Electricity Distribution Systems Losses

Non-Technical Overview

A paper prepared for Ofgem by Sohn Associates Limited

The objectives of this report are
- to provide Ofgem with an understanding of the constituent parts of electrical distribution losses (in relation to a regulated Distribution Network Operator),
- to identify which factors affecting reported losses could have a material effect on the loss incentive in the (current) price control formula and
- to provide easily assimilated information.

Its scope includes:
- electrical Losses in (GB) regulated distribution systems as a whole but not broken down by licensed distributor;
- technical losses and factors affecting them;
- non-technical losses – measurement errors, data errors, theft;
- calculation of reported losses and impact of data volatility and errors;
- interaction of Balancing & Settlement Code (BSC) processes;
- findings of the BSC Audit;
- losses for the periods 2000-01 to 2006-07.

While our report may be a factor to be taken into account when deciding whether or not to proceed with a particular course of action, you remain responsible for any policy or commercial decisions you make. Regard must be made to the limitations on the scope of our work and to the large number of other factors, commercial and otherwise, of which you or your other advisers are, or should be, aware by means other than our work.

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1. Executive Overview

Distribution losses, defined as the difference between the electricity entering the distribution network and that leaving it, arise for technical and other reasons. The technical reasons relate to the physics of electricity distribution though affected by the engineering and economic decisions in, for example, specifying the sizes of cables and transformers. The other reasons cause 'non-technical' losses and include theft, measurement inaccuracy and timing differences.

Losses are important as there is an environmental and economic cost associated with them. Whilst technical losses are directly related to carbon emissions and have an impact on generation capacity, all losses have to be paid for by users of the network. Distributors have an economic incentive, within the price control formula and worth in the order of £100 million per annum, to work to reduce losses. However, some of the causes of losses are not under their direct control.

Since 2000-01 average reported losses have reduced from approximately 6% of the units distributed to 5% with the sharpest decline in the years to 2002-03. Charts of the movement are shown in section 4.2. Figures for different distributors vary widely though all show a general declining trend. The large, initial drop is thought to be too large and sudden to be explained by technical improvements and is probably related to changes within the data used to calculate the losses.

Electricity entering and leaving the networks is measured using the Settlements processes that suppliers use to determine the allocation of energy and thus the amount they have to pay for purchases from generators. These processes are defined in the Balancing & Settlement Code (BSC) and its supporting documents. Distributors use the information about electricity leaving the system to bill suppliers for distribution charges. However, the reported distribution losses are the difference of two large numbers – units entering and units leaving the network. Any errors or uncertainties in the measurement of those quantities, such as meter reading problems or inaccurate records for unmetered supplies, will have a magnified impact. (See section 4 for the detail.)

Within Settlements, there are several problem areas where the data quality is lower than desired. These have been investigated as part of the BSC Audit. Within this paper we have analysed some more detailed figures, provided by Elexon, quantifying the various problems. The data about consumers' usage varies over time as better information comes to hand. For example estimates are replaced by actual meter readings. The normal final data reconciliation run is not until 14 months after the day the electricity flowed. Due to the data problems an additional reconciliation run is being carried out 28 months after the electricity flow.

The impact of these problems on the reporting of losses depends on when the calculations are done. Based on the information analysed, the uncertainty in the losses attributed to a regulatory year is of the order of 0.15% to 0.3% of the units distributed – that is about 3% to 6% of the losses themselves. With a longer time period covered and a longer time after the year-end, this uncertainty reduces. However, some data quality issues are not corrected.

There is a wide variation in the reported losses and it is probable that distributors use different methodologies for handling the uncertain volumes.

This paper provides a background to assist in understanding the different factors affecting measured losses. It reviews the Settlements processes that generate the data used to calculate losses. Management of risk is also discussed.

In the following table, some of the more significant factors affecting losses are listed with the relative materiality and suggestions for further action. The materiality, which is approximate, is based on the impact of the annual volume of electricity involved and the value of the loss incentive in the price control formula (approximately 5p per kWh).

Factor	Underlying causes /also part of	Materiality (annual) & Comments
Theft		Very High (>£100m) Suppliers and distributors equally affected. Very hard to quantify and to reduce. (Section 4.4.3).
Idle Service Energisation Status	Quality of records	High (~£6m) Losses overstated – needs action by suppliers. (Sections 4.4.3, 6.2.2)
GSP Correction Factor variations	Profile errors Incorrect assignment to profile Timeswitch errors Estimated data Lack of meter readings Revisions to data Correction to High AA/EAC issue	High in any one year (~£6m overall with one distribution area ~£13m) Hard to eradicate – general data quality improvement needed. Less of an issue over a long time period but still significant. (Section 5.8)
Unmetered supplies	Inventory of installed equipment Mismatch between records of UMSO and Data Aggregator	Medium to High (~£0.6m total but £2m in one distribution area) UMSOs may need to be more proactive. Suppliers and customers have little incentive to correct some errors. (Sections 4.4.3, 5.4.3, 6.2.1)
High AA EAC Issue	Meter reading and recording errors	Medium to High (>£2m, may be £8m) On-going data quality issues. (Section 4.4.2, 6.2.3)
Meter accuracy	Aging of meters – increased friction in bearings	Medium to High (~£2m on simple estimate) Suggest literature search and enquiries of manufacturers to improve estimate. Large scale replacement of meters (e.g. smart metering) will reduce losses. (Section 4.3.2)
Calculation of losses	Versions of data and methodology used	Potentially High Different methodologies may render comparison more difficult. Discontinuities may occur at changes of price control regime. May need to get clarity of methods, policies used by each distributor. (Section 4.6)
Embedded Generation	Metering, loss factors	Low Small volumes at present. Will grow and is a potential source of error. (Section 4.4.3)
Adjustment of published loss factors	Some distributors adjust loss factors to match GSP Group correction factor.	Zero materiality but may mask errors PAB needs to be aware of distributors' policies (Section 5.7)
Performance Assurance Framework		Zero materiality – change to risk. Periodic review of risk monitoring required. (Section 6.1)

2. Introduction and purpose of paper

Losses, whilst a minor proportion of the electricity distributed, are a significant issue. Apart from the impact of the environment from the lost energy, there is a financial impact on all users of the distribution network. Distributors have an incentive, incorporated in their allowed revenues, to work to reduce measured losses. In 2006-07, the incentive amounted to £114 million.

Several factors contribute to the quoted losses. These range from technical matters through to measurement of amounts of electricity and the time when information becomes available.

Some of the losses are unavoidable but can be reduced by suitable techniques and equipment. Other elements of the losses are avoidable with accurate information and good management.

From an environmental perspective, the losses due to technical reasons link directly to carbon emissions whilst the non-technical ones may not. If the losses arise from a failure to record electricity leaving the system (e.g. theft), it is unlikely that the user will have used the energy responsibly.

This paper aims to provide a high-level, non-technical guide to distribution losses and provide some quantification of the losses and the variability of the data used to calculate them. It is structured to give an overview of electricity distribution, the different reasons for losses, the Settlements system, which provides information crucial to the calculation of losses, and a summary of the main points.

Figures for losses and GSP Group Correction Factors have been taken from publicly available sources and, as a consequence, some approximations (e.g. load shapes) have had to be made. The resultant values are thus approximations themselves and should be viewed accordingly.

In a number of places the impact of the electrical losses has been converted into a money value based on the loss incentive within the distribution price control formula. For the current price control, this is 4.8p per kWh (indexed for inflation). In the calculation of value an approximate figure of 5p per kWh (£50 per MWh) has been used as a guide to the materiality.

A number of charts have been copied from the Balancing & Settlement Code Trading Operations Report with the permission of the copyright owner.

3. Overview of Electricity Distribution

3.1. General Roles and Responsibilities[1]

Electricity distribution networks transport electricity from the national transmission systems through to industrial, commercial and domestic users. In addition, some generators are connected to the distribution networks.

There are 14 licensed distribution network operators (DNOs) - 12 in England & Wales and 2 in Scotland. Each is responsible for a distribution services area. There are also some independent network operators (iDNOs) who own and run smaller networks connected to the DNO networks.

In broad terms, the role of the DNOs is to:

- manage the physical operation of their distribution network;
- invest in the infrastructure by reinforcing, replacing or renewing the equipment to ensure that power is supplied within statutory tolerances;
- connect new consumers and generators to the network as appropriate; and
- promote competition in electricity supply.

They administer movements of customers between suppliers by running the Meter Point Administration Service (MPAS) in their licensed areas.

notes

[1] Please note this is not a definitive statement of the legal rights and obligations of a Distribution Network Operator but rather a general description to aid understanding of electrical losses.

3.2. Physical Arrangements

Electricity enters the distribution network at a number of different points. These include:

- Grid Supply Points (GSP) in England & Wales and Bulk Supply Points (BSP) only in Scotland which are the interface with the national transmission system,
- generators connected to the distribution, as opposed to the national transmission system
- some 'cross border' arrangements with neighbouring distribution systems.

Most electricity enters via the GSPs which take the electricity from the national transmission system at an extremely high voltage (usually 400kV or 275kV) and transform it to 132kV (or 66kV or lower in a number of locations). It is metered and passes into the distribution network where it is transported and transformed to successively lower voltages – 33kV, 11kV and 400/230 volts - at substations for more local distribution to end users.

The National Grid Seven Year Statement for 2007 lists 225 GSPs in England and Wales and a further 280 in Scotland.

Electricity leaves the network at consumers' premises and is metered at that point. Some, however, is used for street lighting, traffic bollards, telecommunications cabinets and similar applications without being metered and thus called unmetered supplies. The arrangements for this are described in Section 5.4.3.

During the course of transmission and transformation, some energy is unavoidably lost in the form of heat in cables and transformers. Section 4.3 covers this in more detail.

3.3. Commercial Arrangements

DNOs do not own the electricity they transport. Their revenues arise not by buying and selling electricity but from charges levied on those making use of the system. Some distributors still use the terms 'purchases' and 'sales' when referring to the units entering and leaving the system,. This terminology dates back to the time prior to privatisation in 1990 and up to the franchised supplier arrangements up to 1998.

Domestic and most industrial / commercial consumers buy their electricity from suppliers who pay the DNOs for transporting their customers' electricity along the networks. Suppliers pass on these costs to consumers with distribution costs accounting for about 10 to 20 per cent of electricity bills.

As mentioned above, electricity is metered as it enters the network and also as it leaves the network. An amount is calculated and applied to account for unmetered supplies.

The meter readings (actual and notional) provide information for calculating how much electricity has been delivered to each customer. For a DNO, the 'customers' are the electricity suppliers, generators and anyone wishing to connect to the network including iDNOs. Most DNOs' charges are paid by suppliers and relate to the amount of electricity delivered and a daily fee. Some DNOs also charge additional amounts where there is a poor power factor (see Appendix) and for electricity exported by embedded generators.

Where the DNO is using electricity in its offices, depots, stores and so on, meters are installed and the DNO contracts with a supplier as would any other consumer. However, in substations and other operational premises where electricity is being used for purposes such as transformer cooling, the usage may be part of system losses or be part of an unmetered supply arrangement.

4. Distribution Losses

4.1. Classification

Distribution losses are the difference between the electricity measured as entering the system and that leaving it. There are two distinct classifications:

- Technical losses and
- Non-Technical losses

The ways in which the measurements of energy entering and leaving the system are also relevant. This is discussed in more detail in Section 4.6.

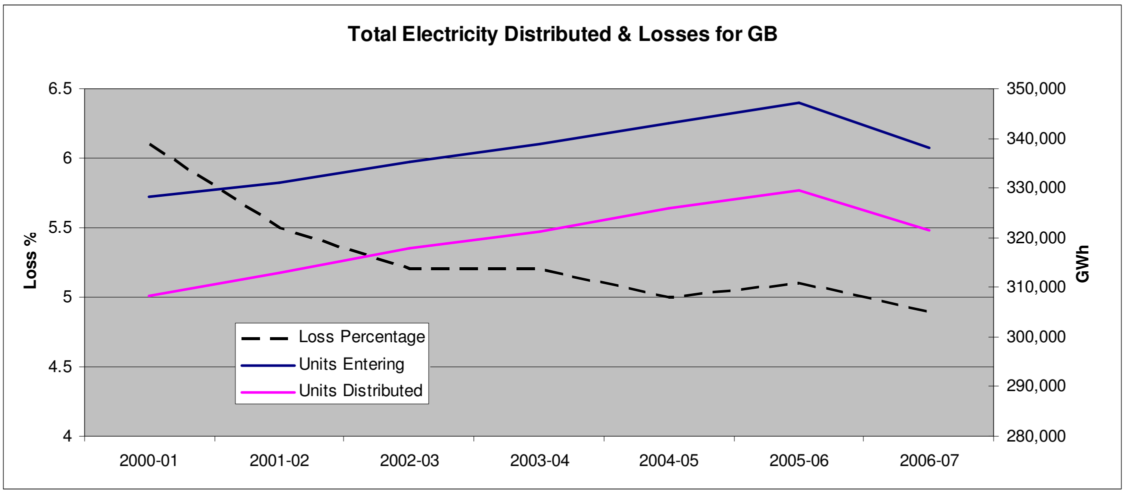
Technical losses arise for physical reasons and depend on the energy flowing through the network, the nature of transmission lines and transformers. The way the network is configured and operated can also influence the losses though this is not discussed further in this paper.

This paper is intended to provide general understanding of technical losses and does not go into this topic in depth.

Non-technical losses, sometimes called commercial losses, incorporate measurement errors, recording errors, theft, and timing differences. Some cases of error may tend to reduce losses.

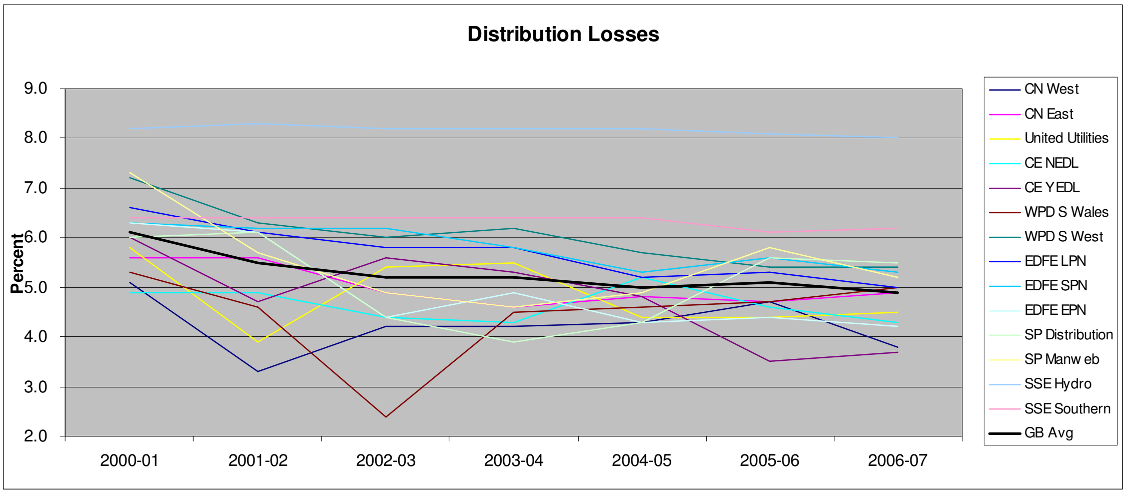
4.2. Reported Level of Losses

Over the last few years there has been a marked decline in reported losses, despite growth in distributed electricity, as illustrated in the following charts derived from the Ofgem factsheet "Electricity Distribution Loss Percentages by Distribution Network Operator (DNO) Area" (1/10/2007). The sheet rightly has caveats regarding the accuracy of data and the methodologies employed.



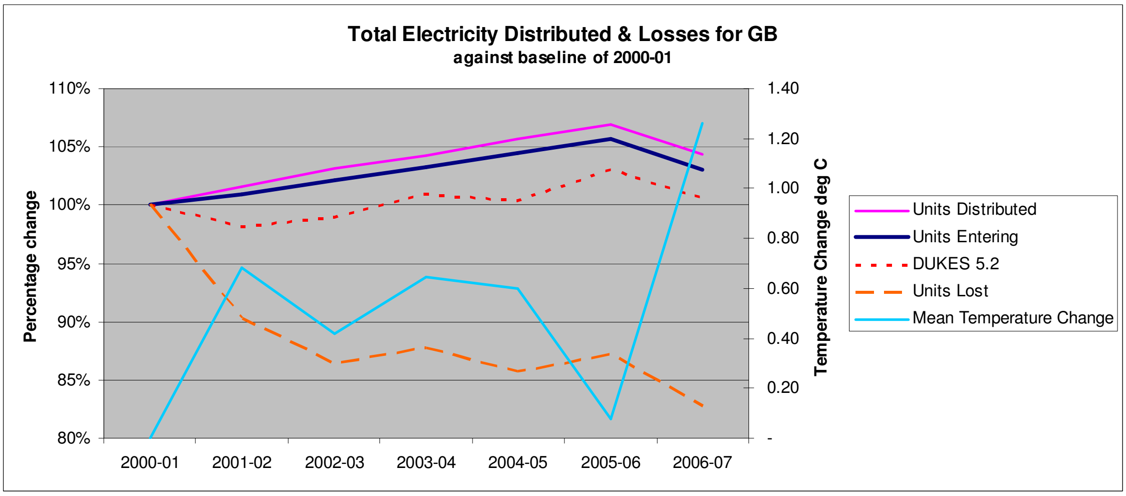
Generally there is an expectation of losses increasing with increased volumes distributed which is not supported by the trends shown by the graph. Also, despite the differing methodologies used by the distributors and the necessary use of estimated data, the growth of volume from 2000-01 to 2005-06 is remarkably steady.

The losses by distributor are not as uniform though the downward trend is visible.[2]



Some volatility in the loss percentage is to be expected as it is the difference between two large numbers, any variability having a magnified effect (of about 15 times).

The change in reported volumes of electricity distributed and the volume (not percentage) of losses are also shown on the next chart against a baseline figure of 100% for the year 2000-01. This illustrates the rate of change. Also shown are trend lines for the total electricity supplied in the UK taken from the "DUKES 5.2" report published by BERR[3]. Whilst the volumes of sales are not directly comparable with the volumes distributed due to different bases (UK vs GB and different sources of information), using a baseline approach enables the trends to be compared. A line on the chart, using the right-hand axis scale, shows the variation in average temperature.



The DUKES trend line exhibits a lower growth with more fluctuation from year to year. The downturn from 2005-06 to 2006-07 within the distribution figures is replicated and is consistent with a large increase in mean temperature. The DUKES variations are in opposite direction to the changes in temperature as is to be expected[4].

Visual inspection of the lines indicates the losses increasing and decreasing (overlaid on the overall downward trend) in a similar pattern to the DUKES electricity supply trend.

notes

[2] Please see the factsheet for detailed numbers; the graph is displayed to illustrate the variations among the distributors.

[3] Department for Business, Enterprise and Regulatory Reform

[4] Higher mean temperatures reduce heating load. Air conditioning lessens this but is not the dominant effect.

Returning to the losses trend line and noting that it related to the volume of energy reported as lost not the percentage, it appears that there was a step change in 2001-02 followed by a shallower trend. This would be consistent with a change in reporting but it is too large to be explained by improvements in technical factors of the networks. Any reduction in losses resulting from technical improvements will tend to be gradual. Each new transformer or reinforced section of network will make just a small difference as there are thousands of transformer and kilometres of cables. New equipment may reduce losses but will not eliminate them. For example, Western Power Distribution has 90,000 transformers and 84,000 kilometres of cables and EDF Networks has 137,000 transformers and 159,000 kilometres of cables[5]. The reported losses reduction from 2000-01 to 2001-02 was 10% with 20 GWh of losses reducing to 18 GWh. If, for example, technical improvements could reduce losses by an arbitrary 30%, a reduction in losses of 10% in one year would require improvements to one-third of the network. The logistics of the engineering work mean that it is infeasible for technical improvements to have caused the observed reduction.

4.3. Technical Losses

This paper gives a description of some of the factors giving rise to technical losses, but not all them. Specialist technical matters such as corona discharges, arcing and the skin effect whereby an alternating current flows in the outside of a conductor also create loss, but are outside the scope of this paper.

4.3.1. "Circuits" i.e. Underground cables and overhead lines

Within the distribution system, electricity is transported through underground cables and overhead lines in which the current flows in the conductor consisting of copper or aluminium. Nearly all overhead lines are steel-cored aluminium or all-aluminium alloy. Very many underground cables have aluminium conductors. At ordinary temperatures and purities, copper is one of the most conductive metals available, second only to silver, but is still has an appreciable resistance to current. Aluminium is less conductive but is lighter. The energy needed to drive the current through the cable causes unavoidable heating. Since this heat in distribution cables cannot be utilised, it is wasted energy.

As copper or aluminium cable heats up, its resistance to the electrical current flow increases, causing more energy to be lost. The increase in resistance between 0 Celsius and 100 Celsius is just over 40%[6]. The increase in temperature can occur as a result of the heating effect of the current flowing through the cable as well as from climatic conditions.

The losses are related to the square of the current so are more significant at times of peak load when most current is flowing[7]. For this reason, the distributors publish higher loss factors for times at which demand is typically higher – e.g. winter afternoons.

Poor power factor will also contribute to higher currents and thus higher losses[8].

Despite the wide use of aluminium, the losses due to resistance are often termed 'copper losses'.

As the losses in the cables are dependent on load, these are normally called Variable Losses and represent about two-thirds of total technical losses.

4.3.2. Meters

Nearly all consumers have their electricity supply metered. These meters consume a small amount of power whether or not there is any consumption to record. Whilst the power used is small, there are many millions of meters and so the energy lost is relevant at about 2% to 3% of

notes

[5] Per the Long Term Development Statements
[6] Per Tables of Physical and Chemical Constants by Kaye and Laby published by Longmans 1966 and also on line at http://www.kayelaby.npl.co.uk/general_physics/2_6/2_6_1.html
[7] See Ohm's Law in the Appendix
[8] See Reactive Power in the Appendix

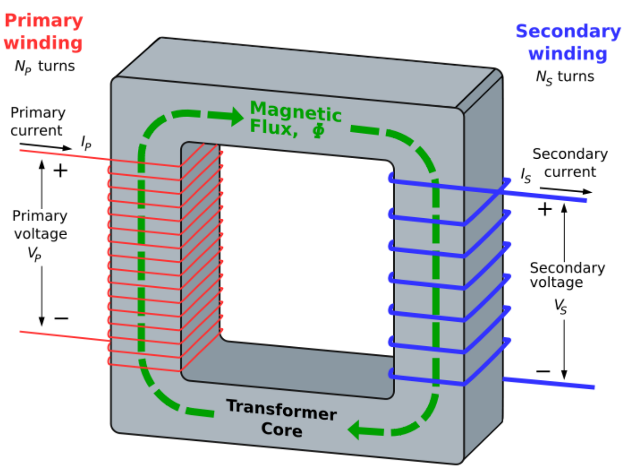
the total technical losses or about 400 MWh per annum[9]. The accuracy with which the meter records the electricity will also affect losses and though the measurement error arises for technical reasons, such losses are classed as non-technical.

4.3.3. Transformers

Electricity is transported over relatively long distances. This is done most economically at higher voltages as it reduces the current flowing and as a result the electrical losses due as mentioned in Section 4.3.1. Within a distribution network, the electricity is carried at between 132,000 volts (e.g. from the Grid Supply Points) and 400/230 volts (for small business and domestic consumers).

For a given amount of power, the current required decreases as the voltage increases. 100 amps carried at 400 volts is equivalent to 0.3 amps (300 milliamps) at 132,000 volts. For reasons already described[10], in a similar sized cable, the losses due to resistance at the higher voltage will be just 1/100,000 (one-hundred-thousandths) of those at the lower voltage.

To change voltage levels a transformer is required. On distribution networks these are large pieces of equipment which are dealing with substantial currents and high voltages. In principle, two coils of wire, one carrying each voltage level, are electrically separate but linked together by a core made of magnetic material such as iron. A stylised diagram is below[11]. Transformers only work with alternating current.



The magnetic field, or flux, produced by one winding causes current to flow in the other winding.

Unfortunately transformers also suffer from losses. Heat is produced by current flowing in the coils of wire (as in the "circuits") and the magnetic field causes unwanted, eddy currents to flow in the iron core. Improved designs and materials can reduce the losses.

As an approximation, the losses in a transformer occur irrespective of the load and are thus called fixed losses[12]. These are about one-third of technical losses.

4.3.4. Losses at various stages in the distribution process

The following table provides a rough guide to the level of both technical and non-technical losses at different points in the distribution network on the basis of units distributed. Losses are dependent on load and vary by time of day and season. They will also vary from DNO to DNO.

notes

[9] An approximation to illustrate magnitude and based on losses of 16.6 TWh, ignoring impact of non-technical losses.

[10] Ohm's Law

[11] Diagram, derived from the entry on transformers in Wikipedia and produced by user BillC - permission to copy, distribute and/or modify this document is under the terms of the GNU Free Documentation License

[12] The heat produced in the wire coils is a variable loss and not part of the fixed losses.

The percentages refer to the amount of electricity lost if the supply is taken at the indicated voltage.

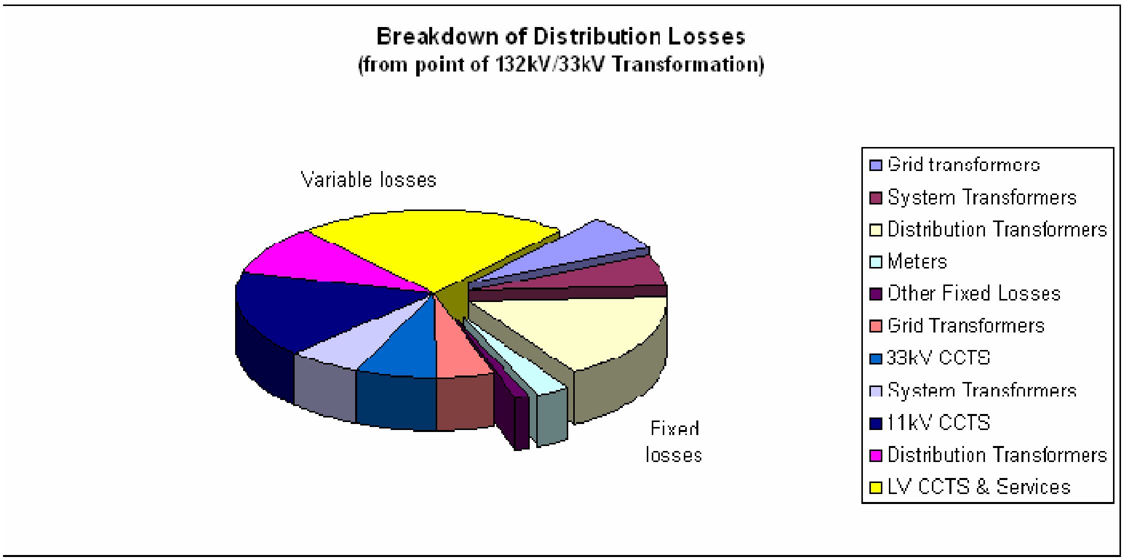
Distribution Losses

Voltage	Indicative Distribution Loss Levels (as a cumulative total at the indicated voltage level)
132kV	0.5%
33kV	1.5%
11kV	3%
400/230V	7%

For example, if the supply is at 230 volts, of 100 kWh put into the GSP, 93 kWh will be delivered to the consumer. However, if the supply is at 11 kV, 100 kWh put into the GSP, 97 kWh will be delivered to the consumer.

Average losses, as indicated earlier, are of the order of 5% of energy put into the GSP and are the combination of the volumes of electricity used at the different voltage levels with the losses associated at each voltage level.

The following graph illustrates the approximate split between different factors giving rise to technical losses. Detailed numbers are not shown as the values are very approximate.



CCTS is an abbreviation for circuits.

The proportions are based on experience and not on any particular network.

4.4. Non-technical Losses

4.4.1. Overview

This section provides a qualitative explanation of the sources of non-technical losses.

Non-technical losses arise due to causes distinct from the physical properties of cables and transformers. Some causes will introduce timing differences such that the losses measured in a period are incorrect. The difference will appear in another time period though, in more complex situations, not necessarily the adjacent one. For example, if a monthly-read meter is read incorrectly such that the consumption in one month is too low, when the meter is read correctly next month, there will be additional kWh recorded. The missing kWh will initially appear to be losses of electricity. Losses will appear high in the first month and low in the second. If the two months are taken together, the losses will be correct.

Other reasons for non-technical losses will cause measured losses to increase or decrease. These have been classed as absolute differences as they are not automatically corrected at a later time.

In reading the section on timing differences, it will be helpful to have a basic understanding of the arrangements for meter reading, profiling of consumption and data aggregation used in Settlements in Great Britain. Please see section 5 for more information.

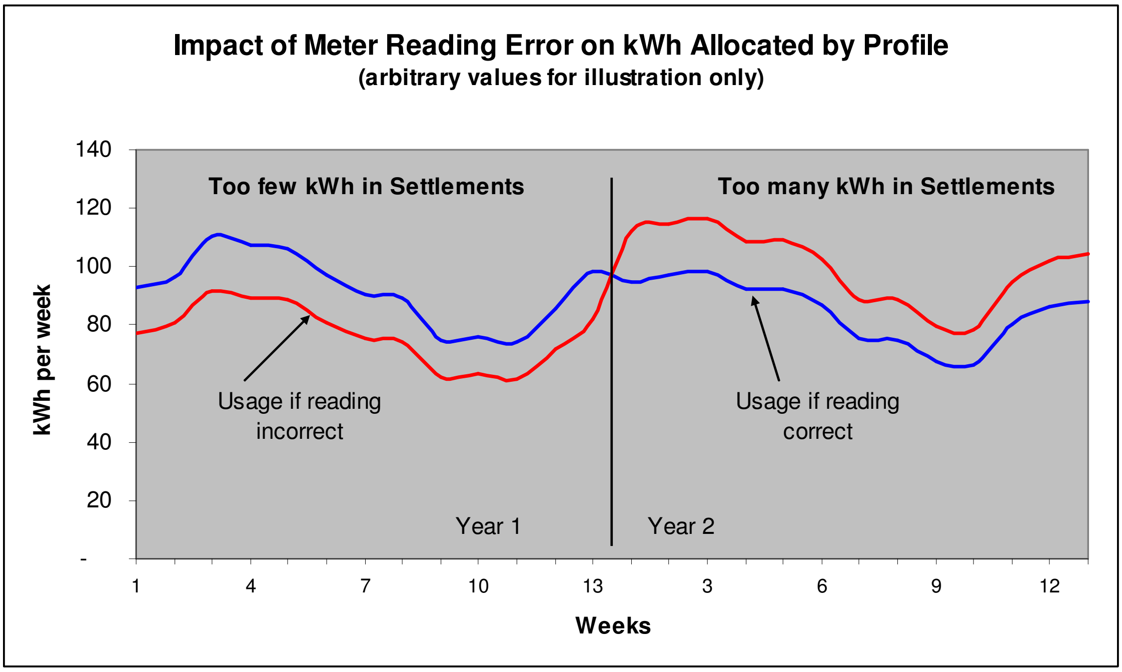
4.4.2. Timing Differences

With the use of profiles to allocate electricity used by smaller customers in each half hour, most timing differences can be said to arise from inaccuracies in profiling. Several factors can drive the profiling inaccuracy.

Meter reading errors

Any error in a meter reading that passes validation will put consumption into the wrong period. The profiling process will spread the kWh relating to the meter advance over the period between meter readings. In the diagram below, a simple meter reading error on 30th March (boundary of year 1 and year 2) has understated the consumption in the last quarter of year 1 leading to an overstatement of consumption in the first quarter of year 2. The profiling within Settlements spreads the consumption over the half hours. The red line is the profiling with the meter reading error; the blue line is the profiling without the error.

For the purposes of calculating losses, there will be too few kWh in the regulatory year including Period 1 and thus losses will be recorded as being greater than they actually were. The situation is reversed in the second period, a different regulatory year. Taking the two periods together, the effect on losses cancels out.



In reality, it is unlikely that the meter reading will be taken that close to the end of a regulatory year and the effect of the error on one regulatory year will be less.

The converse situation (meter reading too high at 30th March) could also occur and whilst there is a slight tendency for consumers to be more likely to query a high consumption rather than a low one, the net impact on reported losses is likely to be small, just adding to the uncertainty in the volume of electricity delivered.

If meters are not read regularly, there is a risk of incorrect consumption never being corrected by the normal Settlements reconciliation processes. With the normal 14 month Settlement timetable, if a meter reading is not taken in time, an estimate will be used. This has been a persistent problem and is illustrated in section 5.4. Approximately 3% of all energy is settled on estimated data though in 2001 the figure was substantially worse, especially in the Eastern GSP Group.

With delayed meter readings there is also a risk that any reading received will fail validation as the usage pattern appears to be inconsistent. Action has to be taken to establish if the reading is incorrect or if the pattern of usage has changed.

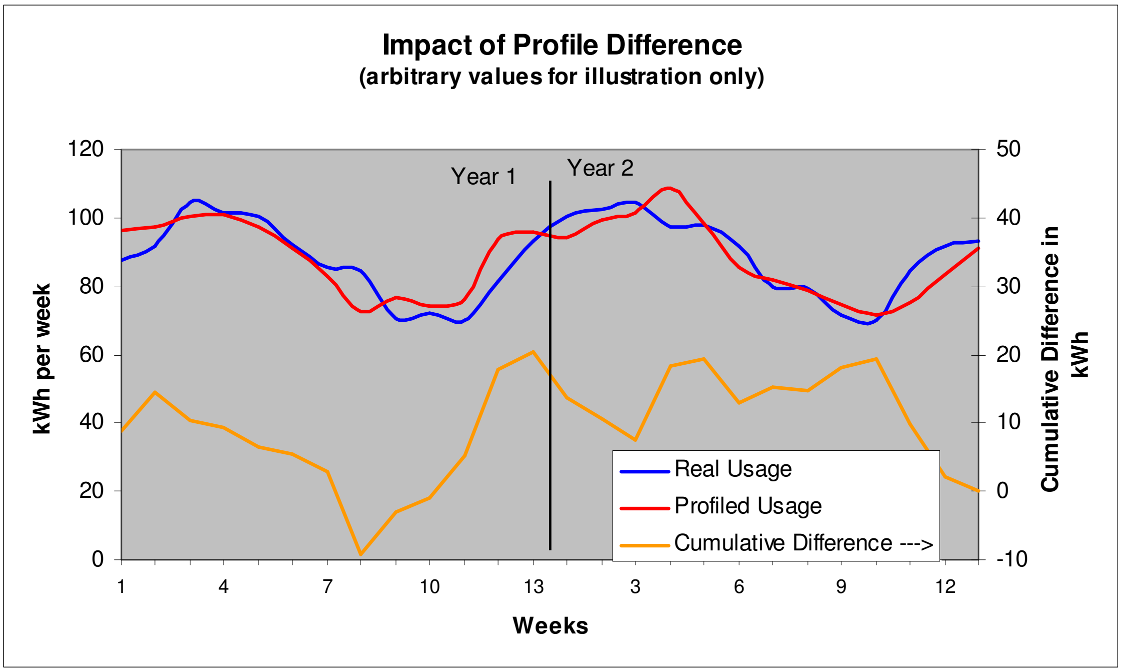
<u>Profiling</u>

Profiling is used to spread into half hourly periods the consumption from the vast majority of domestic and business consumers. There are also profiles for unmetered supplies such as street lighting. Profiling is not required for those customers with half hourly meters

Within the non-half hourly market there are 8 profiles and each applicable meter point is assigned to one. Profile Classes 1& 2 are for domestic consumers, 3 & 4 for quarterly-read small business consumers and 5 to 8 for monthly-read business consumers. The definitions for each can be found in section 5.5.

A profile spreads a consumer's actual or estimated consumption over the period between meter readings in relation to a shape derived from research using a sample of consumers. Various adjustments are made to allow for temperature, sunset times and the day of the week.

The purpose of profiling is to allow the Settlements processes to calculate the volume of electricity taken by the non half hourly metered customers of a supplier in each half hour and match up with that supplier's purchase contract position. It does not and was not intended to provide a precise assessment of the energy taken by each customer in each half hour. Profiles are estimates and as such will always be approximate. The following chart gives an arbitrary example to illustrate the situation of a profile being different from actual consumption over a six month period that crosses a year-end.



As the profiles assign consumption between meter readings, the differences between the profile and the consumer's actual consumption will result in more or fewer kWh being applied to any one period with the difference being placed in other periods. As with the example of errors in meter reading, there will be an impact on losses.

It is evident from the GSP Correction factor (see later in section 5.8) that the profiles are inaccurate at certain times of day, weekends, bank holidays and in early November following the reversion to GMT.

It is not possible to quantify separately the impact of profile errors. The differences appear as variations in the GSP Group Correction Factor.

Inappropriate or incorrect assignment to profile class

If a consumer is assigned to an inappropriate profile class, the resultant shaping of the consumption is likely to be more inaccurate than otherwise. Business customers whose meters are read monthly (Profile Classes 5 to 8) are assigned to a class on the basis of load factor – the ratio of average to peak demand. No account is taken of the nature of the business and whether it is, for example, a shop open seven days per week or a small factory only open on weekdays. As mentioned above, the incorrect profile will result in kWh being allocated to incorrect periods, some of which may be in a different regulatory year. Figures are not available for the impact resulting from this cause but the effect on reported distribution losses is likely to be small as the effect is most significant where meter readings are not taken regularly. It is part of the 'noise' within the GSP Group Correction Factor discussed in section 5.8

Timeswitch errors

Timswitches are used to control meters with more than one register for recording consumption. They may also have contacts that control a consumer's heating load. An Economy 7 installation will have a meter with 2 registers, one for night kWh and the other one for 'day' units. The timeswitch controls the switching times and may well switch on storage heater over the night period.

Timeswitches have proved to be less accurate than meters and the clocks may drift fast or slow. This will cause the day/night periods to shift from the intended times with, for example, some day kWh going into the night period and vice versa.

Whilst the impact of profiling may shift kWh into different periods, the major impact is to shift kWh with a day and thus the impact on measured losses, which look at longer periods, is very limited.

Radio-teleswitches are often used as a replacement for timeswitches and tend to be more accurate.

As with profile assignment errors, this is a relatively minor issue for distribution losses.

Revised information

The Settlements process provides updated information over time. For more detailed information about the type of Settlements run and the timetable see section 5. Updated information about meter readings, consumptions, profile coefficients etc. will be included in the later reconciliation runs. These runs are approximately 3 weeks, 7 weeks, 16 weeks, 7 months and 14 months after the day the energy was consumed (the Settlements day). At present 'Post Final' reconciliation runs are being used to address erroneous large EAC/AAs (see section 6.2) and other Trading Disputes. In the past they have also been used to address a high number of material Half Hourly meter errors. The runs take place approximately 28 months after the relevant settlement day.

Most GSP Groups are in the post final run process. Only Southern, South Eastern and North Scotland groups are currently settling finally at the 14 month point. At the meeting of 18th March 2008, the Trading Disputes Committee, a sub-committee of the BSC Panel, authorised runs for January 2006 and indicated that the South Eastern Group will re-enter the Post Final run process and the Southern GSP Group may re-enter the process. Later months will also be in the post final run process.

Some changes will increase the absolute number of kWh but others will adjust volume over different time periods.

The information about the quantity of electricity distributed will change for anything up to 28 months. Any calculation of losses in a regulatory year will be subject to adjustment for a considerable time. For example, data for losses to 31st March 2006 can make use of the normal Final Reconciliation in June 2007 and the Post Final Reconciliation in August 2008.

Adjustments to data have a significant impact on the reporting of losses. This is discussed in detail in section 5.8.2. In terms of value, the variation of about 0.1% of energy distributed – i.e. 338 GWh out of 338,000 GWh distributed in 2006-07– has a loss incentive impact of approximately £17 million.

4.4.3. Absolute Differences

For the purposes of the paper, the term 'absolute difference' is being used to describe those factors where the total kWh use in the losses calculation is affected and not just the way volume is spread over time.

Theft

Theft can give rise to losses. However, this is only the case if the electricity stolen is not metered in a way that gets into Settlements. Theft affecting losses can happen by:

- connections being made to the distribution rather than consumer's side of the meter; and
- interference with the meter so that it records a reduced number of kWh

It does not affect losses where the electricity been

- stolen from another, metered consumer or
- metered but it is impossible to identify who is responsible for payment.

Wherever the meter has recorded the kWh, there will be no impact on actual losses but the information may be delayed and thus cause a timing difference.

Competition in metering services will have made it more difficult to detect theft as several organisations may operate in the same area and thus one is not responsible for reading meters at every property. Meter Readers may not have had adequate training to aid identifications of cases of tampering. In the past, many cases of tampering were discovered when meters were removed and returned to the Meter Test Stations and refurbished. Inspection of meters may be less detailed if the meter is being disposed of rather than refurbished.

Due to the low instance of cases reported and the paucity of information about theft, it is difficult to quantify the size of the losses. Anecdotally it has been estimated as just under 1% of energy distributed but there is little evidence to back up this figure. (1% of energy equates to approximately £169 million under the losses incentive.) It is unlikely to be evenly distributed over the country.

Distributors have an incentive to work with suppliers to address the problem as a result of the additional allowed revenue that arises from reducing losses. For suppliers, the revenue protection activities have a cost – both in terms of the labour and the cost of the energy attributable to them if theft is discovered. However, some of that energy cost is reduced by the way the GSP Group Correction Factor operates (section 5.8).

Metering Accuracy

Losses are the difference between electricity metered entering the distribution system and that metered as it leaves the distribution system (or calculated as used in street lights etc.). The accuracy and configuration of meters will affect the calculation.

Electricity entering the distribution system at GSPs is measured by a relatively small number of very accurate meters where the accuracy is better than ±0.5%. We are not able to comment about the average error or drift. Check meters are installed, regular inspections scheduled and, as the national transmission losses are scrutinised closely within the Settlements process[13], the risk of error is low.

For electricity leaving the system, there are different classes of metering equipment for half hourly consumers and non-half hourly consumers. Half hourly meters are generally accurate to within 1% and the larger ones also have checking facilities. Codes within the Balancing & Settlement Code specify the type and accuracy of these meters. Non-half hourly meters are within the range of +2.5% and -3.5%[14]. Anecdotally, the traditional Ferraris Disc meters are said to 'slow down' with age as the bearings wear. Whilst this would increase losses, we have not been able to obtain evidence to back this up.

notes

[13] See the BSC Trading Operations Report charts 3.31 to 3.34 produced by Elexon

[14] The Measuring Instruments (Active Electrical Energy Meters) Regulations 2006 or the Electricity Act 1898 as amended for meters already fitted.

To establish the potential materiality a few assumptions are necessary. If a sample meter's accuracy changed from say 1% fast to 1% slow over the 20 year life, the change in any one year would be 0.1%. Thus if the consumer used 10,000 kWh per annum constantly, in the first year of installation the sample meter would record 10,100 kWh and in the 20th year it would record 9,900 kWh. The change from one year to another would be 10 kWh or 0.1% of the units recorded. If the problem relates to just the NHH market (about 50% of all kWh) and say just 25% of meters are so affected, losses would increase year by year by 0.0125% of the units distributed as the meters aged. Of the 338,000 GWh distributed in 2006-07, the additional losses would be 42 GWh, worth approximately £2 million per annum under the loss incentive.

With the move to electronic meters, the aging effect may be different. Also, the move towards the installation of smart metering may accelerate the replacement of Ferraris Disc meters and could reduce apparent distribution losses.

Given the materiality, it may be worthwhile reviewing engineering and metering literature as well as contacting manufacturers to see if any data on accuracy drift has been compiled.

Metering and Recording Errors

In the context of this paper, metering and recording errors are situations where the meter either fails to record the correct consumption or it is interpreted incorrectly. This is distinct from the timing difference arising from an incorrect meter reading that is later replaced by a correct one.

Examples of situations where this can arise are:

- A meter recording consumption on six dials is incorrectly identified as having only five dials and the most significant digits are used. For example, a reading of 123456 is incorrectly entered as 12345.6 and thus only 10% of the consumption is recorded. The converse situation can arise (10 times the consumption recorded) but this is much less common.
- On a 3-Phase supply[15], a fuse connecting the meter to one of the phases blows. The meter will still record consumption but only at half the correct rate.
- A large supply may have a device known as a current transformer connected to the meter. This allows a standard meter to record much larger consumptions. However, the advance (i.e. difference between two readings) on the meter has to be multiplied by the appropriate factor. Other than unity, 10 is the most common multiplier but others exist. If the multiplier is recorded incorrectly the consumption used for billing or Settlements will be out by the relevant factor.
- The meter stops recording due to a fault.
- Excessive consumption is put through the meter and there is a long time between meter readings so that the meter 'goes round the clock' as there are too few dials to record the correct advance On a five dial meter, an advance of 110,000 kWh gives the same reading as an advance of 10,000 kWh.

In most cases the problem will be spotted by the supplier or consumer as a result of the normal bill checking process and the corrective action prevents any impact on losses. In some cases, this may not happen – e.g.

- The problem occurred on a new installation and there is no consumption history or expectation of the normal size of bill.
- Changes to the installation (such as fitting a larger supply capacity and current transformer) did not get recorded properly and whilst a different volume of electricity is being recorded and billed, it is incorrect.
- Additional usage happens at the same time as a fuse blowing in the meter supply circuit thus masking the drop that would otherwise have occurred.

notes

[15] 3-phase supplies are used for larger consumers.

Many billing systems, and the meter reading validation used for Settlements, have crude validation routines – typically passing the reading as acceptable if the consumption is within 50% and 200% of the expected value.

Human nature is such that there is an asymmetry to the way consumers report problems. There is more likely to be a reaction to a bill that is too high than one that is too low. In the business arena, it is common for the duties of checking and paying the bill to be separated from those responsible for the operations of the factory or similar establishment. The accounts department may not know that the electrical installation has been reinforced and that the factory is using more energy.

In addition, the information used to bill customers may be different from that going into the Settlements process and thus into the losses calculation.

From the Balancing and Settlement Code Audit, there is evidence that metering and recording errors have been having a material effect on the volume of electricity reported as being distributed. See section 6.2 for more detail.

Of course, if the problem is identified and rectified in a reasonable time-frame, the data can be corrected. However, it appears that many cases are long-standing. Using the information on the percentage of energy settled on actual data (section 5.4) about 5% of non-half hourly meters have not had a reading within 14 months.

A real case illustrates the problem. A small supplier took over a Profile Class 6 business consumer's supply, the previous supplier being one of the 'big 6'. The supply was not in the large supplier's traditional territory. The consumer's billed demand was 300 MWh per annum but when the new supplier received information about the estimated annual consumption (EAC), as used in Settlements and for calculating the distributor's losses, it was for 3,000 MWh per annum. On investigation it was discovered that the correct value was 300 MWh per annum and that an erroneous multiplier of 10 was being applied. The high EAC and Annualised Advance (AA) had been queried as part of the BSC Audit process and been certified as correct by the large supplier despite the bill being based on the lower figure. The error had been in Settlements for six years. This one case reduced apparent losses by 2,700 MWh, worth £135,000, per annum.

Our experience is that there will be many similar cases which are below the BSC Audit threshold and as such do not receive particular scrutiny. The threshold levels are given in the Appendix at 9.5. Based on our experience, there could be as many as 10 times as many cases under the threshold as above and with an average value of one-quarter of the threshold.

Unmetered Supplies

By their very nature, the electricity used by unmetered supplies is approximate. Errors include an incorrect inventory and an incorrect assignment of the amount of electricity used by each item connected. Within the distribution network, electricity used to power cooling fans and similar equipment within substations will either be treated as treated as an unmetered supply or be part of system losses.

Keeping track of each street light, bus shelter or traffic bollard is a major undertaking and records drift. Similarly, clocks running slow or even dirt on a daylight sensor can alter the time each light is switched on.

Distributors can call for an audit on unmetered supplies but must bear the cost of that audit if no material error is discovered.

Recently the BSC Audit has found problems in this area. The BSC Auditor's Report for March 2007 states that "The introduction of an annual reconciliation of UMSO[16] inventory to that held in Settlement has had some impact on resolving the underlying issues". However, the scope of the Auditor's work was comparing the records in Settlements with those of the UMSO. Comparison of the records to the physical equipment was not undertaken and is noted as a potential source of error.

notes

[16] Unmetered Supplies Operator

As shown in section 6.2, there is a wide variation over suppliers and whilst the errors almost cancel out in the national picture with a net total of losses understated by 11 GWh (equal to £0.6 million under the loss incentive), the range for individual distribution areas is from 18 GWh overstated (value £1 million) for North West down to losses overstated by 36 GWh (value £2 million) for London.

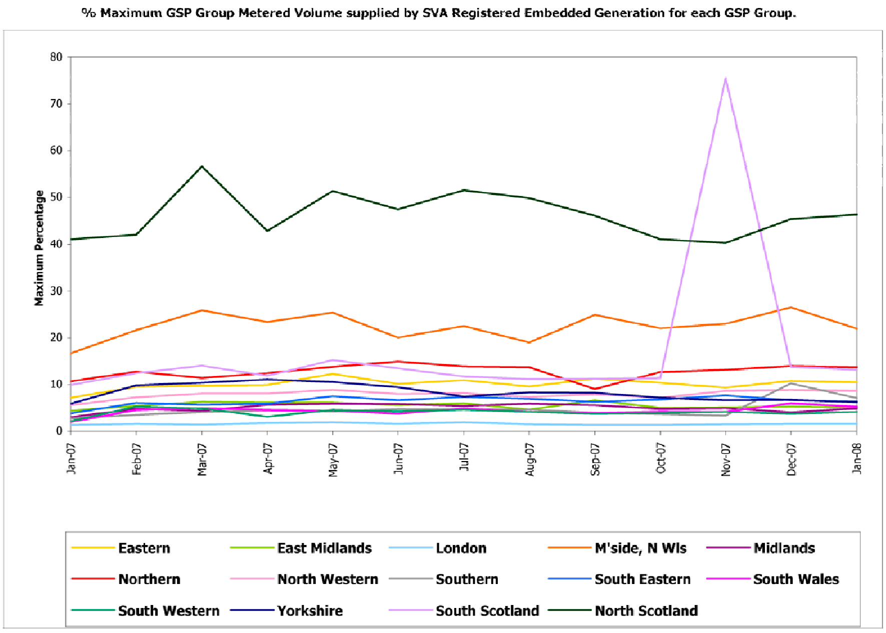
Embedded Generation

As mentioned previously, generation is embedded if it is connected to the distribution system as opposed to the national transmission system. For the purposes of the losses calculation, electricity produced by an embedded generator is treated as an amount of electricity entering the system. Whilst the majority of electricity enters the distribution system through the GSP with losses occurring in distribution cables and transformers in getting that power to consumers, embedded generators are closer to consumers and losses may have been avoided.

For Settlements purposes, an embedded generator is credited with the electricity as if it had been produced at the GSP (and then up to the Notional Balancing Point) by applying a loss factor to the amount produced. This loss factor will normally increase the number of kWh. Thus if it would normally take 102 kWh to provide 100 kWh at the place where the generator is connected, the generator's output will be increased by 2%.

In some situations, the presence of a generator can increase losses as the amount of electricity produced exceeds that which can be used locally and the excess has to be transported.

Currently, embedded generation is relatively small in most GSP Groups (distribution areas). However, with various renewables projects, it is growing. The BSC Trading Operations Report monitors the peak (not average) percentage of GSP energy attributable to embedded generation as the BSC rules assume that a GSP Group is a net importer of electricity, not a net exporter. The peak values from a recent month's report are shown below.



The spike in November 2007 for the South of Scotland (GSP Group N) is attributed to incorrect processing of Half Hourly export Metering System data. ELEXON Circular EL01545 refers.

Chart reproduced by kind permission of and is the copyright of Elexon.[17]

Any error in the amount recorded as being generated will affect the distributor's losses. Overstatement of volume at the GSP will cause an overstatement of losses.

Distributors are able to use different loss factors from those used in Settlements and any error in the factor will have an absolute impact on the losses calculation. Given the small amount of

notes

[17] Elexon's full IPR, Copyright and Disclaimer statement is in the References section at the end of this paper.

embedded generation and the scrutiny applied to loss factors, the impact of this issue is low though it will need to be kept in mind as more embedded generation is installed.

The BSC Audit has identified some errors with embedded generation. Its remit does include the loss factors which DNOs use for reporting embedded generation in the losses calculation.

New Connections, Idle Services and Incorrect Energisation Status

Situations can occur where electricity can be used and metered but because the appropriate information about the site has not been recorded, the consumption is not included in the data used for calculating losses. It is also possible to have consumption included in the losses data even though the supply point is inactive.

Any new connection to the network provides a possibility of the supply not being added to the MPAS database at the appropriate time. Obviously it is in the distributor's interests to be vigilant and avoid the loss of potential revenue. However, with competition in new connections, the difficulties have increased as there are other "hand-offs" of data within the processes.

There are other possibilities for error after the site has been registered on MPAS. If the new consumer's supplier omits to send a particular data flow to the distributor, it is possible for the meter to be read and the annual consumption estimates prepared but the profiled consumption may not be aggregated into the Settlements data.

When a supply is not in use it may be flagged as a service with a status of energised but inactive – an "idle service". Consumption will not normally be put into the Settlements process. A consumer may move into the premises and start using the supply. That may not be known to the supplier until an advance on the meter is found. This will be dependent on the meter reader getting access to the premises and may be a considerable time after the new consumer moved in.

It is also possible to have a supply that is really inactive but incorrectly flagged as active in Settlements. Consumption will continue to be assigned to the supply and correction will only be possible if a meter reading is taken. Access to read the meter may be a particular problem.

All these situations will be corrected in Settlements if the appropriate data is obtained in time. There are, however, many long-standing cases where there is an impact on Settlements and reported losses.

This is an area of risk identified in the BSC Audit as discussed later in section 6.2.

4.5. Significance of losses

Any reduction in energy wasted will have positive economic and environmental benefits. Work done in June 2003 prior to the last Distribution Price Control Review estimated the marginal cost of losses including generation fuel and capacity, impact on transmission, the EU Emission Trading Scheme and pollution control[18]. Since then, fuel prices have increased substantially and environmental concerns have strengthened.

The incentive given to distributors to reduce losses applies to both technical and non-technical losses and is approximately 5p per kWh. With some types of non-technical losses the true incentive is higher as, by discovering and correcting the problem, the distributor is able to increase its allowed revenues by (a) the losses incentive and (b) the distributed volume incentive within the price control formula.

4.6. Calculation of Losses

For the purposes of the regulatory returns and thus calculation of allowed revenues, distributors compile information about electricity entering the distribution system and that leaving it. The losses are the difference between the figures though it is common to express losses as a percentage. E.g. (using arbitrary units)

Total energy entering system = 100

notes

[18] Electricity Distribution Losses - Initial proposals - June 2003

Total energy leaving system = 94
Losses = 100 – 94 = 6 equivalent to 6%.
This may sometimes be expressed as a Sales/Purchase Ratio of 94%.

Distributors obtain information about the electricity entering and leaving the system by reference to industry-standard data flows rather than their own sources (e.g. by taking meter readings).

Information from GSP and interconnector metering is collected, processed and disseminated by the Central Data Collection Agent (CDCA)[19] whilst that for electricity used by consumers is in the data flows from the Supplier Volume Allocation Agent (SVAA)[20] covering the non-half hourly and half hourly markets. SVAA data is also used for billing suppliers for DUoS[21]. The Settlements process provides for updated information being produced according to a regular timetable with the normal final version being produced 14 months after the electricity flowed. There are also post-final reports for some GSP Groups at 28 months after the electricity flowed. The CDCA data does not normally change.

At the time the regulatory reports are prepared, normally as soon after the end of March as practicable, final data will not be to hand. As an example, at the end of April 2007, the following versions of SVAA data would have been available:

Date From	**Date To**	**Days**	**Run Type**
01/04/2006	20/09/2006	173	R3
21/09/2006	01/01/2007	103	R2
02/01/2007	05/03/2007	63	R1
06/03/2007	31/03/2007	26	SF
	Total	365	

Changes to the volume distributed will occur and each distributor will have a policy for dealing with the variations. Some report the volumes using the latest information available at the time and include prior period adjustments with the current data. Others may estimate the impact of expected variations and accrue volume to each reporting period accordingly. (This was the methodology used by the nationalised Area Electricity Boards and the Regional Electricity Companies until the full competitive market opening in 1998. It made use of 'unbilled' consumption – energy consumed but not recorded at the time of the period end. An amount added to the volume at the end of one period is subtracted from the volume in the next period.)

With Post-Final Settlement Runs[22], the data for the year 2005/06 will not be finalised until 28 months after the year-end – August 2008.

Generally it is a good accounting practice to make the best estimate of the volume and revenues relating to a particular period. Some will argue, though, that forecasting the adjustments is impractical and it is best to account for the volume as the information becomes available. This latter method leads to volatility whilst the former involves manipulation and any changes to the methodology could distort results.

notes

[19] I029 and I030
[20] D0030 and D0036
[21] Distribution Use of System Charges
[22] Post-Final Settlement Run known as type DF

5. Settlements Processes

This section gives a high-level view of the electricity Settlements process covered by the Balancing & Settlement Code (BSC) in so far as it is relevant to the understanding of its use in the distribution losses calculation. It describes the process for Settlements with more emphasis on those for the NHH customers as they involve considerable estimations and are more likely to give errors. The steps are registering consumers, data collection, data aggregation and data distribution. The other processes leading to financial settlement are not covered.

5.1. Introduction and history

The current Settlements processes came into being with the opening up of the non-half hourly (NHH) metered, under 100kW, market in 1998/99. Prior to that, consumers with supplies of over 100 kW had been able to select their electricity supplier whilst others were supplied by the franchise holder, the Public Electricity Supplier (PES). The over 100 kW consumers had to be fitted with half hourly recording meters.

Settlements of the volume used by the over 100 kW half hourly (HH) metered consumers was aggregated by each supplier and each GSP Group using the actual consumptions recorded by the half hourly meters. The data was collected electronically (via dial-up facilities in the main) and the competitive supply volumes were deducted from total volume at the GSP Group to leave the residual amount as the responsibility of the franchisee PES for its NHH consumers.

The amount of electricity attributable to each supplier was worked out for each half hour.

A GSP Group related to the Grid Supply Points registered to the PES. When the supply and distribution activities were separated The GSP Group was still identified with the relevant distribution business.

Scotland and England & Wales had separate settlements systems.

Competition in the under 100 kW supply market required a cost-effective way of assigning volumes used by the smaller customers but maintaining the half hour settlement period without the need to fit new meters. The methods of settling the HH volumes were substantially unchanged.

Changes to the way suppliers contracted with generators as a result of the NETA[23] programme had no material impact on the allocation of volumes to suppliers. BETTA[24] unified the wholesale trading arrangements in Great Britain and introduced a single transmission system independent of generation.

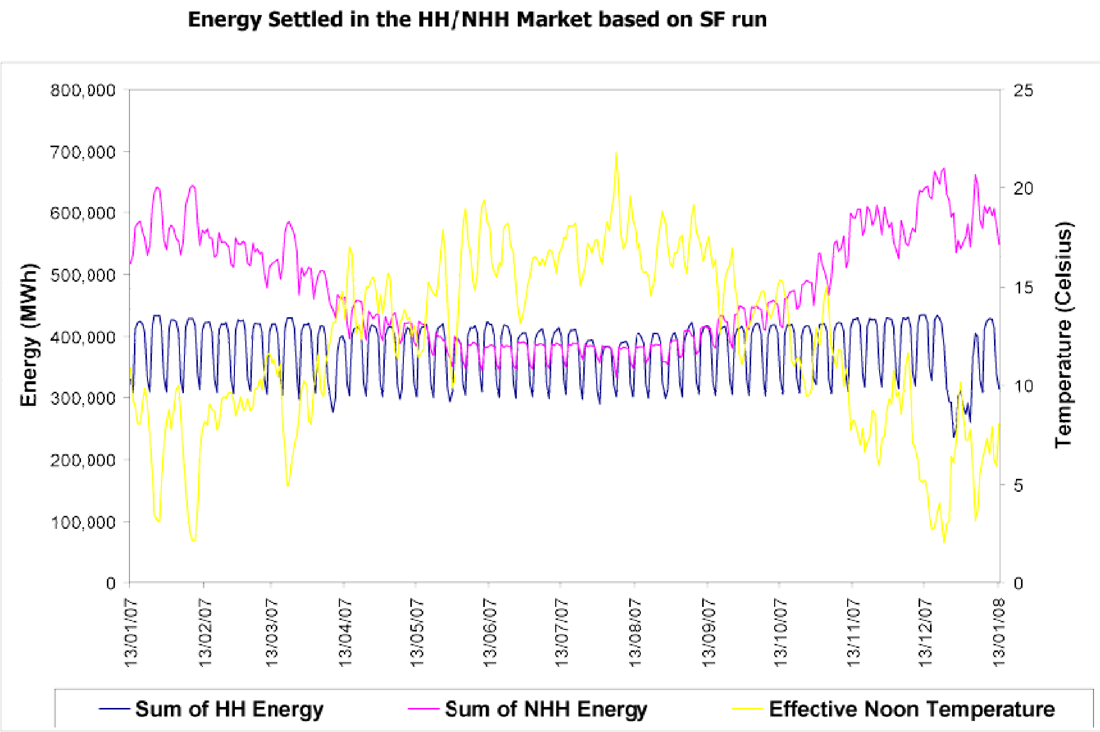
5.2. Relative Size of HH & NHH Markets

The HH and NHH markets have very different characteristics both in the average usage per consumer and the pattern of the demand. The following chart illustrates the demands.

notes

[23] New Electricity Trading Arrangements (2001)

[24] British Electricity Trading and Transmission Arrangements (2005)



Chart, reproduced from the Trading Operations Report, copyright of Elexon.

Whereas the HH market is relatively consistent throughout the year, the NHH market exhibits a profile of lower summer demand. Both have a weekly pattern.

There are approximately 29.1 million NHH supplies and 110,000 HH supply points.

5.3. Registration

Consumer supply points, often called MPANs, are registered in the relevant Meter Point Administration System (MPAS) one of which is run by each distributor covering the licensed area. Every supply point must be assigned to a supplier. The register must keep track of new connections, changes of supplier and removal of supplies. It also has details of the type of consumer. The integrity of this database is critical to both the Settlements process and the distributor's revenues.

5.4. Data Collection

Data collection is the process whereby information about energy consumption is captured and compiled. Data collection is a competitive activity and data collectors are appointed and paid by suppliers.

5.4.1. Non-half hourly Consumers

Predominantly, meter readings are taken from the meters installed in consumers' premises at various times. Larger business consumers are read monthly and the smaller business and domestic consumers are read quarterly or less frequently. Obtaining entry to read meters is an on-going problem. Many consumers provide their own readings, either to the data collection agent or via the supplier. A validated customer reading is acceptable within the Settlements processes and there is no requirement to periodic data collector visits. (Safety and revenue protection inspections are a separate issue.) Smart metering and automatic reading may help address this access problem.

Data Collectors take meter readings, validate them against the meter details and previous readings and pass the details on to the supplier and the distributor by means of a standard industry data flow (D10). They also use the readings to calculate the Annualised Advance (AA) for the period covered by the current and previous reading and the Estimated Annual Consumption (EAC) for future periods.

The AA is worked out by looking at the number of days between the latest and previous valid meter readings and the fraction of a year's electricity used in that period for that type of consumer, making use of the profile coefficients (see later). For example, if the advance on the meter was 1,000 kWh in a summer period of about six months and, for a similar type of consumer, the fraction of the yearly consumption in that period is 45%, the AA would be

$$2{,}222 = (1{,}000/0.45)\ \text{kWh}$$

The EAC is based on a similar calculation but also takes into account the previous EAC to help smooth out fluctuations. The current smoothing parameter places greater weight on the most recent advance. With the example above (reading covered 45% of year's consumption), the new EAC would be based on 90% of the new AA and 10% of the previous EAC.

Some difficulties can arise where the stated period between meter readings is quite short. This makes the fraction of the yearly consumption small and is thus has a big impact on the recorded advance. Suppliers have sometimes put through corrective meter readings as though taken on successive days leading to very high AAs and EACs.

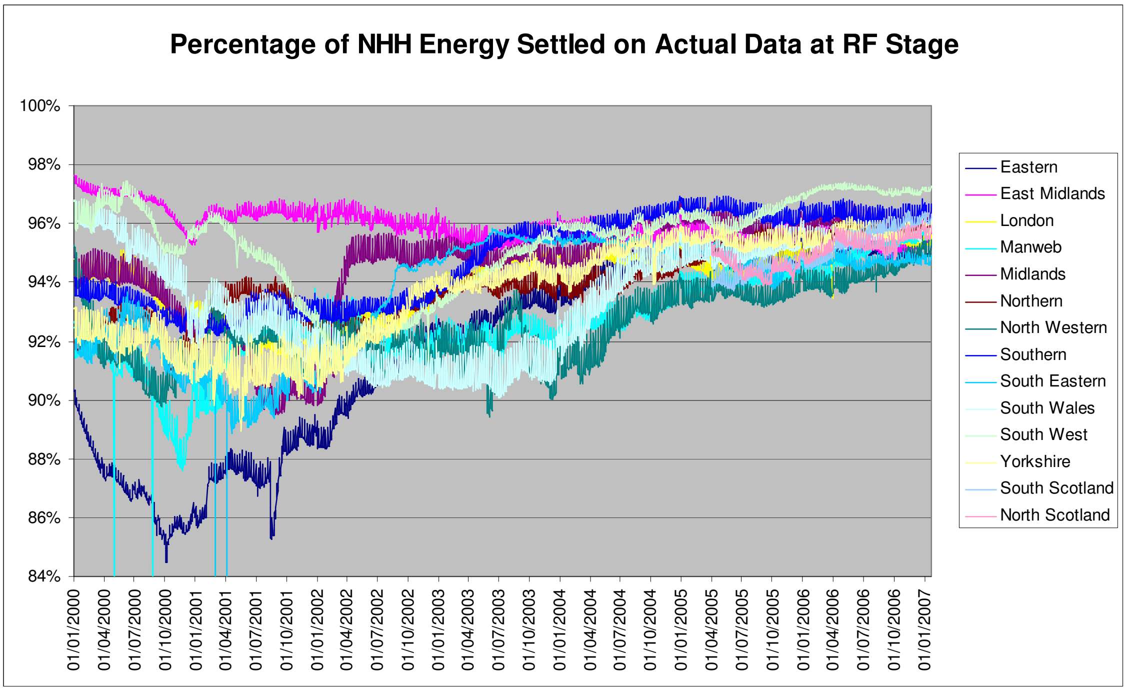
AAs and EACs are sent to the supplier and the data aggregator on an industry data flow (D19). This flow does not go to the distributor at present though a proposal to do so is being considered in BSC modification P222.

Many suppliers use the D10 flow to bill customers and do not necessarily reconcile the D19 annual figures against their billing systems.

It is possible for a meter reading to fail validation by the data collector. In those cases it is not used for Settlements. In the absence of any readings, a default EAC is used.

Any reading of reactive power registers is not used for Settlements but some suppliers and distributors may make charges for the amount used, especially of there is a bad power factor (see Appendix).

There are on-going problems with getting timely data as illustrated in the chart below.



Whilst there has been a distinct improvement since 2000-01, over 4% of the non-half hourly energy is being estimated 14 months after the date of consumption. Only one GSP Group is meeting the BSC standard of 97% actual data. Also, approximately ½% of energy comes from default EACs rather than ones calculated from previous consumption.

5.4.2. Half hourly Consumers

Data is collected electronically, either by some means of telecommunications or by periodic visits to site. The detailed half hourly consumptions are sent through to the data aggregator, suppliers and distributors.

There is also a process for reconciling the half hourly data with the advance on the meter. Any reactive power readings are not used in Settlements.

Some data is estimated due to technical difficulties though most areas achieve 99% of actual data.

Percentage of HH Energy Settled on Actuals by GSP Group based on RF Run

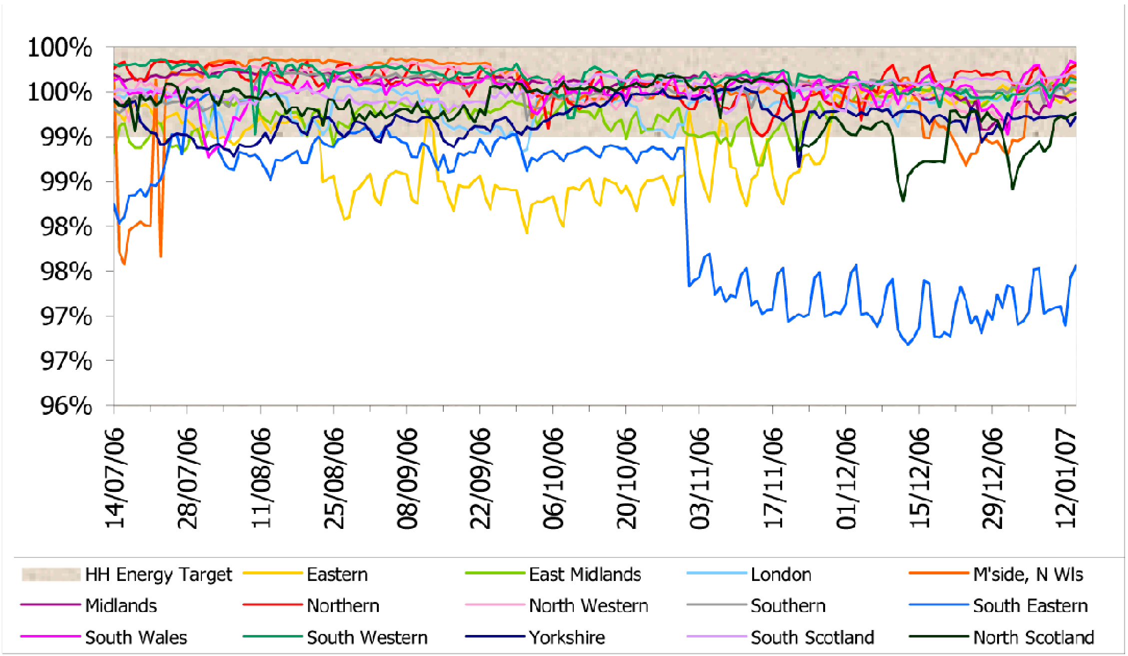


Chart © Elexon.

5.4.3. Unmetered Supplies

Unmetered Supplies (UMS) exist in both the half hourly and non-half hourly markets. The Unmetered Supplies Operator (UMSO), usually the DNO or an affiliate, provides the UMS service on behalf of a distributor. As the Settlements process works on the basis of meters, the implementation for unmetered supplies replicates that feature with “Equivalent Meters”.

Equivalent Meters are of two types:

- Passive Meters – which allocate the Unmetered consumption across the half hourly periods based on a relationship between to the annual hours switched on and the daily time of sunrise and sunset; and
- Dynamic Meters – which allocate the unmetered consumption across the half hourly periods by looking at the operation of a number of photoelectric cells or using actual switching times reported by a Central Management System (CMS).

In each case a profile of consumption is available to be used within the Settlements process.

5.5. Profiles for allocation of NHH kWh

As mentioned profiling is key to being able to apportion a non-half hourly metered consumer's usage to a half hour so that the half hourly balancing process can operate.

At the highest level, each NHH consumer is assigned to a Profile Class:

- Profile Class 1 Domestic Unrestricted Consumers
- Profile Class 2 Domestic Economy 7 Consumers
- Profile Class 3 Non-Domestic Unrestricted Consumers
- Profile Class 4 Non-Domestic Economy 7 Consumers
- Profile Class 5 Non-Domestic Maximum Demand (MD) Consumers with a Peak Load Factor of less than 20%
- Profile Class 6 Non-Domestic Maximum Demand Consumers with a Peak Load Factor between 20% and 30%
- Profile Class 7 Non-Domestic Maximum Demand Consumers with a Peak Load Factor between 30% and 40%
- Profile Class 8 Non-Domestic Maximum Demand Consumers with a Peak Load Factor over 40%

The Peak Load Factor (LF) is the ratio of the average usage to the peak use. The higher the LF, the more even the usage.

There are other sub-divisions and a consumer with multi-rate metering has a number of profiles, one for each period of the day metered.

The production of profiles is a complicated area though in essence it means working out for each type of consumer, what fraction of a year's electricity is used in each and every half hour. Load research is used to derive the profiles and the impact of temperature and daylight hours is also calculated to produce regression coefficients for those factors.

A detailed description of the methodology can be found at in an Elexon factsheet

http://www.elexon.co.uk/documents/Participating_in_the_Market/Market_Guidance_-_Industry_Helpdesk_faqs/Load_Profiles.pdf

Once the temperature for a day is known, the profile coefficients for each consumer class can be calculated. Summing the coefficients over the period of a meter advance allows the AA to be broken down to a value for each half hour.

If, at the time of the Settlements run for a given day, an AA is not available because there has not been a valid meter reading, the EAC will be used.

5.6. Data Aggregation

Given the 29.1 million NHH consumers, it is not practical to calculate the half hourly consumption for each consumer. To reduce the volume of data, the Data Aggregators, who are in competition and appointed and paid by suppliers, group consumers of the same type and calculate the sum of the half hourly volume for that class. They make use of the AAs, EACs and profile coefficients to assign the volume to a supplier by GSP Group by class of consumer. Aggregating consumptions in this manner is often called the 'supercustomer' consumption.

Each working day there are several data aggregation runs as required by the Settlements calendar. For example, on Thursday 27/04/2006, the data aggregators prepared extracts for:

Settlements Date	**Run Type**
Thu 10/03/2005	RF
Tue 27/09/2005	R3
Fri 06/01/2006	R2
Sat 07/01/2006	R2
Sun 08/01/2006	R2
Fri 10/03/2006	R1
Sat 11/03/2006	R1
Sun 12/03/2006	R1
Thu 06/04/2006	SF

The earlier the date, the more likely there is to be actual consumption data rather than estimates.

The aggregators produce two versions of the aggregated data. One is in terms of the volume at the consumer's meter and the other applies the published distribution loss factors applicable for that consumer class to bring the consumption up to that needed to be supplied at the GSP. Factors are also applied to the half hourly consumption data.

5.7. Published loss factors

Distributors publish loss factors which provide an estimate of the losses between the GSP and the consumer. Different factors are produced for different voltage levels and classes of consumer to allow for different losses at peak times. A number of methodologies are used to generate the factors. The factors are used in Settlements to increase the volume as measures at the consumer's meter to a notional figure for the amount required to be purchased at the GSP.

Factors are produced for half hourly customers as well.

It is believed the methodologies often apply technical losses to the factors for half hourly consumers and both technical and non-technical losses to the NHH market.

The loss factors have no impact on the distributor's regulatory loss calculation but can influence the way volume is shared by different suppliers.

Some distributors have adjusted loss factors on a regular basis whilst others have left the values substantially unchanged. Any changes submitted to Settlements are subject to review though the existing tolerances are broad. BSC Modification P216 seeks to increase the degree of control the BSC parties have over changes to loss factors.

5.8. Grid Supply Point Group Correction Factor

When the HH consumption and the profiled NHH consumption, each adjusted by the appropriate loss factors, are compared with the volume measured at GSP, there is a difference attributable to errors and estimation.

Within Settlements there is a presumption that the difference is all attributed to the NHH market and that volume is adjusted accordingly and spread over the suppliers in the GSP Group. A very simplified example may help explain the method. Taking 3 suppliers in a GSP Group, each with different HH and NHH volumes:

	Volume at Customer Meter		
	HH	**NHH**	**Total**
Supplier A	200.0	200.0	400.0
Supplier B	300.0		300.0
Supplier C	-	300.0	300.0
Total	500.0	500.0	1,000.0
Loss Factors	1.05	1.08	
	Volume aggregated to GSP		
	HH	**NHH**	**Total**
Supplier A	210.00	216.00	426.0
Supplier B	315.00	-	315.0
Supplier C	-	324.00	324.0
	525.0	540.0	1,065.0
GSP Volume			1,050.0
Assigned	525.0	525.0	1,050.0
Correction Factor	1.000	0.972	
	Adjusted Volumes at GSP		
	HH	**NHH**	**Total**
Supplier A	210.0	210.0	420.0
Supplier B	315.0	-	315.0
Supplier D	-	315.0	315.0
Total	525.0	525.0	1,050.0

The volume the suppliers A and C have in the NHH market is scaled down to fit the volume at the GSP once the HH volume has been deducted. Any errors in the HH market and in the HH loss factors are absorbed in the NHH market.

A different factor applies for each half hour and each Settlements run for any GSP Group. Many reasons contribute to the variations in the GSP Group Correction Factor including:

HH Supplies

- Estimates and errors in volume
- Estimation errors in loss factors
- Inapplicable loss factor applied to a supply

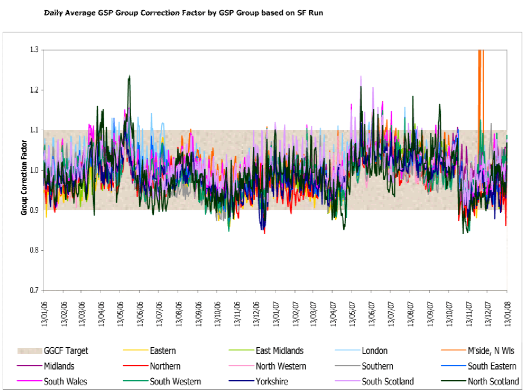
NHH Supplies

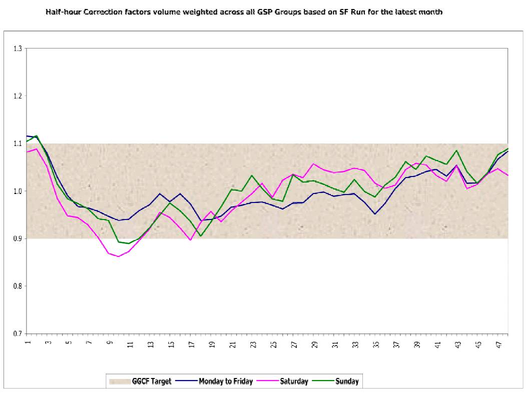
- Estimates and errors in volume including missing supplies, incorrect AAs & EACs
- Estimation errors in loss factors
- Inapplicable loss factor applied to a supply
- Incorrect profile class assignment
- Estimation errors in profiling

Whilst it is generally believed that the average GSP Group Correction Factor (CF), when weighted by the volume for each half hour, should approach unity, this is not necessarily the case. It is dependent on the distribution loss factors and if they are skewed from real losses, the CF will not average unity.

5.8.1. GSP Group Correction Factor Statistics

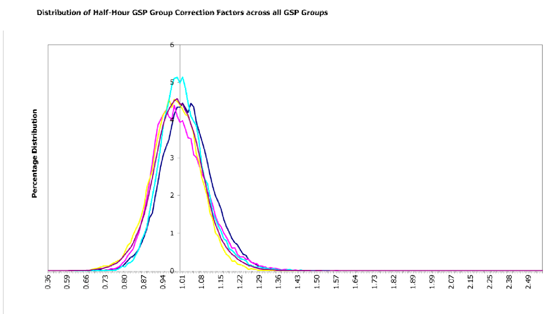
There are so many reasons for the CF to vary it can only be a general guide to the 'health' of the Settlements system. The following charts demonstrate the variability.





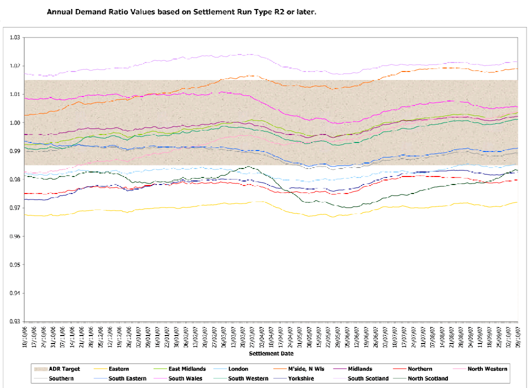
Charts, reproduced from the Trading Operations Report, copyright of Elexon.

The left-hand chart shows the average daily CFs by GSP Group. The movements are erratic though some patterns are apparent due to profiling inaccuracies. The right-hand graph illustrates the CFs within a day. Again, the pattern indicates the way profiles do not predict the consumption precisely.



A distribution curve, also reproduced from the Trading Operations Report is shown (© Elexon). It indicates the level of dispersion of the correction factors. The mode is approximately 1.0. These are not weighted by the volume in the half hour.

The CFs at a half hourly level do not provide a good measure of the uncertainty in the volume for an extended period.



A more valid guide is the Annual Demand Ratio in the chart (© Elexon). This is the half hourly CFs for a year weighted by volume so that a figure represents a long-term average unaffected by seasonal trends.

Different GSP Groups have very different factors though some patters are still apparent. (Note that a CF of less than one indicates more electricity measured at the customer meter, when adjusted for published losses, than is allocated to the NHH market at the GSP.) The general drift downwards in late Spring 2007 is explained by Elexon as being due to the profiling algorithms understating consumption in Spring 2006 but overstating it in 2007.

5.8.2. Variation in losses due to GSP Group Correction Factor Movements

It is also useful to examine how the CF moves over time as better data becomes available. Generally, the electricity measured at the GSPs and from HH consumers' meters does not vary too much. Most of the change arises in the NHH market with actual meter readings replacing estimates as well as the other error corrections discussed earlier.

We have examined the movement from one Settlements run to another for a sample of dates. From this it is possible to estimate the likely size of the movement in reported losses. Unfortunately we were not able to obtain all the historic data needed to provide a full analysis (i.e. 6 sets of half hourly data for every GSP Group over a period 2½ to 3½ years' ago) and thus some approximation has been applied. Also, since the CF can alter from one year to another (see the Annual Demand Ratio chart above), a full year's figures will not necessarily provide a better guide to the movement in other years. However, the sample data does provide an indication of the size of the movement.

The average percentage movements from one Settlements run to another is shown in the table below where the figures relate to the shift in the correction factor applied to the NHH market. A positive movement indicates that the subsequent settlement run has a larger correction factor than the prior run. A negative number indicates that the correction factor reduces.

Percentage Change in GSP Group Correction Factor					
To / From	R1	R2	R3	RF	Post Final
SF	-0.52%	-1.20%	-1.14%	-1.37%	-1.11%
R1		-0.68%	-0.76%	-0.85%	-0.60%
R2			-0.08%	-0.17%	0.09%
R3				-0.09%	0.17%
RF					0.26%

A drop in the correction factor (negative number) indicates that the number of kWh at measured at the consumers' meters has increased.

The impact on reporting of losses is affected by three factors.

i. The time the losses are calculated and the Settlements runs available at the time;
ii. Some change in the CF may have arisen from adjustments to half hourly meters;
iii. The NHH volume is only part of the volume distributed.

In general, the correction factor falls as the runs move towards RF. This indicates additional volume being added. However, for the post final runs, volume is being removed. This is mainly due to the removal of erroneous high AAs and EACs as described in section 4.4.3.

In the table below, two scenarios have been considered: (a) losses are calculated in May following the end of the regulatory year and (b) losses are calculated six months later. The movement is the average from the data sets that would have been available through to the RF and Post Final data if applicable.

As mentioned in section 4.6, all the post final data will not be available for about 28 months after the year end.

Distributor	GSP	Shift in % to RF from		Shift in % to Post Final from		
		End April	End Sept	End April	End Sept	
EDFE EPN	_A	-0.56%	-0.14%	-0.21%	0.21%	
CN East	_B	0.10%	0.27%	1.13%	1.30%	
EDFE LPN	_C	-1.69%	-0.58%	-1.74%	-0.63%	
SP Manweb	_D	-0.28%	-0.10%	-0.27%	-0.10%	
CN West	_E	-0.40%	-0.30%	0.17%	0.26%	
CE NEDL	_F	0.28%	0.27%	0.40%	0.39%	
United Utilities	_G	-0.42%	-0.07%	-0.08%	0.27%	
SSE Southern	_H	-0.19%	0.02%			*
EDFE SPN	_J	-0.49%	-0.09%			*
WPD S Wales	_K	-0.19%	0.02%	0.14%	0.35%	
WPD S West	_L	0.26%	0.27%	0.68%	0.68%	
CE YEDL	_M	0.07%	0.14%	0.10%	0.17%	
SP Distribution	_N	0.41%	0.10%	0.57%	0.26%	
SSE Hydro	_P	-1.51%	-0.96%			*
	All	-0.33%	-0.07%	-0.08%	0.19%	

The two decimal places are shown to illustrate the variation and should not be taken as a reflection of the accuracy of the estimates.

Southern, South East and North Scotland GSP Groups are not in the Post Final reconciliation runs as the errors are not considered sufficiently material to warrant the adjustments. However, it appears that Southern and South East may re-enter the reconciliations as the data quality has deteriorated.[25]

There is a wide range of values and a significant difference between the likely variation from the value calculated using data available at the end of April and that calculated using data available at the end of September. This is due to the major variation in the correction factor coming from the change from SF to R3. The May calculation has no RF data and 26 days of SF data whilst the October calculation has no SF data and 130 days of RF data.

	Days' Data Available	
Run Type	End April	End Sept
SF	26	
R1	63	
R2	103	37
R3	173	198
RF		130
Total	365	365

The impact on losses is also affected by points (ii) and (iii) above. As an approximation, a 1% increase in the GSP Correction Factor will increase reported losses by 0.5%.

Overall, the likely subsequent movement in the losses reported in May as a result of the change in data is of the order of 0.15% though it does vary widely for different distributors. The impact on future regulatory years will depend on the way the distributor handles the adjustments.

As indicated in section 4.6, some distributors may be accruing for expected volume shifts.

notes

25 Trading Disputes Committee minutes of 18/3/08

Some further analysis indicates that the quasi randomness of the correction factors, separate from any systematic shift in volume, is unlikely to affect the value of losses in any year by more than 0.3% of units distributed. Over a five year period this variation reduces to 0.13% of units distributed. It must be stressed that this analysis is extremely approximate as the correction factor has significant inter-period correlation.

Revisions to data, therefore, disturb the calculation of losses by a significant amount though this is very dependent on when the calculation is done. The variation also varies by distribution area. On the assumption that reported losses are calculated on data available soon after the regulatory year-end, the movement through to the post final reconciliation averages a correction factor drop of 0.08% equating to an increase in units distributed of 0.04% of units distributed or 125 GWh (value of loss incentive approximately £6 million). The largest increase in units distributed (reduced losses) arises in the London area with a change of 260 GWh (value £13 million) whilst the largest decrease (increased losses) is in CE East at 166 GWh (value £8 million).

5.9. Data Cleansing

Pressure to improve data accuracy, whether as a result of the BSC Audit (section 6.2) or a supplier's own investigations has caused a number of suppliers to undertake projects to cleanse their data. These tend to result in a large number of changes being put through in a relatively short space of time causing a step-change in data.

There is evidence from the continual problems in data quality that special exercises do not fix the root causes.

6. Risk Management in Settlements

6.1. Performance Assurance Framework

Inaccurate data and process errors pose a risk to all stakeholders in the Settlements process. From the inception of the Electricity Pooling & Settlement Arrangements and through its replacement by the Balancing & Settlement Code (BSC), the risks have been managed by means of

i. Qualification / Acceptance Testing of the systems of market entrants;
ii. Technical Assurance including site visits;
iii. Committees (e.g. Performance Assurance Board) scrutinising the operations of the settlement mechanisms and the performance of suppliers and their agents. This includes peer comparison;
iv. Monitoring for breaches and defaults in relation to the BSC;
v. Supplier Charges for shortfalls in performance; and
vi. Audit

In 2006 a review of the Performance Assurance Framework (PAF) was initiated to ensure it was fit for purpose and against a background of concern about the costs and benefits of the assurance mechanisms and a charge that the compliance-based nature of the PAF made it difficult to discriminate between material issues and instances of less significant non-compliance. In addition, that whilst overall the Supplier Volume Allocation arrangements were believed to be operating satisfactorily, the BSC Audit has been qualified on a number of occasions and a number of issues have remained unresolved for long periods. Further, a large number of low-level non-compliances with the BSC continue to be identified.

In September 2007, as a result of the review, the BSC was modified to include a new risk-based framework. Currently, a methodology has been established[26] and work is underway on identifying the risks and their impacts. Candidate risks have been identified.

notes

[26] Section Z of the Balancing & Settlement Code and paper REM_v1.0.pdf on Elexon web site

There is a danger with risk-based controls, as opposed to compliance checks, that the important risks are not identified and that standards of performance and accuracy decline as there is little external, independent inspection of the operations.

However, given the professionalism being applied to the PAF process, the wide consultation on risks and impacts and the monitoring mechanisms, the new framework should enhance rather than reduce the management of the risks.

6.2. BSC Auditor's Report

As mentioned above, the BSC Auditor has qualified the Audit on a number of occasions citing some recurring problems. These are still being identified as problem areas though the materiality has declined to below the threshold. The areas are:

i. Erroneous values of Unmetered Supplies in the non half hourly market
ii. Errors in the capture of metered data in the half hourly market
iii. Erroneous values of EACs and AAs
iv. Inaccurate energisation status of non half hourly Metering Systems

In total, at 31st March 2007, the materiality was put at 838 GWh compared with 1,164 GWh in the previous year and 549 GWh at 31st March 2003. This is against the 2006/07 figures of 321,502 GWh distributed with 16,653 GWh of losses.

The materiality is quoted as the gross error that is unlikely to be corrected and thus overstates the net impact on the volume distributed. When distribution losses are first calculated for a year, making use of the latest data, the errors will be greater.

The audit makes use of sampling and examination of cases above thresholds. Materiality of error is extrapolated from these. There may be additional error in cases below the threshold. Our experience of the Erroneous AA/EAC issue, for example, is that there are significant numbers of incorrectly high values below the audit threshold. These overstate consumption and reduce reported losses.

Elexon has kindly provided some recent figures for the most significant errors broken down by GSP Group and positive/negative impact on volume. The items are drawn from different data sets and from different periods. Though the figures are derived from the systems used in compiling the BSC Audit numbers given above, they relate to a snapshot of the most recent data available rather than the figures for March 2007 and thus are not equivalent.

	NHH UMS		Energi'n Status	Erroneous AA/EAC			
GSP	Positive Error [GWh]	Negative Error [GWh]	Error [GWh]	Positive Error [GWh]	Negative Error [GWh]	Net Total [GWh]	% of kWh distrib'd
Eastern	19.4	-11.0	-10.5	12.8	-8.2	2.5	0.01%
East Midlands	12.9	-7.0	-14.3	9.0	-7.5	-6.9	-0.02%
London	2.8	-38.8	-12.1	13.0	-2.9	-38.0	-0.13%
Merseyside & N Wales	1.4	-0.4	-13.1	4.5	-0.4	-8.0	-0.05%
Midlands	11.6	-3.4	-7.5	4.8	-7.7	-2.3	-0.01%
Northern	16.0	-14.0	-2.8	3.1	-3.3	-1.0	-0.01%
North Western	30.9	-12.6	-5.2	8.6	-9.0	12.7	0.05%
Southern	11.4	-11.2	-2.9	4.7	0.0	2.0	0.01%
South Eastern	18.4	-28.4	-10.5	9.1	-9.2	-20.6	-0.09%
South Wales	1.7	-0.3	-2.4	4.3	-2.1	1.2	0.01%
South Western	3.7	-0.9	-3.4	5.6	-1.6	3.4	0.02%
Yorkshire	9.1	-11.2	-13.0	7.7	-4.7	-12.1	-0.05%
South Scotland	1.9	-1.7	-21.4	5.3	-0.7	-16.5	-0.08%
North Scotland	12.1	-1.1	-0.5	0.8	0.0	11.3	0.13%
TOTAL	153.3	-142.1	-119.8	93.7	-57.4	-72.3	-0.02%

They are put together to provide a guide to the magnitude of the impact on losses. Negative figures indicate too little consumption in Settlements (increasing reported losses) whilst positive figures are an overstatement of volume in Settlements (reducing reported losses). The percentage in the right-hand column is the net volume error divided by the annual distributed volume in the GSP Group and approximates to the percentage point impact on the reported losses.

6.2.1. NHH Unmetered supplies

These values are calculated by comparing the Estimated Annual Consumption (EAC) values held by UMSO with those held by the NHH Data Aggregator (NHHDA). The UMSO value is taken as correct.

The comparison is based on a 'snapshot' in October 2007, but because annual values are being compared, this can be thought of as a notional annual error. This only includes NHH unmetered supplies. No attempt has been made to estimate errors in HH UMS.

Also, it does not include instances where the inventory held by the UMSO is incorrect.

As shown in the table above, there is a wide variation over suppliers and whilst the errors almost cancel out in the national picture with a net total of losses understated by 11 GWh (equal to £0.6 million under the loss incentive), the range for individual distribution areas is from 18 GWh understated (value £1 million) for North West GSP Group down to losses overstated by 36 GWh (value £2 million) for London GSP Group.

6.2.2. Energisation status

This is an estimate of the energy that is being under accounted because of Metering Systems incorrectly flagged as de-energised, so all the errors are negative.

NHHDAs run an enquiry on their databases to identify "at risk" MPANs (for example those on long-term EACs) every 3 months. Suppliers investigate a random sample of these MPANs and confirm how many are in error. This happens every 6 months.

The proportion in error is extrapolated across the "at risk MPANs" to derive an error value.

Since the energy is not being recorded, the impact is one of overstating losses by nearly 120 GWh (value in loss incentive approximately £6 million)

6.2.3. Erroneous AAs & EACs

Data Collectors provide a report of all AAs & EACs above a threshold and suppliers are requested to identify those which are correctly high. The thresholds are large (e.g. for a general domestic consumer, where the average usage is about 3,600 kWh per annum, the upper threshold is 160.000 kWh and the lower is -50,000. The values for all profile classes are shown in the Appendix.

The figures are for the error in Settlement for latest year for which RF data is available (29 Jan 06 – 28 Jan 07). In the BSC Audit Report for the year to 31st March 2007, the reported gross error of 726,000MWh included positive values totalling 626,000MWh and negative values totalling 100,000MWh. Thus there appears to have been a marked improvement in the level of error in the last year.

Overall, this problem area is overstating consumption and thus reducing the apparent losses by approximately 36 GWh (value in incentive of £2 million). The largest single error is in the London GSP Group at 10 GWh (value £0.5 million).

Our experience is that there will be many similar cases which are below the BSC Audit threshold and as such do not receive particular scrutiny. The threshold levels are given in the Appendix at 9.5. Based on our experience, there could be as many as 10 times as many cases under the threshold as above and with an average value of one-quarter of the threshold. This would result in a total error of the order of 150 GWh (value £7.5 million).

6.2.4. General Conclusions

In percentage terms the level of error arising from the above categories is small and of a direction that if corrected would reduce losses further. However, the value of those errors is a surprisingly large number. 72,000 MWh at the approximate incentive value of (5p for losses + 1p for DUoS =) 6p per kWh is £4.3 million.

Whilst the erroneous AA & EAC issue is starting to be brought under control, there are probably many smaller, incorrect values amounting to several times the impact of the larger values examined as part of the audit. Irrespective of the way the GSP Group Correction Factor reduces the impact, Suppliers have a financial incentive to correct high values (as opposed to the low values) and it is rational to deal with the largest values first. Within Elexon consideration is being given to lowering the thresholds for reporting suspect AAs & EACs though some suppliers are struggling to deal with the current levels of values flagged for investigation.

7. Summary – The Key Issues

7.1. Significant issues in running a loss incentive on the back of the settlement process

Settlements process designed for energy settlements

The Settlements process was developed for the settlement of energy charges amongst suppliers and with the materiality based on the variability of energy costs from one period to another. It was always acknowledged that there were approximations and the GSPG Correction Factor is a method of trimming the loss-adjusted consumer meter measurements to the GSP consumption.

Errors in measuring consumers' consumption for Settlements have an impact on suppliers but one lessened by the effect of the GSPG Correction Factor. If a supplier's data is of average accuracy, the supplier receives a broadly correct allocation of energy. DUoS charges are unaffected by the correction factor but are significantly lower than energy costs.

Suppliers, in conjunction with their agents, are responsible for obtaining accurate metering information. Given the costs and complexity of investigating potential errors only the largest problem areas will be pursued. A supplier's billing system may be using different consumption from that used in Settlements.

Distributors rely on the Settlements data for their DUoS billing (HH and supercustomer), picking up the half hourly and 'supercustomer' billing. Any error in the meter data will have the full impact.

However, over a sufficiently long period of time (12 months), the potential error in the data arising from the various movements due to profiles and actual meter readings replacing estimates, appears relatively small for most distributors and averages about 0.15% of the units distributed. However, it is still a significant number and has an approximate value of £25 million under loss incentive.

Materiality of the losses incentive verses energy price.

Until recent increases in energy costs, the distribution loss incentive was significantly greater than the average cost of energy. The criteria for investigating problems are based on the materiality for suppliers, not distributors.

However, this distinction is not a major issue as the objectives of the parties align. Whereas an individual supplier has no incentive to investigate cases where consumption is under recorded, the other suppliers in the GSP Group do have an incentive to correct the error as collectively they share the cost of the energy.

Greater incentive to address non-technical losses

Any reduction in technical losses is rewarded by the (indexed) 4.8p per kWh incentive in the price control formula. However, a reduction in non-technical losses results in both the loss incentive and the additional DUoS charges relating to those kWh.

Data Quality including the erroneous high AA / EAC issue

From the movements in the GSP Group Correction Factors, it can be seen that the data changes within the various settlement runs up to RF (the normal final run) generally lead to more consumption being attributed to NHH meters. However, the Post Final run is showing a reduction in NHH metered consumption consistent with steps to address the perennial Erroneous High AA/EAC issue.

One of the causes of the erroneous AA / EAC issue is a lack of regular, accurate meter readings. There has been a slow improvement in obtaining actual data by the RF (14 month) stage but still 4% of NHH data remains estimated.

From our knowledge of the problems in resolving the high AA/EAC issue, it is likely that Distributors have enjoyed the benefit of the excess consumption in both the reduction in apparent losses and in the additional DUoS charge revenues. There are indications (see section 6.2.3) that suppliers are starting to address the issue with a consequent increase in apparent losses.

This problem area is of relatively high materiality at 36 GWh (value £2 million) plus any additional amount from the many smaller valued errors not included in the BSC Audit sample.

In addition, the problems with idle services appear to be adding to the recorded losses by 120 GWh per annum (value £6 million).

Whilst not a problem arising from the Settlements system, the accuracy of the older meters installed in the NHH market may be drifting with a very approximate loss incentive materiality of £2 million per annum.

Long time frame in getting accurate data

With the normal 14 month Settlements process, often extended to 28 months due to issues with poor quality data, a relatively static figure for units distributed is not available until a long time after the regulatory year-end. Any reports of volumes distributed that are prepared within a couple of months of the year-end are likely to change by about 0.15% though EDF (London) and SSE (Hydro) have shown significant variations in the sample data. At six months after the year end, the data is more stable.

It is probable that distributors have different methodologies for handling the impact of the changes in data. There may even be subtle changes of methodology from year to year. As a consequence, comparisons between distribution areas are made more difficult. Even year to year comparisons for a single distributor may be distorted depending on the data sets used.

There are particular difficulties with prior period data adjustments that relate to previous price control regimes.

Some distributors adjust loss factors regularly

Despite the knowledge that the GSPG Correction factor does not have to approach unity, it is often used a proxy for data quality. Deviations from unity are investigated. Some distributors revise published loss factors periodically. If that adjustment tends to result in the GSPG Correction Factor being close to unity, it may mask data errors.

Distributors are not in control of all factors affecting non-technical losses1

Issues of data quality are in the hands of the BSC, suppliers and their agents. Distributors have some influence but it is not direct. Of course, distributors can play a part in the various industry committees though members of the Performance Assurance Board, for example, act as individuals and not representatives of any company or trade body.

7.2. Reliance on Settlements data in setting loss targets and the factors affecting the calculation of losses

Movements in data and how prior period adjustments are incorporated

We suspect that distributors have several methodologies for calculating the units distributed though all will be based on Settlements data. The variations will arise from any accrual for estimated movements in data and how prior period adjustments are recognised.

Base Periods and stranded volumes

Since it may take several years to get a stable data set, baseline figures from which to measure movements in losses may be inaccurate. The uncertainty in volume over a five year period could be of the order of 0.1% of annual volume. On top of that, some changes to data for periods prior to the baseline could appear in subsequent years. Alternatively, it is possible that some adjustments have been discarded.

7.3. Changes in Settlements over last five years that could affect settlement accuracy going forward

There appears to have been a slow but steady improvement in data quality over the last few years, firstly in a higher percentage of actual data being used in Settlements and in steps to tackle issues such as erroneous AAs / EACs. Also significant improvements occurred in 2002-04 though the adjustments to data would have occurred later.

7.4. Possible effects of the risk-based PAF/ PAB

It is unlikely that the changes to the way risks are being managed will have an adverse impact on data quality given the effort and professionalism being put into the design of the new list of risks and impacts. It will be important for stakeholders to review the risks and be sure that the process manages the real risks, not the production of lists of risks.

8. References

8.1. General

A useful description of profiling in Settlements is contained in Appendix C of a paper on Advanced Metering Technology For Embedded Generation which can be found at http://www.berr.gov.uk/files/file34820.pdf or at http://www.elexon.co.uk/documents/Participating_in_the_Market/Market_Guidance_-_Industry_Helpdesk_faqs/Load_Profiles.pdf

8.2. Elexon's IPR, Copyright and Disclaimer

Where charts from the BSC Trading Operations report are shown, these are copyright of Elexon and reproduced with the copyright owner's kind permission. The full text of Elexon's statement is below. For the avoidance of doubt, it only relates to those charts and other information within this paper so identified as being Elexon's copyright.

9. Appendix

9.1. Reactive Power and Power Factor

Electricity distribution in Great Britain uses alternating current (AC) rather than direct current (DC) due to the many technical advantages. The voltage and current vary between the peak positive and negative values a nominal 50 times per second (50 Hz). The power available from a circuit is the proportional to the voltage multiplied by the current and is at its maximum if the voltage and current peak at the same instant, i.e. in phase.

Certain types of devices such as electric motors, voltage reduction transformers and fluorescent lights cause the current to flow so that the peaks of voltage and current do not coincide – said to be out of phase with the current ‘leading’ or lagging’ the voltage dependent on the direction of shift. The ‘apparent’ power is the average voltage times the average current – i.e. ignoring the phase difference - whilst the ‘real’ power is the average of the instantaneous voltage times the instantaneous current. In the latter case there will be instants when the voltage is zero or very small and the current is significant. The product of the two numbers is a small number.

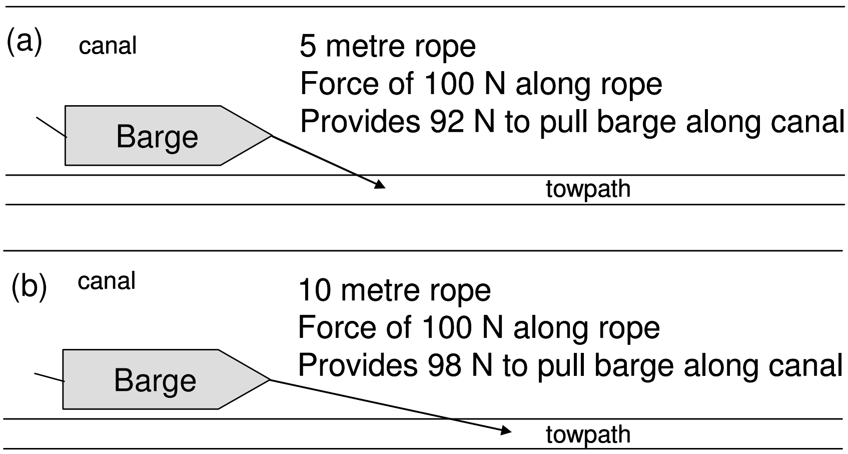
The power factor is the ratio of the real power in kW (kilowatts) to the apparent power in kVA (kilovolt-amperes or kilovars). The real power is always less than the apparent power.

The end result is that for a given usable, ‘real’ power output, more current has to flow. When current flows through a wire, heat is produced in proportion to the square of the current. For a distribution cable, this heat is part of the energy which is defined as electrical losses.

With a power factor of 0.9, over 20% more waste heat is produced for a given usable power output. Equipment and methods are available to correct the power factor in an electrical installation. Generating plant can be adjusted to produce current at the power factor needed to balance up the transmission and distribution systems.

Most small consumers are charged for the real power in kW and not charged directly for the reactive component.

An analogy to reactive power that may help explain the concept is that of pulling a canal barge along a straight canal using a rope and walking along the towpath. If the rope is short it takes a lot more effort to pull the barge than if the rope is longer. With a short rope, the angle of the rope to the desired direction of travel is much sharper (diagram (a) below) and a lot of effort is wasted either by pulling the barge against the bank of the canal or by water flowing over the rudder set at an angle to keep the barge away from the bank. With a shallower angle, the effort is more productive (diagram (b)). The wasted effort is the reactive ‘power’.



9.2. Ohm’s Law

Ohm's law states that in an electrical circuit, the current passing through a conductor between two points is directly proportional to the potential difference (i.e. voltage drop or voltage) across the two points, and inversely proportional to the resistance between them.

The familiar mathematical equation that describes this relationship is:

$I = V/R$

where I is the current in amperes, V is the potential difference between two points of interest in volts, and R is a circuit parameter, measured in ohms (which is equivalent to volts per ampere), and is called the resistance. The potential difference is also known as the voltage drop.

Ignoring the complexities of alternating current, the power, in Watts, produced in the resistance is the product of the voltage drop times the current, written as

$\text{Power} = VI$

Using Ohm's law this can be expressed as

$\text{Power} = I^2R$

Indicating that power lost in a resistance increases as the square of the current.

With alternating currents, even at mains frequencies, the current does not flow uniformly through the cable but more towards the outer surface. This 'skin effect' can lead to a significant increase in the effective resistance of a cable.

9.3. GSP Group Names and Distributors

Within Settlements, the market domain data uses some "old" names, based on the former franchised PES, to describe GSP Groups. There is also a short code used identify the Group. These are listed below with the distributor name often used in Ofgem charts and tables.

GSP Group Id	GSP Group Name	Distributor
_A	Eastern	EDFE EPN
_B	East Midlands	CN East
_C	London	EDFE LPN
_D	Merseyside and North Wales	SP Manweb
_E	Midlands	CN West
_F	Northern	CE NEDL
_G	North Western	United Utilities
_H	Southern	SSE Southern
_J	South Eastern	EDFE SPN
_K	South Wales	WPD S Wales
_L	South Western	WPD S West
_M	Yorkshire	CE YEDL
_N	South Scotland	SP Distribution
_P	North Scotland	SSE Hydro

CN	Central Networks
EDFE	EDF Energy
SP	Scottish Power
SSE	Scottish & Southern Energy
WPD	Western Power Distribution

9.4. Glossary

BERR	Department for Business, Enterprise and Regulatory Reform
BSC	Balancing & Settlement Code
CDCA	Central Data Collection Agent
CF	Correction Factor (as in GSPG CF)
DA	Data Aggregator
DNO iDNO	Distribution Network Operator Independent DNO
DUoS	Distribution Use of System – often refers to the charges for using the system.
Electricity	Electrical energy
Energy	sometimes used as synonym for electricity
GSP	Grid Supply Point
GSP Group (GSPG)	GSPs relating to a distribution area
Kilovolt-ampere- reactive, kVAR kVARh	Reactive power Reactive Energy
Kilovolt-ampere, kVA, kVAh	Apparent power Apparent energy (power x time)
kilowatt, kW, kWh	Real Power Real energy (power x time)
LF	(Peak) Load Factor
MPAS	Meter Point Administration Service -
MPAS	Meter Point Administration Number
NHHDA	NHH Data Aggregator
PES	Public Electricity Supplier (historic reference)
Power	rate of doing work or the rate of consumption of energy. Also sometimes used as a synonym for electricity
Supercustomer	The principle of aggregating demand for consumers of the same type.
SVAA	Supplier Volume Allocation Agent
Three phase / Single Phase	Different systems of wiring for supplying electricity. Single phase is used in nearly all domestic supplies and smaller business supplies. Whilst single phase is often quoted as 230 volts, the 3-phase equivalent is 400 volts.
UMSO	Unmetered Supplies Operator – usually a subsidiary or affiliate of a distributor - an Agent who provides profile data to settlements as a substitute for meter for collections of street lamps etc.

9.5. Thresholds for examination of potential erroneous AAs and EACs

Profile Class	Average Consumption kWh	Large EAC/AA Consumption thresholds kWh per annum	
		Upper	Lower
1	3,600	160,000	(50,000)
2	6,400	110,000	(50,000)
3	12,200	200,000	(50,000)
4	23,200	140,000	(50,000)
5	77,500	220,000	(50,000)
6	100,800	320,000	(50,000)
7	119,300	430,000	(50,000)
8	150,900	690,000	(50,000)

For Profile Classes 2 & 4, the values are per register (day, night).

Version Control

Date	Version	Author	Reviewed	Comment
19/3/08	0	A Sutton	R Brook	Pre-final for client comment
28/3/08	1	A Sutton	n/a	Revisions following client's review
3/4/08	1.01	A Sutton	n/a	Correction of typos
31/3/09	1.02	A. Sutton	n/a	Prepare for external publication