Embedded Generation Working Group

Report into Network Access Issues

Volume 1
Main Report and Appendices

A Consultation Document from
the Joint Government Industry Working Group on Embedded Generation

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Foreword by the Chairman

Embedded generation is not a new concept. It has been a feature of the electricity industry since it began more than a century ago. But recent Government initiatives on generation from renewable sources and combined heat and power (CHP) stations have focused attention on how embedded generators are treated in the energy market. For example, the recent report of the Royal Commission on Environmental Pollution called on the Government to review how electricity networks can best be financed, managed and regulated in order to stimulate and accommodate large contributions to energy supplies from CHP plants and renewable sources, while maintaining reliability and quality of supplies.

During the year 2000, the Embedded Generation Working Group has considered a wide range of issues relating to embedded generation. In this report the Group makes initial recommendations for action by relevant bodies to help ensure that embedded generation is treated on an equitable basis compared to other users of distribution and transmission networks.

The Group has identified that current arrangements are not conducive to the development of embedded generation. This report puts forward a series of initial recommendations, together with a proposed timetable to implement changes. Taking account of the physical limitations of the networks themselves, and how they are planned and operated, the recommendations focus on changes that would facilitate the connection of embedded generation. There are also recommendations on regulatory, transparency and charging issues as well as the wider questions of appropriate incentives and how network operators will achieve their new Utilities Act duty to facilitate competition. However, it may be that the removal of barriers by itself may not encourage the scale of embedded generation implicit in the Government's targets for renewables and CHP. Further incentives which Government may give to embedded generation are outside the scope of this work.

The recommendations of the Group are intended to stimulate feedback and debate. We look forward to challenging responses so that the Group can produce its final recommendations for action in the first quarter of 2001.

The Group's role and its approach to its objectives have been unique. Its membership comes from a wide range of stakeholders including Government (DTI, DETR and other agencies), the regulator, Ofgem, and the industry. The Scottish Executive attended the meetings as an observer. Industry members include representatives of different types and sizes of generators; transmission and distribution companies; suppliers; and large and small customers. The Group agreed at the outset to make its work as clear and readily available as possible. Notes of its meetings and reports have been published on the DTI website to enable all interested parties to see and contribute to the Group's thinking.

One of the most striking features of the Group has been the open, frank and constructive approach of all its members. Despite their different institutional and commercial backgrounds and drivers, each of them has contributed in a positive way. Many mutual misunderstandings amongst stakeholders have been dispelled. And most importantly, members have found it possible to reach consensus views on most of the issues under consideration.

Many of the Group's initial recommendations concern the legislative and regulatory framework for embedded generators and network operators. It will be for the bodies with relevant responsibilities and powers to consider and implement change where appropriate. The Group will have met its objectives when this happens. Its final report and recommendations will be a catalyst for action and a means of tracking progress against the challenging objectives it will set.

Brian Wharmby

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CHAPTER 1

EXECUTIVE SUMMARY

The Issues

1.1 If Government's targets for higher levels of CHP and renewable plant by 2010 are to be achieved, distribution networks will have to be capable of accommodating far more generators connected directly to their networks than we have now. (These are known as 'embedded' generators). Additionally, under the Utilities Act 2000, there is a new duty on distribution businesses to facilitate competition in generation and supply. Present regulatory framework, financial incentives and network design approaches are not conducive to all of the above.

1.2 Much of the distribution network was developed pre privatisation to meet the growing network demand. More recently, network development has been strongly influenced by the incentives and risk exposures that the Distribution Network Operator's (DNO) current regulatory environment provides. As a result of both of these factors, there are several technical and practical limitations to expanding levels of embedded generation:

- network capacity restrictions in rural areas which limit connection of generators, including renewables such as wind,
- Fault levels restrictions in urban areas which limit connection of generators such as CHP,
- Design standards which prevent the variable nature of loads, generation and network capability being fully recognised.

1.3 There are also charging and transparency issues:

- Embedded generators are charged for the full reinforcement costs which result from their connection. While these 'deep' connection charges provide a strong locational signal, they also represent a financial barrier to new plants. If a major reinforcement is triggered, there is no mechanism for sharing the costs of the reinforcement with subsequent connectees. Other charging approaches may retain sufficient locational signals, but provide more flexibility for sharing the cost of reinforcements between those parties who benefit from them,
- DNOs have no further revenue stream from embedded plant because such plant pays no distribution 'Use of System' (DUoS) charges. Other incentives on DNOs to connect embedded plant are weak,
- Lack of published information about the best locations for embedded generation means that potential generators have difficulty in determining charges and the best (or worst) places to connect to the network.

1.4 Without significant changes to many or all of the above, the development of renewables and CHP plant envisaged in the Government's environmental targets could be restricted. The full potential for embedded generation will only be realised if incentives for all the key stakeholders are aligned to create the right commercial environment which will enable embedded generation to contribute to a stable and secure network whilst ensuring a diversity of fuel supplies in a more environmentally sustainable manner.

Recommendations

2.1 The joint Government/Industry Working Group on Embedded Generation Network Access Issues (the Group) has identified a wide range of design, operational, charging and disclosure issues where changes may be appropriate. In some areas, short-term action is a real possibility. Many others require changes to the regulatory regime, design and operational codes and procedures, and some aspects of the law. Many recommendations will require significant changes in approach from DNOs, Ofgem and embedded generators themselves.

2.2 The Group has two key recommendations. These are linked to more detailed recommendations in Chapter 3 :

Recommendation 1 Ofgem should review the structure of regulatory incentives on DNOs in the light of the new statutory duty on DNOs to facilitate competition, - in particular to assess the effect this new framework will have on all the stakeholders including DNOs, Generators, Customers and Suppliers.

It is likely that such a fundamental review would only be practicable at the next price control review. Some changes are possible within the framework of the present price control structure. Given the above, a co-ordinated and managed programme of work needs to start now under OFGEM leadership to:

- Establish a **charging regime for embedded generators** that reflects the DNOs duty to facilitate competition in generation as well as in supply. Ofgem, DNOs and embedded generators should all discuss the scope for addressing the financial implications of adopting a shallower form of charging principle for generator connections in advance of the next price control review. This work should be carried out in the context of a wider review of all entry and exit charges for distribution networks.
- Review and prepare guidance that will allow DNOs to interpret design and operational codes in such a way as to allow the **contribution of embedded generation to network performance** to be taken fully into account. A review of the codes themselves and of the governance arrangements for distribution networks should follow.

- Establish more transparent and consistent arrangements for the **provision of information by DNOs** to developers of embedded generation and demand and in

particular ensuring that the requirements of a proposed distribution licence condition for a Long Term Development Statement are implemented to achieve this goal.

<u>Recommendation 2</u> A Group should be established under Government leadership to co-ordinate and take forward the implementation of the present Group's recommendations for the longer term.

Work needs to start now if changes to the way DNOs design and operate their networks are to be achieved in the longer term. This will need to complement the considerable other work which has begun elsewhere (summarised in Appendix A).

2.3 Without the changes recommended in this report, it is unlikely that the level of embedded generation envisaged by the Government will be accommodated on distribution networks. In reviewing these matters, solutions should be sought which are equitable to all players, which do not impose excessive costs on customers and which preserve security of supplies.

CHAPTER 2

BACKGROUND AND INTRODUCTION

1. The History

1.1 During the last quarter century most large scale steam-based embedded generation has been de-commissioned. The main objective for DNOs has been to build and maintain adequate infrastructure to receive power from the high voltage transmission network and deliver this to customers. This passive role for distribution networks has been formalised in design codes, charging structures, price controls and other regulatory incentives. Today, DNOs use their Supply Businesses to load manage every day through radio-switching and exert demand control limitations through Use of System Agreements. Apart from this, they do not generally operate generation despatch or day to day load management - though some work has been done in recent years to reduce overall demand through the use of energy efficiency measures.

1.2 Those who operate distribution networks are generally driven by three main considerations:

- Under the privatisation structure and that which preceded it, DNOs receive their revenue stream in the form of distribution use of system charges (DUoS) from load customers - not from embedded generators. In return for paying for all infrastructure reinforcement at the time of their connection, generators are left to operate subsequently without paying any charges for using the distribution system. Those

taking demand are seen as the DNOs' main customers; those generating on distribution networks are not.

- Once it has been established that reinforcement of supplies is needed, investments in network assets have been favoured by DNOs since they are rewarded by an increased revenue through the price control mechanism. Alternatives to network investment, for example expenditure through contracts to provide local generation or load management are not similarly rewarded. As a consequence of these factors DNOs are not likely to encourage the development of embedded generation.
- The present network design standard (known as P2/5) recognises the contribution from embedded generation that can be considered in assessing system security. However it does not properly take account of the contribution of different types of modern embedded generation or load management to security of supply.

1.3 It is only during the last decade that a move back to embedded generation has developed - a trend that is accelerating due to changes in technology linked to energy and environmental policy issues. Under the right conditions, embedded generation increases competition in customer choice in sustainable energy supply. DNOs have, on occasion, asked embedded generators to provide generation support at short notice. This indicates that in the right circumstances, embedded plant can make a contribution to security and in such cases should be properly rewarded for this.

2. The Government's Drive towards Environmentally Efficient forms of Generation

2.1 The Government's central energy policy objective is to ensure secure, diverse and sustainable supplies of energy at competitive prices. Its environmental priorities are influenced by global and international factors, including international agreements and EU policies to which the UK is committed. These include legally binding targets for the reduction of greenhouse gases, and in particular carbon dioxide emissions.

2.2 The Government has published a Climate Change Programme. It's three linked issues are :

- the drive for sustainable development,
- the commitment to combat global warming, and
- policies designated to integrate pollution control.

2.3 Ofgem has published an Environmental Action Plan discussion paper. Recognising that Ofgem's work impacts on the environment, the paper sets out the regulator's work and role in relation to that of other government departments and bodies such as the Environment Agency.

2.4 The Royal Commission on Environmental Pollution published its 22nd Report in June entitled 'Energy – the Changing Climate'. This calls on the Government to set tougher

targets to achieve substantial reductions in CO_2 emissions and to put in place much stronger incentives for the generation of electricity from renewable sources. It also highlights the need for polices to encourage the widest possible adoption of CHP in urban locations and the need for the national grid and the regional distribution systems to become more favourable to small generators. It also highlights the need for regulatory policies to promote and not inhibit this development.

2.5 Successive governments have sought to promote generation from renewable sources - such as wind, hydro, and the burning of renewable fuels - and plant which produces heat and electricity simultaneously with high efficiency known as Combined Heat and Power (CHP). Such plant can achieve significant savings in CO_2 emissions. CHP and renewable plant range from the very small (sometimes only watts) to relatively large (several tens of megawatts for renewables and several hundred megawatts for CHP). Both types of plant vary in their predictability of output and in their flexibility of operation. This has significant consequences both for the trading of the energy generated and for the operation of the distribution networks where the generation is connected.

2.6 Government's promotion of Renewable and CHP generators include explicit targets for the amount of energy produced from such plants and the installed capacity of such plants. (These are set out in Appendix A.) Initiatives to encourage CHP and renewable forms of generation have included or will include :

- financial pump priming incentives,
- obligations on suppliers to obtain a proportion of the electricity they sell from renewable and CHP sources, and
- measures to exempt certain outputs from such plant from the Climate Change Levy.

2.7 These commitments have been thrown into even greater focus this year. In addition to the Royal Commission report, speeches by the Prime Minister and other senior government Ministers, a draft Directive from the European Commission all point to major increases in embedded plant.

3. The Utilities Act 2000 and Changes to the Privatisation Structure

3.1 The Utilities Act 2000 gives a principal objective to the Secretary of State and the Gas and Electricity Markets Authority: to protect the interests of consumers, wherever possible by promoting competition. Customers wish to see the lowest sustainable cost of electricity accompanied by progressively improving quality of supply. The Act also modified the way that operators of distribution networks are licensed. From 2001, DNOs will hold licences separate from those of suppliers. A licensed DNO will not be permitted to hold a supply licence. Statutory duties will be placed on DNOs similar to those placed on the holder of a transmission licence requiring them to facilitate competition in generation and supply, not to discriminate between classes of persons when setting connection charges, and to develop and maintain an efficient, co-ordinated and economical system of distribution. To make this a reality, there is a clear and urgent need

to re-examine the incentives given to DNOs, the way in which the contribution to system security from embedded generation is assessed, the charging structures for generators and the information provided both to them and to load customers at the time they are seeking connection. Any incentives need to balance these duties on distributors. To make this a reality, there is a clear and urgent need to re-examine the regulatory framework in which DNOs operate in terms of charging structures for generators, the way in which the contribution to system security from embedded generation is assessed, and the information which allows them to meet their new statutory duty to facilitate competition.

3.2 Separating Distribution from Supply is having a large impact on the policies of DNOs. Some Public Electricity Suppliers (PESs) have already sold their supply businesses. Examples include Western Power Distribution (formerly SWEB), Hyder (formerly SWALEC), United Utilities (formerly Norweb) and GPU Power Distribution (formerly Midlands). This process may continue in the period before legal separation is required.

3.3 During the most recent distribution price control review, Ofgem announced its intention to introduce a programme which would link some revenues to performance measures. This will be limited initially to 2% of revenue and to performance areas which would probably not directly affect the connection of embedded plant. Further development of this approach could be helpful in inducing further changes to DNOs' business approach - and particularly with respect to embedded generation. If revenues are linked directly to what customers value a high quality, safe and continuous supply of electricity - rather than the size of a DNO's asset base, DNOs would have an incentive to form partnerships with other players, such as generators, suppliers and customers to deliver the required quality of service. NETA potentially creates market mechanisms to facilitate these types of relationship, but care will be needed to assess its potential applicability to distribution networks, differentiate the roles of supplier and DNO. The market will need to recognise properly the ability of small players to deliver these services.

3.4 If extended from its initial very low level, a change to performance-based regulation could increase the extent to which DNOs use embedded generation as a means of catering for increased demand as an alternative to the replacement of time expired assets or network reinforcement. While this will take time to have an effect, such a change could play a role in improving security of supply.

The Role of the Embedded Generation Working Group

4.1. The Group was formed following responses to the DTI Consultation Paper in November 1999 on Network Access Management Issues. The Group had a very specific remit. This is set out formally in Appendix B but, the key points are reproduced here :

"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. 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, the group was to consider :

- ways of assessing the degree to which distribution network operators facilitate competition in generation as well as supply,
- how design and operation processes could take a more full account of the contribution made by embedded plant to the operation of the network,
- the charging regimes employed towards the connection and operation of such plant,
- the issues which need to be addressed in respect of smaller and domestic generators,
- the information provided both with respect to the structure of charges applied to embedded generators (including micro generators and the use of dual or net metering) and to the opportunities geographically to developers to connect plant,
- in the longer term, the scope to design and operate networks with much higher concentrations of embedded plant and the way in which incentives might alter the approach DNOs take towards embedded generation.

4.2 The Group comprises representatives of all the main groups of stakeholders who have interests in the way embedded generators could gain access to distribution networks in future. They include :

- embedded generators (including CHP, renewables and conventional plant);
- distribution network operators;
- the transmission network operator, NGC;
- suppliers;
- small and large consumers;
- the Energy Saving Trust;
- the Office of Gas and Electricity Markets;
- the Department of the Environment, Transport and the Regions;
- the Department of Trade and Industry; and
- an independent member, Dr Tony White of Schroder Salomon Smith Barney.

4.3 Dr Brian Wharmby, the Technical Director of Ofgem, chaired the Group. DTI provided the Secretariat. The Group's full membership is set out in Appendix C. In the light of a need to consider similar issues in Scotland, the Scottish Executive sent an observer to the group. The Secretariat (DTI) engaged the services of Professor Ron Allan of the Department of Electrical Engineering at University of Manchester Institute of Science and Technology as a technical adviser.

4.4 The Group met for the first time in March 2000 and, with the exception of a month's break in the summer, met monthly until December 2000. Specific elements of the terms of reference were addressed in position papers and at least two members of the Group acted as rapporteurs in the preparation of each. Rapporteurs discussed their topics outside

the plenary group meetings and consulted other Group members and other interested parties as appropriate.

4.5 In the period March to December 2000, rapporteurs prepared seven key papers, which were discussed and endorsed by the Group. They relate to the:

- network operator reporting on facilitation of competition ;
- assessment of embedded generation contribution to network performance ;
- provision of ancillary services by embedded generators ;
- charging principles ;
- issues for domestic and other micro-scale generation ;
- provision of information ;
- future network design, management and business environment.

Rapporteurs' papers, which provided the main input to the Group's recommendations, are annexed in Volume 2 of this report. (Annexes 1–7).

The recommendations in the paper on the provision of ancillary services have been included in the section entitled assessment of embedded generation contributions to network performance in Chapter 3.

The recommendations from the rapporteurs underpin the Group's main recommendations in Chapter 1 of this report. Chapter 3 summarises the detailed recommendations roughly in the order in which they arise in the rapporteurs' papers.

4.6. As a scene-setting exercise, the independent member, Dr Tony White set out his thoughts on how embedded generation might be encouraged in future. A copy of Dr White's full paper is at Appendix D. He argued that it is a two-step process. The first requires a change to performance-based regulation - because current regulation does not provide incentives for the network operators to reward the services that embedded generation can give to the network. In particular, the use of deep connection charges does not facilitate competition at the distribution network level. However, on its own, a more level playing field may not be enough to encourage sufficient local generation in order to meet Government environmental generation targets. The market may take time to respond or the signals from a level playing field may simply be insufficient. In that event, a second step involving direct Government intervention to provide financial support to embedded generators may be necessary. Therefore, in the short term, it may be necessary to adopt a carrot and stick approach. Dr White's paper identified two possible solutions / mechanisms which are outlined below.

A Market Solution - Performance based regulation could provide DNOs with a financial incentive to score well on performance, whilst a move away from asset based revenue, could encourage novel forms of system support - but only if cheaper alternatives to investment in infrastructure were the result. Innovative DNOs would then recognise that it is in their interests to change the way they both plan and operate their networks by:-

- Developing their own planning procedures;
- Recognising the potential benefits of embedded generation;
- Producing better, more transparent information;
- Identifying where reinforcements are planned and where generation, or load management could be accommodated or welcomed respectively;
- Publishing prices they would be willing to pay for system support services and providing indicative price estimates for frequency responsive generator operation ;
- Changing their system of connection charges to facilitate new generator connection;
- Devising techniques for managing active, rather than passive networks.

For this to work, both Government and Ofgem would need to provide the drivers to ensure that an increasing proportion of DNO revenues are set in this way.

Government Intervention - The main difficulty of relying on the market is the time needed for DNOs to develop the appropriate expertise and for the development of markets for these innovative forms of system support. While much renewable and CHP plant is embedded, not all embedded plant, either existing or proposed is in either of these categories. Government may therefore consider that achievement of its targets would be at risk if these arrangements were not instituted with greater haste. Some form of minimum requirements, as part of the DNOs licence, may be necessary, over and above any commitment to performance based regulation. These may include specific annual targets to have connected and operating renewable or CHP generation, or other measures that achieve the same aim.

This may incur, for a transitional period, some costs to the DNOs to develop the necessary expertise and procedures.

Chapter 3

RECOMMENDATIONS FROM THE GROUP

Overview

1.1 The group's detailed recommendations fall into seven main categories These are:

- Ways of ensuring that DNOs facilitate competition in generation,
- The way in which the contribution of embedded generation to network performance should be assessed,
- The potential contribution that embedded generators might make to services secured by the high voltage transmission network operator including :
  - local arrangements for the management of reactive power and islanded operation,
  - the longer-term structure of ancillary service market arrangements'
- The principles to be employed for charging embedded generation for connection to and use of distribution networks,
- The special issues which arise with domestic and other micro generators – in particular charging and metering arrangements
- The principles for providing information to developers both in respect of charging and of locational opportunities,
- The way in which distribution networks may be designed and operated in the longer term and incentives which will be needed to secure such arrangements.

Each of the above is the subject of an annexed rapporteurs' paper.

1.2. The following sections contain summaries of six of the seven rapporteurs' papers, together with their recommendations. (The conclusions of the subgroup which looked at ancillary services issues have been incorporated into the section on the contribution of embedded generation to network operation.) These recommendations have in turn been used to develop the Group's main recommendations in Chapter 1.

1.3. The rapporteurs set out options and comment on their relative merits, but usually they do not indicate a preferred option. In considering options, Ofgem and Government will need to take account of both the consensus views set out in the 'options' and 'recommendations' sections of each paper and the 'points of view' of the stakeholder groups in each paper.

1.4 A detailed timetable for implementation of the recommendations is also set out in Section 8 leading to full implementation by 2006.

Network Operator Reporting on Facilitation of Competition (See Annex 1 for Rapporteurs' Paper)

2.1 The Utilities Act 2000 gives DNOs a statutory duty to facilitate competition in generation and supply. Establishing effective information flows, understandable processes for market entry, and equitable and transparent terms for connection and use of system are key to demonstrating that the duty is being discharged.

2.2 Under the existing regulatory framework there is no financial or operational benefit to DNOs from embedded generation. Indeed such generators often result in additional costs to DNOs rather than providing an opportunity for business development. (DNOs can develop their business through increased load connections and collect revenue through Use of System charges.) Ofgem should consider what regulatory changes are needed to remedy this. **[target date January 2002]**

2.3 Consideration should be given to establishing an appropriate form for a commercial forum in which distribution customers can meet distribution company representatives.

Assessment of Embedded Generation Contribution to Network Performance (See Annex 2 and Annex 3 for Rapporteurs' Papers)

3.1 Ofgem should put in place a co-ordinated programme of work to assess the changes discussed below and to implement those which are appropriate. These changes cover three main areas:

- Design codes,
- Ancillary services,
- Islanded operation.

The programme should include a clear timetable for delivery (suggested dates are included below)

3.2 Appropriate arrangements for incentivising DNOs should be put in place. Ofgem should assess the costs and benefits of the changes proposed with a view to making any necessary licence changes.

Design codes for distribution networks :

3.3 Ofgem should review the potential network benefits from the provision of security services from embedded generators. This should assess the contribution to network security from embedded generation - particularly with regard to the requirements of, and assumptions in, P2/5 and the potential effects on system performance as experienced by customers. It should also seek to identify short term measures under the existing

standards to allow fuller recognition of the contribution of embedded generation to network security and performance. **[target date January 2003]**

3.4 Ofgem should also examine the present arrangements for amending P2/5 to ensure that all interested parties have an appropriate mechanism for initiating changes to it. It may also be appropriate to carry out a similar review of other relevant Engineering Recommendations used by DNOs. **[target date January 2002]**

Power Quality , Voltage and Ancillary services :

3.5 Ofgem should assess the services - other than security - that generators can provide to networks, concentrating on services such as voltage support; provision or absorption of reactive power, frequency response; reserve and black start. This would differentiate between those services that could be traded with the operator of the high voltage transmission network or with others and those relevant to the local needs of DNOs' networks. DNOs or others could act as an aggregator of the services that could be provided by small independent embedded generation within a DNO network area. All these services become more relevant for DNOs if a generator is supplying an island of load within a DNO's network. **[target date January 2003]**

Islanded Operation :

3.6 Ofgem should review the benefits and disadvantages that could result from allowing embedded generators to operate in islanded mode, supporting local supplies to demand customers in the event of network failure. In certain circumstances, such an arrangement could reduce significantly the number of customer minutes lost - though this is likely to be localised in nature. Responsibility for maintaining voltage, frequency and network safety would be likely to remain with the DNOs and they would need to consider arrangements for operating the network safely under such conditions. **[target by January 2003]**

3.7 HSE and DTI should review the implications of connecting widespread embedded generation for the safety of distribution network operation. Without suitable safeguards, DNOs could no longer be confident that a particular part of distribution network would be "dead" in the event of circuit outages if unknown owners of generation equipment were still connected to the network. **[target date January 2004]**

Charging Principles
(See Annex 4 for Rapporteurs' Paper)

4.1 Under present charging arrangements, generator customers pay deep connection charges, that is the costs of the direct connection to the distribution network together with any necessary costs of reinforcing the network as far as the local grid supply point. Any reinforcement necessitated by the connection of an embedded generator is fully financed by that embedded generator at the time of connection. On the other hand, demand customers pay relatively shallow ('shallowish') connection charges along with Distribution Use of System (DUoS) charges. All other reinforcement costs are met through DUoS - which are presently paid only by load customers.

4.2 The present arrangements seem to favour load customers and it is questionable whether this approach is sustainable given the new requirements of the Utilities Act. In those circumstances where network reinforcement costs are high, the current arrangements can present a significant financial barrier to the connection of new generation. Often they are regarded as inequitable since the developer may only require a portion of the capability of the minimum reinforcement for which it must pay - leading to inequities between first and second comer generator connections. A move towards sharing more of the benefits with others such as existing and future customers and future embedded generators is required.

4.3 Possible alternative charging arrangements which address these problems to varying degrees are set out in Annex 4. While the group did not identify a preferred solution , the duty to facilitate competition in generation makes it important to move from the present arrangements. In order to achieve this, significant changes would be needed to the way in which DNOs charge for the connection to and use of distribution networks. The business environment will need to change accordingly to encourage this behaviour.

4.4 There are two principal alternatives for generator connection charges which could result in more equitable treatment for generators:

- Shallow Charges – the generator pays only for the connection to the nearest suitable point at an appropriate voltage on the distribution network. This is similar to connection charges applied to generators connecting to the transmission network but is less onerous than the charges currently placed on load customers of DNOs.
- Shallowish Charges – the generator pays for his connection as above and for reinforcement made necessary by the connection to the distribution network at the same voltage as the connection and one voltage level above that of the connection. This is similar to the connection charges applied to load customers connecting to distribution networks.

4.5 Both the above options would reduce the capital cost incurred by the generator and would be likely to encourage significant additional connections of such plant. The former

is likely to be more effective than the latter in this respect. It would also cause a step change in net capital expenditure by DNOs – the former option having a greater impact than the latter. Taken on their own, these options weaken the locational signals presented by deep charging – indeed the former provides no locational signal but this can be addressed in other ways as described below. Adoption of shallower charges for connecting larger plant may place significant costs on other users.

4.6 The options also require that reinforcement costs be met through other charges. Possible ways of achieving these include :

- Load customers pay all reinforcement costs caused by generators through increased DUoS. Significant embedded generation would result in significant additional costs to load customers. Load customers would be likely to regard this as inequitable.
- Generation customers pay all reinforcement costs for generators through a new generator entry charge.
- Both load and generation customers pay reinforcement costs through entry and exit charges. This option is equitable while providing significant encouragement overall to the connection of new embedded generation. It could also provide the locational signals to generators and customers lost through a move to shallow or shallowish connection charges. DNOs would have to develop a new charging regime.

Each of the above results in winners and losers - but the third method is likely to level the playing field most effectively.

4.7 It is for Ofgem to consider, in the light of wider Government policy objectives, to what degree embedded generation should be encouraged through connection charging policies. Whichever solution is selected, urgent analysis is required to assess the potential impact of changes, both in the short term (up to 5 years), and in the longer term (beyond 5 years). In considering the options, the position of existing embedded generators that have already paid deep connection charges will need to be considered. A possible timetable is :

- The options should be identified and analysed by **January 2002**,
- A statement of intent by Ofgem in respect of its future approach to charging options should be made by **June 2002**,
- DNOs should move to this new connection charging policy by **January 2003**, and
- the overall package should be formalised in the next price control review in **April 2005**.

Domestic and Other Micro-Scale Generation
(See Annex 5 for Rapporteurs' Paper)

5.1 The development of micro generation such as Stirling Engine or Fuel Cell based central heating systems and Photovoltaic (PV) roof systems will have enormous implications for the future operation of distribution networks. At present a typical household demand averages less than 1 kW but can have a peak of around 10 kW. Typical domestic or micro generation would meet most of this demand. If micro CHP or PV systems gain wide acceptance it is likely that the role of the distribution network will change as a consequence of changing load and generation profiles. Distribution networks would see no net flow of electricity over certain portions of the day. At these times the system would become more like balancing networks providing the appropriate level of backup capacity and security. While the key cost driver for network provision will continue to relate to maximum rather than aggregate energy flows, this has significant implications for DNOs. It will also affect suppliers, generators of all sizes, and the transmission operator.

5.2 Domestic and micro generators are faced with a number of technical and financial decisions when setting up their systems :-

- connection charges;
- payment mechanisms (via metering, profiles and fixed charges) for use of the distribution system, selling exports and buying imported electricity;
- technical requirements for connection to the distribution network to enable 'parallel' operation;
- metering arrangements for measuring the generation output, export to and import from the network.

Taking each of these in turn :

5.3 A simpler and transparent **connection and payment structure** should be considered for smaller generators. Distributor charging options have already been identified in the section above. These should be developed in a way which is appropriate to micro-scale generation technology. **[Target Dates : as for Section 4]**

5.4 The potential costs associated with the metering and charging alternatives identified should be established including:-

- installation cost ;
- any change to meter reading cost ;
- developing and implementing new profiles suitable for domestic and micro-scale generation ;

- the effect of using simple bi-directional metering (often known as net metering) solutions - taking account of DNO and supplier concerns. This is a complex issue and requires further work to analyse the full costs properly;
- the cost of implementing low cost half-hourly metering ; (particularly if there are economies of scale and a change of metering on-site)
- stranded costs of existing metering assets.

5.5 Small Inverter-connected PV systems may connect to a distribution network, provided they comply with a **technical standard** known as Engineering Recommendation G77. All other forms of micro-generation must comply with a more complex Engineering Recommendation G59/1. Work should be started to apply the principles of G77 to other inverter based generators and to apply a simpler form of G59/1 to small non inverter generation units - such as Stirling Engines.
[Target date : June 2002]
The simpler standard would need to be suitable for assessing mass produced equipment, perhaps using a type testing approach, and take fully into account a number of important security and safety issues.

5.6 The key requirement for **metering** is that it should be economic to install and be linked to tariff arrangements which allow all the parties concerned to measure or estimate with confidence the information they need. The main alternatives can be summarised as follows :

- Retention of the existing one way meter linked to a tariff based on a profile which estimates typical power flows in both directions. This would minimise installation costs but might be complex to administer;
- Installation of a bi-directional meter which would operate with a net energy tariff or a profiled tariff which could estimate typical energy flows in both directions;
- Use of import-export meters (which may not be significantly more expensive than bi-directional meters) would provide measurable information as to power flows in both directions and so reduce the dependence on profiles and reduces the scope for profile error.

Note : A generation production meter which would, with suitable changes to legislation, provide householder generators with a possibility of benefitting from Renewable Obligation Certificates.

5.7 The Balancing and Settlement Code (BSC) does not presently permit certain options for settlement by suppliers. Ofgem should ensure that the Code works to enable options for micro generation.

Provision of Information
(See Annex 6 for Rapporteurs' Paper)

6.1 Developers of embedded generation have been concerned for some time that the information made available to them about connection points and the effect of location on likely connection charges is variable, opaque and inadequate. Comparisons are often made to NGC's Seven Year Statement (SYS) which developers value as a source of information about generation opportunities. Against the background of the proposed licence condition requiring DNOs to publish a network development statement, the group set out to identify a framework that would identify what information is actually needed by developers, the ways in which that information might be provided without excessive costs and the minimum standards to which all DNOs might be expected to work in future.

6.2 The subgroup identified three important principles as critical. These are discussed in the following paragraphs. Each principle should be developed to ensure symmetry between information in terms of demand and generation customers.

6.3 **High level network information** needs to be available to meet the proposed licence requirement on DNOs to publish a network development statement :

a) inform the market-place generally ;
b) enable developers to identify potential business opportunities ;
c) provide transparency into the cost of network connections.

Work should commence to identify the distribution network information that should be contained in DNOs' network development statements. Such statements would provide a link to accessing more detailed project specific information.
[Target date : January 2002]

6.4 There needs to be an **appropriate balance** between the value of the information provided and the cost of providing it. Although it can be argued that in principle the level of a distribution network development statement should be similar to that of the National Grid SYS in depth and width, this may not be cost effective. Distribution systems are much more extensive in length and voltage levels, the loads and network are more dynamic. Consequently, the exercise outlined above should establish a pragmatic and economic balance between the information that is required to be generally available in the public domain and that which would be available on request. **[Target date : January 2002]**

6.5 There should be a **consistent approach across DNOs** to the provision of information and to the connection application process. DNOs, together with other users, should work together to agree a standard format for the presentation of information including bringing forward general connection guidelines for Embedded Generation. The guidelines should clarify the roles of developers and DNOs and help to set standards both for the quality of

information submitted by developers but also the quality of the response from DNOs**. [Target date : January 2002]**

Future Network Design, Management and Business Environment (See Annex 7 for Rapporteurs' Paper)

Regulation and Incentives

7.1 The right commercial and regulatory framework has to be in place if the appropriate practical changes are to be made to the way networks are designed and operated. The key issues that arise when considering the implications of introducing embedded generation into distribution networks are :

- Uncertainty about possible future changes in the regulatory process and incentives :
  - Future treatment of DNO business costs ;
  - Lack of incentives to establish a local 'ancillary' services market ;

- Treatment of connection charges.

7.2 The effects of seeking a level playing field through regulation or imposing measures to meet Government targets will be quite different. Pursuing regulatory measures will cause differences to the design and management of distribution networks. But it may not by itself result in targets for embedded generation being met on the timescales that Government presently envisages.

7.3 There is a range of possibilities for creating the right business environment that would encourage change in the approach to embedded generation and load management. At one end of the spectrum is an open market environment - whilst at the other is a more rigid regulatory framework with regulatory requirements to connect additional embedded generation capacity.

7.4 The rapporteurs' paper illustrated one such approach to the **open market environment**:

- Increasing the certainty of the regulatory process;
- Creation of a local ancillary and security services market;
- Moving towards a more performance based regulatory system;
- Creating opportunities for increasing DNO revenue;
- Changing the generator and load management connection charging mechanism.

7.5 At the other end of the spectrum is an **imposed regulatory requirement**, which could be adopted to provide the necessary funds. Options considered include :

- a reward for each MW of Renewable or good quality CHP generation connected, and/or
- a reward for each MWh (Renewable or good quality CHP) generated - or indeed each MWh of load consumption saved.

7.6 A practical solution somewhere between these two extremes is likely. One approach would be for DNOs to discuss with Ofgem proposals which would facilitate, and hence pave the way for increased levels of embedded generation.

7.7 In order to meet the Government's targets, embedded generation and demand side management needs to be considered as an integral part of the distribution and transmission network design and operation. It is appropriate to consider a wide range of changes to stakeholder behaviour which might include :

- A move from the present system of DNO incentives which is biased towards capital assets to a system which is neutral towards assets employed or operating costs and where DNOs are rewarded for performance to a higher degree than at present;
- embedded generators - together with the other stakeholders - designing their plant to be more controllable, provide integrated voltage control and develop commercial arrangements to accommodate constraints, to provide security etc;
- Suppliers developing tariff and metering arrangements to facilitate active load and generation management;
- The operator of the high voltage transmission network adapting its agreements with DNOs so that any impacts on the transmission system from the connection of a new embedded generator can be managed without the need for additional agreements with the operator of the high voltage transmission network. (In this way an embedded generator may benefit from having only a single point of contact with its host network operator).

Potential Technical and Operational Developments

7.8 The sub-group considered a range of possible technical solutions for future network design and management. Introducing embedded generation into distribution networks has technical implications in four key areas:-

- Fault levels : The presence of generation in urban areas can increase current fault levels above plant capabilities;
- Voltage control : Generation connected to rural 11kV circuits tends to increase voltages, potentially above statutory limits;
- Load flows : Inappropriately sized generation connected to the network can cause power flows to exceed plant capabilities and/or affect network losses adversely;
- Network security : The current methodologies for connecting embedded generation ensure that the security of the overall network is maintained – but at a cost to developers. These methodologies could change if networks were managed

differently. Operation of generation in island mode could bring security benefits under outage conditions.

7.9 If given suitable incentives, DNOs could invest in their network to maximise the potential for connection by embedded generators. This might include :

- Strengthening the network to accommodate new generation output while remaining within acceptable fault levels;
- Changing the network's configuration so as to allow more flexible operation of embedded generation under fault conditions;
- Introducing new technology such as :
  - super conducting fault level limiters,
  - energy storage technologies including batteries, super conducting magnetic energy storage, flywheels, and capacitors;
- Utilising technology in the home, including energy efficient lighting and appliances, and PV, fuel cell, Stirling Engine technologies etc;
- A much greater use of communications to allow for more accurate balancing of generation and demand over the network at local levels and in real time.

DNOs are best placed to manage both these processes as a business opportunity but the right commercial framework must be in place to facilitate this .

7.10 The sub group recommended that :

- Ofgem ensures that the regulatory regime supports and incentivises DNOs to meet their obligations to facilitate competition in supply and generation. This should focus on those aspects which dominate DNO business :
  - a clear framework on regulation and incentives on DNOs;
  - generation connection charging principles;

- The industry establish commercial mechanisms to support technical innovation;

- Government should establish a strategic co-ordinated approach to research and development across all the stakeholders. To that end, a long term issues group should consider how to take forward these recommendations and :

  - further investigate the issues;
  - assess their materiality in terms of contribution to the government's targets and impact on stakeholder businesses;

  - with a view to preparing a report in **Autumn 2001** making detailed recommendations of how to move the key longer term issues forward. (Implementation would take longer - say over the period up to and beyond 2005.)

7.11 Network operators have indicated they would welcome discussions leading to definite proposals to address these issues. It will be essential that all stakeholders participate openly and fully in this.

7.12 While demand management does not fall within the terms of reference of this group, customers, distributors and suppliers may wish to make use of such measures rather than additional generation in order to achieve energy savings. When taking forward any changes in respect to embedded generation, stakeholders should also consider demand side measures.

Relative Materiality and Possible Timetable

8.1. The detailed recommendations are set out in sections 2 to 7 of this Chapter and in the rapporteurs' papers. The impact of the recommendations varies - as does the urgency and the possible timescales for implementation. Many changes can be implemented quickly. Others will take longer to achieve, requiring significant planning and further assessment.

8.2. Work needs to start now - before the next distribution price control review, which is due for implementation from 2005. This requires a co-ordinated programme of work to be initiated which will require commitment by all parties. In particular clear statements of intent by Government and Ofgem are essential - both in respect of the programme itself and in respect of the future basis for incentivising DNOs.

8.3. In deciding a definitive timetable, Government and Ofgem will have to balance the practical effects on all parties with the need to get the changes in place so as not to constrain Government targets for renewables and CHP. There may be extra costs involved in implementing changes quickly. The implications of this for companies and customers will have to be balanced against the benefits of embedded generation**.**

8.4. A provisional distribution development and implementation programme could follow a timetable such as that below :

In the table overleaf please note that :

(1) unless otherwise indicated the main action lies with OFGEM;
(2) Each comment box across the table relate to the action immediately above that box in the table.

Rapporteurs' Paper	Outline Possibility	Area	Potential to Increase Embedded Generation	Easy or Difficult	Date
Facilitation of Competition	Review incentives on DNOs through price control structure.	Regulation	high	difficult	April 2005
	Connection process guide	Information	low	easy	January 2002
	Establish commercial forum	Information	low	easy	June 2001
	Overall Implementation Package		low	easy	January 2002
Assessment of contribution	Review of P2/5	Regulation	low/ medium	medium	January 2002
	Security services study	Technical/ Commercial	low	difficult	January 2003
	Power quality, voltage and ancillary services study (This work could be split into several workstreams)	Technical	low	difficult	January 2003
	Island operation (Input from the DTI needed)	Regulatory/ Technical	low	difficult	January 2003
	Network Design Practice analysis	Technical	medium	difficult	January 2004
	Basic active management	Technical/ Commercial	medium	medium	January 2003
	Information systems need upgrading, Additional design / recourses quotation, low ongoing management				
	Overall Package Implementation		medium	difficult	January 2004

Rapporteurs' Paper	Outline Possibility	Area	Relative Impact	Easy or Difficult	Date
Charging Principles	Identify short term changes	Commercial	medium	medium	January 2002
	Statement of Intent by Ofgem	Regulatory	medium	medium	January 2002
	Discussions between Ofgem and DNOs to assess what can be done in advance of next price control review				
	Development of charging options	Commercial	high	medium	January 2002
	Necessary to give DNOs confidence to make changes in advance of review.				
	Regulatory arrangements re next DPCR	Commercial	high	medium	June 2002
	Assess what can be formalised at next review (main points by January 2002)				
	Overall Implementation Package		high	medium	June 2005
	To co-ordinate with next Distribution Price Control Review				
Domestic and Micro Generation	From final draft	Technical	medium	medium	January 2003
Provision of Information (required by distribution licence)	Scoping study	Information	low	easy	January 2002
	Value Balance	Information/commercial	low	medium	January 2002
	Standard system statement format	Information	low	medium	January 2002
	Overall Package Implementation	Information	medium	medium	June 2003
Future network design, management and business environment	Review future possibilities.	Regulatory	low	medium	Autumn 2001
	Dependent upon compatibility with statutory (Elec Supply Regs), regulatory, and commercial frameworks				
	Overall Implementation Package		high	difficult	After 2005

Appendix A

Placing the Work of the Embedded Generation Working Group in Context

1. The Government's central energy policy objective is to ensure secure, diverse, and sustainable supplies of energy at competitive prices. This is best achieved by the operation of competitive markets in energy production and supply, in which commercial pressures ensure that companies strive at all times to improve their efficiency. The Government's priorities in respect of energy and the environment are much influenced by global and international factors, including the international agreements and EU policies to which the UK is committed. The three linked issues which currently have the most bearing on the environmental debate are :

- the drive for sustainable development,
- the commitment to combat global warming, and
- policies designed to integrate pollution control.

All of these issues have global, international, European and national dimensions. This section provides some information on these issues, and how they relate to policy on the environment in the UK.

2. In June 1992 nearly 180 countries met at Rio and agreed a plan of action, *Agenda 21*. This recommended that countries produce their own national sustainable development strategies. The UK's first strategy was issued in 1994, and amended by the present Government in 1997. At the same conference the Framework Convention on Climate Change (FCCC) was opened for signing. Over 160 countries signed up to it, including all the industrialised nations and most of the principal developing nations including India, China, Brazil and Mexico. The Convention entered into force in March 1994. Its objective was to stabilise $C0_2$ emissions by 2000 at 1990 levels but contained no specific timetables or targets for limiting emissions: rather it was a 'framework'.

3. The Kyoto Protocol of December 1997 went considerably further than the 1992 Convention. The objective was to require developed nations to cut their greenhouse gas emissions by an average 5.2 per cent from 1990 levels by 2012. Differentiated targets were envisaged, recognising that each country must address climate change based on its own national energy profile and circumstances. Countries would be allowed to pursue their own paths to lower emissions, whether it be a tax or an internal trading system market-based international mechanisms, such as emissions trading, were embraced. The Protocol will only become law when it is ratified by 55 countries, representing at least 55 per cent of 1990 developed world emissions, a threshold not likely to be met for the foreseeable future. A conference in Buenos Aires in November 1998 continued the work of Rio and Kyoto. The US signed the Kyoto Protocol but Congress has yet to ratify it.

The most recent conference took place in the Hague, in November 2000. Additionally, a much larger Rio+10 Conference is planned for 2002.

4. Under the Kyoto Protocol, the European Union and its Member States can agree to meet their commitments jointly. The EU's target could thus be redistributed among the Member States to take better account of their national circumstances. In June 1998 the EU agreed how its Kyoto target would be distributed. The UK agreed to reduce its emissions by 12.5 per cent. This has now become its legally binding target. Targets for other Member States ranged from a cut of 21 per cent for Germany and Denmark, and a cut of 6 per cent for the Netherlands, to permitted increases of 13 per cent for Ireland, and 27 per cent for Portugal. The Commission issued a Communication on the EU's contribution to a global strategy on climate change.

5. As a result of the Kyoto Protocol and EU commitments resulting from these, the UK has a legally-binding target to reduce its greenhouse gas emissions. The UK Government has decided to exceed both of these targets by setting itself a goal of cutting carbon dioxide emissions by 20 per cent below 1990 levels by 2010. As set out in the DETR's *Climate Change Programme* (November 2000), the Government intends that this will be achieved via a range of policies relevant to the energy sector.

6. Those relevant to the work of the group are listed below :

- improving business use of energy (stimulating investment and cutting costs) ;
- climate change levy - to improve efficiency and the use of low carbon technologies ;
- suppliers obliged to obtain 10 per cent of electricity from renewable sources by 2010 - subject to cost to consumers being acceptable ;
- target to double the capacity of CHP by 2010 to at least 10,000MWe;
- stimulate new and more efficient sources of power generation ;
- improvements to community heating ;
- carbon trading ;
- promote better efficiency in the domestic sector ;
- New Energy Efficiency Standards of Performance requiring gas and electricity suppliers to help (disadvantaged) domestic customers ;

- and ensure the public sector takes a leading role, for example:

- New targets for improving the energy management of public buildings;
- Energy efficiency targets for local authorities, schools and hospitals.

7. In 1999, renewable energy accounted for 2.8% of electricity generated in the UK. The Government has proposed that 5% of UK electricity requirements should be met from renewables by the end of 2003, and 10% by 2010, subject to the cost to consumers being acceptable. The Government is consulting the industry and consumer groups on the detail

of the new Renewables Obligation, including the price implications of a 10% by 2010 target.

8. The Renewables Obligation on all licensed electricity will require suppliers to supply their customers with a specified proportion of their electricity from renewable sources. Eligible supplies are likely to include a wide range of renewable sources of energy. They may exclude hydro-electric schemes with an installed capacity exceeding 10 MW since large scale hydro is long established and is better able to compete in the open market.

9. The Utilities Act makes it possible for suppliers to fulfil their obligation through the purchase of green certificates rather than taking actual delivery of the electricity over the grid. This increased competition in electricity supply and a cap on the maximum price paid for renewables will limit the impact on consumer prices. Exemption of electricity from renewable sources from the climate change levy will also be important in relieving electricity consumers of some of the cost of renewables and in helping to achieve higher levels of renewable generation.

10. The UK's installed Combined Heat and Power (CHP) capacity in 1999 was around 4,300 MWe, and during 2000 over 500 MW of new capacity came into operation – a record figure. Over 1,600 MW of good quality CHP was approved under the stricter consents policy. The Government's Climate Change Programme announced several measures to encourage the expansion of CHP. These included:

- The CCL exemption for fuel used and direct electricity supplies from Good Quality CHP;
- the provision of enhanced capital allowances for Good Quality CHP;
- the exemption from business rates for plant and machinery Good Quality CHP;
- the provision for climate change agreements, giving an 80% Climate Change Levy discount, where CHP will be an important means for industries to deliver the agreed emission reductions;
- Government encouragement for the modernisation of outdated community heating systems, in conjunction with CHP where possible.

The effective implementation of a number of these remain to be achieved.

11. The Government announced that following the lifting of the stricter consents policy, developers will be expected to show that they have seriously explored opportunities to use CHP. The Government's new CHP target is to achieve an installed capacity of at least 10,000 MWe by 2010. Government will publish shortly a consultation on the UK's CHP Strategy, setting out the policies and programmes to support the achievement of the target.

12. These initiatives are carried out against a background of Government policy towards the electricity sector which was set out in the White Paper: 'Conclusions of the Review of

Energy Sources for Power Generation (DTI October 1998)'. The key elements of this policy included :

- new arrangements for electricity trading ;
- pressing ahead with competition in electricity supply for all customers ;
- separating supply and distribution in electricity markets ;
- resolving certain technical issues about the growth of gas, including the proper remuneration of flexible plant.

13. The Embedded Generation Working Group is chaired by Ofgem. This is just one of many areas of work undertaken by Ofgem which involves environmental matters and links with Government energy policy :

As part of the current price control structure for DNOs, Ofgem has initiated an Information and Incentives Project. This Project seeks to link price controls and revenues of DNOs with standards of customer service, such as the number of supply interruptions and has examined how good performers should be rewarded and companies that fall below the standards of others penalised.

Proposals issued by Ofgem in September 2000 will require companies to report on their performance from April 2001 using specified definitions and approaches for measuring three key outputs: the number of supply interruptions; their duration; and customer satisfaction. The performance of companies will be taken into account when Ofgem next reviews the price control, due to take effect from April 2004.

14. In July Ofgem also issued a consultation document on its proposals for an Environmental Action Plan which will bring together for the first time all the environmental issues that need to be addressed by the energy regulator. The plan recognises that the activities of gas and electricity companies have an important impact on the environment and the way that these companies are regulated needs to take account of this. Many of the issues and areas of work set out in the consultation paper are relevant to the work of the Group, in particular the Government's targets for more CHP and renewables. Ofgem intends to publish the Environmental Action Plan in March 2001 – following consideration of the responses and discussions with industry, other government departments and other interested parties.

15. In June 2000, during the period the Embedded Generation Working Group was doing its work, the Royal Commission on Environmental Pollution issued a report 'Energy – the Changing Climate'. The report makes 87 recommendations. Many are addressed to the devolved administrations in Scotland, Wales and Northern Ireland as well as the Government in Westminster. A key conclusion of the report is that the UK should plan a reduction of 60% over the next 50 years in the amounts of carbon dioxide it produces by burning fossil fuels. Absolute reductions in energy demand and a large deployment of alternative energy sources will be needed if the UK is to make deep and sustained cuts in carbon dioxide emissions while protecting its environment and quality

of life. The report explores what this would mean for industry and ordinary households, and how Government policies would need to change.

16. Two key recommendations are :

- Longer-term targets should be set for expanding the contribution from renewable sources well beyond 10% of electricity supplies to cover a much larger share of primary energy demand;
- A range of targets should be developed for raising energy efficiency in all sectors of the economy.

A central policy objective must be a very large reduction in demand for energy for heating and cooling, achieved through sophisticated management of heat and much wider use of combined heat and power schemes for industrial, commercial and domestic markets. The resulting heat networks, supplied initially by fossil fuels, could ultimately obtain heat from energy crops and electrically powered heat pumps.

17. The report stated that the relatively small size of renewable energy plants generating electricity and local CHP plants did not fit easily with an electricity distribution and transmission network based on massive generators and highly centralised control. The national grid and the regional distribution system need to become more favourable to small generators and regulatory policies need to promote and not inhibit this development. The Government should stimulate research into solving the problems that large-scale intermittency and embedded generation would pose to the electricity supply system as a matter of urgency. The Commission recommended that the Government should take the lead in a fundamental review of how electricity networks can best be financed, managed and regulated in order to stimulate and accommodate large contributions to energy supplies from combined heat and power plants and renewable sources, while maintaining reliability and quality of supplies.

18. The Government plans to review the options for longer term energy choices, considering the scale of emission reductions that might be needed in view of current projections for energy use and the scope and cost of low carbon or energy efficiency options that may exist to bridge the gap. It will need to consider issues such as the public acceptability, potential market penetration and the environmental impact of different options. This work will inform its response in 2001 to the report by the Royal Commission.

Appendix B

Terms of Reference of the Working Group (with Rapporteur Allocations)

"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. 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, the group was to consider :

	TECHNICAL ISSUES	**Rapporteurs (alternate)**
1	Possible measures for ensuring that distribution companies, in managing distribution networks economically, compare embedded generation on an equitable and transparent basis as an alternative to any proposed network augmentation. This includes the possible need for revision of the distribution network planning document 'Engineering Recommendation P2/5' and other relevant documents, to ensure that the potential contribution to network security of embedded generation as an alternative to network reinforcement is fully recognised. Engineering Recommendation P2/5 would need to recognise under what circumstances individual generation could be considered to contribute to network security and also the potential contribution of embedded generation on an aggregate basis.	Phil Jones, Stephen Andrews (Phil Baker)
2	Possible measures for ensuring that distribution companies have regard to the possibilities of obtaining security services from embedded generators and are incentivised to do so.	Phil Jones Stephen Andrews (Phil Baker)
3	Possible arrangements for ensuring that the National Grid Company has regard to the use of embedded generators for the provision of ancillary services (known as 'balancing services') under NETA.	Lewis Dale Stephen Andrews

	PUBLICATION OF INFORMATION	Rapporteurs (alternate)
4	The possible need for further requirements on distribution companies to publish sufficient technical and commercial information to allow prospective generators to make informed judgements concerning appropriate points of connection and opportunities to make proposals which would avoid the need for network reinforcement	Phil Jones and David Porter (Colin McNaught)
5	The adequacy of the present arrangements under which NGC and the distribution companies presently report publicly, at regular intervals, how they have facilitated competition in generation.	Lewis Dale and David Porter (Phil Baker)
6	The possible need for new rules on the publication of charges by distribution companies, so as to ensure transparency, and to provide a definitive basis for the financial appraisal of new embedded generation proposals.	Alan Laird and Terry Brookshaw (Colin McNaught)
7	The possible need for new rules on the publication of information by distribution companies on actual charges for connection to and use of systems.	Alan Laird, Stephen Andrews (Karen Marshall)

	CHARGING ISSUES	Rapporteurs (alternate)
8	The principles and ground rules under which embedded generators should be charged for connection to and use of distribution systems.	Alan Laird and Catherine Mitchell (Karen Marshall)
9	Issues for domestic and micro generation	Alan Laird and Catherine Mitchell (Phil Baker)
10	The possible case for basing DUoS payments by embedded plant on actual use of distribution assets, but with connection charges made on a ‘shallow’ rather than ‘deep’ basis.	Alan Laird and Catherine Mitchell (Karen Marshall)

	LONGER TERM ISSUES	Rapporteurs (alternate)
11	The possible need, in the medium and longer term, to encourage distribution companies to design networks so as to facilitate the accommodation of embedded generation.	Phil Jones and Catherine Mitchell (Phil Baker)
12	The possible need to encourage distribution companies actively to manage the operation of those parts of their networks where significant embedded generation exists or is proposed, possibly through forms of incentive for security services and active planning	Phil Jones and Catherine Mitchell (Phil Baker)

Outline Programme And Method Of Working

The terms of reference set out the main issues which the subgroup will address. It is envisaged that the work will proceed in three stages :

- Draft and agree key questions and positions in respect of each issue. (subgroup members supported by DTI secretariat) We propose that an individual member from the generator representatives and from the distributors will take ownership of and speak to each issue.
- Seek technical and other support to investigate these questions and challenge these positions and to produce a position paper for group discussion. (Technical and other bodies advised by subgroup members).
- On the basis of the position paper establish where possible a consensus for the advice the subgroup is to give in its final report. Where consensus is not possible, differences in position will be indicated. (Group members)

Prepare and forward final report. (Secretariat on the advice of Group Member

Dissemination

The Group is invited to discuss means for disseminating its interim views to the wider audience. One possibility would be that key meeting papers be made available on the DTI web site – this being supported by a short pointer note distributed to all respondents to the November 1999 Consultation Document on Network Management Issues.

Scotland

The Working Group considered the issues in the above Terms of Reference in the context of the England and Wales electricity network. It did not consider the situation in Scotland where there are considerable differences including geography, the large amount of embedded generation already connected to the network in the north and west of the country, and the pricing mechanisms used. As it was recognised that the general

principles and themes arising from the work could have some relevance to Scotland, a member of the Scottish Executive attended meetings of the working group as an observer.

Arrangements for the future treatment of embedded generation in Scotland are matters for the authorities (the Scottish Executive and OFGEM Scotland) and the various parties who have an interest in the network in Scotland (including Scottish distributers, generators, suppliers and consumers.) They will be examining thoroughly the conclusions identified in this paper, with a view to identifying what solutions in Scotland are appropriate.

Appendix C

Membership of the Working Group

CHAIRMAN, INDEPENDENT ADVISER, AND SECRETARIAT		
NAME Nominating Organisation	Job Title and Address	Telephone, Fax and Email
Dr Brian Wharmby Chairman	Technical Director Ofgem 9 Millbank London SW1P 3GE	Tel 020-7901-7294 Fax 020-7901-7077 brian.wharmby@ofgem.gov.uk
Dr Tony White Independent Member	Schroder Salomon Smith Barney European Utilities Team 33 Canada Square GR18, Canary Wharf London, E14 5LB	Tel: 020 7986 4266 Fax: 020 7986 4342 Email: anthony.white@ssmb.com
Dr Graham Bryce Secretary to Working Group	Deputy Director, Energy Utilities DTI 1 Victoria Street London SW1H 0ET	Tel : 020 7215-2733 Fax : 020 7630-9570 graham.bryce@.dti.gov.uk
Steve Jacobs Dep Secretary to Working Group	Manager Industry Sponsorship, Energy Utilities DTI 1 Victoria Street London SW1H 0ET	Tel : 020 7215-2676 Fax : 020 7630-9570 steve.jacobs@.dti.gov.uk

CUSTOMERS AND SUPPLIERS		
NAME Nominating Organisation	Job Title and Address	Telephone, Fax and Email
Bob Spears	Utilities Buyers Forum The East Wing Norwood Park, Southwell, Notts NG25 0PF	Tel/fax 01636-816653 rspears@res-consultants.demon.co.uk
Terry Brookshaw Suppliers BGT	formerly - British Gas Trading now - British Energy Barnet Way, Barnet Gloucs GL4 3RS	Tel : 01452-652222 Terry.Brookshaw@British-Energy.com
Andrew Horsler NECC/Energy Watch Domestic and other small customers	6th Floor, Abford House, 15 Wilton Road, London SW1V 1LT	Tel 020 7931 0977 nfoster@gass.org.uk

NETWORK PROVIDERS		
NAME Nominating Organisation	Job Title and Address	Telephone, Fax and Email
Dr Lewis Dale NGC	Market Analysis, Standards and Data Manager National Grid Company National Grid House Kirby Corner Road Coventry CV4 8JY	Tel : 02476-423074 Fax : 02476-423145 lewis.dale@uk.ngrid.com
Dr Phil Jones Distribution Representative	Yorkshire Electricity 161 Gelderd Road, Leeds LS1 1QZ	Tel : 0113 241 5911 Fax : 01977-605682 phil.jones@yeg.co.uk
Alan Laird Distribution Representative	Maintenance Business Manager Power Systems, Scottish Power plc Prenton Way, Birkenhead CH43 3ET	Tel : 0151 609 2411 Fax : 0151 609 2210 alan.laird@scottishpower.plc.uk

GENERATORS		
NAME Nominating Organisation	Job Title and Address	Telephone, Fax and Email
Dr Stephen Andrews ILEX CHPA Embedded CHP plant	CHPA Grosvenor Gardens House 37/37 Grosvenor Gardens London SW1W 0BS ILEX King Charles House Park End Street Oxford OX1 1JD	Tel : 020 7828-4077 Fax : 020 7828-0310 Tel : 01865 812203 Fax : 01865 722988 stephen.andrews@ilex.co.uk
Dr Catherine Mitchell Confederation Renewable Energy Associations	Centre for Management under Regulation Warwick Business School University of Warwick Coventry CV4 7AL	Tel : 02476-524985 Fax : 02476-524965 catherine.mitchell@warwick.ac.uk
David Porter AEP (Generators) Substitute: Dr Malcolm Taylor	Chief Executive Association of Electricity Producers 1st Floor 17 Waterloo Place London SW1Y 4AR	Tel : 020 7930-9390 Fax : 020 7930-9391 dporter@aepuk.com

GOVERNMENT AND ADVISERS		
NAME Nominating Organisation	Job Title and Address	Telephone, Fax and Email
Karen Marshall OFGEM	OFGEM 9 Millbank London SW1P 3GE	Tel 020-7901-7000 Fax 020-7901-7066 karen.marshall@ofgem.gov.uk
Leslie Packer DETR	Head, Sustainable Energy Policy Division DETR Ashdown House 123 Victoria Street London SW1E 6DE (now moved to another post)	Tel : 020 7890-6688 Fax : 020 7890-6679 leslie_packer@detr.gsi.gov.uk
Colin McNaught DETR Adviser	ETSU AEA Technology Harwell Didcot Oxfordshire OX11 0RA	Tel : 01235-433302 Fax : 01235-322923 colin.mcnaught@aeat.co.uk
Philip Baker DTI	Energy Policy, Technology and Coal Directorate DTI 1 Victoria Street London SW1H 0ET	Tel : 020 7215-2675 Fax : 020 7215-2848 philip.baker@dti.gov.uk
Ben Maguire Scottish Executive Observer for Scottish feed across.	Energy Division Scottish Executive Meridian Court Cadogan Street Glasgow G2 6AT	Tel : 0141-242-5643 Fax : 0141-242-5812 ben.maguire@scotland.gov.uk
Nick Eyre Looking at energy savings across all areas	Energy Saving Trust 21 Dartmouth Street London SW1E 9BP	Tel : 020 7654 2443 Fax : 020 7654 2444 nicke@est.co.uk

Appendix D

Independent Member's Paper

Assessment of Embedded Generation Contribution to Network Performance

1 Statement of the Question

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 renewables plant and CHP and the wish among developers to introduce various types of generating plant in distribution networks. 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 relevant technical issues. In particular, it addresses measures for ensuring that Distribution Network Operators (DNOs) manage networks economically and compare the connection and use of embedded generation on an equitable and transparent basis with other alternatives and that they have regard to the possibilities of obtaining security services from embedded generators and are incentivised to do so.

2 The Independent Member's view of the current position

2.1 In the past, investments in network assets have been favoured by DNOs, owing to their interpretation of the current regulatory arrangements. In simple terms, the DNOs believe that they are rewarded with a return on investments they make in network assets. The rate of return is believed to be at or above that deemed by the regulator to be their cost of capital. Expenditure via contracts to provide local generation or load management is not similarly rewarded. In addition, the DNOs have concerns regarding the real time availability of the "non-conventional" means of system support.

2.2 As a consequence of these views, DNOs have not sought to encourage the development of embedded generation. Indeed, the DNOs' planning procedures do not currently take account of the contribution to security from either embedded generation or load management. However, I am aware of occasions where DNOs have asked embedded generators to provide generation support at short notice.

2.3 The recent attempt by OFGEM to link revenues to performance measures could cause the DNOs to change their attitude to embedded generation. If revenues are linked directly to what customers actually value (few interruptions, stable voltages, speedy response to queries or requests for work or connection, low accident rates etc) rather than the size of a DNOs asset base, then the DNOs would not be "guaranteed" a return on their investments. Indeed, the DNOs would have an incentive to score well on the performance

measures, but to spend as little money in doing so. In essence, they would seek to deliver the system at lowest possible cost by whatever means possible. The DNOs would then encourage novel forms of system support, but only if they provide cheaper alternatives to investment in infrastructure.

2.4 If performance based regulation is to be the future, and we would need some encouragement from Government and OFGEM that an increasing proportion of DNO revenues are to be set in this way, then there are, in my view, two ways to proceed. We could let the "market" decide. In this case, the more innovative DNOs would recognise that it is in their interests to change the way they both plan and operate their networks. To this end they may consider:-

- Developing and implementing their own planning procedures which explicitly recognise the potential benefits of embedded generation and load management;

- Publish maps identifying where network reinforcement is being planned and where generation could be easily accommodated or where load management would be welcomed. Clearly, covering the whole 415V or 11kV systems could be labour intensive and expensive. Maps of the 33kV system, identifying the maximum in-feed that could be accommodated without further investment may be more feasible;

- Change their system of connection charges to make them "shallower"; so that new generators would not have to fund the reinforcements to non-local parts of the network. This would bring the DNO charging policies in line with those of NGC;

- Publish the prices they would be willing to pay for system support services at planning and operational time-scales;

- Devise techniques for managing active, rather than passive, networks;

- Give indicative price estimates, where appropriate, for frequency responsive generator operation, so that the generator could, if required, support a part of the network that might become isolated.

2.5 The provision of this information and creation of new procedures will not come without cost. DNOs will only be willing to countenance such expenditure if they believe that:-

- a greater proportion of their revenues will be set by performance, rather than asset bases;

- that the encouragement of these innovative forms of system support will allow them to deliver the system at a lower cost and with the same security and quality; and

- the shareholders will enjoy the benefits of any associated cost savings.

2.6 DNOs with the most effective and innovative approach to securing the system would be likely to earn higher profits than the laggards. In other words, the "market" would reward superior performance.

2.7 However, it may take some time for the DNOs to develop the appropriate expertise and develop markets for these innovative forms of system support. On the other hand, the DETR, DTI and OFGEM may consider that achievement of the Kyoto targets and those for CHP and renewables would be at risk if these arrangements are not instituted with some haste. As a consequence, some form of "minimum" requirements, as part of the DNOs' Licence, may be necessary, over and above any commitment to performance based regulation. It may also be necessary to allow, for a transitional period, some additional revenue for the DNOs to develop the necessary expertise and procedures. These may be of the form:-

- The planning guidance for the DNOs' networks (Engineering Recommendation P2/5) needs to be updated to allow explicit recognition of the contribution to security from modern forms of embedded generation plant and load management. This would include the benefit that diversity of generation and load management could offer on particular parts of the network;

- The publication of information equivalent to NGC's "Seven Year Statement", to an agreed standard for all DNOs, setting out the development plans for the networks, identifying opportunities where novel forms of system support may allow the DNO to forgo investment or at least reduce the cost, either for reinforcement or replacement. This may include:-

- Maps of the 33kV system (possibly lower), identifying where new generation (up to 1 MW, 5MW, 10MW, 40 MW) could be accommodated with minimum further expenditure;

- maintenance policies and anticipated schedules for the following years(s);

- expected loads and load growth on the networks;

- Embedded generators should no longer be charged for "deep connections". The DNOs will make a connection charge for the assets involved in physically connecting the plant to the network. In principle, the DNOs would then only levy a "use of system charge" which would only depend on the local balance of supply and demand. This would bring the DNOs charging principles in line with those of NGC. However, as long as the DNOs' networks remain essentially "passive" it may be necessary to develop an appeals procedures, involving both OFGEM and the Regional Development Agencies, for particularly large connections;

- The publication of a system support schedule each year, setting out the price the DNO would be willing to pay for load management and embedded generation services in particular areas of their network.

Carrot or Stick?

3.1 It may be the case that, having introduced performance-based regulation, the DNOs find that the novel forms of system support cannot compete with investment in assets. Moreover, the Government may also find, possibly as a consequence, that it will be unlikely to meet its targets for CHP and renewables. The Government may then wish to set targets for embedded generation. There is no doubt that this would involve the DNOs with higher costs and some mechanism would be required to ensure that the DNOs carried this out at lowest cost. Such an outcome would clearly be detrimental to the DNOs shareholders as it would increase the amount of Government intervention in their business.

3.2 Since the DNOs do not yet know whether embedded generation can provide wide-scale system support services cost effectively, it is essential that the Government gives the DNOs adequate time and adequate incentive (in the form of performance based regulation) to explore the possibilities of innovative forms of system support.

Appendix E

Summary Of Recommendations

Overall

1. **Ofgem should review the structure of regulatory incentives on DNOs in the light of the new statutory duty on DNOs to facilitate competition**.

   A co-ordinated and managed programme of work needs to start now under OFGEM leadership to:
- Establish a charging regime for embedded generators that reflects the DNOs' duty to facilitate competition in generation as well as in supply.
- Review and prepare guidance that will allow DNOs to interpret design and operational codes in such a way as to allow the contribution of embedded generation to network performance to be taken fully into account.
- Establish more transparent and consistent arrangements for the provision of information by DNOs to developers of embedded generation and demand. (Chapter 1 Paragraph 2.2)

2. **A Group should be established under Government leadership to co-ordinate and take forward the implementation of the present Group's recommendations for the longer term**. (Chapter 1 Paragraph 2.2)

Detailed

Ways of ensuring that DNOs facilitate competition in generation

3. No financial or operational benefits exists under the present regulatory framework for DNOs to benefit from embedded generation. Ofgem should consider what regulatory changes are needed to remedy this. [target January 2002] (Chapter 3, paragraph 2.2)

The way embedded generator contributions to network performance should be assessed

4. The electricity industry led by Government and Ofgem should put in place a co-ordinated programme of work (to address recommendations 5 -10)

Design codes for distribution networks:

5. Ofgem should review the potential network benefits from the provision of security services from embedded generators. It should also seek to identify short term measures under the existing standards to allow fuller recognition of the contribution

of embedded generation to network security and performance [target January 2003] (Chapter 3, paragraph 3.3)

6. Ofgem should examine the present arrangements for amending P2/5 to ensure that all interested parties have an appropriate mechanism for initiating charges to it. [target by January 2002] (Chapter 3, paragraph 3.4)

7. It may be appropriate to review other engineering recommendations used by DNOs together with an assessment of security and ancillary services. [target January 2002] (Chapter 3, paragraph 3.4)

Power quality, voltage and ancillary services:

8. Ofgem should assess the services (other than security) that generators can provide to networks concentrating on voltage support, provision or absorption of reactive power, frequency response, reserve, and black start. [target January 2003] (Chapter 3, paragraph 3.5)

Islanded operation:

9. Ofgem should review the benefits and disadvantages that could result from allowing embedded generators to operate in islanded mode, supporting local supplies to demand customers in the event of network failure. DNOs would need to consider arrangements for operating the network safely under such conditions. [target January 2003] (Chapter 3, paragraph 3.6)

10. HSE and DTI should review the implications of connecting widespread embedded generation for the safety of distribution network operation. [target January 2004] (Chapter 3, paragraph 3.7)

The principles to be employed for charging embedded generation for connection to and use of distribution networks

11. The duty to facilitate competition in generation makes it important to move from the present (charging) arrangements. (Chapter 3, paragraph 4.3)

12. Ofgem should consider to what degree embedded generation should be encouraged through connection charging policies. Analysis is required to assess the potential impact of changes, both in the short term, and in the longer term. A possible timetable is :

- The options should be identified and analysed. [target January 2002];
- A statement of intent by Ofgem in respect of its future approach to charging options should be made. [target June 2002];
- DNOs should move to this new connection charging policy. [target January 2003];

- The overall package should be formalised in a new price control. [target April 2005] (Chapter 3, paragraph 4.7).

Special issues which arise with small scale domestic generators – in particular charging and metering arrangements

13. A simpler and transparent connection and payment structure should be considered for smaller generators. Charging options should be developed in a way which is appropriate to micro scale generation technology [target date as per recommendations 11 and 12] (Chapter 3, paragraph 5.3)

14. The potential costs associated with the metering and charging alternatives identified for domestic and micro-generation should be established. This is a complex issue and requires further work to analyse the full costs properly. (Chapter 3, paragraph 5.4)

15. Work should be started immediately to apply the principles of G77 to other inverter based generators and to apply a simpler form of G59/1 to small non inverter based generation units – such as Stirling Engines. [target June 2002] (Chapter 3, paragraph 5.5)

16. The Balancing and Settlement Code does not presently permit certain options for settlement by suppliers. Ofgem should ensure that the Code works to enable options for micro generation. (Chapter 3, paragraph 5.7)

Principles for providing information to developers both in respect of charging and locational opportunities

17. Work should commence to identify the distribution network information that should be contained in DNOs' network development statements. [target January 2002] (Chapter 3, paragraph 6.3)

18. The work in recommendation 17 should take account of the need for an appropriate balance between the value of the information provided and the cost of providing it. [target January 2002] (Chapter 3, paragraph 6.4)

19. DNOs, together with other users, should work to agree a standard format for the presentation of information - including bringing forward general connection guidelines for Embedded Generation. [target January 2002] (Chapter 3, paragraph 6.5)

The future network design, management and business environment

20. Ofgem should ensure that the regulatory regime supports and incentivises DNOs to meet their obligations to facilitate competition in supply and generation. This should

focus on a clear framework on regulation and incentives on DNOs and generation connection charging principles. (Chapter 3, paragraph 7.10)

21. The Industry should establish commercial mechanisms to support technical innovation. (Chapter 3, paragraph 7.10)

22. Government should establish a strategic co-ordinated approach to research and development across all the stakeholders. To that end, a separate long term issues group should consider taking forward these recommendations and:
- Further investigate the issues,
- Assess the materiality in terms of contribution to the government's targets and impact on stakeholder businesses with a view to preparing a report making detailed recommendations of how to move the key longer term issues forward. [target Autumn 2001]
  (Implementation would take longer –say over the period up to and beyond 2005)
  (Chapter 3, paragraph 7.10)

Materiality and Timetable

23. Work needs to start now on the above - before the next distribution price control review, which is due for implementation from April 2005. This requires a co-ordinated programme of work to be initiated which will require commitment by all parties. [target date for completion April 2005] (Chapter 3, paragraph 8.2)

24. Clear statements of intent by Government and Ofgem are essential - both in respect of the programme itself and in respect of the future basis for incentivising DNOs. In deciding a definitive timetable, Government and Ofgem will have to balance the practical effects on all parties with the need to get the changes in place so as not to constrain Government targets for renewables and CHP. (Chapter 3, paragraph 8.3)

END OF MAIN REPORT