LLF sensitivity data analysis for P216 'Audit of LLF Production'

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Overview or Purpose of Document:

This document has been produced for use by the Modification Group in the assessment of Modification Proposal P216. The purpose of the work undertaken is to provide some sensitivity analysis of changes in Line Loss values. The analysis aims to determine what impact variations in Line Loss Factors (LLFs), for certain categories of LLF Classes, have on GSP Group Correction Factors and Corrected Supplier Consumption Volumes.

Target Audience:

P216 Modification Group; Assessment Consultation recipients

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1 Introduction

Modification P216 'Audit of LLF Production' seeks to provide additional assurance to the industry and the BSC Panel that the Line Loss Factors (LLFs) being approved are accurate and consistent with the methodologies published. P216 proposes that this assurance is achieved by auditing these methodologies and using spot checks on the allocation of the correct Line Loss Factor Classes (LLFCs) to Metering Systems. P216 further seeks to ensure that LLFs are not changed part way through a year.

As part of the Modification Group discussions surrounding P216, it was noted that it was unclear what the impact of inaccurate LLFs (or variations in LLFs due to the varied calculation methodologies employed by Licensed Distribution System Operators (LDSOs)) would have on the Settlement process. The Modification Group requested that ELEXON carry out some sensitivity analysis in an attempt to quantify this impact.

2 Aim

The aim of this analysis is to quantify the sensitivity of Supplier Volume Allocation (SVA) Settlements' results on variations in LLFs.

3 Method

3.1 Data Requirements

A set of RF Settlement Dates were chosen to give a variety of Seasons (used in the Profiling of Non Half Hourly data) and Day Types (weekday and weekend) in a single Grid Supply Point (GSP) Group. An assumption was made that Settlement Days of the same Day Type will exhibit similar sensitivity in the same Season and that, whilst factors and volumes are materially different across GSP Groups, sensitivity would not be. As a result, the analysis was carried out for a single GSP Group only. The final reconciliation run (RF) dates selected for the analysis were:

Season	Date of Day Type 1 (Tuesday)	Date of Day Type 2 (Sunday)
1: Winter	10/01/06	15/01/06
2: Spring	18/04/06	23/04/06
3: Summer	13/06/06	18/06/06
4: High Summer	09/08/05	14/08/05
5: Autumn	27/09/05	02/10/05

Table 1: RF Dates

For each of the RF dates in table 1, the following data was obtained and loaded into an SQL Server database:

1 Distributor D0030 reports for the GSP Group were used to source the uncorrected, unadjusted Non Half Hourly (NHH) volumes in each Settlement Period for each Supplier and Line Loss Factor Class (LLFC) in the GSP Group;

2 A number of Half Hourly Data Aggregators (HHDAs) operate in the selected GSP Group. An extract from each HHDA system for each RF date[1] provided HH unadjusted volumes in the GSP Group for each Supplier, by Settlement Period and LLFC;

3 ELEXON receive Settlement Run outputs from the Supplier Volume Allocation Agent (SVAA). This data was used to compare accurate aggregated Supplier consumption volumes against the aggregated Supplier consumption volumes contained within the HHDA data described in (2). Data is sent by the Half Hourly Data Collectors (HHDCs) to HHDAs and LDSOs when readings are obtained rather than according to a timetable. As a result, an extract from an HHDA system contains information from that particular point in time as opposed to what was potentially used for a particular Settlement Run. The comparisons provided valuable assurance that the HHDA data was accurate enough for the purpose of this analysis;

4 The SVAA data in (3) was also used to obtain the GSP Group Correction Factors (GCFs) for each Settlement Period;

5 The GSP Group LDSO D0265 reports for 2006 were used to obtain the LLFs for each Settlement Period for each LLFC across the ten days. The LLFs were then manipulated in conjunction with the variation strategy (see section 3.2) to provide the variations in LLFs to be used in the analysis; and

6 Any Independent Distribution Network Operator (IDNO) operating in the GSP Group was asked to provide the mappings by which their LLFCs marry up with the host LDSO LLFCs. This information was used to ensure the LLF information within the database tool was complete. When asked, the IDNOs stated that they replicate the LLFs provided to them by the host LDSO when submitting their LLFs for a given BSC year. They do not necessarily do so under the same LLFC IDs as the host.

3.1.1 Summary of data

For the ten RF Settlement Dates for the selected GSP Group, the Access database contained the following data:

- NHH unadjusted volumes by Supplier, Settlement Period and LLFC;
- HH unadjusted volumes by Supplier, Settlement Period and LLFC;
- GSP GCFs for each Settlement Period; and
- LLFs for each Settlement Period and LLFC.

[1] Some HHDA data for Settlement Date 15/01/06 was not provided in time for the analysis. The results for this date could not be used to derive any conclusions.

3.2 LLF Variation Strategy

Using the original D0265 data as a baseline, the LLFs for the 10 RF Settlement Dates were altered and stored as variations within the database. In summary, LDSOs determine LLFs s by taking the overall losses for their region and apportioning them across Very High Voltage (VHV), High Voltage (HV), Low Voltage (LV) and Site Specific (SSp) LLFCs. With this in mind, the variation strategy was derived in an attempt to gauge volume allocation sensitivities for the following methods:

1 The method used to establish overall losses;
2 The method used to apportion of losses across VHV, HV and LV;
3 The method used to allocate MPAN specific losses (SSp);
4 The method used to allocate export losses; and
5 The method used to time bound losses

Table 2 details the alterations that took place to produce the series of variations that were used in the calculations. The table references the volume allocation methods as described above. The LDSO provided a breakdown of their LLFCs by VHV, HV, LV and SSp to aid with the processing of these variations. In addition, data stored within Market Domain Data (MDD) was also used to determine the import / export allocations.

The following formulas were used to increase and decrease the LLFs:

Increase:	1 + ((Original LLF – 1) x 1.2)
Decrease:	1 + ((Original LLF – 1) x 0.8)

The factors represent the alterations that would be acceptable for a SVA LLF submission (+ or – 20% of the previous submission). Whilst a submission with such deviations would not realistically be expected, it is important to note that it could be approved for use in accordance with the current validation rules.

Variation Id (Ω)	Alteration Action	Method Tested
1	Overall Losses increased but VHV, HV, LV and SSp proportions maintained	1
2	Overall Losses decreased but VHV, HV, LV and SSp proportions maintained	1
3	SSp LLFs increased	3
4	SSp LLFs decreased	3
5	Export LLFs increased	4
6	Export LLFs decreased	4
7	Nov – Feb LLFs switched with Mar- Oct LLFs	5
8	HV LLFs increased & LV factors decreased in a manner to compensate for the increase but ensuring that overall losses are maintained	2
9	HV LLFs decreased & LV factors increased in a manner to compensate for the decrease but ensuring that overall losses are maintained	2

Table 2: LLF Variations

It is important to note that all variations except 8 and 9 changed the overall volume of losses.

3.3 Calculations

Once the data had been entered into the database, a series of calculations were carried out for each RF Settlement date.

3.3.1 Phase 1 - Baseline

For each Supplier, Settlement Period and LLFC, the following was determined and stored;

- Unadjusted NHH volume [UN];
- Actual Line Loss adjustment NHH volume $[AN_0] = (LLF - 1) \times [UN]$;
- GSP Group correction NHH volume $[GCN_0] = (GCF - 1) \times ([UN] + [AN_0])$;
- Unadjusted HH volume [UH];
- Actual Line Loss adjustment HH volume $[AH_0] = (LLF - 1) \times [UH]$

For each Supplier and Settlement Period, the following aggregations took place for LLFC Ids (β) = 1, 2, 3, …, n;

- Total [UN] = [TUN] = $[UN]_{\beta=1} + [UN]_2 + [UN]_3 + \ldots + [UN]_n$
- Total $[AN_0] = [TAN_0] = [AN_0]_{\beta=1} + [AN_0]_2 + [AN_0]_3 + \ldots + [AN_0]_n$
- Total $[GCN_0] = [TGCN_0] = [GCN_0]_{\beta=1} + [GCN_0]_2 + [GCN_0]_3 + \ldots + [GCN_0]_n$
- Total $[UH] = [TUH] = [UH]_{\beta=1} + [UH]_2 + [UH]_3 + \ldots + [UH]_n$
- Total $[AH_0] = [TAH_0] = [AH_0]_{\beta=1} + [AH_0]_2 + [AH_0]_3 + \ldots + [AH_0]_n$
- Total Supplier Volume $[SV]_\omega = [TUN] + [TAN_0] + [TGCN_0] + [TUH] + [TAH_0]$

  where ω represents unique Suppliers 1, 2, 3, …, n

For each Settlement Period the following was determined and stored;

- GSP Group Take $[GGT_0] = [SV]_1 + [SV]_2 + [SV]_3 + \ldots + [SV]_n$

3.3.2 Phase 2 - Variations

For each Variation (Ω) defined in table 2, the following was determined and stored;

For each Supplier, Settlement Period and LLFC;

- Line Loss adjustment NHH volume $[AN_\Omega] = (LLF_\Omega - 1) \times [UN]$
- Line Loss adjustment HH volume $[AH_\Omega] = (LLF_\Omega - 1) \times [UH]$

For each Supplier and Settlement Period, the following aggregations took place for LLFC Ids (β) = 1, 2, 3, …, n;

- Total $[AN_\Omega] = [TAN_\Omega] = [AN_\Omega]_{\beta=1} + [AN_\Omega]_2 + [AN_\Omega]_3 + \ldots + [AN_\Omega]_n$
- Total $[AH_\Omega] = [TAH_\Omega] = [AH_\Omega]_{\beta=1} + [AH_\Omega]_2 + [AH_\Omega]_3 + \ldots + [AH_\Omega]_n$

For each Settlement Period, the following aggregations took place for Suppliers (ω) = 1, 2, 3, …, n;

- Total GSP $[TUN] = [GUN] = [TUN]_{\omega=1} + [TUN]_2 + [TUN]_3 + \ldots + [TUN]_n$
- Total GSP $[TAN_\Omega] = [GAN_\Omega] = [TAN_0]_{\omega=1} + [TAN_0]_2 + [TAN_0]_3 + \ldots + [TAN_0]_n$
- Total GSP $[TUH] = [GUH] = [TUH]_{\omega=1} + [TUH]_2 + [TUH]_3 + \ldots + [TUH]_n$
- Total GSP $[TAH_\Omega] = [GAH_\Omega] = [TAH_0]_{\omega=1} + [TAH_0]_2 + [TAH_0]_3 + \ldots + [TAH_0]_n$
- GSP Group Correction Factor $[GCF_\Omega] = ([GGT_0] - ([GUH] + [GAH_\Omega])) / ([GUN] + [GAN_\Omega])$

3.3.3 Phase 3 – Supplier Deltas

For each Variation (Ω), Supplier and Settlement Period, the following parameters were determined and stored;

- GSP Group correction NHH volume $[GCN_\Omega] = ([GCF_\Omega] - 1) \times ([TUN] + [TAN_\Omega])$
- Change in GSP Group correction NHH volume $[\Delta GCN_\Omega] = [GCN_\Omega] - [TGCN_0]$
- Change in Supplier adjustment volume $[\Delta SAV_\Omega] = ([TAN_\Omega] + [TAH_\Omega]) - ([TAN_0] + [TAH_0])$

3.3.4 Phase 4 – Materiality

For each Variation (Ω) and Supplier, the following parameters were determined and stored;

- Net Supplier volume $[NSV_\Omega] = [\Delta SAV_\Omega] - [\Delta GCN_\Omega]$
- Materiality $[M] = [NSV_\Omega] \times £56$

(£56 represents the average trading price as defined in Appendix B)

4 Results

4.1 HHDA Comparison Checks

As discussed in section 3.1, the HHDA data was compared with data from the RF Settlement Run. The majority of Supplier volume figures were satisfactorily comparable. There were a few anomalies, however, the differences in volumes for those Suppliers did not result in unrealistic Settlement scenarios. The differences were present in the baseline calculations as well as the remaining Variation, Supplier Delta and Materiality calculations. As a result, whilst the analysis was not based on actual Settlement figures, it was based on an entirely realistic Settlement scenario. The differences did not compromise the validity of the results in the context of the objectives of the analysis.

4.2 Supplier Deltas and Materiality

In total, 180 graphs were produced as a result of the analysis undertaken. For each of the RF Settlement dates and Variations, the following was plotted:

- $[\Delta SAV_{\Omega}]$ (Energy Delta) and $[\Delta GCN_{\Omega}]$ (GCF Delta) for each Supplier[2]
- [M] for each Supplier

Suppliers were represented by randomly generated and assigned numbers to ensure the results were anonymous. The same numbers were assigned across all Suppliers for all results produced.

Figures 1 to 20 are presented within Appendix A. These are a selection of the graphs produced and this selection is used as a reflection of the results that were common to each set of graphs per variation.

4.2.1 Variation 1: Overall losses increased

For this variation, we expected to see positive changes in Supplier adjustment volumes and negative changes in GSP Group Correction volumes to compensate for this. Figure 1 shows the expected changes in volumes. It also shows that the changes in correction volumes do not directly cancel the adjustment changes for individual Suppliers. This is because adjustment changes comprise of HH and NHH volume alterations whilst the correction changes only affect NHH volumes. The increased losses are accounted for by re-apportioning the total adjustment volume change across Suppliers depending on their NHH market share.

This benefits some Suppliers but negatively impacts others. Figure 2 shows that Suppliers 4, 14 and 35 significantly lose out from the variation in LLFs with a material impact of over £2000. Supplier 24 on the other hand benefits from the situation with a material impact of almost -£4000. The results across all RF dates exhibited changes of similar orders; we could therefore conclude that there were negligible seasonal differences for this variation.

4.2.2 Variation 2: Overall losses decreased

The results from this variation in LLFs could be directly related to the results in 4.2.1. In this instance however, we expected to see negative changes in adjustment figures, as a result of the decrease in LLFs, and positive changes in correction figures to account for this. Figure 3 demonstrates this. Figure 4 also confirms that due to the same reasoning as described in 4.2.1, Suppliers either benefit or are negatively impacted from this variation in LLFs depending on the makeup of their portfolio of HH and NHH customers. We concluded that there were negligible seasonal differences for this variation.

[2] A sanity check was carried out that proved that the sum of the Energy Deltas was equal but opposite in magnitude to the sum of the GCF Deltas as expected. The rules of Settlements are such that, for this analysis, any changes in adjustment volumes would need to be accounted for by resulting changes in correction volumes except where overall losses are maintained.

4.2.3 Variation 3: Site Specific LLFs increased

For this variation we expected to see small positive adjustment changes affecting a limited number of Suppliers due to the small number of SSp LLFCs in the GSP Group. Figure 5 shows that only Suppliers 4, 14, and 95 experience changes of this nature (as they are the registrants of MPANs with the SSp LLFCs). The changes in correction factors, however, are apportioned across a number of Suppliers in accordance with their NHH market share. Figure 6 shows that the materiality of the volume changes was far less significant compared to variations 1 and 2. We concluded that there were negligible seasonal differences for this variation.

4.2.4 Variation 4: Site Specific LLFs decreased

For this variation we expected to see similar behaviours to that described in 0. Figure 7 shows that again only Suppliers 4, 14 and 95 experienced adjustment changes. These changes were however in the opposite direction to variation 3 due the decrease in SSp LLFs. Once again the adjustments were accounted for by opposing changes in correction volumes (this time positive changes) which were also distributed across Suppliers depending on their portfolio of NHH customers. We concluded that there were negligible seasonal differences for this variation.

4.2.5 Variation 5: Export LLFCs increased

For previous variations we expected to see positive changes in adjustment volumes where LLFs had been increased. This was not the case for this variation as export consumption figures were negatively signed. As a result we expected negative adjustment changes for this variation. This can be seen in Figure 9. Only a few Suppliers (1, 8, 14, 35 and 43) experienced significant adjustment changes. These alterations were again accounted for by consequent changes in correction volumes that were spread across Suppliers depending on their NHH market share. Figure 10 shows that the material impact of the changes in volume was again far less significant to those in variations 1 and 2. We concluded that there were negligible seasonal differences for this variation.

4.2.6 Variation 6: Export LLFCs decreased

The results from this variation were, as expected, similar but opposite in direction to those described in 4.2.5. This can be seen in Figure 11. In addition, all seasonal varieties experienced similar orders of materiality therefore we concluded that there were negligible seasonal differences for this variation.

4.2.7 Variation 7: Time Bound LLF swap

This variation swapped LLFs applied between November and February (referred to as winter LLFs), with LLFs applied between March and October (referred to as summer LLFs). As a result of this swap, winter LLFs were decreased and consequently summer figures were increased. The results from this variation experienced similar behaviours to that described in 4.2.1 and 4.2.2. The effects of the summer increases in LLFs can be seen in Figure 13 whilst the winter decreases can be seen in Figure 15. This is the only variation that showed seasonal sensitivity. As a result, it could be shown that the way in which an LDSO chooses the periods of its winter and summer allocations could be significant. This is especially so as some Suppliers experience a material impact of between ±£6000 to £8000, as seen in Figures 14 and 16, under this scenario.

4.2.8 Variation 8: HV LLFs Increased

This variation increased HV LLFs and decreased LV LLFs in a manner that kept the overall losses the same. We expected the results from this variation to show no change in correction volumes due to the maintenance of overall losses. The positive changes in adjustment figures, due to the increase in HV LLFs, would be accounted for by negative adjustments that would stem from the drop in LV LLFs. This can be seen in Figure 17. This variation is the most significant of all variations due to the current methods adopted by LDSOs to apportion overall losses across VHV, HV, LV and SSp LLFCs. Figure 18 shows that some Suppliers are materially impacted by in excess of ±£1000. We concluded that there were negligible seasonal differences for this variation.

4.2.9 Variation 9: HV LLFs Decreased

As expected, the results from this variation were similar but opposite in nature to those described in 4.2.8. This can be seen in Figures 19 and 20. We concluded that there were negligible seasonal differences for this variation.

5 Conclusion

This analysis has shown that as a result of varying LLFs in the strategy chosen, material impacts are experienced by Suppliers. The magnitude of this impact depends on the nature of the portfolio of NHH and HH customers attributed to a specific Supplier. In addition, changes to SSp and Export LLFs impact Suppliers more evidently due to the nature by which those changes are applied and illustrated.

On the whole the variations did not show seasonal sensitivity. However, Variation 7, the Time Bound LLF swap, did due to differences in LLFs for winter and summer months. This proved that the method by which an LDSO defines its summer and winter periods could have an impact.

For the purpose of this analysis, LLFs were increased or decreased by 20% (multiplied by 1.2 or 0.8 respectively). It was thought that these were extreme scenarios that would be unlikely to happen in reality. Altering the LLFs by 20% for this analysis, however, did more clearly define what the impacts to Settlements would be as oppose to smaller changes that may not have been as evident on the graphs produced. In addition, and as discussed in section 3.2, an LLF change of this magnitude is allowed under the current SVA LLF validation rules. Therefore, whilst the material impacts highlighted are un-realistic, they are possible. The impact of a variation is proportional to the extent of the variation. For example, if the LLFs were increased or decreased by 10%, the extent of impact would be half of what is presented within this report.

The analysis was undertaken for one GSP Group and for a Settlement Date within each BSC season. To extend the scope of the analysis, the results could, in theory, be extrapolated out to show the likely impact on the whole SVA market over the course of a year.

All variations displayed potential impacts on Settlements. Variations 8 and 9 were thought to most accurately reflect a realistic change in LLFs that could be experienced under the current methods of LLF production. Relatively significant material impacts were experienced under these particular scenarios. The analysis shows that the variety of LLF calculation methods, adopted by LDSOs, can have an impact on the SVA market.

6 Appendix A - Graphs

A selection of graphs (Figure 1 to 20) from the results set is presented over the next 20 pages.

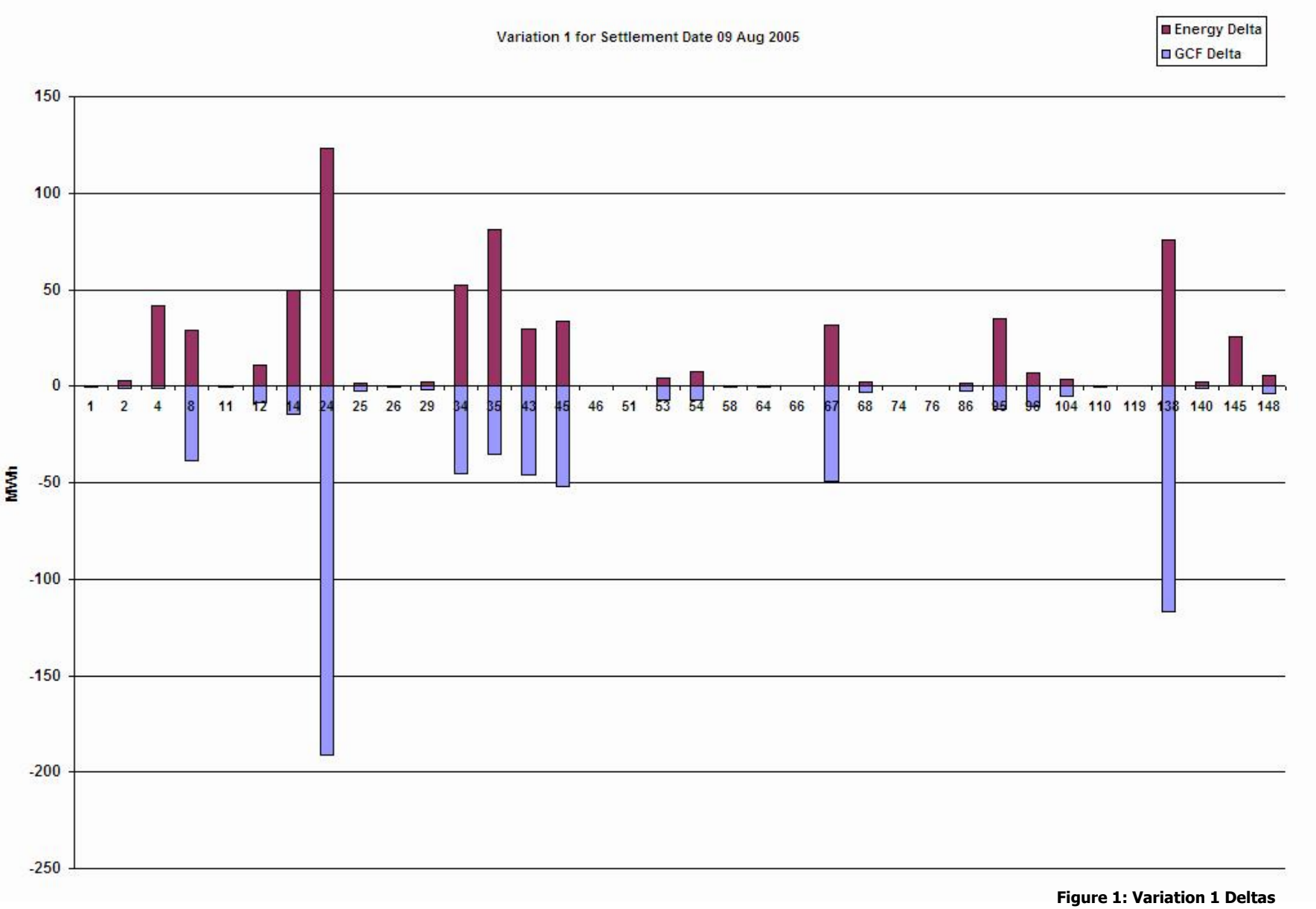

Figure 1: Variation 1 Deltas

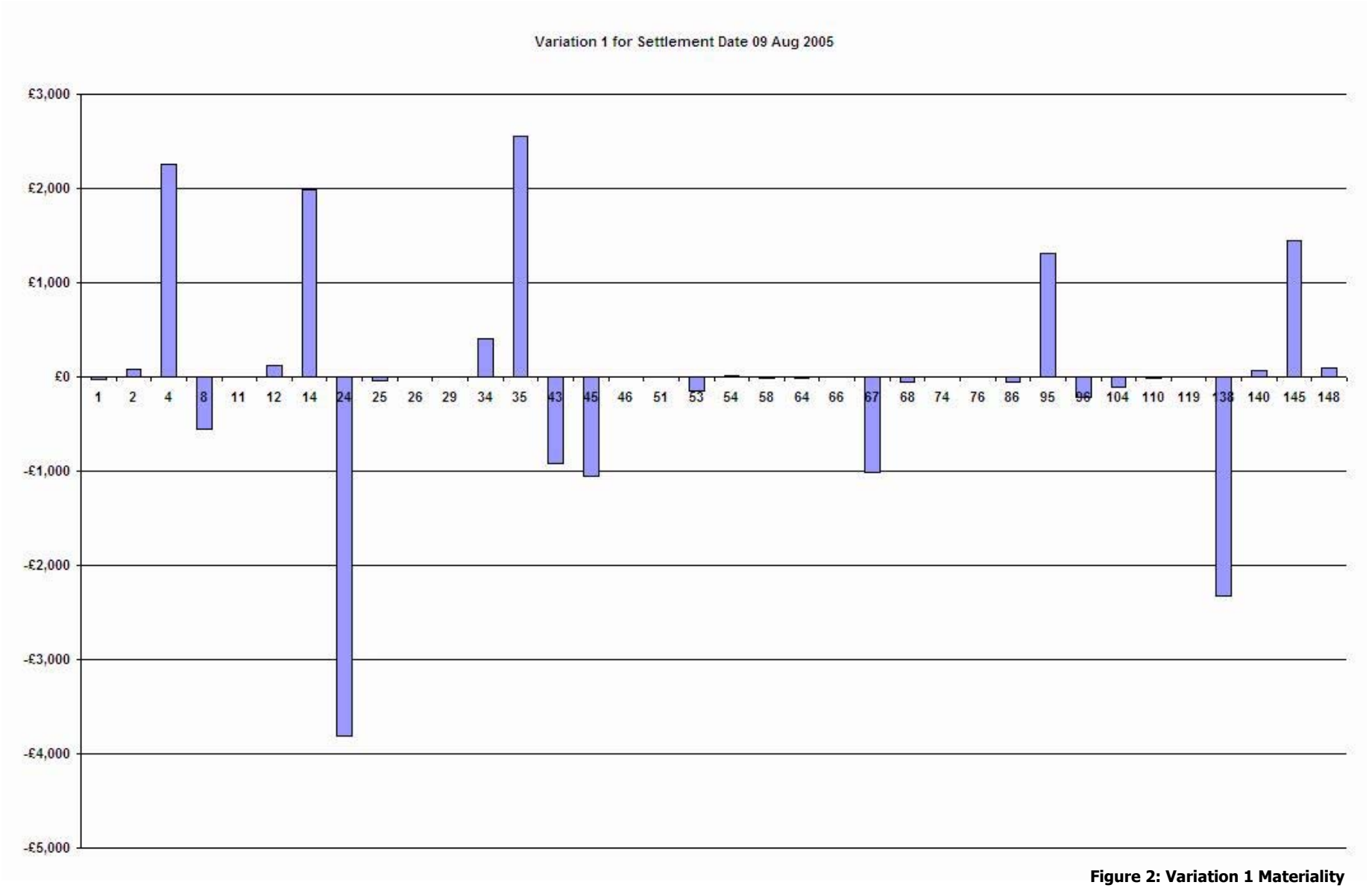

Figure 2: Variation 1 Materiality

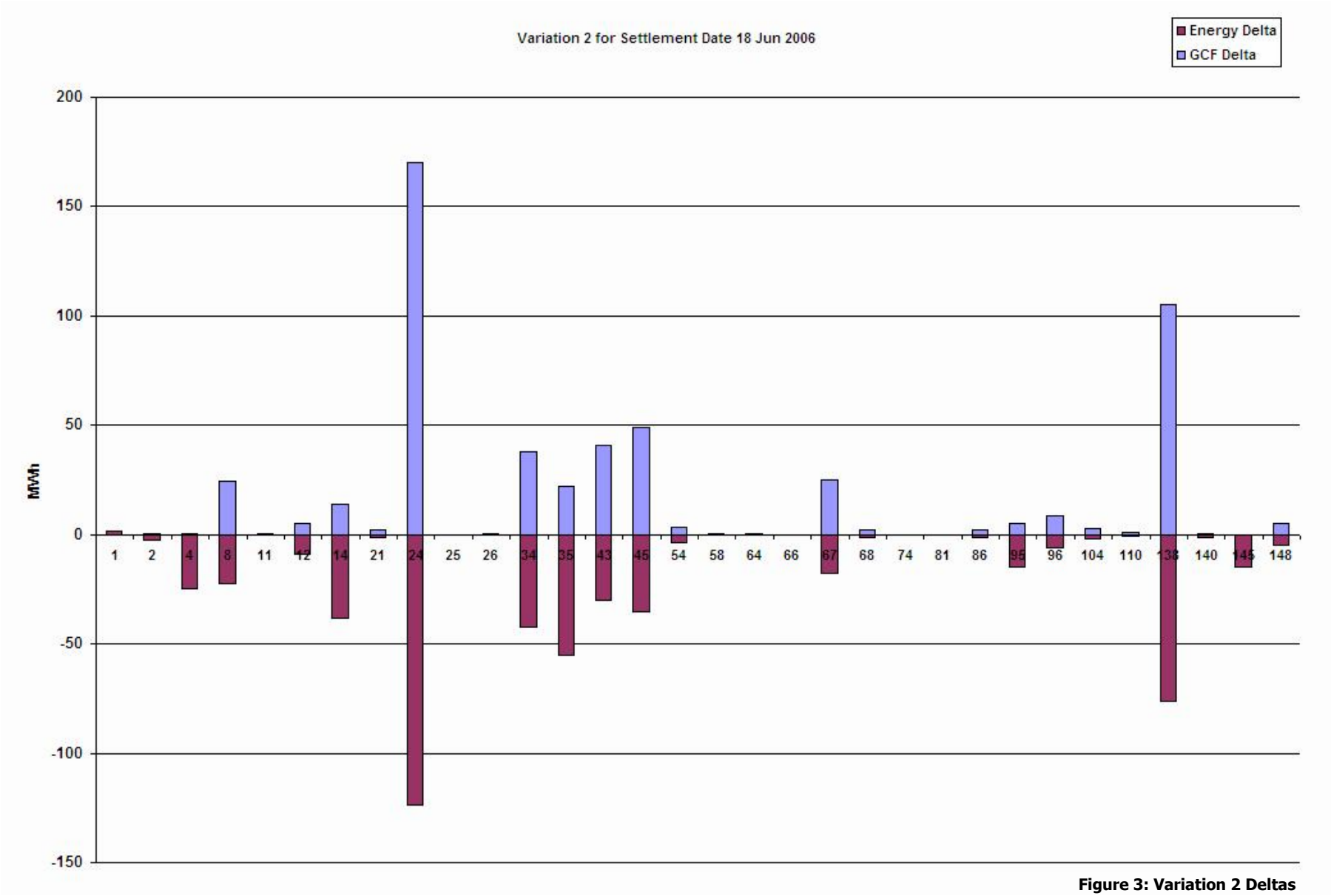

Figure 3: Variation 2 Deltas

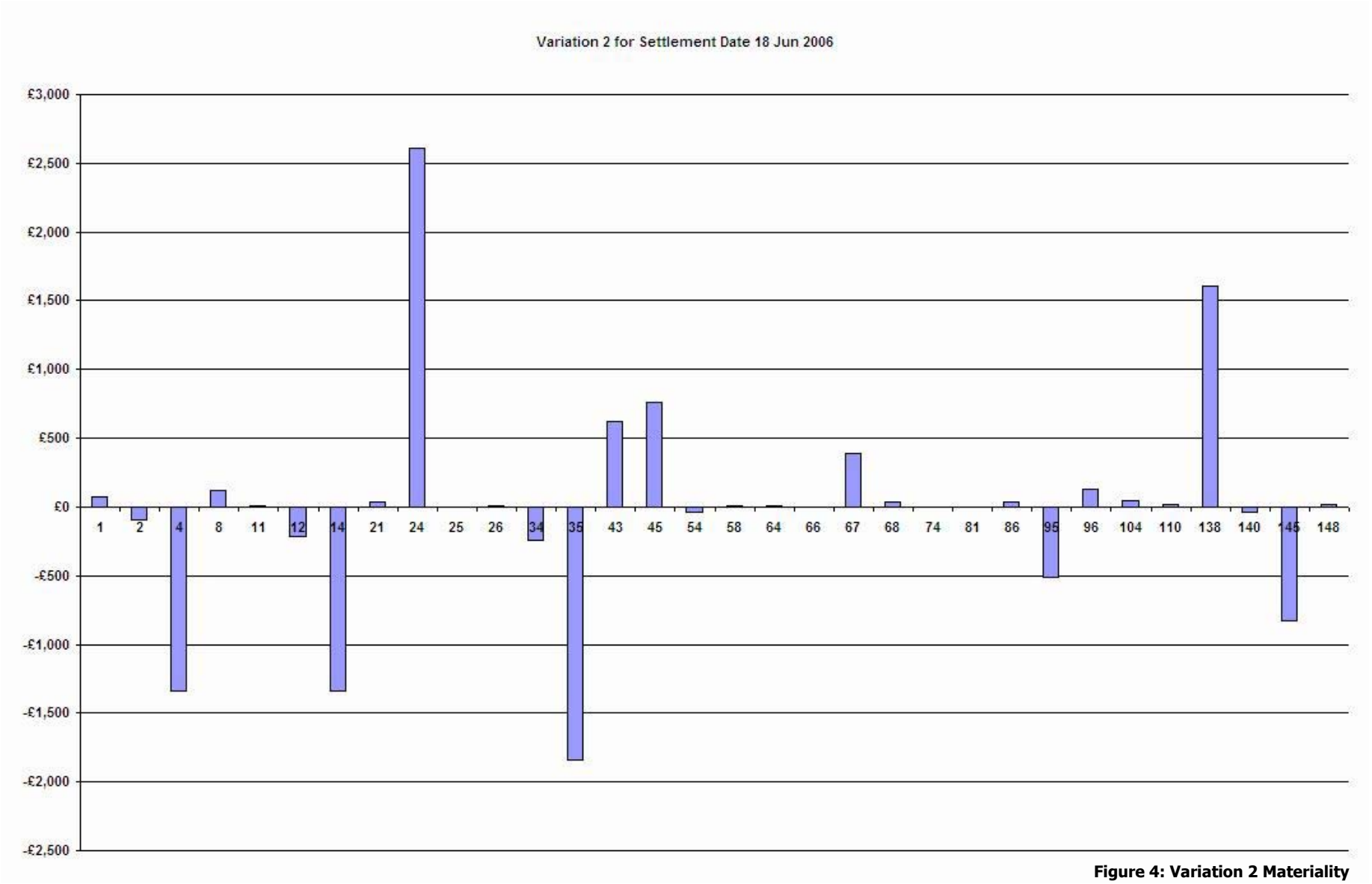

Figure 4: Variation 2 Materiality

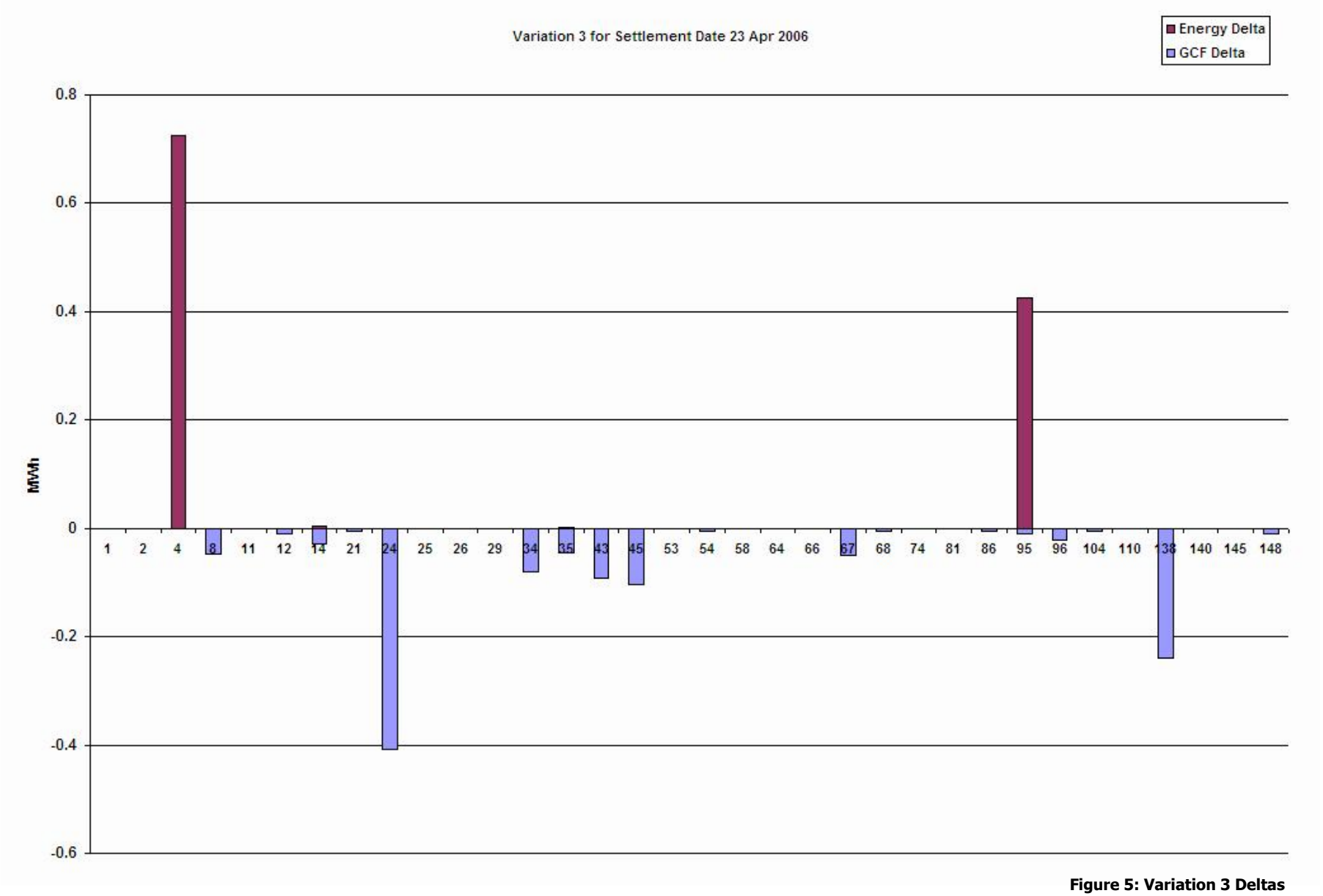

Figure 5: Variation 3 Deltas

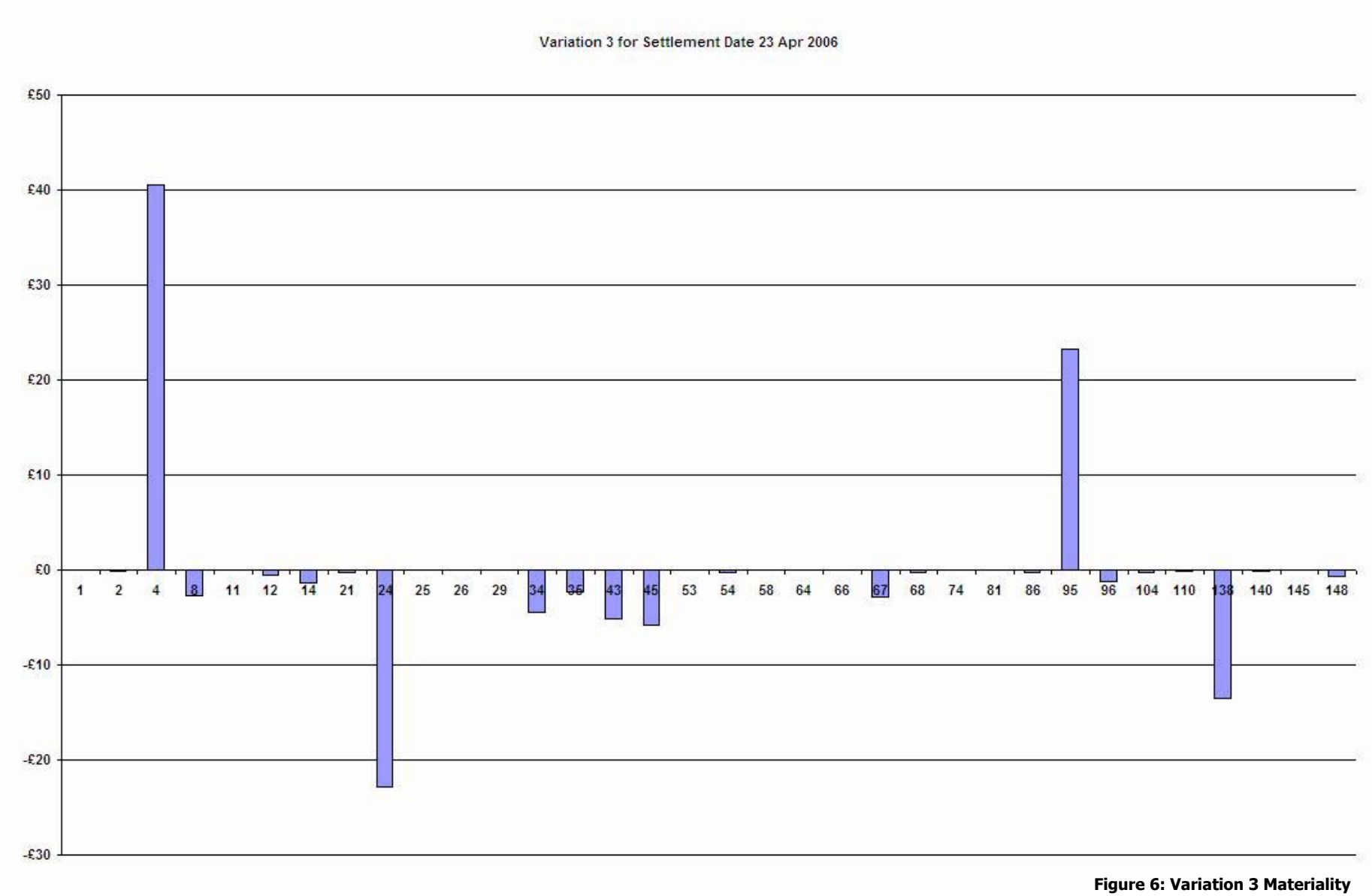

Figure 6: Variation 3 Materiality

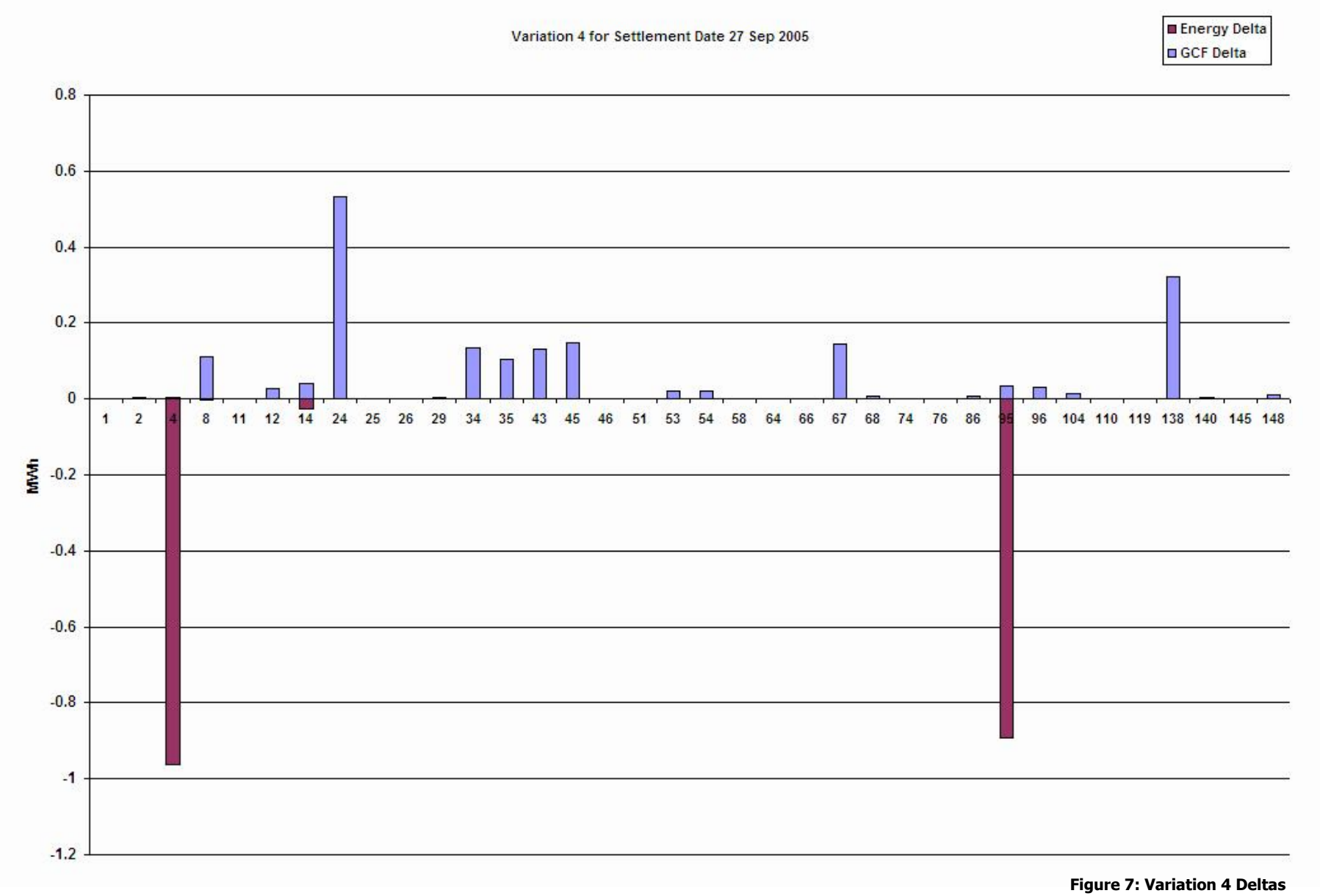

Figure 7: Variation 4 Deltas

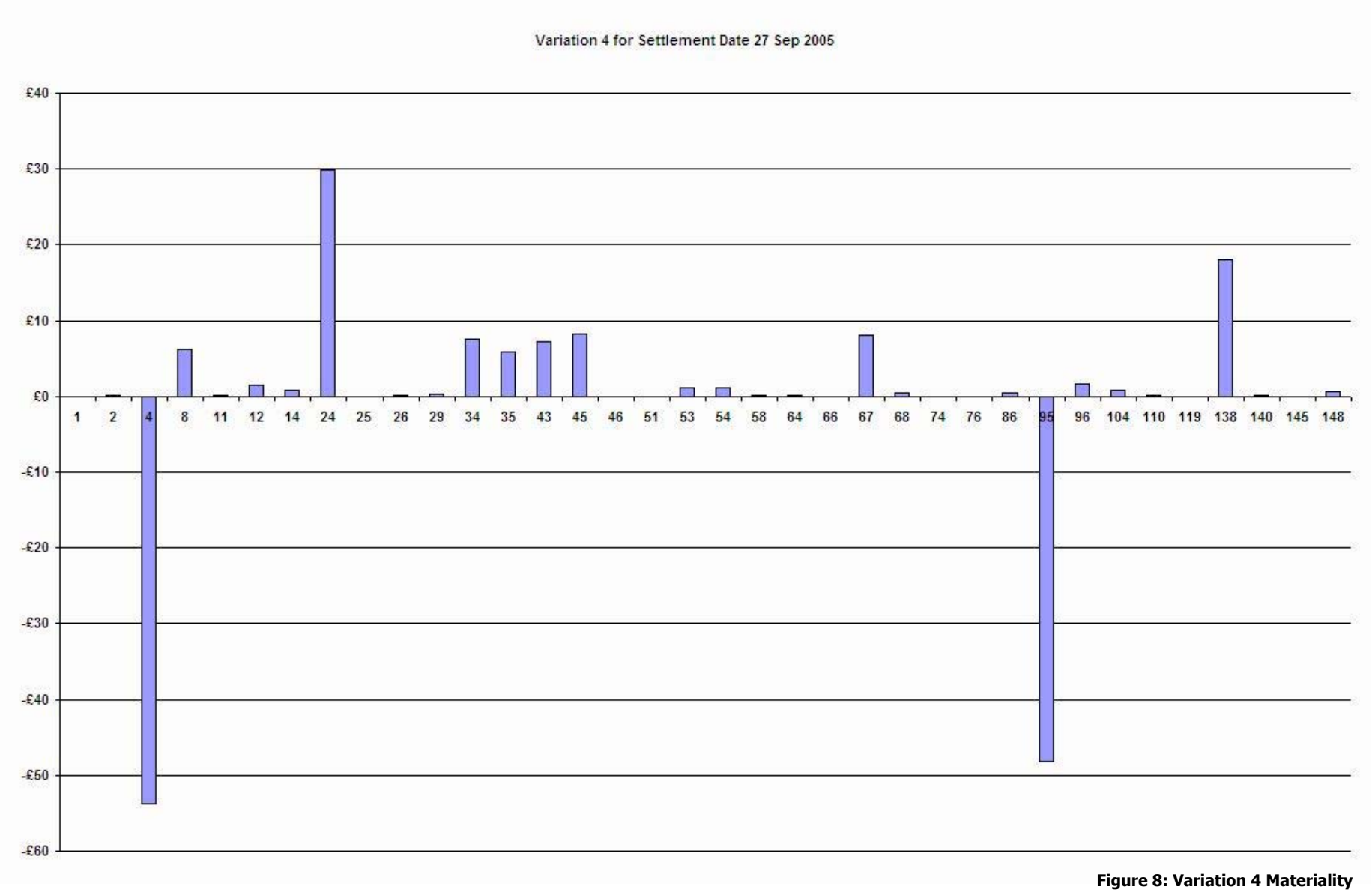

Figure 8: Variation 4 Materiality

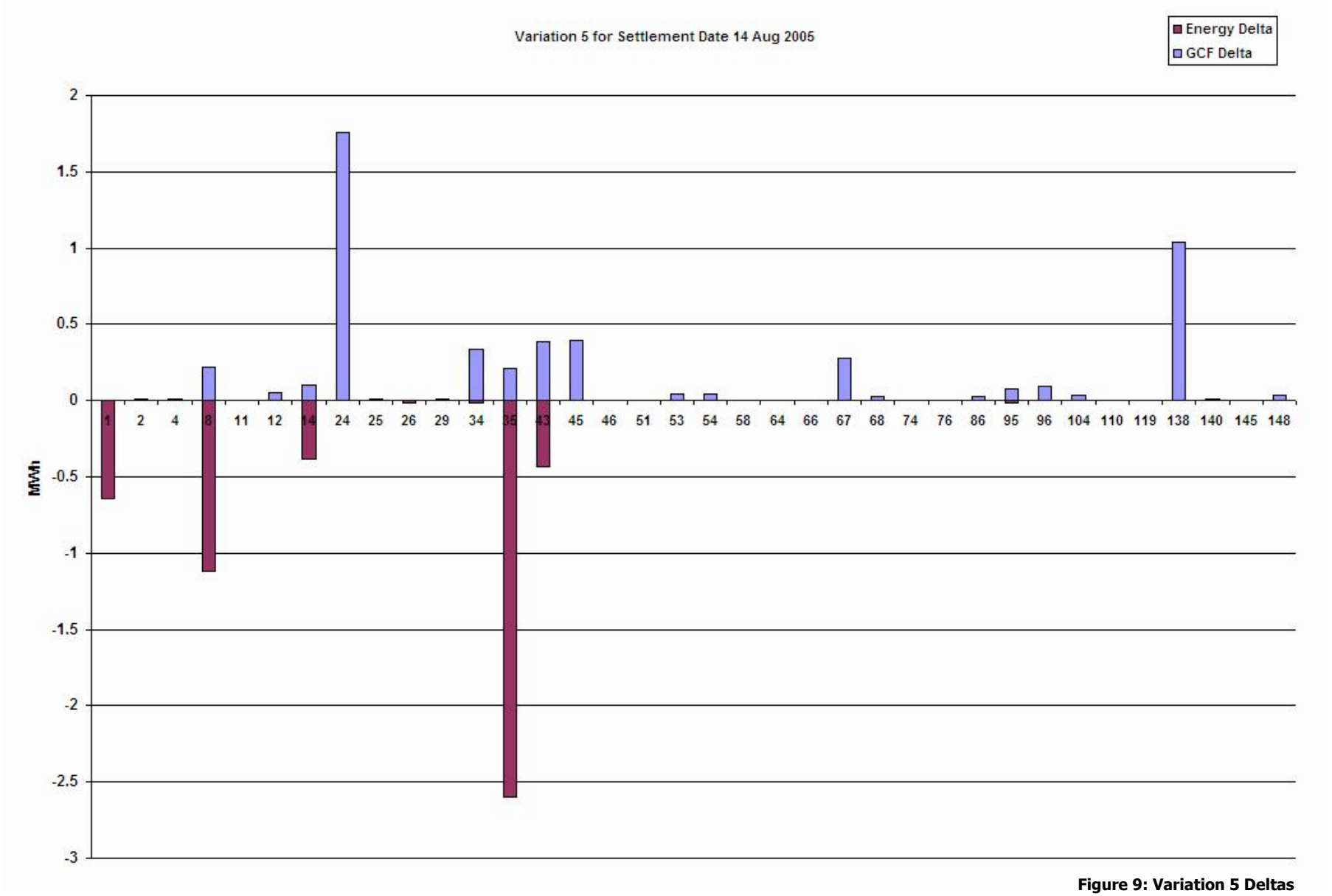

Figure 9: Variation 5 Deltas

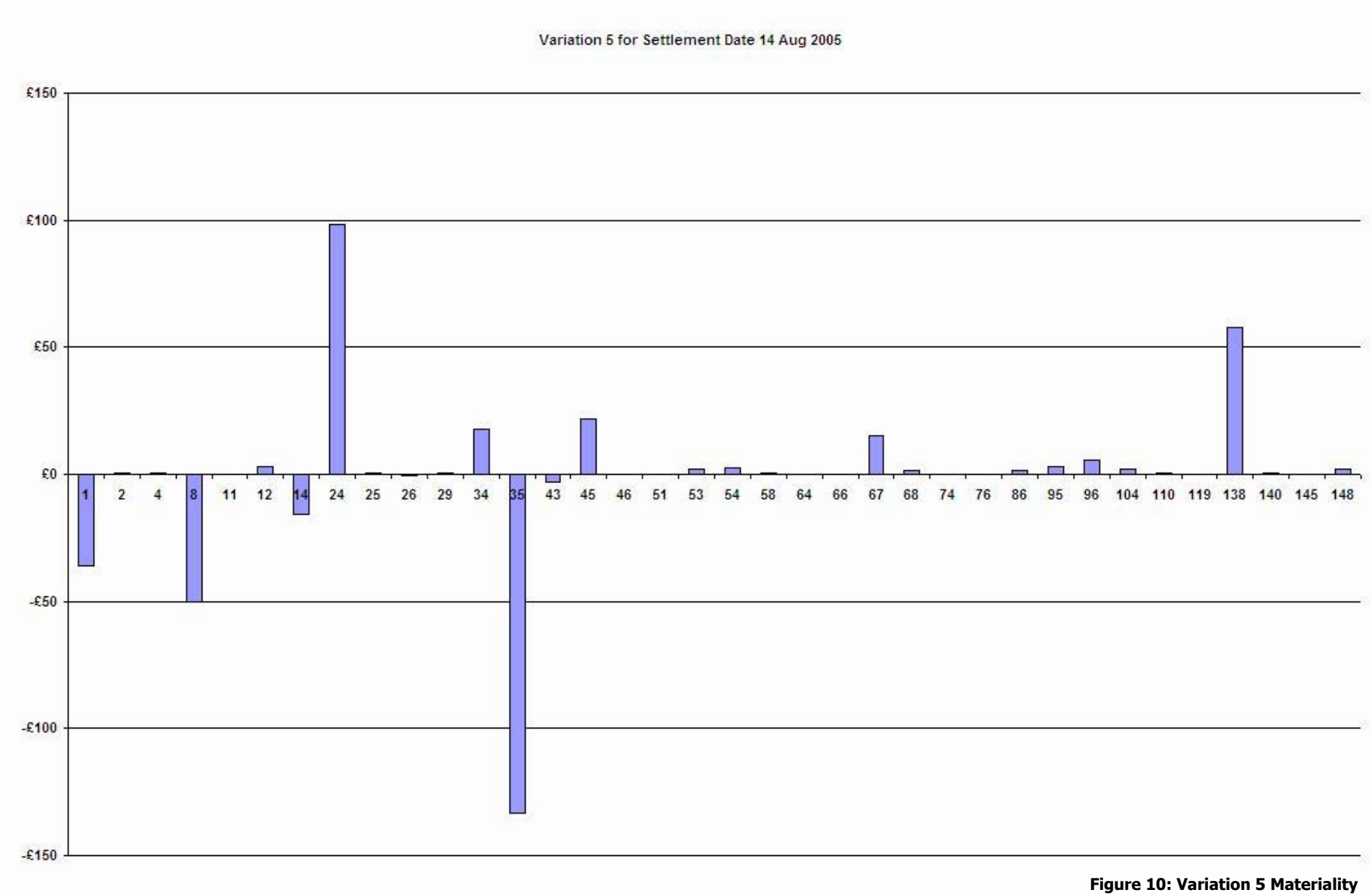

Figure 10: Variation 5 Materiality

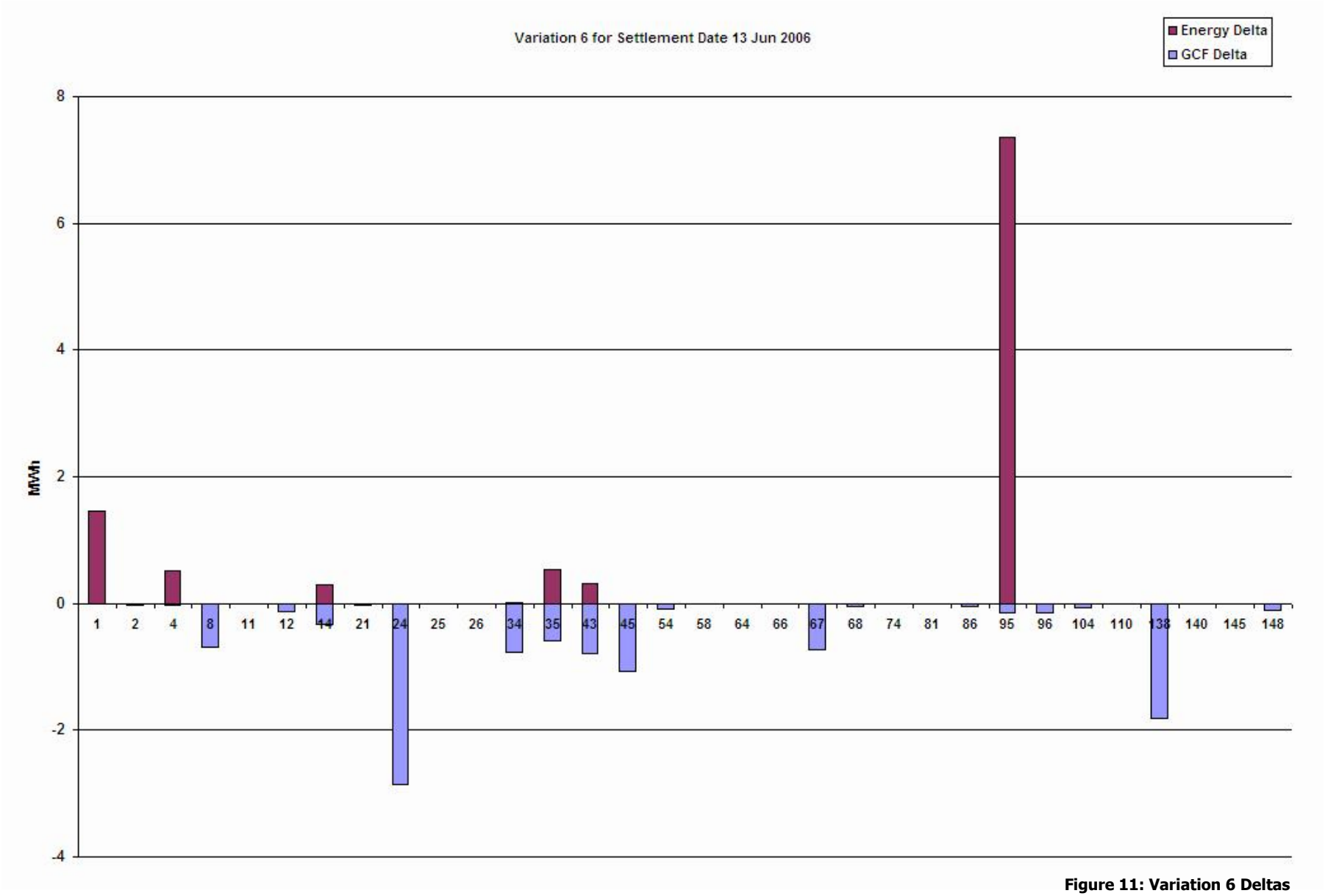

Figure 11: Variation 6 Deltas

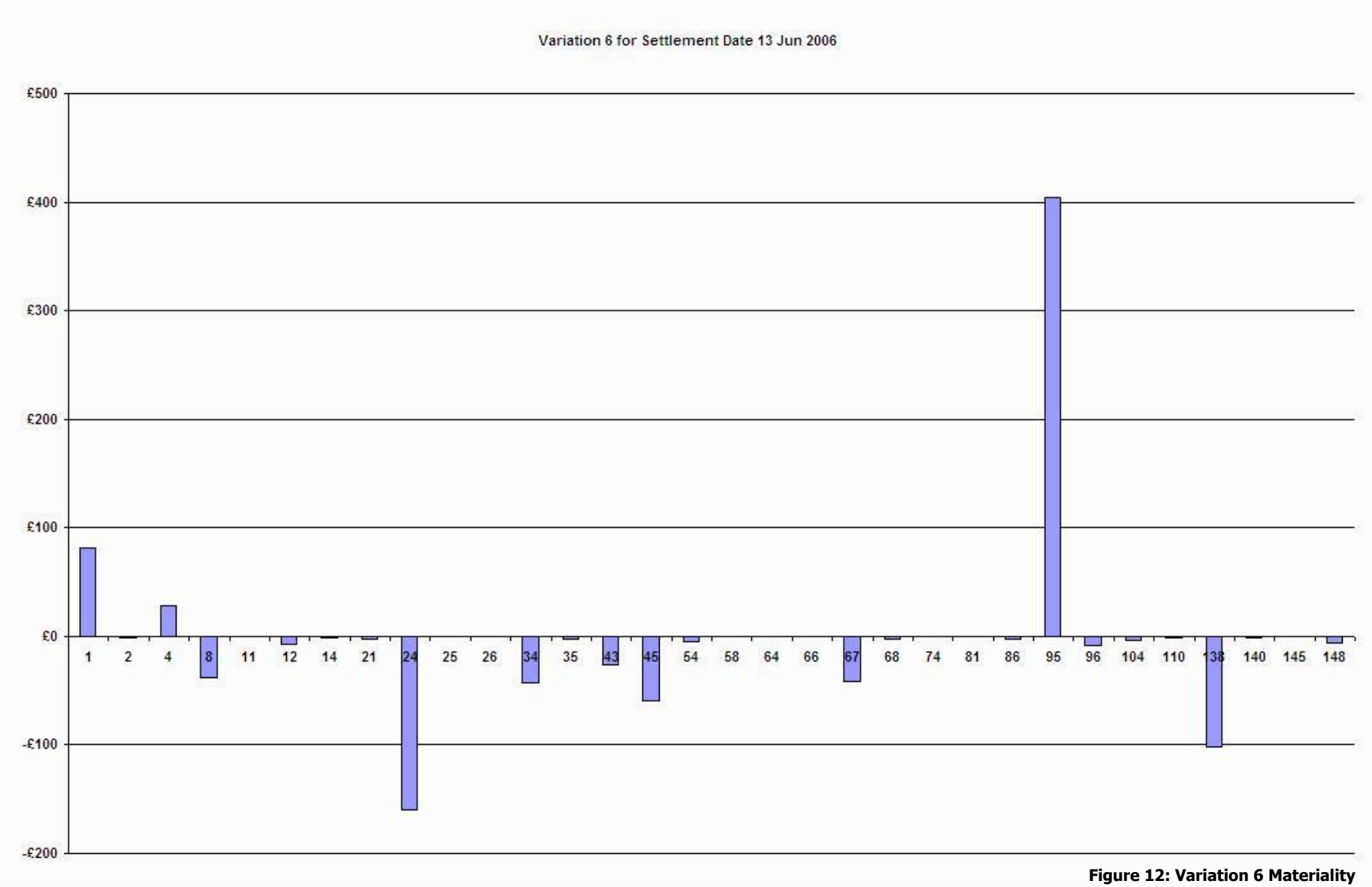

Figure 12: Variation 6 Materiality

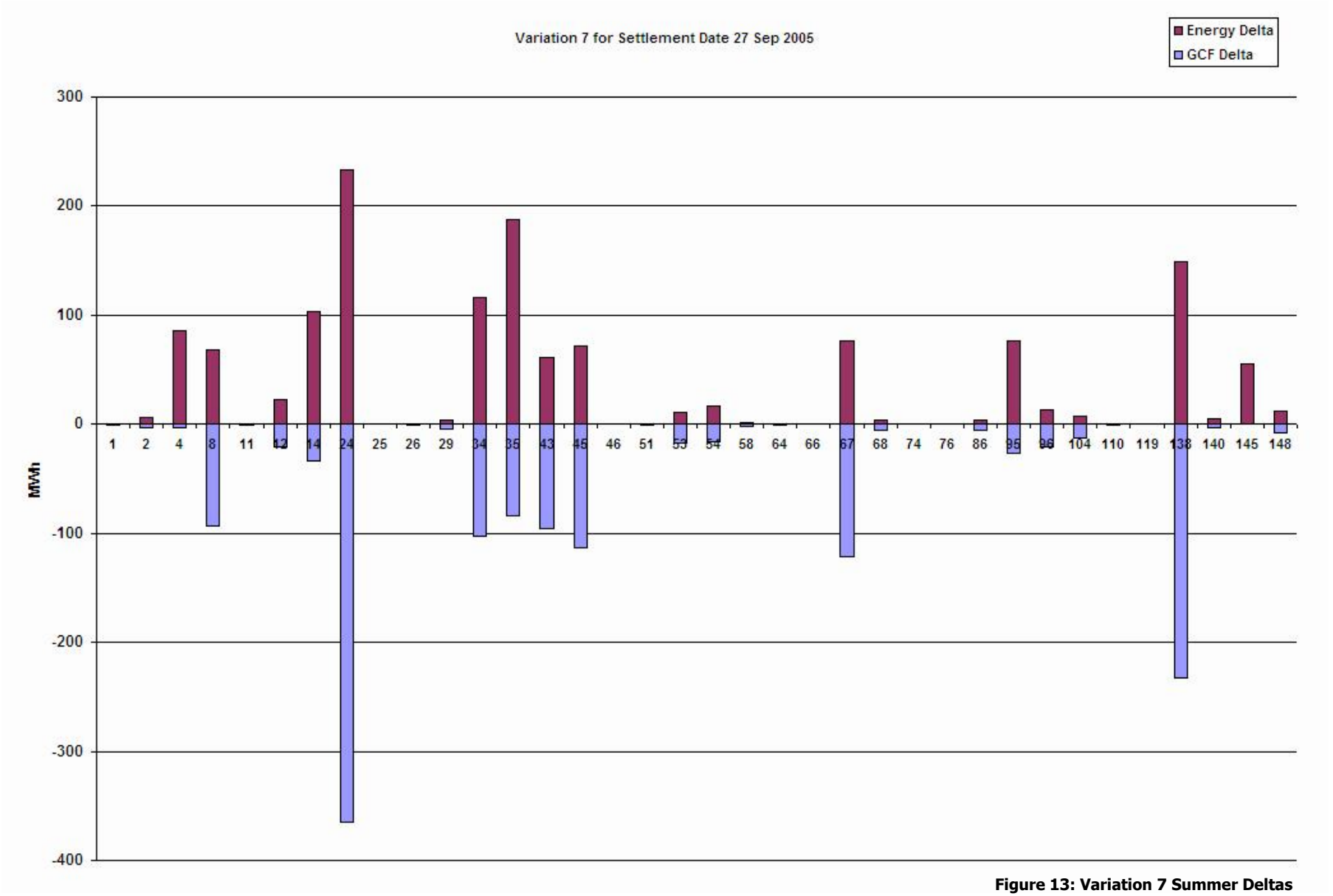

Figure 13: Variation 7 Summer Deltas

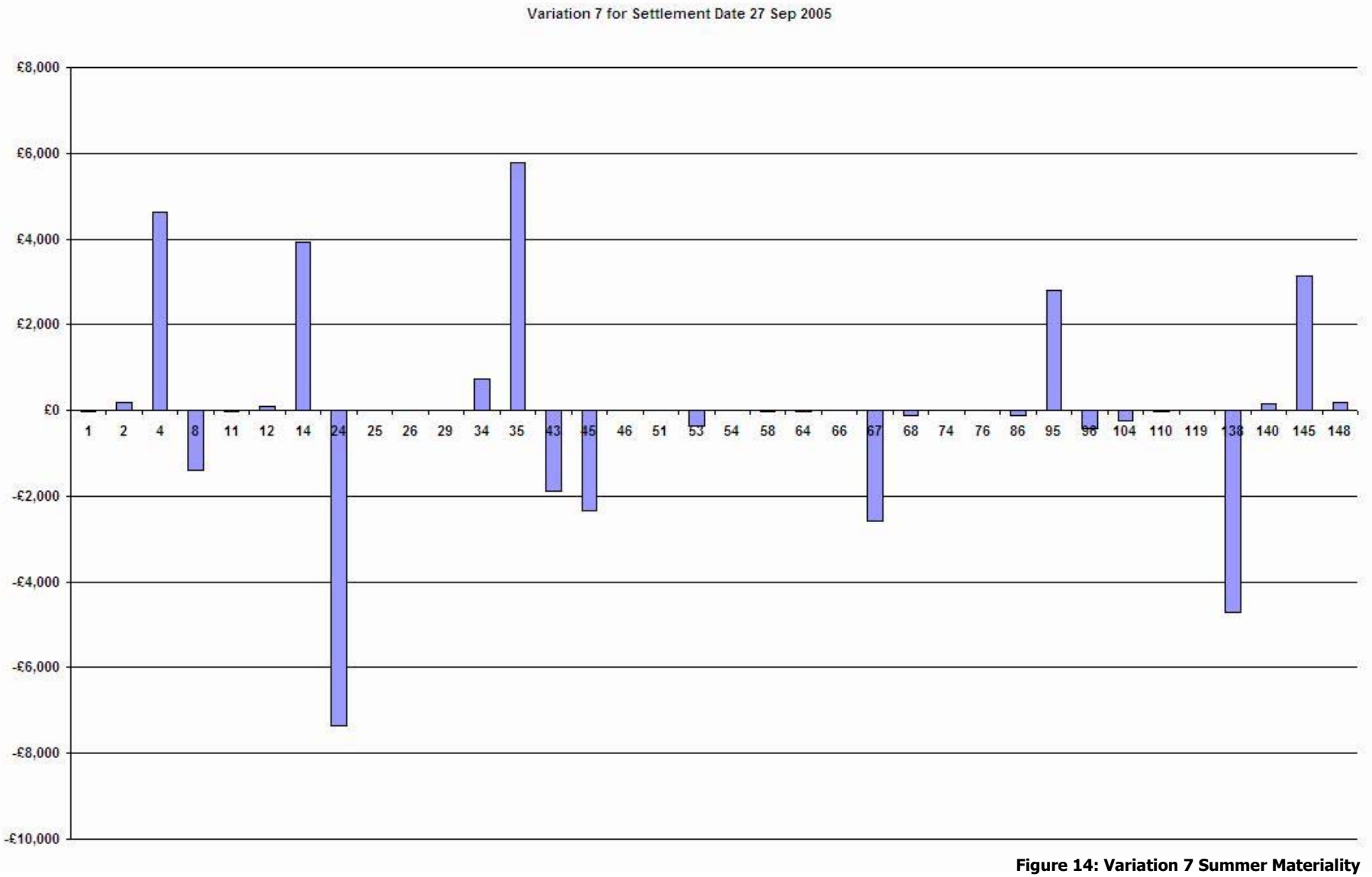

Figure 14: Variation 7 Summer Materiality

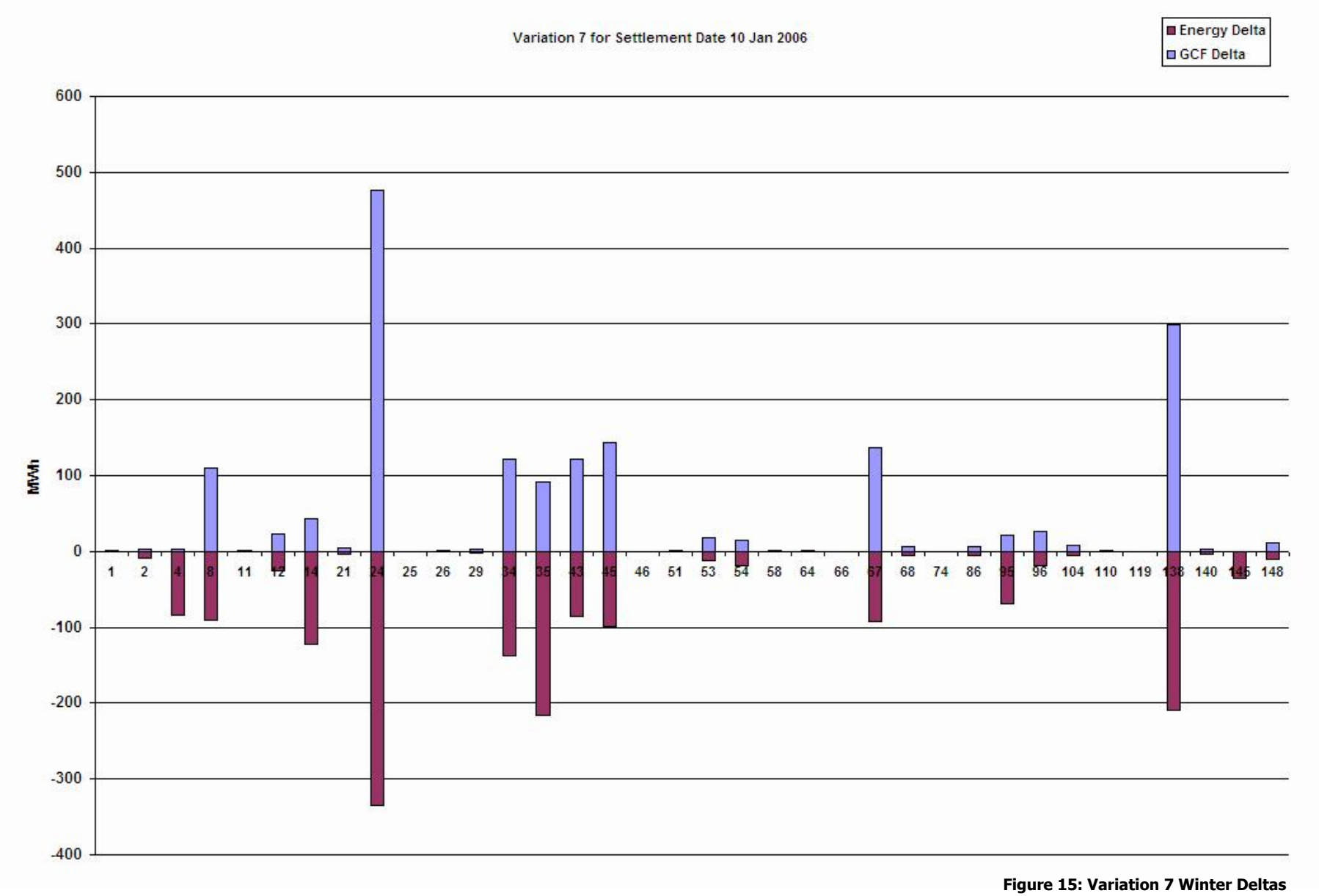

Figure 15: Variation 7 Winter Deltas

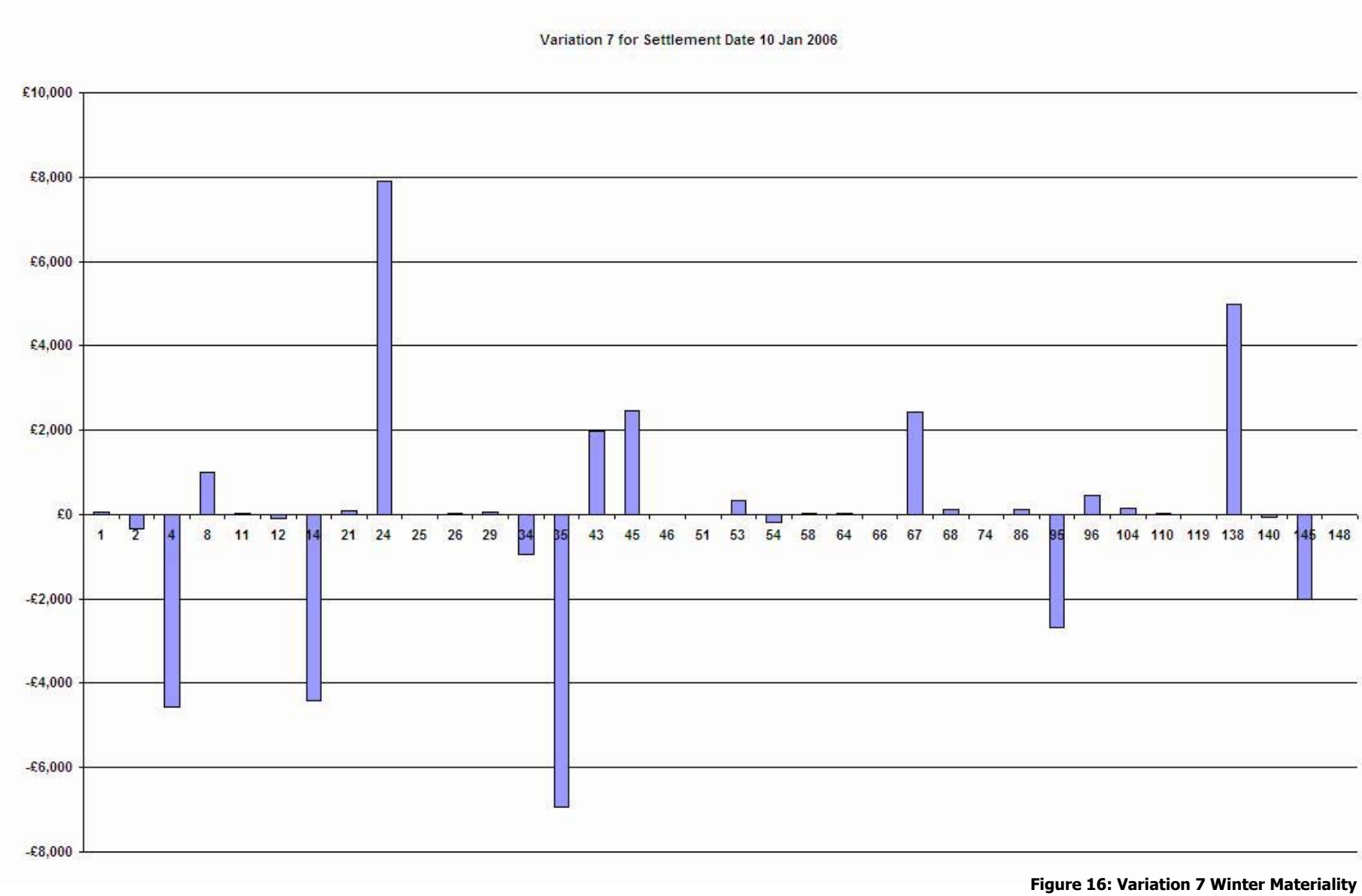

Figure 16: Variation 7 Winter Materiality

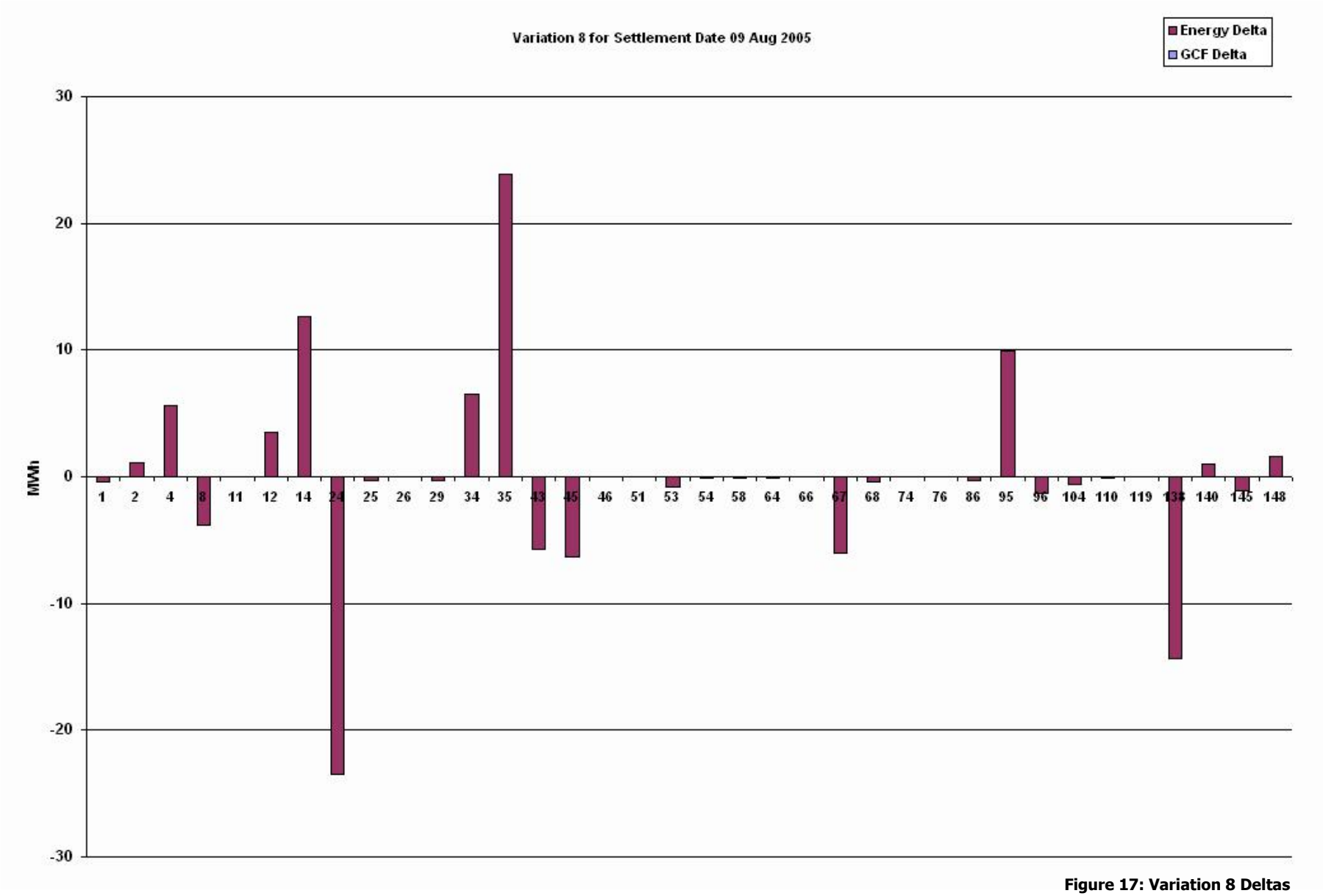

Figure 17: Variation 8 Deltas

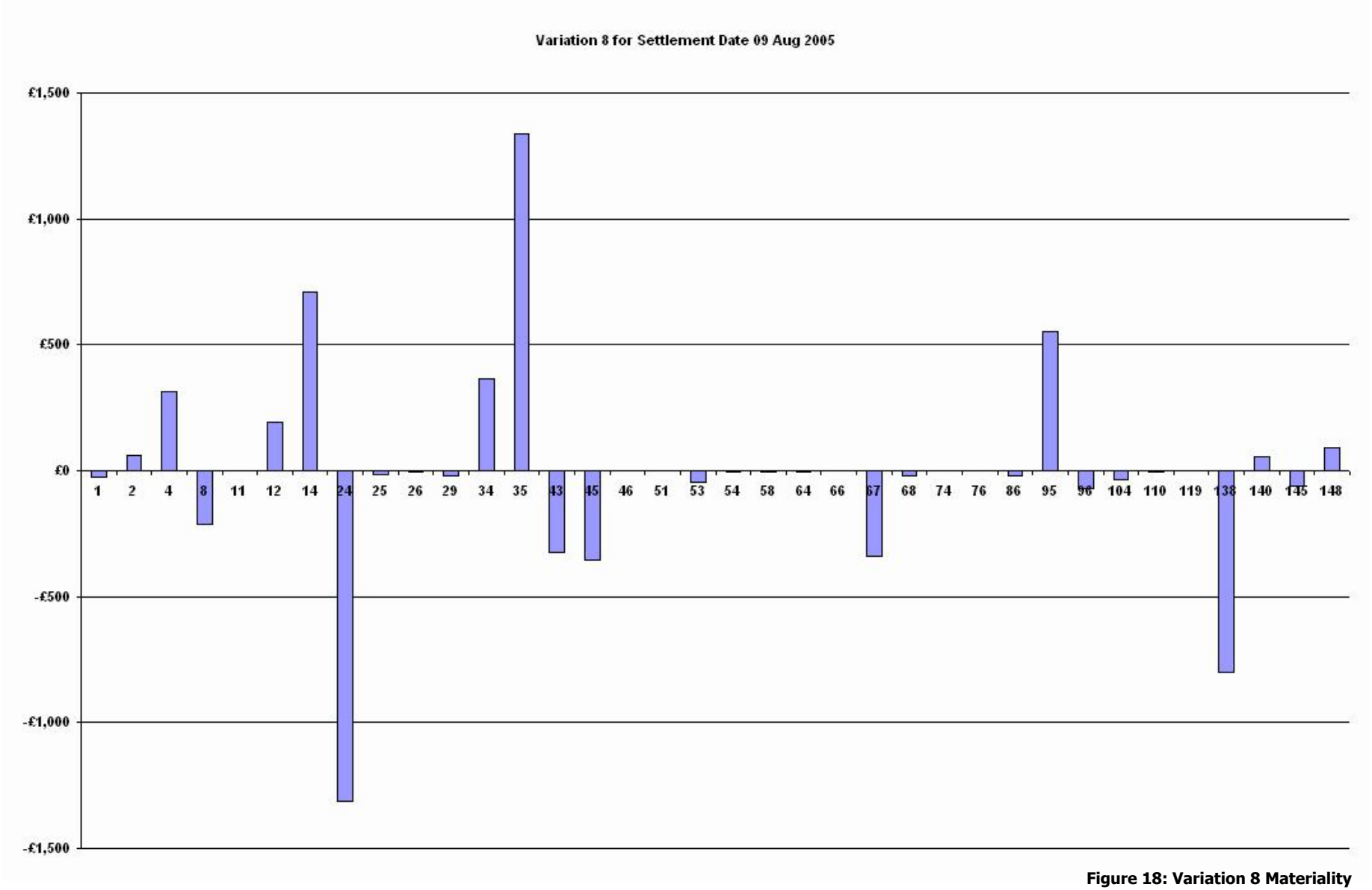

Figure 18: Variation 8 Materiality

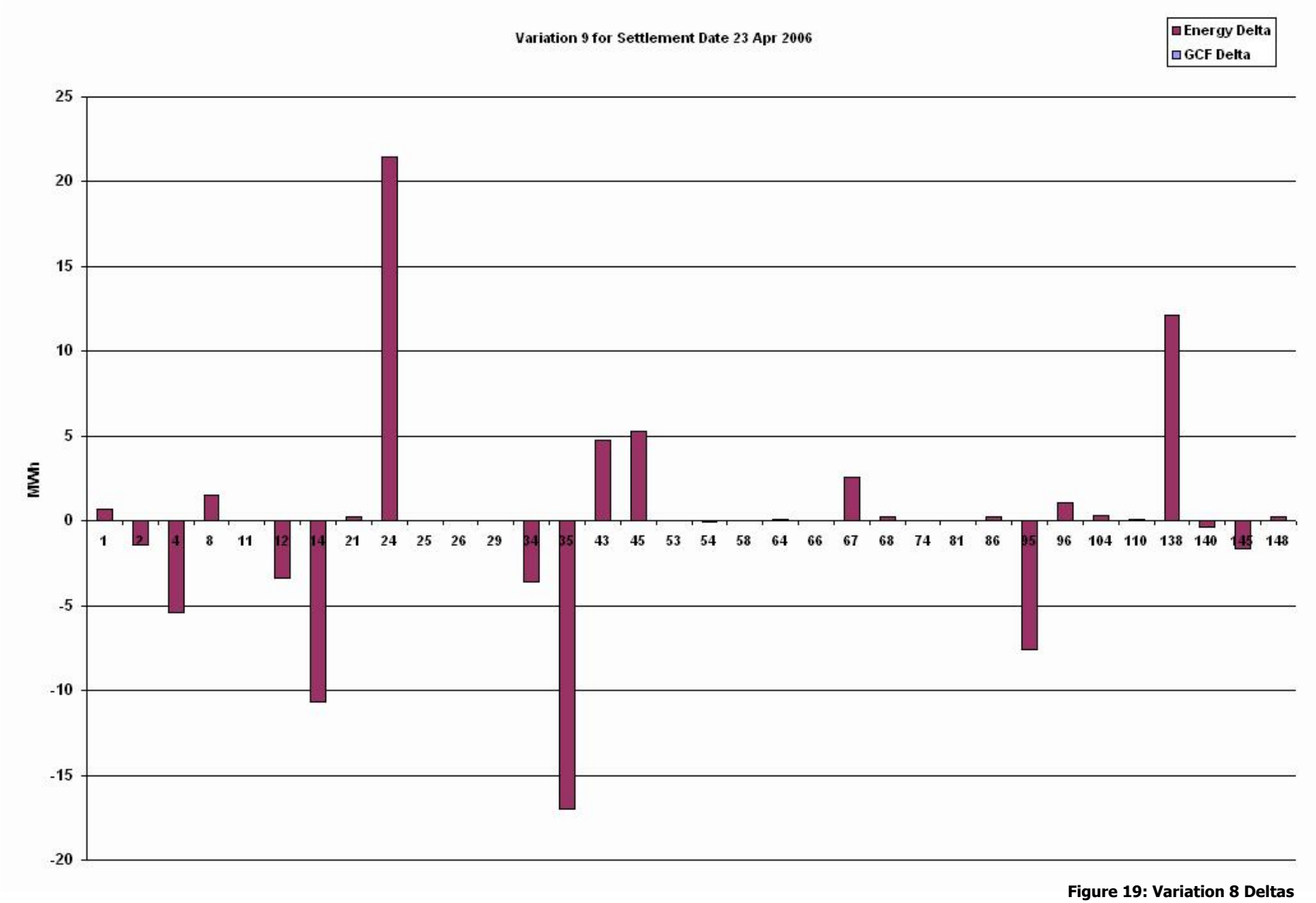

Figure 19: Variation 8 Deltas

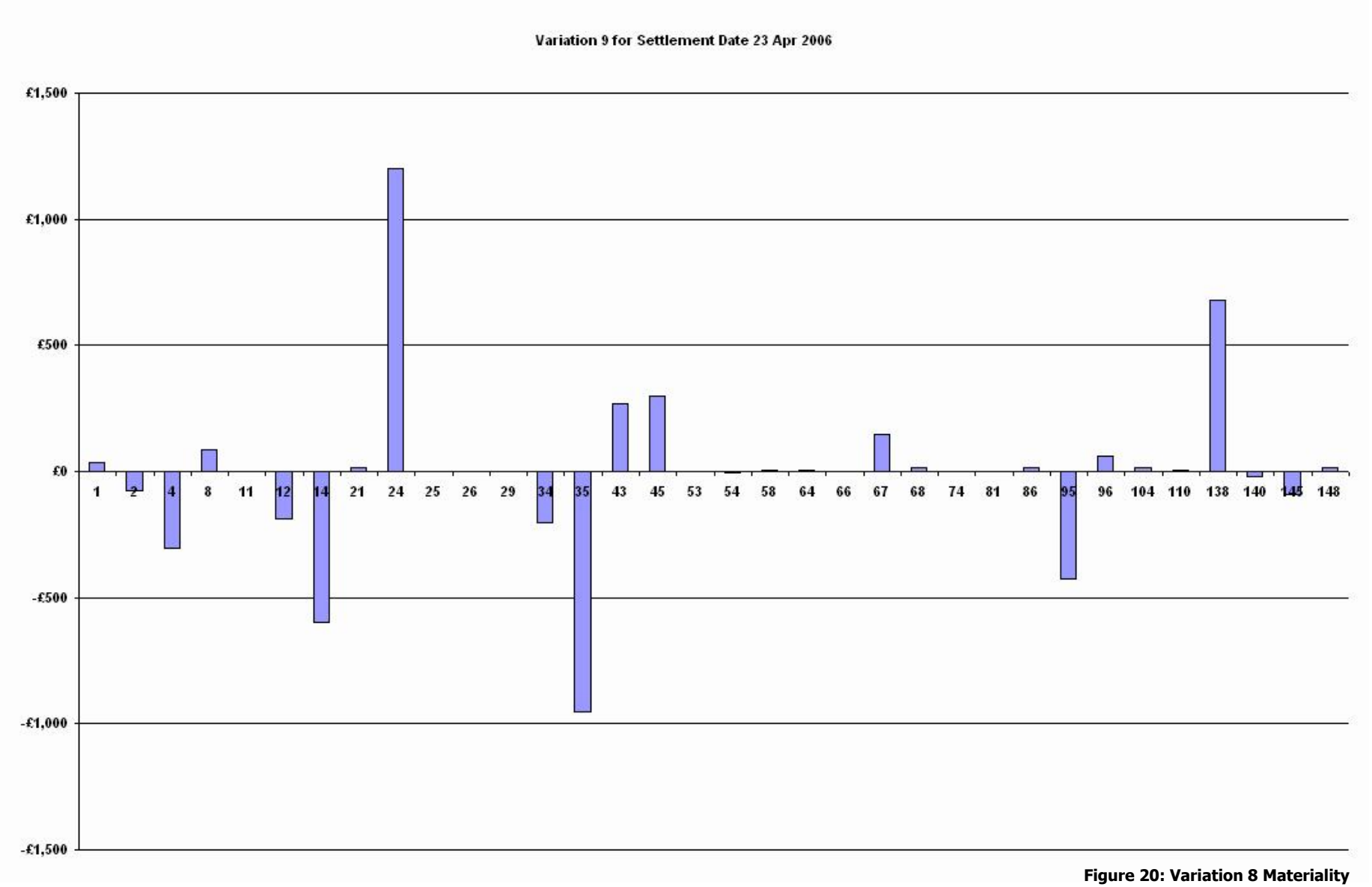

Figure 20: Variation 8 Materiality

7 Appendix B – Materiality Prices for P216

At the P216 Modification Group meeting, the Group discussed the sensitivity analysis undertaken so far regarding changes to Line Loss Factor (LLF) values. The Group agreed a number of actions regarding further analysis, one being a materiality calculation so as to give an indication of the potential impact on Suppliers for particular changes in LLFs.

The group suggested that the change in materiality calculation be based on:

- Volume difference due to the change in LLF values, i.e. the difference between the daily sum[3] of LLF adjusted volumes and the daily sum of GSP Group Corrected volumes by Supplier; and
- A set of month ahead traded prices that would be used by a Supplier to trade out these differences in volume.

Suggested Prices

A set of prices have been obtained from a broker that were traded on 11th December 2007 for various periods in 2008. These prices have been averaged by period and are shown in Table 1 below.

Table 1. Average traded prices for 2008, as of 11/12/07

Time Period	Average Price (£/MWh)
Jan-08	62.96
Feb-08	63.40
Mar-08	56.05
Quarter 1 2008	59.92
Quarter 2 2008	47.25
Summer 2008	47.38
Winter 2008/2009	54.44

The average of these prices is £56/MWh. The ten Settlement Days chosen for the sensitivity analysis are shown in Table 2 below.

Season	Date of Day Type 1 (Tuesday)	Date of Day Type 2 (Sunday)
1: Winter	10/01/06	15/01/06
2: Spring	18/04/06	23/04/06
3: Summer	13/06/06	18/06/06
4: High Summer	09/08/05	14/08/05
5: Autumn	27/09/05	02/10/05

The prices from each time period could be applied to each of the ten Settlement Days, e.g. Jan 2008 price could be used for the winter season (1). However, it is believed that due to the analysis approach used (and the approximations within the model), it is more appropriate to use the average of these traded prices for the Settlement Days.

Group Agreement

The Group agreed to support this above approach of using an average price of £56/MWh.

[3] It may also be required to look at the absolute settlement period by settlement period values to determine any cancelling affects in the daily sums.

8 Document Control

a Authorities

Version	Date	Author	Reviewer	Reason for review
0.1	18/12/07	Keith Banwaitt	Ysanne Hills	
0.1	18/12/07	Keith Banwaitt	David Jones	
0.3	19/12/07	Keith Banwaitt	David Jones	
0.3	19/12/07	Keith Banwaitt	Richard Cullen	

Version	Date	Author	Approver	Signature
1.0	20/12/07	Keith Banwaitt	David Jones	

Version	Date	Author	Authoriser	Signature

b Distribution

Recipient	Version	Date	Reason

c References

Reference	Document