ELEXON

Stage 03: Attachment A: Additional Information

What stage is this document in the process?

01 Initial Written Assessment

02 Definition Procedure

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P266: Improving the allocation of Reactive Power flows between Import and Export Metering Systems

Contents

About this document:

This is Attachment A to the Assessment Report. This attachment provides additional information and Terms of References.

1 Impact of P266 on Different Customer Types

On 16 November 2010 the P266 Modification Group agreed (by teleconference) that ELEXON should perform some initial analysis of the impact of P266 on different types of customers. This note describes the analysis that we performed.

Recap of Relevant CDCM Provisions

The structure of DUoS charges is specified in the Common Distribution Charging Methodology (in Annex 16 of the DCUSA). Reactive Power data (for a Half Hourly customer with on-site generation) affects four separate charges:

- The **Import Capacity Charge** (which is a p/kVA/day charge). The chargeable capacity will be increased to match the peak value of actual capacity, defined as:

  $$\text{Import Demand} = 2 \times \sqrt{\text{AI}^2 + \max(RI, RE)^2}$$

  where AI is the metered Active Import; and RI and RE are the metered Reactive Import and Reactive Export "occurring at times of kWh Import". See CDCM paragraphs 155 – 158.

- The **Export Capacity Charge** (which is a p/kVA/day charge). The chargeable capacity will be increased to match the peak value of actual capacity, defined as:

  $$\text{Export Demand} = 2 \times \sqrt{\text{AE}^2 + \max(RI, RE)^2}$$

  where AE is the metered Active Export; and RI and RE are the metered Reactive Import and Reactive Export "occurring at times of kWh Export". See CDCM paragraphs 159 – 162.

- The **Import Reactive Power Charge** (which is a p/kVArh charge). The chargeable units in each half hour are:

  $$\text{Chargeable kVArh} = \max\left(\max(\text{RI}, \text{RE}) - \left(\sqrt{\left(\frac{1}{0.95^2} - 1\right)} \times AI\right), 0\right)$$

  where AI is the metered Active Import; and RI and RE are the metered Reactive Import and Reactive Export "occurring at times of kWh Import". See CDCM paragraphs 163 – 168.

- The **Export Reactive Power Charge** (which is a p/kVArh charge). The chargeable units in each half hour are:

  $$\text{Chargeable kVArh} = \max\left(\max(\text{RI}, \text{RE}) - \left(\sqrt{\left(\frac{1}{0.95^2} - 1\right)} \times AE\right), 0\right)$$

  where AE is the metered Active Export; and RI and RE are the metered Reactive Import and Reactive Export "occurring at times of kWh Export". See CDCM paragraphs 169 – 172.

However, the Modification Group has noted that calculation of the Export Capacity Charge and Export Reactive Power Charge is potentially problematic, in that the Metering System with the AE data does not have any Reactive Power data (due to the current industry rules for allocation of Reactive Power flows). Distributors have different interpretations of how to overcome this issue:

- Some Distributors calculate these Export Capacity Charge and Export Reactive Power Charge using Reactive Power data from the Import Metering System (in Settlement Periods that have Active Export but no Active Import). We have previously referred to this as 'Work around 1'.
- Some Distributors do not believe this is appropriate, and default to a power factor of 0.95 (as no Reactive Power data was provided on the Export Metering System). We have previously referred to this as 'Work around 2'.

Approach Taken to the Analysis

As agreed with the Modification Group, this analysis has been based on a theoretical categorisation of customers, rather than analysis of actual data from specific sites. For the purposes of this analysis, we have considered that customers can be categorised based on the following characteristics:

- Whether their generation capacity is significantly larger than their demand, of a comparable size to their demand, or significantly smaller than their demand;
- Whether or not their demand creates significant Reactive Power flows (i.e. demand power factor close to 1.0 or not close to 1.0);
- Whether or not their generation creates significant Reactive Power flows (i.e. generation power factor close to 1.0 or not close to 1.0).

Taking all possible combinations of these three factors give twelve groups of customers to consider. For each group, we have compared the total charges payable by the customer (under both interpretations of the current baseline, and the P266 solution) against a hypothetical 'accurate baseline' in which:

- The customer has separate connections for demand and generation;
- The metering on the demand connection only ever records demand i.e. it never records Active Export; and
- The metering on the generation connection only ever records generation i.e. it never records Active Import.

It should be noted that:

- This hypothetical baseline is not physically possible to achieve, because even if the customer chose separate connections for their demand and their generating plant, the metering on the generation connection would still be liable to record Active Import at times when the generating plant was not running. However, it represents a simple baseline which is unaffected by P266 issues, and can therefore be used as a reference point against which to judge the P266 solution
- The decision to focus on total charges (rather than the allocation of charges between Metering Systems or Suppliers) is consistent with the approach suggested by Ofgem.

Details of Spreadsheet Model

In order to perform the analysis, we have developed a spreadsheet model which (given a minute-by-minute profile of Active Power and the relevant Power Factors) calculates Import Capacity, Export Capacity, chargeable Import Reactive Power and chargeable Reactive Power (under the hypothetical accurate baseline, under both interpretations of the current baseline, and under the P266 Proposal).

This spreadsheet model is attached (P266_Model.xls). It contains twelve separate worksheets, each one containing the same model, but for a different hypothetical customer. The following table shows which worksheets are relevant to each category of customer:

Customer Type			**Relevant Worksheets (from P266_Model.xls)**
Generation Capacity	**Demand PF**	**Generation PF**	
Larger than demand	Close to 1.0	Close to 1.0	No examples provided – reactive power flows are small, so charging issues will not be significant.
		Not close to 1.0	The Large Generation 1 worksheet provides an example in which the generation occurs for the whole Settlement Period (and therefore the boundary meter records AE but no AI). The Large Generation 2 worksheet provides an example in which the generation occurs for part of the Settlement Period (and therefore the boundary meter records both AE and AI).
	Not close to 1.0	Close to 1.0	The Large Generation 3 worksheet provides an example in which the generation occurs for part of the Settlement Period (and therefore the boundary meter records both AE and AI).
		Not close to 1.0	The Large Generation 4 worksheet provides an example in which the generation occurs for part of the Settlement Period (and therefore the boundary meter records both AE and AI).
Comparable to demand	Close to 1.0	Close to 1.0	No examples provided – reactive power flows are small, so charging issues will not be significant.
		Not close to 1.0	The Comparable Size 1 worksheet provides an example with only AI at the boundary. The Comparable Size 2 worksheet provides an example with both AE and AI at the boundary.
	Not close to 1.0	Close to 1.0	The Comparable Size 3 worksheet provides an example with both AE and AI at the boundary.
		Not close to 1.0	The Comparable Size 4 worksheet provides an example with both AE and AI at the boundary.
Smaller than demand	Close to 1.0	Close to 1.0	No examples provided – reactive power flows are small, so charging issues will not be significant.

Customer Type			Relevant Worksheets (from P266_Model.xls)
Generation Capacity	**Demand PF**	**Generation PF**	
		Not close to 1.0	The Small Generation 1 worksheet provides an example in which the demand occurs for the whole Settlement Period (and therefore the boundary meter records AI but no AE). The Small Generation 2 worksheet provides an example in which the generation occurs for part of the Settlement Period (and therefore the boundary meter records both AE and AI).
	Not close to 1.0	Close to 1.0	The Small Generation 3 worksheet provides an example in which the generation occurs for part of the Settlement Period (and therefore the boundary meter records both AE and AI).
		Not close to 1.0	The Small Generation 4 worksheet provides an example in which the generation occurs for part of the Settlement Period (and therefore the boundary meter records both AE and AI).

Impact of P266 on Each Category of Customer

The following table summarises the findings for each group of customer (based on the analysis in the attached spreadsheets). Particular issues (i.e. aspects of charging that may not be cost-reflective) are highlighted in red.

<table>
<tr><th colspan="3">Customer Type</th><th colspan="3">Total Charges (compared to hypothetical 'accurate baseline')</th></tr>
<tr><th>Generation Capacity</th><th>Demand PF</th><th>Generation PF</th><th>Current Baseline (with 'Work around 1' i.e. reallocation of data from Import to Export)</th><th>Current Baseline (with 'Work around 2' i.e. default data for Export charges)</th><th>P266 Solution</th></tr>
<tr><td rowspan="2">Larger than demand</td><td rowspan="2">Close to 1.0</td><td>Close to 1.0</td><td colspan="3">Reactive power flows small, so no significant P266-related issues.</td></tr>
<tr><td>Not close to 1.0</td><td>Where the generation runs for the whole period (see Large Generation 1 worksheet) the total charges are similar to the 'accurate baseline' (except for a slight reduction in capacity charges and increase in reactive power charges due to netting of AI and AE).

Where the generation runs for only part of the period (see Large Generation 2 worksheet), so that AI and AE are both metered at the boundary, work around 1 does not charge for Reactive Power at all.</td><td>Export Capacity Charges and Export Reactive Power charges are based on a default power factor of 0.95 (not the metered Reactive Power data).

Any Reactive Power flows in a half hour with both AI and AE will affect the Import Capacity Charge as well as the Export Capacity charge. This potentially leads to double charging (or worse) of Capacity Charges associated with Reactive Power. See Large Generation 2 worksheet for an example.</td><td>Total charges are similar to the 'accurate baseline' (except for a slight reduction in capacity charges and increase in reactive power charges due to netting of AI and AE)</td></tr>
</table>

Customer Type			Total Charges (compared to hypothetical 'accurate baseline')		
Generation Capacity	**Demand PF**	**Generation PF**	**Current Baseline (with 'Work around 1' i.e. reallocation of data from Import to Export)**	**Current Baseline (with 'Work around 2' i.e. default data for Export charges)**	**P266 Solution**
	Not close to 1.0	Close to 1.0	See Large Generation 3 worksheet for an example. Issues appear to be similar to Large Generation 2 worksheet (see above).		
		Not close to 1.0	See Large Generation 4 worksheet for an example. Issues appear to be similar to Large Generation 2 worksheet (see above).		
Comparable	Close to	Close to 1.0	Reactive power flows small, so no significant charging issues.		

Customer Type			**Total Charges (compared to hypothetical 'accurate baseline')**		
Generation Capacity	**Demand PF**	**Generation PF**	**Current Baseline (with 'Work around 1' i.e. reallocation of data from Import to Export)**	**Current Baseline (with 'Work around 2' i.e. default data for Export charges)**	**P266 Solution**
to demand	1.0	Not close to 1.0	Netting of kWh from demand and generation decreases capacity charges but increases chargeable Reactive Power. **Where the site both Imports and Exports Active Power during the period, work around 1 does not charge for Reactive Power at all.**	Netting of kWh from demand and generation decreases capacity charges but increases chargeable Reactive Power. **Export Capacity Charges and Export Reactive Power charges are based on a default power factor of 0.95 (not the metered Reactive Power data). This issue is exacerbated by netting of AI and AE, as the default value is calculate from a net kWh value that may bear little relation to gross power flows. See Comparable Size 2 worksheet for an example.** **Reactive Power flows in a half hour with both AI and AE potentially ne charged to both Export and Import.**	Netting of kWh from demand and generation decreases capacity charges but increases chargeable Reactive Power.
	Not close to 1.0	Close to 1.0	See Comparable Size 3 worksheet for an example. Issues appear to be similar to Comparable Size 2 worksheet (see above).		

Customer Type			**Total Charges (compared to hypothetical 'accurate baseline')**		
Generation Capacity	**Demand PF**	**Generation PF**	**Current Baseline (with 'Work around 1' i.e. reallocation of data from Import to Export)**	**Current Baseline (with 'Work around 2' i.e. default data for Export charges)**	**P266 Solution**
		Not close to 1.0	See Comparable Size 4 worksheet for an example. Issues appear to be similar to Comparable Size 2 worksheet (see above).		
Smaller than demand	Close to 1.0	Close to 1.0	Reactive power flows small, so no significant charging issues.		
		Not close to 1.0	Where the demand runs for the whole period (see Small Generation 1 worksheet) the total charges are similar to the 'accurate baseline' (except for a slight reduction in capacity charges and increase in reactive power charges due to netting of AI and AE). **Where the demand runs for only part of the period (see Small Generation 2 worksheet), so that AI and AE are both metered at the boundary, work around 1 does not charge for Reactive Power at all.**	**Export Capacity Charges and Export Reactive Power charges are based on a default power factor of 0.95 (not the metered Reactive Power data).** **Any Reactive Power flows in a half hour with both AI and AE will affect the Import Capacity Charge as well as the Export Capacity charge. This potentially leads to double charging (or worse) of Capacity Charges associated with Reactive Power. See Small Generation 2 worksheet for an example.**	Total charges are similar to the 'accurate baseline' (except for a slight reduction in capacity charges and increase in reactive power charges due to netting of AI and AE)

Customer Type			**Total Charges (compared to hypothetical 'accurate baseline')**		
Generation Capacity	**Demand PF**	**Generation PF**	**Current Baseline (with 'Work around 1' i.e. reallocation of data from Import to Export)**	**Current Baseline (with 'Work around 2' i.e. default data for Export charges)**	**P266 Solution**
	Not close to 1.0	Close to 1.0	See Small Generation 3 worksheet for an example. Issues appear to be similar to Small Generation 2 worksheet (see above).		
		Not close to 1.0	See Small Generation 4 worksheet for an example. Issues appear to be similar to Small Generation 2 worksheet (see above).		

Summary

The key findings of the analysis can be summarised as follows:

- Both the current baseline and P266 lead to lower capacity charges than separate metering of demand and generation (because of netting of demand and generation used on-site). This would not appear to be an issue – it correctly reflects the fact that generation used on-site has not been distributed across the network.

- In the examples we analysed, both the current baseline and P266 lead to higher Reactive Power charges than separate metering of demand and generation. This is because there is on-site netting of the Active Power from demand and generation, but not (in the examples we analysed) on-site netting of Reactive Power. Again this does not appear to be an issue.

- Work around 1 (under the current baseline) is not able to charge for Reactive Power flows in any half hour that has a mixture of Active Import and Active Export (as measured at the site boundary). Arguably this is unlikely to affect Capacity Charges (because the peak capacity for the month will probably appear in a period that does not have a mixture of Import and Export). However, it will lead to a systematic under-charging of Reactive Power units for some sites (particularly those where demand and generation are closely balanced, and therefore many half hours have both Import and Export).

- Work around 2 (under the current baseline) leads to capacity charges for Exporting sites being calculated on a default power factor of 0.95, not the actual power factor. This is issue is likely to be particularly significant for sites with significant demand and significant generation, where the default power factor is applied to a net Import or Export value that may not be representative of the physical demand or generation capacity.

- Work around 2 (under the current baseline) leads to significant overcharging of capacity and reactive power in periods that have both Active Import and Active Export. In effect the Reactive Power flow is double charged, as it is allocated both to the Import Account, and to the Export Account (albeit using a default power factor). Note that:

  - The effect on total charges is most pronounced for sites at which either Active Import or Active Export is non-zero, but small compared to the Reactive Power flows; and

  - The effect on Capacity Charges is particularly significant, because even a single Settlement Period with a mixture of Import and Export can potentially affect the Import Capacity and/or Export Capacity for a whole month. It seems likely that this is the cause for (anecdotal reports of) wind farms with very excessive Import Capacity charges.

The analysis suggests that P266 addresses the issues with the current baseline, without (so far as we have been able to identify) introducing any new anomalies in the total charges levied

2 Terms of Reference and MG membership

P266 Terms of Reference	
The P266 Modification Group have been formed from members of the Volume Allocation Standing Modification Group (VASMG), Settlement Standing Modification Group (SSMG) and Distributor representatives. The Group have considered the following items:	
Ref	
01	Development and confirmation of the P266 solution
02	Confirm the assumptions and impacts under P224 are still valid
03	Identify and quantify benefits/disadvantages of P266 against the Applicable BSC Objectives
04	Ensure the evidence/data obtained is sufficient for the Modification Group to: • Consider a various types of sites and fully assess whether the P266 solution would cause problems for other types of sites • In particular, consider those sites with significant demand and generation where (even at times of net generation) the demand could be causing the Reactive Energy flows • Perform assessment to use appropriate (and adequate numbers of) examples of shared sites in determining the cost-benefit of the solution
05	Identify if there are any potential impacts on the CDCM
06	Any alternative solutions (Ref 02 – 04 need to be taken into consideration)

Member	Organisation	27/10/10	16/11/10	14/12/10	22/12/10
Colin Berry	ELEXON (Chairman)	✓	✓	✓	✓
Bu-Ke Qian	ELEXON (Lead Analyst)	✓	✓	✓	✓
Martin Brandt	Proposer	X	X	X	X
Peter Gray	SSE	✓	☎	☎	X
Howard Gregory	Npower	✓	☎	☎	☎
Matthew Hays-Stimson	EDF Energy	✓	☎	☎	☎
Glenn Sheern	E.ON UK	✓	☎	☎	X
Mike Smith	Western Power Distribution	✓	☎	☎	X
Steve Dodd	Scottish Power	☎	☎	X	X
Andrew Neves	Central Networks	X	X	X	X
Neil McKeown	Electralink	X	X	X	X
Tony McEntee	Electricity North West	X	X	☎	X
Attendee	**Organisation**				
Diane Mailer	ELEXON (Lawyer)	✓	✓	✓	✓
John Lucas	ELEXON (Design Authority)	✓	✓	✓	✓
Donald Smith	Ofgem	☎	☎	☎	☎
Gareth Evans	Ofgem	✓	X	X	X
Dominique Tilquin	SSE	X	☎	☎	☎
Janice Thompson	Scottish Power	☎	X	X	X
Tariq Hakeem	National Grid	✓	X	X	X
Ben Nicaudie	Electralink	✓	☎	X	X
Tracey Pitcher	Western Power Distribution	X	X	X	☎