Distributed Generation – Future Energy Resources

Project Report

ROADMAPPING OF THE PATHS FOR THE INTRODUCTION OF DISTRIBUTED GENERATION IN EUROPE

March 2004

CONTENTS

Summary

The European Union is facing a number of key energy supply challenges over forthcoming decades. Demand for electricity within the EU is predicted to grow at a rate of 1.4% per year with carbon dioxide emissions from power generation over the same time period predicted to grow by 1.0% per year. This growth is in the context of recognised long-term issues with respect to energy supply security within Europe, and the European Commission's greenhouse gas reduction programme. These statistics suggest that long-term energy consumption issues within the EU must be addressed, and that more novel approaches to energy supply and delivery must be adopted and implemented in order to ensure the long-term stability of the EU's energy supply infrastructure. This was alluded to in the European Commission's Green Paper on Energy Security [2].

Distributed power generation (DG) provides flexible and potentially highly efficient energy solutions, and has already seen some market growth in areas like the United States and in applications such as CHP where the capture of heat enables overall efficiencies above 75%. With appropriate policy and developmental support, the DG market within the EU can be stimulated to provide a significant contribution to the resolution of future energy supply concerns within the EU. A flourishing DG industry within the EU will also enable wealth creation and will generate significant employment benefits to the EU as a whole. However, no strategic plan or roadmap has yet been developed within the EU to assess the case for DG and to and implement appropriate courses of action to enable the European Union to realise the full technical and economic benefits of this technology.

This report therefore provides a review of the issues pertinent to DG within the EU, and proposes a series of actions that should be considered by the European Commission, Regulatory bodies, manufacturers and other stakeholders, with the ultimate goal of creating a thriving DG market and industry in the EU. This approach is based on the rationale that an environment must be created whereby DG is afforded fair access to the energy markets of the EU, and that the legislative and technical rules must reflect this fact.

The actions and recommendations contained in this document fall into two main categories: (i) technical issues, and (ii) policy and economic issues. For example, from the technical perspective, there is an urgent need to develop and implement a European Interconnection Standard for DG to ensure that DG schemes are treated fairly in terms of their interconnection requirements and potential impact on the host electricity network. Other important technical issues include the need for standardised DG certification and authorisation protocols, and the need for a co-ordinated EU approach towards DG system demonstration and performance

validation via a dedicated European test centre. From the policy and economics perspective, important areas for future work include the development of mechanisms for the capitalisation of the total value of DG based on its operational, commercial and environmental benefits, and the need for consistent and transparent incentive regimes for DG. A Road Map for the introduction of DG in Europe, including an outline implementation timeline, and based on the implementation of these recommendations, is also presented.

1. The Need for a DG Road Map

The European Union is facing a number of key energy supply challenges over forthcoming decades. Over the thirty-year period between 2000 and 2030, demand for electricity within the EU is predicted to grow at a rate of 1.4% per year[1] with carbon dioxide emissions from power generation over the same time period predicted to grow by 1.0% per year[1] [1]. This growth is in the context of recognised long-term issues with respect to energy supply security within Europe, and the European Commission's greenhouse gas reduction programme. As a result, long-term energy consumption issues within the EU must be addressed, and novel approaches to energy supply and delivery must be implemented in order to ensure the long-term stability of the EU's energy supply infrastructure. This was alluded to in the European Commission's Green Paper on Energy Security [2]. Additionally, whilst this document only directly covers issues associated with the EU-15, the forthcoming expansion of the EU to 25 Member States brings with it other challenges, for example the need for efficiency improvements arising from ageing electricity industry infrastructure.

Distributed power generation (DG) is an example of a novel, but technically and economically feasible, approach to energy delivery. It relates to the deployment of small-scale power generation plant, generally close to the point of energy consumption. This approach differs significantly from the traditional electricity industry model comprising large, centralised power stations, connected to customers through an extensive electricity grid network. The adoption of DG can offer significant advantages over the traditional electricity industry model, with these savings varying depending on the particular application and DG technology deployed. Example benefits of DG include:

- Through-life energy cost reductions
- Network infrastructure investment deferral
- Fuel diversity
- Reductions in operational losses
- Operational flexibility improvements
- Carbon emissions savings

DG has already seen market growth in areas like the United States and in applications such as CHP where the capture of heat enables overall efficiencies above 75%. In the US, for example, there is a co-ordinated approach to DG, facilitated by the Department of Energy, to enable directed research and

[1] IEA World Energy Outlook 2002 "reference scenario" for the European Union

development in DG technologies, and to provide suitable host site for technology demonstrations.

Although there are a number of Energy-related European Directives either in place or being discussed at the present time, it is clear that current European Energy Policy does not consider DG specifically. Hence, to enable the European Union to maximise the benefit of DG deployment across Europe, and to position EU industry to capitalise on the expanding worldwide DG market, there is a need for a clear EU policy and strategy for DG. This requires the systematic evaluation of the many economic, technical and environmental aspects of DG that can contribute to the European energy supply debate. Furthermore, any resulting strategy should be focussed on the creation of a “level playing field” for DG within the energy markets of Europe which recognises the real commercial value of DG, and allows DG to compete on a fair and non-discriminatory basis with alternative energy solutions. It is clear that such a level playing field does not exist at the present time within the EU. Additionally, there is a need for increased European research and development co-ordination in DG activities in order to maximise R&D benefits across Member States, and to create a dynamic EU DG industry capable of capitalising on the global market.

The many RTD activities currently being undertaken on DG under the 5th Framework Programme could provide a significant input into the development of a more coherent policy and strategy for DG in Europe. However, these projects cover many technical and managerial aspects of DG technologies, power storage and network design and management issues, but do not cover in any great detail issues associated with the policy development and commercial aspects of DG. Some projects include the development of "roadmaps" relating to specific technologies or applications (eg solar photovoltaics, CHP, etc), but no strategic plan or roadmap has been developed to cover distributed generation as a whole. Such a strategy and/or roadmap for the introduction of DG is critical in enabling the European Union to realise the full technical and economic benefits of this technology.

The purpose of this document, therefore, is to re-dress this through the development of a roadmap for the introduction of increasing levels of DG into the European Union energy market to enable the many benefits of DG to be realised. This roadmap document therefore:

- Considers the current status of DG market penetration in the EU
- Provides an analysis of the current technical and policy issues that are affecting the uptake of DG within the EU

- Develops a series of practical recommendations for consideration by legislative and technical policy makers that, if implemented, will facilitate the increased penetration of DG in the EU and contribute to the achievement of the DG-FER vision for DG

- Provides a dated visionary roadmap plan for DG within the EU, based on the implementation of these recommendations, which maps out the way forward for the European Union in terms of DG development and implementation.

This roadmap document has been developed through studies and analysis performed by members of the DG-FER consortium which has been presented and tested out at three stakeholder workshops[2] held between October 2003 and February 2004.

[2] The three stakeholder groups identified and included in the workshops were (i) DG manufacturers, (ii) utilities/energy companies, and (iii) policy makers, all representing cross-EU interests

2. Current Status of DG in the European Union

2.1 Barriers to DG in the European Union

The barriers that DG has to overcome in order to increase market share in a particular market are well documented, and to a degree will be specific to the case being considered. However, there are a number of common features to these barriers that apply in almost all situations, and which must be overcome through policy or other means if DG penetration is going to increase within the EU. These fall into three broad categories:

- Interconnection aspects
- Economic aspects
- Legislative aspects

These are summarised in turn as follows:

Interconnection Aspects

Most utility technical planning standards and approaches within the EU are based on the "centralised" electricity generation model. This generally assumes that electrical energy is generated centrally by large power stations and distributed to consumers through a transmission and distribution electrical network comprising a number of intermediate voltage levels. As a result it can often be time consuming and costly to implement changes in grid infrastructure (eg protection and control equipment) to accommodate reversing power flows as can be the case with DG. In order to maintain a truly competitive energy market it is important to provide an environment whereby DG is able to participate.

In addition, many of the specifications that define the technical performance requirements of generation plant connected to electrical grid networks assume that these stations are large-scale, ie several 10s MW to several 100s MW power output. These technical requirements are often extremely detailed and require substantial investment in equipment development and electrical system studies in order to demonstrate compliance. For larger power stations this additional cost is relatively small in comparison with the investment cost of the power station itself. However, for smaller generation systems, like DG, these additional costs can be a very significant proportion of the scheme development costs and can often tip the balance against investment in DG. There is also a concern among DG proponents that authorisation procedures are used by hostile utilities as a mechanism to discriminate against new DG schemes.

Hence the mitigation of potentially disproportionate infrastructure costs on new DG schemes must be addressed in order to enable DG to compete fairly in the competitive energy market place.

Economic Aspects

It is clear that one of the key aspects that will determine the long-term future of distributed generation within the European Union is the economic performance of DG schemes within commercial markets. Currently, energy markets within the EU are going through a period of substantial change as a result of market liberalisation initiatives and the introduction of increasing levels of customer choice. The principles and intentions of these initiatives are fully supported by the authors of this report, although there is some way to go to make European energy markets truly competitive and open to all potential players.

At the present time, many “newer” DG technologies are in the early stages of commercialisation, and hence their initial costs are relatively high in comparison with more established technologies (although these costs are reducing as further development investment occurs). DG technologies can, however, offer significant through-life benefits in other areas such as emissions reductions and operational flexibility. In view of this, there is a generally accepted view of stakeholders in the DG industry that the economic framework within which distributed generation is required to operate is at the present time not enabling DG schemes to compete with alternative energy solutions in a fair and non-discriminatory manner. This is because there is a lack of price recognition for the additional services and benefits that DG technologies can offer customers, and the disproportionately high interconnection costs associated with DG can limit their economic application. This aspect is addressed later in this document.

These issues are compounded by the price and market uncertainty that investors in the power generation market are facing generally within the European Union. The liberalisation of the gas and electricity markets within Europe has created the situation where the input fuel and the products of DG are now open-market commodities with inherent risk of large price fluctuations. Experience in North America (and Europe) shows that these price fluctuations are generally not correlated with other events or the value of other market commodities, with the result that much uncertainty exists with respect to DG profit margins. Additionally, using DG only at times when profits are guaranteed (eg evening peaks) is likely to drastically reduce the number of running hours of the system and therefore heavily increase the specific capital cost of the installation. Furthermore, because of their size DG systems are generally not in a position to secure beneficial long-term contracts either for energy sales or for fuel purchase, as would be the case for larger generators. Finally, because a number of costs levied against DG schemes are “fixed” in nature, and would not vary significantly for larger schemes (eg power system studies), these costs have a much greater relative impact for DG than would be the case for larger power stations. Hence, the relative financial burden associated with energy trading (€/kWh) is much more significant for small players.

These uncertainties must be addressed and removed in order to stimulate a genuinely competitive energy market in Europe for the benefit of all European citizens.

Legislative Aspects

The legislative environment for DG within the European Union is considered to be at best inconsistent. There are a number of legislative initiatives either currently under development or recently implemented within the EU that attempt to clarify the EU’s position and goals with respect to issues such as CHP and renewable energy. However, there is still wide variation between Member States on issues such as environmental policy and “green” levies and taxation, and the market signals for small power plants can be contradictory between the drive for lower prices on the one hand and the drive for greater fuel efficiency and reduced emissions on the other. Furthermore, some market rules penalise variable output systems (eg wind power and solar power) because of their inability to accurately predict their output due to weather variations. This can have severe commercial consequences that can tip the balance against DG applications.

There are a number of other legislative issues that can negatively influence the deployment of DG in a negative way. For example, the lack of clarity and consistency relating to the treatment of the stranded costs that can occur following the deployment of a new DG application can harm the business case for DG. Furthermore where generation plant owners also have financial interests in the electrical “wires” utilities, then there is scope for conflict of interest and anti-DG behaviour (through refusal to interconnect DG or through charging excessively for the interconnection infrastructure to be installed).

All these legislative aspects require consideration in order to “level the playing field” for DG within the European Union, and this is probably best achieved through some form of European Union strategy that provides a visionary outlook and legislative guidelines for the subject of distributed generation as a whole.

2.2 Opportunities for DG in the European Union

As has already been mentioned, the energy market within the European Union is undergoing a period of substantial change. EU Directives require all EU Member States to open up their electricity and gas markets to competition, the degree of which is defined in European legislation. This opening up of competition should be a key driver for DG within the EU, although evidence suggests that the market mechanisms currently in place are not allowing this to happen. Figure 1 shows the current status of electricity market opening within EU states as of 2002.

Another key driver for DG in Europe is security of energy supply, in particular for DG in the trends in reducing generation margins within the EU [3]. This has occurred as a result of the market liberalisation process and the increasing financial risks associated with new investments in the European power generation sector. EU State electricity reserve margins and import capacities are shown for reference in Appendix B. Whilst some States (eg Austria, the Netherlands) appear to have adequate reserve provision, there are a number of countries within the European Union that are already experiencing relatively low reserve margins. With load growth expected in all EU States for the foreseeable future, as shown in Appendix B, there are opportunities for flexible DG systems

to capture some of the new power generation market. In particular there are some countries (eg Greece, Italy, Ireland) that are both in the "low reserve margin" bracket and are likely to experience above-average peak demand growth. These countries may be the first to experience supply shortfalls, and the deployment of DG systems within these markets must offer significant potential given their flexibility and rapid installation potential.

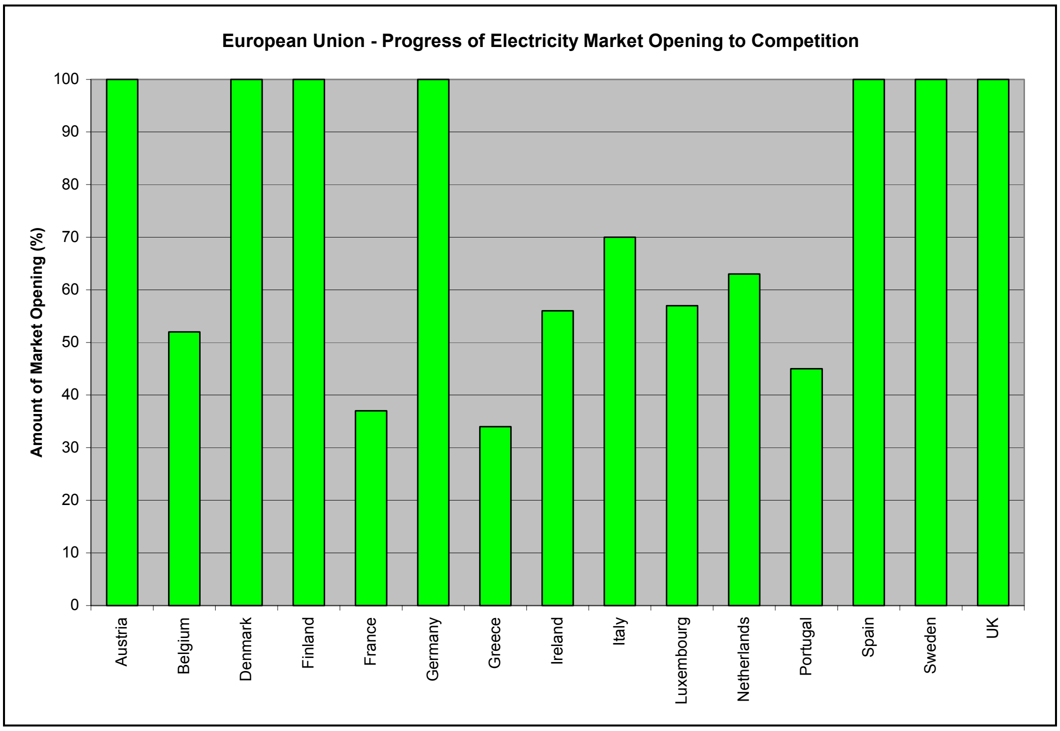


Figure 1 - Status of electricity market opening within EU states (2002) [3]

As a means of quantifying those EU States potentially at risk from electricity generation shortfalls, a relative measure graph has been constructed as shown in Figure 2. This provides a very simplistic relative measure of the risk of generation shortfalls in the different European Union States by plotting the ratio of reserve availability (incumbent generation plus import capability) to the predicted load growth for each State. The lower the value, the lower reserve margin measure, and the greater risk of generation shortfalls.

Hence, with an appropriate legislative environment, DG has the opportunity to make a significant contribution to the way that electrical energy is delivered to customers in the future within the European Union. This contribution will almost certainly be complementary to the existing electricity infrastructure and will enable improvements to be made in system technical performance (eg power quality and security enhancements), through-life cost of energy delivery (especially where heat recovery/CHP is implemented) and other aspects such as emissions reductions (through increased fuel efficiency, low-emission generation technologies, etc).

[3] Data taken from EC Staff Working paper SEC (2003) 448, reference [5]

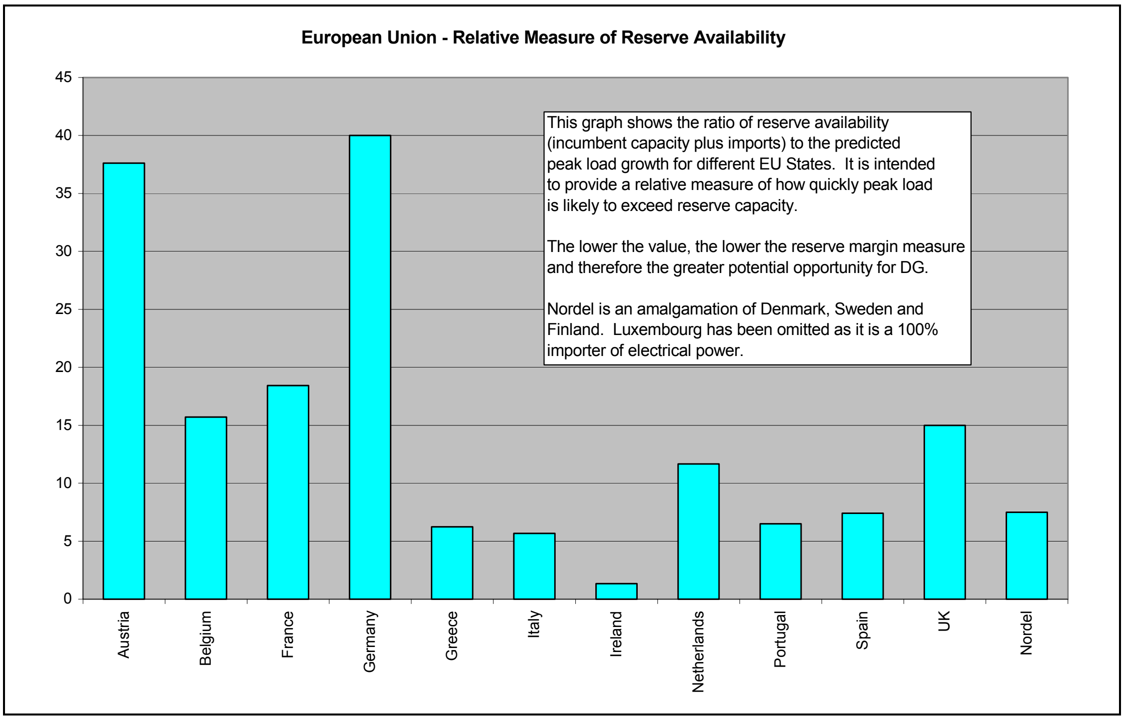


Figure 2 – Relative Degree of Reserve Availability in the EU States

Opportunities for DG are likely to be heavily dependent on the particular market, operational and environmental drivers that exist in a given country. However, it is possible to categorise the opportunities for DG that are likely to materialise in traditional "regulated" markets (ie minimal market liberalisation) and compare those with the opportunities that are likely to be found in more liberalised markets as shown in Figure 3.

Typical Opportunity Areas for DG	
Market with No or Minimal Liberalisation	Liberalised Market
CHP/community heating Power quality & supply reliability Network investment deferral Sustainable energy systems Economics (reductions in cost of electricity) Peaking applications Back-up power	Portable rapid-deployment units Network congestion relief Peaking applications CHP Arbitraging gas and electricity Aggregation of small DG plants Sustainable energy systems Residential energy (eg domestic CHP) Economics (reductions in cost of electricity) Energy trading Emissions trading Turnkey energy management solutions Back-up power Power quality and supply reliability

Figure 3 – Typical Opportunity Areas for DG in the European Union

3. Rationale Behind the Road Map

There are a number of key issues that form the rationale and principles behind this roadmap for distributed generation in the European Union. These principles underpin the approach taken and the development of the policy and technical recommendations presented in this report.

(i) *Fair Access and Fair Rules for DG in Competitive Markets in the EU*

The concepts and principles of competitive energy markets within the European Union are fully supported by the DG-FER project consortium. However, for markets to operate effectively, it is critical to ensure that all potential market players have the opportunity to compete in a fair and equitable way. Small players in the power generation market, such as DG, are often subjected to disproportionate authorisation and other technical requirements prior to commissioning and commercial operation. This creates an environment where the competitiveness of such schemes can be impaired as a consequence of unfair and often arbitrary external factors. It is therefore important to create a set of market rules that do not discriminate against DG market players through, for example, the imposition of unnecessary technical performance requirements or costly pre-authorisation certification requirements that can render schemes uneconomic. It also means ensuring that market players are appropriately remunerated for the particular market services and technical performance that they can offer.

The need to enable DG to compete in a "level playing field" within the energy markets of the European Union is probably the most important driver behind this roadmap document. The environment must be created within the EU to enable DG solutions to be given a fair chance of capturing market share based on their true overall value to customers and society as a whole.

(ii) *Quantification and Capitalisation of the True Benefits of DG*

It is well recognised that DG can provide utilities and customers with a number of benefits over and above reductions in energy costs. These (depending on the technology and application) include power quality and availability improvements, emissions reductions, and the provision of network ancillary services. With the current market mechanisms and network planning approaches in place within the EU, it is almost impossible to enable these additional benefits of DG to be capitalised into an economic benefit that can be offset against the initial capital outlay. This is not because these benefits don't exist, it is a direct consequence of the market structures and rules not giving due consideration to the economic benefits of "smaller scale" generation plant that is connected in distribution networks.

A fundamental change of approach is therefore needed in this area to enable the true value of DG to the European Union to be quantified and realised. This will create the environment to enable DG to make a very positive contribution to the future energy delivery requirements of the European Union.

(iii) *Removal of "Big Player" Market Dominance in the EU Energy Market*

Energy markets in the EU have been going through a protracted period of consolidation. This has been most visible in the number of mergers and de-mergers that have taken place over recent years in the European utility industries. Whilst early trends were towards industry and ownership fragmentation as a means of stimulating competition, the economic environment has recently shifted emphasis towards the creation of so-called "super utilities". These large companies typically hold strategic interests in a number of traditional utility areas, for example gas and electricity, and they can consider DG to be threat to their core business rather than a potential business opportunity. As a result, there is a suspicion that large, dominant market players can manipulate market conditions and rules to keep DG and other alternative energy delivery approaches out of the marketplace.

This market dominance issue is a key factor restricting the implementation of DG in the European Union, and it is therefore in urgent need of resolution.

(iv) *The Need for a Co-ordinated DG Research, Development and Demonstration Focus within the European Union*

At the current time there are a number of DG technology research and development activities ongoing within the EU both at the long-term fundamental research stage and at the nearer-term commercialisation stage. However, whilst progress is generally being made with these specific individual activities, there is a general lack of cohesion and strategic focus pulling all the research and development activities in DG together in the same direction for the good of the EU as a whole.

Given the highly competitive nature of the power generation industry both within the EU and elsewhere, a co-ordinated approach across the EU towards DG research, development and demonstration is therefore considered to be of high strategic importance. As a result, the European Union must consider mechanisms by which DG is given a strong central steer and co-ordination across all EU States. It is likely that this would be best achieved with direct European Commission involvement and leadership.

In the United States, for example, there is already an extensive and co-ordinated DG and interconnection research activity being driven through the Department of Energy. These activities involve many research organisations and a significant number of US DG companies[4]. The programme supports the development of technologies and policies that enable DG, energy storage, and direct load control technologies to be integrated into electrical networks. As a result, the DG market in the US has developed to a degree where significant growth is now already being observed. A number of micro-turbine and fuel cell companies, for example, have emerged in the US in recent years, and these companies are already selling significant numbers of units outside the United States.

(v) *The Need for the Recognition of DG in European Union Policy Initiatives*

Whilst there are currently no EU policy initiatives relating specifically to DG, there are a number of ongoing policy initiatives that have relevance to the DG debate. Further details of these are provided in reference [9]. The EU has also set itself a number of challenging targets in the area of energy policy and emissions reductions in the context of the Kyoto protocol [10]. These include indicative targets for electricity generation from renewable sources within Member States as defined in the 2001 Renewables Directive[5].

In general, these policy initiatives allude to the more efficient transportation and use of energy, and to the increasing use of more sustainable power generation technologies. The increased application of DG is likely to have a very significant role to play in enabling the EU to realise these goals. For example, its ability to provide energy close to the point of consumption can provide significant benefits in terms of overall system efficiency.

In view of this, there is a need to ensure that DG is recognised *generically* within EU policy initiatives as an approach to energy delivery that will support many of the EU's policy goals, and that will provide significant benefits to the citizens of the EU in the long term

(vi) *The Social and Economic Importance of a Thriving EU DG Industry*

There are a number of reasons why a thriving DG industry within the EU is of high strategic importance. These include:

[4] See http://www.eere.energy.gov/distributedpower/

[5] Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal energy market

- Industrial competitiveness – the ongoing research and development activities being performed in the United States in particular are positioning US industry to take advantage of the expected growth in distributed generation over the forthcoming years. The lack of a co-ordinated EU response will lead to EU industry being unable to compete strongly with the US in this area, and to capture the undoubted market opportunity for DG in the worldwide context. This has serious implications for EU industrial competitiveness in this area.

- Employment – the market for DG systems both within and outside the EU is potentially very significant. The consequent positive impact on European employment should not be underestimated as this market materialises. Similarly, there is potentially a very significant negative impact on European employment should the future DG market be serviced primarily by companies based outside the European Union. Early positioning of the European DG Industry, in a co-ordinated manner, should be a key priority of future EU activities in this area.

- Low-cost delivery of increased energy supply security – the future security of energy supplies within the European Union has already been recognised by the European Commission as an area of concern [3]. In view of its localised nature, and as a result of its potential flexibility (depending on technology type), DG has the opportunity to provide a key contribution to delivering a secure energy infrastructure within the European Union over the forthcoming years.

- Reductions in greenhouse gas emissions – a strong policy driver within the EU (see section (v) above) that has implications for the long-term social environment. Appropriate DG deployment, using low-carbon emitting technologies, can provide a significant contribution in this area. Additionally, the savings that can be achieved through reductions in network infrastructure losses by local siting of DG can also make a difference to the overall carbon emissions profile within the EU.

4. Road Map Technical Issues

There are a number of technical issues that have been identified during the DG-FER analysis process[6] which at the present time are limiting the uptake of DG within the European Union and which must be addressed and these are shown in Figure 5.

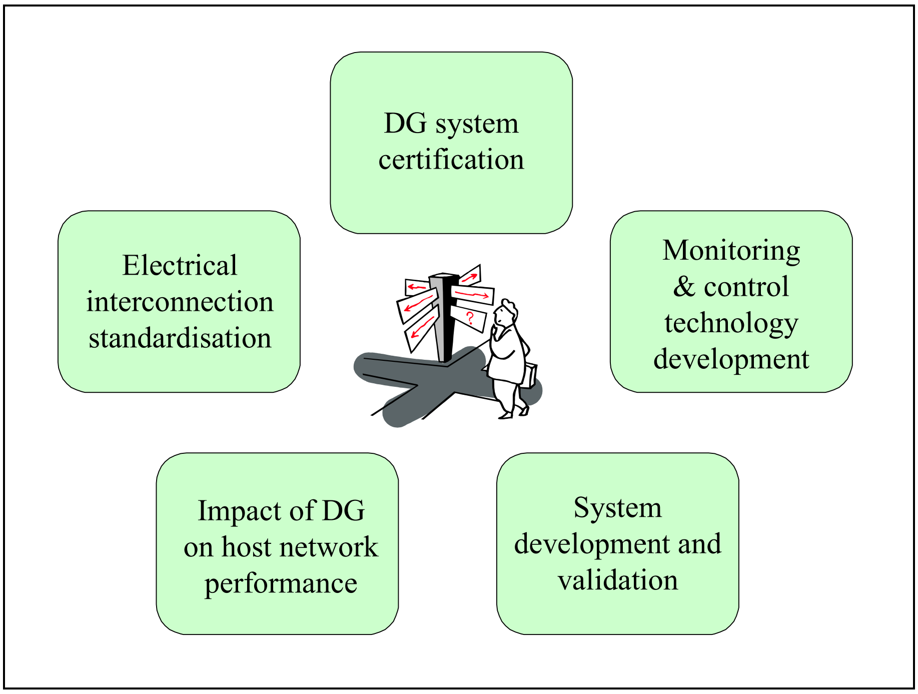


Figure 5 – Technical issues limiting DG uptake in the European Union

In the following section each of these issues is discussed in turn:

4.1 Electrical Interconnection Standardisation

The approach within the Member States of the EU towards DG technical interconnection is at the present time inconsistent, fragmented and generally unfavourable for smaller players. This is partly historical given that many planning specifications in the past were developed on the centralised generation model, with large-scale power stations feeding into large high-voltage power grid systems. Few interconnection performance specifications are available at the current time relating specifically to DG-scale applications, and these when they do exist are relatively high level [12][13]. As a consequence each DG scheme is typically considered on an individual basis by the host utility. This approach firstly introduces uncertainty to the installers of the DG system, as there is the potential for the interconnection technical specification to be made over-complex and costly if based on the practices employed when connecting centralised plant. Secondly, it can provide incumbent

[6] As reported in DGFER Task 3 report, ENELP/RIC/PI-2003/T3-DGFER, 20 May 2003

utilities that view DG as a threat to their traditional business with the opportunity to restrict the deployment of DG through the imposition of unreasonable authorisation requirements.

There has already been a significant amount of work performed on interconnection standardisation for DG systems in the United States. This has occurred both at the State level [14][15] and more generally through the IEEE [11]. The IEEE P1547 Standard for Interconnecting Distributed Resources with Electric Power Systems [11] is a major document covering a range of technical issues relating to DG interconnection within the context of the US energy market, including DG system testing. It proposes and specifies the requirements for a series of technical requirements relating to DG interconnection. These are summarised in Figure 6. The primary motivation for the development of this standard was the desire of many market participants to rationalise and simplify the process for interconnecting a DG device with the electric power system. This goal is therefore exactly the same as that of the many potential DG market participants in the European Union. Hence IEEE P1547 is considered to be a good model that could be developed with a European focus to fulfil similar technical and policy requirements within the European Union to that already achieved by the DOE in the United States.

IEEE P1547 Technical Issues Coverage for DG Schemes

Voltage regulation
Integration with Area electric power system grounding
Synchronisation
Monitoring and Metering
Isolation
Response to voltage disturbances
Response to frequency disturbances
Disconnection for faults
Loss of synchronisation
Generator out of synchronism operation
Feeder re-closing co-ordination
DC injection
Voltage flicker
Harmonics
Immunity protection
Surge capability
Islanding

Figure 6 – IEEE P1547 Technical Issues

In view of this, there is a clear role for Standardisation within the European Union context to define the minimum technical performance requirements applicable to new DG systems in terms of their interaction with the host electrical grid network. This will go some way to enabling much of the technical uncertainty associated with utility authorisation to be removed, thus enabling DG developers to be able to perform accurate business cases prior to embarking on lengthy (and otherwise costly) development programmes.

Such a Standard must fulfil three general high-level objectives:

- The clear definition of the electrical network performance envelope within which the DG system is required to operate both under steady-state and dynamic conditions. This would typically include system technical parameter variations such as frequency, voltage, pre-existing harmonic voltages, etc.

- The clear specification of the required performance characteristics of the DG scheme once it is connected to the host electrical network. This would typically include voltage regulation requirements, response to network faults and voltage fluctuations, EMC immunity requirements, protection and control requirements, etc.

- The clear specification of the performance type testing that will be required prior to operational acceptance of the DG system by the host network.

A key aspect of the successful implementation of this requirement is the need for current utility generator interconnection practices to be fundamentally reviewed to ensure that the performance requirements for DG schemes are appropriate given their low likely impact on the main interconnected electricity grid. For example, it is likely that many of the technical performance requirements associated with 1000 MW coal-fired power stations will be inapplicable or inappropriate for a 100 kW micro-turbine installation.

<u>RECOMMENDATIONS</u>

- ***As a matter of urgency, an industry-wide European Union Standards preparation group is convened with the remit of developing a European Standard for the electrical interconnection of distributed generation plant. This Standard must be flexible enough to enable specific requirements of individual Member States to be catered for, assuming of course that these requirements are a result of specific technical issues and not as a means of market manipulation.***

- ***For the interim period until a European Standard is prepared, the European Commission, in conjunction with the electricity Regulatory bodies within Member States, should perform an urgent review of utility generator interconnection practices. This is with the purpose of ensuring that the performance requirements for DG schemes currently in use are appropriate given their low likely impact on the host electricity grid network.***

4.2 DG System Certification and Permitting

This topic is closely related to the interconnection issue discussed in section 4.1, and relates to the various performance verification processes that a new DG scheme has to complete before it can be declared acceptable for operational and commercial use.

Certification and permitting processes within the EU for electrical equipment connected to an electrical transmission or distribution network take a number of forms. For individual equipment items such circuit breakers or disconnecting switches, a new equipment design would normally be expected to complete a series of proof-of-design (or "type") tests. These tests are extensive and are performed in order to confirm that the design of the equipment is sound and that the plant would be expected to perform adequately over its service lifetime within the bounds of the specified operational regime. A much-reduced series of tests would then be performed on all production units of the same design (so-called "routine" testing) in order to confirm that the manufacturing quality of these units is adequate.

For more complex systems, such as large centralised power generators, the certification and permitting process is very different, with each plant being subjected to a series of system performance tests as defined by the host electrical network utility. These tests are extensive, and can take significant amounts of time and financial resource. Prior to this, it is usual for detailed electrical system modelling to be performed to determine the expected impact of the new generator on the host grid network and vice versa. This modelling exercise can also be very time consuming and expensive, but is normally a specified requirement of the host utility, as well as being an opportunity for the generator to mitigate some of the financial risks associated with the potential technical non-compliance of their equipment when connected into an electrical grid network.

The certification and permitting requirements for DG schemes effectively fit somewhere between those of large power plants and discrete power plant components in that on the one hand they can be complex systems, but on the other they are relatively small-scale. Within the EU the processes associated with DG certification are very inconsistent and are generally agreed bilaterally between the host utility and the connecting DG system owner. As has already been discussed in section 4, electrical interconnection requirements are variable and are potentially open to manipulation by market players. Other certification requirements, such as those relating to emissions performance, also tend to vary with between Member States and between regions within a State.

A key issue affecting the viability of many DG systems is the cost associated with completing and administering the certification and permitting process, especially as these generally apply each time a new installation is built even if identical systems are being installed. Also, these costs do not generally vary proportionally with power plant size and they therefore tend to have a much greater impact on DG schemes than would be the case for larger, centralised power plant.

Therefore, to level the playing field so that DG schemes are able to compete on an equitable basis with alternative power solutions, there is a strong case for standardised certification and permitting rules for new DG schemes. It is suggested that these take the form of pre-defined technical and other requirements (such as emissions performance, health and safety, etc), and that the certification process is administered by, for example, approved laboratories or agencies. These agencies would be genuinely independent of the host utility and the DG developer, and would therefore ensure that all parties involved in the implementation of the DG scheme were in compliance with the appropriate procedures. Alternatively, compliance with some of the technical performance requirements of the DG system specification could be verified through manufacturer “self-certification”, reducing the financial burden associated with employing a third party assessor. The legal boundaries between self-certification and the need for certification by third-parties, as would probably be required for the health and safety aspects of the installation, would have to be determined generically. Finally, if the certification process were to be made legally binding, it would also enable DG developers to assess future schemes on the basis of known and defined technical and certification requirements, thus removing some of the uncertainty that currently restricts investment in DG applications.

Ideally, with suitable electrical interconnection standardisation (as discussed in section 4.1), the certification of a new design of DG system, either through self-certification or by an independent third party, would validate this design for application at a wide range of host sites without the need for further extensive type and site testing. It is of course recognised that an appropriate set of commissioning tests would still be required for safety and operational reasons, but the minimisation of design verification tests through an auditable certification process has clear benefits for all parties and should be considered further.

<u>RECOMMENDATIONS</u>

- ***Standardised DG system certification and authorisation protocols should be developed and implemented within the European Union. The scope of these protocols would be such that compliance will validate a new DG system design for application at a wide range of host sites without the need for extensive system design and site testing. This would include emissions performance certification.***
- ***The certification process for new DG schemes, at the highest level, should be administered by an independent, approved agency. However, DG system manufacturers should be permitted to "self-certify" certain aspects of the performance of their systems in order to minimise the financial burden associated with the certification process. The boundaries and scope of DG system self-certification should be the subject of a separate study.***

4.3 Monitoring and Control Technology Development

The increased penetration of DG into electrical power systems will be reliant on the availability of robust monitoring and control technology to enable the devices to be integrated fully with pre-existing control and protection schemes without impacting on the host grid networks in a negative way. This issue is often cited by host utilities as a major concern with DG, especially when the devices are controlled locally by their owner rather than centrally by the main grid network operator. The adoption of standard electrical interconnection requirements, as discussed in section 4.1, will go a long way to mitigating these concerns. However, the ongoing development of control and monitoring technologies will be required in order to ensure that the network control aspects of DG integration are fully catered for.

Most modern distributed energy systems are equipped with multi-function microprocessor-based control systems that are needed in view of the vast number of variables that must be monitored when the units are interconnected with a distribution system. Monitoring is essential when the DG is exporting power to the electric power system, primarily as a consequence of operational and safety concerns.

The control of a distribution electrical network must account for system energy flows and the dispatching of distributed generation resources at the right time. This becomes a more complex control problem when the DG scheme is not controlled centrally by the operator, but instead self-schedules. This requires very robust and reliable monitoring and telemetry equipment, and must be achieved whilst maintaining reliable communication and control between DG systems and loads. In modern transmission and distribution systems SCADA (Supervisory Control and Data Acquisition) is a common control systems approach that has the ability to integrate with plant-wide systems, such as energy management and distributed process control [8]. SCADA can also be easily customised and expanded to add new technology, and its compatibility with gateways for other networks enables easy data transmission now and in the future. Whilst SCADA has very significant advantages as a control system, the integration of large quantities of DG schemes with conventional SCADA systems is expensive and this issue needs to be addressed. Several products, almost exclusively American, are available that automatically despatch DG units. These systems generally combine distributed computing with distributed intelligence to provide real-time control and communications capabilities to, for example, a multiple DG unit micro-grid system. These systems can provide automatic generator scheduling, and take account of overall system condition and the condition of individual components within the system in order to make these scheduling decisions.

To create the conditions to allow the increased penetration of DG within the European Union, the development of new enhanced core controller technology must be supported and pushed forward. The goal will be to develop a high-performance computing platform and associated algorithms capable of high-speed monitoring and detection of system faults, and the safe and reliable operation of the DG scheme within a range of host network conditions. The main challenge is to achieve these technical requirements in an economic way. One possible option could be by providing a modular system that would enable expansion whilst maintaining a low cost for the basic system configuration.

It is important for the European Commission to note that technology development in this area has been lead by Companies in the United States, with considerable support from the United States Government agencies. European development and manufacturing capability on the monitoring and controls side with respect to DG should be increased.

RECOMMENDATIONS

- ***To create the conditions allowing increased DG penetration within the European energy market, support must be given to the development of new enhanced core controller technologies within the European manufacturing base. The ultimate goal is a high-performance computing platform and associated algorithms capable of high-speed monitoring and detection of system faults, and the safe and reliable operation of DG schemes within a range of host network conditions. The European Commission should therefore urgently consider research funding requirements and the availability of technology demonstration facilities in order to support and facilitate this development.***

4.4 System Development and Validation

Distributed generation power plant technologies comprise those that are already well proven (eg gas turbines, reciprocating engines), those that are in the early stages of commercialisation (eg micro gas turbines), and those that are undergoing development and which show significant levels of promise for the future (eg fuel cells).

As well as creating the right legislative and market framework to enable these technologies to compete fairly with other power generation technologies in the market place, it is of fundamental importance that new-generation DG technologies are able to validate their performance and reliability in real operational environments. Furthermore it is also critical that new-generation and more-established DG technologies are given the opportunity to focus on system efficiency improvements and capital cost reduction through targeted research and development funding.

For the new generation of DG technologies, customer credibility is likely to be very limited without system performance validation through some form of real demonstration activity. "Demonstration" in this context can of course also apply to the demonstration of novel control technologies that could improve the functionality of very well proven power generation technologies used in DG applications.

The European Commission and other European funding agencies have provided support to a number of new-generation DG technology research and development programmes, such as in the area of solid-oxide fuel cells [20]. Other work addressing some of the network integration issues associated with DG has also been implemented [21]. Some DG technology demonstration projects are also ongoing [18], but it is felt that a more co-ordinated approach to DG technology and system demonstration is required within the European Union to ensure that the benefits of DG application over the wide range of technology types are fully determined and realised. As already mentioned, this includes the need to focus research funding on efficiency improvements and capital cost reductions for more established DG technologies as well as for the new-generation technologies.

Where demonstration activities are implemented, these must include demonstration facilities in real environments (eg utility networks) as well as within the laboratory. It could be an opportune time for the European Union to consider setting up a central DG test facility, with integral utility interconnection, where new technologies and control approaches could be validated in a purpose-built environment. This facility could also have a dual use as the independent certification agency for new DG schemes that is alluded to in section 4.2.

RECOMMENDATIONS

- ***As DG system development and validation within the EU has to date generally been performed on an ad-hoc basis, it is considered that a more co-ordinated approach across the European Union will assist in taking DG implementation forward. It is therefore recommended that the European Commission gives consideration to the setting up of a central DG test and demonstration facility for this purpose. This facility would comprise integral utility interconnection facilities where new technologies and control approaches can be validated in a purpose-built environment.***

- ***This DG test facility could also be used as an independent DG certification body as recommended in section 4.2.***

- ***The European Commission should recognise that as well as supporting the development of new DG technologies, there is an important role for it to play in providing R&D support for efficiency improvements and capital cost reductions for more-established DG technologies.***

4.5 Impact of DG on Host Network Performance

As has already been mentioned, a significant barrier to DG at the present time within the European Union and elsewhere is the uncertainty relating to the impact of large penetrations of DG on the controllability and performance of the host electrical grid networks. This can partly be mitigated through interconnection standardisation, although this tends to relate to the connection of a single or small number of generator units only. The situation is clearly much more complex if there are numerous DG schemes connected within a distribution network, especially if there is a degree of generator scheduling autonomy, and if there are is a multitude of interconnected micro-grid systems each containing several DG power plants.

In order to gain a clearer understanding of the potential impacts of large penetrations of DG on the main interconnected grid systems, it is important that detailed, scenario-based analysis covering all regions of the European Union is performed. This analysis should have the purpose of determining the DG penetration breakpoints at which operational difficulties are likely to increase beyond the expected value of the installations themselves, and would provide pointers for longer-term research and development into the areas that need to be addressed to facilitate increased levels of DG penetration in the future. This is no mean task and requires a wide-ranging analysis methodology, based on many system study scenarios.

RECOMMENDATIONS

- ***To gain a clearer understanding of the potential impacts of large penetrations of DG on interconnected grid systems, detailed, scenario-based analyses covering all regions of the EU should be commissioned. These studies will have the purpose of determining DG penetration breakpoints at which operational difficulties are likely to occur, and will provide pointers for long-term research and development activities in order to mitigate these impacts.***

5. Road Map Policy Issues

In addition to the technical issues discussed in section 4, there are a number of policy issues that have been identified during the DG-FER analysis process[7] which at the present time are limiting the uptake of DG within the European Union. These policy issues must be addressed in conjunction with the technical issues in order to create a fair market place for DG to compete within. These policy issues are shown in Figure 6.

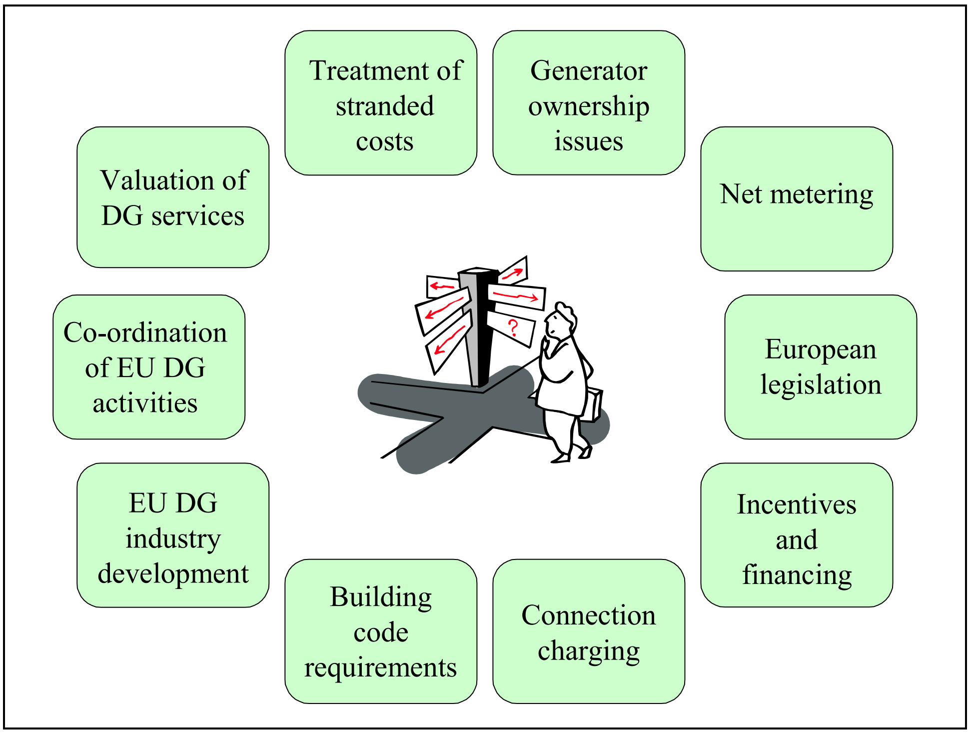


Figure 6 – Policy issues limiting DG uptake in the European Union

In the following section each of these issues is discussed in turn:

5.1 Valuation of DG Services

The fact that DG is generally located at, or close to, the point of electricity consumption enables it to provide a number of operational and commercial benefits over and above pure power generation. Additionally, a number of DG technologies currently available or in the advanced stages of commercialisation offer very favourable emissions performance. In the current climate of emissions reductions and the European Union's commitment to the Kyoto protocol [10], this ought to provide DG with a degree of commercial advantage. However, with the current market structures and pricing mechanisms, few of the benefits of DG are capitalised to their true commercial value, if at all. To ensure a "level playing field" for DG within

[7] As reported in DGFER Task 3 report, ENELP/RIC/PI-2003/T3-DGFER, 20 May 2003

the liberalised markets of the European Union, any benefits that DG provides to the electrical grid system or to the commercial operations of third parties should be fully and fairly reflected in system pricing and other payments to DG systems.

The benefits that DG can provide can be summarised as follows:

System Benefits: These relate to the positive contribution that DG can make to the operation of the electrical grid network to which it is connected. Examples of this include voltage support, frequency support (for smaller networks), system reliability and availability enhancements, energy transportation loss reduction, and system response services (eg spinning reserve).

Commercial Benefits: These are the financial benefits that DG can provide to the different stakeholder groups impacted by the interconnection of a DG scheme. Examples include energy transportation loss reductions which can benefit the host utility if they receive efficiency-related payments through the regulatory regime, emissions savings and resultant tax/levy mitigation, ancillary service provision which can save ancillary service payments for utilities if these services are provided free by the DG scheme, cost-of-downtime savings for customers using DG to mitigate service outages.

The potential technical and commercial contribution of DG, whilst recognised by most stakeholders, has not yet been fully appraised or quantified. It is imperative that this is done to ensure a truly liberalised market environment that reflects the real value of all of the power generation resources within the energy supply system. To make progress towards achieving this, there are a number of significant issues that must be addressed:

- The determination of a true market value for the services provided by DG. Whilst the exact value of these services will be case-specific, the general rules and approaches taken in determining the market value for DG should be agreed and implemented.

- To complement the establishment of a market value for DG services, contractual arrangements that reflect this value must be developed and implemented. These must be applied fairly and consistently to reduce the financial uncertainty that is often associated with new power generation schemes.

- Network planning approaches must fully consider the benefits of DG when assessing new infrastructure or power generation options, as in some cases the deployment of DG will provide a more commercially attractive solution than network reinforcement. Indeed, DG has already been shown to provide potential advantages in network security applications [25], but utility practices have shown little sign so far of encompassing DG as an alternative to conventional reinforcement approaches.

RECOMMENDATIONS

- ***Utility network planning procedures within the European Union should be reviewed, and if necessary revised, to ensure that DG is actively considered within the planning process as an alternative design solution to conventional infrastructure reinforcement. This would be best achieved through the development and implementation of a set of standardised European planning rules and approaches that define the mechanisms by which DG performance should be analysed (eg how to treat the potential security contribution of DG).***

- ***An assessment of the system operation, commercial and environmental benefits of DG within the European Union should be commissioned. Such a study should focus on the development of mechanisms for the capitalisation of the benefits of DG to enable true through-life economic performance analysis of DG schemes to be performed. In this way, a more accurate cost benefit analysis of DG in comparison with alternative solutions can be made, thus making the market environment more fair and cost reflective.***

- ***New contractual arrangements that reflect the true commercial value of DG should be developed and implemented on a EU-wide basis. These must be applied consistently to reduce the current financial uncertainties associated with new power plant investment.***

5.2 Treatment of Stranded Costs

In the utility environment, planning and construction decisions are made on the basis of a certain set of market conditions. If these conditions change, they can have a consequent impact on the viability of the investment decisions. Under very extreme market change conditions, such as those that occur when electricity market liberalisation is introduced, the financial implications can be huge. It is such circumstances that give rise to the term *stranded costs*.

Stranded costs are defined as any costs incurred by network utilities in the development of their networks in the "pre-liberalised" market environment that cannot be recovered via the market if the market is opened up for competition. A typical example of this might be the infrastructure costs associated with the connection of a new generator, only for that generator to be closed after a few years' operation because it is no longer commercially viable following market liberalisation. In a non-liberalised environment, the infrastructure costs would normally be recovered over the book lifetime of the generator, and therefore the early closure of the generator results in a significant recovery shortfall.

In the context of DG, stranded costs often relate to a reduction in use of some part of the existing network infrastructure as a consequence of connecting the DG scheme. For example, if a large industrial customer with a 10 MW electrical supply installs a 5 MW on-site generator, it potentially halves the demand requirement from the main grid, assuming availability isn't impaired. The income the utility receives consequently diminishes, but the costs of the connection to the site have already been paid. Hence the utility has an asset investment recovery shortfall.

The recovery of stranded costs is therefore a balancing act between the rights and responsibilities of various stakeholders with often different, and potentially competing, interests. Again in the context of DG specifically, utilities argue that if they are not compensated for the stranded costs associated with DG connection, either their shareholders or non-DG customers will ultimately bear the burden. This is in the background of utilities making investments in their network infrastructure on the assumption that they would receive a fair economic return on their assets.

In the United States, the stranded cost issue has been addressed through Competitive Transition Charges (CTCs) and exit fees. In the case of CTCs, the total stranded costs eligible for recovery are effectively reclaimed through regulated levies on all utility customers. In the case of exit fees, the utility is allowed to levy a charge when a customer decides to leave the grid or reduce its load through the deployment of DG. This charge is intended to compensate the utility for the investments it has made in its infrastructure on behalf of that customer. Utilities generally argue that exit fees are needed in order to enable infrastructure investment to the benefit of all customers, and that if a customer decides to install DG and remove part of its existing load from the grid, that customer is responsible for stranding part of the investment and therefore should be charged an exit fee.

To enable a fair market environment for DG, it is necessary to examine the approaches to stranded costs and establish an appropriate charging mechanism for DG-type applications. There is a strong argument that DG technologies should be completely exempt from CTCs and exit fees, because these charges discourage the adoption of innovative DG energy solutions, and can effectively limit increased levels of market competition contrary to European Union competition policy. It can also be argued that the amount of DG that is likely to be installed in the near term is unlikely to outpace demand growth, thus ensuring that utility systems experience no net loss in load. When described in these terms, it seems appropriate from the perspective of policy makers that DG should not be exposed to stranded cost charging. At the very least, the competition and innovation benefits that are accrued through the development and deployment of DG technologies should not be put at risk through artificial penalties imposed by stranded cost recovery measures. In view of the relatively small penetration of DG to date, and the current environment within the power generation industry within the European Union, it is unlikely that DG installation rates in the EU are likely to escalate more quickly than projected load growth. Under these circumstances, the recovery of DG-related stranded costs through utility rates should be possible without significant impact on customer prices.

RECOMMENDATIONS

- ***DG schemes should be exempt from stranded cost charges. These exemptions will enable the competition and innovation benefits of new DG approaches to be realised without unfair financial penalties. Any stranded costs that result from the deployment of these DG technologies should be recovered through general utility rates. The exemption of the DG scheme from stranded cost charges must be performed by an independent third party.***

5.3 Generator Ownership Issues

The question of who could, or should, own and operate DG facilities is key to the entire debate, and will have a significant impact on the future penetration of DG within the European Union.

Most companies involved in the promotion of DG technologies and systems are of the opinion that DG penetration in the European market place is likely to be maximised, and competition is likely to be best facilitated, if the ownership of DG schemes by grid owners and operators is generally avoided. Hence, their role would be solely that of grid system operator, with the remit of facilitating competition in the generation market. This viewpoint is partly due to concerns relating to the ability of such utilities to cross-subsidise their DG operations with profits derived from their regulated "wires" businesses. Furthermore there are concerns about the ability of DG-owning utilities to favour their own DG operations over those of other market players, which is clearly anti-competitive. Of course in this scenario the network operators would need to be aware of the scheduling regimes of DG schemes in order to ensure satisfactory network performance in real-time.

One very important exemption, however, where it can be argued that network operators should be able to own DG schemes, is when there is a genuine system operation or stability risk that is best, and most economically, serviced through DG deployment. Market and operational rules should be written in these circumstances to ensure that DG owned by the network operator cannot be used to adversely affect the normal operation of the power generation market in that region.

The approach to market liberalisation also has an important role to play. Most markets undergoing liberalisation have some form of unbundling rules that split the generation, transmission, distribution and supply parts of traditional utilities into separate companies. This ensures that cross-subsidisation of operations is minimised and that independent market entrants have a genuine opportunity to compete in the newly liberalised environment. This approach is fully supported by the authors of this report.

RECOMMENDATIONS

- ***Market rules should ensure that the ownership of DG schemes by grid system owners and operators should not be used to adversely affect the market place.***

5.4 Net Metering

The concept of net metering is to enable the electricity meters of customers with their own generation facilities to turn backwards when their generators are producing more energy than their own demand. It therefore allows customers to offset their electricity consumption over a

long period of time, rather than just instantaneously, and is of particular interest to the renewable energy community as it effectively increases the economic value of the energy produced by these facilities. This is because allowing the meter to counter-rotate means that the generating facility in effect receives the full retail price for the electricity that they generate. This is different from common utility practice where a second meter is installed which measures energy flow back to the grid, and the facility is paid for this export energy at a rate much lower than retail prices.

From the policy perspective, the widespread introduction of net metering within the European Union for DG schemes could provide a significant economic incentive that could contribute to the increased deployment of these technologies without the need for a significant financial investment burden in technology development out of public funds. As the exported energy from on-site generation is considered to have the same value as the retail energy price, it can lower the economic threshold for project implementation. In view of this, some parties are of the view that net metering provides a reasonable replacement for those benefits of DG that can be difficult to capitalise accurately (eg environmental benefits). These are discussed in section 5.1.

However, the net metering approach described above does not necessarily reflect the true market value of energy sales on a time-varying basis as it simply measures net energy transfer without taking account of dynamic price fluctuations. Hence, a more market-reflective approach is to allow the implementation of "time-varying" net metering, which effectively measures the net financial flow between the DG scheme and the market.

There is significant activity in the United States looking at net metering, with all States involved in implementation in some way [26]. Debate in the United States is currently focussed on how far eligibility size limits should be extended and how emerging technologies (such as fuel cells) could be included within the current regulations. Similar activities need to be introduced within the European Union.

Hence, in the European Union context, a broad-ranging debate initially needs to take place in order to establish the degree to which net metering could be applied to stimulate DG introduction within the EU. As a policy mechanism, for the reasons detailed above it is considered to be a favoured option as it would create an environment where DG-generated power is given a fair market value, especially if time-varying net metering is implemented and if consideration is given to those benefits of DG that currently receive no financial credit.

<u>RECOMMENDATIONS</u>

- ***European Commission policy should be reviewed such that the option to adopt simple or time-varying net metering should be considered for all new DG schemes. The size (power rating) of DG schemes to which this policy applies should be made as high as possible to enable a broad range of DG technologies to take advantage of the policy.***

- ***A EU mechanism for time-varying net metering should be developed and made available for DG schemes (ie based on net financial flow between the generator and the market and therefore taking account of the time-varying value of electricity).***

- ***To enable the speedy implementation of this policy change, an urgent assessment of the mechanisms by which net metering could be introduced for DG schemes within the European Union should be commissioned.***

5.5 European Legislation

There are a number of policy and legislative initiatives within the European Union that cover a number of aspects related to DG (eg renewable energy, combined heat and power, etc). The Security of Supply Green paper of November 2000 [2] alluded to the need to carefully consider future technology choices in energy policy and to evaluate the deployment of DG in that context. A number of recent legislative measures, such as the Directives on electricity from renewable energy sources [29], the internal electricity market [27, 28] and on CHP [30], can generally be expected to increase the levels of DG within the European Union although it is unlikely that this was the original intention of the Directives.

In some cases, the positive effect on DG is likely to arise from provisions that are specifically designed to promote DG, for instance in the new Electricity Directive or in the Directive on the Energy Performance of Buildings [31]. Other Directives that penalise the inefficiencies of thermal centralised power production or that pose other additional burdens on centralised generation can be expected to have an indirect positive effect on DG through increasing its relative competitiveness. The Directives on Large Combustion Plants [32] and Emissions Trading [33], and the proposed Directive on the Taxation of Energy products [34] are examples of these. An assessment of the consequences of EU policy initiatives on the development of DG is provided in Figure 7. This is reproduced from reference [9].

As already mentioned, and as can be seen from Figure 7, a number of Directives and programmes within the EU are likely to have a positive effect on DG. However, the real impact of these programmes on DG in terms of market growth and technology development is almost impossible to predict, and is really a consequence of actions unrelated to DG specifically.

Hence the main conclusion that can be drawn is that whilst some of the current legislation and policies within the EU may assist DG by default, there is no clear European policy or action plan that considers DG an end in itself. Furthermore, the European Commission is far from having systematically evaluated the many economic, technical and environmental aspects and benefits of DG. It is therefore unclear to what extent DG can foster competition in an open market, environmental protection and security of supply. These aspects need to be addressed fundamentally in order for the true benefits of DG to be understood, and for the appropriate policy mechanisms to be put in place for the European Union to realise the full potential of these benefits through DG deployment.

	Withdrawal of central thermal electricity generation capacity	Enhanced position of DG compared to centralised generation	Promotion of forms of electricity generation which in most cases are DG	economically, environmentally and socially more beneficial than centralised	No discrimination against DG in the design of the electricity system	Design and management of electricity networks to accommodate electricity output from DG	Development of DG technologies and enabling technologies; innovation
Large Combustion Plant Directive	●	❍	-	-	-	-	-
Energy Taxation Directive (envisaged)	❍	●	●	●	-	-	-
Emissions Trading Directive	❍	●	●	❍	-	-	-
Directive on Energy Performance of Buildings	-	●	-	●	-	-	-
Renewables Directive	-	❍	●	❍	❍	❍	-
CHP Directive (envisaged)	-	❍	●	❍	❍	❍	-
Intelligent Energy for Europe Programme	-	-	●	-	-	❍	❍
New Electricity Directive	-	❍	❍	❍	❍	●	-
5th and 6th Framework Programme for RTD	-	-	❍	-	-	❍	●
New Gas Directive	-	❍	-	-	-	-	-
EU state aid guidelines for environmental Protection	-	❍	-	-	-	-	-

● = Strong, direct impact ❍ = Minor, indirect impact - = No impact

Figure 7 - Expected Direct and Indirect Effects of EU Legislation and Programmes on DG

The many RTD activities that are currently being performed on DG-related subjects under the 5th framework programme [9] could provide a significant input into the development of a more coherent European policy and strategy on DG. These projects cover many of the technical and managerial aspects of DG technologies, energy storage, and network management and design issues. However, very little research activity is dedicated to policy development and the commercial aspects of DG, which, it could be argued, are at least as important as the technical aspects in terms of increasing the deployment of DG within Europe. Some programmes include the development of "roadmaps" for specific DG technologies (eg CHP, renewable energy systems, etc), but a clear roadmap for DG has not yet been considered. That is, of course, the purpose of this document.

In view of the fragmented DG technology approach that is currently being implemented, there is a significant risk of incompatible and conflicting development scenarios emerging. Hence, a more coherent view of the features, benefits, problem areas and development paths for DG in the context of the key European energy policy goals is required. Such an undertaking must start with very fundamental questions relating the future delivery of electricity within the European Union.

RECOMMENDATIONS

- ***Whilst there are ongoing activities within the EU into the development and integration of certain DG technologies, it should be recognised by policy makers that at the present time there is no coherent EU approach towards the implementation of DG as a generic concept within the European Union. Such an approach is urgently needed.***

- ***The European Commission should therefore, with the assistance of stakeholders in the DG industry, take steps to develop an action plan and associated policy recommendations for the introduction of DG (generically) within the European Union. This will enable the significant benefits of DG to be evaluated and fully realised for the benefit of the EU as a whole. It will also help to stimulate the DG industry within the EU, which at the current time is losing out to significant industry expansion in the United States. This document provides a basis from which this action plan and recommendations could be developed.***

- ***As an interim measure, current EU policies and Directives that impact on DG should be reviewed and rationalised to ensure that incompatible and conflicting DG development scenarios are eliminated. This will enable a consistent and rational approach to DG barrier removal.***

- ***Increased focus within European RTD programmes should be given to the assessment and resolution of the policy and commercial aspects of DG. These activities should complement existing RTD activities focussing primarily on the technical aspects of DG introduction within the European Union.***

5.6 Incentives and Financing

In order to level the playing field for DG, it is important to generate initial interest in order to stimulate DG technology and system development. The provision of incentives and financing through policy mechanisms is a traditional way of creating such an environment, and this approach has been deployed very successfully in the past, for example as a means of stimulating renewable energy developments. However, it is important that once the initial market has been stimulated through these mechanisms that technology is commercialised to a degree that it ultimately becomes self-sustainable, ie it does not rely on incentives in the long term. This has to be the clear goal for DG.

It is fair to say that the installed costs of newer DG technologies (eg fuel cells, micro turbines, etc) are, at the current time, too high to enable them to achieve a significant market penetration breakthrough without some degree of cost reduction. Hence to stimulate the deployment and consequent further development of new DG technologies, the European Union must assess an appropriate policy and incentive regime that will assist European manufacturers of DG systems to achieve market commercialisation. Such a regime must offer sufficient incentives to enable developments to take place, whilst ensuring that DG manufacturers are encouraged to develop genuinely "commercial" systems. Typical incentive mechanisms that could be applied to DG are:

- Capital grants to offset installation costs
- Tax incentives and rebates
- Priority grid access
- Compensation payments for avoided network infrastructure costs
- Guaranteed prices or "top-up" payments for exported energy
- Net metering
- Appropriate interconnection requirements and standardisation
- Payments to account for system efficiency improvements
- Credits for system performance benefits
- Credits for environmental performance benefits

Each of these mechanisms has its merits and potential drawbacks. Furthermore, the use of incentive mechanisms within the energy sector is a complex issue that is impacted by many variables, many of which are very hard to predict and control. Hence it is extremely important that detailed analysis on a Europe-wide basis is performed to determine an appropriate mix of incentives for DG that will fulfil the requirements of all DG stakeholders, and that will enable a truly competitive DG market to evolve within the European Union. This, of course, includes the energy policy aspirations of the European Commission, and may mean the development of different sets of incentive mechanisms for different States and even regions within the EU.

To enable DG incentive scenarios to be reviewed continuously, it is recommended that a detailed (and freely-available) financial model of the European Union energy market is developed by the European Commission. This will enable the impacts of different incentive schemes on the likely penetration of different DG technologies to be analysed, and will enable a pro-active response to changes in market structure and technology developments by policy makers through changes in incentives and other mechanisms. Looking further ahead it could also be used as a tool for assessing the likely impact of carbon taxation on the European energy market.

RECOMMENDATIONS

- ***The principle of consistent and transparent incentives at the European level for new DG schemes should be adopted by the European Commission to encourage the uptake and commercialisation of DG within the European Union.***

- ***To progress this, a full assessment (on a Europe-wide basis) should be performed to determine appropriate, fair and consistent incentive regimes for DG across the Member States of the European Union. These incentive regimes must both encourage the uptake of DG within Member States, and importantly must lead to the commercial development of DG technologies to enable them to compete and maintain market share in the long term.***

- ***The European Commission should develop a detailed financial model of the European Union energy market, with the purpose of enabling the impacts of different incentive schemes on the penetration of different DG technologies to be analysed. Such a model will also enable a pro-active response to changes in market structure and technology developments by policy makers through changes in incentives and other mechanisms.***

5.7 Connection Charging

When the installation of a new DG scheme introduces complexity into the local grid network that cannot be managed without network infrastructure or control and protection upgrades, it is very important to ensure that any charges that are levied on the DG scheme as a result of these upgrades are consistent, fair and transparent.

There are two general approaches to connection charging in the context of DG:

Deep Connection Charging

This relates to the situation where all of the costs of connecting the DG scheme are levied against the DG installer as a one-off capital payment at the time of connection. This includes the costs of the connection itself and any other downstream reinforcement costs that are a consequence of the addition of the generator onto the network. The reinforcement costs are not limited to the connection voltage of the DG. Furthermore there are no restrictions that prevent a newly connected DG scheme from being faced with the costs of reinforcement if they happen to be the particular generator whose connection results in reinforcement being necessary, regardless of the number of other generators that are already connected in the locality. This means that the DG scheme's connection charge effectively reflects the impact that all other local users have on the host distribution system, hence skewing the market place. However, in paying this single up-front charge, there is generally no requirement for the DG scheme to pay charges for the ongoing use of the system following the start of commercial operation. But the DG scheme does not generally receive any credit (payment) for situations where it can contribute to reductions in the total cost of distribution and hence provide a direct benefit to the distribution network operator.

If deep connection charging is implemented, it is very important from the perspective of DG that they are able to benefit from the fact that their location is generally closer to the point of final consumption, thus reducing transportation costs. Unfortunately, pricing structures have not generally evolved sufficiently to allow this to occur. In the UK market, for example, suppliers who buy from DG schemes and then who supply energy to distribution demand customers are required to pay Distribution Use of System Charges on the basis that the energy supplied has originated from the transmission system [22]. This is clearly discriminatory practice and should be rectified.

Shallow Connection Charging

This relates to the situation where the connection charge applicable to the DG scheme only relates to the equipment up to the point of connection to the local network. There is no charge relating to any costs of network reinforcement that may be required elsewhere on the local grid network. In effect this means that the costs of connection of DG schemes would, by and large, be the same regardless of the location of the connection point to the local grid network. This satisfies the requirements for "non-discriminatory access" to distribution networks for DG, hence enabling them to compete in a fair and equitable way with alternative energy supply approaches. Any assets that the distribution utility has to install for reinforcement purposes can be added to the asset base of the company, and therefore the associated costs can be recovered through normal asset return mechanisms.

There are other charging mechanisms that fall some way between the deep and shallow approaches. These require some sharing of the costs of any network reinforcement between the DG, other local network users and the host utility.

From the perspective of DG, deep connection charging can subject the DG scheme to very high capital costs. These additional charges negatively impact the economic viability of the scheme and can render them uneconomic, especially where they effectively have to pay for network reinforcement associated with other pre-existing DG schemes. This is not considered to be a fair and "level" approach as it can clearly discriminate against some schemes purely on the basis of network capacity limitations and location. Shallow charging on the other hand, with reinforcement cost recovery through conventional distribution network operator asset return mechanisms, provides the fairest and most transparent approach to DG connection charging. It also satisfies the requirements for "non-discriminatory access" to distribution networks for DG, hence enabling them to compete in a fair and equitable way with alternative energy supply approaches.

RECOMMENDATIONS

- ***The principle of shallow connection charging for new DG schemes should be implemented as standard practice throughout the European Union. This should be coupled with utility reinforcement cost recovery via conventional asset return mechanisms.***

5.8 Building Code Requirements

The European Directive on the Energy Performance of Buildings [31] was implemented in December 2002. This, as its name suggests, has the aim of improving the energy performance of buildings across the European Union, and is expected to be in force in all Member States by 2006.

The Directive defines a methodological framework for the calculation of the integrated energy performance of buildings. This requires that the positive influence of electricity produced by technologies such as CHP, solar energy or other renewable energy sources must be taken into account "where relevant in this calculation". The Directive also sets minimum requirements for the energy performance of buildings and it asks Member States, when defining national standards within this framework, to differentiate between different building types and to take into account good practice. The Directive therefore effectively encourages building owners to consider installing technologies like small-scale CHP or renewable energy systems, or to find novel ways of energy consumption reduction, in order to meet the energy performance standards for their building.

For larger buildings, those with a total useful floor area over 1000 m^2, the Directive appears to make a clearer and stronger case for CHP and renewable energy DG technologies. Here, Member States have to make sure that the technical, environmental and economic feasibility of decentralised energy supply systems based on technologies such as renewable energy and CHP are considered and taken into account at the planning stage. Hence, it is not just a question of encouraging these specific technology options, there is a clear onus on planners to consider these as part of the building planning process.

The buildings Directive is therefore, in general terms at least, a positive sign for DG as it encourages the consideration of some DG solutions for buildings efficiency applications. However, its wording suggests a fairly narrow focus towards small CHP and so-called "greener" power generation technologies. It is clear that DG, in its more generic sense, has a very significant role to play in directly supporting this Directive due to the efficiency savings associated with generating power close to the point of consumption, regardless of technology type. This argument therefore also applies to more-conventional DG technologies that some consider to be less environmentally friendly, such as those based on fuel combustion, as new emissions control technologies are now emerging to mitigate emissions concerns. There are also likely to be significant commercial advantages is deploying well-proven DG solutions due to their much-lower installation costs.

For new buildings, the appropriate deployment of DG technologies can offer additional benefits in terms of overall electricity supply availability, especially if the main grid interconnection is at the remote end of a long, radial feeder or is subjected to other regular disturbances. Examples of this could be out-of-town shopping centres and industrial estates. This supply availability benefit, however, appears to be outside the current scope of the buildings Directive which is focussed on energy performance (efficiency). There is a strong argument that the energy performance of new buildings should also consider electricity supply availability as a key issue, given its particular importance to commercial installations and industrial processes. This additional focus would enable the consideration of novel approaches to supply availability to be applied when new building designs are considered. DG would be a key approach underpinning this.

Hence, whilst the energy performance of buildings Directive is fully supported, there is a need for policy makers to broaden their vision to enable novel DG solutions, regardless of technology or fuel type, to be considered in the building planning process. Such schemes may be able offer significant efficiency and supply availability improvements to building owners, and may offer more commercially acceptable solutions. This is an issue that needs to be addressed at the European policy level.

<u>RECOMMENDATIONS</u>

- ***Generic DG solutions, not just those relating to CHP and renewable energy technologies, have a very significant role to play in the successful implementation of Directive 2002/91/EC relating to the energy performance of buildings. The application of novel DG solutions, of whatever base technology, should therefore be actively considered in future building planning processes as a means of energy efficiency improvement.***

- ***As a specific measure, Directive 2002/91/EC should be strengthened to require novel DG solutions, of whatever base technology, to be actively considered in future building planning processes as a means of energy efficiency improvement.***

- ***The scope of Directive 2002/91/EC should be expanded to include the improvement of electricity supply availability as a key goal in addition to the desire for energy efficiency improvement.***

5.9 DG Industry Development within the European Union

As summarised in section 3(vi) of this document, there are a number of critical social and economic reasons why there is a need for a thriving DG industry within the European Union.

One of the key drivers is the fact that the DG market is predicted to grow consistently in the foreseeable future, both within the European Union and throughout the world. Without doubt this offers significant opportunity to manufacturers of DG power plants and systems, and gives the European Union's high quality scientific and engineering base significant opportunity in both the EU and in the lucrative export markets. South-east Asia and North America in particular are already seeing growth in their DG markets, and this sustained growth is likely to provide a huge opportunity for EU manufacturers and energy companies.

However, other regions, especially the United States, are already positioning themselves to take advantage of this new energy approach, and significant amounts of governmental funds are being directed towards activities in the DG area in these regions. A speedy and co-ordinated EU approach is needed to enable the EU to compete in this global market place, and without such a response EU industrial competitiveness in this area is likely to be compromised.

A thriving DG industry in the EU will have a substantial consequent impact on employment prospects and overall standard of living within the EU. Conversely, if non-EU companies are positioned to service most of the global future market in DG, then there is likely to be a significant transfer of funds and prosperity out of Europe. This is a policy issue that must be addressed at the highest level within the European Community.

A fully operational DG market within the energy supply infrastructure of the EU will contribute to the achievement of a number of European policy goals. In particular, the flexibility potential of DG, appropriately applied, will help achieve increased energy supply security within the EU at acceptable cost. The future security of energy supplies within the European Union has already been recognised by the European Commission as an area of concern [3]. Additionally, more focus is being given to the issue of emissions reductions in the context of global climate change. Reducing greenhouse gas emissions is a key policy driver within the EU that has implications for the long-term social environment for all European citizens. Appropriate DG deployment, using low-carbon emitting technologies, could provide a significant contribution in this area. Additionally, the savings that can be achieved through reductions in network infrastructure losses by local siting of DG can also make a difference to the overall carbon emissions profile within the EU.

Hence it is critical for the European Union that fledgling DG technology and service companies within the EU are provided with the right environment to enable them to grow given the potential benefits that they can offer European society as a whole, and given the large potential export markets that are likely to develop. Directed, co-ordinated funding and technology development support for DG within the EU would be a significant step towards achieving this. Furthermore, the removal of the institutional and policy barriers that are currently limiting the uptake of DG, as described elsewhere in this document, will progress this issue in the positive direction.

RECOMMENDATIONS

In the presence of significant competition from outside the European Union to capture the emerging global market in DG, it is critical that the EU's DG industry is developed and expanded to enable a global market presence and to generate wealth and employment for EU citizens. In particular:

- ***A strategy for the development of the European Union's capabilities in DG systems should be generated and implemented. This should provide both a strategic vision for the European DG industry, and should ensure Europe-wide co-ordination between research and development activities in this area.***

- ***Directed funding and technology development support for European DG programmes and activities, through co-ordinated initiatives like the Framework R&D programme, should be expanded to address system integration issues and the removal of other technical and institutional barriers to DG.***

5.10 Co-ordination of DG Activities in the European Union

There are two key benefits of DG to the European Union:

- The technical and market-based benefits arising from DG deployment
- The social and wealth-creation benefits of having a thriving DG industry

At the current time there are a number of activities, both at the long-term fundamental research stage and at the nearer-term commercialisation stage, that are contributing to the development of a fledgling DG industry and market within the EU. Whilst progress is generally being made with these individual activities, there is a general lack of cohesion and strategic focus pulling all the research and development activities in DG together in the same direction for the good of the EU as a whole. Such a focus is being implemented in the United States through the DOE with US manufacturers and utility groups, and given the highly competitive nature of the power generation industry both within the EU and elsewhere, a similar co-ordinated approach across the EU is considered to be of high strategic importance. Without this approach, it is unlikely that DG will find the widespread market application that the industry, and the European Commission, aspires to. Hence, the European Union must consider mechanisms by which DG is given a strong central steer and co-ordination across all EU States, probably with European Commission leadership.

In order for this to occur, it is important that a central European database is kept that monitors the dynamics of the power generation industry, including the levels of DG penetration, across Europe. Such a database should be freely available to interested parties via the internet, and should include (amongst other things) up-to-date and continuously-maintained information on power ratings, fuel types, connection voltages, and ownership data for power plant within the different countries of the EU. A key requirement will be to include accurate statistics on the penetration of DG within the EU States that can be used as the basis for future policy initiatives and research and development funding decisions. It will also help provide a monitoring facility for policy targets such as CHP and renewable energy system penetration.

RECOMMENDATIONS

- ***The European Commission should consider and review the mechanisms by which a more co-ordinated cross-European DG development activity could be implemented within the bounds of ongoing support programmes. Particular consideration should be given to the increase of research and development support for novel European DG technology developments, and the increased focus of funding for DG barrier removal.***

- ***Given the high strategic importance of developing a successful DG industry within the European Union, a central European DG industry research and development co-ordinating group should be convened to promote the benefits of DG. It is considered that the best way to achieve this is by setting up such a group in a dedicated "DG office" funded by, and located in, the European Commission. This group will have the remit, amongst other things, of:***

    - ***Being a centre of competence and information on DG issues within the EU for stakeholders of DG***
    - ***Providing a focal point for DG technology and institutional barrier removal within the EU***
    - ***Providing guidance to the European Commission for the co-ordinated and directed support of DG technology development support in the European Union***

- ***A continuously maintained database of EU power generation and DG statistics should be developed and made freely available to interested parties through the internet.***

6. Recommendations Summary

The following is a high-level summary of the recommendations provided in sections 4 and 5, with a subjective indication of priority (1 = needed and urgent; 2 = needed). The recommendations are numbered in the sequence in which they appear in sections 4 and 5.

	Technical Issues – Recommendations from Section 4	Priority
1	Development of a European Union electrical interconnection Standard for DG applications	1
2	Review of utility practices associated with the interconnection of DG to ensure fair treatment of DG	1
3	Standardised DG system certification and authorisation protocols across all Member States	1
4	Independent authority appointed to oversee the high-level DG scheme certification process covering EU-wide system application. Within this process, the extent to which DG manufacturers can self-certify certain performance aspects of their systems should be determined.	2
5	Facilitation, through funding support, for the development of enhanced core controller technologies within the European manufacturing base	2
6	Co-ordinated approach to DG demonstration and validation through the setting up of a European DG test and demonstration facility. This facility could also perform the independent DG certification role.	1
7	European Commission to consider ways that R&D support can be provided for efficiency improvements and cost reductions for "more-established" DG technologies as well as new-generation technologies.	2
8	Detailed, scenario-based analyses of the potential impacts of high levels of DG penetration on European interconnected grid systems.	1

	Policy Issues – Recommendations from Section 5	Priority
9	Review and revision of utility network planning procedures to require DG to be actively considered in the planning process, best achieved through the development and implementation of a set of standardised European planning procedures.	2
10	The commissioning of a detailed assessment of the electrical system operation, commercial and environmental benefits of DG within the context of the European Union.	1
11	The development of mechanisms for the capitalisation of the benefits of DG within the European Union, to enable the true through-life economic performance of DG schemes to be evaluated.	1
12	The development and consistent implementation of new contractual arrangements across the EU reflecting the true commercial value of DG.	1
13	DG schemes to be exempted from stranded cost charges.	2
14	Market rules ensuring that DG ownership by grid system owners/operators should not be used to adversely affect the market place.	2
15	EU policy to be reviewed such that the option to adopt simple or time-varying net metering should be considered for all new DG schemes. The kW rating threshold for DG to qualify for net metering terms should be made as high as possible.	1
16	A EU mechanism for time-varying net metering to be developed for DG based on net financial flow between the DG scheme and the market.	2
17	An assessment of the mechanisms by which net metering could be introduced for DG schemes within the EU to be commissioned	1
18	Development of a European Commission action plan for the introduction of DG within the EU in order to stimulate DG industry in the EU. This would be based on the outline recommendations detailed in this document.	1
19	As an interim measure, current EU policies and Directives that impact on DG to be reviewed and rationalised to ensure that incompatible and conflicting DG development scenarios are eliminated, thus enabling a consistent and rational approach to DG barrier removal.	1
20	Increased focus within European RTD programmes to be given to the assessment and resolution of the policy and commercial aspects of DG.	2
21	The principle of consistent and transparent incentives at the European level for new DG schemes to be adopted by the European Commission.	1
22	A full Europe-wide assessment to be commissioned to determine appropriate, fair and consistent incentive regimes	1

	for DG across all Member States.	
23	A detailed financial model of the EU energy market to be developed to enable the impact of differing incentive schemes on the likely penetration of DG to be evaluated.	1
24	The principle of shallow connection charging for new DG schemes to be implemented as standard practice throughout the EU. This to be complemented by utility reinforcement cost recovery via conventional asset return mechanisms.	2
25	Directive 2002/91/EC to be strengthened to require novel DG solutions, of whatever base technology, to be actively considered in future building planning processes as a means of energy efficiency improvement. The scope of the Directive to also be expanded to include the improvement of supply availability as a key driver.	2
26	A EU strategy for the development of its capabilities in DG systems to be generated and implemented. This will provide both a strategic vision for European DG industry, and recommendations for Europe-wide co-ordination between research and development activities in the area.	1
27	Directed funding and technology development support for European DG programmes and activities, through co-ordinated activities like the Framework RTD programmes, should be expanded to address system integration issues and the removal of other technical and institutional barriers to DG.	2
28	A EU "DG Office" to be created, funded by the European Commission, with the remit of: - Being a centre of competence and information on DG issues within the EU for DG stakeholders - Providing a focal point for DG technology and institutional barrier removal within the EU - Providing guidance to the European Commission for the co-ordinated and directed support of DG technology development in the EU	1
29	A continuously maintained database of EU power generation and DG statistics to be compiled and made freely available via the internet	1

Each of the above recommendations falls into one of the four categories shown in the following table:

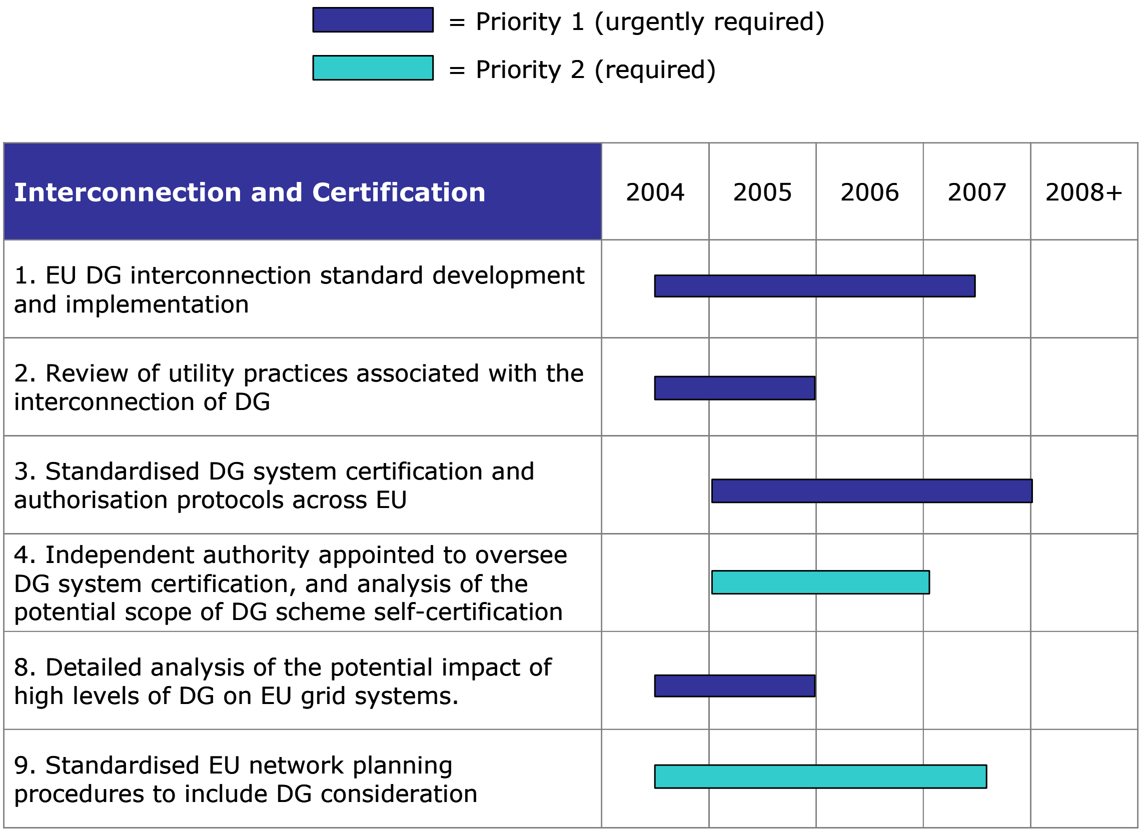
Category	Recommendations
Interconnection and certification	1, 2, 3, 4, 8, 9
Technology development and demonstration	5, 6, 7, 27
Commercial issues and market rules	10, 11, 12, 13, 14, 15, 16, 17, 22, 23
General EU Policy issues	18, 19, 20, 21, 24, 25, 26, 28, 29

7. The Road Map

7.1 Recommendations Implementation Timeline

For DG to generate maximum benefit to the EU, it is necessary to map out a vision for the timescales within which the implementation of the recommendations in this document could occur in practice. The following, therefore, is an outline timeline for each of the recommendations described in section 6, assuming no external contrains will occur. These timescales are considered by the authors to be challenging, but achievable, and necessary for DG implementation to occur to a sufficient degree to enable maximum benefit to be produced. Each of the recommendation categories are considered in turn in order to determine a co-ordinated approach to addressing each of the major issues that are currently restricting DG application within the EU.

In each of the following graphs, the following key is used to provide a relative prioritisation of the recommendations (as per the prioritisation in section 6), and the numbering of the recommendations is consistent with the numbering applied in section 6.



Technology Development and Demonstration	2004	2005	2006	2007	2008+
5. Development of enhanced core controller technologies within the EU manufacturing base					
6. Setting up of a European DG test facility					
7. R&D strategy to support improved efficiency and cost reduction for "more established" DG technologies					
27. Directed funding and technology development support for system integration and barrier removal issues					

Commercial Issues and Market Rules	2004	2005	2006	2007	2008+
10. Detailed assessment of the network performance, environmental and commercial benefits of DG in the EU					
11. Development of mechanisms for the capitalisation of the benefits of DG					
12. Development and implementation of new contractual arrangements across the EU reflecting the real value of DG					
13. DG scheme exemption from stranded cost charges					
14. Market rules to ensure that DG ownership by grid system owner/operators is not used to influence the operation of the market place					
15. EU Policy reviewed to provide net metering option for DG owners					
16. EU mechanism for time-varying net metering to be developed					
17. EU-wide study into the mechanisms for introducing net metering for DG schemes					
22. EU-wide assessment of appropriate, fair and consistent incentive regimes for DG across Member States					
23. Development of a detailed financial model of the EU energy market to enable the impact of different incentive regimes to be analysed					

General EU Policy Issues	2004	2005	2006	2007	2008+
18. European Commission action plan for the introduction of DG within Europe					
19. Rationalisation of existing EU policies and Directives impacting on DG to ensure a consistent approach to barrier removal					
20. Increased focus within RTD for the assessment and resolution of the policy and commercial aspects of DG					
21. Principle of consistent and transparent incentives for new DG schemes to be adopted by the European Commission					
24. Shallow connection charging for DG schemes to be implemented across the EU					
25. Directive 2000/91/EC to be revised to make DG and system availability issues integral parts of the building planning process					
26. Generation and implementation of a EU strategy to develop its capabilities in DG system design, manufacture and installation					
28. A European Commission funded "DG Office" to be created, providing a centre of competence and information on DG issues for stakeholders					
29. A database of EU power generation and DG statistics to be compiled and made available via the internet					

7.2 Long Term Vision and Road Map for DG in Europe

With the implementation of the recommendations described in the previous sections, and with the political will to drive and develop a strong DG industry within the EU servicing both the European and external DG markets, a long-term vision for DG in the European context can be developed. This is shown in Figure 8.

The base starting point in 2004 reflects the current position of DG in Europe whereby the overall penetration levels are relatively low and are generally targeted at a number of niche applications. Market conditions, market rules and utility practices within the EU are generally weighted against DG, thus restricting its uptake. The practical recommendations provided within this report are intended to redress some of these issues.

The aim is to have a thriving DG manufacturing base, coupled with a genuinely competitive energy market enabling DG to compete on a level playing field with more conventional energy delivery approaches, within the EU by 2008. At this stage it would be expected that significant DG penetration into the European power generation market would be taking place. This target is important both in terms of the future wealth and prosperity of the European Union, and in terms of diversity and security of energy supply that is currently receiving significant attention at the Policy level.

Hence, with appropriate action being taken during 2004, it would be expected that by the end of 2005 a EU Action Plan for DG Implementation, ratified and supported by the European Commission, would be in place. Coupled with this, it is envisaged that a European "DG Office" could be started up during 2004, enabling full operation towards the middle/end of 2005. Its role would be to provide a centre of competence and information on DG issues for DG stakeholders within the EU, along with providing guidance to the European Commission in issues such as DG technology development requirements and institutional barrier removal. Additionally by the end of 2005 significant steps will have been taken to address at least some of the Policy issues currently restricting the access of DG to energy markets. For example, there appears to be no reason why agreement could not be reached at the European level as to the appropriate EU incentive mechanisms that need to be put in place to help DG overcome some of the barriers to its implementation.

By the end of 2006 it is envisaged that a central EU test facility for DG systems could be completed and up and running, providing new DG approaches with a vehicle for technology demonstration in a real operational environment. Furthermore, very significant progress could be made on the Policy side by the end of 2006. Very importantly, it is envisaged that mechanisms could be agreed and implemented by this time for an appropriate capitalisation method for the full range of benefits of DG. Additionally, it is anticipated by 2006 that the issues associated with compensation payments for network operators arising from stranded costs could be resolved, and that steps could have been made to enable net metering and shallow connection charging for new DG schemes to have been implemented.

2004	2005	2006	2007	2008
DG within the European Union at relatively low penetration levels Market conditions, market rules and utility practice weighted against DG "Conventional" DG technologies (eg gas turbines, reciprocating engines) readily available Some new DG technologies in advanced stages of development & undergoing or approaching demonstration phase	EU Action Plan for DG in Europe complete and ratified by the European Commission EU "DG Office" in place, providing a focal point for EU DG activities Generator ownership rules harmonised across the EU Agreement reached on appropriate EU incentive mechanisms for DG DG demonstration projects on the increase across the EU as a result of directed R&D support through Framework and other programmes	EU DG test facility in place Mechanisms agreed and implemented for the capitalisation of the full range of benefits of DG New DG model contractual arrangements implemented reflecting the true value of DG to industry as a whole Stranded cost issue resolved Net metering available for all new DG schemes Shallow connection charging implemented for DG connection across the EU New DG technologies becoming increasingly "commercial"	Binding EU DG Interconnection Standard completed and issued Standardised EU utility network planning procedures in place incorporating DG solutions as alternatives to conventional network reinforcement Common DG certification protocols implemented across the EU Genuine "level playing field" for DG becoming a reality	Unprecedented levels of DG installation occurring throughout the EU Thriving EU DG manufacturing base gaining significant market share both within and outside the EU True "level playing field" achieved for DG

Figure 8 – Long Term Road Map for DG in Europe, assuming no external constrains

A key constituent of the DG Road Map is the development of European Standards for the interconnection of DG systems with electricity grid networks. Given the diverse nature of electricity networks across the EU, this is likely to be a complex and potentially lengthy process. Hence, if work starts during 2004 or early in 2005 on the preparation of these Standards it is envisaged that a completed EU DG interconnection standard would be published by 2007. It is also expected that standardised EU network utility planning procedures, requiring consideration of DG options as alternatives to traditional network reinforcement, would also most likely be completed by 2007. Another key issue to enable increased DG penetration within the EU relates to the need for common DG certification protocols enabling increased "type" certification of DG systems by independent third parties. This will reduce the testing demands for DG schemes on individual contracts, and hence will reduce the cost of DG system installation. It is again expected that such a certification regime could be implemented fully by 2007.

At this stage, given the successful completion and full implementation of these issues, the creation of a genuine "level playing field" for DG within the EU would be starting to become reality.

Moving on to 2008 and beyond, it would be expected that increasing (and unprecedented) levels of DG installation will occur given the much fairer and realistic market conditions within which DG will be operating. This will provide the European energy market with increased flexibility and diversity, and importantly will have lead to the creation of a thriving and successful DG industry within Europe. Given that it is expected that the future market for DG is likely to be global, this will position European industry vary favourably to capture external (non-EU) market share.

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Appendix A

- About the DG-FER Project and Consortium

About the DG-FER Project and Consortium

The DG-FER project aim is to develop a roadmap for distributed energy in Europe, bringing together the various elements that comprise all the technologies which make up distributed generation (DG) in order to provide an understanding of the links between RES, CHP, distributed electricity-only projects and changes in the operation of the electricity network and the needs for network reinforcement.

Until now, although there is a Commission policy for cogeneration and for renewable (which make up most of the DG technologies), there is no coordinated approach towards DG technologies. The project will help overcome this in order to help developing a Commission policy on DG. This will help making the best use of these technologies in the future. DG-FER is supported by the EU's ALTENER Programme, a non-technological programme aimed at promoting the use of renewable energy sources.

Objectives:

- Draw upon existing work, e.g. the RES White Book and the new SAVE Project MICROMAP for data input;
- Create a European DG strategy / policy overview and consider the synergy between all distributed generation techniques;
- Undertake a comparative analysis between Europe and US / Japan regarding the application of DG;
- Undertake a market analysis of DG in Europe;
- Create a consensus view by spreading information and creating a dialog about distributed generation;
- Suggest an action plan for the future.

Project Duration: From January 2003 to March 2004.

Phases and Tasks of the Project:

- **Phase 1:** deals with project set up and assessment of the issues to be addressed and analysis of the existing knowledge base;
- **Phase 2:** deals with the development of a strategic plan and roadmap for distributed energy in Europe;

- **Phase 3:** provides ample time and effort for consultation with stakeholders, Commission officials and Member State administrations. It also includes resources for the revision of the strategic plan and roadmap;
- **Phase 4:** deals with the dissemination of the results of the project and the development of an action plan for future activities.

Project Partners:

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Project Website

www.dgfer.org

Appendix B

- EU Reserve and Peak Growth Statistics

EU Reserve and Peak Growth Statistics

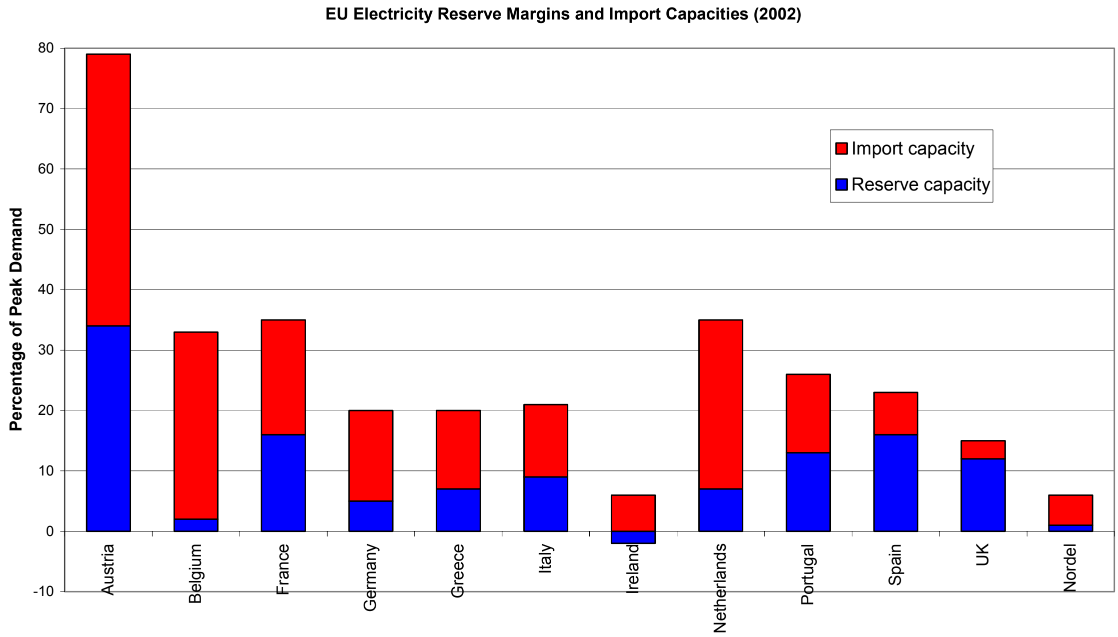

Figure B.1 - EU State Electricity Reserve Margins and Import Capacities (2002)

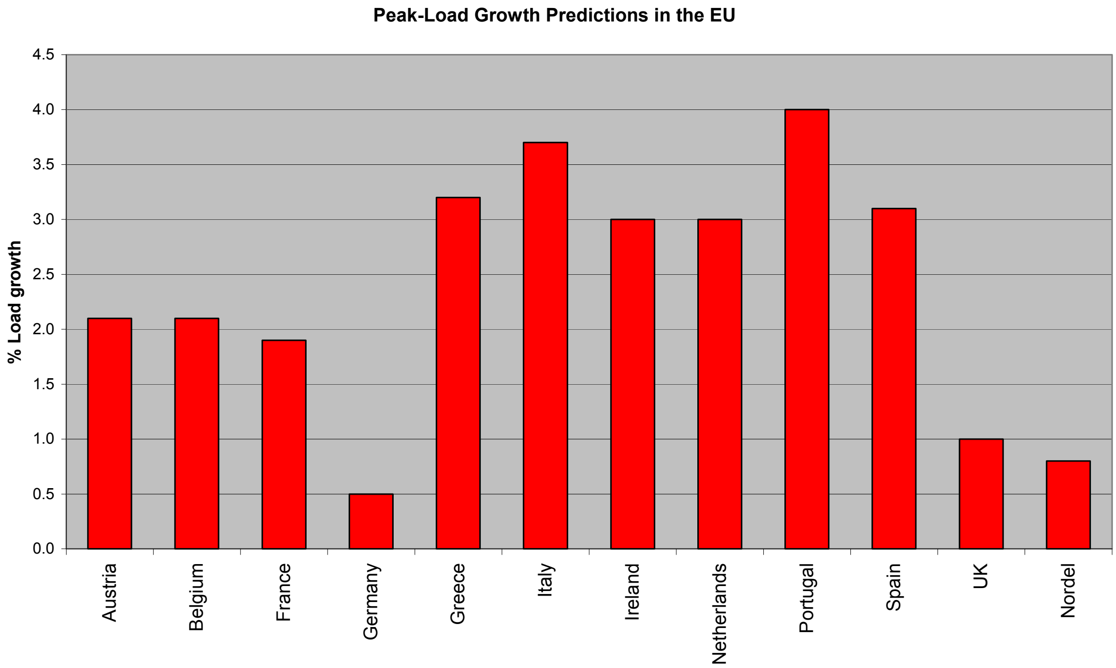

Figure B.2 - Predicted Peak Load Growth in the European Union