5m. EirGrid is currently developing a suite of standard harmonics mitigation equipment and will have more accurate estimates for same in the coming months.

This approach would have similar allocation and rebate problems as the "Actual Solution" method when more than one connection and optimised solutions were involved.

However, the resultant charge would be more predictable than charging for the actual solution implemented, particularly where only one customer was involved. It would be consistent with the concept of standard ex-ante charging which is applied to transmission shallow connections. Customers would have some clarity regarding the potential cost of harmonics mitigation at the time of requesting the underground cable.

LCC determination principles would be applied to develop a framework for charging for these mitigation solutions in a clear and consistent manner. These charges would be based on EirGrid's current best estimates and these would be adjusted over time as experience of delivering these solutions is acquired.

In this scenario, TUoS may not always fully recover the cost of harmonics mitigation driven by each individual connection.

While not entirely cost reflective in all cases, this approach is a reasonable proxy for charging for harmonics mitigation works required as a result of the customer's choice, which is consistent with connection charging policy and ex-ante pricing.

The downsides of this methodology include:

1. equitable allocation of costs where an optimised solution is chosen by EirGrid is difficult, even with additional power quality studies;
2. equitable allocation of rebates is equally difficult as outline under option 4.1; and
3. the standard LC charge is likely to change from EirGrid's current estimates as EirGrid's experience in harmonics mitigation develops.

The same principle that TUoS should not pick up any elements of the costs associated with non-LCC customer driven works, where a subgroup has requested the works, in the event that one or more parties within a subgroup falls away during the implementation phase, as referred to earlier re charging option 1 would apply here also.

This charging option would provide some degree of certainty to connecting customers considering a request for underground cable in a weak part of the system. It would ensure that customers driving the works, through their own choice, would contribute to any associated additional system costs while allowing the TSO to facilitate customer preferred connection method requests, without compromising the interests of the TUoS customer.

4.3. Apply a "harmonics levy"

This would involve applying a levy to all customer requests for underground cable connections. This levy would be applied on a standardised basis most likely linked to the length of the underground cable. Customers would have clarity regarding the potential cost of harmonics mitigation at the time of requesting the underground cable.

This option would be based on the premise that all underground cable connections contribute to amplifying harmonics resonance issues on the transmission system and these are cumulative as more underground cable is installed. A customer connecting now may cause amplification in harmonic levels in a particular area but may not drive harmonic levels in the area over permissible planning limits. Subsequent customers requesting underground

cables in the same geographic area may however cause these limits to be exceeded. A levy would ensure that all CPCMs contributing to harmonic resonance difficulties on the system pay towards the eventual solution, whenever required and independent of the solution determined by the TSO and independent of the timing of individual applications for cabling connection methods or the implementation of those connection methods.

Applying a levy would involve charging for the request rather than the solution, although the charge per kilometer would be based on EirGrid's assessment of the overall cost to the system of mitigating harmonics effects. It would be a different approach to standard connection charging recognising the difficulty of assigning causation to harmonics mitigation assets. There would be no requirement for rebates with this solution.

This approach would recognise the increasing level of underground cable connections on the network and would ensure to a degree that no single connecting party would bear the cost of mitigating harmonics on the system while other contributors connected to the system earlier avoid the charge.

This approach would provide certainty in terms of cost to customers connecting to the system and could be designed to ensure that the harmonics levy recovers the cost of mitigating harmonics caused by customer requests on average, therefore protecting the interest of the TUoS customer.

The main difficulty with this approach would be the limited potential to send targeted cost signals to those customers causing the problems. Unless a form of "post code" multiplier was included, this approach would socialise the cost of harmonics mitigation across all underground cable connections regardless of the underlying strength of the system in the relevant area. Customers requesting underground cables in strong parts of the network would therefore subsidise customers requesting underground cables in weak parts, in the absence of a "post code" multiplier or similar.

Application of the harmonics levy would most likely be on a per kilometre basis for all new customers that specifically request underground cable as part of their connection method.

In order to implement such a levy, a methodology would need to be developed in order to ensure that the levy applied adequately recovers the costs accrued in mitigating harmonic levels.

In an effort to estimate the quantum of the levy, EirGrid has taken account of the level of customer requests for underground cable to date and estimated the expected level of customer requests for underground cable in the short to medium term. Taking account of estimated harmonics mitigation likely to be required should all expected customer requests materialise and assuming that the cost estimates referred to earlier are accurate, an average € per km of underground cable of ~ €130k has been calculated[5].

Aligning the "post code" concept with the Areas previously defined for the Group Processing Approach and applying these in this context gives rise to a per km charge for underground cable ranging from €0 to €200k per km, with 6 of the 12 Group Processing Approach Areas requiring no mitigation and having no associated charge.

Essential components of a proposed methodology would include:

- A reasonably accurate estimate of underground cable requests over a proposed levy period e.g. 1 or 2 years
- An estimate of harmonic mitigation techniques to be employed and associated costs over the proposed levy period, and
- Appropriate postcode definitions

Forecasts of underground cable length likely to be requested could be based on information from existing customers, with the corresponding underground cable lengths taken from relevant applications and modification requests. Given that a customer specifically requesting underground cable and the subsequent requirement for harmonic mitigation techniques is an emerging issue, the reliance on historic information could lead to inaccuracies.

[5] Resulting in a total expected capital spend of ~€34m.

The costs associated with remedying harmonic effects can vary significantly depending on individual cases and the solutions applied. Given that the TSO would not have knowledge of specific lengths or parts of the system where underground cable is likely to be requested in future, there would be a high probability that forecasts of costs could differ significantly from actual costs.

Since the fundamental components of such a methodology are difficult to forecast, it is highly likely that the levy would lead to substantial under or over recovery. Subsequently, this could drive a need to apply k factors in later levy periods. Given the variance in costs for differing harmonic mitigation techniques as well as the unpredictability of underground cable requests, the levy could also be volatile and lack transparency.

In order to better control the levy, the TSO could impose a condition such that all underground cable requests must be submitted within a narrow time frame prior to the commencement of the levy period; this could perhaps be one month every year or 2 years. This would allow for more accurate forecasting and ensure the appropriate levy is applied. An obvious disadvantage of such a control is that is very restrictive on applicants seeking new offers or modifications to their connection agreements and could potentially lead to significant project delays.

4.4. Recover the cost of harmonics mitigation via TUoS tariffs

A further option is to recover the cost of harmonics mitigation via TUoS charges where harmonics mitigation solutions are deemed to be System Assets under the application of the charging rules. TUoS charges cover the cost of developing, maintaining and operating the transmission system. Under this option customers/subgroups could request underground cable with the cost of associated system reinforcements borne by customers via TUoS. The cost would therefore be borne, to some degree, by all TUoS customers regardless of whether or not they required underground cable as part of their connection method.

This approach would recognise the difficulty in determining individual causation in relation to harmonics mitigation assets. It would also recognise the fact that whilst underground cables amplify harmonics, the harmonics themselves are generally injected into the system by Demand and Generation customers with Demand customers more likely to cause harmonics. As network TUoS costs are split 75:25 between Demand and Generation customers, Demand customers would pay the greater share of the costs. There would be no need to consider rebates with this solution.

If this option were implemented, it would shield a customer requesting a non-LCC solution from the full additional costs they would be driving and therefore it is the charging option detailed in this paper which is least aligned with Clause 5.4 of the CMS.

5. Scope

As mentioned earlier, since this issue has come to light, EirGrid thought it prudent to include a holding statement in connection offers issued to customers, stating that this issue is being considered by EirGrid and CER, that a consultation may be imminent and that a customer may, on conclusion of that consultation, be liable for additional charges associated with harmonics mitigation in certain circumstances.

With regard to the scope of this proposed charging policy's application, it is suggested that the CER's eventual decision on this issue be applied to all TSO customers who request a change to underground cable after the date of publication of this consultation paper and all customers who have already been put on notice re their potential liability in this context via holding statements in their connection agreements.

6. Next steps

Industry is invited to comment on the detail above via the public consultation process. Submissions are invited via email to connection.charging@eirgrid.com by close of business on **Friday, 18th July 2014**.

Appendix 1: Relevant policy

Extracts from EirGrid's CMS, 14 March 2008

Charging is based on LCC

"4.1 ***Connection Assets*** *are:*

4.1.1 Those assets, which are installed to enable the transfer of the Maximum Export Capacity (MEC) or the Maximum Import Capacity (MIC) of the ***User's*** *facility, to or from, as appropriate, the* ***Transmission System*** *for the term of the Connection Agreement in accordance with the* ***Grid Code*** *and* ***Transmission and Distribution System Security and Planning Standards****, subject to subparagraph 4.2; and*

4.1.2 Those assets which are installed as a result of the ***User's*** *effect on fault current levels on the transmission system at the transmission node to which the User connects, but does not include any assets installed at any location other than the transmission node to which the* ***User*** *connects.*

4.2 In deciding which assets are required to enable the transfers referred to in subparagraph 4.1.1, power flows other than those to or from the ***User*** *are disregarded."*

System Assets are not generally chargeable

"4.3 Assets which are not ***Connection Assets*** *are* ***System Assets*** *and the costs of these assets are recovered through use of system charges."*

Appendix 2: Rebating Examples

Following on from Section 4.2, assuming that the Least Cost System Asset basis is to be applied, two different scenarios are outlined here. It is proposed that rebating would be estimated on a per MW share basis, in line with current charging policy.

<u>Non-Contestable Connections: One Standard Filter Bank used to mitigate harmonic effects</u>

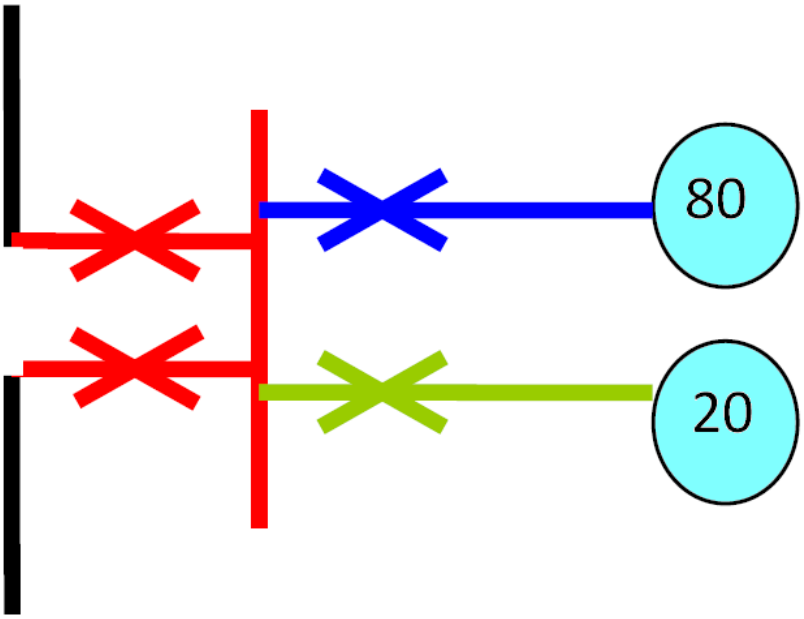

Figure 1: Looped station 2 connections

Figure 1 shows an example of a looped station with an 80MW and a 20MW connection. We assume that the 80MW generator connected to the system first having specifically requested an underground cable as part of their connection method. In order to mitigate harmonics associated with this underground cable a filter bank is required. The 80MW generator is charged 100% of the standardised cost of a filter bank as well as standard charges appropriate to its connection (assuming the assets are not being built contestably).

Subsequently a 20 MW generator also connects at this node and also requests underground cable as part of their connection method. In this case, it is assumed that the original filter bank in place is sufficient to mitigate the harmonic effects caused by both underground cable connections[6]. This filter bank makes up part of the shared assets between both generators (highlighted in red).

[6] Such a scenario is unlikely to materialise in practice and is assumed here for illustrative purposes only i.e. it is likely that some additional works would be required for the additional 20 MW's.

In order to charge on the basis of the Group Processing Approach, the costs of shared assets are apportioned on a per MW basis. For all shared elements of the connection except the filter bank, the 20MW generator will pay 20% of the actual costs. The 20MW generator will also pay 20% of the standardised cost for a filter bank. Based on the rebating hierarchy as outlined in Joint TSO/DSO Group Processing Approach Pricing Principles Guidelines, the TUoS/DUoS customer or GUDP fund is rebated first if applicable and then the 80MW generator. The first connecting party cannot receive more than has been recovered from the second. Using the above example, the first 80MW party is only rebated 20% of the costs of shared assets excluding the filter bank and 20% of the standardised cost of a filter bank regardless of the length of underground cable requested to connect either generator.

Under this scenario, if the 20 MW generator connected first, and did not trigger the need for harmonics mitigation, the 80 MW generators would be required to pay for all the harmonics mitigation work when it requested an underground cable connection.

<u>Non-Contestable Connections: Two Standard filter banks required to mitigate harmonic effects</u>

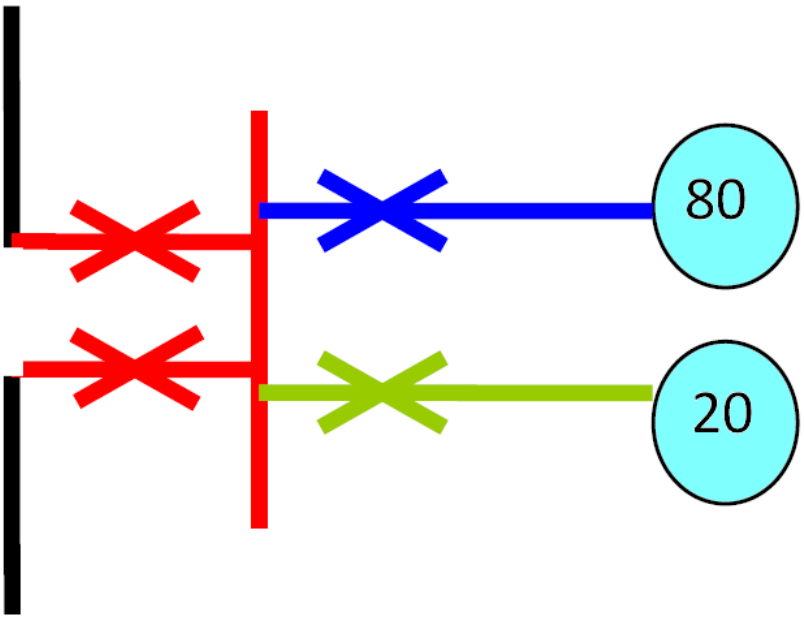

Figure 2: Looped station 2 connections

Figure 2 shows an example of a looped station with an 80MW and a 20MW connection. We assume that the 80MW generator connected to the system first having specifically requested an underground cable as part of their connection method. In order to mitigate harmonics associated with this underground cable, a filter bank is identified as the optimal solution. The connection is not built contestably and the customer is charged the standardised cost of a filter bank as well as standard charges appropriate to its connection.

Subsequently a 20 MW generator also connects at this node and also requests underground cable as part of their connection method. In this case, the connecting generator increases harmonic levels above the permitted limit even with the existing filter bank. The 20MW generator will be charged 100% of the standardised cost of any additional harmonics mitigation e.g. a second filter bank.

In order to charge on the basis of the Group Processing Approach, the costs of shared assets are apportioned on a per MW basis. Neither of the filter banks forms part of the shared assets. For shared elements of the connection assets the 20MW generator will pay 20% of the actual costs. Based on the rebating hierarchy as outlined in Joint TSO/DSO Group Processing Approach Pricing Principles Guidelines, the TUoS/DUoS customer or GUDP fund is rebated first if applicable and then the 80MW generator. The first connecting party cannot receive more than has been recovered from the second. Using the above example, the first 80MW party is only rebated 20% of the costs of shared assets.