DTI/OFGEM Embedded Generation Working Group
Rapporteur Contribution

Options For Domestic and Other Micro-Scale Generation

08 January 2001

1 Introduction

1.1 It is likely that in the future generating plant embedded in distribution networks will contribute a larger proportion of total national generation, considering the Government's policy objectives for renewable plant and CHP and the wish among developers to introduce various types of generating plant in distribution networks.

1.2 The proposed Directive on the Promotion of Electricity from Renewable Energy Sources states (Article 7, 5) that 'Member States shall consider the measures to be taken to facilitate access to the grid system of electricity from renewable energy sources. This report shall examine, inter alia, the feasibility of introducing two-way metering' (October 00 draft).

1.3 The UK is in the process of establishing a new renewable energy policy. The central plank of this will be an obligation on electricity suppliers to source a certain percentage of their supplies from renewable sources. Suppliers, in order to prove that they have sourced the requisite percentage of supply from renewables, will have to purchase renewable energy certificates (ROCs) which are awarded to metered renewable generation. More expensive domestic and other micro-scale generation, such as photovoltaics or domestic scale wind is unlikely to be purchased by Suppliers for their renewable obligation as they are not currently competitive with larger scale renewable generation, such as landfill gas or onshore wind energy, and such other micro-scale generation is often not metered.

1.4 Set against this background, and taking into account the new regulatory structure under which distribution companies will have to facilitate competition in generation and supply across their networks, this paper discusses the current situation and issues concerning the connection of domestic and other micro-scale generation and identifies possible options to facilitate increased levels of domestic and other micro-scale generation. To address this issue more fully, the original terms of reference set by the Embedded Generation Working Group for this paper have been revised.

1.5 The paper has chosen to define domestic and other micro-generation as being smaller than 30 kW. It is recognised that this figure is to some extent arbitrary and that there are a number of possible break points between micro and larger generation , which are discussed. This paper does not wish to define where this break point should be. What it intends to do is point out how domestic and other micro-scale generation is likely to be affected by the various recommendations made by the Embedded Generation Working Group in other

papers but also the ways that domestic and other micro-scale generation may face a specific set of difficulties.

1.6 As the proportion of domestic and other micro-scale generation increases, the technical and commercial questions relating to it will change over time.

1.7 While the paper sets out a number of options for change, the rapporteurs have not sought to select any 'preferred' option. That is a matter for OFGEM and HMG following more detailed work and full consultation with affected parties. In considering these options further, HMG and OFGEM should take account both the consensus comments set out in the options and recommendations sections of this paper and the points of view of the Network Operators, Generators, Suppliers and customer groups which are annexed.

2 Background – The Current Situation

2.1 The electricity market framework recognises the long tradition of investment by large customers in energy efficiency/generation and explicitly deals with the possibility. For instance, customers can elect to amend their distribution supply capacity and half hourly metering of imports and exports is the norm for such customers.

2.2 For smaller customers who are interested in self-generation, the electricity market framework has numerous differences of approach. For instance, customers are not able to reduce their maximum connection capacity. They are also assumed by their supplier to conform to one of a series of standard consumption profiles unless they (unusually) have half-hourly metering.

2.3 There is no natural break point between domestic and other micro-scale generation and larger generation. There are a number of points which can used as an artificial divide between types of generation. As a result there tends to be a variation in the experiences by generators on different sides of the break points for connection, charging and contractual relationships that they are required to enter in to. Examples of such break points are:

- generators with/without half hourly metering
- generators connected to
  - transmission network
  - distribution network (high voltage)
  - distribution network (low voltage – CT metered)
  - distribution network (low voltage – whole current – 3 phase)
  - distribution network (low voltage – whole current – single phase)

- generators whose capacity and/or exports cause reconfiguration to the network and those that do not
- generators that export significant amounts to the distribution network and those that do not
- generators that require payment for units exported and generators for which it is not a commercial necessity.

2.4 The Distribution Network Operators (DNOs) derive their allowed revenue under the current Price Control from (in part) the units distributed on the network. The main driver is, in reality, network capacity, for which distributed units are a proxy. The capacity requirement is derived from profiling units distributed as maximum demand and time of day usage for most non half-hourly metered customers is not available. This derived capacity is used to determine DUoS charges for non half-hourly metered customers.

2.5 Profiles are currently used for up to 100 kW demand capacity. Currently the Pool (and NETA in future) use 8 consumption profiles which would need to be augmented to capture the benefit of domestic and other micro-scale generation. However the current settlement system was set up with allowance for up to twenty profiles, so expansion of the number of profiles would not be limited by the system (see appendix 2 on profiles).

2.6 Domestic and other micro-scale generation is widespread in the USA. Thirty-four states have developed specific payment mechanisms for such generation and targeted where net exports were expected to be limited. Up until the point where generation equals imports, each unit is effectively valued by the customer and supplier at the import price. There is a variation in the arrangements for dealing with exported generation. In 31 of the 34 states, any generation that exceeds the consumer's consumption within the netting period is either valued at zero or a value less than import price. Thus, if a domestic and other micro generator generates more than it consumes on site, the average value of electricity generated is less than 100% of import price.

2.7 With respect to net energy tariff schemes in the US, both capacity limits (individual customers) in some states and maximum penetration limits (gross level) in others are imposed to avoid technical problems and unduly high costs to distributors and suppliers.

2.8 Similar approaches apply in Germany, France and the Netherlands (amongst many others such as Australia) for customer-generation, which takes place outside the renewable energy support programmes.

3 The Future Situation

3.1 In a level playing field, domestic and other micro-scale generation should not be treated any differently from any other forms of embedded generation. However, in practise, such equity may still leave small-scale generators at a disadvantage. Domestic and other micro-scale generators would like a simplified charging mechanism and simple technical requirements for connection that allows them to connect to the networks easily and quickly, with transparent charging and payment systems.

3.2 Whilst there are only limited amounts of domestic and other micro-scale generation at the moment it is anticipated that there will be a significant increase in the domestic and other domestic and other micro-scale generation connected to the distribution network. This is in part to do with Government targets (renewables and CHP) but also due to technological advances, lifestyle changes and the growth in participation in the 'knowledge economy' with individuals wishing to take control over more activities in their lives, such as being a customer-generator. Equally, those customers who choose to continue to receive their electricity (and other utilities) from the incumbent suppliers will look for equity of treatment.

3.3 It is clear that self generation has the potential to radically alter the import profile of a small customer. In turn, self generation will have the potential to alter the needs of the customer for distribution services, transmission services, supply of external electricity and also may create a need for an export purchase service.

3.4 The freedom of choice to become a customer-generator may itself be of great value to that customer.

4 Issues for Domestic and Other Micro-scale Generation

4.1 Issues Summary

4.1.1 Domestic and other micro-scale generators are faced with a number of decisions, possible costs and possible charges when setting up their systems. The key issues relate to:-

- meter arrangements for measuring the domestic and other micro-scale generation output, export and import units and maximum demand
- technical requirements for connection to the distribution network to enable 'parallel' operation
- the connection charge

- tariff mechanisms (via metering, profiles and fixed charges) for use of the transmission and the distribution system, selling domestic and other micro-scale generation exports and buying imported electricity

Each of these key issues are dealt with in more detail below.

4.1.2 All of these issues interact with each other and for domestic and other micro-scale generation to be a viable option they will have to be resolved to the satisfaction of all involved parties (customer-generator, NGC, DNOs, Suppliers and the customer community).

4.1.3 The current standard consumption profiles do not cater for non-half hourly metered generation and so either additional profiles or a cheap and appropriate form of half-hourly metering is required.

4.1.4 The governance of profiles rests with the Balancing and Settlement Code and the profiling processes are embedded within the Trading Stage 2 system. Reform of the profiling processes to deal with small customers who self-generate will require special attention, as will the issue of who should pay for development and incorporation of new profiles.

4.1.5 Further attention will be required in relation to the proposed Renewable Obligation. Currently, it is intended that a renewable obligation certificate (ROC) will be awarded to a generator who can provide proof to OFGEM of their generation sale to a Supplier. The majority of domestic and other micro-scale generation would currently be ineligible for ROCs.

4.2 Metering Issues

4.2.1 To define options for metering arrangements for domestic and other micro-scale generation a number of terms need to be defined for clarity. There are defined below and used in the rest of this document.

Meter types

Single Direction Meter	This is the most widely used metering arrangement in the UK which is designed to run forward (ie advance the meter register) when electricity is imported, but does not run backwards if electricity is exported. This may be a single register or dual register (ie economy seven) meter. It may also be a card operated meter.

Bi-directional meter (sometimes known as 'two way' metering)	This type of meter is designed to run forward when electricity is imported, and backwards when it is exported. The register records the 'net' result.
Import-export meter	This type of meter records both imported electricity and exported electricity on two separate registers.
Generator production meter	A meter (single register) directly connected to the generating set, which would record the generation output irrespective of consumption on site. This metering arrangement would be of value if there were a way for customer-generators to benefit from Renewable Obligation Certificates.
Half-hourly metering	A meter which records imports and exports summated in each half hour period. There are a number of cost/technology options within this general group, for example differing data collection techniques.
Charging arrangements	
Net energy tariff (sometimes known as net metering)	Where the price paid to a customer-generator for an exported kWh is equal to the price paid by the customer-generator for an imported kWh. This can be achieved by only charging for the *net* electricity imported (using a bi-directional meter), or by assigning equal prices for import and export when using an import-export meter. An agreement is required for the payment of net exports in both cases.
Netting period	The netting period is an agreed time period in a net energy tariff during which imports and exports are accounted.
Dual energy tariff	Where the price paid to a customer-generator for an exported kWh is different to the price paid by the customer-generator for an imported kWh.

4.2.2 The tariff options for generator-customers, and the different metering types are illustrated in Appendix 1 with a 'typical' usage and generation output to show how each meter arrangement would record imports and exports.

4.2.3 A careful review of the metering arrangements shown in Appendix 1 together with the load flow examples shown in Appendix 2 shows the following points:-

- The impact of domestic and other micro-scale generation on the load flow at the meter terminal (with illustrative values only) can be seen by comparing the 'load profile' chart with the 'electricity flow at the meter position' chart in each example in Appendix 2. The profiles have been simplified for clarity.

- Comparison of the profiles shows that the existing load profile of a conventional customer with no on-site generation (shown as the 'load profile') is considerably altered if on-site generation is added (shown as electricity flow at meter position) for both examples.

- It should also be noted that the type of generation has a considerable effect on the resulting profile of import / export from / to the network (by comparing the load flow at the meter position) as shown in the two examples.

- In the first example the addition of on-site generation has no impact on the maximum capacity imported from the network, whilst in the second example the maximum import demand is reduced and there are several changes of direction of the electricity flow during the twenty four hour period.

4.3 Technical Issues

4.3.1 As with all connection of generation to networks there are legal and safety issues (for DNOs and customers) to be considered when accepting domestic and other micro-scale generators to run in parallel with the incoming supply. Without suitable protection arrangements the generator could continue to supply faults out on the distribution network, or be damaged when a network supply is restored following an outage. Nevertheless these problems are not insoluble and progress has already been made in addressing these issues.

4.3.2 In the UK, small inverter-connected photo-voltaic (PV) systems up to 5 kW peak capacity may connect to the distribution network, provided they comply with Engineering Recommendation G77. All other forms of domestic and other micro-scale generation must comply with (the more complex)

Engineering Recommendation G59/1, regardless of size and whether or not they are inverter-connected. Compliance with G59/1 places a significant technical compliance cost on domestic and other micro-scale generators.

4.3.3 Issues relating to harmonics, voltage limits, network design or cumulative impact on the network may all make connection of such generation technically complex or cost prohibitive. This is dealt with in general in the Embedded Generation Working Group Charging Principles paper. Domestic and Other Micro-Scale Generation would expect to be charged for their connection to and use of system. However, it may be preferable that they pay via a simplified charging structure.

4.4 Connection Charge Issues

4.4.1 A critical issue for a domestic and other micro-scale generator relates to cost of connection to the distribution network. A description of the current connection charging mechanism is set out in the Embedded Generation Working Group Charging Principles paper. That paper puts forward a number of recommendations for change. It is expected that domestic and other micro-scale generation will benefit from those changes to some extent. Nevertheless, domestic and other micro-generation offers some particular problems for connection charging and these are explained below.

4.4.2 The capacity requirement of connection to the distribution network, whether for demand or generation, largely determine the capital (and therefore maintenance) costs of the network. When a Distribution Network Operator (DNO) works out the cost of connecting a domestic housing estate to the network a number of assumptions are made. It will provide each property with a certain capacity of connection. However that household will not use the maximum capacity all the time and the maximum demand of each household in the area will not coincide. As a result the DNO makes use of this diversity when calculating the required network capacity throughout the network and at higher voltages. At present, the DNO may then make an allowance against the connection cost for the estimated future revenue from DUoS. These allowances may be reduced if it is known at the time of calculation that there will be on site generation.

4.4.3 However, if an established load-only customer household subsequently becomes a customer-generator, the energy to that customer through the network will reduce and hence the DUoS revenue will fall. The DNO total costs would remain the same as it has to maintain the network. Therefore, under the current charging methodology, the DUoS charges to all customers would rise, albeit minimally given limited customer-generation, as a result. This may be affected by revised charging mechanism (as put forward in the Charging Principles paper).

4.4.4 Facilitating competition is a licence requirement of DNO, but may result in loss of DUoS revenue from their licensed area which cannot be recovered (as they are restricted to their licensed area, and not subject to direct competition, hence regulated). Similarly if a load-only customer becomes a customer-generator their unit consumption will reduce and suppliers may lose revenue.

4.5 Tariff Issues

4.5.1 The DNOs major revenue driver is presently from the DUoS charge on each unit distributed for Suppliers. Generators do not currently pay DUoS on their exports. However, DNOs would expect DUoS to be paid to them on all imports to customers and size the network capacity based on the maximum demand.

4.5.2 Any arrangement of 'net metering' impacts on these assumptions above.

4.5.3 Suppliers may contract bi-laterally with any customers. Suppliers may agree a bi-lateral contract based on a customer-generator's half-hourly demand and for export. In all situations, suppliers would expect to pay for the generation they buy and to be paid for the electricity that they supply. In addition, suppliers would expect payment for metering and billing. There is a large population of customers and considerable historic data which has been used to create profiles and hence the probability of error is small. If profiles were to be used for energy billing purposes for generation the population will be small and there will only be limited data available. Hence in the short term, at least, there is a potential for significant error in the settlement position where profiles are used.

4.5.4 In the 'net metering' situation the audit trail for exported generation (units exported into the DNO network) cannot be fully defined so as to explicitly allocate costs and benefits arising from the appearance of these units in the distribution network. Nevertheless the development and application of appropriate profiles would allow deemed allocation of these units and costs. Application of half-hourly metering would allow explicit (ultimate) allocation of these costs and values in the settlement process.

4.5.5 As a replacement for DuoS income annual capacity charges (ACC) could complement the ideas put forward in the Embedded Generation Working Group Charging Principles paper. A DNO could set an ACC (in a way to be decided following detailed discussions) to provide positive and negative locational signals for demand and generation within a distribution network area.

4.5.6 Combined with ACC charge could be a DUoS charge (not currently paid on exports) to be levied by DNOs to support the cost of providing the distribution

network to customers with other micro-scale generation to enable units to be exported. These charges would be levied on Suppliers who would pass them on to customers (in some form of their choosing).

4.5.7 DNOs and Suppliers consider that the use of an ACC removes one element of the risk that they have to cover off in their contractual offerings to all customers.

4.5.8 One implication of the use of an ACC is that it may reduce the incentive on DNOs to reduce losses.

5 Possible Options

5.1 There are a number of options based on a combination of meter and tariff arrangements which could facilitate domestic and other micro-scale generation.

5.2 The Meter arrangements shown in Appendix 1 could be combined with new profiles and annual capacity charges for Suppliers and DNOs to create a number of charging options as follows:-

[Meter arrangement 'A' - single direction meter, meter arrangement 'B' - bi-direction meter, meter arrangement 'C' - import / export metering]

Option 1 Meter arrangement A - provides information on imports, exports are not registered, existing load profile is used.

Option 2 Meter arrangement B - provides information on net imports or exports. It would enable a customer-generator to have a net energy tariff with a supplier, using the existing load profile.

Option 3 Meter arrangement C - provides information on gross imports and gross exports. It would enable a customer generator to have an import energy tariff and an export energy tariff. It would also facilitate a net energy tariff. These could be the same or different.

In addition, if customer -generators would like to gain the benefit of a Renewable Option Certificate (ROC) then it would need a Generation production meter added. These would be options 1a, 2a and 3a.

Option 4 Meter arrangement A - with an existing or revised import profile and (optionally) a separate export profile.

Option 5 Meter arrangement B - with the addition of an import profile and export profile.

Option 6 Meter arrangement C - with the addition of an import profile and export profile.

Option 7 Meter arrangement A - with the addition of an import profile and export profile and a capacity charge for DNOs.

Option 8 Meter arrangement B - with the addition of an import profile and export profile and a capacity charge for DNOs.

Option 9 Meter arrangement C - with the addition of an import profile and export profile and a capacity charge for DNOs.

Option 10 Half hourly metering with the information stored until the meter is read unless a communication link is established

5.3 The simplest arrangement is that generation output mainly used on site in the generator-customer premises. The existing single direction meter is used. In this case, when generation displaces imports, it is effectively valued by the customer at the import price. When generation results in export, the customer-generator is not paid for it. Revised profiles may be required by suppliers.

5.4 If the customer-generator wishes to be paid for their exports, they must enter some contractual agreement with a supplier or purchaser. The cheapest metering arrangement for a supplier would be to agree a contract using the existing single direction meter but linked to a profile, or profiles for both demand and generation.

5.5 If the generator-customer wishes to be paid for actual units exported then one option would be for it to negotiate a contract with the supplier which would value exported units at the same value as imported units. In this case a bi-directional meter could be installed.

5.6 If a meter which records imports and exports is installed, the range of contractual options for charging/payment increases. This meter arrangement allows the gross imports and exports to be known, although an additional (generation production) meter is required if the gross generation is required. Imports could be paid for with a (revised) profile. Exports could be paid for in conjunction with a new generator-export profile.

5.7 A generation production meter allows the renewable energy generation information to be captured. Currently, only the generation sold to a supplier via half-hourly metering would be eligible for a renewable obligation certificate (ROC). It would be very advantageous to domestic and other micro-scale generation if all renewable generation were awarded a ROC, whether the generated units are used on or off site.

5.8 An ultimate option would be to use a half-hourly import-export meter so that payment for generation could be related to its market value to the supplier. This is effectively the market today - the most expensive metering option but even then there are a number of technology options at increasing cost.

5.9 Each of these options above (apart from half-hourly metering) would need a methodology for

- providing the network operator with an appropriate revenue to support the ongoing provision of the network, either an ACC (for available capacity) or revised DUoS levels for generator-customers to avoid non-generator customers being disadvantaged (as per Charging Principles paper).
- Suppliers to create revised settlement profiles to reflect the on-site generation and for the settlement process to reflect the transactions that suppliers would need to make in the contractual market under NETA.

5.10 To enable domestic and other micro-scale generation to be given benefit for exports significant changes to the settlement system with profiles being created to cater for each type/size of domestic and other micro-scale generation will be required.

5.11 A substitute to the use of a profile for DUoS revenue, is a annual capacity charge (ACC) that may be paid to DNOs in lieu of DUoS income. This would complement the ideas put forward in the Embedded Generation Working Group Charging Principles paper. A DNO could set a fixed charge (in a way to be decided following detailed discussions) to provide positive and negative locational signals for demand and generation within its distribution area.

5.12 Combined with locational signals, the annual capacity charge (ACC) could be a DUoS charge (not currently paid on exports) to be paid to DNOs in lieu of forgone payments on imports.

5.13 Issues relating to safety (for network and customer installation) harmonics, voltage limits and frequency limits mean that the connection must be to an appropriate standard. G77 provides this for small PV installations. Similar engineering recommendations to G77 would ideally be required for other domestic and other micro-scale generation covering both inverter and non-inverter connected variants. This would enable the production of ‘type tested’ equipment for ease of connection.

6 Recommendations

6.1 To facilitate a significant increase in the amount of domestic and other micro-scale generation connected to the distribution network a number of simplified connection standards (along the lines of G77) for inverter and non-inverter connected domestic and other micro-scale generation technologies are required. Work on creating these standards should be started immediately.

6.2 The connection charging options identified in the Embedded Generation Working Group Charging Principles paper should be developed (with appropriate recognition of the Distribution Price Control implications) to enable domestic and other micro-scale generation technology to be implemented.

6.3 The potential costs associated with the metering and charging arrangements identified in this paper should be established and include:-

- on-site cost of meter change (installation cost)
- any change to meter reading costs
- developing and implementing new profiles suitable for domestic and other micro-scale generation

existing metering assets becoming 'stranded' (i.e. existing meters being removed ahead of normal replacement - see DNOs Point of View section).

6.4 Net energy tariffs are very complex and a detailed cost/benefit analysis should be undertaken of each of the options identified to fully understand the potential impact each option would have.

6.5 A comparison of the cost of implementing low cost half-hourly metering should be made as an alternative option (particularly if there are economies of scale and a change of metering on-site is required).

6.6 Metering arrangements are defined in the Balancing and Settlement Code (BSC). Changes may be required to the BSC if options identified in this paper are to be taken forward. However, if an individual supplier wishes to offer 'net metering' to the retail market that would be a commercial decision for that supplier.

7 Contributions to the report

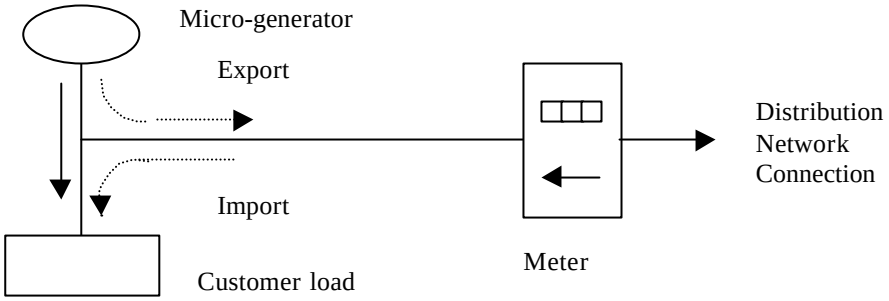
The paper has been compiled by the following DTI embedded generation working group members:
Catherine Mitchell and Alan Laird, acting as rapporteurs, with Phil Baker acting as an observer.

Contributions were received from Alan Laird and Phil Jones (on behalf of Network Operators, Lewis Dale (on behalf of NGC), Terry Brookshaw (on behalf of Suppliers), Catherine Mitchell, Malcolm Taylor and Stephen Andrews (on behalf of Generators), Andrew Horsler (on behalf of domestic customers), Phil Baker (on behalf of DTI). Review comments were provided at DTI Embedded Generation Working Group Meetings.

8 Appendix 1 - Metering Arrangements

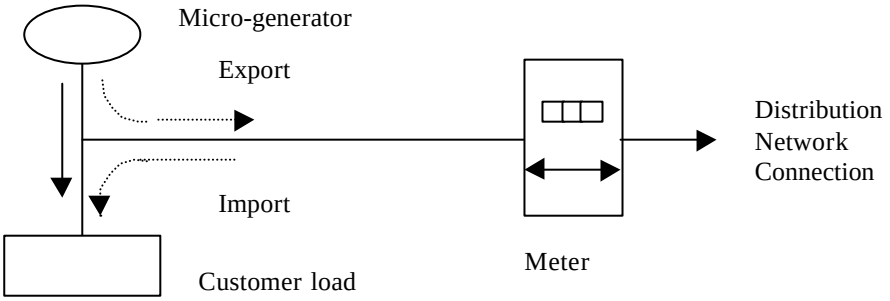
Metering arrangements

Metering Arrangement "A"
Single Direction Meter



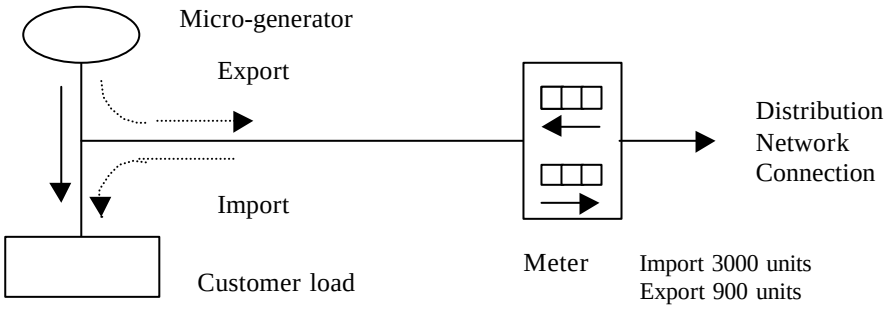
Import 3000 units
Export 900 units
Meter registers 3000 units

Metering Arrangement "B"
Bi-directional Metering



Import 3000 units
Export 900 units
Meter registers 2100 units

Metering Arrangement "C"
Import-export metering

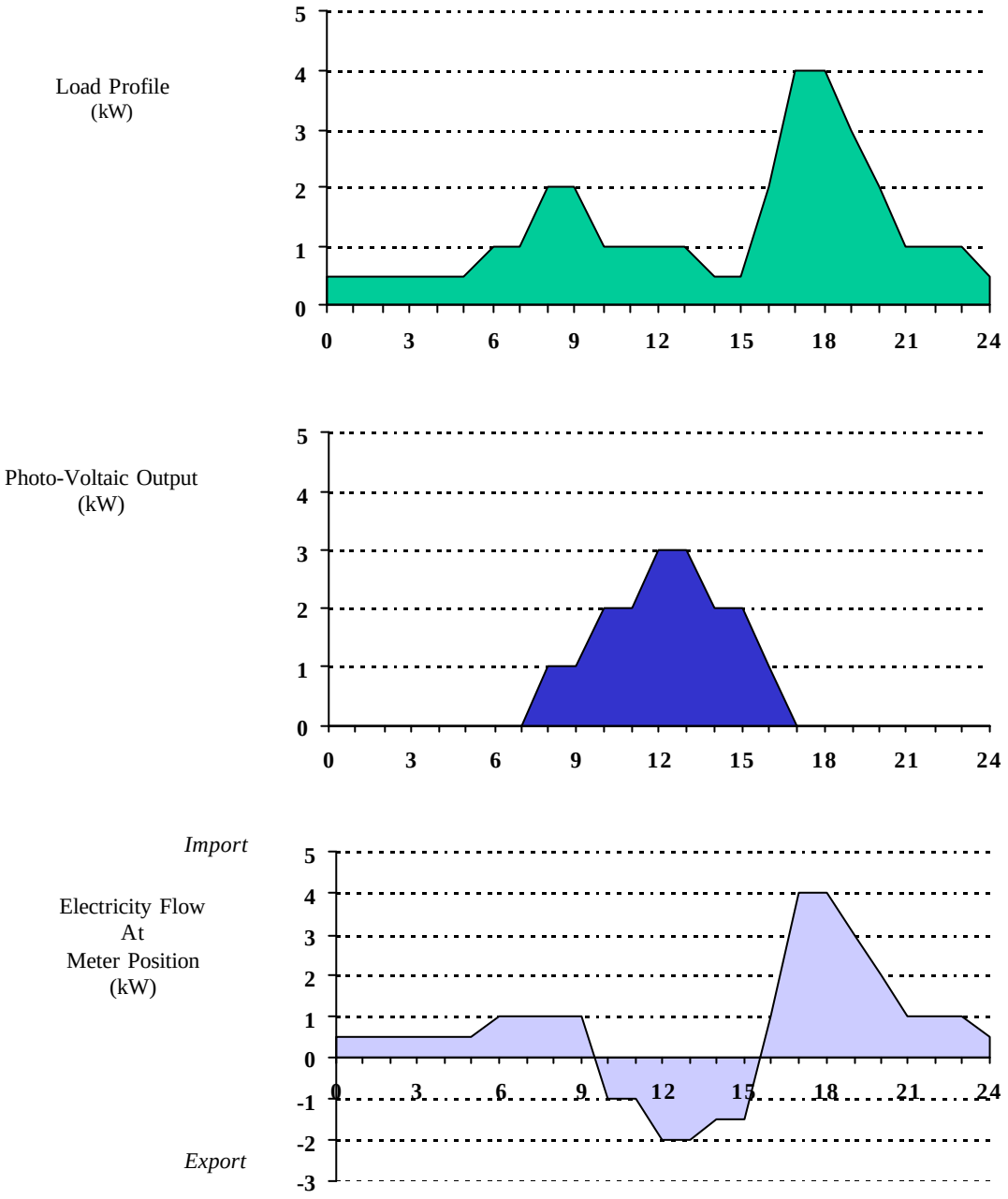


Import 3000 units
Export 900 units
Meter registers 3000 Import
900 Export

Note: The registers show what may be registered in a meter reading period (could be three months to a year). A generation production meter could be added to any of these metering arrangements to record actual units generated by the domestic and other micro-scale generator

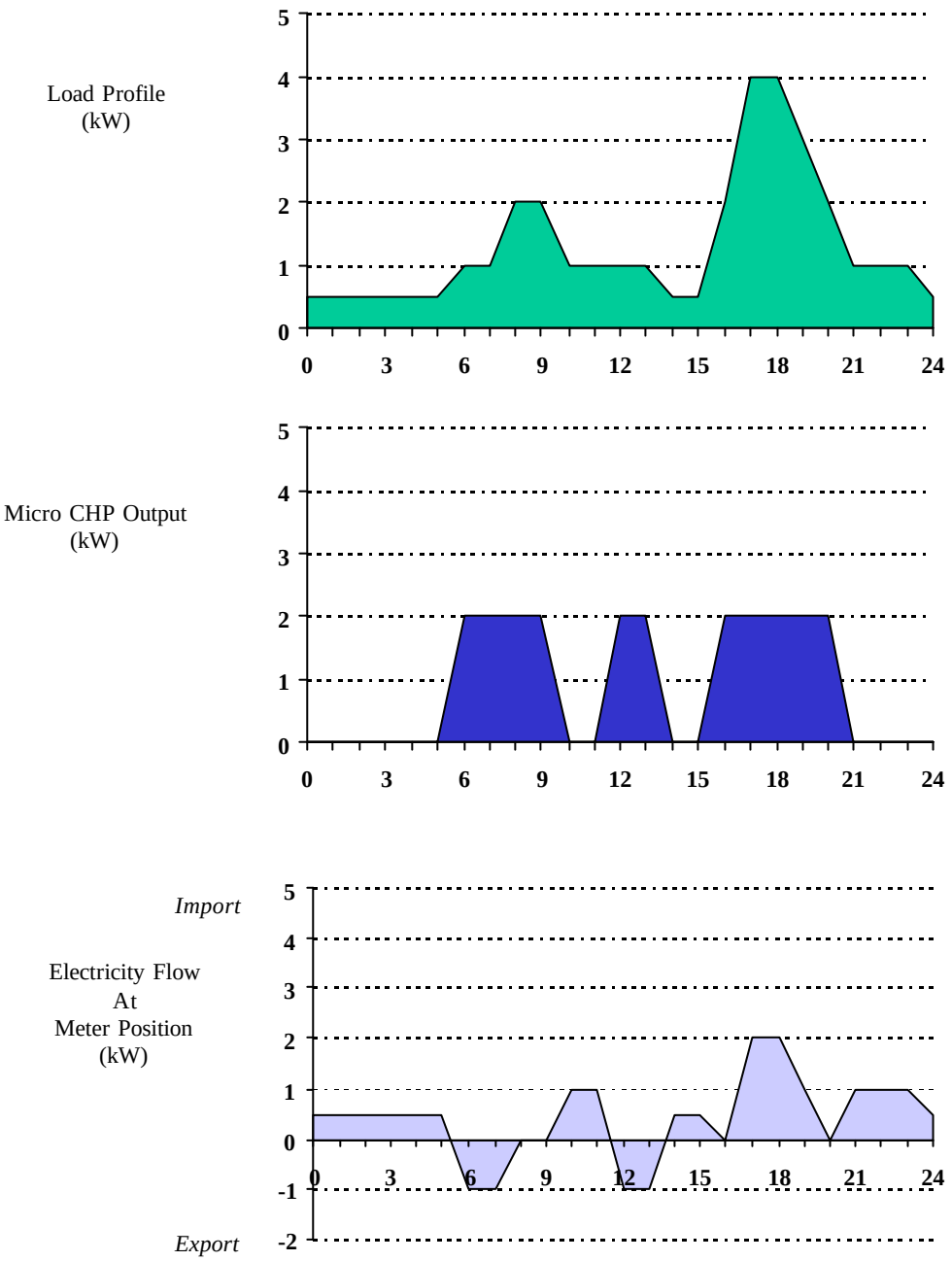
9 Appendix 2 - Profiles

Electricity Flow - Domestic Customer (Photo Voltaic array)



Note: For a typical day

Electricity Flow - Domestic Customer (Micro CHP)



Note: For a typical day

Profiles

Profiles are used by the current Pool trading arrangements and will continue to be used under the NETA. They provide an estimate of the variation of consumption by domestic customers over a day on a half-hourly basis and thereby allow Suppliers to settle their consumption in the wholesale half-hourly market. The total consumption by a domestic customer can only be known over a meter reading cycle that can be as long as 12 months. However, the cost of electricity in the wholesale market can vary on a half-hourly basis. The profiles used in Pool Settlement (Stage II Settlement) provide the link that allows allocation of demand (and therefore wholesale purchase costs) between Suppliers.

The profiles have been determined using large samples of households and are subject to yearly fine-tuning by an independent service provider. Currently, there are 8 profiles of this type used in the Pool. It should be noted that when they are used in the Settlement process the variation of ambient temperature and lighting-up time around England and Wales is taken into account.

The addition of domestic and other micro-scale generation to a house obviously changes the demand profile actually observed and could lead to a substantial shape error between the standard Pool profile applied to the house and the actual demand drawn. Such a difference may change the pattern of 'losses' and / or the group correction factor within a particular area (Grid Supply Group).

In order to deal with customer generators in Pool Settlement, there are 3 types of option available:

- Settlement Meters: The customer's demand and export can be metered with meters which integrate consumption and export each half hour and are interrogated soon thereafter, so that the demand and exported generation are explicitly accounted for in Pool Settlement. This is routinely done for premises with demand >100kW already. No profile is required to complete settlement of accounts.
- Other Half-hourly meters: The customer's demand and export can be metered with meters that integrate consumption and export each half hour and then store the data for subsequent interrogation that could be less frequent (monthly or less frequent are typical interrogation cycles). This is called Code 6 metering, is already in operation and has substantially lower installation and operation costs than full settlement metering. A variant of this is Code 7 metering where local data storage is limited and interrogation takes place more frequently via mains borne signalling, low power radio, or no-ring telephony. This standard is approved and ready, but has not been practically implemented. An initial profile may be required for Pool Settlement, but subsequently no profile is required to complete settlement of accounts.
- Non-Half-hourly meters: These do not allow half-hourly consumption or exported generation to be recorded and hence require a profile.

The Pool Stage II Settlement System can accommodate more profiles. The Pool Stage II Settlement Systems were sized in the expectation of approximately 20 profiles. Additionally, the algorithm uses settlement standard configurations (ssc) that take the (8) profiles and apply switching to them to allow allocation of demand between customers and therefore Suppliers. At the present there are approximately 664 (ssc)s in operation, but the systems have been sized to allow over 2000. Running settlement with more profiles merely increases the amount of processing arithmetically.

The most difficult and expensive part of introducing new profiles will be the derivation of the profiles. The existing profiles have been determined using statistically large populations so as to minimize intrinsic error. It may be difficult to achieve statistically meaningful samples to allow derivation of profiles for all of the varieties of domestic and other micro-scale generation. The costs of deriving a profile have been roughly estimated as of order £100,000-£500,000. However adding a well-defined generation profile to an existing demand profile is unlikely to significantly increase the overall error associated with the use of profiles.

There must be an agreement reached about allocation of development and operational costs, if profiling is used. Issues of this type have been addressed in the recent development of the Pool Settlement Systems.

10 Appendix 3 - USA Arrangements

10.1 These are shown in the tables below.

Table 1 - Maximum Eligible Capacity for Net-Metering in the United States

Capacity Limit	Number of States
10kW	8
15kW	1
20kW	1
25kW	5
40kW	2
50kW	2
60kW	1
80kW	1
100kW	7
Energy cap	2
No limit	4
TOTAL	34

Table 2 - Maximum Obligation Agreements for Net-Metering in the United States

Limits to overall obligation	Number of states
0.05% of total supply	1
0.10% of total supply	6
0.20% of total supply	1
0.50% of total supply	1
1% of total supply	3
100 customers per utility	1
1MW (for single utility)	1
TOTAL	14

11 Appendix 4 - Points of View

11.1 Distribution Network Operators

11.1.1 A Distribution Network Operator (DNO) uses units (kWh) as a basis of charging domestic and small commercial customers directly as a result of the universal availability of this data and because (for demand-only customers) it is possible to predict with a degree of certainty a reasonable relationship between units and maximum demand over a large population. Units delivered are therefore used as a proxy for maximum demand (or capacity) which is what in an unconstrained charging mechanism would be preferred.

11.1.2 Net energy tariffs (and to some extent even dual energy tariffs) destroys this relationship and hence some basic assumptions of DUoS pricing for domestic and small commercial customers (with no capacity charge). In particular, [and perhaps more importantly] irrespective of how DUoS charging structures may develop, the distribution price control mechanism which determines the allowed revenues uses as one of the cost driver determinants the units delivered to end users. Net metering breaks this assumption and therefore the basis of the current price control. This is recognised for larger generators (where there is a capacity or demand element in the [DUoS] tariff) by treating this element of charge as an excluded revenue which is [currently] outside the price control formulae.

11.1.3 Where there is a common use of data for different purposes, (e.g. units distributed at present is used to settle both energy purchases and DUoS charges), it is necessary to consider implications of change of use on other parties. This is especially important where the change may result in additional costs on one or more parties in the industry that could significantly alter the economics of the service provider. This does not mean that change is not possible or desirable but all the implications of change need to be recognised.

11.1.4 Distributors support the concept of the creation of simplified connection agreement for these small (<5kVA) domestic and other micro-scale generators. The connection agreement would include the requirement for the installation to comply with technical standards similar to G77.

11.1.5 Notwithstanding the regulatory caveats, the DNOs support the concept of import export metering as opposed to bi-directional or single direction meters i.e. gross metering of imports and exports, and believe that a simplified profiling system will be needed to enable the generator's supplier to trade equitably in the BSC.

11.1.6 Standard Connection Principles/Support – Distributors would need to develop procedures to give simplified network information for LV connection to prospective users.

11.1.7 There is probably a case (at least in the medium term) for a direct limit of this type of connection acceptance (as per USA) e.g. so much capacity per substation to minimise some of the technical network design issues.

11.1.8 Neither of the two points above are directly concerned with the concept of 'net energy tariffs' but may well be intrinsic to the economics of the connection and operation of this form and size of domestic generation implicit in the case for net metering.

11.2 Generators

Domestic and other micro-scale generation should not be treated any differently from any other forms of embedded generation. However, in practice such equity imposes barriers to these generators. Specific charging mechanisms for domestic and other micro-scale generators should help to overcome these barriers.

11.2.1.1 Generators argue that there are two different underlying commercial reasons for creating a charging and payment mechanism for domestic and other micro-scale generators:

(1) ensuring equitable costs for connection to and use of the distribution system
(2) ensuring the opportunity for domestic and other micro-scale generators to negotiate competitive prices for their purchase of demand from Suppliers and their sale of generated and / or exported electricity

The mechanisms should also be consistent with allowing the capture of other value such as ROCs.

11.2.1.2 Any agreed option should be straightforward and comprehensible to potential customers.

11.2.2 Technical and connection issues

11.2.2.1 Small generators would like a simplified charging mechanism which allows them to connect to the grid easily and quickly, with transparent charging and payment systems.

11.2.2.2 G59/1 is a major barrier to domestic and other micro-scale generation. It was not written in anticipation of a single phase domestic and other micro-scale generation capacity (<15kW) embedded generators being connected

and is inappropriate for domestic and other micro-scale generation on account of its technical requirements being developed for larger directly connected rotating generators rather than small inverter connected or single phase directly connected generators. It also requires access by the DNO to a lockable disconnect switch in order to ensure safety of operatives, which is impracticable when many small generators might be connected. The nature of the technical approval process for each connection makes it costly for the DNO and the customer-generator to apply to multiple small generators.

11.2.2.3 G77 is a simplified set of requirements for the connection of single phase PV generators of less than 5kVA capacity. It provides more appropriate technical standards for such generators and embraces the concept of type test approval for the inverter and protection unit which minimises the amount of effort required by the DNO to approve each installation.

11.2.2.4 Generators believe that two alterations to standards should occur. Firstly, G77 should be extended to all inverter-connected systems of 5kWp, regardless of generation technology. Secondly, a simplified connection arrangement would also be appropriate for non-inverter-connected systems, such as micro-CHP, up to a certain size. It may be that the transition between the latter standard and the fully blown G59/1 should occur when the supply changes from single to three phase. The move towards this extension of G77 and development of new standards should be fast-tracked.

11.2.2.5 A type test to G77 for PV systems is now in use. The first 18 months of operation are being monitored by joint PV/supply industry working group to confirm the principles. Some underlying technical issues are still being researched. Accompanying this work, the two industries have worked to develop standard forms for notification of proposed connections and signing off commissioning tests. A simplified legal connection agreement has been developed in PV programme and has been used as a basis for the forms used by some DNOs. These arrangements minimise the work needed from DNOs to agree connections, including disposing of the need to witness tests of every installation.

11.2.2.6 Similar type-testing mechanisms should be available for all inverter and non-inverter D&MG technologies.

11.2.2.7 We understand that studies have been undertaken already to establish network capacity limits in certain circumstances. Given the current domestic and other micro-scale generation installation rate there is no foreseeable network capacity problem. Generators accept that different parts of the distribution network may, in time, have different capacities to absorb domestic and other micro-scale generation, particularly before the

advent of active management. Generators therefore wish to see DNOs clearly identifying where they can and cannot accept small-scale customer generation on their networks, along with any limits set on maximum penetration. (See Embedded Generation Working Group Information Paper)

11.2.3 Metering and payment issues

11.2.3.1 The simplest solution for domestic and other micro-scale generation is to generate, using the standard domestic meter. If generation is small, application of demand side management measures will cover supply and value generation at the domestic import price up to the point where generation equals demand over the netting period. Any further generation would be spilled onto the network for no return to the customer generator. This is the current situation for most domestic and other micro-scale generation.

11.2.3.2 For a generator wishing to sell their exports, the next simplest solution would be to contract with a supplier for the exports, with a profile developed for domestic and other micro-scale generation, still using a domestic single direction meter, The tariff is a matter of commercial negotiation and would be a function of the profile shape and may be higher or lower per unit metered than the ordinary domestic tariff. This arrangement would require no meter change but the development of an appropriate profile and would allow credit to be given for those periods when that profile indicated net exports.

11.2.3.3 It may sometimes be appropriate to install a new bi-directional meter (one that can run backwards). Again in association with an appropriate new profile for the type of generation this would allow credit to be given for periods of net export.

11.2.3.4 The next stage is then a meter which records imports and exports. This with a new profile would allow less predictable types of generation to be satisfactorily billed/credited in the wholesale market and thus between the supplier and the customer generator.

11.2.3.5 As discussed in the section on profiles it may be that once a new meter has to be fitted the marginal cost of fitting a meter that records and stores half hourly data (termed 'Code 6')is so small that this may be more cost effecitve than developing an accurate new profile, notwithstanding that a profile will always have to be used for initial settlement with such meters. Generators want the most economic solution that gives results of acceptable accuracy. For generation types that are not suited to profiles i.e. the customer generator pattern can not, as a group, be deduced from non half

hourly meter readings with the same level of accuracy as can be done for load customers, 'Code 6' meters may be the best way forward. They may also be the answer for generation types which, whilst possibly amenable to profiling, are likely to occur in such small numbers as to make the development of a profile more expensive than fitting half hourly metering. For generation types whose output can be predicted from the type of data used in profiling i.e. local weather data and which are expected to occur in large enough volumes, the development of a profile, with no meter change or possibly a change to a meter cheaper than a half hourly one, may be the cheapest solution.

11.2.3.6 A profile or profiles suitable for domestic and other micro-scale generation should be developed and implemented. Some fair mechanism of payment should be established. Domestic and other micro-scale generation should not be expected to pay the whole cost - this is analogous to the estimated £1.5 bn costs of NETA not being paid for by generators or the cost of supply competition not being paid for solely by those customers who chose to change supplier. The establishment of a standard profile for micro CHP, linked to central heating may require a number of standard profiles to be created. Again, this may represent an additional cost and complexity.

11.2.3.7 In the case of entities using renewable generators, it would be advantageous to record all generation, regardless of the arrangements for calculating imports and exports; as under the renewable energy obligation, they could be entitled to claim Renewable Obligation Certificates (ROCs) for *all* of their generation.

11.2.3.8 Currently, a renewable obligation certificate is to be awarded following the direct sale of a kilowatt-hour of renewable electricity via a half-hourly meter to a supplier. The only way for domestic and other micro-scale generation to have their generation awarded a ROC is to install meter(s) that records gross exports to the DNO. This is an added expense for a domestic and other micro-scale generation. It would be very helpful for domestic and other micro-scale generation if ROCs could be awarded via the same profile as the customer-generator's contract with the supplier. This contract will be for a certain number of units and a similar number of ROCs could be awarded. This would increase the suppliers interest in domestic and other micro-scale generation. Clearly it is just as good for the environment if benign generation is located on customers' premises as elsewhere.

11.2.3.9 Net energy tariffs have clearly been successful in other countries in kick-starting the domestic and other micro-scale generation market. As such, generators would welcome the development of whatever is the most economic metering solution for particular generation types, whether

utilising the current meter or changing it with or without new profiles as appropriate.

11.2.3.10 Domestic and other micro-scale generation clearly poses a number of issues for DNOs and suppliers. If more and more customer generators occur, the DNO and supply business volume will reduce, but new products may result. As such, this would be fulfilling the requirement on them to facilitate competition in generation and supply. It is always important to categorise the impacts on DNOs and Suppliers between (1) effects of competition, to be sure not welcomed by them although supported by customers and generators, and (2) other impacts. Generators recognise however that the arrangement for remunerating DNO's must always give them a fair return on the provision of the network required by all their customers, whether pure consumers, pure generators or customer-generators.

11.2.4 Renewable Issues

Whilst renewable energy generators fully support the above points there are a number of additional issues which need to be addressed for renewable generators. These are outlined below.

11.2.4.1 The EU White Paper on renewable energy, the basis of the RE Directive, suggests a 500,000 PV system target for Europe. The UK share of this target would be around 80,000 systems (around 0.3% of households) by 2010.

11.2.4.2 One supply company has introduced a net energy tariff programme on a voluntary basis. It is clear that apportioning costs and benefits to all actors which result from net energy tariffs is very complex. Renewable generators would like to see an analysis of such costs and benefits undertaken as a matter of urgency.

11.2.4.3 Net energy tariffs have been implemented throughout the world. They have clearly been successful in kick-starting domestic and other micro-scale generation markets. Renewable generators would like to the Government to examine the costs and benefits to all actors of a short-term, capacity capped net energy tariff obligation (and the potential barriers to it), versus the voluntary establishment of such schemes. Following such an analysis, HMG would be able to make an informed decision on whether an imposed net energy tariff obligation would be appropriate.

11.3 Suppliers

11.3.1 The wholesale energy trading arrangements of NETA are founded on the basis of half-hourly information streams provided either directly via half-

hourly meters or indirectly via a combination of non-half hourly meters and standard profiles.

11.3.2 The subsequent treatment of the half-hourly information streams within the balancing and settlement process depends on the 'form' of trading.

11.3.3 The two traditional types of trading are illustrated in the table below.

Suppliers supplying customers wholly via NETA processes	Gross aggregated GSP half hourly data
Suppliers supplying customers via NETA processes and partly via off-site distributed purchases	Gross aggregated GSP half hourly data Less aggregated half hourly data for distributed purchases

11.3.4 New types of trading are beginning to emerge. For example: a) the advent of consolidators b) the emergence of more on-site generation, in some cases on Domestic premises) the prospect of off-site supply by exempt generators/suppliers 'Net metering' has also been raised as one potential way forward.

11.3.5 These concepts are likely to have a variety of impacts on the central wholesale NETA processes and on grid/distribution charging processes. For instance, new netting processes may be required and new profiles may be necessary, say for a Domestic PV customer.

11.3.6 Other issues may arise in respect of 'net volumes'. For instance, there may be no income to a DNO or to the grid in the event that imports/exports net to zero.

11.3.7 Where a customer chooses to install on site generation it would be for the customer to nominate the maximum import or export capacity needed.

11.3.8 Therefore, Suppliers recommend that the existing and potential forms of trading, including net metering, should be reviewed with the aim of identifying any changes to the industry framework which would facilitate more efficient trading.

11.4 Domestic Customers

11.4.1 Domestic consumer representatives work from the following principles:

- Any customer wishing to install his own generating capacity must be able to do so with the minimum of technical and commercial barriers

- For those customers who choose not to install generation, the overwhelming majority, there must be no adverse effects in terms of price or quality of supply as a result of the introduction of generation into some premises

11.4.2 The first principle means that there must be a ready availability of information for potential uses of small-scale generation, the lowest cost and most appropriate types of meters, as simple connection agreements as possible, and a proper analysis of costs on which to base a new and non-discriminatory charging mechanism.

11.4.3 The second principle requires that there should be no cross-subsidy from one group of consumers to another, and that any adverse effects on quality of supply are remedied without increasing the charges of the majority of consumers from what they would otherwise have been. Appropriate incentive arrangements will be necessary.

11.4.4 Reconciling these objectives will require a full analysis of the options.

11.4.5 The implications for non-generation customers (especially the fuel-poor) would need careful consideration.

12 Appendix 5 - Examples of Options

Example 1

Using meter arrangement 'A' with an import of 2000 kWh/yr and a domestic and other micro-scale generator output of 900 kWh/yr all used on site. Total load is 2900 kWh/yr.

	Benefit	Disbenefit
Customer-Generators	Current situation, value of generator equal to cost of import.	No ROCs available for power
DNOs	marginal: if had reinforcement problems this might help defer reinforcement; it might help reduce maximum capacity demand; might reduce NGC charges in the long run Profile error may reduce or increase losses, and benefits would be spread across all suppliers in GSP group	customer-generators have 900 kWh less demand but is unlikley to reduce DNOs requirement to provide maximum capacity demand provision.
Suppliers	Any reduced GSP correction factor benefits all suppliers in same GSP group Some benefit spread over all suppliers for avoided losses	Suppliers will supply reduced demand. Will impact on current profiles and lead to profile 'drift'. This 'drift' the difference between profile and settlement will be paid for by all suppliers within GSP group. A new profile should ameliorate this problem
Customer Community	Benefit from reduced CO2 emissions if renewable generation, paid for by individual customer	Costs incurred by DNOs and Suppliers passed to customers

Example 2

Using meter arrangement 'B' with a gross import of 2000 kWh/yr and generation output of 1000 kWh/yr, of which 300 kWh/yr are used on-site with the rest exported and valued at import price. Total load is 2500 kWh/yr. Meter registers 1500 kWh/yr.

	Benefit	Disbenefit
Customer-Generators	Same value for generated units and paid for exports	No ROCs available for power
DNOs	Marginal: if had reinforcement problems this might help defer reinforcement; it might help reduce maximum capacity demand; might reduce NGC charges in the long run Profile error may reduce or increase losses, and benefits would be spread across all suppliers in GSP group	Customer-generators has 220 kWh less demand but is unlikley to reduce DNOs requirement to provide maximum demand provision
Suppliers	Benefit from reduced CO2 emissions if renewable generation, paid for by individual customer	Suppliers will supply reduced demand. Will impact on current profiles and lead to profile 'drift'. This 'drift' the difference between profile and settlement will be paid for by all suppliers within GSP group. A new profile should ameliorate this problem
Customer Community	Benefit from reduced CO2 emissions if renewable generation, paid for by individual customer	Costs incurred by DNOs and Suppliers passed to customers

Example 3

Using meter arrangement 'C' with an import of 2500 kWh/yr and a domestic and other micro-scale generator output of 1000 kWh/yr, of which 500 kWh/yr are used on site. Meter would register 2500 and 500 kWh/yr import/export. Total load is 3000 kWh/yr. Charges for import payment level for export may be the same or different depending on the agreement with the Supplier. ACC paid to DNO (via Supplier).

	Benefit	Disbenefit
Customer-Generators		ACC charge fixed, not linked to imports and exports
DNOs	no uncertainty, therefore limited risk	dis-incentive to be innovative
Suppliers	Could get access to ROCs if renewable generation	Supplier passes ACC charge to generator-customer
Customer Community	Benefit from reduced CO2 emissions if renewable generation, paid for by individual customer	