A REGULATORY ROAD MAP
FOR THE UK

January 2004

Road Map for Transition of the Regulatory Framework
of the UK Electricity Supply System

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### Abbreviations

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<thead>
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<th>Abbreviation</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>BETTA</td>
<td>British Electricity Trading and Transmission Arrangements</td>
</tr>
<tr>
<td>DG</td>
<td>Distributed Generation</td>
</tr>
<tr>
<td>DGCG</td>
<td>Distributed Generation Co-ordinating Group</td>
</tr>
<tr>
<td>DNO</td>
<td>Distributed Network Operator</td>
</tr>
<tr>
<td>DPCR</td>
<td>distribution price control review</td>
</tr>
<tr>
<td>ESI</td>
<td>Electricity Supply Industry</td>
</tr>
<tr>
<td>IFI</td>
<td>Innovation Funding Incentive</td>
</tr>
<tr>
<td>IIP</td>
<td>Information and Incentive Project</td>
</tr>
<tr>
<td>NGT</td>
<td>National Grid Transco (UK Transmission Network Operator)</td>
</tr>
<tr>
<td>NETA</td>
<td>New Electricity Trading Arrangements</td>
</tr>
<tr>
<td>nTPA/rTPA</td>
<td>negotiated/regulated Third Party Access</td>
</tr>
<tr>
<td>PIU</td>
<td>Policy Innovation Unit</td>
</tr>
<tr>
<td>RAB</td>
<td>Regulatory Asset Base</td>
</tr>
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<td>RAV</td>
<td>Regulatory Asset Value</td>
</tr>
<tr>
<td>RES</td>
<td>Renewable Energy</td>
</tr>
<tr>
<td>RES</td>
<td>Renewable Energy Sources</td>
</tr>
<tr>
<td>RPZ</td>
<td>Registered Power Zone</td>
</tr>
<tr>
<td>UoS</td>
<td>Use of System</td>
</tr>
</tbody>
</table>
Executive Summary

This document has been prepared as part of the SUSTELNET programme. It aims to outline the beginnings of a regulatory roadmap for the UK, as a precursor to a more advanced set of descriptors, and as an eventual contributor to an overall roadmap for the EU.

The main objective of this document is to develop a regulatory road map for the UK’s transition to an electricity market and network structure that creates a level playing field between centralised and decentralised generation and network development. In the short term this will generally mean removing prejudicial barriers to distributed generation within economic regulation. Sustelnet does not address support mechanisms which ‘tilt’ economic regulation in favour of sustainable energy or within markets and networks. This does not mean that some Sustelnet members do not agree with ‘tilting’, merely that Sustelnet addresses only ‘neutral’ regulation.

The document can be regarded as an attempt to address the specific issues and barriers raised by an earlier review of the UK situation which described the relationship between economic regulation and distributed generation (DG).

In simple terms, the failure of current economic regulation to incentivise DNOs to operate and manage distribution networks economically acts as a market failure. Traditionally, the DNO has been ‘passive’, in that it operates and manages the network in a ‘fit and forget’ manner. That is, once work is undertaken in the network, DNOs do not expect to return to it until a fault occurs. The general solution to this is the imposition of incentives which turns DNOs from ‘passive’ to ‘active’ market facilitators. An ‘active network’ will require the DNO to be actively involved in the design and operation of its duties, and in that respect active networks will require new energy regulation. The technical analysis of future electricity systems shows that whatever the technological future, active management will improve network efficiency.

Defining a roadmap for the UK requires the taking into account of a range of different descriptors. These are used to evolve a central scenario in which the move to an active network is described under a positive set of circumstances. The robustness of this central scenario is then tested using firstly, some less positive overarching circumstances and then some particular disruptive events.

This paper progresses from the same basis as the earlier UK case study that there are four interlinked major building blocks for a future distribution charging policy. These are;

- Connection Charges

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1 Mitchell and Connor, UK Case Study [http://www.sustelnet.net/images/ukfinaldoc.pdf](http://www.sustelnet.net/images/ukfinaldoc.pdf)
- Use of System charges
  - Entry
  - Exit
- Performance Based Incentives
- Benchmarking

It is assumed that the move to an actively managed network and to a level playing field for all technologies is a desirable one. The current position of Ofgem with regard to DG is considered, including current proposals to change the way DNOs are incentivised to operate with regard to DG and the roadmap takes these as the starting point to assess the way in which the UK can most rapidly move a level laying field.

The Embedded Generation Working Group (EGWG) report produced in 2001 set out a timetable for change. It was recommended that the changes be included in the 2005 distribution price control review. The authors regard this as the preferable option in ensuring the UK moves more rapidly towards the desired state of achieving both a more balanced playing field for regulation of DG, and reaching its goals for sustainable development. Clearly, following the timetable recommended by the EGWG is no longer possible and the roadmap will attempt to follow a realistic timetable for change, taking into account the dates that are fixed in the calendar relating to distribution.

With this in mind the regulatory roadmap suggests the following changes:

<table>
<thead>
<tr>
<th>Category</th>
<th>Action</th>
<th>Responsibility:</th>
<th>Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network regulation</td>
<td>Outlining form of new RPZ/IFI mechanisms</td>
<td>Ofgem</td>
<td>2003-05</td>
</tr>
<tr>
<td></td>
<td>Consulting on changes to DG related regulation as part of 2005 DPCR</td>
<td>Ofgem</td>
<td>2003-05</td>
</tr>
<tr>
<td></td>
<td>Adoption of RPZ/IFI</td>
<td>Ofgem</td>
<td>2004-05</td>
</tr>
<tr>
<td></td>
<td>Operation of RPZ/IFI</td>
<td>Ofgem, DNOs</td>
<td>2004-05</td>
</tr>
<tr>
<td>2005 DPCR</td>
<td>Ofgem - Consulting with relevant stakeholders</td>
<td>Ofgem</td>
<td>2005</td>
</tr>
<tr>
<td></td>
<td>Long term assessment of costs and benefits to the network of increased DG</td>
<td>Ofgem, and all relevant stakeholders or alternatively Consultants/academics</td>
<td>2004-2006</td>
</tr>
<tr>
<td></td>
<td>Consulting on shallow charging and UoS charging for DG in the 2010 DPCR</td>
<td>Ofgem, DNOs, DG, NGT</td>
<td>2008-10</td>
</tr>
<tr>
<td></td>
<td>Other changes in performance based incentives</td>
<td>Ofgem, consulting with relevant stakeholders</td>
<td>2005 onwards</td>
</tr>
<tr>
<td><strong>Extension of RPZ concept</strong></td>
<td>Ofgem</td>
<td>Ofgem</td>
<td>2007-2015</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>--------</td>
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</tr>
<tr>
<td><strong>Initiation of shallow charging and UoS charging for DG ahead of 2015 adoption</strong></td>
<td>Ofgem, DNOs, DG, NGT</td>
<td>Ofgem</td>
<td>2010</td>
</tr>
<tr>
<td><strong>Adoption of Shallow Charging and entry charging for DG</strong></td>
<td>Ofgem, DNOs, DG, NGT</td>
<td>Ofgem</td>
<td>2015</td>
</tr>
<tr>
<td><strong>Follow up assessment and any necessary alterations to deep charging</strong></td>
<td>Ofgem</td>
<td>Ofgem</td>
<td>2015-2020</td>
</tr>
</tbody>
</table>

**DG access to market & market regulation**

| **Improvement of the generating facilities (RES and CHP) to be able for participation on the market with auxiliary services** | Ofgem | Ofgem | 2004 onwards |
| **Improvement of the transmission and distribution system necessary to support the higher share of DG electricity on power and auxiliary service markets** | NGT, DNOs | Ofgem | 2004 onwards |

**Governance**

| **Extension of the national target for RE to 20%** | Government | Government | 2004 |
| **Extension of the RO to 20%** | Government | Government | 2004 |
| **Social and Environmental guidance** | Government | Government | As appropriate |
1. Introduction

This document has been prepared as part of the SUSTELNET programme. It aims to outline the beginnings of a regulatory roadmap for the UK, as a precursor to a more advanced set of descriptors, and as an eventual contributor to an overall roadmap for the EU.

The objectives of SUSTELNET are to:
- Analyse the long term technical, socio-economical and institutional dynamics that underlie the changes in the architecture of the European electricity infrastructure and markets;
- Develop road maps for network regulation and market transformation to facilitate the integration of RES and decentralised electricity systems;
- Lay the foundations for a regulatory process on the regulation of distribution networks in the EU, involving distribution and supply companies, national regulators and national and EU policy makers.

The main objective of this document is to develop a regulatory road map for the UK’s transition to an electricity market and network structure that creates a level playing field between centralised and decentralised generation and network development. In the short term this will generally mean removing prejudicial barriers to distributed generation within economic regulation. Sustelnnet does not address support mechanisms ‘tilting’ economic regulation in favour of sustainable energy or externally to markets and networks.

1.1 The UK Context

The document can be regarded as an attempt to address the specific issues and barriers raised by an earlier review\(^4\) of the UK situation which described the relationship between economic regulation and distributed generation (DG).

It is apparent from the review document as well as the increasing range of publications in the public domain\(^5\), that there are a range of barriers to the increased use of DG resulting from current regulatory arrangements.

Current economic regulation incentivises DNOs to operate and manage distribution networks and fails to take account of the benefit and disbenefits of distributed generation. The general solution to this is the imposition of incentives which allows DNOs to move from ‘passive’ to ‘active’ market facilitators. Since the DNO will always act to maximise revenue, what is essentially needed is system of incentives which provide the option for the DNO to maximise its revenue through maximising the efficiency of the network.

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\(^4\) Mitchell and Connor, UK Case Study [http://www.sustelnet.net/images/ukfinaldoc.pdf](http://www.sustelnet.net/images/ukfinaldoc.pdf)


Historically, the DNO has been ‘passive’, in that it operates and manages the network in a ‘fit and forget’ manner. That is, once work is undertaken in the network, DNOs do not expect to return to it until a fault occurs. In addition, the DNOs economic incentives are to transport electricity across wires from the transmission system to consumers. An ‘active network’ will mean the DNO becomes actively involved in the design and operation of its duties, and in that respect active networks require new energy regulation. To drive this change in behaviour, a system of incentives need to be introduced such that the DNO has options as to how it develops its network. This effectively widens the definition of efficiency as it currently applies. Such an approach allows DNOs greater flexibility in operating the system. There are currently no fully implemented active distribution networks anywhere in the world and it is therefore somewhat uncertain as to eventual configurations.

The DNO remains a monopoly in this paradigm, but has the potential to improve revenue through new revenue sources and improved management, and through the increased options available to it, be able to move away from what is essentially a fixed paradigm for DNO behaviour, and begin to operate in more innovative ways to widen its range of commercial activities.

The technical analysis of future electricity systems shows that whatever the technological future, active management will improve network efficiency. 6, 7

1.2 Defining a Regulatory Roadmap

In the context of Sustelnet a road map is a guide to the development of economic regulation of an electricity sector. A road map stipulates the regulatory actions that are necessary to reach a desired future state of market organisation. In Sustelnet this desired future state is described as a ‘level playing field’ between centralised and distributed generation. This broadly means that centralised and distributed generation should be able to participate in the electricity market on equal terms. This rather general conception of a level playing field is operationalised through criteria for electricity regulation.

A road map contains a series of regulatory actions and developments. Furthermore, the road map indicates the timing of regulatory steps. The timing of these steps depends on key developments in the electricity sector and the penetration of DG in the electricity market. The level of detail in the description of the regulatory actions is higher for the short-term actions than for the long-term actions. Finally, considering that regulation never takes place in isolation, a road map should address all stakeholders. 8

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8 Scheepers et al, 2003, Outline for Regulatory Roadmaps, ECN.
This document will address a range of regulatory and political factors currently impacting on DG in the UK and explore how these might best be addressed with regard to the removal of barriers and the altering of market structure to address current market failures as they apply to DG. These descriptors have been identified during the initial, analytical, stages of Sustelnet as being those which are of most significance, from a more extensive list of relevant descriptors.

In order to establish a common reference point, the year 2020 is established as the end point of the roadmap, though in reality, this is a “waypoint” in the long-term development that will continue beyond this year. It is important to note that the creation of a roadmap for the creation of a level playing field for all generators does not aim to outline the easiest way to make changes up to 2020, but with the fastest way to make the necessary changes given the prevailing circumstances in each scenario. This is based on an assumption that the creation of a level playing field is desirable as a first step towards the more efficient operation of the network and of UK electricity supply. The choice of the year 2020 is such that it is thought that this will allow enough time to make the necessary changes, regardless of the barriers within each scenario.

1.3 Defining a level playing field

Policies relating to the incentivisation and disincentivisation of DG in the UK can be split into two groups; delivery mechanisms and economic regulation. The first of these are the economic instruments which act to stimulate increased use of DG by attempting to:

- capture the value of the environmental benefits of DG in comparison with the external costs of more traditional generating facilities. These reflect the value placed by society on the current and future benefits of RE technology, or, if preferred, a reflection of the comparative harm caused by other fuelstuffs; and,
- stimulate innovation and the promotion of options within the energy system.

The second group relates to the prejudicial impact of economic regulation on levelling the playing field for distributed generation. The concerns arising from this and how to address the bias inherent in the system are central to Sustelnet.

It is difficult to provide an exact definition of a level playing field. However, discussions in the Sustelnet project have yielded valuable insights into what might constitute some of the ingredients of a level playing field. There is general agreement that a level playing field entails economic regulation which provides neutral incentives to both centralised and distributed generation.

There are two competing methodologies for valuing the costs and benefits of DG. The first is at the micro-level, and involved the assessment of the costs and benefits of situating a generating plant at a location X, and how these might be paid. A breakdown of both the energy-related and network-related costs and benefits relating to DG has been

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9 See earlier Sustelnet documents, [http://www.sustelnet.net/documents.html](http://www.sustelnet.net/documents.html)
inventoried as another part of the Sustelnet programme\textsuperscript{10}. The Leprich \textit{et al} document also discusses how valuation of costs and benefits might best be attached to relevant stakeholders.

The second methodology, rather than assessing costs/benefits on an individual level, puts the onus on the DNO to maximise the benefits to the network. The latter approach is supported within this document. The incentives should be provided to network operators and generators to exploit these values in the most efficient way and there should be an absence of disincentives forcing a particular behaviour.

However, it is recognised that the provision of non-discriminatory incentives and proper valuation of benefits and cost associated with distributed and centralised generation alone may not result in a level playing field in the long run. Technological innovation policy literature shows that DNOs will continue to favour the area in which they have the greatest experience. These path dependencies in the electricity infrastructure are likely to create a bias towards the historically prevalent centralised generation. If this is to be overcome on the grounds of longer term efficiency and customer value, then it may initially require temporary additions to economic regulation to provide some additional incentive to overcome the barriers created by the historic advantages of CG in the investment market, that is, ‘tilting’. Sustelnet employs an interpretation such that modifications or interventions to the market up to 2020 are acceptable and do not constitute ‘tilting’. Rather, they are necessary to overcome the resistance to change inherent in the current system. This is not the case in UK regulation, as described above. UK regulation takes the view that ‘tilting’ within economic regulation is not acceptable. In other words, the rules and incentives should be technology ‘blind’. The government is prepared to promote new technologies externally to the market. The UK is therefore unique in this respect. Other countries, for example Germany, effectively give renewable generators priority access to market, as supply companies must buy their electricity at a price specified by the state and thus will use it before buying from other sources. In the UK this would be seen as direct intervention in the marketplace and thus unacceptable. Furthermore, in the UK, it is not possible under current regulatory duties to provide a regulatory ‘tilt’.

The crux of the problem is that as energy and electricity systems become more sustainable, so the characteristics and operational demands of the systems increasingly differ from conventional technologies and operations today. Support for those new techniques and operational modes may have to increase as energy system sustainability increases. One can either expect that (a) the notion of a level playing field converges with path dependencies or (b) that the economic regulation of the electricity system will have to implement sustainable energy characteristics. In the former path, as DNO experience at facilitating greater DG capacity grows then the costs associated with investing in DG should decrease, thus allowing the additional incentives to be removed and a system of neutral regulation to be achieved. A level playing field should balance long term and short term benefits and costs of the electricity infrastructure. The latter

\textsuperscript{10} Leprich, U. and Bauknecht, D., Development of criteria, guidelines and rationales for distribution network functionality and regulation.
path represents a theoretical situation where cost of a sustainable energy system diverge rather than converge over a period of time. It is usually assumed that costs will converge but there is no evidence to support this. This paper takes the view that as a rise in the percentage of sustainable energy occurs, costs may diverge if current economic principles continue. In this situation a constructed energy regulation system would appear to be more cost effective for customers. This is an area which requires further work, and this topic has not formed a specific topic within the Sustelnet project.

Currently, DNOs in the UK are effectively tied to an inflexible revenue raising system which encourages them to maximise throughput of electricity over their networks. One of the conclusions of the UK case study is the need to move away from this structure towards a system which allows them flexibility in the way they raise revenue, thereby providing them with the opportunity to choose other revenue raising options where these may be more appropriate to achieving long term goals for network development.

1.4 Defining ’level playing field’ specific to the UK case

In the UK, the creation of a level playing field requires the adoption of a number of changes to the overall operation of economic regulation of the UK electricity supply industry.

As part of the UK Case Study, a number of conclusions were drawn as to the incentives and disincentives for both centralised and distributed generation stemming from the current regulatory framework in the UK.

It was concluded that a number of fundamental changes are required to achieve a level playing field: those relating to network regulation and others relating to markets. Specific changes include:

- The creation of a new framework for networks including connection and Use-of-System charging mechanisms;
- The creation of new performance output measures;
- Benchmarking;
- The ability to incentivise back-up capacity through the market. This essentially means attempting to provide greater flexibility to generators through changes in the way that links between the operation of the market and the development of networks operates.

After summarising the conditions for development of this document, the second part will concern itself with addressing the specifics of change to current regulation necessary to facilitate movement towards an eventual ‘neutral’ state of regulation. This will lead to consideration of a multiplicity of routes which focus on specific scenarios based on various possible future characteristics of the regulatory environment.

1.5 The role of DNOs
One problem central to the regulation of DG is the incentivisation of DNOs. DNOs in the current electricity supply industry are passive organisations whose main purpose is the provision of distribution network services, mainly transport of electricity. The secure operation of the transmission system and provision of ancillary services is handled by the transmission network operator, NGT. However, if the expected increase in DG is to be successfully accommodated in the electricity system, electricity networks will need to reconfigure into more active networks, where DNOs evolve from passive organisation into more active agencies. In other words, DNOs should be encouraged to become active and innovative entrepreneurs, operators and managers that act to facilitate and profit from the connection of DG into the system, where this is the most appropriate solution for the network. By creating a regulatory environment flexible enough to allow DNOs to receive the benefits DG creates where this is appropriate to the most efficient running of the network, the DNOs would be provided with incentives to allow them to share in the benefits of connecting DG and to provide the correct signals to generators and consumers in order to efficiently manage the network such that it accounts for all forms of generation and the services they provide, rather than doing so for centralised generators alone.

2. Framework for Development of a UK Regulatory Roadmap

The regulatory issues that need to be tackled in the regulatory roadmaps have been distinguished in relation to both network regulation and to issues related to market access for DG. Five stages of network regulation have been identified, and the specific characteristics of each tabulated, as shown in Appendix I. These stages have been generalised within the context of the Sustelnet project to apply for a range of Western and Eastern European countries. They are thus not totally appropriate specific to the UK situation. The five stages are;

- Self regulation;
- Cost-based incentive regulation;
- Multiple-drivers incentive regulation;
- Innovative regulation; and
- Active Networks.

Each is described in terms of how the network is driven, the regulatory issues it throws up, the access it allows to generators and the connection charges that generally apply with its application.

Each of the regulatory issues arising from the various tabulated stages was classified with the following distinctions;

- **Short/Long term:** The timeframe in which benefits or costs accrue to the DG or DNO.
- **Measurable/Non-measurable:** Whether benefits or costs can be measured and quantified.
- **Individual/socialised:** Whether the benefits or costs can be assigned to the individual party that creates them or should be socialised where it is difficult to identify the individual components, and if so amongst which stakeholders the costs should be
spread. This distinction is strongly related to the distinction between measurable and non-measurable.

Three stages of market access for DG were also identified, the protected niche market, settlement in energy and ancillary services markets and active participation in energy and ancillary services markets. The defining characteristics of each is tabulated in Appendix II.

In order to create a regulatory roadmap, we require both an end point and a start point. The end point has already been defined by the project as being the creation of a level playing field for economic regulation of centralised and distributed generation, to be in place by 2020 at the latest. Defining a start point can be achieved by establishing a matrix which combines the stages of regulatory network as shown in appendix 1, and the stages of market access as defined in appendix 2. This matrix can be seen in Table 1;

Table 1 Regulatory Roadmaps Scheme

<table>
<thead>
<tr>
<th>Level of DG/RES supply</th>
<th>Low (A)</th>
<th>Moderate (B)</th>
<th>High (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market access</td>
<td>protected niche market</td>
<td>DG/RES in wholesale market</td>
<td>Level playing field</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Network regulation</th>
<th>Level of DG/RES supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>No regulation/ self-regulation</td>
</tr>
<tr>
<td>II</td>
<td>Cost driven incentive regulation</td>
</tr>
<tr>
<td>III</td>
<td>Refinement of cost driven incentive regulation</td>
</tr>
<tr>
<td>IV</td>
<td>Innovative predominant passive network</td>
</tr>
<tr>
<td>V</td>
<td>Innovative active network</td>
</tr>
</tbody>
</table>

By defining starting points in this way we can produce a number of potential starting points relevant to the various different conditions for network regulation and for levels of market access which currently prevail in the different Member States taking part in Sustelnet. This matrix also provides a framework of ongoing regulatory steps against which it is possible to define the roadmap.

In Table 1 the arrows indicate the possible routes for improvement of the regulatory framework. Network regulation can be improved separately from market access, but if
market access of DG improves this will probably also require changes in network regulation.

2.1 The Step Plan for Developing Regulatory Roadmaps

By laying down a number of the most relevant descriptors affecting the possible future scenarios for the development of possible scenarios, it is possible to develop a number of potential future scenarios. Whilst Sustelnet identified over 120 descriptors, these have been reduced to those described in Table 2 in order that the scenarios remain functional.

Table 2: Scenario Descriptors

<table>
<thead>
<tr>
<th>Category</th>
<th>Descriptors</th>
</tr>
</thead>
</table>
| Technical                  | • share of DG in the electricity supply system  
                              • share of natural gas and renewables in power supply  
                              • interconnection with other countries/imports  
                              • reliability of the electricity network  
                              • Information and Communication Technology development  
                              • investment plans for power plants  
                              • network innovation, experiments  
                              • new DG technologies                  |
| Socio-economic/political   | • market concentration in electricity supply  
                              • national/EU policy on energy markets (harmonisation)  
                              • environmental policy  
                              • energy/fuel prices  
                              • support schemes for CHP and RES  
                              • cross border trade  
                              • market opening                        |
| Institutional              | • ownership of networks  
                              • vertical/horizontal integration/unbundling  
                              • regulator  
                              • electricity trading markets              |
| Regulatory                 | • network regulation considering DG  
                              • type of network access (nTPA/rTPA)          |

It is clear that some of these factors are likely to be considerably more significant than others, specific to each national roadmap, and that some will feature more prominently in the process of regulatory change from one roadmap to another. In the UK case, the authors suggest that the most important are likely to include;

- Energy Security
- Regulatory Duties
- Market access

The next step in utilising the frameworks so far described is to describe a possible future or futures for the electricity supply system. For the purposes of Sustelnet, two independent factors are employed; the degree of harmonisation of EU regulation and the level of incentives for DG and RES in the UK national framework. These two factors being chosen as the development of the arguments presented in the drawing up of the
diagram in appendix 1. EU harmonisation has essentially been chosen as one key determinant on the basis that it has the largest across the board effect and is a key trend relevant to the development of national policy. The availability of national support is a key determinant of the level of national political support likely to accrue to the changes required to achieve level playing field.

By employing these two variables it is possible to draw up a total of four scenarios, as shown in table 3, which together provide a wider portion of development of a roadmap in different contexts. However in terms of roadmap development it is more effective to advance one scenario to provide a reference roadmap and to then correlate the robustness of this reference roadmap against each of the other three scenarios. It should also be noted that factors impacting on scenarios must be contextualised. Some of the factors are outside the influence of the electricity industry, that is, they form the ‘landscape’ in which the national ESIs develop, one example is the level of harmonisation occurring within the EU. Another set of factors, and the most prominent in terms of the factors which will be accounted for in individual scenarios are ‘regime’ factors, i.e. those that are a part of the electricity system itself and which can be affected by actors within the system. A third and final group of descriptors are ‘niches’; these can be defined as small, protected areas created to allow the development of specific technological innovations which would otherwise be unable to compete with established technologies. These may offer the potential for significant breakthroughs in the use of DG/RES technologies.

Table 3: Scenarios

<table>
<thead>
<tr>
<th>Stronger EU harmonisation policy</th>
<th>Reduced EU harmonisation policy</th>
</tr>
</thead>
<tbody>
<tr>
<td>DG opportunities in a fully harmonised EU market</td>
<td>DG opportunities in national markets</td>
</tr>
<tr>
<td>Scenario A</td>
<td>Scenario C</td>
</tr>
<tr>
<td>High RES &amp; DG incentives</td>
<td>Moderate RES &amp; DG incentives</td>
</tr>
<tr>
<td>Efficient regulation (EU Regulator)</td>
<td>No harmonised regulation (national focus)</td>
</tr>
<tr>
<td>Market concentration</td>
<td>Some MS implement fair grid access</td>
</tr>
<tr>
<td>Non discriminating grid access rules</td>
<td>Ambitious EU-wide targets for RES &amp; DG</td>
</tr>
<tr>
<td>Ambitious EU-wide targets for RES &amp; DG</td>
<td>Diversity of national support schemes</td>
</tr>
<tr>
<td>Strong EU-wide support schemes (tradable certificates)</td>
<td>Strong RES &amp; DG support compensates for regulatory deficits</td>
</tr>
<tr>
<td>Scenario B</td>
<td>Scenario D</td>
</tr>
<tr>
<td>Difficult times for DG in a fully harmonised EU market</td>
<td>Difficult times for DG in national markets</td>
</tr>
<tr>
<td>Efficient regulation (EU Regulator)</td>
<td>No harmonised regulation (national focus)</td>
</tr>
<tr>
<td>Market concentration</td>
<td>No improvements in grid access</td>
</tr>
<tr>
<td>Grid access rules disfavour small units</td>
<td>National support schemes partially reduced</td>
</tr>
<tr>
<td>Harmonisation of RES &amp; DG support at a low level</td>
<td>No compensations for regulatory deficits</td>
</tr>
<tr>
<td>EU wide certification schemes (tradable certificates)</td>
<td></td>
</tr>
</tbody>
</table>

Devising roadmaps which remove regulatory barriers to increased deployment of DG and RES are central to the aims of Sustelnet, and can also be regarded as being socially and politically desirable at the national and EU level; thus a scenario which complies with
higher deployment is preferable as the reference roadmap. International commitments within the EU to increased liberalisation and harmonisation of electricity sectors mean that it also makes sense to use increased harmonisation as the default scenario. The default scenario employed is thus scenario A, as outlined in table 3, above. It is worth noting that the four scenarios have been agreed upon after taking into account the likely variations in each of the Member States considered within the Sustelnnet project, and with the aim of combining the prospective national roadmaps into an overall EU-wide regulatory roadmap. Historically, the position of the UK at the forefront of electricity sector liberalisation will tend to mean that even if EU efforts towards harmonisation were to falter over the next twenty years, it is unlikely that the movement of the market would reverse significantly. Thus, it is the other central variable, EU harmonisation, which will provide the greater test of the robustness of the lead scenario.

2.2 Key Factors for the UK

A regulatory roadmap will centre on the potential for change from the current operational conditions. Facilitating change will stem from those particular occurrences which affect these conditions. With regard to moving towards an idealised market situation such as the level playing field, this can be interpreted as meaning there are only limited opportunities to effect the changes necessary for the new operating conditions. For the purposes of creating a regulatory roadmap for the UK, likely focal points for change and the major DG related policy impacts over the period till 2020 would appear to be;

- Distribution price control reviews (DPCRs): These act as the central review of the regulation relevant to the operation and incentivisation of the DNOs, setting prices for the new period and imposing any new conditions on the DNOs. They are currently conducted every five years, though there is the potential for this to reduce in order to capture greater market benefits for consumers. It is not possible to forecast changes at this level. For the purposes of the roadmap the assumption of five year periodicity will be maintained, with the publication of reviews becoming apparent in 2005, 2010, 2015 and 2020. It should be noted that each publication will see years of activity beforehand as consultations are carried out, and input taken into account. The effects of review publication may also be introduced over an extended time period.
- The potential for an increased target for the Renewables Obligation (RO) to be adopted at some point before 2020.
- Any change in Ofgem’s duties regarding social and environmental regulation. It is assumed in each of the scenarios that the basic structure of UK ESI governance will remain the same with Ofgem continuing to act as an independent economic regulator, and changes only being made in Ofgem’s duties by the government.
• Any change to the New Electricity Trading Arrangements (NETA), or any functional change to the GB-wide rolling-out of NETA as it becomes the British Electricity Trading and Transmission Arrangements (BETTA)\textsuperscript{11}.
• The need to strengthen transmission and distribution networks specifically relating to DG/RES and the RO, and more generally with regard to strengthening of the network overall.
• The impacts of EU regulation concerning the operation of the market, commitments relating to DG/RES policy and security of supply issues.
• Continuation of the current regulatory regime.

The legislative process is a slow one and changes in policy take a number of years to be agreed on. The adoption of the RO, for example, took three years from the publication of the original consultation document in March 1999 to its adoption in April 2002. Issues relating to regulatory risk also impact on the regularity with which the UK government is willing to interfere with the distribution sector. The RO is also subject to review and possible change in order to address any problems arising from its operation, underlining the difficulty of applying appropriate and effective regulation at the first attempt. For example, some problems with the RO have already come to light. The failure of TXU and of Maverick Energy during the 2002-03 period of the RO resulted in each failing to make good on their obligations during the period\textsuperscript{12}. The result was a lower than expected buy-out fund and thus a reduced effective worth for ROCs in the period. A further problem that came to light was that funds collected from companies which met their obligations after the period was complete could not legally be passed through Ofgem to those who had submitted ROCs. It is not legal to do so. This problem was solved by companies agreeing to make payments direct to the affected companies, but both problems require changes in regulation to be properly resolved.

The RO is currently scheduled to be comprehensively reviewed in 2005/06 to assess how it might best serve long-term development. However, the down side of this is that simply having the potential to change increases the risk to investors, with negative implications for investors and thus to the availability of capital.

2.3 Factors Common to all Four Scenarios

The drawing up of this regulatory roadmap relies on the production of four scenarios, each addressing the move to a level playing field under different conditions. However, the methodology is to build up one central scenario and then test this with two sets of more negative conditions to provide a matrix of four scenarios. While some conditions obviously change between scenarios, other factors will be common to each. The major common factors include;

• The commitment of UK RE policy to a 20% RE by 2020, and the timing of this commitment;

\textsuperscript{11} See \url{http://www.ofgem.gov.uk/ofgem/work/index.jsp?section=/areasofwork/betta00#} for more information on BETTA.
\textsuperscript{12} Ofgem, 01/10/2003, Press Release ‘TXU (UK) Ltd and Maverick Energy Ltd fail to comply with the Renewables Obligation’ See \url{http://www.ofgem.gov.uk/temp/ofgem/cache/cmsattach/4659_r9403_1oct.pdf}
• NETA/BETTA and government unwillingness to intervene in the market;
• The degree of change required in the UK regulatory roadmap if a level playing field is to be achieved.
• The specific changes that will be required in each scenario, if a level playing field is to be achieved. This is described in depth in Scenario A.

Central to the issue of how the ESI should approach the need for change to the network structure, and the assessment of the likely future needs of the network is the perceived commitment to DG/RES goals at the earliest possible stage. Each of the scenarios also assumes that moves towards an active system of network management and to a sustainable energy future are desirable outcomes. To this end, each scenario aims to provide a context in which the conditions for an active network, and thus for a level playing field are in place by 2020. More positive scenarios allow this to occur prior earlier than less positive scenarios.

Each Scenario requires continued firm commitments to DG/RES investment at all levels of UK Government policy. The early announcement of a 20% by 2020 goal as a political commitment rather than an aspirational target – as it was declared to be in the 2003 Energy White Paper\(^\text{13}\) – is seen as desirable in each scenario though it is accepted that this is likely to be later in more negative scenarios. Such a commitment would need to be backed with additional policy support and a significant degree of willingness to become more involved with the regulatory process where appropriate. The UK government would have to be responsive to the needs of DG/RES stakeholders as regards the policy and regulatory needs of meeting UK policy goals. Whilst a firm policy commitment to a 20% target for 2020 does not mean that the UK will necessarily achieve that figure, its adoption would act to drive the implementation of other policies designed to aid its facilitation. It should be noted that since the authors initial report on the situation in the UK, the government has announced the adoption of a 15% by 2015 target, with the aim of bolstering long-term efforts for sustainable energy expansion.

The general outline for scenario A, as shown in table 3, calls for the EU to be generating 40% from both RE and DG by 2020, it is clear that the UK is not going to be in a position to generate 40% of its electrical power from either of these sources by this point, no matter how positive the landscape for its support becomes. The figure of 20% by 2020 is considered as a credible apogee for applied policy - this is the both the recommended target of the Policy Innovation Unit (PIU) in its Energy Review\(^\text{14}\) and the aspirational target adopted by the UK Government as part of the 2003 Energy White Paper\(^\text{15}\). The figure is accepted on the basis that it presents a target that is attainable but which will be challenging to achieve.

\(^{15}\) See DTI (2003)
The decision to change to adopt the 20% target will also have significant implications for RES policy in the UK, both in terms of the policy which is adopted to make its meeting a real possibility and the overall costs of achieving the final target. Policy relating to the target is also significant in that the likely tying of UK capacity to the target set within the context of the RO will continue to impact directly on installed capacity and thus on the necessity for change in the level of innovation required of the network. It thus also relates to the levels of investment required for these changes. That is, if the installed capacity of RES/DG on the network is comparatively low, the UK may not require the high level of innovation described in rank V-C of table 1. The likeliest change is represented in Table 4.

Table 4: The Likeliest Change within the UK Regulatory Roadmap

<table>
<thead>
<tr>
<th>Level of DG/RES supply</th>
<th>Low (A)</th>
<th>Moderate (B)</th>
<th>High (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market access</td>
<td>protected niche market</td>
<td>DG/RES in wholesale market</td>
<td>Level playing field</td>
</tr>
<tr>
<td>Network regulation</td>
<td>I No regulation/ self-regulation</td>
<td>I-A</td>
<td>I-B</td>
</tr>
<tr>
<td></td>
<td>II Cost driven incentive regulation</td>
<td>II-A</td>
<td>II-B</td>
</tr>
<tr>
<td></td>
<td>III Refinement of cost driven incentive regulation</td>
<td>III-A</td>
<td>III-B</td>
</tr>
<tr>
<td></td>
<td>IV Innovative predominant passive network</td>
<td>IV-B</td>
<td>IV-C</td>
</tr>
<tr>
<td></td>
<td>V Innovative active network</td>
<td>No innovative networks required</td>
<td>V-C</td>
</tr>
</tbody>
</table>

2.4 The Current Position of Ofgem

It should be noted that the 2000 DPCR set in motion a process to consider a number of changes to regulation as it affects DG, and that some of the recommendations of this review process should be in place for adoption by 2005. Thus there is the potential for some changes to the way DNOs are incentivised from that point. The first annual report of the Distributed Generation Co-ordinating Group¹⁶ (DGCG) notes a number of areas for change and outlines its plans for research into driving changes in the way increased DG can best be accommodated onto networks, and how these networks will need to change to accommodate DG, though it declines to make any specific recommendations as to changes.

Current plans for action already adopted by Ofgem can be tabulated as follows:

- 30/06/2003 - Development of 'information packages' for potential embedded generators
- 31/01/2004 - Analysis of network design practice
- 01/04/2005 - Review of incentives in price controls
- 01/06/2005 - Implementation of revised charging principles
- 01/04/2006 - Implementation of revised network design package

As part of the consultation process for the 2005 distribution price control review Ofgem must address the future needs of DG. Ofgem notes that it must act to:

- ensure that DNOs have appropriate incentives to develop and operate their economic networks on an economic, efficient and co-ordinated basis;
- ensure that the DNOs facilitate competition in generation and supply; and
- take account of the government’s social and environmental guidance provided to Ofgem by the Secretary of State.

In an Open Letter in January 2003\textsuperscript{17}, Ofgem consulted with stakeholders on the development of the regulatory framework for DG. Its initial conclusions proposed, subject to consultation, the adoption of:

- common charging principles applied consistently across all DNOs;
- a common connection boundary for demand and generation, which leads to most reinforcement costs being recovered through the use of system charges rather than connection charges;
- use of system charges for all users of the system (demand and generation); and
- flexibility for generators or demand connectees to establish non-standard arrangements with DNOs.

The more specific changes which Ofgem currently appears to favour, as indicated by the July document\textsuperscript{18}, are:

- shallowish charges for generators connecting below the 132kV grid;
- the use of a £/MW revenue driver based on the amount of DG capacity a DNO has on its network;

• the costs incurred by the DNOs to provide network access to DG are given a partial pass-through treatment;
• the inclusion of DG-related reinforcement costs in the RAV with an appropriate rate of return;
• the use of a £/MWh revenue driver;
• the use of Registered Power Zones and the Innovation Funding Incentive to stimulate DNO interest in innovation on their networks.

The July consultation document moves from the conclusion of the June document that shallower connection charge boundaries would be beneficial. It notes the potential for greater competition to be stimulated by such a development. The December 2003 document does not appear to make any significant changes to these proposed changes\textsuperscript{19}. The inclusion of DG-related reinforcement costs in the RAV with an appropriate rate of return and the adoption and use of a £/MWh revenue driver both relate to increasing DG access to the network by providing additional incentives to DNOs. The £/MW driver, as outlined by Ofgem, would operate by being linked to the capacity of DG connected to the network revenue. By combining the £/MW driver with partial pass-through Ofgem hopes to help protect DNOs against the risks of investing in infrastructure for DG while incentivising the DNO to invest efficiently through the offer of a ‘premium’ return.

The use of the £/MWh revenue driver relates to DNO operation of their networks. As outlined by Ofgem it aims to incentivise the use of DG as an alternative to network investment. Incentives relating to loss reduction were also considered relevant to altering DNO behaviour in this regard.

Each of Ofgem proposals will be discussed in the context of the scenarios with regard to their future development.

3 The Scenarios

3.1 Scenario A: DG Opportunities in a Fully Harmonised EU Market

Scenario A takes as a starting point some assumptions about the future of Electricity in Europe. Premises include the successful rolling out of competition policy to the newly associated states, following the rapid liberalisation and unbundling of industry throughout the fifteen Member States. Further assumptions include that unbundling has occurred at all levels of the ESI within all member states. A single postage stamp tariff operates throughout Europe, 75% of power is generated in six countries and 20% is traded at power exchanges. Indicative targets from the EU renewables directive have been met across Europe, and growth is supported by a cross-border trading mechanism. Both RES and DG account for 40% of Europe-wide generation. At the technological niche level, strong demand has seen the development of increasingly effective DG technologies, including much increased application of ICT for the optimised integration of DG into load management. Specific to the UK, the RO mechanism, supported by additional

technology specific instruments has enabled the UK to fit easily into an EU trading scheme for green certificates, and has led to the establishment of new international business opportunities for RE technology and electricity which has acted to justify continued support.

It is apparent that some of the factors inherent to the scenario may have less significance to the UK than may be the case for other Member States. International trading, for example, seems likely to have less impact in the UK for purely geographical reasons.

3.1.1 DG and Energy Regulation of Networks

There are a number of ways to divide the areas in which change may be applied. Firstly, DNOs require more revenue sources. Secondly, they need incentives to manage networks holistically. This paper progresses from the same basis as the earlier UK case study that there are four major building blocks for a future distribution charging policy. These are;

- Connection Charges
- Use of System charges
  - Entry
  - Exit
- Performance Based Incentives

Whilst these issues can be categorised separately it is important to understand that they are essentially linked, and that changing the system will require an approach which is inclusive of each of them in order that the changed aspects complement each other and provide the set of incentives necessary to best shape the operation of networks and allow the most efficient operation of the markets linked to them.

3.1.1.1 Connection Charges

As discussed in the general section above, this scenario has the greatest potential to see the most positive changes. Central to this is the change over from deep to shallow connection charging. The first category of major change identified by the UK case study as required in achieving a level playing field was the need to move from deep to shallow charging with an entry charge for the connection of DG to distribution networks. This leads to a concomitant need to account for this change in the way that distribution network operators (DNOs) generate revenue by introducing Use of System (UoS) charges.

The current thinking from Ofgem suggesting the use of ‘shallow-ish’ charging continues to fail to address the need to incentivise DNOs to keep costs of connection down. It also fails to address the issue of excluding smaller developers, though this can be regarded as an additional benefit of a change to shallow connection charging.

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combined with entry charging, and not something which is within the purview of economic regulatory goals that are the focus of this document. It is the view of the authors that shallow-ish charging will not fully address the problems associated with the current system of deep connection charging, and that a change to shallow charging, combined with appropriate entry charges is the only equitable solution which is effectively technology-blind. It would be preferable to move straight to shallow charging directly. However, shallow charging alone is not economically efficient, primarily as it places the risk for the investment in the new part of the network with the network owner/operator. Alone it provides no useful incentives to assist in making systems more efficient. Generators are free to choose any site, regardless of cost and operators must bear the connection costs. This risk can be mitigated by the use of entry charging alongside shallow charging. Entry charges can be made specific to particular locations, dependent on the value to the network of additional generating capacity at those locations. This provides price signals to generators concerning location and enables the operator to begin to adopt a more active response to the operation of its network. In this way, the introduction of shallow connection charging and entry charges provides the most efficient incentives for economic network development.

The drawing-up of this roadmap is based on the assumption that the route will be taken which most quickly brings the UK too a level playing field for DG. As an ideal, the authors of this roadmap also favour adoption of shallow generation and appropriate entry charges as part of the 2005 DPCR. The authors regard this as the preferable option in ensuring the UK moves more rapidly towards the desired state of achieving both a more balanced playing field for regulation of DG, and reaching its goals for sustainable development. However, the process undertaken by Ofgem, in connection with the industry means this is no longer possible and the roadmap will attempt to follow a realistic timetable for change, taking into account the dates that are fixed in the calendar relating to distribution.

The move from deep to shallow charging with an entry charge is an essential building block of the framework for the future. To preserve willingness for future investment it is necessary for the transformation to be signposted some distance ahead in order to minimise impacts on DNO operations and to avoid unnecessary potential for stranded costs. At the same time, its delay will act as an unnecessary brake on the adoption of increased DG capacity.

The switch to shallow connection and entry costs acts to introduce a greater level of competition and transparency to the connection process and allows the creation of location price signalling on distribution networks. The DNO would no longer have an incentive to maximise costs of each individual connection but instead is incentivised to design and manage the network holistically, and at least cost. By allowing connection investment costs to be added to the asset base of the DNO, a proportion of the major disincentive for DNOs to look positively on DG connection is removed.

With each of these factors in mind, this roadmap takes the position that the earliest opportunity for the adoption of shallow connection charging will be as a result of the
2010 DPCR, with an adoption point of 2015 to allow for sufficient notice of change to network investors. Implicitly, the adoption of entry and exit charging will follow the same time table.

3.1.1.2 Use of System Charges

The current distribution use of system (DUOS) charge is very simple. A deep connection charge paid for by generators is matched with a use of system charge. Customers under a certain size also pay an annual standing charge. The DNOs receive a payment from the DUOS charge and this is their sole source of revenue. Recent work within Ofgem has concentrated on this broad area but delivered change only in relation to the connection charge and additional drivers, such as a payment to the DNO related to MW installed (discussed above).

This paper argues that a re-balancing of the relationship between the connection charge and how the use of system charge is constituted is vital to a move to an actively managed and designed network. This is discussed in greater depth elsewhere\(^{21, 22}\). In brief, this paper argues that DNOs have to become responsible for all costs of designing and maintaining their network. Only in this way, can they be incentivised:

- to reduce the total costs of running that network;
- to design and maintain the network holistically;
- through PBR to ensure certain outputs;
- to be benchmarked against each other.

The constituents of DUOS should therefore exclude a shallow connection charge with an entry charge (paid by generators enabling locational signals) and an exit cost paid by customers (equivalent to a standing charge but which can be negative or positive) but include:

- the cost to DNOs of the difference between the shallow and deep connection cost;
- the cost to DNOs for transporting electricity;
- the cost to DNOs for designing, upgrading and maintaining network;
- an incentive to reduce losses and to more effectively manage their networks.

3.1.1.3 Entry and Exit Charging

The options for changes relating to exit and entry charges are presented in the UK case study. With regard to scenario planning, their adoption is effectively fixed at the same point that the switch from deep to shallow connection charging is made. As noted, inclusion in the 2010 distribution price control review, with an eventual adoption five years later in 2015 is the most realistic earliest point for introduction of the new charging

\(^{21}\) Catherine Mitchell, Response to Ofgem’s Update on Structure of Electricity Charges, Warwick Business School October 2002

\(^{22}\) Catherine Mitchell, Response to Open Letter from C McCarthy to DNOs and Electricity Distribution Losses, Warwick Business School, 24\(^{th}\) February 2003
mechanism. Negative conditions arising from particular circumstances may have the potential to slow this adoption.

In the long-term there is perhaps potential for the introduction of entry charges for power flowing from transmission to distribution grids. For this to occur however, two essential characteristics would have to be met; firstly, it would have to be possible for DNOs to apply such charges and secondly the level of DG/RES capacity on their distribution network would have to be sufficient for the DNO to be in a position to refuse the supply of electricity from the transmission network. Within the UK context, the maximum envisaged capacity of 20% by 2020 means that this is not likely to arise as an issue.

3.1.2 DG and Regulation of Electricity Trading in the UK

It is also not possible to discuss the UK’s regulatory framework as it impacts DG without discussion of the New Electricity Trading Arrangements (NETA). Whilst many of the changes necessary to address the problems regarding the interaction of DNOs and DG stem from problems inherent to the current characteristics of network regulation, and thus can be addressed through distribution price control reviews, there are other barriers which link very closely to these which arise from the market conditions to which generation is subject. NETA is currently technology and fuel blind. This supports the status quo for technologies. The current government principle is that there should be no intervention in the primary market. While this principle continues to dominate, new technologies and technologies with non-reliable output will be at a disadvantage. This is not a market failure; rather it is the outcome of the market. Currently the position of the UK government is to acknowledge that new technologies do suffer within NETA, and that corrections should be made externally to the market.

3.1.3 Performance Based Incentivisation

As noted in the UK case study, the use of shallow charging with entry and exit charges does not in itself provide incentives for DNOs to meet performance targets while keeping prices down. By making changes to these revenue streams it should be possible to make changes to DNO behaviour on a more continuous basis. A 2001 Ofgem press release suggested that incentives for connection and utilisation of distributed generation were one of two primary issues that would inform the price control review to be implemented in 2005.

Alteration of revenue streams to motivate innovation is the central issue. A sub-issue of this is how to incentivise DNOs to have operational expenditure so that they can design and maintain the network differently rather than capital expenditure. The mechanism preferred by this paper is through performance based regulation. Currently the only aspects of DNO revenue related to performance are the Information and Incentive Project (IIP) and a small amount of revenue linked to loss reduction\textsuperscript{23}. However, these

\textsuperscript{23} Ofgem calculates that almost 20 000 GWh of electricity were lost on distribution networks in 2000/01. To the industry this means about £600 million worth of electricity. For the average customer, this means about 5 per cent or £12 of the electricity bill. Ofgem also suggest that reducing losses by 1 percentage point
mechanisms are basically marginal to a rigorous move to Performance Based Regulation (PBR). What would make a difference to DNO design and management actions would be a move to link a much larger percentage of revenue (perhaps in the order of 20-50%) to PBR. What is needed is balancing of incentives for DNOs. Changing from a system where 2-3% of income is related to performance to a system where 20-50% of revenue is related to performance will change the underlying way in which businesses value outputs. The IIP acts to improve quality of supply for all customers, and links this to a maximum 2% of DNO revenue, which the DNO stands to lose should their performance fall below the specified standards.

With regard to losses, currently, Ofgem allows DNOs extra income at a rate of 2.9p/kWh of losses saved against a 10-year rolling average based on variable and fixed losses, with income reduced if losses rise. However, the calculation of losses is regarded as lacking in accuracy, and the mechanism for stimulating loss reduction tends to incentivise investment to reduce non-technical losses whilst failing to incentivise DNOs to act on technical losses. DNO incentives related to loss prevention are currently under review by Ofgem. Concern has arisen that different DNOs currently calculate losses differently. Naturally this will impact on the way in which any loss related incentive is calculated. This too is under review by Ofgem. The regulator is expected to make proposals on benchmarking by March 2004 and to have proposed a figure in June 2004, with the expectation of changes in the incentive structure being adopted in the 2005 DPCR.

Ofgem is currently considering three alternatives for better incentivisation of loss reduction, with possible implementation at the 2005 price control review. Each of these options has the potential to incentivise DNOs to address the potential for reductions in losses through greater use of DG and to provide a more accurate representation of the economic value of DG to the network in terms of the potential it offers in assisting loss reduction. The options are:

- to enhance the current regime by increasing the value or share of the benefits to be retained by the DNOs if they beat the targets;
- to introduce a scheme based upon the National Grid Company's System Operator incentive model which gives companies different shares of the costs or benefits depending on their performance against a losses benchmark;
- to make DNOs responsible for the purchase of electricity to cover losses - for example, this would require DNOs to buy electricity in the wholesale market or from suppliers to cover the amount of electricity lost on their networks for that day.

With regard to applying a timeframe to changes, the adoption of a mechanism which accounts for reductions in distribution losses related to DG would seem to be most easily justified; it fits with Ofgem’s duties regarding cost reflectivity as well as providing an

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would reduce UK CO₂ emissions by 750,000 tonnes of Carbon, equivalent to 4% of the UK total annual emissions.
environmental benefit. It must be noted that the loss reduction aspect of DNO operations will only ever form a small part of the potential for incentivising DNO behaviour in such a way as to radically change the operations to enable a more efficient network, which is better suited to achieving environmental and social goals as well as economic goals.

Whilst the change from deep to shallow charging is, by necessity, a step change and must occur as the result jointly and as the result of a single DPCR, there are options available for regulatory changes with regard to DNO incentivisation that can be built incrementally. By making alterations to DNO revenue sources it should be possible to make incremental changes which have an impact on DNO behaviour. Changes can be made in each of the DPCRs between now and 2020.

Perhaps one of the most notable problems with the system as it stands is that it is anti-innovatory due to the presumption it makes against operational expenditure by allowing returns based solely on its benchmark-driven minimisation. Performance based incentivisation of DNOs essentially provides incentives to DNOs to achieve certain outputs in order to secure their revenues. To force them to do so at least cost requires the application of incentives based on their comparative performance with other DNOs - benchmarking.

One interesting - though only very partial - policy solution currently being consulted upon by Ofgem with regard to both stimulating innovation and overcoming DNO risk aversion is the use of Registered Power Zones (RPZ). Initially proposed in an Ofgem publication in March 2002 and then further expanded upon in a January 2003 document, Power Zones are “envisaged to be a defined electrical, or perhaps geographic, area that is proposed by the DNO and forms a ‘bounded network’. Within a power zone, a DNO could apply new technologies, technical solutions and operating practices, as well as pilot new commercial structures to exploit the possibilities for DG to improve quality of supply, reduce losses, minimise constraints to generator operation, and ultimately enable the network to be run at a lower overall cost. Power zones could also provide a framework in which Ofgem could encourage, in a controlled manner, DNO initiatives in relation to distributed generation by specific regulatory treatment such as appropriate treatment of costs that are incurred and other incentives.”

One aspect of current UK regulatory policy to be highlighted by the UK country report was the failure of the current system to stimulate innovation. This was largely regarded as a result of the way in which the system provides no rewards for DNOs to take risks to improve overall network performance. The intention behind the possible introduction of RPZ’s is to provide an opportunity for DNOs to invest in innovations to the network, which Ofgem rules to be in the interests of consumers. The RPZ’s attempt to provide an incentive for DNOs to do so within the context of well managed projects, acting to offer

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greater rewards for innovatory projects, to balance the greater risks associated with them. As currently proposed RPZs will offer incentives within specific limits, though this is subject to change dependent on the results of the ongoing consultancy. The central incentive as currently proposed offers a rate-of-return below that of the WACC (Weighted Average Cost of Capital) plus a £/MW driver. This driver will have a multiplier applied to it, dependent on the classification of the level of innovation of the project, said classification to be decided by Ofgem. No two projects may be identical. Ofgem currently suggests an availability period for projects of 5-10 years. A limit of three projects per DNO has been proposed, though it is difficult to see the justification for such given the disparities between the different DNOs in terms of size and RE/DG resource. A number of issues have still to be addressed, one key issue amongst them being the difficulty of assigning value to failed projects.

The January 2003 Ofgem document (see footnote 15) proposed a further mechanism to stimulate innovation, as a complement to the potential use of RPZs. The Innovation Funding Incentive (IFI) is intended to allow increased DNO spending on R&D technology by making it allowable, whilst capping it to ensure good practice. Ofgem has concluded that it will be too difficult to judge output from the mechanism and thus allowability is based on input. Ofgem will rule as to the level of benefit accruing to customers as a result of R&D spending in making a determination. The working characteristics of the IFI are still subject to the results of the ongoing consultation process. Both RPZ and IFI mechanisms are set to be adopted as part of the 2005 distribution price control review, though Ofgem has asked for opinions on the potential for their interim adoption before that date.

The DNOs have welcomed the future use of the RPZ and IFI mechanisms, naturally as their use allows the potential for extra income, while nothing is lost if the opportunity is declined. Predictably, the DNOs favour a high return with regard to the use of both mechanisms. It is too early to predict what the final form of the two mechanisms will be. Clearly however, if success is to depend on the risk/reward of the scheme it is not clear what the relationship is of the RPZ and quality outputs. Potentially, DNOs could lose money if the RPZ negatively affects their quality. These kinds of risks to the DNO have to be reduced if RPZs are to be a success.

In scenario A we see Ofgem adopt all of the current suggestions for improving the lot of DG as detailed in the general section above, in the framework 2003-2006. These are matched with the introduction of the RPZ/IFI initiatives in the same framework. The RPZ/IFI instruments are currently proposed to stretch to 2010. The success of technologies stemming from the RPZ programme leads to its expansion as an incentive programme aiming to increase the use of the better technology solutions. This is provided through a wider ranging availability of a lower level of incentive for network development. These reductions in costs, together with greater experience of DG technology assist in creating a more positive DNO attitude towards the use of deep charging, that leads to reduced resistance to change in the face of increased government pressure for the network to respond appropriately to increases in distributed output. The
success of the initial programme enables further action to be taken by the regulator, supported by government.

Prior to those changes however, Ofgem introduces additional changes to the incentivisation bases for DNOs by ramping up performance based measures aimed at changing the behaviour of the DNOs with regard to their operational rather than capital expenditure. By allowing greater flexibility relating to their income, combined with the use of the more advanced technology promulgated by the RPZ/IFI mechanism there is further movement on the part of the DNOs to grasp the new opportunities offered by the possibility for making savings in areas where innovation has previously brought little reward.

By 2006, a political will to move towards reducing the regulatory barriers to DG develops to match a growing awareness of the comparable situations in other EU Member states and by the potential for the creation of system which drives increased customer benefits, both in relation to cheaper electricity supplies and in the longer term, an increased availability of services.

3.1.4 Energy Services

One operational change in the UK ESI as it moves towards the end of the period to 2020 is an increased emphasis on suppliers to provide energy services to consumers, rather than simply as providers of electricity ‘on-tap’. Provision of services such as guaranteed minimum supply quality, amongst others – currently unforeseeable – are likely to be driven by customer needs which become apparent over relatively short periods of time. These may be limited by the technical capabilities of the network, but demand has the potential to drive greater flexibility in the electricity system and to stimulate more innovative networks capable of a more active response to customer needs. By regulating to allow the greater provision of energy services in the interests of the consumer, a greater potential for the capture of the system benefits of DG/RES should be possible. There is a likelihood that this will be an important driver for the eventual move to an active network.

3.2 Scenario B: Difficult times for DG in a fully harmonised EU market

The basic assumption of this scenario is a less optimistic installation rate of DG/RES up to 2020. It is relatively easy to envisage the conditions that might lead to such a scenario. The failure on the part of the UK government to commit to increased targets at an early stage may well act to raise the overall costs of installation due to the impacts it has on planning. The likely lagging effect that is expected in relation to legislated RO targets means that 10.4% of capacity from RES is unlikely to be in place by 2011, as in the original version of the RO mechanism, and nor is the new 15% target UK RE policy, making a jump to 20% by 2020 even more demanding. Slow periods of expansion relating to the RO have the potential to see efforts stall and for this to act as a brake on the overall changes required for a future involving a balanced availability of generating options. Whilst the use of the RO should allow the UK to stay in line with any EU efforts on harmonising policy in favour of an international tradable green certificate mechanism,
the failure to actively deal with regulatory barriers to DG could see limited availability of UK generated power by suppliers, increasing demand for overseas generated power, and thus the potential undermining of government willingness to engage with increasing targets. A less strong tradable green certificate mechanism than imagined in Scenario A, perhaps arising from intransigence on the part of some Member States regarding the use of additional national policies, acts to further deter the growth of DG/RES in the UK, due to the reduced opportunities for international trade that this implies. Such a scenario almost certainly means that the UK is less likely to absolutely require the adoption of innovative active networks, though the barriers stemming from the current regulatory regime suggest that the need for some innovation of the passive network will remain. This does not rule out the move to active networks as being desirable for the more efficient operation of distribution networks, just that it might not be as necessary to make the switch as in states with higher DG penetration. The reduction in the speed with which changes in DNO incentivisation may be adopted in this scenario require that DNOs will have to address this issue later than is the case in Scenario A. The need for the step change from deep to shallow connection charging remains as a central area requiring change, and implicitly the restructuring of entry and exit charges that would need to accompany this. A less progressive attitude on the part of the UK Government seems likely to result in less emphatic guidance to Ofgem regarding environmental and social concerns, with a concomitant reflection in Ofgem behaviour regarding regulatory priorities. This scenario would also see a comparatively reduced likelihood of the Government introducing changes in legislation as appropriate to deal with any intransigence on the part of the regulator or where the regulator is trapped by the legal boundaries of its existing duties. A reduced willingness to engage with the problems of DG/RES within the regulatory framework could still leave the UK in line with aggressive EU-wide efforts on harmonisation due to the already advanced nature of UK liberalisation.

Concern over interference with the market, and of committing public funds to risk bearing - judged to be the domain of the private sector - with no clear guarantee of savings to consumers means a less pro-active approach to changing DNO incentives on the part of the Government. The result is that the timeframe for change described in Scenario A is significantly impacted. The slower rate of change in regulation leaves barriers in place for longer - or possibly indefinitely - as DNOs have even less stimulation to try new methods for interacting with DG whilst old options for revenue remain less risky.

3.3 **Scenario C: DG opportunities in national markets**

As in scenario A, the advanced state of liberalisation already apparent in the UK means that the impacts of lessened EU-wide harmonisation of the ESI may have fewer effects on the outcome than is the case in other Member States. A continued UK emphasis on seizing the benefits of increased DG/RES capacity may mean that many of the events occurring in Scenario A also arise in Scenario C. The historic development of liberalised markets in the UK suggests that change is possible where this will result in benefits to consumers. If it can be demonstrated that a market which offers the possibility for greater flexibility, greater innovation can lead to reduced prices by allowing DNOs a
greater range of revenue options, then there is significant potential for the UK to adopt such a position. If it can be also shown that this will remove barriers to greater use of DG/RES then this may also shift the balance in favour of change, or at least provide additional motivation for government support. The drawing up of scenarios assumes that commitments to the global position on the environment remain constant and thus it can be suggested that the timeframe given for many of the changes detailed in Scenario A also apply within this scenario.

3.4 **Scenario D: Difficult times for DG in national markets**

As described in Scenario C, the relative lack of harmonisation at the EU-level should not impact with any severity on the move towards regulating for a level playing field for DG. As with Scenario B however, any lack of willingness on the part of the UK government to become involved in assisting the growth of DG/RES may impart a significant level of drag on the timescale for achieving a ‘neutral’ position for DNO incentivisation with regard to centralised versus distributed generation. It is possible that the lack of European integration will slow things a little, perhaps with regard to the failure to see an EU-wide market for electricity generated from RES. Again, however, the UK’s commitment to liberalisation may mean an ongoing emphasis on increasing cost-reflectivity where scope exists to do so, and in creating the circumstances to best capture any potential for cost reduction that remains in the system.

4. **Robustness of Scenarios**

Scenario A lays down a possible route towards establishing a level playing field for regulation of generation by 2020. Clearly, there is potential for alternative routes to the future to be followed. Scenarios B, C and D attempt to take into account some of the gradual changes which may impact on the overall movement towards a level playing field, and the potential for slowing the process these might have. Additionally however, there remains the potential for major disruptive events to impact on movement towards levelling of regulation, and these act to test the robustness of the scenarios. Clearly, it is not possible to predict the full range of possibilities for what might be classed as a disruptive event in this context. Instead, three possibilities for events with EU-wide implications and one UK event specific to the UK have been selected as a means for assessing the likely impacts of such events on the described flow of the scenarios.

4.1 **Disruptive Events**

4.1.1 EU-wide Disruptive Events

1. Gas price crises (i.e. high prices caused by a shortage in supply)
2. Collapse of the Kyoto process (i.e. CO2-emission reduction is no longer the major policy driver)
3. Technological breakthrough of fuel cells
Clearly, these events have the potential to impact more or less severely on the events described in the scenarios dependent on the juncture at which they occur within the context of the scenarios. For the purpose of testing robustness of the scenarios, it will be assumed that the events occur at the juncture most disruptive to the events of the scenarios. To allow their impacts to have an effect within the limits of the scenario, each will be applied such that it begins at some point in the period 2005-2015. Additionally, each partner in Sustelnet has chosen potential disruptive events specific to their own country. One nationally disruptive event has been chosen for the UK: The closing down of a significant fraction of UK nuclear generating capacity on safety grounds. A further possible disruptive event - the announcement of the expansion of the nuclear sector - was considered for adoption as a nationally disruptive event, but was rejected on the grounds that it was difficult to justify its occurrence within the positive context of Scenario A.

4.1.1.1 Gas Price Crises

Approximately one third of all electricity generated in the UK in 2002 came from gas. However, the UK has indigenous supplies of gas, is currently a net exporter, and expects to remain so until 2006. The UK also has a surfeit of generating capacity at present, with price reductions induced by NETA resulting in some plants being mothballed and the nuclear sector in repeated economic trouble. In the event of a crisis in the near-term, it is likely that these plants would be able to cover any shortfall and prevent any security of supply issues.

Thus it is likely that gas price crises in the middle- and long-term may have the greatest disruptive potential. Obviously, the extent of any price rises would dictate whether further power was needed; the role of Government is difficult to predict since there is obviously an onus on them to ensure security whilst the UK has a clear commitment to allowing the free operation of the market to meet customer demand. Key to their response is the rapidity with which a crisis becomes apparent. Increased DG/RES has the potential to be brought on-line rapidly but the technology is unlikely to be sufficiently economic in the short term. If a crises was to occur between 2010 and 2015, and within the context of Scenario A, it would be expected that DG/RES would occupy a larger fraction of the supply market than is currently the case, and that regulation would already have begun to shift quite heavily towards the level playing field. In this context, increased gas prices should act to assist the economics of DG/RES, adding to the advantages captured as a result of the shift to recognise their full costs and benefits.

4.1.1.2 Collapse of the Kyoto Process

Clearly the Kyoto Protocol is the major international driver for achieving international agreement on greenhouse gas emissions and thus for stimulating national and international efforts in this regard. Thus it also underlies national efforts to increase DG uptake. Its collapse acts to undermine these efforts, though still leaving in place policy commitments at the national and EU levels. It is clear that the earlier that such an event were to occur, the less will have been done in meeting the policy targets and efforts that it acts to encourage. Within the limits set by Sustelnet, the most disruptive point for the
collapse would thus appear to be in 2005, the earliest date allowed. The potential
disruption arising from the event is further maximised by the changing conditions this
implies immediately following the adoption of the 2005 distribution price control review.
Perhaps the primary effect of such a collapse in the UK would be to undermine the
potential for the UK Government to adopt its current policy aspirational goal of 20% RE
by 2020 as a firm goal of policy, instead allowing it to stick to the 15% by 2015 target
that is currently the upper policy goal. The earlier that the collapse occurs, the more
likely it is that the government will yet have committed to the 20% national target.
However, the effects of a collapse in the Kyoto Protocol negotiations should have a more
limited effect on the 15% target which is currently the mainstay of UK policy. This
commitment forms the basis of UK policy as well as being central to commitments within
the EU. Thus it can be expected that the central mechanism currently in place in the UK,
the Renewables Obligation, will be maintained. It is possible though that some other
support mechanism may be withdrawn, depending on the forecasts made for the potential
for returns relating to the stimulation of new technology through capture of international
market share in new technology sectors. A lack of a commitment to a target higher than
15% in the long term – and where no increase is expected – would mean that Ofgem
would have reduced expectations of the level of DG that it could expect to require
connection to DNOs and could accordingly afford to apply less stimulus to altering the
incentives for DNOs to upgrade their networks to account for such. Thus there exists
considerably less potential for the UK to achieve the high target of 20% set within the
scenario, in turn reducing the need for a move towards a more active network to deal with
that amount of networked capacity and potentially less regulatory stimulus for the
alteration of DNO behaviour. The economic justification for a level playing field could
still exist but the need for change would be reduced, and thus there may be a retarding
effect on the emplacement of the policies needed to bring it in to play.

4.1.1.3 Technological Breakthrough of Fuel Cells

Technological breakthroughs relating to fuel cells are likely to come in stages, each an
effective scaling down of the technology. However, even in the early stages, the
technology is likely to have applications with regard to economic use as distributed
generation. Significant factors impacting on the use of the technology seem likely to
include the nature of the fuelstuff being used for the fuel cells. Development of fuel cells
driven by fossil fuels will have different implications for the growth of the technology in
comparison with hydrogen driven cells, with regard to both fuel sources and
infrastructure support. Additionally, the use of fuel cells for transport purposes will also
have implications for fuel source. Notably, if hydrogen is to become the central fuel
source, this provides a significant driver for the increased use of RE, though not
necessarily for its increased DG application. The largest potential for disruption
stemming from a breakthrough in fuel cell technology and a resulting rapid increase in
take-up of the technology comes from the earliest date for the breakthrough, within the
context of Sustelnet and the constraints allowed for disruptions, again means 2005. The
potential impacts of a rapid increase in fuel cell use from that date allow the creation of
the greatest political moment for the adoption of more significant regulatory change than
is currently allowed in scenario A, creating many more potential stakeholders. This in
turn has the potential to place more strain on the passive networks which currently exist, forcing action from Ofgem. The reduced throughput of electricity should also provide considerably more incentive for DNOs to wish to adopt alternative modes of operation in order to maintain revenues.

4.1.2 UK Specific Disruptive Event: The closing down of a significant fraction of UK nuclear generating capacity on safety grounds

As the least economically competitive of the current large scale generators, the nuclear power sector has already faced problems in coping with the economic challenges posed by NETA. The ongoing bailout of British Energy by the UK Government in place since late 2002 on the grounds of national energy security was controversial. Further problems nearly led to bankruptcy though this was averted when the owners agreed to give up the majority of the equity along with the companies debts, in a deal with the company creditors. The deal is still subject to EU State Aid rules.

The UK currently has nineteen nuclear power stations, with a total of forty-one reactors. Of these, sixteen stations, comprising thirty-five reactors, are currently fully operational, and three stations, each with two reactors, have been closed down and are being decommissioned. Eight of the currently operational stations are Magnox, seven are Advanced Gas Cooled Reactors (AGR) and one is a Pressurised Water Reactor (PWR). The Magnox reactors are the oldest, followed by the AGRs – commissioned between 1976 and 1988 – with the single PWR commissioned in 1995. The reactors contribute up to 25% of UK generation. It is possible that safety issues could arise with regard to any of the particular models of nuclear reactor which would result in each of the examples of that model being required to halt generation. The fact that both the Magnox and AGRs are approaching the end of their working lives already undercuts their reliability and is reported to be having an effect on their contribution to the finances of their operators.

The removal from the electricity market of all the reactors of either technology would have an immediate effect. The amount of disruption it might herald is very much linked to the amount of alternative capacity available at the time of the disruptive event, as well as to the volume of nuclear capacity that was caused to be withdrawn from the market. The first obvious effect is that it would cause a significant increase in the wholesale price of electricity, and the likely immediate drawing of any available mothballed UK capacity back into production. The current behaviour of the market is such that generating plants are moving in and out of the marketplace as the wholesale price fluctuates, and there is remaining excess capacity which would help to provide some security. Interconnection with France means any shortfall in supply would also see a likely upsurge in imports of electricity to help balance demand, though this is clearly not without limit. The establishment of further interconnections with other EU States offers other avenues for addressing a supply shortfall over time. It is evident that the most disruptive time for the occurrence of this event would be in the autumn/winter, thus allowing the least time for

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26 See [http://www.dti.gov.uk/nuclear/nuclear.htm](http://www.dti.gov.uk/nuclear/nuclear.htm)
27 For example, See Guardian 18/12/2003, pp21. See [http://www.guardian.co.uk/nuclear/article/0,2763,1109287,00.html](http://www.guardian.co.uk/nuclear/article/0,2763,1109287,00.html)
preparing additional options for increased security of supply before the highest levels of annual demand.

Even given the potential for other sources to pick up the levels of supply no longer available from nuclear generation, it is possible that other sources would be required as rapidly as possible in order to meet demand and to ensure energy security was maintained. It is clear that RES/DG have amongst the shortest development times for establishing new capacity, thus making their increased use desirable in helping to address short term supply issues. Whilst the increased wholesale prices caused by the withdrawal of considerable nuclear capacity would benefit the economics of DG/RES, other stimulation might be required to ease their increased exploitation, or alternatively, their more rapid expansion could be aided by the removal of any regulatory, institutional or other barriers. Furthermore, supply shortages might stimulate action to maximise the benefits of DG already generating, offering the potential for the introduction of regulation - perhaps through legislation - to drive the creation of circumstances which would offer greater opportunity to increase active operation of distribution networks by offering the potential for DNOs to act to increase network security.

This disruptive event thus has the potential to create more favourable conditions for DG/RES, and while it is possible that any financial benefits that might arise for either DG or DNOs may not survive in the long term, even changes in the short term can act to drive increased knowledge creation and thus risk reduction.

Within the 2005-2015 timeframe, and in the context of the events of Scenario A, perhaps the most disruptive year for the event would be around 2010. Thus it is presupposed that the UK is already adopting shallow connection charges as part of the DPCR of that year; it is suggested that the additional stimulants resulting from a dropping off in nuclear generation at that point would have the greatest potential for helping to aid DG in overcoming path dependencies stemming from the historical use of centralised generation.

5. Actions and Responsibilities

Implementation of the regulatory roadmaps described here will require actions by various actors within the UK ESI. The following table assigns responsibility for action, based on the default roadmap described in Scenario A.

<table>
<thead>
<tr>
<th>Category</th>
<th>Action</th>
<th>Responsibility:</th>
<th>Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network regulation</td>
<td>Outlining form of new RPZ/IFI mechanisms</td>
<td>Ofgem</td>
<td>2003-05</td>
</tr>
<tr>
<td>Network regulation</td>
<td>Consulting on changes to DG related regulation as part of 2005 DPCR</td>
<td>Ofgem</td>
<td>2003-05</td>
</tr>
<tr>
<td>Network regulation</td>
<td>Adoption of RPZ/IFI</td>
<td>Ofgem</td>
<td>2004-05</td>
</tr>
<tr>
<td>Network regulation</td>
<td>Operation of RPZ/IFI</td>
<td>Ofgem, DNOs</td>
<td>2004-05</td>
</tr>
<tr>
<td>Network regulation</td>
<td>2005 DPCR</td>
<td>Ofgem Consulting with relevant stakeholders</td>
<td>2005</td>
</tr>
</tbody>
</table>

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| DG access to market & market regulation | Improvement of the generating facilities (RES and CHP) to be able for participation on the market with auxiliary services | Ofgem | 2004-2020 |
| DG access to market & market regulation | Improvement of the transmission and distribution system necessary to support the higher share of DG electricity on power and auxiliary service markets | NGT, DNOs | Ofgem | 2004 onwards |
| Governance | Extension of the national target for RE to 20% | Government | 2004 |
| Governance | Extension of the RO to 20% | Government | 2004 |
| Governance | Social and Environmental guidance | Government | As appropriate |
## Appendix I

<table>
<thead>
<tr>
<th>Network Access</th>
<th>Description</th>
<th>Type of regulatory issues</th>
<th>Criteria</th>
<th>Guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>I Self regulation</strong></td>
<td>Passive, monopoly, nTPA, no real unbundling required</td>
<td>Access possible?</td>
<td>(negotiated) connection charges</td>
<td>Negotiated TPA</td>
</tr>
<tr>
<td><strong>II Cost-based incentive regulation</strong></td>
<td>Passive, cost-driven, efficiency improvements, accounting/legal unbundling</td>
<td>Access mandatory</td>
<td>(standardised) connection charges</td>
<td>Shallow connection charges e.g. Large scale power generation charged with UoS charges of the transmission network</td>
</tr>
<tr>
<td><strong>III Multiple-drivers incentive regulation</strong></td>
<td>Passive, cost-driven, short-term benefits and costs of all DG incorporated, multiple-drivers (quality, etc), DG integrated part of the regulation model, legal unbundling</td>
<td>Short-term; measurable/non-measurable; socialised.</td>
<td>Short-term Socialised: network losses, avoided investments, (extra) DNOs OPEX</td>
<td>Shallow connection charges e.g. dummy compensation for DG connected to low/medium voltage for network losses; DNOs contract system services with DG</td>
</tr>
<tr>
<td><strong>IV Innovative regulation</strong></td>
<td>Innovative network predominantly passive, multiple drivers, long-term/short-term, benefits/costs of DG, some individual allocation, incentives for innovation, legal unbundling</td>
<td>Some short-term / long-term; measurable/non-measurable; socialised/individual.</td>
<td>Short-term Individual: metering, connection costs. Socialised: network losses, (extra) DNO’s OPEX Long-term Individual: avoided investments Socialised: improved security of supply by DG, DNO’s innovation incentive</td>
<td>Shallow connection charges plus entry/exit charges e.g. surcharge UoS charge in order to cover for innovation experiments costs.</td>
</tr>
<tr>
<td><strong>V Active Networks</strong></td>
<td>Holistic approach, active, innovation, DG integrated part of regulatory model, legal (ownership?) unbundling</td>
<td>Short-term/Long-term; measurable/non-measurable; socialised/individual.</td>
<td>Short-term Individual: network losses, metering, connection costs, system services (reactive power, voltage support, etc). Socialised: (extra) DNO’s OPEX, Long-term Individual: avoided investments Socialised: improved security of supply by DG, DNO’s innovation incentive</td>
<td>Actively managed networks Shallow connection charges plus entry/exit charges e.g. Higher allowable rate off return for innovation investments (consequence of higher risk).</td>
</tr>
</tbody>
</table>
## Appendix II

<table>
<thead>
<tr>
<th>Market Access</th>
<th>Description</th>
<th>Rationale</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A: Protected niche market</strong></td>
<td>DG outside the markets; good market mechanisms in place?</td>
<td>Low (Moderate) penetration level of DG</td>
<td>Energy</td>
</tr>
<tr>
<td><strong>B: Settlement in energy and ancillary services markets</strong></td>
<td>Assuming markets for energy and ancillary services in place, DG anticipates in the demand side of this market. Demand side is regulatory/mandatory. DG has no or indirect effect on prices.</td>
<td>(Low) moderate penetration level of DG</td>
<td>Supply of energy and demand of services.</td>
</tr>
<tr>
<td><strong>C: Active participation in energy and ancillary services markets</strong></td>
<td>DG participates in demand and supply side of markets, DG has direct effect on prices through markets</td>
<td>High penetration level of DG</td>
<td>Supply and demand of energy and services</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Market access issues</th>
<th>Guidelines</th>
</tr>
</thead>
</table>
| DG supplies: Energy | - Priority dispatch, obligatory purchase regimes  
- Regulated feed in tariff possibly also compensating for system benefits |
| DG supplies: Energy  
DG demands: Reactive power, balancing power, back up power, voltage support. | - Separate commodity price  
- Market support mechanisms to stimulate technologies and account for externalities  
- DG in competition with large scale generation |
| DG supplies: Energy, balancing power, reserve power, voltage support, reactive power.  
DG demands: Balancing power, back-up power, voltage support, reactive power. | - Separate commodity price  
- Market support mechanisms account only for externalities  
- DG in competition with large scale generation |