METERING AND MONITORING OF DOMESTIC EMBEDDED GENERATION

PART I – DATA COLLECTION

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This is the final report on Project K/EL/00312/00/00 Metering and Monitoring of Domestic Embedded Generation of Domestic Embedded Generation funded by the Technology Strategy Board. The project was carried out between 2004 and 2007 and examines the electrical generation and export of 144 microgenerators fitted in the United Kingdom as well as issues of export reward.

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1 EXECUTIVE SUMMARY

This project was initiated in order to provide real data to support the development of profiles for the P81 non-half hourly settlements of exports process. P81 allows the owners of microgenerators to sell their exports to Suppliers on the basis on a single quarterly export meter read. In order to sell on this power, the Suppliers have to know its half hourly output profile, as this is the basis on which it is priced. This is achieved by using Standard Settlement Configurations (SSCs) that indicate an assumed export profile. When P81 was set up there was limited real data available to define these SSCs. This project has collected real data for 133 sites selected from PV, wind, microCHP and one hydro site over across a period of two years.

This project was established to collect data to allow Elexon to re-evaluate these SSC's. This involved:

- the identification of sites
- design, procurement and installation of data acquisition system
- data collection and storage

This report sets out the details of how these tasks were carried out.

A number of major issues were encountered during the site installation phase that resulted in a major delay. There was also an issue over the availability of occupied microCHP properties. These two delays between them pushed back the original project schedule by two years.

Despite the delays the project succeeded in its original aims and a total of 153 data sets were obtained from a period of over 2 years, beginning with the first site in January 2005 and ending in June 2007. From this data set, a total of 88 sites provided a continuous data string between June 2006 and May 2007.

2 INTRODUCTION

This report sets out the data collection process used in the Project K/EL/00312/00/00 Metering and Monitoring of Domestic Embedded Generation that has been carried out by BEAMA Limited. The project has been part funded by the Technology Strategy Board. The project was intended to provide data on all forms of microgenerators so that Elexon could review the standard settlement configurations that are currently used in the P81 non half hourly (NHH) export settlement process. At the same time it was intended to use the data obtained to examine the issue of export reward and to cast light on the actual performance of microgenerators.

The project commenced in December 2003 and included data collection from sites between December 2004 and May 2007. The project involved a number of participants; EDF Customer Field Services who installed the meters, EDF, Eon, Good Energy, npower, who provided sites and EA Technology who shared in the data analysis. Elexon, the Energy Savings Trust and OFGEM were represented on the project steering board. Finally, considerable assistance was received from Elster Meters who supplied metering equipment, data collection software and provided technical support.

The results obtained from the analysis of the data are presented in the report; K/EL/00312/00/00 Metering and Monitoring of Domestic Embedded Generation, Part II – Data Analysis[i]. A further report; "Impact of Profiles on Settlement Costs, EA Technology, Linda Hull, Rob Green and Bingning Dai[ii]" presents further analysis of the data. There is also likely to be further review of the results presented by Elexon.

3 OBJECTIVE OF PROJECT

In September 2003 Elexon introduced P81, a new procedure for dealing with power exported by small generators (initially up to 16A/phase, later increased to a maximum of 30kW nominal capacity on the site). This relieved the owners of such generators from a previous requirement to settle all exports with half hourly metering. Under P81, the exported

power was brought within the non-half hourly metering arrangements so that it only had to be metered via a single register on a non-half hourly meter. As any Supplier purchasing the exported power would be required to trade it on against its half hourly value, Elexon introduced a series of Standard Settlement Configurations (SSCs) that could be used to indicate when the power export occurred.

Elexon used the best generation data available to it to determine the SSCs but availability of such data was limited. Any error in the SSCs results in under or overpayment of the owners of the generators and hence it was important to ensure their accuracy. It also causes errors in the charges and payments to Suppliers. To this end it was agreed that this project would be carried out in order to provide far greater quantities of data that Elexon could use to check and, if appropriate, revise the SSCs.

To meet the objectives of this project it was necessary to gather generation, export and import data for a representative number of sites.

4 PRINCIPLES OF DATA COLLECTION

At the outset of this project a number of ruling principles were agreed:

- It was intended to sample enough sites so that they could be considered statistically representative of the whole population of sites. Thus, there would not be a need to try to match the sample to the characteristics of the population. A total of 200 sites had been identified in the proposal and this was seen as an upper limit.
- It was not an objective of the project to study the performance of the different generation technologies. Their output would be considered to be representative of their actual performance. This meant, for example, that no wind speed or direction monitoring equipment was fitted at the sites; only the output from the generators was monitored, not its efficiency of operation.
- Ideally, a wide geographical distribution would be sought to avoid any local effects influencing the results. However, it was clear early on that the operation costs of ECS, installing the meters, would be minimized if the sites were close to their London bases. Also, it was apparent that ECS would find it more difficult operating outside of their own areas. As a consequence, it was agreed that sites close to London would be given priority.
- It was recognised that the owners of embedded generators would not be representative of the general population and might be expected to be more conscious and careful of energy consumption. However, it was also assumed that, there would be a reasonable degree of homogeneity within this population, so no special efforts would be needed to select a representative sample.
- By virtue of the number of units in operation, the principle focus of the project was upon PV and microCHP units. During the operation of the project, however, it became apparent that there was growing interest and market penetration for microWind generators. As a consequence it was decided to recruit as many small wind sites as possible. Also, although there was no prospect of obtaining a statistically significant sample, it was considered worthwhile recruiting some hydro sites, simply to see how these operate.
- Data resolution of 30 minutes is that used for import / export settlement in the UK and was the resolution used for subsequent data analysis. However, as part of the data exchange deal with the Carbon Trust (see 6.1.3) and on the basis that a shorter data resolution could provide useful insight, all data was downloaded in 5 minute resolution.

5 PROJECT DESIGN

It was agreed with the project participants and sponsors that the project would be implemented thorough the following steps:

- Site Selection
- Data acquisition and metering design

- Site Installations
- Data Collection and storage
- Data processing
- Data analysis (described in K/EL/00312/00/00 Metering and Monitoring of Domestic Embedded Generation, Part II – Data Analysis)

BEAMA was to act as project manager, provide the meters, carry out data collection and conduct data analysis with EA Technology. ECS Field Services (a division of EDF Energy) was to carry out the meter installations. The other project participants were involved to provide suitable sites.

The steps of the project are described in turn below.

6 SITE SELECTION

6.1 Site Selection Process

The initial intention had been for the Supplier companies involved in the project to recruit the sites. However, for a variety of reasons additional sources were pursued. Each of these sources, and the reasons for following it, are set out below.

6.1.1 SUPPLIER SOURCED SITES

The intention for site selection when the project proposal was being prepared was for the Suppliers involved in the project to provide them from their customer base. Each of the Suppliers had a list of sites that had registered for their embedded generation support schemes. It was agreed that the Suppliers would forward an invitation from BEAMA to take part in the project to appropriate customers. The names and contact details of those that expressed an interest would be passed to BEAMA so that a contract could be offered to them. Copies of the invitation and contract are included in Appendix B Customer faq'Ss and Appendix C Customer Contract. Those customers who wished to take part in the project simply signed the contracts and returned them to BEAMA. These sites were added to the list of identified sites and passed to ECS for installation.

6.1.2 BEAMA APPEAL FOR WIND SITES

Part way through the project it became clear that there was growing public interest in wind generators and it was thought prudent to recruit sites to give information on this technology. The Suppliers had few customers with wind sites and it was not possible to recruit a useful number via this route. As a result it was agreed that BEAMA would conduct a public recruitment campaign to appeal for sites directly. A letter (Appendix A BEAMA SITE APPEAL) was prepared and distributed to a variety of renewable energy organizations. In response to the call a number of sites came forward. These sites were sent copies of the Customer Agreement for signing. This process yielded a number of suitable sites that were added to the list of identified sites.

6.1.3 CARBON TRUST SMALL SCALE CHP SITES

When the project was began it was known that there was a related project being conducted by the Carbon Trust; the small scale CHP trial[1]. It was understood that this field trial would be gathering a wide range of operating data from

[1] See - Micro-CHP Accelerator, Interim report, Carbon Trust, November 2007, Executive summary

microCHP sites. These would include the generator power output and site import and export. As it was believed that there would be a restricted number of suitable microCHP sites it seemed prudent that competition for these sites should be avoided. To this end, the Carbon Trust was approached and agreed to exchange data from their microCHP sites for an equal number of PV and wind sites from this project. One consequence of this agreement was that the Carbon Trust specified that data should be obtained at a 5 minute resolution. This was accepted as a necessary concession and there was some merit in having short resolution data if there was a need to study effects. It had one important result, however. The Elster A1700 meter contained a data store of 21600 data items. This was intended to provide 450 days of 30 minute data resolution. However, when spread across the 3 channels and for 5 minute resolution, the data capacity fell to 25 days. This had implications later on for sites where it was only possible to make infrequent GSM contact for data downloads (see 7.2.1).

6.1.4 MICROCHP SITES

The other major source of microCHP sites was E.On, who was the only company with sufficient microCHP sites for the needs of this project. Access to some of their sites had already been obtained via the Carbon Trust but more sites were required. E.On was conducting a major installation of WhisperGen microCHP units at the Lovell residential building development in Manchester. Some of the properties on this site were to be fitted with microCHP units during construction. It was agreed with E.On that BEAMA meters would be fitted to some of these sites during installation of the generators. At this stage there were no occupants of the properties so no agreement could be offered. Indeed it was arranged with E.On that the BEAMA meters would be considered part of the E.On monitoring agreement with the customers.

There were some important consequences to this arrangement:

- There was no control over the completion of the homes and these suffered considerable delays that impacted on the project schedule.
- Even once completed, the homes were not all occupied immediately so some sites, even though installed and available for data collection, did not have data to collect.
- Customers were under no obligation to operate the microCHP units they found in their homes. There were a small number of sites that never turned on their generators and provided no useful data to the project.

As well as the E.On WhisperGen sites, BG Microgen was also a project participant. BG Microgen had developed a different design of microCHP unit. The project team was keen to include these sites to provide data on how alternative system designs and operation strategies affected generation and export patterns. Shortly after commencing the project, BG Microgen announced that it was going to withdraw from future field trials as it carried out further development work. At a later date, however, BG Microgen offered to make available data from 5 of its previous field trial sites. This data was considered to be representative of future operations and the offer was accepted. Several meetings were held with BG Microgen to agree how this data should be formatted for transfer. Unfortunately, just prior to handing over this data, BG Microgen was shut down and the offer of the data was withdrawn.

6.1.5 NORTHERN IRELAND ELECTRICITY (NIE)

It had become apparent at an early stage that there were going to be serious delays to the project as a result of the difficulties ECS faced in carrying out installations outside the London area. It was considered that it would be beneficial if some sites could be acquired during the period when ECS were sorting the issues affecting them. BEAMA had been put in contact with staff at NIE who were conducting a renewable generation trial. A meeting was held with NIE and it was agreed that they would ask their customers if they wanted to join the BEAMA project. Five sites volunteered and returned signed Customer Agreements. These were all wind sites, while two also had a PV generator. It turned out that NIE was already monitoring the import and export from these sites and had fitted Elster primary meters with GSM modems. However, they did not gather any data on the generator outputs. It was agreed that BEAMA would provide

Elster A1700 meters to measure the generator outputs. NIE staff connected these meters to the ones they had already fitted using a data link. This allowed BEAMA to collect the data for generation, import and export. One limitation of this arrangement was that BEAMA could not change the resolution of the NIE primary meters and hence, its own meter. Thus these sites provided only ½ hour data during the project.

6.2 Customer Agreement

The BEAMA Legal Department produced a Customer Agreement to be offered to customers when they expressed an interest in the project. A copy of this is shown in Appendix C Customer Contract.

6.3 Possible Sites

A Microsoft Access data base was set up to hold all the site information and all details provided from the various sources were added to this. At the end of the site selection process there were a total of 455 possible sites. These comprised 62 microCHP sites, 7 hydro sites, 58 wind sites and the remainder, 328, solar sites. Of these sites 5 were provided by BG Microgen, 125 by Good Energy, 80 by EDF, 14 by NIE, 130 npower, 58 E.On and 43 direct to BEAMA.

6.4 Sites Identified

Once the list of possible sites had been produced there was a process for converting some of these to trial sites. This is best explained in the table below.

Number of possible sites identified *Total of sites BEAMA was provided some details of. This represented the total pool of sites.*	455
Number of customers expressing an interest and sent a contract *Those sites meeting the basic requirements for the project were approached by their Supplier and, those registering an interest were sent a customer contract (this excludes microCHP sites)*	93
Number of customers returning signed contracts *This is the sites who returned signed contracts (this excludes microCHP sites)*	75
Number of sites not installed where contract held *These sites were either visited and rejected for various reasons or not visited before the end of the installation phase (this excludes microCHP sites).*	26

Number of generators monitored[2] *The number of sites that had meters installed (this excludes microCHP sites).*	64
Number of generators monitored (all sources) *Total number from all sources.*	152

Table 6-1Site Selection Summary

6.5 Site Selection Process

There was a detailed discussion within the project team about the site selection process. The main priority was to minimise inconvenience to sites and time spent by ECS engineers.

The possibility of an assessment visit had been considered during the design of the installation process but rejected on the grounds that, for the sites identified in this project which were often rural, the highest cost element of the installation process was the visit itself. It followed that sites were not seen until an installation visit was carried out so it was not known until then whether they were suitable or not. Because of this it was decided with ECS that, to ease their installation process, a surplus of sites would be provided to them. This would allow ECS to reject sites when they visited them on the grounds that:

- The GSM signal was too weak
- The installation would not fit the standard model and there was no simple alternative arrangement
- ECS had concerns over the correctness of the electrical installation at the site.

To support this process BEAMA agreed with ECS on the target number of sites to be installed. BEAMA then supplied ECS with sufficient meter sets (with a compliment of spares) to cover these sites. At a later stage of the installation process ECS were working in three UK areas and at this time they took responsibility for maintaining sufficient stock with each engineer. BEAMA also obtained a number of contracts from sites in excess of the target number of sites.

In practice the constraints on the number of sites installed were the time available to the ECS engineers and the meter sets they had available to them.

6.6 Site Location

Figure 1 shows the locations of the sites that were monitored for this project. More details have not been given to protect the confidentiality of the trial sites. In general it can be noted that the installation process was relatively

[2] For various reasons there is a difference in the numbers of sites, meters and generators. This arose because if non-standard sites where:

- Two A1700 meters were needed because the generator was too far away from the import export meter to link

- There was more than one generator on the site

There were two generators on one site

6-2 Site Selection Process

successful in maintaining a concentration of sites around London (to minimise ECS costs) whilst ensuring that sites were spread across a wide enough area to allow local affects being examined so as to identify any bias in the results.

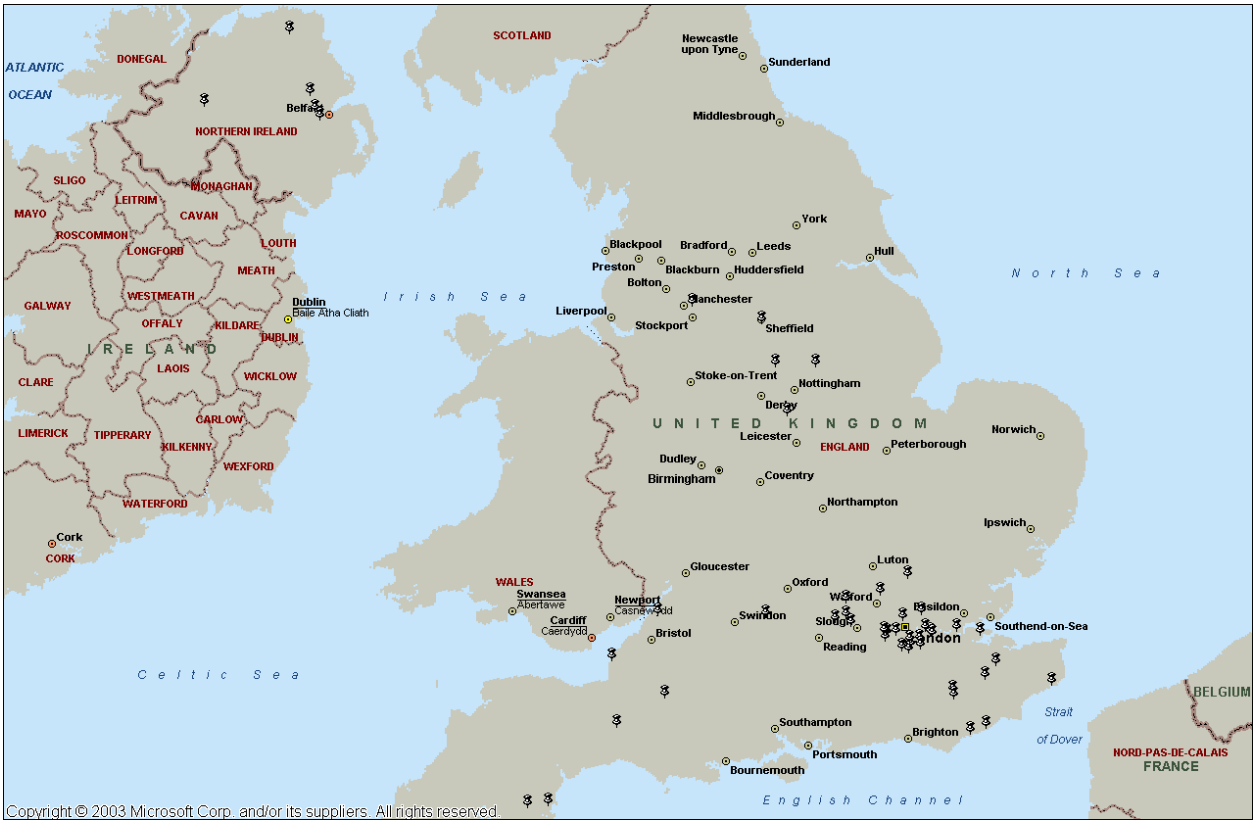

Figure 1 Site Locations

7 DATA ACQUISITION SYSTEM

The requirements for this project were to gather data for electricity imports, exports and generator output for individual sites across the UK. The original intention was for one year of contiguous data collection from all sites. The data collection system requirements were set out in a project document (Appendix D DAta Acquisition Specification).

7.1 Metering Components

The main constituents of the data acquisition system were decided during the development of the project proposal. Specifically, it was decided that the data would be collected by a combination of Elster A1700 and A100 meters (details of these are shown in Appendix F Meter Details). The A1700 is a whole current, polyphase, interval data meter. Although the meter was designed for 3-phase systems, it was an option to use it for single phase supplies. The meter has a RS232 port for connection to a communications modules and a multi utility input module that allows pulse signals from other meters to be read and stored by the A1700. This meter was to be used to measure the import and export to the site, provide communications and gather data from other meters via the pulse link. The generator output was provided for by the A100 meter, which is a single phase, whole current, non-half hourly meter. The A100 meter supplied by Elster was fitted with a low voltage pulse output signal. This sends a pulse after a certain number (adjustable on the A100 meter) of Wh had passed through the meter. Thus, although the A100 had no data storage capability, by counting the pulses from the meter via the multi-utility input module, it was possible to store the generation profile on the A1700 meter. From there it could be downloaded via the communications module.

7.2 Communications Options

7.2.1 GSM MODEMS

The A1700 has an RS232 interface for connection to various communications modules. The simplest of these for general use was a GSM modem. This allowed the meters to be read completely independently of the customers' telephone line. This was the preferred solution and was used where possible.

In practice there was a mixed experience with the GSM modems. A number of sites were found to have too weak signals and were rejected at the installation stage. Despite these tests some sites were found to be difficult to contact during the data collection phase. It was found that the mobile network was in the habit of temporarily rejecting data sites from the network when there was high demand for voice calls. The GSM modems were programmed to re-connect with the network 24 hours after losing contact. Thus data could always be collected but there was usually some disruption to the data collection programme, which required time to manage.

There were two sites that were passed the GSM signal test at installation but which subsequently could not be contacted. Of these, one was completely uncontactable, the other only very sporadically. In the later case it was not possible to collect continuous profile data but stored profile data could be collected for the days preceding successful calls as well as the quarterly register data.

7.2.2 SIM CARDS

The GSM modems required SIM cards to connect to a network. Various options were explored for the supply of these. One concern was that the cost of the communications had not been included in the project budget and, thus, had to be kept as low as possible. SIM cards have a monthly rental cost and a usage cost. As the calls to meters were all outbound, i.e. from the base station to the meter and never inbound, then the SIM cards would never have any usage costs. This meant that the lowest monthly rental cost was the key economic factor. As well as this there was the consideration of which network operator to contract with as these have different coverage and would affect the suitability of some of the sites.

Eventually, Wyless[3] Limited, a SIM card supplier was identified who specialised in the supply of SIM cards for data communications. A contract was negotiated with Wyless for the bulk supply of SIM cards for the duration of the project.

7.2.3 CLI MODEMS

There were a number of sites where there was insufficient signal to use a GSM modem. In these cases, after some research, it was found that that a Caller Line Identity (CLI) modem was the most suitable in these cases. For CLI modems, the modem is connected to the customer's land line and is contacted via this. The CLI modem is programmed to recognise certain incoming phone numbers. When it sees one of these numbers it picks up the phone call before the other phones in the house have a chance to ring. Thus the modem can be called silently and with no disruption to the customer. The modem is designed to drop the line if a call is made from any of the phones in the house; this is in order not to prevent emergency calls. The modem will block incoming calls, however. To minimise possible inconvenience to the customers the data collecting software was programmed to call during the night when other calls were unlikely. However, this did have the potential disadvantage that, on the rare occasions when there was a problem, the customer

[3] **Wyless Group (Head Office),** Regus House, Highbridge, Oxford Road, Uxbridge UB8 1HR

would receive nuisance calls late at night. It was also necessary for the customer to request that their telephony provided turned on caller number identifying, where necessary BEAMA paying for this. In all there were two sites that were fitted with CLI modems, all of the others were fitted with GSM modems.

7.3 Meter Installation Choices

There was considerable discussion at the beginning of the project on how the import/export meters should be installed. There were three major choices, each with their own pros and cons. These are discussed below.

Option	Advantages	Disadvantages
Fit meter as Primary meter in place of existing meter	1. *Simplest physical arrangement needing least space* 2. *Meter would be adopted and maintained by local meter operators*	1. *There would be great difficulty reaching agreement with local meter operator* 2. *The meter switch process would be very complicated* 3. *The meter operator might have placed restrictions over the data collection from the meter*
Fit meter as secondary meter in series with primary meter	1. *There would be no need to reach agreement with the local meter operator over adopting the meter* 2. *The installation was relatively simple, just needing the meter to be inserted in series between the primary and meter and consumer unit*	1. *There would need to be space for an additional meter* 2. *There was still a need to pull the main supply fuse and replace and seal it.* 3. *Any problems with the meter might cause problems with the house power supply*
Use split current transformer to pick up line current	1. *The meter could be installed without pulling the supply fuse or turning off the house supply* 2. *The meter could be removed simply* 3. *The A1700 meter could be located further from the primary meter as it did not need to connect into the main power supply cables*	1. *This arrangement was the most expensive and required most space* 2. *The use of a current transformer lowered the accuracy of the measurements*

Table 7-1 Meter Design Options

Based on the above analysis it was agreed that the secondary meter arrangement would be used. This was the preferred choice for early sites where ECS had authority to remove and replace the main fuse. The first meter installations were carried out with this arrangement.

At the point when it became necessary to carry out installations outside of the London region it became apparent that there would be serious difficulties obtaining permission for ECS to carry out installations according to the secondary

meter arrangement. Specifically, the local DNO managed permissions for people to work on their network. In each region the DNO offered training courses that engineers needed to complete before they could be given permission to work on that network. This included the pulling and re-fitting of main supply fuses. ECS were reluctant to incur the cost of putting their engineers through these courses only for this project so this was not an option. A number of other options for supplying engineers to carry out this work were explored but none were suitable or willing to carry out the work.

Finding solutions to deal with this impasse caused a considerable delay to the project, approaching a period of one year (the time between the first and second installation phases). Because of the need to press ahead with the project it was decided that the split current transformer option should be re-visited. This option avoided all problems over access to the supply fuse as there was no longer any need to remove it. Despite this clear advantage, it was complex to implement this option, owing largely to the need for a 15A CT (which were large, heavy and expensive) for the A1700 meters that were available to the project and also because of the need to design, build and install shorting blocks to allow safe removal of the meters. The revised design was carried out and the necessary components purchased and the next phase of installations begun.

This switch in meter installation did require research on Part P of the Building Regulations that covers competence to carry out electrical work in residential buildings. This new scheme was introduced during the project. Normally, ECS and other meter operators do not deal with Part P as the meter and connections between it and the network are outside of the Part P scope. The split CT arrangement, however, does fall under Part P. Part P requires that qualifying electrical work should either be assessed and certified by a Building Control inspector or self approved by a competent installer. The Part P self approval scheme requires the employing organisation to be registered and it is its responsibility to ensure the competence of its engineers. ECS went through the process of gaining registration during the project and was thus able to carry out these installations on a self certified basis.

7.4 Secondary Metering

Error! Reference source not found. shows a diagram of the secondary metering arrangement used in the first phase of installations. Figure 3 shows a photograph of this meter arrangement as installed at the first site in December 2004.

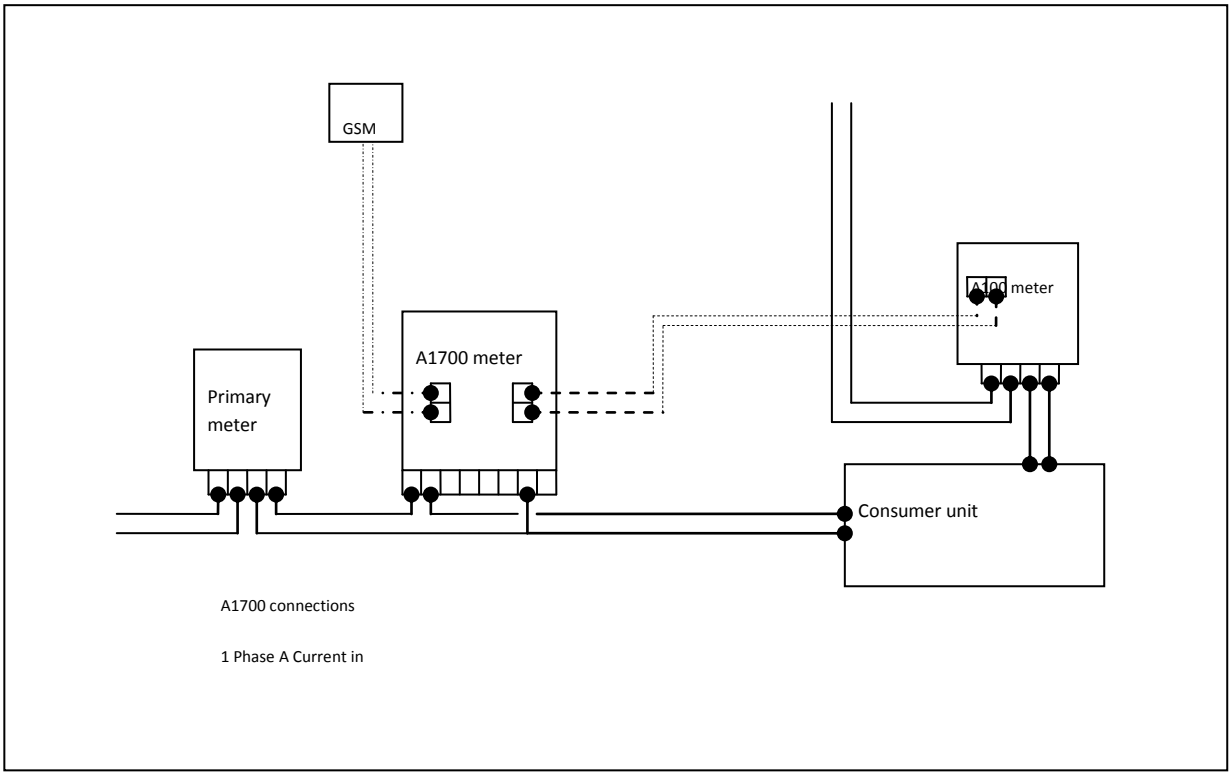

Figure 2 Secondary Meter Design Option

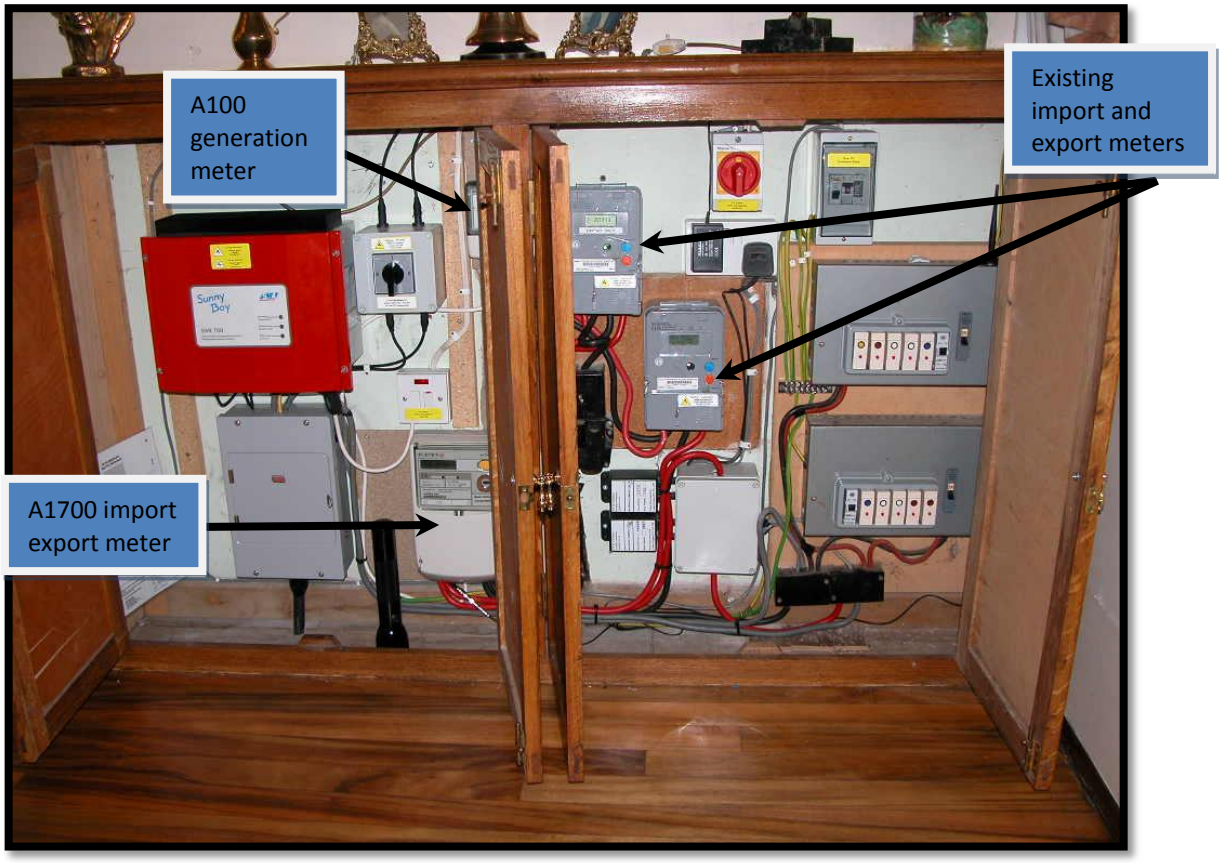

Figure 3 Meter Installation at first site

7.5 Split Current Transformer

Figure 4 shows the revised split CT arrangement used in the second phase of installations.

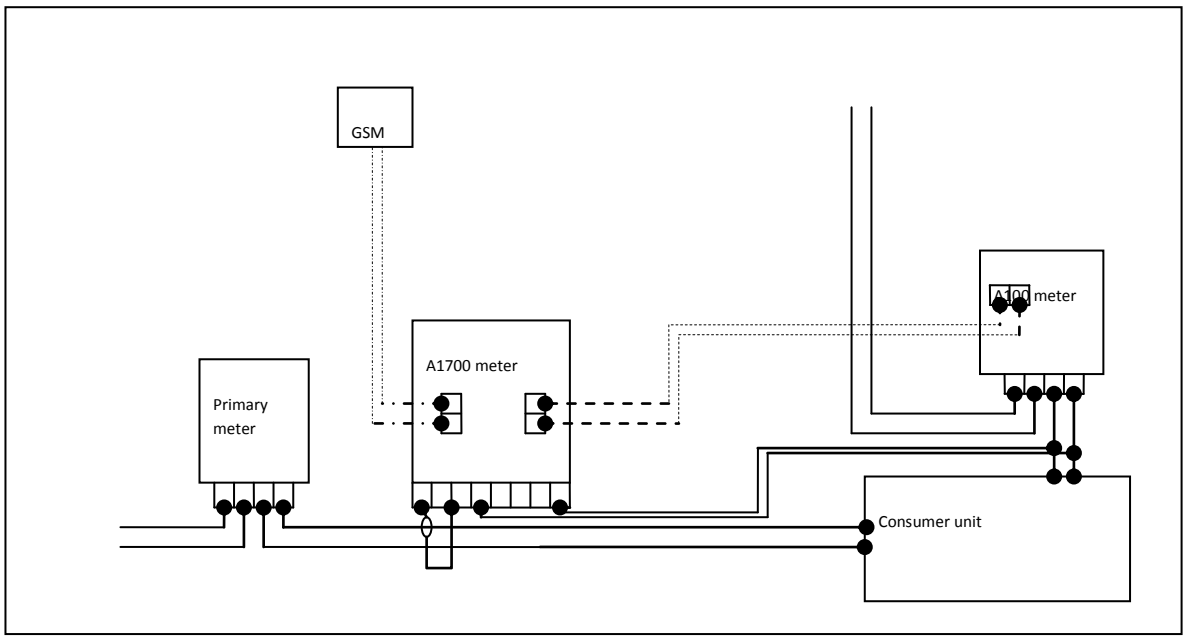

Figure 4 Split Current Transformer Meter Arrangement

7.6 Installation

Installations were carried out by ECS staff apart from a small number of cases, specifically one site in London, all the sites in Northern Ireland (carried out by NIE) and those at the Lovell sites (carried out by Central Networks). To manage the installation process, ECS was responsible for arranging appointments at sites. BEAMA provided a SIM card and a record sheet for the engineer to note the site installation details. This could be forwarded to BEAMA if there was no contact during the installation. It was preferred for ECS staff to contact BEAMA during installations so that any problems with the meter communications could be identified before the engineer left the site. In most cases the installation was carried out in a single visit and seldom took more than a few hours to carry out. Happily this caused little disruption to customers and no complaints were received from any customers about the installations.

7.7 Data Downloading

Figure 5 shows a diagram of the data collecting base station arrangement. This system was designed around the Elster Meridian data collection software system. BEAMA obtained a License for Meridian, which provided a number of key functions for the project:

- Data downloading from the Elster A1700 meters

  The remote data access protocol for the A1700 is specific to the meter and not an open standard. There was the possibility to obtain of copy of the protocol from Elster and write a bespoke software package to carry out this function. However, a calculation showed that this would have the same cost as purchasing the software package and would introduce an ongoing risk of software failure, whereas the Meridian software would be provided with full technical and software support.

  The Meridian software contained appropriate drivers to link to the meters and retrieve the data from the meters. It also had facilities to programme scheduled data downloads. By and large, these greatly reduced the time needed to collect the data. However, it was still necessary to check that there had been no fault during the data download. This necessitated an individual inspection of each data set and a repeat of the data call if there was a fault. One characteristic of the data download process was that, if there was a loss of communications, then all of the data that had been downloaded up to that point was lost. This meant that the repeat data call had to begin from the point of the last successful data download. This could not be automatically programmed so that a spreadsheet had to be set up and maintained with the last successful download date. Using the data in this spreadsheet, repeat data calls would be programmed.

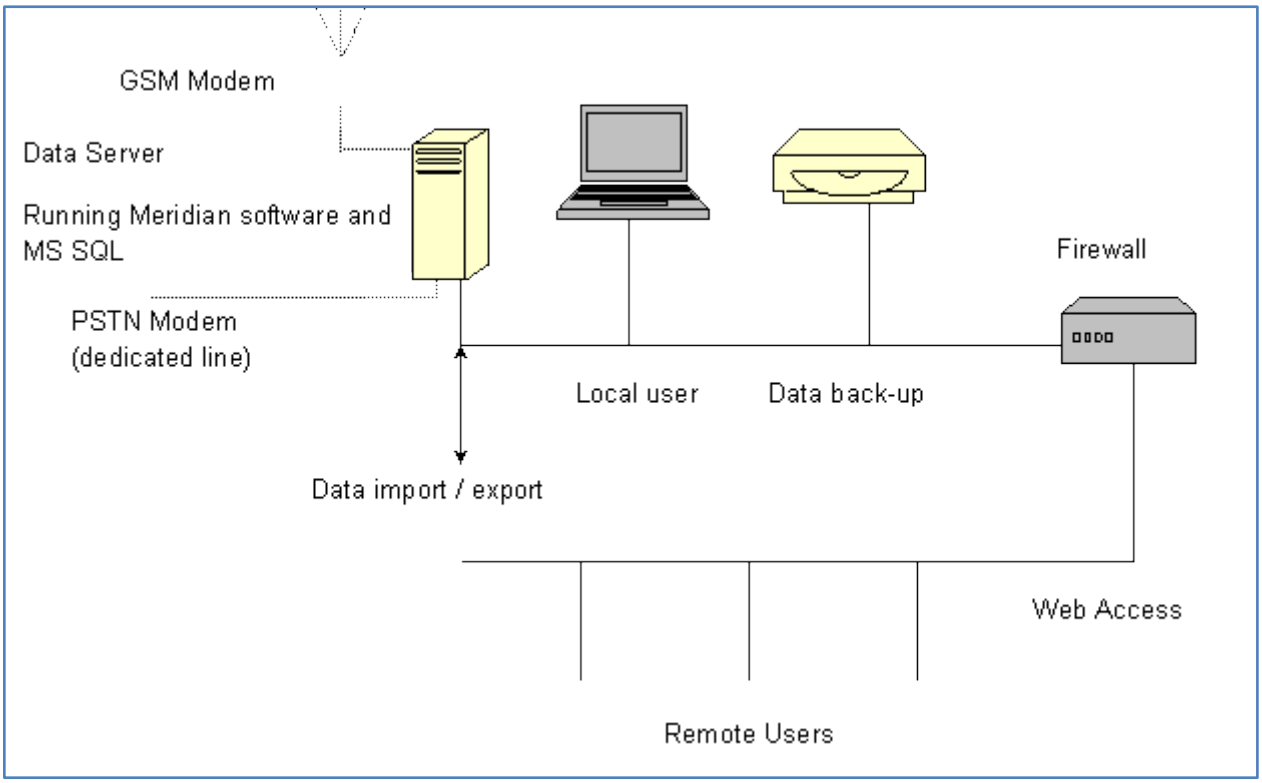

Figure 5 Data Collection Base Station

7.7.1 DATA STORAGE

The Meridian software was designed for use collecting billing meter data and data integrity was a key concern of the software. All data downloaded was stored in an SQL data base with each data value linked to time and meter data. Any processing of the data was carried out on copies of the raw data and the raw data was fully protected. The data could be examined using reports. These reports could be programmed to display the raw data for specified meter channels and periods. The software also allowed the data to be displayed on a graph.

7.7.2 DATA ANALYSIS

One drawback to using the Meridian software was that its purpose was for collecting and analyzing billing meter data. It was found that the analysis functions provided were insufficient for this project. The major lack was the ability to compare data for different time periods from a single site; a key requirement when producing profile data. This lack led to the need for exporting the data from the SQL database and importing it into other tools.

7.7.3 DATA EXPORT

The Meridian software contained a function for exporting the data in XML format. Unfortunately, there was no detail available for the data formatting and it was not considered worthwhile working this out. In practice it was found to be easier to extract the data direct from the SQL data tables. EA Technology developed an Access data base and set up a series of data links between the SQL and Access data bases. One important choice made was

that the EA Technology data analysis would only be on 30 minute resolution data. Thus all the data exported was in 30 minute resolution and there was no facility for exporting the 5 minute resolution data. This remains as a task to be done after the project so that the project participants can have access to the full data set in a form that they can use in their normal data analysis tools.

7.7.4 DATA IMPORT

The Carbon Trust passed data to the project as a series of Excel data files. It was agreed that these should be imported into the Meridian data base so that the EA Technology data analysis tools could be used for all the data. Meridian had a data import function but the data had to in a specific format to be accepted. BEAMA was responsible for working out the necessary format and checking that the data was imported correctly. Once this had been done a series of spreadsheets macros were written to import various data files. Once this had been set up the Carbon Trust data could be imported into the SQL data base in the form of virtual meters.

7.8 Data Analysis Sharing

BEAMA purchased a computer server to run the Meridian software and to store the downloaded data. BEAMA included the stored data in its data backup process. Remote access to the server was provided to EA Technology so that they could both process and analyse the data. This remote access was password protected to ensure that the privacy of the trial sites.

8 METROLOGY

There were a number of features of the data collection system that require elucidation here:

8.1 Data Accuracy

The meters purchased were Class 2, meaning they had a maximum error of 2% across their range. Advice from Elster was that the A1700 meter maintained good linearity down to low current levels although no quantitative evidence was received for this.

The meters were certificated by OFGEM for use in legal metrology. The Certificates are shown in Appendix G Meter Certificates. This Certification also allowed the A100 meters to be used by customers to qualify for ROC's under the OFGEM process.

8.2 Power Consumption

8.2.1 IMPORT EXPORT METER

The meters installed had their own power consumption which slightly affected the quantities measured. The import export meter had an approximate power consumption of 4W (maximum allowance for a complex meter is 5W). This power is drawn from the supply side of the meter. This is so that the cost of providing the energy normally falls on the Supplier. In this case, the meter is fully contained in the property so the power drawn in added to the house consumption. At 4W, the meter would consume 35kWh per year. This would appear as extra consumption. It is considered to be negligibly low compared to the consumption of most houses in the trial as the typical annual consumptions seen were of the order 2000 – 5000 kWh.

Power A1700 meter in the split current transformer was drawn from the supply line to the generator. This did not affect the generation output reading as the A100 meter was sited closer to the generator than the A1700 supply tappings. The net effect on the measurements was identical to the secondary meter case.

8.2.2 GENERATION METER

The A100 meter is a simple meter and has lower power consumption, especially as it has no wireless communications facility. A power consumption of 2W could be assumed for these meters. The power would be drawn from the supply side of the meter again and so would appear to reduce the power output of the meter by 2W. Given that the nominal outputs of the generators were around 1kW, this would have a negligible effect on the data accuracy, of around 0.2% at full output. When the generator was not running the power would be drawn from the other side of the meter. This would not affect the generator output figures but would add an additional 2W onto the house consumption.

8.3 Time Synchronisation

All data values on the meters are time stamped. The meters have their own time reference but this is liable to drift over time. One of the functions available from the Meridian software is to synchronise the meter clock with the base server time setting. This was set as an automatic function for the data collection process to be carried out each time the meter was called. As the server was now acting as a time reference software was installed to synchronise the pc with accurate reference time signals on the Internet. The pc was synchronized at least once a month and no time steps of more than 10s were ever observed.

8.4 Time Standard

All time reference in the project is to GMT and neither the meters nor the server were changed to BST.

9 REVIEW OF DATA SET

Appendix E Site Details, shows a list of all sites registered in the project. Because of various issues, discussed below, not all sites were able to provide data for the analysis exercise as described in the BEAMA Report, Part II. In fact BEAMA imposed a very strict requirement for inclusion in its data analysis; specifically a full data set across the months June 2006 – May 2007. This was imposed in consequence of the scope of the data analysis to be carried out by BEAMA. Indeed there is a considerable amount of data that has not been subject to analysis. Appendix E Site Details also shows the generator technology, nominal capacity and the months for which a full data set was collected.

Regarding the sites that did meet this requirement, there were a total of 88 sites that were used in the analysis. For all of the sites one calendar year of 30 minute data has been used (June 2006 – May 2007). Table 9-1 shows the details of the groups of sites for different technologies.

For a few sites one of either import or export was unobtainable (usually because the locations of the import and generation meters were too far apart) and for these sites the consumption could not be calculated. Such sites were simply been omitted from the graphs where appropriate.

Site Group	Comments
Photo voltaic (PV)	31 sites of around 1kW capacity
Large Wind	4 sites, each of 20kW capacity located in Northern Ireland.

Small Wind	9 sites, varying from 2.5 – 5 kW capacity, located in Northern Ireland, the Midlands and South East England. These have been dealt with separately from the large wind sites because of a concern that their behavior might be intrinsically different to larger turbines and also because their larger output would skew the analysis.
Hydro	1 site (this site experienced extended difficulties with GSM communications, resulting in there only being reliable register data available for analysis). This site could not be statistically valid but was included simply to give some understanding of the operation al profile of hydro sites.
Carbon Trust DCHP	8 sites with 1kW WhisperGen microCHP units. The data for these sites was provided by the Carbon Trust under an exchange agreement with this project. The data came from the Carbon Trust's Small Scale CHP Pilot Field Trial programme. These sites were not fitted with heat stores.
Lovell DCHP	35 sites with 1kW WhisperGen microCHP units. These were all installed in Lovell's building development in Manchester. These sites were fitted with heat stores.
Total Sites	88 sites

Table 9-1 Site Summary

This study has not examined the particular conditions at sites because the objective was to obtain representative data of actual performance; it was not necessary to explain the performance, rather the objective was simply to record the output from a sample of sites. In the course of the project information was obtained regarding the individual sites and this could be used for further analysis but this was beyond the scope of this project.

Although the project scope did require the collection of detailed site data, it was considered useful to collect some data on them to address questions such as the make of generator and nominal output. To gather this data a questionnaire was sent to sites to gather background data. A copy of this Questionnaire is shown in Appendix H Customer Questionnaire.

10 DATA COLLECTION ISSUES

Unfortunately, data collection did not proceed smoothly throughout the project. There were a number of issues that impacted on data collection.

Mis-programmed Modems

For the final phase of installations, Elster provided BEAMA with some battery backed GSM modems. Instead of requiring a separate mains supply to meet the peak power demand of the modem during communications, they were fitted with a battery. This battery met the peak power demand during communications and was trickle charged from the meter power supply at other times. This design made installation simpler and eliminated a possible source of unreliability. However, the modems supplied by Elster had been previously used and although refurbished it had not been known that the communications settings had been altered. The meter communications port and the modem have to be able to communicate. This means that the settings for the RS-

232 interface are correct. In this case, for some modems, the baud rate had been moved from 9600, as was expected by the meter. This fault only came to light at a later date after the ECS engineers had carried out a number of installations. It was possible to connect with the modem from the base station, but the modem could not exchange data with the meter. It was not possible to re-programme these modems remotely (this is possible with some) so they could only be fixed by a site visit. Regrettably, it was not possible for ECS to make any repeat visits and so it was not possible to collect any data from those sites. There were a number of sites close enough to BEAMA staff to allow a visit to re-set the modems and these sites were able to provide data for the project.

- Meter communications unreliable

  As was discussed earlier, several sites suffered from unreliable communications. This ranged from very few sites that could never be contacted; some that were called just a few times during the project and many more that would regularly require repeat calls. The main significance of these failed calls depended on the length between successful calls. The meters contained a store for 21,600 data values. This data store scrolls continuously as new data was added. When a data call is made the requested data range is communicated to the base station. There is a danger that, if the previous call was so too long ago, the first data values will have been overwritten by more recent data. For 3 channels and 5 minute resolution data, there are 25 days of data capacity. Thus, so long as there was a successful data call within 25 days, then the data could be recovered. If the interval between data calls exceeded 25 days, then there would be data permanently lost.

  As a substitute for the full profile data, the meters record register data values every 3 months. These registers were available for download for 3 months without losing any data, giving much more scope to collect this data from hard to read sites.

- Site behavior unsuitable

  A number of microCHP sites were found not to utilise their generators and so did not provide any useful data. This was a consequence of how these sites were recruited. Unlike the other sites, the microCHP sites were pre-installed in houses before customers moved in. Thus there was no specific commitment to the generators on the part of the householders. Because the meters had to be installed with the generators it was not feasible to recruit customers after they moved in and decided if they were going to use the generators. Thus it was simply accepted that these sites would have to be rejected. Although the sites did not produce any generation and export data they were monitored and did provide consumption profiles. This could be used to compare against the active sites.

  A number of the wind sites were observed to suspend operation on occasion. It was not clear why this happened although feedback received via Gastec site visits suggest that there were problems with a number of generators. Despite these shut downs the data from these sites was not eliminated because it was felt be a feature of current experience with wind generators.

  PV sites were never seen to suspend operation.

11 CONCLUSIONS

1 The project has collected real import, export and generation data for 153 microgeneration sites. This provides real performance data for microCHP, PV and wind systems.

2 The data logging system, based on utility metering and software has proven very reliable and well matched to the task.

3 A series of major issues have confronted the project, largely related to the availability of appropriate sites and authority to carry out meter installation. All of these issues have been dealt with but they have had serious effects on the project schedule, adding 2 years to the original plan. The project has stayed within budget and quality targets.

4 Despite the delays, the data collection system has operated well and has supplied the data needed to meet the original project scope.

12 ACKNOWLEDGEMENTS

The author would like to acknowledge the major contribution to this project made by Tony Rabone of ECS, without whom few of the meters would have been installed, and Robert Steele of Elster Meters, without whom little data would have been collected from them.

APPENDIX A BEAMA SITE APPEAL

METERING AND MONITORING OF DOMESTIC EMBEDDED GENERATION

Wanted – < 30kW, Grid Connected, Wind and Hydro Generation Sites

BEAMA is leading a DTI funded project that aims to increase the rewards for small generators who export surplus electricity onto the grid.

Background

Exporting surplus power from a small embedded generator is easily done, provided the appropriate regulations are observed. Getting paid for the electricity is not so straightforward. Until recently all exports had to be recorded with half hourly metering. The cost of the meter, data communication and processing could easily exceed the value of the exports. This meant that this value was lost even though it could make all the difference to the economics of the generator.

Now, there has been a modification to the regulations (P81) that permits small generators to record only a single kWh figure for their exports and have the value of their electricity worked out by relating it to an assumed profile (in the same way that domestic customers demand profile is determined). Currently this is limited to generators with outputs less than 16A/phase, but it expected to be revised upwards to include generators with a nominal output of 30kW or less.

Challenge

To work though, this scheme needs accurate export profiles and this project has been established to provide them. The project remit covers microCHP, photo voltaic, wind and hydro and a total of up to 200 sites will be monitored for at least one year to produce import / export and generation profiles.

Requirement for Sites

BEAMA has identified sufficient photo voltaic and DCHP sites but is keen to identify up to 40 wind and hydro sites. The generators should be grid connected and the nominal output should be less than 30 kW.

Offering

Any sites selected in the trial will have meters installed to measure import, export and generation free of charge. The meters are GSM enabled and the meters will be read remotely. At the end of the trial the ownership of the meters will be transferred to the host site. The meters will be in addition to the existing primary meter.

Request

APPENDIX B CUSTOMER FAQ'S

Metering of Embedded Generation Project

Frequently Asked Questions

1) THE PROJECT

What is the aim of the project?
The aim of the project is to gather information about the amount of electricity transported into the national grid from a site with a renewable generator. This data will be assessed and provided to the central electricity settlement systems, so that in the future small generators can receive an income for the export of their generation without having to have expensive metering equipment installed.

Why is it so difficult for household generators to get paid to export into the grid?
The regulations governing the electricity industry never expected to have to deal with export from such small-scale household generators. The infrastructure at the moment is biased one-way, so that electricity can only easily be withdrawn from the grid for property supply. The purpose of projects such as this one is to increase the ease of small-scale export and to reduce the costs.

Who has set up the project?
The project was set up by a number of electricity suppliers, generator manufacturers and metering companies with the support of the Department of Trade and Industry and the GB electricity regulator OFGEM.

The group has a key aim- to see a change in metering requirements for houses with an onsite renewable or micro CHP generator. Once metering difficulties are overcome, it will help clear the path for small-scale renewable generation.

Who will get the data?
Processed data from this project will be passed on to Elexon, who manage the electricity trading arrangements in England & Wales, and Northern Ireland Electricity.

How is the data being assessed?
The import and export data from each property will be interpreted to create profiles for properties with on-site generators. This will help us to better understand how generators of this kind affect energy usage.

Who is participating in the project?
There are about 180 micro-generation sites taking part in the project. These will cover a range of generators including solar panels, small-scale wind, hydro-electric turbines and combined heat & power, CHP, systems. The generator size will range from less than 1kW up to 30kW in capacity.

How long is the project duration?

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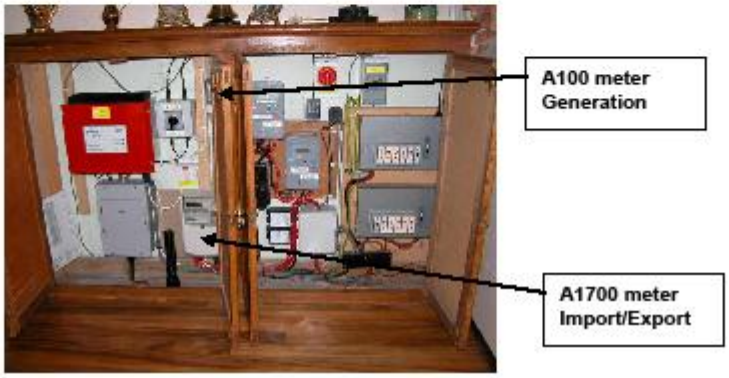
The project is scheduled to run for 24 months. We are aiming to start our process in summer 2004, finishing by the middle of 2006.

2). THE PARTICIPANT

What will happen if I take part?
On being accepted into the trial, 2 additional electricity meters will be installed at your property. The data from these will be collected and analysed over the 18 month project duration. The photograph below shows the installation at one of the first sites.



There are a total of four meters in the photo; the import and export meters used for billing that were there before. In addition there are now the generation and import/export meters fitted by us. You may not have an export meter. The import export meter that we fit will not be counted as a billing meter. Your supplier will not be able to use the readings from it for billing purposes. The project is independent of the billing process.

What is your benefit for helping the project?
Firstly you will be helping us to test new metering systems and collect data on your electricity usage. This will enable us to lobby forward and change the present metering regulations, so that they are more supportive of micro generation in the future. You will also have a new meter installed at your site free of charge.

Will it affect my bill?
The project is being run completely independently from the billing system and the data collected will not affect your bill or any payments made to you for your generation.

Metering of Embedded Generation Project

Where will these meters be fitted and what will they read?
One of these meters will be fitted where your renewable generator is connected into your home electricity supply. This will record the total generation from your installation. The other meter will record the export and import of electricity between the property and the national grid. This meter will be placed close to your normal house meter. These meters will be clearly labelled to avoid any confusion with regards to meter reading.

How will the data be read?
Once these meters are in place, the data flowing through them will be read remotely. No-one will need to come and look at your meters, unless a fault were to occur.

Do I have to have so many meters?
Unfortunately, we cannot use the meters you already have for a number of reasons. Most importantly, they lack the communications channel that we need to read the meters remotely. It would also compromise our independence from your existing billing arrangements. Also, we cannot link your existing generation meter to the A1700 meter, whereas there is a purpose built data link between the A100 and A1700 meters.

What would you require of me?

- To allow us access for a site assessment and meter installation.
- To complete an Energy Usage questionnaire.
- To allow us access to check the meters, should it be necessary.
- To allow us to use the data for our project and pass it on to other project members.

3). BEING PART OF THE PROJECT

Who will install the meter?
Your meter will be installed by NIE Powerteam metering, a subsidiary of NIE.

When will they come and install the meter?
You will be contacted within the week by a NIE Powerteam staff member who will arrange to book an appointment to come in and look at the suitability of the site. Powerteam need to check that there is adequate space for the meters and the mobile phone signal is strong enough for the meter.

Assuming that the site is okay, they will then carry out the installation at an agreed time and date. The meters may be installed on the spot if the site is suitable and you and the Powerteam engineer are in agreement.

How will the installation contracts work?
You will have received two copies of the project contracts with this FAQ. They will both need to be signed before the installation takes place and a signed copy posted to us. One copy should be kept for your records.

If I want the meter removed at any point what do I do?

Metering of Embedded Generation Project

You will need to contact BEAMA at the address given on the Contract.

What support will I receive during the trial?
Within a week of the installation you will receive a letter from BEAMA containing a phone number for you to call if you have any problems or questions during the trial. BEAMA will endeavour to respond to questions within 3 working days. You will also be given the details of a web site where you can view the data being collected throughout the trial.

If there are any urgent problems with the installation who shall I call?
In the unlikely event of an urgent technical problem with your meter, the first point of call is NIE via the support number on your bill.

Can I have the data from the meter?
The total generation and export will be available for you to read on the meters. At the end of the project we will be able to provide you with a report detailing your profile.

Where can I see the progress of the project and find out further information?
There will be a website for you to find information on the project and its progress. This address will be supplied in the project information pack.

APPENDIX C CUSTOMER CONTRACT

Our Reference MDG/Contract/SP«Customer_ID»

Letter of agreement between BEAMA Ltd and xxx

(A) **Agreement to take part in** The Department Of Trade & Industry (the "DTI") investigation into the metering and monitoring of domestic embedded generation as part of DTI project reference number K/EL/00312/00/00 (the "DTI Project")

This letter of Agreement sets out the terms on which you, xxx, agree to participate in the DTI Project by having relevant metering equipment installed at your premises and to co-operate in the gathering of data from such equipment, in return for being provided with access to the information resulting from the DTI Project.

1. Your Obligations

1.1 You must allow access to your premises by BEAMA's subcontractors ECS Metering for the purpose of installing metering equipment. This may involve access to your telephone line and the charges resulting from this will be met by BEAMA. You must allow reasonable access to your premises by BEAMA's subcontractors ECS Metering when necessary to carry out support, servicing, maintenance or replacement of the installed metering equipment. In all cases at least 7 working days notice will be given when access to your premises is required, unless such notice is waived by you. BEAMA will make good any damage to property caused by us, our contractors or agents as a result of any of these activities. You must not damage the installed metering equipment

2. Our Obligations

2.1 Subject to you complying with the terms of this Letter of Agreement we shall provide you with access to reports and analysis of information resulting from the DTI Project 'Metering and Monitoring of Domestic Distributed Generation K/EL/00312/00/00'.

2.2 The installed metering equipment will be the property of BEAMA until the termination of this Letter of Agreement at which point ownership will transfer to you. If, however, the Letter of Agreement is terminated before the conclusion of the DTI Project BEAMA may retain ownership of and recover the installed metering equipment.

3. Length of the Agreement

3.1 This Letter of Agreement shall commence as soon as we have received the signed counterpart of this Letter of Agreement from you and will continue (subject to the provisions for early termination)

4. If you sell your premises or move

4.1 This Letter of Agreement will end if you sell your premises or move. Please endeavour to give us at least 10 working days notice.

5. Termination

MDG_Doc_041 Customer Contract

Our Reference MDG/Contract/SP«Customer_ID»

5.1 The Letter of Agreement will terminate automatically 18 months after the start of the agreement Either of us may, however, terminate this Letter of Agreement on 30 days written notice.

5.2 We may terminate this Letter of Agreement if you are in breach of its terms and/or if the electricity to your premises is disconnected by your relevant electricity supplier and/or you no longer require the supply of electricity to your premises and/or we have reason to believe that the Data you have provided to us is inaccurate.

6. Consequences of Termination

6.1 If we terminate for your breach or for reasons set out in paragraph 4.1 you shall no longer be entitled to any information in respect of any period beyond the date of termination.

7. Liability

7.1 Nothing in this contract excludes or limits our liability for death or personal injury resulting from our negligence or affects your statutory rights. Under no circumstances shall we have any liability arising in any way out of this Letter of Agreement, for indirect or consequential loss or economic loss including loss of profit, revenue or contract or third party claims.

8. Data

8.1 You agree that we can use all data obtained by us pursuant to this Agreement for any purpose (including the supply of such data to all other parties involved with this DTI Project) and that we shall have an irrevocable royalty free licence to use the Data for those such purposes. .

9. General

9.1 This Letter of Agreement forms a contract between BEAMA Ltd and you. No term of this Letter of Agreement is intended to confer a benefit on, or to be enforceable by, any person who is not a party to this Letter of Agreement.

9.2 We may assign any of our rights and obligations under the contract and subcontract any of our obligations.

9.3 This Letter of Agreement represents the entire agreement between us both concerning the subject matter of this Letter of Agreement and supersedes any previous agreements or understanding between us. Nothing in this Letter of Agreement shall exclude either party's rights in relation to any fraudulent misrepresentation by the other.

9.4 Any notice required to be given by you to us in writing under this Letter of Agreement should be addressed to John Parsons, BEAMA, Westminster Tower, 3 Albert Embankment, London SE1 7SL. Any notice required to be given by us to you in writing under this Letter of Agreement shall be to the signatory with the contact details set out in Schedule 1 unless otherwise agreed.

9.5 This Letter of Agreement is governed by the laws of England and we both submit to the exclusive jurisdiction of the courts of England and Wales.

MDG_Doc_041 Customer Contract

Our Reference MDG/Contract/SP«Customer_ID»

10. Signatures

BEAMAenergy Ltd	**Customer**
Signature:	Signature:
Name:	Name: xxx
Date:	Date:

13 APPENDIX D DATA ACQUISITION SPECIFICATION

Metering and Monitoring of Domestic Distributed Generation

Title: Data Collection System Design and Specification

Document Number: MDG_Doc_042

Site Metering and Communications Design

Detailed Requirements

This Table contains a list of requirements for the data collection system. It is split into a number of different sections. Each requirement is reviewed against the design presented in this report.

ID	Description	Value	Requirement	Status
	Data Collection System			
	Maximum number of sites	200	Shall	Meridian software is capable of serving > 200 sites Server will have data storage capacity for > 200 sites
	Data to be collected	Net Import Net Export Generation Consumption	Shall	Satisfied (via A1700 meter) Satisfied (via A1700 meter) Satisfied (via A100 meter) Satisfied (calculated onboard A1700 meter)
	Measured quantities	KWh active	Shall	Yes
	Resolution	½ hour profiles data	Shall	Yes
	Resolution can be increased remotely to higher frequency	1 minute profile data	Should	Minimum resolution of A1700 meter is 5 minutes. The resolution of the meter can be set remotely by Elster or ECS.

Version: 1.0 Author: John Parsons Date: 26th Feb 2004

Metering and Monitoring of Domestic Distributed Generation

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	Data availability	To project participants	Shall	Via web browser, password protected and variable access
		To host sites	Should	Via web browser, password protected. It is possible to generate automatic emails providing host sites with regular reports on their consumption.
	Download frequency	Daily	Shall	Yes. Can be set for any frequency.
	Reliability	< 1 failure during trial	Shall	Failure rate of meters is 0.25% per product life Life = 10 years No of meters = 400 Project life = 2 years Failure rate is linear Number of failures during project = 0.2
	Data quality			
	Accuracy	Class 2.0	Shall	Yes
	Data identification	All data to be time and site stamped	Shall	Yes
	Data verification			Yes
	Site identification	Two identifiers	Shall	Each site is identified within Meridian by a phone number and the serial number of the meter. The serial number will be used to verify that the correct site has been contacted.
	Site Issues			

Version: 1.0 Author: John Parsons Date: 26th Feb 2004

Metering and Monitoring of Domestic Distributed Generation

Title: Data Collection System Design and Specification

Document Number: MDG_Doc_042

	Local support required	None	Shall	None
	Local indication of data	None	Should	A1700 meter can be user programmed to read out some data (to be decided what this will be used for, if at all)
	Security			
	Meters adjustment	Requires password access	Shall	Yes
	Local storage capability	150 days of ½ hour data	Shall	A1700 has capacity for 450x30 min data points for 1 profile channel. We are using 3 channels, hence 150 days capacity.
	Health and Safety			Risk assessment to be carried out
	Approval of meters	OFGEM approved	Should	Yes. The meters are being used as secondary meters and so do not require approval. However, it may be necessary to use them as primary meters in some cases. Approval also ensures the quality of the data.
	Costs			
	Maximum meter set costs	< £500 each	Shall	Yes
	Communications costs	Zero (not included in	Should	Not possible.

Version: 1.0 Author: John Parsons Date: 26th Feb 2004

		project budget)		CLI option may require payment of £25/site GSM option will require payment of £5/month (minimum cost of £60/site) . Use of pay as you go SIM cards will reduce this cost to £0.71 per month.
	Installation costs			To be reviewed with ECS
	Data server costs	< £5000	Shall	Quote for < £2000 (using Small Business Server 2003, may not be compatible)
	Data manipulation	Will handle all basic data analysis automatically	Should	Meridian is capable of al basic data manipulation automatically
	Communications			
	Reliability	<1 meter data communications loss per month	Should	Assumed only, no data available to judge this on
	Data verification		Shall	Error checking routine used in Meridian communications protocols. The Administrator can set this.

APPENDIX E SITE DETAILS

This Appendix contains a Table listing all of the sites that were registered for data collection. A short postcode is included to indicate the location of the generator without revealing the location of the site. The Table shows the generator technology, nominal capacity (kW), months for which data was collected and comments on the site.

Site ID	AS_xxx	Technology	Capacity	01/05	02/05	03/05	04/05	05/05	06/05	07/05	08/05	09/05	10/05	11/05	12/05	01/06	02/06	03/06	04/06	05/06	06/06	07/06	08/06	09/06	10/06	11/06	12/06	01/07	02/07	03/07	04/07	05/07	06/07	07/07	Comments
153	--	solar	1.50																																
--	AS_001	dchp	1.00																																Data from Carbon Trust
--	AS_002	dchp	1.00																																Data from Carbon Trust
--	AS_003	dchp	1.00																																Data from Carbon Trust
--	AS_004	dchp	1.00																																Data from Carbon Trust
--	AS_005	dchp	1.00																																Data from Carbon Trust
--	AS_006	dchp	1.00																																Data from Carbon Trust
--	AS_007	dchp	1.00																																Data from Carbon Trust
--	AS_008	dchp	1.00																																Data from Carbon Trust
--	AS_013	dchp	1.00																																Data from Carbon Trust
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--	AS_027	dchp	1.00																																Data from Carbon Trust
--	AS_028	dchp	1.00																																Data from Carbon Trust
--	AS_029	dchp	1.00																																Data from Carbon Trust
27	AS_030	dchp	1.00																																
28	AS_031	dchp	1.00																																
29	AS_032	dchp	1.00																																
30	AS_033	dchp	1.00																																Generation signal not working, Import and export data gathered

Site ID	AS_xxx	Technology	Capacity	01/05	02/05	03/05	04/05	05/05	06/05	07/05	08/05	09/05	10/05	11/05	12/05	01/06	02/06	03/06	04/06	05/06	06/06	07/06	08/06	09/06	10/06	11/06	12/06	01/07	02/07	03/07	04/07	05/07	06/07	07/07	Comments
31	AS_034	dchp	1.00																																
32	AS_035	dchp	1.00																																
33	AS_036	dchp	1.00																																
34	AS_037	dchp	1.00																																No generation signal until 2/7. Import and export monitored throughout
35	AS_038	dchp	1.00																																
36	AS_039	dchp	1.00																																
40	AS_040	dchp	1.00																																
42	AS_041	dchp	1.00																																Data gathered but mCHP not used
44	AS_042	dchp	1.00																																
49	AS_043	dchp	1.00																																
50	AS_044	dchp	1.00																																
53	AS_045	dchp	1.00																																Generation meter installed in reverse, parasitic data only seen. Import and Export monitored
54	AS_046	dchp	1.00																																
55	AS_047	dchp	1.00																																
56	AS_048	dchp	1.00																																
57	AS_049	dchp	1.00																																
61	AS_050	dchp	1.00																																
62	AS_051	dchp	1.00																																
63	AS_052	dchp	1.00																																
64	AS_053	dchp	1.00																																
66	AS_054	dchp	1.00																																Data gathered but mCHP not used
69	AS_055	dchp	1.00																																
78	AS_056	dchp	1.00																																
79	AS_057	dchp	1.00																																
82	AS_058	dchp	1.00																																
60	AS_059	dchp	1.00																																
97	AS_060	dchp	1.00																																Carbon Trust Trial Site
84	AS_061	dchp	1.00																																Generation signal not working, Import and export data gathered
94	AS_062	dchp	1.00																																
95	AS_063	dchp	1.00																																Unusual operation observed
96	AS_064	dchp	1.00																																
45	AS_065	dchp	1.00																																Generation signal not working, Import and export data gathered
48	AS_066	dchp	1.00																																
70	AS_067	dchp	1.00																																mCHP in intermittent use
76	AS_068	dchp	1.00																																
77	AS_069	dchp	1.00																																Data gathered but mCHP not used

Site ID	AS_xxx	Technology	Capacity	01/05	02/05	03/05	04/05	05/05	06/05	07/05	08/05	09/05	10/05	11/05	12/05	01/06	02/06	03/06	04/06	05/06	06/06	07/06	08/06	09/06	10/06	11/06	12/06	01/07	02/07	03/07	04/07	05/07	06/07	07/07	Comments
81	AS_070	dchp	1.00																																
83	AS_071	dchp	1.00																																
39	AS_072	dchp	1.00																																Data gathered but mCHP not used
41	AS_073	dchp	1.00																																Data gathered but mCHP not used
46	AS_074	dchp	1.00																																
65	AS_075	dchp	1.00																																Generation signal installed 3/7
75	AS_076	dchp	1.00																																Unusual demand profile observed
109	AS_077	dchp	1.00																																
68	AS_084	dchp	1.00																																Carbon Trust Trial Site
74	AS_085	dchp	1.00																																Carbon Trust Trial Site
38	AS_086	dchp	1.00																																Carbon Trust Trial Site
67	AS_087	dchp	1.00																																Carbon Trust Trial Site
93	AS_089	dchp	1.00																																Carbon Trust Trial Site
59	AS_090	dchp	1.00																																Carbon Trust Trial Site
72	AS_091	dchp	1.00																																Carbon Trust Trial Site
73	AS_092	dchp	1.00																																Carbon Trust Trial Site
43	AS_093	dchp	1.00																																Carbon Trust Trial Site
47	AS_094	dchp	1.00																																Carbon Trust Trial Site
51	AS_095	dchp	1.00																																Carbon Trust Trial Site Modem failure caused data loss
98	AS_096	dchp	1.00																																Carbon Trust Trial Site Modem failure caused data loss
85	AS_097	dchp	1.00																																Carbon Trust Trial Site
52	AS_098	dchp	1.00																																Carbon Trust Trial Site
92	AS_099	dchp	1.00																																Carbon Trust Trial Site
1	AS_150	solar	1.20																																
2	AS_151	solar	2.88																																Partial data 2/7 - 4/7
3	AS_152	solar	1.20																																
4	AS_153	solar																																	
6	AS_154	solar	0.90																																
7	AS_155	solar	1.92																																
9	AS_156	solar																																	
10	AS_157	solar	1.44																																
11	AS_158_1	pv	2.50																																NIE Site - combined site (PV-Wind)
11	AS_159_2	Wind																																	NIE Site - combined site (PV-Wind)
12	AS_160_2	wind	20.00																																NIE Site
13	AS_161_2	wind	20.00																																NIE Site
14	AS_162_3	wind	20.00																																NIE Site, not much generation from 2/7 onwards
15	AS_163_2	wind	20.00																																NIE Site
18	AS_164	solar	0.96																																

Site ID	AS_xxx	Technology	Capacity	01/05	02/05	03/05	04/05	05/05	06/05	07/05	08/05	09/05	10/05	11/05	12/05	01/06	02/06	03/06	04/06	05/06	06/06	07/06	08/06	09/06	10/06	11/06	12/06	01/07	02/07	03/07	04/07	05/07	06/07	07/07	Comments
19	AS_165	solar	4.92																																
20	AS_166	solar	2.28																																
21	AS_167	solar																																	
23	AS_168	solar	0.00																																
24	AS_169	solar	5.00																																Partial data during highlighted month
25	AS_170	solar	1.44																																
26	AS_171_2	solar	2.23																																Partial data during highlighted month
26	AS_172_2	wind																																	
100	AS_173	solar	1.20																																
104	AS_174	wind	5.00																																
107	AS_175	solar	0.00																																Export and generation only
120	AS_176	solar	2.00																																
126	AS_177	solar																																	
127	AS_178	wind	0.00																																
135	AS_179	solar	2.88																																Communications fault during period highlighted
139	AS_180	solar	1.50																																Unresolved communications fault
140	AS_181	hydro	12.00																																Partial data recovered owing to poor communication link
141	AS_182	solar	0.96																																
157	AS_183	solar	1.50																																GSM signal too weak
158	AS_184	solar	3.40																																
209	AS_185	solar	2.00																																
119	AS_186	solar																																	Export and generation only
122	AS_187	solar	0.00																																Export and generation only
125	AS_188	solar	0.00																																Export and generation only
133	AS_189	solar	0.00																																
8	AS_190	wind	2.50																																no import/export data - generation only
8	AS_191	solar																																	
171	AS_193	solar	0.00																																Export and generation only
101		solar	0.00																																Unresolved communications fault
103		wind	2.50																																no import/export data - generation only
103_1		solar																																	no import/export data - generation only
103_2		solar																																	no import/export data - generation only
103_3		solar																																	no import/export data - generation only
105		solar	1.00																																Unresolved communications fault

Site ID	AS_xxx	Technology	Capacity	01/05	02/05	03/05	04/05	05/05	06/05	07/05	08/05	09/05	10/05	11/05	12/05	01/06	02/06	03/06	04/06	05/06	06/06	07/06	08/06	09/06	10/06	11/06	12/06	01/07	02/07	03/07	04/07	05/07	06/07	07/07	Comments
106		solar	1.00																																Unresolved communications fault
108		solar	0.00																																Unresolved communications fault
110	AS_191	solar	1.50																																Unresolved communications fault
113		solar	2.00																																Unresolved communications fault
114		solar	4.80																																No generation data, import/export only
115	AS_192	wind	2.50																																Partial data during highlighted months
121		solar	0.00																																Unresolved communications fault
130		wind 1	5.00																																Partial data during highlighted months
130		wind 2	6.00																																Partial data during highlighted months
137		solar	0.00																																Unresolved communications fault
154		solar	0.00																																Unresolved communications fault
155		solar																																	Unresolved communications fault
156		solar	0.00																																Unresolved communications fault
159		solar	4.80																																Unresolved communications fault

Table 0-1 Site Data Collection Summary

14 APPENDIX F METER DETAILS

A100

BS Series of Electronic Single Phase Meters

Advanced domestic metering...

Features

- Accuracy - kWh Class 1 or Class 2
- kWh import or kWh import/export
- 20 years certified life
- Large digit (7.5mm) multilingual display with chevron information indication
- IrDA (Infrared Data Association) output for transmitting billing, security and status data
- 12kV impulse withstand
- BS double insulated, glass filled polycarbonate case
- High security, compact design
- IP53 in accordance with IEC 60529:1989

Options

- One or two rates controlled by external device
- Auxiliary terminals configured for rate selection (two rate meters) and pulsing output or serial data output
- RJ11 socket configured as pulsing output or serial data output
- Pulsed output (IEC 62053-31)
- Extended terminal cover
- A102 - kWh and kvarh energy measurement

The successful A100 range of meters from Elster Metering Systems has been enhanced. The range provides an extremely cost-effective solution for one or two rate domestic applications. The use of leading edge electronic metering technology ensures outstanding accuracy and a long service life. Serial communications and security data are provided as standard.

The liquid crystal display has large (7.5mm), high contrast characters that are viewable over a wide angle. Chevrons and multilingual legends on the nameplate identify the values being displayed. The energy registers can be configured at manufacture for the required number of digits and the position of the decimal point.

The A100 range of meters offer high security and detect many of the most commonly used tamper techniques. Security features of the meter include reverse run energy total and count; power fail and elapsed time count; hours in anti-creep; hours in Rate 1, Rate 2 and total on time. These are stored as security data and can be included as part of the display sequence.

Communications is provided via an IrDA port allowing the meter registers and security data to be read electronically using a hand-held device, greatly reducing the possibility of manual meter reading errors. As a manufacturing option the serial data output or the pulsed output can be transmitted via an RJ11 socket or the meters auxiliary terminals.

The A100 can be used as a simple import meter or for import/export schemes for domestic or small scale generation sites. The meters offer one or two rate operation. The rate select for the two rate meter is switch to neutral.

The A102 is an active/reactive meter ideally suited for utilities who wish to bill or monitor energy consumption based on kvarh measurement. The meter measures import or import and export energy.

Meters can be supplied to meet accuracy Class 1 or Class 2 requirements. They are approved to EN 61036:1996, have an ingress protection of IP53 to IEC 60529:1989 and comply with EMC standard EN50081-1 1992.

ELSTER

A1700 Alpha®

CT Metering

The Power to Change...

Features

- CT & CT/VT operated
- Comprehensive tariff structure
- 2 line dot matrix multi-lingual display
- Instantaneous instrumentation values
- Plug-in modules for extended functionality
- Communications via optical port or communications module
- 450 days of load profile data
- Internal clock and calendar with battery back-up
- Concealed utility/reset pushbutton
- 2 or 3 element availability
- Accuracy Class 0.2s, 0.5s, 1 or 2
- High security design

Options

- 4 relay outputs
- Range of interchangeable input/output and communications modules
- 900 days of load profile data
- Data stream communications mode

The A1700 meter offers outstanding measurement and complex tariff capabilities for use in both CT and CT/VT operated applications.

The meter features include a fully programmable customer defined display, an IEC 62056-21 port for local communications, two slots for the addition of input/output and communications modules and load profile data storage for up to 900 days. Data stream communications mode allows up to 90 days of data to be collected in less than 30 seconds.

Communications modules can be RS232 or RS485. A range of PSTN, or a GSM modem plug into the module directly under the meter terminal cover. An input module provides the ideal solution for multi-utility metering. Alternatively an output module increases the number of relays from four to eight. Windows™ 'Power Master Unit' software programs or reads the meter data.

The CT meter can be supplied to meet accuracy Class 0.2s, 0.5s, 1 or 2 and is fully compliant to EMC regulations EN 50081-1 and EN 50082-1.

ELSTER

15 APPENDIX G METER CERTIFICATES

Your Ref: A100

Our Ref: TD/EMES/APP/ABB/001

Date: 18 September 2000

Mr T A Adlington
ABB Metering Systems
Oulton Road
Stone
Staffordshire
ST15 0RS

Dear Mr T A Adlington

ELECTRICITY ACT 1989

APPROVAL OF NEW METER TYPE SD1 and SB1 see scope of approval

I enclose the Director General of Electricity Supply's approval of the construction and pattern of the above meter(s).

The meter(s) described above have been given a certification life of 20 years.

Yours sincerely

Mr Barry Johnson
Laboratory Manager

The Office of Gas and Electricity Markets
9 Tiger Road Wigston Leicester LE18 4YN Tel: 0116 276 5954 Fax: 0116 277 2537 Internet: www.ofgem.gov.uk

ofgem

Mr T Adlington
Elster Metering Systems
Tollgate Business Park
Beaconside
Stafford
Staffordshire
ST16 3HS

Your Ref:
Our Ref: TF/TS/MET/APP/21
Direct Dial: 020 7901 7124
Email: graham.fowles@ofgem.gov.uk

26th January 2005

Dear Mr Adlington

ELECTRICITY ACT 1989

Modification to Meter(s) Type PB2 & PB3 (A1700)

Approval Number 907, 911, 912, 913,& 914

I refer to your application requesting a modification approval to the above meter(s), the pattern and construction of which, have been approved.

The Office of Gas and Electricity Markets would advise you that the retesting, assessment and verification of characteristics against IEC 62053 series standards, does not constitute an alteration which would necessitate a re-approval of the meter(s) and that any meters incorporating the said modifications but being otherwise in accordance with the pattern and construction as aforesaid would be covered by the said approval(s).

Yours sincerely,

Technical Advisor

16 APPENDIX H CUSTOMER QUESTIONNAIRE

Metering and Monitoring of Embedded Domestic Generation

Site Questionnaire

Please answer as many questions as possible. Questions marked with an * are required

1*	Surname:	.....
2*	Postcode:	.....
3	e-mail (work):	.....
4	e-mail (home):	.....
5* Generator Information		.....
PV 1	Manufacturer	.....
	Nominal Capacity	.....
	Panel Size (m^2)	.....
PV 2	Manufacturer	.....
	Nominal Capacity	.....
	Panel Size (m^2)	.....
PV 3	Manufacturer	.....
	Nominal Capacity	.....
	Panel Size (m^2)	.....
Wind 1	Manufacturer	.....
	Nominal Capacity	.....
	Blade Length (m)	.....
Wind 2	Manufacturer	.....
	Nominal Capacity	.....
	Blade Length (m)	.....
Hydro	Manufacturer	.....
	Nominal Capacity (kW)	.....

6* What type of property is your property?

- Detached
- Semi Detached
- Mid Terrace
- End Terrace
- Flat
- Bungalow
- Other (please specify)

7 How many bedrooms do you have? .....

8 How old is your property?

- Pre 1919
- 1919-1944
- 1945-1964
- 1965-1984
- 1985-1996
- 1997 or Later

9 How many people within each of the following age ranges live permanently at your property?

	Number of people:
Under 2 years:	.....
2-10 years:	.....
11-20 years:	.....
21-34 years:	.....
35-64 years:	.....
65 or older:	.....

10 When is the house usually occupied?

- All home all day
- All out all day
- Some home all day
- Some home most of the day
- Other (please specify):----------

11* Do you have an immersion heater

- Yes
- No

Thank you for taking the time to complete this questionnaire.

John Parsons

REFERENCES

[i] K/EL/00312/00/00 Metering and Monitoring of Domestic Embedded Generation, Part II – Data Analysis, BEAMA Limited, John Parsons, October 2007

[ii] Impact of Profiles on Settlement Costs, EA Technology, Linda Hull, Rob Green and Bingning Dai, Report No: 6169, Project No: 45690, October 2007