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DISTRIBUTED GENERATION CONNECTION CHARGING WITHIN THE EUROPEAN UNION

REVIEW OF CURRENT PRACTICES, FUTURE OPTIONS AND EUROPEAN POLICY RECOMMENDATIONS

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EXECUTIVE SUMMARY

There has been significant discussion in recent years about the technical and legislative barriers that currently limit the penetration of Distributed Generation (DG) and Renewable Energy Sources (RES) within the energy markets of Europe and elsewhere (e.g. the United States). This study focuses on one of the key non-technical issues in this area, that of connection charging[1]. It provides:

- A review of the current legislative framework relating to connection charging at the European level, and a summary of the connection charging options available to policy makers within Member States
- A benchmark review of the specific connection charging approaches currently adopted in the EU-15, and a summary of best practice taken from this review
- A series of European-level connection charging policy recommendations in the context of DG and RES integration for consideration by policy makers and legislators within the EU

The key conclusions from the study are:

- The legislative and regulatory framework relating to connection charging varies significantly across the EU-15 Member States. Deep[2] connection charging is currently the most widely used charging mechanism in the EU-15, it predominating in 8 of the 15 Member States. Only 4 States within the EU-15 currently use shallow[3] charging, with the remaining 3 either using a hybrid of the deep and shallow systems or have no consistent approach to connection charging.
- The high prevalence of deep charging, and the fact this is usually coupled with a significant degree of "negotiation" between the host Distribution Network Operator (DNO) and DG/RES developer to determine the costs of connection, generally leaves the DNO in a position of strength and puts the developer at a disadvantage. Interestingly, those Member States that have implemented shallow charging mechanisms tend to have higher relative penetrations of DG and RES within their markets.
- The current level of transparency in connection charging methodology within the EU-15 generally remains low. This is in spite of the fact that Directive 2003/54/EC[4] requires that the terms, conditions and tariffs for connecting new electricity producers are "objective, *transparent* and non-discriminatory". This low level of transparency has led to investment uncertainty for developers, and can add considerable time delays into the project development process. Both of these issues introduce artificial barriers to DG and RES, and should therefore be addressed urgently at European and Member State levels.
- It is generally very difficult for new DG and RES plant developers to obtain public-domain information from DNOs regarding the methods they use for deriving the costs of a new connection.
- Whilst the general situation within the EU-15 remains negative towards DG and RES in terms of connection charging, there are a number of cases where innovative procedures and mechanisms have been introduced to create a fairer and much more transparent environment for DG and RES. Examples of

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[1] Those costs payable by DG and RES schemes (usually to the network owner) to provide the physical interconnection with the host electricity grid network to which they are connected

[2] Where the generator pays all costs associated with its connection, including the cost of the physical connection to the grid along with the costs of any upstream network reinforcement work arising from the connection of the generator

[3] Where the generator only pays the cost of equipment needed to make the physical connection to the grid, there being no contribution to upstream network reinforcement costs

[4] The Electricity Liberalisation Directive

this can be found in the Netherlands, Belgium, the United Kingdom, Denmark and Germany[5].

The key recommendations[6] from the study are:

- The European Commission should recognise that increased consistency and transparency is needed in the approach to generator connection charging across Member States in order to create a non-discriminatory environment for DG and RES. Fully transparent interconnection procedures, connection charging mechanisms and connection costs should be introduced (and enforced) across Member States.
- In general, connection charging for DG and RES should follow a SHALLOW charging philosophy. In cases where grid network reinforcement is necessary following the connection of the new DG or RES scheme, and when pure shallow charging is not considered acceptable, it is recommended that:
    - The DG or RES is required to make a (percentage) financial contribution towards reinforcement costs, derived from the power capacity of the generator relative to the capacity of the local grid network following reinforcement. Furthermore, the reinforcement cost liability of the generator shall be limited to those costs incurred at the voltage level at which the generator is connected[7].
    - The proportion of reinforcement costs not paid for by the generator should be the responsibility of the DNO.
    - The calculation methods used by the DNO in determining connection charges, along with the costs of interconnection equipment used in the derivation of those costs, shall be published by the DNO and approved by the appropriate regulatory authority on an annual basis.
    - For very small generators[8], no contributions to distribution network reinforcement costs shall be required, with these costs being the sole responsibility of the DNO.
- DNOs shall be required to submit binding connection quotations to DG and RES developers, including any reinforcement cost apportionment proposals, within 60 days of the developer's application.
- Prospective DG and RES developers should be given the right to access the network technical parameters of DNO's system in order to facilitate the optimal placement of new generation plant within distribution networks.
- Annual connection charges levied by DNOs should only be used as a means of recovering the costs of maintaining the DNO's assets involved in the connection of the generator.
- Regulatory bodies within Member States should be given the responsibility for arbitration, in conjunction with the power to impose changes to connection charging costs and practices.

[5] Details can be found in section 5 of this report

[6] Detailed recommendations can be found in section 8

[7] This ensures that the developer is only charged in proportion to the costs of reinforcement that directly and clearly arise from the need to provide his connection

[8] For the purposes of this study, those systems below 10 kW in power rating (e.g. domestic micro-generation systems)

1 INTRODUCTION

There has been a significant amount of debate and publication activity in recent years relating to the technical and legislative barriers that are currently limiting the penetration of DG and RES in European energy markets. The collaborative research project DGFER[9] produced a "Road Map" for DG in Europe[10] that identified areas for further policy and technical research in order to address specific barriers to DG and RES within the European Union, based on the intention of creating a "level playing field" for all market players.

A number of these research areas have been taken forward in a new collaborative research project, ELEP[11], focussing solely on legislative and policy issues. This report is a contractual deliverable of the ELEP programme, and covers the subject of generator connection charging in relation to distributed generation and renewable energy sources.

This report provides:

- A summary of the legislative framework relating to generator connection charging at the European level (both existing and proposed)
- A high-level description of a number of different connection charging approaches that are, or could be, adopted by Member States
- A benchmark review of the current connection charging approaches within the EU-15 Member States
- A review of best practice taken from the current approaches for the EU-15
- A series of European-level connection charging policy recommendations, specifically related to the integration of distributed generation and renewable energy sources into electricity grid networks

2 DISTRIBUTED GENERATION & CONNECTION CHARGING

This section is intended to introduce some of the terms and issues relating to DG and RES connection charging that are referred to throughout this document. It is by no means an exhaustive list, but attempts to cover those issues of relevance to the connection charging debate.

Distributed Generation itself has been defined many ways, each of which describes a general move away from large centralised power systems[12], to a more distributed situation where increasing numbers of smaller generators are connected within distribution networks closer to the loads they serve. This can provide a number of benefits to market actors, but can also introduce technical challenges relating to the integration of DG systems into the existing distribution network infrastructure. For the purposes of this study the following working definition of DG, taken from the DG-FER[9] project, is used: "Power generation equipment and systems used generally at distribution voltages and where the power is mainly used locally on site".

Benefits of deploying DG and RES: There is a range of benefits that can result from the installation of DG and RES systems. They include (amongst others) reduced through-life energy costs, reduced carbon emissions, reductions in overall energy system losses, and increased operational flexibility (for fossil-fuelled systems). DG can also be used an alternative to electricity infrastructure investment when

[9] "Distributed Generation Future Energy Resources", European Commission Altener contract 4.1030/Z/01-141/2001, http://www.dgfer.org/

[10] http://www.dgfer.org/Downloads/DGFER_Road_Map.pdf

[11] "European Local Electricity Production", part of the European Commission "Intelligent Energy Europe" Programme, Contract EIE/04/175/S07.38664, http://www.elep.net/

[12] Typified by electricity generation in large power stations (e.g. coal, nuclear), and power transmission and distribution to customers via a series of intermediate voltage steps. Power flow is generally in one direction from the HV grid system down to mains voltage.

connecting new loads, leading to significant cost benefits and the avoidance of the costly and time-consuming permitting processes associated with building new overhead lines.

Disadvantages of deploying DG and RES: As mentioned above DG and RES can introduce technical challenges relating to their integration into existing distribution network infrastructures. These challenges are generally control-related and are associated with the increased operational complexity that can arise from having significant quantities of DG and RES connected to distribution networks. The other potential disadvantage of DG and RES in the context of connection charging is the fact that in some cases the connection of a generator can lead to the need for grid network reinforcement upstream of the connection point in order to accommodate the new generator, and this needs to be paid for somehow.

Connection charges: In order to obtain a connection to a distribution grid network, the developer of a new DG or RES scheme is normally required to make a formal application to the host Distribution Network Operator (DNO), who in return makes the developer a connection offer. This describes the terms & conditions of the connection offer, along with details of the connection works needed to physically connect the generator to the network. As part of this connection offer, the developer will be requested to pay a "connection charge" that covers some or all of the costs of making the physical connection to the grid network, along with (in some cases) a contribution to network reinforcement costs remote from the connection point itself that are necessary as a consequence of connecting the generator.

Connection charge approaches: There are several connection charging approaches that are currently used within EU Member States. These are generally classed as "shallow", "deep" or a combination of the two. *Shallow* charging relates to those cases where the developer pays simply for the cost of the equipment to make the physical connection to the grid network at the chosen connection voltage. The developer pays no contribution towards any upstream network reinforcements that are needed as a consequence of the generator being connected. *Deep* charging relates to those cases where the developer pays for all costs associated with the connection, including all network reinforcement costs. Other alternatives are generally a combination of the shallow and deep approaches, typically requiring the developer to make a contribution towards some of the costs of network reinforcement. A more detailed summary of the different connection charging approaches is provided in section 3.

Use of System (UoS) charges: These are those charges levied by DNOs on electricity supply companies and generators to pay for the use of their distribution system in transporting electricity to customers. For most DNOs[13] the UoS tariff is their main source of income, with their charges normally being regulated in order to allow them to generate a return on their assets whilst at the same time encouraging them to improve system performance or efficiency. Generator UoS charges are often used in conjunction with shallow connection charges to recoup the deep costs of network reinforcements (see above).

3 CONNECTION CHARGING METHODS

The choice of connection charging method relating to DG and RES is a subject of considerable debate as it can profoundly affect the economic viability of a new generation scheme. The main points of contention relate to how the costs of connecting DG and RES schemes should be allocated between the parties involved in such a way that they are considered fair and reasonable by all of these parties. At the current time there appears to be no general consensus in view of the fact that there are many parties involved, each with their own vested interests, and the fact that the costs of connection for a generator is highly dependent on the point of connection and the characteristics of the grid network at the connection point.

[13] "Wires" companies (i.e. owners and operators of the distribution network assets)

A number of papers[14] have been published in recent years discussing the various connection charge approaches and the potential options open to regulators and network operators. Whilst these options are significant in number, they are generally variants of the four charging methods summarised in Table 1 below. Further details of these methods can be found in Appendix 1.

Charging Method	Brief Description	Advantages	Disadvantages
"Shallow"	Generator pays only for the cost of equipment needed to make the physical connection to the grid. Any upstream costs of grid reinforcement resulting from the connection of the generator are the responsibility of the DNO (often recovered through Use of System tariffs).	Lowest cost approach for DG and RES Cost transparency & consistency (for DG and RES) regardless of connection point Reinforcement costs can be passed through the tariff system	Poor locational signals DNO reinforcements may be needed before connection – may add project delays DG and RES plant likely to be subject to Use of System (UoS) charges
"Deep"	The generator pays for all costs associated with its connection. This includes the cost of the physical connection to the grid along with the costs of any upstream network reinforcement work arising from the connection of the generator.	Generally there is no requirement for DG and RES schemes to pay ongoing UoS charges in commercial operation Provides strong locational signals (arguably)	Discriminatory to DG and RES - connection costs can be prohibitively high Network reinforcement costs are often uncertain (lack of transparency) The DNOs hold significant power, and can deter DG & RES A single generator can end up paying for reinforcements caused by other generators
"Mixed" [15]	A hybrid of the shallow and deep charging methods. The generator generally bears the cost of the physical connection to the grid network (the shallow costs) plus a proportion of any upstream network reinforcement costs. The proportion of these costs paid by the generator is usually based on an assessment of the proportional use of any new infrastructure by the generator.	The generator's network reinforcement costs are a function of the generator's usage of the new connection assets Provides some locational signals to generators	Must have clear (non-discriminatory) rules to calculate the proportion of costs borne by generators DNO reinforcements may be needed before connection – may add project delays Generator liability can extend to the HV grid network, can lead to prohibitive costs on DG and RES schemes DG and RES may have to pay UoS charges
"True"	The costs paid by the generator for the new connection are equivalent to the cost of connecting the generator to the nearest point on the grid system at which the grid has sufficient capacity to accommodate the generator without network reinforcement.	Provides some locational signals to generators	Connection costs for DG and RES are potentially very high. Can be even higher than the "deep" charging method if there is a significant distance to the nearest connection point not needing reinforcement.

Table 1 – Summary of Connection Charging Methods

[14] Examples include papers published under the EU programmes DGFER (http://www.dgfer.org/), DECENT (http://www.izt.de/decent/) and SUSTELNET http://www.electricitymarkets.info/sustelnet/index.html)

[15] Also sometimes referred to as "shallowish"

4 EUROPEAN LEGISLATIVE FRAMEWORK

4.1 Existing European Legislation

The four European directives that are most relevant to the connection of distributed generation sources to the electricity grid network are the Electricity Liberalisation Directive of 2003, the Renewables Directive of 2001, the Cogeneration Directive of 2004 and the Buildings Directive of 2002. Apart from these legislative acts, general European internal market and competition rules apply.

4.1.1 Electricity Liberalisation Directive, 2003/54/EC [1]

Directive 2003/54/EC constitutes together with the Gas Liberalisation Directive and the Regulation on Cross-Border Networks the so-called 2nd European energy liberalisation package of 2003. The Electricity Liberalisation Directive covers a range of measures, including rules on new generation capacity, legal unbundling of electricity generation and transmission companies, third party access to electricity networks, the right to choose electricity suppliers, and the establishment of independent regulatory authorities.

The role of the regulatory authority is crucial in the liberalisation process. Article 23 stipulates that the regulatory authority must be wholly independent from the interests of the electricity industry and shall ensure non-discrimination, effective competition and the efficient functioning of the market. Among its extensive responsibilities is the task to monitor

> "*The terms, conditions and tariffs for connecting new producers of electricity to guarantee that these are objective, transparent and non-discriminatory, in particular taking full account of the cost and benefits of the various renewable energy sources, distributed generation and combined heat and power*".

Furthermore, the regulator is in charge of "fixing or approving (…) at least the methodologies" for calculating connection and transmission tariffs, and other terms and conditions. If any party has a complaint against the grid operator, the regulatory authority acts as a dispute settlement authority with the power to request the modification of tariffs, rules, mechanisms and methodologies.

The majority of Member States failed to adequately implement the Electricity Liberalisation Directive by the deadline of 1 July 2004. One year later, in several countries (including the largest electricity market, Germany) the national transposition laws did not enter into effect. This significant delay in implementing European law is very uncommon and can partly be explained by the tight deadline and partly by massive lobbying of the national electricity industries opposing the opening up of their markets.

In its fourth annual benchmarking report [COM (2004) 863 final] [7], the European Commission expressed its dissatisfaction with the liberalisation process so far, and points out that after five years of nominal competition fewer than 50% of energy consumers have switched their supplier. The annual benchmarking report identifies four key reasons for the lack of success in achieving a competitive market: lack of cross-border transmission links, existence of dominant, integrated power companies, biased grid operators, and the non-existence of a liquid wholesale electricity market. Market concentration and dominant incumbents are "the most important obstacle to the development of vigorous competition", according to the European Commission.

The Directorate-General for Competition is currently undertaking a sector inquiry in order to receive more in-depth information on the main barriers to competition in the electricity and gas markets. The outcome of this exercise will significantly influence the discussions within the European Commission, whether to wait for the effects of the 2nd energy liberalisation package (once adequately transposed in the whole EU area) or to develop a 3rd energy liberalisation package. Observers expect the main item of such a 3rd package to be full (i.e. ownership) unbundling between electricity generators and grid operators.

4.1.2 Renewables Directive, 2001/77/EC [2]

Directive 2001/77/EC aims at increasing the share of renewable energy by 2010 to the indicative target of 22.1% of EU gross electricity consumption. With the accession of the ten new Member States on 1 May 2004 the indicative target has been adapted to 21.0%.

Article 7 deals exclusively with grid system issues and obliges Member States to ensure that transmission and distribution system operators guarantee grid access for electricity generated by renewables. Furthermore, the grid operators are required "to set up and publish their standards rules relating to the bearing of costs of technical adaptations, such as grid connections and grid reinforcements". These rules must be non-discriminatory and shall take into account also the benefits of connecting renewables to the electricity networks. Grid operators have to provide new renewable electricity producers with a "comprehensive and detailed" cost estimation associated with the connection. Grid operators are equally required to publish their standard rules on sharing grid connection and reinforcement costs between the benefiting parties. Finally, grid fee charging must not discriminate against renewable electricity producers. All of these provisions have to be met in each Member State, and violations can lead to the launch of infringement procedures by the European Commission.

In addition, the Renewables Directive gives the option to Member States to go beyond the common obligations. Member States can ask grid operators to provide "priority access" to the grid and to cover "in full or in part" connection and reinforcement costs. Regarding grid fees, Member States shall "where appropriate" require grid operators to take into account the "realisable cost benefits" resulting from connecting a renewable energy plant to the network, such as the direct use of the low-voltage grid.

The Renewables Directive foresees an extensive reporting procedure, and requires Member States to document their progress in facilitating grid access for renewables. The European Commission will present a progress statement to the European Parliament and the Council by 31 December 2005, although observers expect this report to be tabled during the autumn of 2005.

The following table summarizes the policy assessment of "non-economic factors" (i.e. grid connection and administrative procedures), which has been published by the European Commission as a "Staff Working Document" on 25 May 2005 [5]. While this document covers the whole EU-25, only the policies of the old Member States have been assessed with a point system. One point corresponds to "hardly any or no support" whereas five points corresponds to "very high support".

AT	BE	DK	FI	FR	GE	GR	IR	IT	LU	NE	PO	SE	SP	UK
3-5	2-3	3-4	3-4	3-4	3-5	2-3	1-4	2-3	4-5	2-4	3-4	2-3	3-4	3-4

Table 2 – Assessment of RES promotion policies regarding "non-economic" factors (EU-15)

Various renewable energy associations have accused the European Commission of having taken a too lenient approach when assessing Member States' "non-economic" policies in the promotion of renewables. The benefit of such highly aggregated indicators can also be questioned on a general level, however they help to identify best practices in a highly differentiated area such as the European Union.

4.1.3 Cogeneration Directive, 2004/8/EC [3]

Directive 2004/8/EC borrows much from the Renewables Directive (2001/77/EC) adopted 28 months earlier. Consequently, article 8 ("Electricity grid system and tariff issues") of the Cogeneration Directive refers to article 7 of the Renewables Directive discussed above. It should be noted, that some EU-wide and optional provisions of article 7 Renewables Directive do not apply in the case of combined heat and power production from non-renewable energy sources. This concerns, for example, the possibility for Member States to transfer grid connection and reinforcement cost, in full or in part, to the grid operators.

In addition to the provisions referring to the Renewables Directive, article 8 of the cogeneration directive gives the opportunity to Member States to "particularly facilitate access to the grid" for small scale and micro-cogeneration. Finally, Member States shall ensure that tariffs and terms of conditions for top-up and back-up electricity shall be published by the utilities until their customers have the effective possibility to switch to another supplier. The possibility to choose suppliers should apply according to the Electricity Liberalisation Directive by 1 July 2004 to non-household consumers, and by 1 July 2007 to all electricity consumers in the European Union.

Member States have to implement the Cogeneration Directive by 21 February 2006. In contrast to the Renewables Directive, the reporting system of the Cogeneration Directive does not foresee documenting the facilitation of grid access for cogeneration units. However, the European Commission is authorized to include Member States' "measures" and "conditions" in its progress report on the implementation of the Cogeneration Directive. This report shall be tabled to the European Parliament and the Council by 21 February 2008 and can be accompanied by "an action plan for the development of high-efficiency cogeneration" in the European Union.

4.1.4 The Buildings Directive, 2002/91/EC [4]

Directive 2002/91/EC aims at promoting energy efficiency in residential and tertiary sector buildings, which presently represent more than 40% of the final energy consumption within the EU. This Directive is considered as a very important legislative component of energy efficiency activities of the EU designed to meet the Kyoto commitment and addresses many issues raised in the recent debate on the Green Paper on energy supply security.

The Directive enforces Member States to implement four main requirements including (i) a general framework for a methodology of calculation of the integrated performance of buildings, (ii) minimum energy efficiency standards in new and existing buildings, (iii) energy certification of buildings and (iv) the inspection and assessment of heating and cooling installations. The Directive is foremost a measure that concerns a very large number of actors on all levels and with different impacts and different motivations: designers, housing associations, architects, providers of building appliances, installation companies, building experts, owners, tenants, essentially all energy consumers in the EU.

The Buildings Directive makes significant progress in terms of the need to for consideration of some DG solutions for building efficiency improvements and hence is expected to have a large impact on the future deployment of DG and RES in the tertiary sector. It compels Member States to take the necessary measures in order to ensure that the technical, environmental and economic feasibility of alternative systems such as decentralised energy supply systems based on renewable energy or based on combined heat and power generation is taken into account before construction of new buildings with floor area over 1000 m^2 starts. The economic feasibility of those alternative DG and RES solutions, and hence the success of this initiative, is directly and strongly affected by the technical and economical issues related to the connection of these generators to the distribution networks. In particular, the connection cost charging methodologies, if correctly chosen by Members States, will potentially lead to a considerable positive impact on the deployment of DG and RES schemes in those applications considered in the scope of the Buildings Directive.

4.2 <u>Planned Security of Supply Directive</u>

The proposal of the European Commission for a directive on "measures to safeguard security of electricity supply and infrastructure investment" [COM (2003) 740 final] [6] aims to stimulate future investment in new electricity networks. The guiding idea behind this proposal is to increase the power of public authorities over the investment plans of private transmission and distribution system operators. The European Commission justifies this seemingly anti-liberal move by the need to ensure the security of electricity supply and the need to open up markets by forcing the construction of more cross-border network connections.

Two articles of the Commission proposal directly affect the connection of distributed generation units to the electricity networks. Article 6 deals with network investment on the national level and stipulates that:

> "*Member States shall ensure that investment decisions take into account of the need for increased possibilities for connecting renewable electricity, in view of meeting the indicative targets as set out in Directive 2001/77 on the promotion of electricity from renewable energy sources and in the Directive 2004/xx on cogeneration*".

The phrasing reflects the fact that at the time when this proposal was drafted the Cogeneration Directive was still under discussion and not finalised. Similar to network investment within a Member State, cross-border investment shall also be planned with a high degree of state control. Article 7 on interconnector construction foresees the active involvement of the national regulatory authorities, which shall base their decisions *inter alia* on "the need to promote distributed generation".

These provisions of the Security of Supply Directive go far beyond the current legislative framework on connecting distributed energy sources to the electricity networks. However, the Commission faces firm opposition in the European Parliament and in the Council as both Institutions regard the proposal as being a deviation from the general process of restricting state influence on the electricity and gas markets since the start of European energy liberalisation in 1996. It is widely expected that substantial amendments to the original Commission proposal will be made before the final adoption.

5 BENCHMARK REVIEW OF EU-15 MEMBER STATES

This section provides a review and overview of the current approaches to DG and RES connection charging within the EU-15 Member States. In the case of each Member State an assessment is made of:

- The general connection charging philosophy applied
- The method(s) by which these philosophies are implemented in practice
- The degree of transparency in terms of the methods and procedures by which connection charges for DG and RES are calculated
- Typical values of connection charges levied on new generation plant when connecting to the distribution grid (where this is available)
- The impact that the current approach to connection charging has on new DG and RES installations

The key points from the information contained this section is summarised for ease of reference in Appendices 2 and 3.

5.1 AUSTRIA

5.1.1 Connection Charging Approach

In Austria, there is a "deep" connection charge approach, i.e. the generator who wishes to be connected to the grid bears the costs for physical connection (*Netzzutrittsentgelt*) and an additional entry fee (*Netzbereitstellungsentgelt*). The entry fee is used to maintain and upgrade the grid where the new entrant is connected. The *Systemnutzungstarife-Verordnung SNT-VO 2003* adopted by the National Regulatory Authority (e-control[16]) lays out the rules for charging grid fees and foresees in §3(3) that "the income stemming from entry fees must not exceed

[16] http://www.e-control.at/

30% of average annual grid investments." Neither e-control nor the VEÖ[17] was able to indicate the actual percentage for the past years.

5.1.2 Method of Implementation

The federal government adopts *Bundesgesetze* (federal laws), which apply in the entire Republic of Austria. It is up to the regional governments to execute these laws according to local circumstances. A key role in ensuring fair and transparent mechanisms is the national regulator (e-control[16]) whose main tasks are to create framework conditions for the energy markets, to monitor the liberalisation process, and to settle disputes between market participants[18].

Costs for physical connection here means: cost for cables, ground works, labour and for a transformer if the grid operator feels it adequate to connect directly to a higher voltage line. According to §2 of the *Systemnutzungstarife-Verordnung* "prices have to be adequate and according to customary market conditions". The additional entry fee serves to maintain and upgrade the networks where the entrant connects to the grid. The calculation of charges has to be "fair, reasonable and unbureaucratic" [§3(2) *Systemnutzungstarife-Verordnung*].

5.1.3 Level of Transparency

The situation in Austria is far from being transparent. On the one hand, federal legislation has provided e-control with extensive monitoring tasks and powers. The *Energie-Regulierungsbehördengesetz* of 2000 gives authority to e-control to "examine the files of all market participants" and to "inquire about all activities that fall under the scope of its competences". On the other hand, there is no specific requirement for e-control to carry out regular monitoring reports. Consequently, the regulator is not able to state what "customary market conditions" means in terms of average prices and costs. Similarly, neither the VEÖ nor the DG associations are equipped with this information.

As one consequence, it is at this stage not possible for e-control (or for any other agency) to assess whether grid companies discriminate against potential competitors in the power generation sector or not. According to sources of the DG industries, vertically integrated regional utilities do not shy away from demanding inadequately high connection charges in order to avoid competition. The regulator e-control had to settle various disputes in this regard, but the exact number of cases remains unknown to the public. The term "non-discriminatory" is not explicitly mentioned in the *Systemnutzungstarife-Verordnung*.

5.1.4 Typical Connection Costs and Charges

The connection charges are calculated on a case-by-case basis. E-control has neither fleshed out the relevant *Systemnutzungstarife-Verordnung* requirements nor published a model contract for market actors. According to the VEÖ, also the grid companies have omitted to publish such data. The *Systemnutzungstarife-Verordnung* foresees in §2 that "charges for physical connection have to be disposed by the grid operator in a transparent and understandable manner". Although the wording allows for a broad interpretation, the actual practice is limited to concrete cases. A similar provision for the entry fee is missing.

Due to the variety of DG technologies, it is difficult to indicate the concrete level of costs for new DG operators. The highest costs have to be borne by the wind power sector as grid operators demand in most Austrian regions an entry fee of €100,000 per MW on top of the physical connections charges. With typical investment costs of €1 million per MW of wind power, overall connection charges therefore exceed the 10% level.

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[17] The National Association of Electric Utilities, Verband der Elektrizitätsunternehmen Österreichs, www.veoe.at

[18] The utilities are represented by VEÖ[17], and VEÖ is member of the European association Eurelectric. There are a couple of associations representing DG industries, such as ÖEKV (cogeneration), IG Windkraft (wind power), KWÖ (small hydropower), and ÖBV (biomass).

5.1.5 *Impact of Current Approach on DG and RES*

The non-transparent nature of the system may not only hinder the rapid deployment of DG in Austria, it also makes it difficult to draw general conclusions. There is no common pattern visible and practices differ not only due to technology differences but also due to the decentralized structure of the Austrian republic.

The adverse impact of high grid charges is strongest for the wind power sector with an across-the-board entry fee of €100,000 per MW. Given the fact, that in the years 2003 and 2004 a total 468 MW of wind power have been constructed in Austria, considerable sums are taken in by grid operators in this way. At the same time, it should be noted that Austria experiences a boom in wind power construction in recent years, irrespective of these practices. This indicates that grid issues play a minor role to other factors, such as the quality of support mechanisms.

5.2 BELGIUM

Belgium is a federal state. Energy legislation, policy and regulation are the responsibility of both the federal government and of the three Regions (Flanders, Wallonia and Brussels-Capital).

5.2.1 *Connection Charging Approach*

Belgium has adopted a predominantly shallow connection charging methodology. The costs of the physical grid connection are borne by the owner of the generating plant, and the costs of any network reinforcements are generally recovered via the tariff system.

5.2.2 *Method of Implementation*

The general approach concerning connection charging for DG and RES in Belgium is dealt with by the "*Arrêté royal*" (Royal Decree) of 11 July 2002, published in the *Moniteur belge* of 27 July 2002[19] (hereon referred to as *A.R. du 11 juillet 2002*). Chapter II of this Decree details the general tariff structure ("structure tarifaire générale"). The tariff structure distinguishes between 3 tariffs applicable to each user per connection point:

- Connection tariffs to the distribution network (Article 4);
- Use of network tariffs (Article 5);
- Ancillary services tariffs (Article 6).

5.2.3 *Level of Transparency*

Distribution System Operators (DSOs) and Transmission System Operators (TSOs) are required to publish their connection charging tariffs on the website of the Belgian Energy Regulator, CREG[20]. The tariffs proposed by each DSO, as well as those proposed by the TSO (Elia), are subject to approval by the CREG[21].

Hence the connection charging system in Belgium is considered to be very transparent.

5.2.4 *Typical Connection Costs and Charges*

Connection charges vary depending on which DSO network the generator is being connected to, although the structure of the connection charges is identical for all DSOs. This follows the items enumerated in Article 4 of the *A.R. du 11 juillet 2002*.

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[19] The full name of the Arrêté is "*Arrêté royal du 11 juillet 2002 relatif à la structure tarifaire générale et aux principes de base des procédures en matière de tarifs de raccordement aux réseaux de distribution et d'utilisation de ceux-ci, de services auxiliaires fournis par les gestionnaires de ces* réseaux et en matière de comptabilité des gestionnaires des réseaux de distribution d'électricité."

[20] Commission de Régulation de l'Electricité et de Gaz (CREG), www.creg.be. As of 1 July 2005, the CREG listed 32 electricity distributors on its Website. Tariffs can be found for each company under "Publications", then "Tariffs électricité".

[21] See Chapter III of the A.R. of 11 July 2002, and in particular Article 9.

Six items are taken into consideration, with the costs linked to grid connection being accessible on the CREG's website:

1. Orientation study ("*Etude d'orientation"*)
2. Detailed study ("*Etude de detail"*)
3. Connection ("*Raccordement"*)
4. Metering ("*Formule de location des appareils de comptage"*)
5. Transformers ("*Formule de location des installations de transformation"*)
6. Additional security ("*Formule de location d'installations complémentaires de sécurité"*)

The tariffs for each of these items will also vary according to the voltage of the network to which the installation is connected.

DSOs in Belgium distinguish between the low voltage network ("*basse tension*") and the high voltage distribution network ("*haute tension*"). However, some DSOs refer to the high voltage distribution network as the medium voltage network *("moyenne tension*" – MT)[22]. Most DSOs have developed specific sets of tariffs for at least 3 different levels of network voltage:

- Low voltage ("*basse tension*" – BT)
- TransBT
- 26-1kV

Some DSOs also have specific tariffs applicable for connection to the "*TransMT*" network.

Overall, the costs of connection typically fall in the range 5-10% of total installation costs for a small cogeneration installation, but they vary in accordance with the particulars of the site concerned. The costs are, however, validated by the CREG, thus ensuring transparency and removing a significant potential source of discrimination by the DNO (for a small and medium scale installations).

Prior to the commissioning of the plant, the orientation study (item 1 above) and detailed study (item 2 above) have to be performed. The orientation study typically costs €500 for installations between 250 kVA and 1,000kVA; €250 for installations between 56 and 250 kVA; €100 for installations under 56 kVA and is free for installations below 25kVA[23]. The detailed study can cost anywhere between €100 and €11,000 depending on the company, the power range and the network that the installation is to be connected to. Typical costs given by Cogensud[24] are €6,300 for a medium voltage connection or €1,000 for a low voltage connection.

The most important item for DG and RES electricity producers is item 3 above that deals with connection tariffs ("*raccordement*"). Examples of connection tariffs from SIBELGA for 2005 are provided for information in Table 3.

Article 4 of the *A.R. du 11 juillet 2002* states that

"The (connection) tariff… is function of the operating voltage level, of the length, of the power, of the destination (injection or extraction) of the connection and… of technical parameters defined in the technical regulation."

[22] In the case of the DSO SIBELGA, TransMt, the 26-1kV network and the TransBT network are considered to be medium voltage ("moyenne tension").

[23] Prices from SIBELGA for 2005. These figures vary from Distribution system operator to another, e.g. WAVRE charges 3,172 EUR for the orientation study in the case of installations with a power rating above 56kVA and injecting power to the grid.

[24] Cogensud is the association for the promotion of cogeneration in the Walloon Region of Belgium.

Network	Power level (kVA)	Tension/ Voltage (kV)	Tariff per kVA (EUR/kVA)	Connection[25] (EUR)	Metering installation[26] (EUR/metre)
TransMT	>5000	5-6 or 11	33	189,910[27]	1,140
MT	<5000	5-6 or 11	33	7,351	1,140
	Power level (kVA)	**New connection (EUR/ connection)**	**Lengthening of connection (EUR/ connection)**	**Connection reinforcement (EUR/ connection)**	**New Metering installation (EUR/metre)**
Standard BT	≤25kVA	965	510	1,128	71
	56kVA>*x*>25kVA	1,028	530	1,168	446
	≥56kVA	1,187	569	1,355	590

Table 3 – Examples of connection tariffs from SIBELGA for 2005

5.2.5 Impact of Current Approach on DG and RES

DG and RES have developed at a fast rate in Belgium since market liberalisation, unhindered by adverse interconnection regulations. The transparency of the present connection charging system is beneficial to the deployment of DG.

5.3 DENMARK

It is well documented that Denmark has invested heavily in its wind energy industry over recent years. Furthermore Denmark has introduced a number of policy measures that have led to the rapid deployment and integration of significant quantities of renewable energy (particularly wind power) and CHP into its grid network over the last 10-15 years. Around 36% of electricity production in Denmark is derived from DG [12].

There are currently 2 transmission companies in Denmark: Eltra, which covers Western Denmark, and Elkraft covering Eastern Denmark, although these companies will be merged along with Gastra (the Danish natural gas transmission company) in the autumn of 2005 to form Energinet. In addition there are around 100 distribution or grid companies, which are predominantly owned by the municipalities or consumer co-operatives.

5.3.1 Connection Charging Approach

Denmark has adopted a shallow generator connection policy, as generally defined in the Danish Electricity Supply Act[28]. However, there are different rules depending on the particular generation technology that is being connected.

For example, when "environmentally benign" electricity and CHP plants[29] are connected to the electricity supply grid, the owner of the plant is only required to pay the cost of connection to the 10-20 kV grid system, regardless of whether the grid owner selects another (higher voltage) connection point. The grid owner meets all other costs, including grid upgrade and expansion. If, however, the generation plants themselves choose to be connected at a higher voltage than the 10-20 kV grid system, then they will meet the costs of connection at this higher voltage level. In

[25] Includes 2 underground cables with 10 meters maximum in private property.

[26] Does not include TI and TP transformers.

[27] For connection with a maximum power rating between 5 and 10 MVA.

[28] http://www.ens.dk/graphics/publikationer/laws/bill_234.pdf

[29] As defined in section 57 of the Danish Electricity Supply Act; includes CHP and renewable energy systems under 10 MW with the exception of wind turbines

this case any costs associated with grid upgrade and expansion will still be borne by the grid owner.

In the case of wind turbines, the Minister for Environment and Energy can define the rules regarding the construction and connection of wind turbines to the electricity grid, including rules concerning the distribution of costs involved in grid connection and being connected to the electricity grid[30]. In practice, the connection costs for wind turbine developers are similar to those of CHP plants, with the exception being that they are only required to pay the costs of connection up to the boundary of specific planning zones allocated for turbine construction, leaving the grid owner to cover all other costs. This can give wind turbines a slight advantage over CHP, as they can be exempt from providing some of the overhead line or cable costs up to the 10-20 kV grid connection point. However, if the wind turbine is to be connected outside one of the stipulated planning zones, then the wind power owner must pay all connection costs to the 10-20 kV grid connection point.

In all cases, the costs of grid system upgrades or extensions borne by the grid owner are eventually recovered through the tariff system.

5.3.2 Method of Implementation

The Danish Electricity Supply Act[28] lays down the rules governing consumer protection, environmental protection and security of supply in a liberalised market. The main parts of the Act came into force on 29 December 1999, with further amendments made in the new Danish Electricity Supply Act of June 2004. One of the key changes in the new act was the creation of Energinet[31].

The system operators' prices and conditions are public and must be notified to the Danish Energy Regulatory Authority, which may order adjustments of prices and conditions if they are found to be in contravention of the Act. Further regulation of the system operators was laid down in Executive Order No. 444 of 11 June 2002.

5.3.3 Level of Transparency

Given the clear policy of shallow connection charging in Denmark, from the perspective of generators there is a high level of transparency in terms of the requirements and costs associated with obtaining a new grid connection.

5.3.4 Typical Connection Costs and Charges

Due to the shallow connection charge methodology applied in Denmark, the connection costs incurred by a new generator are only those that relate to the physical connection to the grid network itself. This typically includes all equipment up to, and including, the connection transformer and service line to the grid, within the cost boundaries summarised in section 5.3.1 above.

A number of published cases studies have been analysed[32] in order to establish the typical connection costs that are attributable to DG and RES systems in Denmark. Whilst these costs do vary considerably with the particular circumstances, connection costs of the order 5-10% of the total installation costs of the system appear to be fairly typical[33].

More specifically pages 50-55 of reference [16] provide an indicative model for the cost of connection of a CHP or wind turbine unit in Denmark. This cost is broken down into a fixed cost, which varies according to the power rating of the generator, and a variable cost that is the sum of the cost of line or cable (to the nearest 10-20 kV line) and any transformer and switchgear plant required[34].

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[30] See section 68 of the Danish Electricity Supply Act

[31] http://energinet.dk/composite-18.htm

[32] E.g. the Middelgrunden wind installation, http://www.middelgrunden.dk/

[33] Note that grid reinforcement costs are normally covered separately by the grid owner

[34] The total costs vary depending on the selected cable type, connection voltage, etc. The indicative connection cost given in reference [16] for a 3.5 MW wind farm, requiring 4.0 km of connecting line (excluding transformer and substation) is 1.45M DKK (~ €200,000)

5.3.5 *Impact of Current Approach on DG and RES*

The high penetration levels of DG that already exist within Denmark would suggest that the current market regime, coupled with the significant levels of political will that have been a feature of Danish energy policy over the last 20 years, provide a favourable environment for DG and RES.

Specifically in relation to generator connection charges, the shallow cost allocation approach deployed in Denmark is favourable towards DG and RES in that they have access to the grid network and electricity market at (relatively) low cost, enabling grid reinforcement costs to be recovered through the tariff system. The main regulatory issue that arises from this approach is whether the relative ease of generator access to the network and market place leads to the most optimal overall electricity delivery system, both in terms of efficiency and cost. To a degree this has been recognised in respect of the wind turbine planning zones that are implemented in Denmark, but it is also understood that electricity transmission limitations, caused by the high penetration of RES and CHP, are creating operational difficulties to the transmission companies[35].

5.4 **FINLAND**

The Finnish electricity market is very diverse with around 120 generation companies in existence operating around 550 separate power plants, although the three largest power producers between them provide 75% of all electricity to the market. CHP plants (mainly district heating and industrial plants) provide around 32% of all electrical energy in Finland, with hydro schemes providing around 17%. The share of "new" renewables is low, amounting to less than 1%.

There are 91 regional distribution companies responsible for electricity distribution below 110 kV in Finland. The majority of these companies are in municipal ownership.

5.4.1 *Connection Charging Approach*

There is no standard approach to connection charging in Finland, as the individual distribution network owners are responsible for determining policy in this area. As a result, connection charges in Finland can be either shallow or deep depending on the network owner.

However, all generators have open access to the network (as defined in legislation), and distribution network owners are obliged to connect producers that meet the published technical requirements for a "reasonable" and "non-discriminatory" charge.

5.4.2 *Method of Implementation*

Finnish law requires network owners to publish the prices of their network services, including connection to the network. These prices must be "reasonable"[36] and non-discriminatory. As a result, the network owners are obliged to provide a detailed estimate of connection costs to a new generator upon request.

The Finnish Energy Market Authority (EMA)[37] supervises electricity network operations and the pricing of network services within Finland. Should generators feel aggrieved at the level of connection charge that they are being asked to pay, they can take the matter up with the EMA. Unfortunately network owners are only obliged to comply with EMA's decisions once they are final, and this process can take several months[38]. In this respect, the distribution network owners and operators can be considered to be in a position of significant influence in relation to DG and RES connection.

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[35] E.g. http://distribution-europe.2r-itservices.com/papers/session4_3/Peter_Eriksen.zip

[36] Defined by the Finnish Electricity Market Authority in their publication 9/429/2004, http://www.energiamarkkinavirasto.fi/files/Guidelines_Electricity_Distribution_2005-2007.pdf

[37] http://www.energiamarkkinavirasto.fi/index.asp?languageid=826&start=1

[38] Some extreme cases are understood to have taken 1-2 years to resolve

5.4.3 Level of Transparency

Whilst network owners are obliged to publish the prices of their network services, including grid connection costs, detailed connection costs are generally only established following a connection application by a DG or RES owner. It should also be borne in mind that there is no consistent approach in this area between Finnish network owners.

Therefore, the degree of transparency of connection charges in Finland is considered at best to *medium*.

5.4.4 Typical Connection Costs and Charges

In Finland the connection charge levied by a network owner on a new generator is generally either:

- A fixed fee per MW (generation plant or transformer capacity)
- The actual cost of connection, including new lines and in some cases network infrastructure upgrade if the connection of the generator causes this to be required

5.4.5 Impact of Current Approach on DG and RES

With the current regulatory approach in Finland, the network owners are in a strong position regarding their influence on the amount of DG and RES that is installed. Whether they actually use this influence to limit the amount of new DG and RES being installed on their networks is unclear, and further investigation is needed to establish this. However, whilst CHP and district heating schemes are already very widely applied in Finland, the amount of "new" renewable energy (such as wind) within the Finnish electricity market is extremely low in comparison with other European countries.

5.5 FRANCE

5.5.1 Connection Charging Approach

In general, France is now implementing a "shallowish" connection charge mechanism. DG and RES schemes are generally required to pay for the costs of their physical connection to the grid network, plus any network reinforcements at the connection voltage. They are not normally required to pay for upgrades on the higher voltage networks.

5.5.2 Method of Implementation

The French legislative decree N° 2002-1014[39] of 19 July 2002 defines the tariffs for use of the public electricity transmission and distribution networks. This was published in the French *Journal Officiel* of 23 July 2002 and has been applied since 1 November 2002. For generators of less than 250 kVA capacity, French legislative decree N° 2001-365[40] defines additional specific rules.

In summary the procedure for processing connection requests is as follows:

(i) For installations greater than 250 kVA:

Distributed generators in France who wish to connect to the public electricity distribution grid operated by EDF have to file a request for connection. The document named '*Procédure de traitement des demandes de raccordement des installations de production d'électricité aux réseaux publics de distribution*'[41] details the procedure.

In particular, it gives the rules relating to the management of the waiting list and the principles of the contractual relations between the project owner and the distributor

[39] http://www.legifrance.gouv.fr/WAspad/UnTexteDeJorf?numjo=INDI0200343D

[40] http://www.legifrance.gouv.fr/WAspad/UnTexteDeJorf?numjo=ECOI0100077D

[41] Identification NOP-RES_18E ; Version V4 of 13 May 2005.

(in this case EDF) from the connection request until the entry into operation of the electricity production installation[42].

The connection procedure is broken down into the following:

- The Feasibility Study ("*étude de faisabilité*")

Projects with an installed capacity below 2.5 MWe can send EDF an information request ("*demande de renseignement*") to which EDF will respond with a feasibility study ("*étude de faisabilité*"). This document gives an estimate only and is absolutely non-binding for EDF.

- The Detailed Study ("etude détaillée")

Once the project is more advanced, the project owner has the possibility to request a detailed study from EDF. This is optional.

- The Technical and Financial Proposal ("*Proposition Technique et Finanacière*")

Once the project has been validated by the administration, the project owner has to request a detailed proposal for the connection of his installation ("*demande de PTF*"). EDF will then carry out, within 3 months from receipt of the necessary documents, a detailed study. This is mandatory and the technical and financial results are binding for both parties, if the project owner wishes to carry through his project.

- The Connection Convention ("*Convention de raccordement"*)

Once the project owner has accepted the PTF and paid an initial payment, the distributor (EDF) carries out the final realisation studies. Based on these studies, EDF prepares the connection convention/contract. It contains the same elements as the PTF.

(ii) For installations with a power less than or equal to 36 kVA:

These installations are connected to the Low Voltage (BT) network and are not subject to the waiting lists relating to HTB[43] infrastructure, HTA[44] networks and HTA/HTB transformer installation. However, they potentially remain subject to the consequences of the constraints that they can generate on the BT networks and the HTA/BT transformers. A connection request for these installations leads to the establishment of a connection contract ("*convention de raccordement*") from the reception of technical elements and administrative elements covered by paragraph 4.9 of the document.

(iii) For installations greater than 36 kVA and less than or equal to 250 kVA:

These installations are not subject to the waiting lists relating to HTB infrastructure and HTB/HTA transformers in cases where the cumulative power of these installations at the level of their HTB/HTA source transformer is below or equal to 1 MWe. However, these installations potentially remain subject to the consequences of the constraints they could generate on the BT networks, HTB/HTA transformers and the HTA network. These installations are processed in a similar way to the installations with a power above 250 kVA (see section (i)).

[42] It should be noted that EDF, acting as a distributor, refuses to answer parametric studies of the type: "what power can your network accommodate in this given location?"

[43] "Haute Tension B (1)" – high voltage lines between 50 kV and 130 kV

[44] "Haute Tension A" – high voltage lines between 1 kV and 50 kV

Necessary documents for entry into the waiting list (regardless of installed power):

- Pour les installations soumises à permis de construire, une copie de la décision accordant le permis de construire (notamment le cas des projets éoliens de hauteur supérieure à 12 mètres) spécifiée à l'article R. 421-29 du code de l'urbanisme, ou de l'attestation prévue par l'article R. 421-31 du même code ;
- Pour les installations soumises à la déclaration de travaux, une copie de la déclaration de travaux ou de la mention de notification de prescriptions comme indiqué à l'article R. 422-10 du code de l'urbanisme ;
- Pour les installations soumises à une autorisation administrative exigeant la fourniture d'une étude d'impact préalable avec enquête publique (notamment les installations hydroélectriques ou celles qui sont classées pour la protection de l'environnement), une copie de cette autorisation ;
- Pour les installations ne relevant d'aucun des cas ci-dessus, une copie du récépissé de déclaration d'exploitation ou une copie de l'autorisation d'exploitation, documents délivrés dans les conditions prévues par le décret n° 2000-877du 7 septembre 2000,
- Pour les installations retenues à un appel d'offres lancé dans le cadre de l'article 8 de la loi 2000- 108 modifiée par la loi 2003-8, le document confirmant l'éligibilité des installations.

La date d'entrée en file d'attente est fixée à la date de réception par le distributeur EDF de ce document. Les caractéristiques de l'installation prises en compte, dont notamment la puissance, pour l'entrée dans la file d'attente sont celles de fiches de collecte initialement transmises au distributeur EDF.

5.5.3 Level of Transparency

Traditionally, the degree of connection charge transparency within the French electricity market has been low, caused primarily by the dominance of EDF. There have, however, been some improvements in recent years, although for DG and RES schemes in particular there is still little visibility of final connection costs until a detailed study has been performed by EDF. Furthermore there are often significant cost changes (almost exclusively increases) between the early indicative connection costs given by EDF and the final costs following detailed studies.

5.5.4 Typical Connection Costs and Charges

Connection costs in France depend on:

- The capacity of the generating unit;
- The location and local context (urban/rural; industrial/residential);
- The export options (full export; partial; selective);
- The will of the utility

There are no official average costs or benchmarking for connection but they seem to be usually around 10% of total investment costs for low voltage – with no specific requirements. For mid voltage, the figure is between 11 and 20% depending on the installed capacity and the number of units. However connection costs can be much higher, as shown by a 1995 THERMIE-supported study that gave examples of connection costs as high as 20 to 30% of total investment costs.

Connection costs associated with the connection of a 1 MWe unit to the HTA network would typically include: Low voltage liaison, transformer, 20 kV liaison, protection cell, EDF delivery facility, metering and protection against de-coupling from the grid. Also typically included are a passive filter (above 50,000 EUR) and a TGS liaison (20,000 EUR) as options. An active line trap ("*circuit bouchon actif*") is proposed at around 100,000 EUR. On the other hand, there are no civil engineering costs.

Decree 2002-1014 specifies that the connection charge for the injection of electricity to the distribution network is zero €/MWh. Reactive energy consumed or not supplied according to the dispositions of the distribution network contract will be charged at the price and during the period set out in Section 8 of Chapter II of the Decree.

Metering charges for low voltage above 36 kVA carried out by EDF for injection are charged according to the approach found in Section 2 Chapter III of the annex to Decree 2002-1014. Metering services for low voltage below 36 kVA carried out by EDF for injection are not covered by the Decree and are examined by the French Energy Regulator, the *Commission de Regulation de l'Energie* (CRE)[45].

(i) <u>Charges for connection to the LV network for producers with an installed rated power generation capacity of less than 250 kVA (from 1 January 2005):</u>

The application of Decree 2001-365 of 26 April 2001 on tariffs for use of the transmission and distribution networks means that generation with capacities of under 250 kVA linked to the low tension network *will no longer have to bear the induced costs for adaptation of the high voltage networks*.

Other key points are:

- No additional cost is charged to the producer for his connection to the LV network if the existing network infrastructure can accommodate the connection without new investments.
- If works need to be undertaken to the HTA/LV transformer or to the existing LV network, the cost of these works is integrated in the quotation relating to the connection to the LV network. The cost of these works is evaluated on the basis of the minimum technical solution achievable from the technical thresholds of standardised equipment ("*paliers techniques de matériel standardisés*") by the network operator, allowing for the connection of the generation plant at the level desired by the electricity producer.
- If the connection of the generation plant requires the installation of a HTA/LV transformer, the quote proposed to the electricity producer by the network operator will be based on the basis of the minimum technical solution achievable from the technical thresholds of standardised equipment ("*paliers techniques de matériel standardisés*") by the network operator, allowing for the connection of the generation plant at the level desired by the electricity producer. The location of the transformer is defined by the network operator according to:
    - The technical connection constraints of the generation plant;
    - The supply/servicing needs of the network in the locality of the generating unit;
    - The technical and administrative feasibility of the blueprint.

(ii) <u>Connection charges to the HTA network as from 1 November 2002 for an electricity generator</u>:

According to Decree 2001-365, the connection charges levied on a generator connected to the HTA (1-50 kV) network no longer include any induced costs of reinforcement necessary of the HTB (50-130 kV) network.

Other key points are:

- No cost related to HTB-HTA transformation is charged to the electricity producer when connected to existing infrastructure.
- If works on the HTB-HTA transformer or the HTA network is necessary, the cost of these works is included in the HTA network connection quote.
- If the connection of the installation leads to the creation of a "*poste source*", the proposed quote will be based on the minimum technical solution corresponding to the power need defined by the generator, the transformer located nearest to the producer, and to technical and administrative feasibility of the installation.

[45] http://www.cre.fr/

- Simultaneous requests by several producers will be taken into account so as to allow a distribution of costs between these producers, provided that an agreement is made between the parties concerned.

5.5.5 Impact of Current Approach on DG and RES

Many problems have arisen between EDF and independent generators over the cost of connection to the distribution network. Dissatisfaction is high among cogenerators and decentralised generators because whilst EDF's initial estimates for connection costs given at the preliminary stages of the projects (which are non-binding) have often been low, these are often subject to huge increases later on when the generator is finalising his project and when EDF produces its definitive proposition (PTF: Technical and Financial Proposal). Furthermore small generators cannot negotiate the cost of connection with EDF, which makes the situation all the more detrimental. EDF has already been criticised for excessively increasing the cost of connection between the two stages on unfounded grounds[46].

To address these persistent problems, EDF launched in late 2003 a coordination committee of electricity producers to look into issues of connecting to the public distribution grid, whether in medium voltage (20KV) or low voltage. Cogenerators sitting on the committee believe that some progress has been made but many issues remain unresolved and will probably be decided upon by the CRE.

The problems linked to grid access are extremely complex. Overall, they have two serious consequences for cogeneration and distributed generators. Firstly, the cost of grid access is sometimes excessive: for a 2MW$_e$ cogeneration plant, which costs on average €1.8 M, the cost of connection to the grid can be over €300k. Secondly, the administrative burden, due to the number of contracts that have to be signed, acts as a powerful deterrent, especially for smaller projects.

5.6 GERMANY

5.6.1 Connection Charging Approach

There is a "shallow" connection charge philosophy in Germany.

The *Erneuerbare-Energien-Gesetz – EEG* (Renewable energy law) of 2004 (§13), states that "the plant operator bears the necessary costs of connecting plants which generate electricity based on renewable energy sources, as well as the costs for the appliances necessary to meter incoming and outgoing electricity". The same paragraph stipulates that "costs for upgrading the grid due to newly connected plants generating electricity from renewable energy sources are borne by the grid operator. He has to present a detailed report on these costs and is allowed to pass them on to the customers when calculating the use of system fees."

The *Kraft-Wärme-Kopplungsgesetz* of 2002, which in §5 obliges grid operators to connect cogeneration plants, does not contain any specific provisions on charging methods. Therefore §13 of the *EEG* applies for cogeneration as well.

5.6.2 Method of Implementation

The federal government adopts laws that apply across Germany. It is up to the regional governments to execute these laws according to local circumstances. A key role in ensuring fair and transparent mechanisms is the National Regulator (Bundesnetzagentur[47]) whose main tasks are to create framework conditions for the energy markets, to monitor the liberalisation process, and to sanction non-compliance[48].

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[46] The CRE (French Energy Regulator) ruled against EDF in a case opposing Cogé de Kerverzet and EDF on 30 November 2003. The cost of connection had increased 15-fold between the preliminary assessment and the PTF.

[47] http://www.bundesnetzagentur.de/

[48] The utilities are represented by the national association VDEW (Verband der deutschen Elektrizitätswerke) and the grid operators in particular by its member-association VDN (Verband der Netzbetreiber). VDEW is member of the European association Eurelectric. There are a couple of

Germany has been considerably lagging behind the transposition deadline that has been set by the Electricity Liberalisation Directive of 2003. In July 2005, the *Energiewirtschaftsgesetz – EnWG* eventually entered into force and new rules on unbundling and grid access apply. In addition to that, the national regulator Bundesnetzagentur has been officially created.

The *EnWG* provides in §17 for "adequate, non-discriminatory and transparent" grid connection conditions. Moreover, the grid operators must offer conditions no less favourable than those that apply within their own or to associated companies. In §18 the federal government with the consent of the upper house is authorized to issue regulations on the "general terms and conditions for connecting to the medium- and low-voltage electricity net". Currently, such a regulation is in the legislative pipeline; adoption, however, is not expected before summer 2006.

5.6.3 Level of Transparency

In order to ensure transparency, the Bundesnetzagentur has received with §69-71 of the *EnWG* extensive monitoring powers, the right to confiscate company documents included. One of the 12 single items the regulator has to monitor according to §35 is

> "*The terms and tariffs for connecting new generators. Costs and benefits of various technologies for the production of electricity from renewable energy sources, for decentralized generation, and for cogeneration, have to be carefully considered*."

Every year, the Bundesnetzagentur has to publish a report on all its monitoring activities, and has to send (together with the national anti-trust agency) to the European Commission a report on market dominance and anti-competitive behaviour (§63 of the *EnWG*). In summary, the *EnWG* represents a solid legal basis for ensuring transparency of the market, including the current practices on connecting DG to the distribution network. It remains to be seen, however, whether the Bundesnetzagentur will receive adequate funding for fulfilling its tasks. It should be noted that the German market is very difficult to monitor, since 954 grid operators are active there. According to the 4th Benchmarking Report of the European Commission, this represents more than one third of all grid companies in the EU-25. The first Bundesnetzagentur monitoring report will be published in summer 2006.

5.6.4 Typical Connection Costs and Charges

The connection charges are calculated on a case-by-case basis. Overall, they are rather low due to the "shallow" charging approach. The main cost items are the meter, cables, and labour costs. The last two factors vary according to the distance between the plant and the connection point. Generally, the relative share of connection costs in total investment costs increases, the lower the plant capacity is. It is for this reason, that connection charging is a bigger issue for traditionally low-capacity technologies (such as PV) and less for big-capacity technologies (such as wind power).

Regarding the publication of connection charging methods, it should be noted that neither legislation nor any "soft law" in the form of VDEW model contracts is in place. Due to the high number of German distribution companies, it is not possible to assess the general practice (if there is any) on publishing connection charging methods.

The German law excludes the possibility to levy UoS or "entry" charges for electricity generators.

5.6.5 Impact of Current Approach on DG and RES

The "shallow" connection charging approach has a positive impact on DG deployment in Germany, and qualifies for the attribute "fair".

At the same time, one must mention that those vertically integrated utilities, which oppose the further spread of distributed generation, use the "shallow" charging approach as a political weapon. By claiming that increased UoS rates for consumers

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associations representing DG industries, such as BKWK (cogeneration), BEE (renewables), BWE (wind power), SFV (solar power), and IBBK (biomass).

are caused by the fact that DG necessitate higher grid maintenance costs, they try to build up political momentum against the feed-in law according to the *EEG* and the *KWK-Gesetz*.

5.7 GREECE

Since 1999, a specific Law (2773/99[49]) regulates the electricity produced by renewable sources. It stipulates priority in network dispatching when the capacity of the power plant is lower than 50 MW (10 MW for hydropower plants). It gives the same priority for the surplus of auto-producers within the same capacity limits. The Transmission System Operator and the Public Power Corporation are obliged to provide connection to new generators. In practice the development of wind power in some mountains and island areas is slowed down by the need to simultaneously extend the transmission networks[50]. In fact, IEA reports regularly outline the lack of infrastructure in Greece for a rapid development of renewable energies.

Regulated Third Party Access has been established both by the Law 2773/99 on the liberalisation of the Greek Electricity market and subsequent secondary legislative Acts endorsed by the Greek Parliament.

More specifically, the functions of the DNO in Greece will be assumed by the former public utility Public Power Corporation (PPC). Following the enactment of Law 2773/99, PPC's corporate structure was changed to that of "Société Anonyme" and was floated to the stock market. Under the Law, PPC SA is the owner of both the Transmission System and the Distribution Network and remains a vertically integrated utility with the obligation to publish separate accounts for each one of the electricity business activities that it exercises. The administration of the Transmission System has been assigned to the Hellenic Transmission System Operator S.A (DESMIE in its Greek abbreviation), which operates under a separate legal status from PPC.

Regarding the administration of the Distribution Network, Law 2773/99 envisages it being taken over by an entity that would operate within PPC SA under completely separate accounts. The establishment of the Greek DNO has not been realised so far, nor has the Greek Parliament endorsed the Distribution Network Operating Code.

5.7.1 Connection Charging Approach

Fundamentally the Greek system is based on deep charging, in the sense that the DNO itself has no responsibility for the costs incurred from the connection of a new plant to the grid. However, in the case of wind energy, the producer is entitled to subsidies up to 50% of the cost of reinforcement, although these are considered as investment subsidies for RES rather than a discount as such in terms of connection charges.

The future connection philosophy for the Distribution Network is anticipated to follow broadly the same principles that apply currently for the Transmission System Connection Conditions. These will in turn lead to a transition towards a more "shallow" charging approach.

The normal procedure requires the DNO to provide a Connection Offer to an applicant upon request. This involves the preparation of the relevant studies for the connection requirements. Where no network reinforcement is required, the applicant generator will cover the total costs. In cases where some reinforcement is needed the DNO shall, according to its studies and analysis, implement all necessary network reinforcements and proceed with the connection of the applicant. In this case the costs will be recovered by means of the Distribution Use of Network Charges.

[49] "Liberalisation of the Electricity Market – Regulation of Energy Policy Issues and other Provisions"

[50] IEA Greece Country Report 2002

5.7.2 Method of Implementation

Despite efforts to simplify procedures, in particular in relation to the licensing of Renewable Energy Source plants (Law 2941/2001), the situation regarding the connection of small-scale generating units[51] to the Distribution Network in Greece is rather obscure in terms of the connection conditions.

The procedure itself is now clearly established, albeit an extremely lengthy one. Once the electrical generation licence and the environmental licence have been obtained from the Ministry of Development and the Regional Authorities respectively, the DNO must provide the producer with, successively:

- The specification of the terms and conditions for interconnection to the grid
- The technical interconnection contract
- The commercial electricity sales contract
- The completion certificate for the interconnection works

Detailed information is hard to come by, and the process of interconnection itself is very cumbersome, several DNO directorates having to be consulted and to provide an opinion before the conditions for interconnection are even set.

Charging itself is at the current time purely the result of a negotiation between the applicant and PPC, thus potentially giving the DNO a significant amount of influence on the commercial success of a connecting generator.

5.7.3 Level of Transparency

At the current time there is a low level of transparency relating to DG and RES connection charging in Greece. An example of this is the negotiated connection charging process between the PPC and generators. However, a more transparent connection charging methodology is expected to be included in the future Distribution Network Operating Code (DNOC). The current situation is thus considered to be a transition period and it is hoped that many of the discriminatory practices that currently exist might be eliminated should the DNOC be endorsed.

Taking this into consideration, the present low level of transparency is expected to rise as legislation passes through.

5.7.4 Typical Connection Costs and Charges

It is anticipated that Distribution connection charges will be regulated so as to reflect the costs incurred by the utility for the implementation of the connection, allowing for a reasonable profit for the utility and for adjustments relating to asset depreciation.

The methodology is expected to be published in the DNOC. Most probably there will be Use of System charges in line with the respective regulations for the Transmission System Users.

In terms of deriving typical costs of connection for DG and RES within Greece, this has proven to be hard to evaluate given the very low number of installations of small-scale DG units so far in the country, along with the lack of transparency that is currently a feature of the Greek market. Further work is needed in this area.

5.7.5 Impact of Current Approach on DG and RES

The present system has a rather negative impact on DG and RES, mainly because of its lack of transparency. The new framework, once fully implemented, is expected to increase transparency, but it is hard to tell whether the procedures will be made any less lengthy and if the economic impact will be negative or positive with respect to the present situation.

Indeed, the anticipated moves towards a more "shallow" charging approach, and the use of UoS charges to recoup the costs for the DNO, could be favourable to DG

[51] Including all generating units connected to autonomous island grids

projects whose impact on the existing network and resulting reinforcement costs were prohibitive in practice. However, all the small-scale projects that did not require any grid reinforcement before the implementation of the new arrangements (and which would constitute a significant share of DG, even with a limited existing network such as Greece's) may end up having to pay a new UoS charge, unless specific derogations are put in place for DG. Whether this will happen isn't clear at the current time.

5.8 IRELAND

Structurally, the Electricity Supply Board (ESB) dominates the electricity supply industry in Ireland. ESB is the national vertically integrated utility, 95% of which is owned by the Irish Government, with the remaining shares being held by an employee share option trust. ESB incorporates a number of divisions, each of which is ring-fenced and operated independently in the electricity market.

ESB Networks is the monopoly owner of the high voltage transmission system in Ireland and is the monopoly owner and operator of the medium and lower voltage distribution system. It provides services to all 1.7 million electricity customers and the generators and suppliers of electricity in the Republic of Ireland. ESB Networks is the authority to which new generation plant must apply to in order to obtain a connection to the grid network.

5.8.1 Connection Charging Approach

For new generators connecting to the ESB distribution network a system of **deep** connection charging applies[52]. ESB also indicate in reference [9] that they apply three principles relating to connection charging. These are equality of treatment (consistency towards new generators), economic efficiency (connection charges should transparently favour customer decisions that make best use of resources), and simplicity (in order to encourage clarity, faster quotations and reduced administrative burden).

5.8.2 Method of Implementation

The method of implementation of connection charging in Ireland is through a mixture of legislation and specific ESB policies.

The legal requirements placed on ESB (e.g. transparency, equality of treatment for all new generators) are set out in the legislation that established the new electricity market structures in Ireland. These are incorporated into the licences issued to ESB by the Commission for Energy Regulation (the CER).

The specific ESB policies relating to the development of a new connection proposal, and the general philosophy regarding connection charging are detailed in references [9] and [10].

5.8.3 Level of Transparency

As the policies and approach towards connection charging in Ireland are well defined and published via ESB's website, the level of transparency of the technical and commercial requirements for new generators in Ireland is considered to be *high*. The main exception to this is the lack of detail in relation to the calculation of network reinforcement costs that may result from the connection of a generator, although these are of course highly dependent on the local network configuration. To counteract this, the ESB policy is clear in that the reinforcement costs will be based on the least cost technically acceptable solution (see section 5.8.4 below), and that these are the subject of a formal offer once a connection application has been made.

5.8.4 Typical Connection Costs and Charges

For reasons of economic efficiency the DSO[53] chooses the design for connection to the network that will provide the required capacity and technical performance (as defined in the Distribution System Security & Planning Standards) at the lowest cost. This is

[52] Clauses 5.2.2 and 6.3 of reference [9] indicate that the generator pays "100% of the cost of connection (including reinforcements)"

[53] Distribution System Operator

known as the least cost technically acceptable solution (LCTAS), calculated assuming an expected lifetime of 25 years for the connection asset.

For *demand* customers, connection charges comprise a *standard charge* that includes a contribution to the cost of the equipment used to connect a single user to the grid system[54], plus a *capacity charge* that is effectively a contribution to system reinforcement[55].

However, for new *generators* connecting to the ESB network at MV[56], 38 kV or 110 kV, as they are not liable for Distribution Use of System Charges on exported energy they are required to pay 100% of the cost of connection, including reinforcements. The assets attributable to new connecting generators when ESB determine the cost of connection are summarised in Table 4 below.

	Refundable?	Connection Voltage and Range				
		LV	MV			110 kV
			0-5 MVA	5-10 MVA	>10 MVA	
Metering customer station, LV costs		✓	✓	✓	✓	✓
MV/LV transformer capacity	✓	✓				
MV network reinforcement	✓	✓	✓			
New MV network	✓	✓	✓	✓	✓	
HV/MV station capacity	✓		✓	✓	✓	
New HV network	✓		✓	✓	✓	✓
110 kV switching/customer station	✓					✓
110 kV network reinforcement						
220 kV network reinforcement						

Table 4 – Assets attributable to generators when determining grid connection costs (ESB, Ireland)

In addition to the information in Table 4, ESB have published indicative generator connection charges[57] in reference [9] that will be levied against new generators for different sizes of generator and different grid connection voltages. These indicative costs are shown in Table 5.

[54] The contribution paid is 50% of the equipment cost including metering, cables/lines and DSO equipment, but excluding the distribution transformer

[55] This in general is 25% of the average reinforcement cost of the existing system per kVA

[56] Medium Voltage

[57] Excluding reinforcement costs

<table>
<tr><th colspan="5">Indicative Connection Voltage and Method Options MEC[58] Capacity Ranges</th></tr>
<tr><th>MEC[58] (kVA)</th><th>Connection voltage kV</th><th colspan="3">Connection Method Options</th></tr>
<tr><td>> 30,000</td><td>110</td><td colspan="3">Consult with ESB National Grid for details</td></tr>
<tr><td rowspan="2">12,000 – 30,000</td><td>110</td><td colspan="3">Consult with ESB National Grid for details</td></tr>
<tr><td>38</td><td colspan="3">38 kV Dedicated feed from 110 kV/38 kV substation</td></tr>
<tr><td rowspan="2">6,000 – 12,000</td><td>38</td><td colspan="3">38 kV Dedicated feed from 110 kV/38 kV or 38 kV/MV substation</td></tr>
<tr><td>38</td><td colspan="3">38 kV Tee (not permitted in every situation)</td></tr>
<tr><td rowspan="3">700 – 6,000</td><td>38</td><td colspan="3">38 kV Dedicated feed from 110 kV/38 kV or 38 kV/MV substation</td></tr>
<tr><td>38</td><td colspan="3">38 kV Tee (not permitted in every situation)</td></tr>
<tr><td>MV</td><td colspan="3">MV Dedicated feed from 38 kV/MV substation</td></tr>
<tr><td rowspan="2">< 700</td><td>MV</td><td colspan="3">MV Dedicated feed from 38 kV/MV substation</td></tr>
<tr><td>MV</td><td colspan="3">MV Tee</td></tr>
<tr><th colspan="6">Typical Costs of Connection Methods (Indicative Only)</th></tr>
<tr><th colspan="2">Connection Method</th><th>On-site substation (€ '000)</th><th>Cable (€ '000/km)</th><th>Overhead Line (€ '000/km)</th><th>ESB substation (€ '000)</th></tr>
<tr><td colspan="2">38 kV Dedicated</td><td>54 – 57</td><td>63</td><td>34 – 82</td><td>68 – 162</td></tr>
<tr><td colspan="2">38 kV Tee</td><td>54 – 57</td><td>63</td><td>34 – 82</td><td>N/A</td></tr>
<tr><td colspan="2">MV Dedicated</td><td>14</td><td>39</td><td>12 – 28</td><td>40 – 54</td></tr>
<tr><td colspan="2">MV Tee</td><td>14</td><td>39</td><td>12 - 28</td><td>N/A</td></tr>
</table>

Table 5 – Indicative generator connection charges in Ireland (excluding network reinforcement costs)

There are other costs that are likely to be levied against a new generator when consideration is given to a new connection in Ireland. For example, it is likely that ESB will have to undertake planning studies to assess the implications of a connection at a particular point on the Distribution System. This study is subject to a standard ESB charge (€720) in advance of the planning study being performed. This value is then offset against the cost of connecting the proposed installation to the Distribution System in the event of the project proceeding. This ESB study itself takes up to 3 months to be completed. As a guide, the timescale for generator connection in Ireland (for planning purposes) is can typically be around 12 months from initial enquiry.

5.8.5 Impact of Current Approach on DG and RES

Whilst there is a relatively high level of transparency in the connection process in Ireland, the deep connection charging methodology that has been implemented has a generally negative impact on DG and RES. This is due to the fact that generators are exposed to potentially significant, and often uncertain, network reinforcement costs. These are risks that many potential DG and RES developers would be unprepared to take. It is not surprising, therefore, that the share of DG in Ireland is currently relatively low[59] in comparison with other European countries.

[58] Maximum Export Capacity

[59] Around 4% according to reference [12]

5.9 <u>ITALY</u>

5.9.1 Connection Charging Approach

Italy has adopted a "deep" connection charging philosophy.

In relation to grid connections, Resolution 50/02 of the Italian Regulator (AEEG) differentiates between connection from the side of network operator (DNO) and connections from the side of network customer/producer, in the sense that the first is of general interest for the electrical system as a whole, while the second is considered to relate only to the connection of the customer plant. The customer must pay for the management and maintenance of this dedicated connection.

It is difficult to find clear criteria for the division of network manager side connection costs between the new producer and the network operator, however the general practice seems to be that the producer is responsible for all the costs directly resulting from the installation of the new plant. Additional network reinforcement resulting from the connection of the generator is paid by the network operator only in cases where the connection is shared by various customers/producers, or where for system reasons the DNO chooses a solution that differs from the least cost technically acceptable solution.

The new producer must also pay the network operator for his management activities, technical analysis, and for the delivery of the connection services. Moreover the new producer is also required to pay a bank guarantee that can be cashed in by the network operator should the plant be disconnected from the system (i.e. a type of "exit fee").

In the near future the Regulator will determine the value of the costs for the DNO management activities, technical analysis and for the bank guarantee. The cost of connection services, however, is related to many conditions specific to the application and can therefore only be determined after the identification of a specific solution.

5.9.2 Method of Implementation

In Italy, connection charging is presently not defined in legislation, but the Italian Electricity Authority (AEEG) is planning to issue a binding resolution on this matter. Proposals for this resolution were published as a consultation document[60] in March 2005.

5.9.3 Level of Transparency

The level of transparency of the connection charging system within Italy is currently low. However, the forthcoming AEEG resolution (see 5.9.3 above) is intended to increase transparency and improve non-discriminatory market access. It is expected that this will require DNOs to publish costs and indicative technical solutions for any connection requirement.

Additionally it is intended that generator connection costs will be clearly reported in the website of AEEG. The generator will be able to decide whether to cover all connection costs themselves in accordance with these published costs without being obliged to accept the network manager budget estimate.

5.9.4 Typical Connection Costs and Charges

A specific (published) method for calculating connection services costs does not currently exist. Furthermore it is not included in the AEEG consultation document as this only covers the amount paid by the generator to the DNO for the DNO's management activities and technical analysis. The proposed standardised costs of these activities (in the consultation document) are as detailed in Table 6 below. So for a distribution connection, a fee of €2000 plus €0.1/kW applies to cover the DNO's management activities and technical analysis.

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[60] *"Condizioni Economiche per il Servizio di Connessione alle Reti con Obbligo di Connessione di Terzi Degli Impianti di Produzione di Energia Elettrica a Tensione Nominale Superiore ad 1 kV"*, 17th of March 2005.

Network Type	Connection Capacity	Fixed Component [EUR]	Variable Component [EUR/kW]
Transmission	Up to 10 MVA	20,000	0.70
	Exceeding 10 MVA	20,000	0.20
Distribution	All	2,000	0.10

Table 6 – Standardised costs of DNO management and technical analysis activities (in relation to generator connection)

Generally, the cost of all interconnection equipment has to be paid by the entity requesting the connection, i.e. the owner of the DG plant. The deep charging approach implemented in Italy also implies that any costs of network reinforcement ("deep costs") are also paid by the generator[61].

There is no typical connection charge for DG in Italy as the deep charging approach means that the costs for a particular installation have to be assessed individually. They actually do not depend only on the specific connection conditions, but also on the rise in prices applied by the DNO. The aim of transparency and non-discrimination philosophy proposed by the AEEG consultation document should enable the connection costs for every specific solution to be established.

5.9.5 Impact of Current Approach on DG and RES

The existing connection charging principles and lack of transparency can be considered a barrier towards the development of DG and RES in Italy.

5.10 LUXEMBOURG

5.10.1 Connection Charging Approach

In general Luxembourg applies a deep connection charging methodology, with connection costs being determined on a case-by-case basis.

5.10.2 Method of Implementation

The Law of 24 July 2000[62] extended the remit of Luxembourg's regulatory authority (the ILR[63]) to the electricity market. One of its three core missions with regards to Luxembourg's electricity market is to control the conditions for network access (Chapter VII).

Article 15 creates a regulated access system to the network. Electricity suppliers, electricity generators as well as eligible clients (defined in Article 17) have the right to access the network, on the basis of published tariffs, for the use of the transmission and distribution networks.

Article 18 states that independent power producers and auto-producers have the right to ask for access to the network. The negotiating parties must negotiate in good faith and none of the parties are allowed to hinder the negotiations by misusing its dominant position.

In addition, for auto-producers, Section 13 of the document detailing the connection requirements for installations with a nominal voltage equal or inferior to 1,000 V in the Grand-Duchy of Luxembourg[64] states that:

[61] Complaints have also been reported in Italy relating to DNOs attempting to impose themselves as the contractor of generator interconnection works, under their own terms and conditions.

[62] http://www.ilr.etat.lu/elec/legal/pdf/loi-e.pdf

[63] Institut luxembourgeois de Régulation, http://www.ilr.etat.lu/content.html

[64] "Prescriptions de raccordement pour les installations à courant fort disposant d'une tension nominale inférieure ou égale à 1000 V au Grand-Duché de Luxembourg"

"The developer, installer, owner of the connection and the operator negotiate with the VNB (utility) the technical elements of the connection and the installation on a case by case basis for the following installations:

- Auto-producing installations operating in parallel to the VNB's low voltage network ("*réseau à basse tension*").
- Back-up emergency stand-alone generators for electricity supply during public network breakdowns."

The technical requirements applicable to DG and RES generators for connection to the grid in Luxembourg can be found in the German "*Richtlinie für den Parallelbetrieb von Eigeberzeugungsanlagen mit dem Niederdpannungsnetz des Elektrizitätsversorgungs-untemehmens (EVU)"* published by the German VDEW.

The Grand-Ducal Regulation of 30 May 1994[65] requires Cegedel[66], the owner and operator of the Luxembourg electricity network, to purchase green electricity. Article 1 provides for the quantities of electricity produced from renewable sources or combined heat and power to be taken over by the Grand Duchy, at the request of the producer, on behalf of the public network. Under the Grand-Ducal Regulation of 30 May 1994, the selling prices for electricity produced in an environmentally friendly manner are also allowed to be higher than those for electricity produced by conventional means.

Under the Law of 24 July 2000 on liberalisation of the electricity market, the legal obligations incumbent on Cegedel, including those on environmental protection provided for in the Grand-Ducal Regulation of 30 May 1994, apply to all electricity distributors. However, only Cegedel actually distributes green electricity via its network, in spite of the presence of other distributors. This reflects the decision of green electricity producers to deal with Cegedel rather than with other distributors.

Article 4 of the 30 May 1994 Regulation and its the Annexes create standard contracts ("*contrats-types*") detailing the modalities of the connection to the electricity network and the supply of electricity.

There are two generic types of standard contracts, depending on the installed electrical capacity of the installation:

- Category I standard contracts for the connection of installations with an installed capacity of up to 500 kWe for electricity from RES and up to 150 kWe for cogeneration units[67].
- Category II standard contracts for connection of installations with an installed capacity of 500 to 1500 kWe for electricity from RES and for cogeneration installations with an installed capacity of between 150 and 1500 kWe.

Article 3 of the standard contracts deals with connection issues. The DSO is responsible for determining the technical requirements. All costs are to be borne by the generator (Article 3, paragraph 2), including those linked to metering (Article 6, paragraph 3).

5.10.3 Level of Transparency

There appears to be very little transparency regarding the methodology and costs associated with providing a generator connection to the grid network for DG and RES in Luxembourg.

5.10.4 Typical Connection Costs and Charges

There are no publicly available tariffs for the connection of electricity generation installations (whether from RES or cogeneration). Connection costs are determined on a case-by-case basis through a process of negotiation between the generation plant owner and the distribution network operator (DNO). Where a generator is not

[65] http://www.ilr.etat.lu/elec/legal/pdf/rgd-1994.pdf

[66] http://www.cegedel.lu/

[67] To benefit from the terms of the standard contracts, cogeneration plants must be in operation for a minimum of 2500 hours per year and reach a minimum total efficiency of 80%

satisfied with the outcome of the negotiation process, the ILR can be requested to arbitrate between the generator and DNO. It has not been possible in this study to provide an indicative range of connection costs, or use case study examples, as Cegedel has been unwilling to publish this data.

For consumption-only customers, Cedegel publishes standard connection fees[68]. The standard fee for the connection of a business (consumption-only) customer to the electricity distribution network is currently €630.

5.10.5 Impact of Current Approach on DG and RES

There is a distinct lack of transparency in Luxembourg in terms of DG and RES connection charges. Furthermore there is also a lack of transparency in relation to the connection procedures associated with DG and RES. It is therefore considered that this has a negative overall impact on the installation of DG and RES within Luxembourg.

5.11 PORTUGAL

The demand for electricity in Portugal has grown at a rate of 59% over the last decade (1992-2002), which corresponds to a growth rate above 5% per year. As a result the electricity production sector has been undergoing a fast expansion: 3,9 GW in 1980 and 11 GW in 2004. The opening of the electricity production market occurred during the 1980s (independent power production) and by the end of the 1990s, natural gas was introduced into Portugal giving the opportunity for gas-fuelled generation.

The Portuguese electricity generation system is organised into the Public Service Electrical System ("binding system") and the Independent Electrical System ("non-binding" and Special Regime Production). In the public system, a group of power stations sells electricity to a single buyer, REN (transmission system operator). REN sells the energy to the supply business of EDP[69], which then sells the electricity to customers under the regulated tariff system. In the independent system, customers are eligible to choose from whom they buy their electricity, and for these customers, only the costs of the networks are regulated.

In the case of distributed energy power plants, the connection is mostly made to the low or medium voltage grid, owned under a near-monopoly by EDP - Distribuição. There are a few independent operators, but their network is so small and isolated that they are not considered in this study.

5.11.1 Connection Charging Approach

Portugal currently follows a deep connection charging approach.

For decentralized generation, the promoter of the new power plant pays for the costs of the equipment needed to connect the power plant to the pre-existing electricity grid network. This assumes that the connection assets are intended for the sole use of the power plant ("uso exclusivo"), even though the network operator owns these assets. In cases where the new connection assets are shared by several power plants ("uso partilhado"), the costs of the common sections of these assets are shared in proportion with the capacity of each power plant. More detailed information about what these direct costs can include are provided later in section 5.11.4.

The costs of adjustment/adaptation and reinforcement of the grid, such as a transformer, or any installation needed to make the output of the power plant receivable by the network at the connection point, are negotiated between the promoter and the network operator.

5.11.2 Method of Implementation

Connection charging is partially regulated by the General Director for Geology and Energy (DGGE - Direcção Geral de Geologia e Energia). Since DL nº189/88, which defines the conditions of connection for decentralized power plants comprising

[68] http://www.cegedel.lu/imperia/md/content/cegedel/professionnels/pdf/tarif_prof_juin2005.pdf

[69] Electricidade de Portugal

renewable energy sources and CHP power plants, the charging principles for connection are the same. However, the precise conditions are the result of a case-by-case negotiation between the generator and the network operator.

The administrative procedure for a power plant to be connected to the grid is rather long: a request is to be made to the DGGE, and another one to EDP, which includes the cost-sharing negotiations.

The administrative procedures applicable to RES and CHP power plants are defined in Decree-Law DL nº312/2001 as follows:

- Previous Information Request (Pedido de Informação Prévia or PIP):

The first step is the PIP that promoters have to forward to the DGGE in order to know the grid technical conditions at the desired point of connection. The Request must include the technical specifications of the power plant and can only be sent by promoters in the first two weeks of each quarter of the year. The PIP is then forwarded to the network operators, who must reply within 30 days so that DGGE can send it to the promoters 40 days after their initial request. The Previous Information indicates:

- Exact location of the connection point,
- Nominal voltage,
- Neutral regime,
- Indicative date for the availability of the reception capacity or eventually indication of the grid capacity limitation at this point.

Whenever the Previous Information indicates technical unfeasibility due to unavailable network reception capacity, this has to be technically justified in detail. Requests falling into this category are taken into consideration in later grid expansion programmes, unless the promoter is prepared to pay for the adaptation and reinforcement charges and costs himself.

- Interconnection Point Request (IPR)

When the Previous Information confirms technical feasibility for the interconnection of the considered power plant, promoters may formalise the request for the interconnection with the DGGE within 70 days. At this point of the procedure a deposit must be paid to the DGGE.

- Interconnection Point Attribution (IPA)

DGGE has to decide whether or not to assign the connection point to the promoter within 30 days after receiving the IPR. If needed it amends the predicted date for the network capacity availability. The request can only be refused in one of the following cases:

- Project incompatibility with the national energy policy,
- Project incompatibility with other projects that have legal prevalence,
- Non-fulfilment of established legal standards

Whenever the network reception capacity is not sufficient to attend all the interconnection point requests, DGGE may select part of these according to environmental, efficiency and social criteria.

Simplified licensing procedures have been developed for micro-generation systems to be connected to low voltage distribution networks, with a maximum of 150 kW of connected capacity. In this case, all administrative procedures are managed by regional economic authorities rather than with DGGE. For the technical issues, particularly the technical information needed about the interconnection point, the promoter deals directly with the distribution network operators.

In some particular situations, such as projects that are included in specific governmental programmes, the attribution of a connection point may also be made by a public call for tender, which is managed directly by the Ministry of Economic Affairs.

After these administrative and legal procedures, technical details regarding the compatibility of the connection point with the output of the new power plant have to be discussed with EDP. At this point a negotiation starts between the project developer and EDP that is considered by EDP on a case-by-case basis. This can imply high additional connection costs.

5.11.3 Level of Transparency

The part of the procedure for which the DGGE is responsible is relatively transparent, even though it sometimes takes a long time. As the examples given in section 5.11.4 below indicate, these delays are not always caused by the DGGE. The part of the connection procedure that relies on the network operator appears to be much more subjective and is less transparent, and does not always depend on rational factors. The result may depend on the particular EDP technician that the power plant promoter negotiates with[70].

5.11.4 Typical Connection Costs and Charges

The EDP website mentions that the connection may require the payment of one or more of the following charges:

- Costs of exclusive use connection elements
- Cost of shared use connection elements
- Costs of reinforcement of the grid (if necessary)
- Charges related to an expansion of the grid (if necessary)

Reinforcement of the grid is necessary if the Requested Capacity is larger than the Reference Capacity[71]. If this is the case it may be advantageous for a promoter to make use of an existing programme of grid expansion and therefore locate its power plant where sufficiency capacity is likely to exist, thus minimising reinforcement charges.

The main problem, therefore, for DG and RES power plants in Portugal is that it is very difficult to accurately predict connection costs, particularly if the capacity of the grid is not sufficient in the area where the power plant wants to be connected. In these cases reinforcement costs may be very high if EDP decides not to make any financial contribution, and these costs may turn a viable project to an unviable one. The lack of transparency of EDP criteria for charging the power plant with the reinforcement and adjustment costs may not allow promoters to take all connection costs into account in their viability studies.

Hence, whilst licensing costs and taxes are defined clearly as a function of the capacity of the power plant, making these particular costs very transparent and non-discriminatory, there is no equivalent transparency for connection costs. Furthermore there is currently no Regulatory support to independent producers in relation to connection charging.

As information about standard costs is difficult to obtain for the equipment necessary to connect new power plants into the grid, two practical cases have been chosen to illustrate connection costs to the low or medium voltage network in Portugal.

Example 1 – Very Small Independent producer with Solar Energy in Estoril[72]

The first case is a small photovoltaic installation of 5 kW for a particular house in the Lisbon area. The house owner aims at being energy independent. The application process began in May 2004 with the presentation of the PIP[73] to the DGGE (General Director for Geology and Energy). The evaluation of the PIP took place between May 2004 and January 2005, with the Interconnection Point Request[73] being made in April 2005. Interconnection Point Attribution[73] is currently being assessed, and this is still being awaited before installation works can start.

At this stage of the project the costs of grid expansion are summarised in Table 7.

[70] From interviewed promoters experience

[71] Defined by the law as a percentage of the minimum short-circuit capacity: around 100 kW for low voltage and 5000 kW for medium voltage

[72] The project was designed by Suntechnics, COEPTUM – Projectos de Engenharia e Equipamentos, unip. Lda., which provided the presented information.

[73] See section 5.11.2

Specific costs for interconnection	Amount per unit	Effective cost
Administrative costs		
Caution (to be returned) for the Previous Information to the DGGE	5000 € per MW	0,005 x 5000 = 25 €
Tax for the evaluation of the PIP paid to the DGGE	500 € per MW	0,005 x 500 = 2,5 €
Tax for the evaluation of the connection project paid to the DGGE	400 € per MW	0,005 x 400 = 2 €
Caution (to be returned) for the license of exploitation request to EDP	2500 per MW	0,005 x 2500 = 12,5 €
Total estimated costs of taxes and licenses		**220 €**
Equipment		
Electric counter		1.575 €
Cables H07RN-F1x4mm	0,43 € per metre	43,00 €
Digging and closing of a standard ditch	7,70 € per metre	231,00 €
Supply and installation of PETØ63 tube	2,70 € per metre	81,00 €
Supply and installation of an equipped door for the counter		170,00 €
Supply and installation of XV (0,6/1kV) 2x16 cable, including terminals	11 € per metre	330,00 €
Total installation costs		**2.430 €**
Total connection specific costs		**2.650 €**

Table 7 – Interconnection costs of the Estoril Solar House project

These costs are very high for such a small installation (equivalent to ~ €500/kW). Although Portugal presents one of the best potentials for Solar Energy in Europe, interconnection costs of this magnitude are clearly a major barrier to the development of DG and RES within Portugal.

Example 2 – Small CHP Power Plant in Frielas

This DG system comprises a gas microturbine CHP package, which provides 80kW of electricity and 170kW of heat in the form of hot water. The system is installed in a gas pressure reduction station, where gas from a high pressure transmission pipeline is supplied to a lower pressure gas distribution network. The heat produced by the CHP package is used in the gas pressure reduction process, while the produced electricity is used onsite or exported to the grid when the station demand is lower than the electricity production.

This system was licensed under the simplified administrative licensing procedure developed specifically for micro-generation schemes, which is applicable only for DG systems up to 150 kWe and connected to the distribution network at low voltage level.

In this specific case the pre-existing low voltage network was not capable of receiving all the power from the microturbine. So there was the need to install a new low voltage connection to the site, which included the investment in a new transformer connected to the medium voltage network, and all the cabling and protection equipment from that point to the station, as well as all construction works. The cost for this operation was entirely supported by the project promoter. The new low voltage connection became property of the DNO, who also became responsible for its operation and maintenance. From the legal point of view, the connection point between the DG system and the network is considered to be at the electricity meter.

The new low voltage connection was built by the DNO in agreement with the project promoter. However, these works could also have been performed by a third party installer chosen by the project promoter, according to the technical requirements provided by the DNO.

Administrative Costs	
Private Service Establishment Tax ("Taxa de Estabelecimento de Serviço Particular", DL nº4/93, Portaria 362/93)	323,00 €
Installation Costs	
New LV connection (MV/LV 160kVA transformer, cabling and installation)	14.560,00 €
Electricity meter (bi-directional)	667,35 €
Interconnection Protections and Dual Mode Switching	4550,00 €
Total connection costs	**21.100,35 €**

Table 8 – Connection costs supported by the CHP promoter (example 2)

The licensing and connection processes were carried out over a period of around 6 months. The costs associated with the construction of the new low voltage connection were a consequence of insufficient capacity of the former connection. In a project where there is no need for grid reinforcement, the connection cost could be significantly lower. However, when there is the need for grid reinforcement its costs are entirely supported by the project promoter, in line with the deep charging approach.

In the present case, the connection costs represented around 15% of the total project cost. It should be noted that the remaining project costs (other than connection costs) were also higher than what could be considered for a typical installation of such a microturbine system. This was due to the specificities and special requirements of the gas pressure reduction station.

5.11.5 Impact of Current Approach on DG and RES

EDP Distribution has a monopoly power that currently enables it to have a significant part of its distribution network expansion (reinforcement) costs borne by DG promoters.

This deep charging system with a high lack of transparency in the negotiations with the distribution network operator may be able to turn some DG projects economically unviable, particularly when many reinforcement works are needed. This is considered to be a considerable barrier to the development of DG projects within Portugal.

5.12 <u>SPAIN</u>

The liberalisation of the Spanish energy markets was started in the 1990s and has progressed rapidly in comparison with most other EU countries. By 2003, the electricity market was fully open to competition, and most of the generation capacity had been privatised, although the government still holds a golden share in Endesa, Spain's largest utility. The transmission system and market operations have been separated out from the vertically-integrated utilities following the establishment of a Market Operator (OMEL) and a Transmission System Operator (REE - Red Eléctrica de España). REE is responsible for the technical management of the transmission system, for its security and expansion, as well as for granting fair and equal access to the transmission grid. It owns most of the national high-voltage networks (84% after acquiring transmission assets from Unión Fenosa and Endesa in 2002).

5.12.1 Connection Charging Approach

Spain follows in principle a deep charging approach. Producers make up-front payments for the capital costs of connection, including the costs of the required network reinforcements.

In the case of the Transmission network, new users (generators and demand) connecting to the same line extension within a period of 5 years may be responsible for a pro-rata payment of these costs, based on their relative use of the installed capacity. These payments will be used to reimburse the original contributor. In the case of the Distribution system, which applies to DG and RES in the overwhelming majority of cases, the producer requesting access pays all necessary network reinforcements. Of course, if there is sufficient available grid capacity, the producer only pays the costs for its connection to the existing network and no reinforcement costs apply.

5.12.2 Method of Implementation

The procedures regarding access and connection to the transmission and distribution grids are established in the Royal Decree 1955/2000[74], which regulates transport, distribution and generation activities, as well as the necessary administrative authorizations for electrical equipment. Additional dispositions for Renewable Energy Sources and CHP are laid out in the Royal Decree 2818/1998, and an entirely separate Decree (1663/2000) covers the specific case of PV connected to the low-tension grid.

However, although this legislation lays out the general guidelines for access to the grid, the whole process in Spain is a simple negotiation between the producer and the DNO.

Because DG implies a connection to the distribution rather than transmission grid, the producer must first send an access request to the distribution system operator (DNO) responsible for the area. This request must contain all the technical information necessary for the DNO to determine whether there is sufficient available capacity for this new connection, and an answer must be given within two weeks. If this connection might have an influence on the transmission network (which is rarely the case for DG, being generally only significant above 50 MW), the DNO forwards the access request to REE, who then must reach a decision within two months. The regulator, CNE, may settle any conflict on access rights.

Once a preliminary access point has been conceded, the producer may obtain the connection permit, which implies a more thorough examination by the DNO (and possibly the TSO) of the producer's Basic Project and Programme of Execution. Both the access and connection requests can be sent simultaneously, but the final connection permit will not be granted unless the access request has already received a favourable reply. Once the connection permit is obtained, the connection contract may be signed immediately.

The whole procedure is simplified in the case of PV installations connected to the low-voltage grid, and must be concluded within a month of the initial request, giving Spain one of the speediest connection processes in Europe.

The law underlines the right of producers to non-discriminatory access to the grid, and draws out the general framework for connection procedures, but the connection process itself is purely a negotiation between the producer and the DNO. The DNO then has to inform the administration, but the latter doesn't directly intervene in the process.

Although the costs and conditions of connection may then vary case-by-case and among the different DNOs, the timeframe set by law generally ensures a quick and efficient process.

5.12.3 Level of Transparency

Whilst the framework for grid connection of DG and RES in Spain is generally well defined, the agreement of connection charges is generally a negotiation between a new power producer and the local DNO. With the deep charging philosophy adopted in Spain, this can lead to a poor level of transparency of connection costs for new DG and RES schemes prior to detailed analysis and negotiation.

5.12.4 Typical Connection Costs and Charges

In line with the deep charging principle, connection costs can vary significantly according to the reinforcement requirements of the grid. It would therefore be necessary to examine a great range of specific case studies in order to achieve a faithful representation of DG connection costs.

[74] http://www.cne.es/pdf/NE007_04.pdf

On the other hand, the whole process being negotiated with the DNO means that there are no administrative connection charges as such to be collected by government authorities in addition to the contract with the distribution network. This can have a significant positive influence in the case of small PV projects, where several hundred euros can be saved with respect to, for instance, the neighbouring country of Portugal.

5.12.5 Impact of Current Approach on DG and RES

Spain in general offers a favourable context for renewable electricity production. It is also nearly alone in offering an explicit compensation for the benefits of DG, in the form of reactive power compensation.

The framework for grid connection in general offers a streamlined and rather efficient procedure, in theory at least. PV is clearly advantaged by specific legislation, and power plants of equivalent capacity but using a different technology would not benefit from the same privileged regulation. However, the reliance on a deep charging approach constitutes an obstacle to promising DG projects in areas where grid reinforcements are required. This is further complicated by the fact that the process of connection charging itself is generally a negotiation between producers and the DNO. The fact that the negotiation depends so much on the DNO might also induce discrepancies in the treatment of requests according to the region in which the investment is proposed, even if it is possible to appeal against a DNO's decision.

5.13 SWEDEN

Power generation in Sweden is dominated by a small number of major players, with the five largest companies supplying around 90% of electricity generated. In recent years, the three largest generators (Vattenfall, Sydkraft and Fortum) have also started to become key players at the supply end of the market by forging links, and in some cases taking over, electricity trading companies. It is believed that these three companies now account for over 70% of sales to end customers in Sweden. The transmission network in Sweden is owned and operated by Svenska Kraftnät.

In terms of fuel sources for power generation, Sweden is currently dominated by hydro and nuclear power, each of which contributes around 45% of electricity consumed. Most DG in Sweden is in the form of industrial CHP plants, these contributing around 3.5% of electricity supplied annually, whilst wind power contributes less than 0.5%. CHP as part of district heating schemes provides around 4%.

5.13.1 Connection Charging Approach

Generally, deep connection charges apply if there is a need for reinforcement for a single generator. In the (unlikely) case where a number of generators use the same connection then a more shallow form of connection charges will apply based on an assessment of the relative use of the connecting assets by each generator.

The current system relies on DNOs calculating the connection costs. In the light of a number of complaints made to the Swedish Energy Agency[75] relating to the charges that were being levied, a working group was set up in 2004 to review industry practices for setting connection fees and to agree a standard basis for calculating connection fees. Towards the end of 2004 recommendations were drafted for the formulation of indicative connection charges for consumers (NÄT2004 K) and commercial enterprises (NÄT2004 N)[76].

5.13.2 Method of Implementation

The Swedish Electricity Act of 1997[77] provides the basis from which network connection and transportation charges are derived. The general provisions of this Act (Chapter 4 Item 1) indicate that network tariffs shall be reasonable and based on

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[75] http://www.svenskenergi.se/engelsk_sida.htm

[76] http://www.bjorklingeenergi.se/pdf/NAT2004N.pdf

[77] http://www.stem.se/web/biblshop_eng.nsf/FilAtkomst/eng_ellag.PDF/$FILE/eng_ellag.PDF?OpenElement

objective criteria. There are special provisions in the Act relating small generation plants (Chapter 4 Item 10). These indicate that the owner of a generating plant not exceeding 1,500 kW shall, for the transmission of electrical energy, only pay the part of the network tariff corresponding to the annual costs for metering, computation and the reporting of results for the network. The generation owner is also required to pay a (non-recurring) connection fee.

5.13.3 Level of Transparency

The degree of connection charging transparency in Sweden is considered to be low, primarily as a consequence of the evaluation of connection charges being the responsibility of the DNO.

This situation may change once the working group set up by the Swedish Energy Agency to review connection charges has concluded its work. It is unclear at present how long this process will take.

5.13.4 Typical Connection Costs and Charges

The present deep connection charge approach in Sweden means that each case is considered individually and as a result the connection charges can be highly variable. Furthermore there appears to be very little published material giving reliable breakdowns of installation costs for DG and RES in Sweden.

As an example only the connection costs for a typical onshore wind farm installation in Sweden are around 8-10% of the total installation costs[78].

5.13.5 Impact of Current Approach on DG and RES

The lack of transparency in connection charging and the significant influence of the DNOs in Sweden make the environment for DG and RES generally fairly negative. This situation may change once the working group set up by the Swedish Energy Agency to review connection charges has concluded its work.

5.14 THE NETHERLANDS

5.14.1 Connection Charging Approach

Connection tariffs in the Netherlands depend on the capacity of the connection and are split into two different categories.

Connections up to 10 MVA are shallow, regulated and averaged, while connections with a capacity over 10 MVA are negotiated on a case by case basis and follow a deep charging philosophy.

5.14.2 Method of Implementation

Connection charges are defined in the Network Code set up by the Dutch energy regulator[79], and cover a range of different connection types.

5.14.3 Level of Transparency

The implementation of connection charging is very transparent for connection capacities up to 10 MVA, as there is no place for negotiation between the DNO and the DG project promoter during the connection process. This approach guarantees non-discriminatory access to the network for the generation plant.

For connections of a capacity higher than 10 MVA the process is less transparent, as there is the need for a case-by-case analysis, while the connection tariff is negotiated between the DNO and the generator plant owner.

5.14.4 Typical Connection Costs and Charges

The Electricity Tariff Code lays down the basis of the general tariffs. This provides the basis on which the DNOs calculate their particular tariffs.

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[78] Offshore Wind Energy Europe website, http://www.offshorewindenergy.org/

[79] DTe – Dienst uitvoering en toezicht Energie

Connection charges of connections up to 10 MVA include only the payment of capital and maintenance costs of the connection needed to integrate the DG system into the existing network. Other possible costs resulting from adjustments, reinforcements or upgrades on the network beyond the point of interconnection are not included in the connection charges, instead being diluted in the global use-of-system costs or absorbed by the DNO.

Connection charges for connections with capacity over 10 MVA are negotiated case by case and follow a deep charging philosophy. This means that the charges to the generator also include those costs incurred to upgrade or reinforce the pre-existing network, caused by the connection of the new generator.

The Dutch regulator has decided that, from 2006 onwards, operators of DG installations, which feed electricity into distribution networks, will receive compensation due to savings on transmission costs on the transmission network. This compensation will be governed by the Grid Loss Savings Scheme[80], which will be included in the Electricity Tariff Code. The difference in costs between centralised and decentralised generation of electricity was previously included in the transmission tariffs through the National Uniform Producer Transmission Tariff[81]. Producers with centralised installations paid a transmission tariff while decentralised electricity generators were exempted from this. When the National Uniform Producer Transmission Tariff was set at zero on 1st July 2004, this distinction no longer applied. This difference in cost causation is, once again, expressed through the Grid Loss Savings Scheme.

5.14.5 Impact of Current Approach on DG and RES

The high level of penetration of DG in the Netherlands suggests that the impact of the existing regulatory framework and connection charging philosophy has been positive on DG. The shallow, regulated and averaged type of connection charging that exists in the Netherlands for connection capacities up to 10 MVA has proven to be one of the best examples in the EU with respect to barrier removal for DG.

However, connection charging has represented a barrier to the development of larger DG projects, as for connection capacities over 10 MVA a deep charging philosophy has been in practice. It has been observed that many operators of generation plants exceeding 10 MVA have many times split the total capacity of the system into several smaller capacity systems in order to avoid the deep connection charges. Because of this, the Dutch regulator is presently studying the possibility of reducing the capacity limit of shallow connection costs from 10 MVA down to 1 MVA.

The Dutch government intends to change the current regulatory framework in order to allow DG projects' promoters to develop and build the connections to the existing network by their own means. This is expected to increase competition and decrease costs.

5.15 UNITED KINGDOM[82]

The UK electricity industry has undergone a significant market liberalisation process over the last 15 years. All generation plant is privately owned, and the trading of wholesale electricity is generally implemented through bilateral contracts between purchasers and suppliers.

Since April 2005, the operation of the main electricity transmission network within England, Scotland and Wales has been the responsibility of National Grid Transco, a regulated monopoly business.

Distribution also remains a monopoly business. In England & Wales there are nine distribution companies operating twelve licences distribution areas. In Scotland, distribution is the responsibility of two vertically integrated energy companies that are

[80] RUN - Regeling Uitgespaarde Netverliezen

[81] LUP - Landelijk Uniform Producenten transporttarief

[82] The situation in Northern Ireland is not included in this study

also responsible for generation. Under the Utilities Act 2000 all distribution companies have an obligation to be non-discriminatory in all aspects of their business.

5.15.1 Connection Charging Approach

The general approach in the UK has been to use deep connection charging for new DG schemes and renewable energy sources. However, there has been considerable debate since 2002 (e.g. [18], [19]) at the regulatory level regarding the need to move towards a "shallower" charging regime for DG and RES, supported by OFGEM[83] (the gas and electricity market regulator in Great Britain) [19]. As a result of this, connection charges to the distribution network are generally now considered to be "shallowish" in that the connecting generator pays for the assets required to connect it to the distribution network plus a proportion of network reinforcement costs. The amount of reinforcement cost paid by the generator is normally defined in published "Apportionment Rules".

5.15.2 Method of Implementation

The businesses of distribution network operators are licensed by OFGEM, and the DNOs are required to publish the terms and conditions that apply to network connections for both generation and demand customers. These published terms and conditions are subject to OFGEM approval, and are normally available via the DNO websites. In some cases a breakdown of indicative connection costs are provided within the published statement, but these are not binding[84].

In addition to the specific Licence obligations, there are regulatory obligations defining the time period within which the DNO must respond to a connection request[85].

A key concern in the UK has been the lack of any incentives on distribution network operators to facilitate the connection of DG and RES into their networks. Indeed, previous pricing regimes have tended to discourage the network operators from connecting DG and RES. One mechanism introduced by OFGEM with the intention of redressing this has been the concept of Registered Power Zones (RPZ). These are clearly defined areas on the distribution network in which the network operator intends to address the technical challenges and opportunities of integrating DG into its network, and in which certain incentives will be applicable. The first RPZ was announced by OFGEM in June 2005[86].

5.15.3 Level of Transparency

Given the regulatory requirement for published connection terms, it is considered that the level of connection charging transparency in the UK is relatively *high,* although the terms may not necessarily be particularly favourable to DG and RES. It should be remembered of course that network operators do not formally offer the actual connection terms until an application has been received.

5.15.4 Typical Connection Costs and Charges

To provide examples of typical connection charges levied in the UK, reference is made to the connection charge methodology statement[87] issued by Central Networks[88]. This provides details on the process that generators have to follow in order to obtain a connection in the Central Networks service area, the principles adopted in calculating the connection charge, and indicative costs of connection for a number of examples (loads and generators).

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[83] http://www.ofgem.gov.uk/ofgem/index.jsp

[84] Formal connection terms and costs are provided to the generator by the DNO upon written request, no longer than 90 days after application submission

[85] The Electricity (Standards of Performance) Regulations 1993 and the Electricity (Standards of Performance) (Amendment) Regulations 1995 and 1998

[86] OFGEM press release R/28, 29 June 2005, "New power zones will connect more renewable generators to the electricity network"

[87] http://www.central-networks.co.uk/Pdfs/CN%20East%20UoS%20methodology%20statement.pdf

[88] Central Networks is the electricity distribution business covering central England

The connection charge is levied on the cost and installation of the assets that are installed to physically connect the generator to the existing distribution system. These are derived from the estimated costs of the minimum scheme, which would be designed to meet the requirements of the connection consistent with "sound engineering practices". These costs are paid in full by the generator.

In addition to this charge, the generator is also required to pay a contribution to any network reinforcement costs that result from the connection of the generator. These are limited to one voltage level above that to which the generator is connected. The amount of reinforcement costs paid by the generator is calculated on a sliding-scale basis (so called "Apportionment Rules"). The Apportionment Rules are intended to provide locational signals and recognition that others may get benefits from the installed assets. They are split between a contribution for network capacity (security) and a contribution relating to fault level.

The reinforcement cost apportionment factors (CAF) relating to network capacity and fault level are calculated as follows:

$$\textit{Network}\ \text{CAF} = \frac{\text{Required connection capacity x 100\%}}{\text{New network capacity}^{89}}$$

$$\textit{Fault level}\ \text{CAF}^{90} = \frac{\text{3 x fault level contribution from the connection x 100\%}}{\text{New equipment fault level capacity}^{91}}$$

In Central Networks' charges statement there is also a special condition relating to "high cost" generator projects, which are defined as being projects where the total reinforcement costs are in excess of £200/kW of generation capacity connected. In these circumstances the generator seeking connection has to bear all costs in excess of the £200/kW as part of the connection charge.

Examples

Reference [19] provides indicative connection costs for the example of a 3 MVA DG scheme, connected to the distribution network at 11 kV, that requires 500 m of underground 11 kV cable and 1500 m of 11 kV overhead line to connect to the local distribution network. Three cases are considered as follows:

Case 1 *- Generator connection with no reinforcement (i.e. just the physical connection of the generator to the nearest point on the network)*

Cost of HV cable	= £45,400
Cost overhead line	= £30,100
Cost of metered switchgear	= £26,600
Total cost to the generator	= **£102,100**

Case 2 *- Generator connection including fault level reinforcement. In this example switchboard reinforcement, assuming the existing 11 kV switchboard has a fault level capacity of 250 MVA and the new 11 kV switchboard has a fault level capacity of 315 MVA. The generator registered fault level capacity is 24 MVA.*

Cost of physical connection	= £102,100 (as above)
Cost of new switchboard	= £200,000
Fault level CAF[92]	= 3 x 24 / 315 = 22.9%
Charge on generator	= 22.9% x £200,000 = £45,800
Total cost to the generator	= **£147,900**

[89] The secure network capacity following the reinforcement of the relevant assets

[90] Maximum value is 100%

[91] The equipment rating following the replacement of assets

[92] The proportion of the reinforcement cost attributable to the generator

Case 3 *- Generator connection including capacity (network) reinforcement, assuming that the existing 11 kV circuit to which the generator is to be connected has a rating of 3 MVA while the export capacity of the generator is 4 MVA. The circuit is to be replaced with one rated at 8 MVA.*

Cost of physical connection	= £102,100 (as above)
Cost of new circuit	= £81,000
Network CAF[92]	= 4 / 8 = 50%
Charge on generator	= 50% x £81,000 = £40,500
Total cost to the generator	**= £142,600**

Assuming a typical DG generator installation costs the order £400/kW, these indicative connection costs are equivalent to around 8% - 12% of the generator installation cost. This is not insignificant, especially when account is taken of the Use of System charges that would also be levied on the generator during its operational life.

5.15.5 Impact of Current Approach on DG and RES

The connection charging process for DG and RES within the UK is in a period of transition, with the traditional "deep" charging mechanisms generally being replaced by a more "shallow" approach. This, in principle at least, is a positive step in relation to the ability of DG and RES to gain access to the network. Furthermore, there is a high level of transparency in terms of the process and likely charges that DG and RES schemes are likely to incur in order to get access to the network, given the publication of typical terms and conditions by network operators.

However, whilst it is recognised that there is a need for locational signals in order to maximise overall system optimisation and efficiency, the move towards shallower connection charging, as is being implemented in the UK, will still result in a significant network reinforcement cost burden being levied on DG and RES projects. This is seen from the examples shown in section 5.15.3 where up to 50% can be added to the cost of the installation assets to account for network reinforcement, and this figure can be much higher depending on the particular connection circumstances.

It is therefore considered that even with the introduction of shallower connection charging, the connection system in the UK is still likely to be problematic from the perspective of DG and RES given the potential for significant degrees of exposure to network reinforcement costs. This is further exacerbated by the additional burden of Distribution Use of System Charges.

6 SITUATION IN NEWLY-ACCEDED EU MEMBER STATES[93]

The main focus of this report is the EU-15 Member States. For completion, however, it is also useful to make general reference to the position within the ten newly acceded Member States.

The Commission's annual benchmarking report on energy market liberalisation [7] confirms that significant steps have already been taken within many of these Member States towards the implementation of the European internal market structural and legislative requirements, although there is still some way to go. What is clear is that liberalisation of energy supply will be a key factor in the success of these markets, and that all European legislation will apply, although there may be specific derogations agreed during transition phases.

In terms of DG and RES connection charging, there appears to be a significant involvement of state regulators on the setting (or at least monitoring) of connection tariffs, and in addition some examples of legislation relating to connection charging (and associated issues) have already been introduced.

In Slovenia[94], for example, the conditions and procedures for connection to the distribution network are defined by the "*Decree on general conditions for the supply*

[93] Estonia, Latvia, Lithuania, Poland, Czech Republic, Slovakia, Hungary, Slovenia, Cyprus & Malta (all became full members of the EU on 1 May 2004)

and consumption of electricity" and partly in the "*Regulation on system rules for operation of the electricity distribution network"*. Distribution network operators (DNOs) also have technical rules/requirements that must be considered by connecting generators, and it is these rules that can have negative consequences for DG and RES as these give the DNOs a significant amount of influence on the costs and timescales associated with the installation of connection infrastructure. The current Slovenian approach is not fully transparent, and the framework for determining connection costs for generators is not precisely defined[95] although it appears, in general, to be based on a deep charging approach.

In the Czech Republic, the Energy Act (458) of 28 November 2000[96] provides the base legislative framework for the Czech energy market. Within this document are specific rules and requirements for generators (section 23). These include the entitlement of generation plant to connect to the electricity grid network, provided that the generator is an electricity generation Licence Holder and that it complies with the conditions of connection to the distribution system. Furthermore, the Energy Act is clear (section 23 (2)) that "the generator shall provide at its own expense the connection to the transmission or distribution system" and shall "contribute to the covering of the justified costs incurred by the transmission system operator or the respective distribution system operator in respect of the connection of the electricity generating plant; details of the calculation of such a contribution to the covering of the justified costs shall be specified in the connection and transport conditions". The connection and transport conditions referred to here are defined by the Czech Regulatory Authority[97], but the costs of connection are determined on a case-by-case basis. For demand customers, their contribution to these costs is capped at 60% of the total costs[98]. It is unclear whether this cap applies to connecting generators.

In Poland, the legislative framework is defined in the Energy Law of 10 April 1997[99]. Article 7 (8) of this Law dictates that the fee for connection to the grid for demand customers is limited to one quarter of the investment incurred. However, for generation sources Article 7 (8-3) states that the connection cost is calculated on the basis of 100% of the costs of investment. The only exceptions to this are RES below 5 MW and cogeneration plant of less than 5 MWe and at least 70% average annual conversion efficiency, where the connection fee is restricted to 50% of the actual costs of investment.

Further details of the regulatory regimes within other newly-acceded Member States, and the approaches towards DG and RES connection, can be generally obtained from the website of the Energy Regulators Regional Association (ERRA)[100], a voluntary organization of independent energy regulatory bodies of the Central/Eastern European and Newly Independent States region.

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[94] Data taken from the Final Report *Financing and Support for RES Electricity and CHP* (in Slovenia) by KEMA Consulting, part of the project "Regulatory Framework in Completion of the Internal Energy markets in Slovenia", 2005.

[95] There have been cases where DNOs have insisted on additional investments not directly linked with a new generation plant, but necessary for the local network (i.e. deep charging)

[96] http://www.eru.cz/doc/vyhl_458_aj.doc

[97] http://www.eru.cz/frameset_aj.htm

[98] ERO Decree 297/2001 of 15 August 2001 (http://www.eru.cz/doc/vyhlaska_297aj.doc)

[99] http://www.ure.gov.pl/download.php?s=3&id=2

[100] http://www.erranet.org/

7 SUMMARY OF FINDINGS AND REVIEW OF BEST PRACTICE

The general philosophy of connection charging is critical for any developer wishing to connect a new generator to a grid network. Shallow charging is generally more favourable to DG and RES developers than deep charging both in terms of costs (any network reinforcements needed following the connection of a generator are not paid for by the generator itself), and installation timescales (procedures are generally much shorter).

The level of transparency in the connection charging system is also very important for new developers in terms of their ability to estimate scheme costs and timescales as accurately as possible before committing to a new development. Transparency in this context also extends to the availability of published calculation methods for the costs of the electrical interconnection with the distribution grid network.

High-Level Summary of Findings

The review of EU-15 Member States detailed in section 5 and summarised in Appendices 1 and 2, has found that:

- Deep connection charging methodology is the most widely used charging approach in the EU-15 Member States, it predominating in 8 of the EU-15. Only 4 of the EU-15 currently use shallow charging. The remaining 3 Member States either use a "shallowish" methodology (a hybrid of the two systems) or have no consistent approach to connection charging. It is interesting to note that in general terms those Member States that have implemented shallow charging mechanisms are those that generally have relatively large DG penetration levels.
- Where shallow charging is adopted, it is typical for the costs of any network reinforcements resulting from the connection of a new generator to be recovered through the tariff system (usually Use of System tariff).
- The current level of transparency in connection charging methodology within the EU-15 Member States remains relatively low, even though the Electricity Liberalisation Directive (2003/54/EC) requires that the terms, conditions and tariffs for connecting new producers of electricity are objective, *transparent* and non-discriminatory. Only 5 of the EU-15 Member States[101] are considered to provide a high level of transparency within their connection charging systems.
- It is generally very difficult for new DG plant developers to obtain public domain information from distribution network operators (DNOs) regarding the methods they use for deriving the costs of a new connection. Only in 4 of the EU-15 Member States were published calculation methods for connection costs readily accessible in the public arena. More typically, the developer must apply for a connection and wait for an offer from the DNO before an estimate of costs is made available. There is then a period of negotiation between the DNO and the developer before a final agreement is made. Whilst it is recognised that each new generator connection has its own requirements and will therefore require specific consideration (especially where deep charging is deployed), there is a strong case for more publicly-available connection cost estimates and/or case studies to allow developers earlier visibility of the implications of connecting at a particular site.
- As indicated above, the costs of connection for a new generator are highly dependent on the particular conditions at the connection point. However, anecdotal data gathered from this research suggests that the connection costs of a new generator within the EU-15 Member States are typically likely to be up to 20% of the total equipment installation costs.
- The legislative and regulatory environment relating to connection charging varies across the EU-15 Member States. In a majority of cases there is at least some national legislation describing general requirements and approaches towards connection procedures, licensing and other related issues. However, it is typical for this legislation to be very high-level, thus leaving much of the detail either to

[101] Belgium, Denmark, Ireland, The Netherlands and the United Kingdom

be determined by the DNO or to be subject to negotiation between a developer and a DNO. This generally leaves a DG developer at a disadvantage. In some cases[102] there are requirements placed on DNOs by Regulators to publish terms and conditions for generator connection, and this practice should be encouraged for reasons of transparency and market fairness. In the specific case of the Netherlands, connection charges are defined in the Network Code set up by the Dutch energy regulator (DTe).

Member State Specific Findings and Review of Best Practice

Amongst the EU-15 Member States considered during this study, a range of different approaches and philosophies towards connection charging were observed. This section attempts to condense these Member States' approaches and extract specific items of best practice[103] which then contribute to the development of the policy and legislative recommendations found in section 8.

Probably the most important issue for a newly connecting generator in terms of connection charging is the degree to which these charges have to be negotiated with the host DNO, and the time that can be taken up in performing these negotiations. Whilst the administrative fees associated with obtaining a connection are often set by legislation, in the majority of cases the actual connection costs themselves are subject to this negotiation process between the DNO and the developer. In reality, as the DNO usually is a natural monopoly, any "negotiation" normally means that the developer has to accept the DNO's connection conditions. Hence the DNO can have a significant influence on whether a DG scheme proceeds.

Of all the Member States studied, **the Netherlands** appears to have one of the most progressive approaches to connection charging for generators up to 10 MVA. In this power range a shallow charging regimes applies, and therefore generators pay no contribution to network reinforcement costs. Furthermore there is no scope for negotiation between the DNO and the DG developer as the whole process and the connection charges are defined in the Regulator's Network Code for a range of standard connection types. Each new plant is charged the averaged price for its category. This approach eliminates the possibility for price negotiations and ensures that each scheme is treated in a consistent manner. It has proven to be a powerful incentive for small DG projects. For schemes over 10 MVA, however, connections in the Netherlands are negotiated on a case-by-case basis and follow a deep charging philosophy.

Like the Netherlands, **Belgium** has also adopted a predominantly shallow connection charging approach, with any costs associated with grid network reinforcement being recovered via the tariff system. DNOs are required to publish their connection tariffs on the website of the Belgian Energy Regulator (CREG), and these must be approved by CREG before publication. Whilst the connection charges vary with the DNO, the structure of the charges is identical for each DNO in accordance with the Belgian Royal Decree of 11 July 2002. This approach provides a significant level of transparency and clarity within the Belgian market in terms of the costs that new generators have to pay for new connection, and consequently DG and RES have developed quickly in **Belgium** since market liberalisation.

Denmark is well known for having invested heavily in its renewable energy industry in recent years, and a number of policy measures have been introduced that have led to the rapid deployment and integration of significant quantities of DG and RES. A key aspect of this policy is the adoption of a shallow connection charging approach, as generally defined in the Danish Electricity Supply Act. There are, however, different rules depending on the particular generation technology that is being connected, with environmentally benign systems generally getting more favourable terms. In these cases the plant developer is only required to pay the cost of connection to the 10-20

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[102] For example Belgium, Denmark and Finland

[103] In this context "best practice" means those procedures and approaches that are considered to best promote fair and non-discriminatory market access for new generation plant

kV grid systems, regardless of whether the grid owner selects a connection point at a higher voltage.

One other innovation in **Denmark** is the creation of specific planning zones, albeit at present just for the installation of wind turbines. If a new wind turbine system is connected within such a planning zone the developer is only required to pay the shallow costs of connection up to the boundary of the zone, leaving the grid owner to cover all other costs. This approach could be expanded to encourage the connection of more-generic DG technologies in specific areas and is worth exploring further.

As is the case in the Netherlands and Belgium, DNO prices and conditions in **Denmark** are public and must be notified to the Regulator (Danish Energy Regulatory Authority). The Regulator has the power to impose adjustments to prices and conditions if they are found to be in contravention of the Electricity Supply Act.

Germany has also adopted a shallow connection charging philosophy for RES and cogeneration schemes, with the costs of grid network reinforcement being passed on to customers through the tariff system. This in general has a positive effect on DG and RES. However, the German Regulator (Bundesnetzagentur) has only been in existence since July 2005, and federal regulations relating to the general terms for connecting to medium and low voltage networks are not expected until the summer of 2006.

The need for action in relation to DG connection charging (along with other DG issues) has been recognised in the **United Kingdom**, and a number of measures have been implemented in an attempt to level the playing field for DG and RES within the energy markets of the UK. The first is a move away from a deep connection charging philosophy to a "shallower" approach, whereby connecting generators pay a proportion of any network reinforcement costs rather than all costs, as would be the case with deep charging. The proportion of these costs paid by the generator is defined in published "Apportionment Rules" which are intended to provide locational signals and recognition that others may get benefits from the installed assets. Whilst this approach appears to be a sensible middle ground between deep and shallow charging, from the perspective of DG and RES developers there remains the potential for significant network reinforcement cost burden, particularly if the generator wishes to connect in a location that offers poor locational signals.

A more positive innovation in the **United Kingdom** has been the introduction of Registered Power Zones (RPZ) by the regulator, OFGEM. These are clearly defined areas on the distribution network where the DNO commits to addressing the technical challenges and opportunities of integrating DG into its network, and in which certain incentives will be applicable that the DNO can take advantage of. The introduction of shallow connection charging for new DG and RES schemes within such zones would be a logical next step forward.

When analysing connection charging issues it is also important to consider procedural aspects that can add significant delays to new generation plant installations. These constitute another barrier to DG development, closely related to connection charging. **Spain** for example, has focussed on the procedural aspects of DG connection rather than on connection charges themselves and has through legislation imposed a very tight timeframe for the implementation of connection procedures. Hence whilst connection costs can be relatively unpredictable, the connection timescales can be short in comparison with other EU-15 countries. In the specific case of PV, **Spain** has fully recognised the characteristics of the technology and provided it with what is probably one of the best regulatory frameworks in Europe, leading to an extremely swift (1 month) and relatively affordable connection procedure for small (domestic) PV systems. This has been implemented through a standardised procedure with little or no contribution from the generators to general network costs. This approach provides a good model for a streamlined and simple process for connecting small-scale DG plants in general.

In **Portugal**, whilst the environment for DG and RES is generally not favourable due primarily to the high level of influence of the DNO (EDP) and the deep connection charging method that has been adopted, simplified licensing procedures have been developed for micro-generation systems up to 150 kW in size. For these systems all of the administrative procedures are managed by regional authorities, thereby making the processes quicker and more focussed.

The connection charging processes and procedures that currently exist in the following Member States are not generally considered to be advantageous to DG and RES installation:

The connection charging system in **Austria** is based on a deep charging methodology, with new generators bearing the cost of the physical connection to the network plus an "entry fee" which is used to maintain and reinforce the grid network in the location of the connection. The charges are required by law to be "fair, reasonable and unbureaucratic", and there are rules that limit the DNO's income from entry fees to 30% of the average annual grid investment. However, the connection charging system lacks transparency and charges are calculated by the DNOs on a case-by-case basis, leaving significant scope for the DNOs to influence the amount of DG and RES being connected.

As in Austria, there is a lack of transparency in connection charging procedures and costs in **Luxembourg**. Currently there is a deep connection charging methodology, with costs for connection being determined on an individual basis through a negotiation between DNO and generation plant developer. There are specific legal requirements allowing generators the right of access to the electricity network (as is required by European law), and negotiating parties must participate in good faith without hindering negotiations by misusing market dominance. Whilst there are standard contracts in place for the connection of RES and cogeneration units, these contracts defer to the DNO to determine technical interconnection requirements with the generator bearing all costs.

In **Finland** the electricity market is extremely diverse and there is no standard approach to generator connection charging. As a result the Finnish DNOs are in a position of significant influence in relation to DG and RES connection. Generation plant developers can appeal to the Finnish Energy Market Authority (EMA) if they object to the charges being levied by the DNOs, but the appeals process can take several months.

In **France**, whilst a "shallowish" connection charging mechanism is now being generally implemented, many problems have arisen between EDF and independent generators over the cost of connection to the distribution network, primarily as a consequence of significant increases between EDF's initial connection cost estimates and when EDF produces its definitive connection proposals. Furthermore the limited scope for negotiation with EDF has made the situation all the more detrimental. To address these persistent problems, EDF launched in late 2003 a coordination committee of electricity producers to look into issues of connecting to the public distribution grid, whether in medium voltage (20kV) or low voltage. Cogenerators sitting on the committee believe that some progress has been made but many issues remain unresolved and will probably be decided upon by the CRE[104].

The approach to connection charging in **Greece** has historically been based on a deep charging methodology. Furthermore, at the current time the charging process is a based on negotiation between the applicant and the DNO (Public Power Corporation), meaning that the DNO has a significant level of influence on the implementation of DG and RES schemes. However, **Greece** is now in the process of switching to a more transparent, shallow system in which network costs will be recovered through Use-of-System (UoS) tariffs. It is unclear at present how this UoS tariff will be implemented, and therefore it is unclear what the net impact of the new legal framework will be on DG. If its rates are fair and non-discriminatory then UoS can be an efficient tool to promote DG and RES, especially if special discounted rates or exemptions are established for these technologies. Conversely, inadequately set rates can create an additional burden for small DG developers. In terms of transparency, the forthcoming Distribution Network Operating Code should at least define a detailed connection charging methodology.

[104] Commission de Regulation de l'Energie (http://www.cre.fr/)

One specific action taken in **Greece** to promote wind energy, and of relevance to connection charging, has been the introduction of subsidies of up to 50% of the cost of grid reinforcement for wind generation systems. However, these are looked upon more as investment subsidies for wind power as opposed to discounts as such in terms of connection charges.

In terms of connection methodology and charging, **Ireland** has a very transparent system with relevant publications being readily available on the ESB website. However, whilst transparency is high, **Ireland** has adopted a deep connection charging approach for new generators based on the payment of 100% of any network reinforcement costs. This has made Ireland a relatively unattractive market for DG and RES, although there are no Use-of-System (UoS) levied against generators given the fact that they are responsible for the full costs of connection.

A deep connection charging methodology has also been adopted in **Italy**. Furthermore there is no reference to connection charging in current legislation, although the Italian Regulator (AEEG) is expected to be issuing a binding resolution on this matter in the near future. It is envisaged that this resolution will establish a national framework for connection charging thereby increasing transparency and market access within Italy. It appears likely that this will require DNOs to publish costs and indicative technical solutions for new connections, but it is unclear at present whether the new guidance will define limits on the liability of new generation schemes in terms of contributions towards network reinforcement costs.

In **Sweden** a deep connection methodology also applies, with the DNOs being responsible for calculating the costs payable by a new generator. The only exception to this is when a number of generators use the same connection in which case a more shallow charging mechanism applies. In response to a number of concerns about the levels of charges being levied against new generators, the Swedish Energy Agency set up a working group in 2004 to review industry practices for setting connection fees and to agree a standard basis for their calculation. This work is ongoing.

8 POLICY RECOMMENDATIONS

There are a number of connection charging options that are available to regulators and other bodies responsible for developing energy market policy, each of which has advantages and disadvantages depending on the particular perspective of the market actors involved. These options are summarised in section 3 of this report.

The following summarises the recommendations developed by the ELEP Project Team based on the findings of the research performed in this study.

1. The European Commission should recognise that **increased consistency and transparency** is needed in the approach to generator connection charging across Member States in order to create a non-discriminatory environment for DG and RES. Therefore, it is recommended that **fully transparent interconnection procedures, connection charging mechanisms and connection costs be introduced (and enforced) across Member States**.

2. In general, it is recommended that **connection charging for DG and RES should follow a SHALLOW charging philosophy**. This means that generators pay only for the equipment needed to make the physical connection of their generation plant to the grid network, and that all other costs (including any potential network reinforcement upstream of the connection point) are the responsibility of the Distribution Network Operator (DNO).

   However, there are two issues with the shallow connection charging approach that must be considered:

   (i) The need to develop fair and transparent mechanisms for the recovery of those costs incurred by DNOs relating to the reinforcement of the grid network following the connection of DG or RES (the so-called "deep" cost elements)

   (ii) The need, where appropriate, for financial (or other) signals to discourage generator siting in locations that would adversely affect overall system efficiency

3. In relation to items 2(i) and 2(ii) above, **where grid network reinforcement is necessary following the connection of a new DG or RES scheme, and in cases where pure shallow connection charging is not considered acceptable,** it is proposed that**:**

   (i) **The DG or RES is required to make a (percentage) financial contribution towards reinforcement costs,** similar in principle to the Apportionment Rules being adopted in the UK[105]. Using this approach the DG or RES developer is charged only that proportion of network reinforcement costs representing his proportional use of the network after reinforcement has been completed. Charges of this type are intended to provide locational signals to generators (for efficient siting of generation plant) and give recognition to the fact that others may gain benefit from the installed reinforcement assets.

   It is of course critical in these cases that the percentage contributions to reinforcement costs paid by DG and RES schemes are fair, transparent and non-discriminatory. Therefore, it is proposed that **this proportional contribution is derived from the power capacity of the new generator relative to the capacity of the local grid network following reinforcement**[106]. This is considered to provide a good

[105] Described fully in section 5.15.4

[106] For example, to accommodate a 5 MVA generator, a DNO chooses to reinforce the local distribution network at the connection voltage from 3 MVA up to 10 MVA. In this case the generator's contribution to reinforcement costs would be 5 / 10 = 50% of the cost of works at the connection voltage only. In the system proposed here, the generator does not pay for any reinforcements at voltages above the connection voltage.

representation of the generator's proportional use of the reinforced grid infrastructure at the connection point. However, **the reinforcement costs liability of the generator shall be limited to those costs incurred at the voltage level at which the generator is connected**[106], thus ensuring that the DG or RES developer is only charged in proportion to the costs of network reinforcement that directly and clearly arise from the need to provide his connection.

(ii) **The proportion of the reinforcement costs not paid for by the generator is the responsibility of the DNOs**. The DNOs are then allowed to recover these costs from customers through normal tariff mechanisms. These tariffs are subject to regulator approval. This approach allows the DNO to choose for deeper network reinforcement (than needed merely to connect the proposed DG or RES), at his own costs, whenever that is beneficial from his viewpoint.

(iii) In deriving the costs of reinforcement, **the DNOs should base their calculation method on the reinforcement works being the "least cost technically acceptable solution". The calculation methods used by the DNO, along with costs of interconnection equipment**[107] **used in the derivation of costs, shall be published by the DNO and approved by the appropriate regulatory authority on an annual**[108] **basis**. To further increase transparency and competition, connecting generators shall have the right to obtain Third Party quotations for the connection and reinforcement works in compliance with the DNO's technical specification.

(iv) **For very small generators**[109] it is recognised that very simple connection charges and rules are required. Therefore, it is recommended that **pure shallow charging shall apply for these systems, with no contributions being required from very small generators towards local distribution network reinforcement**. **Any reinforcement costs in these instances shall be the responsibility of the DNO**. In order to facilitate this, it is recommended that individual generators of this type be required to provide notification to the DNO of their intention to connect to the DNO's network[110]. In cases where a developer wishes to connect multiple generation units of this type to the same section of DNO network, the DNO must be notified prior to connection and within a time period commensurate with the implementation of reinforcement works should they be necessary.

(v) In the case where a generator is connected to the distribution network in a region that has already been reinforced following the connection of a previous DG or RES scheme, the same apportionment methods described above shall apply for the new generator.

4. A key issue relating to connection charging is the need for defined (and enforced) timescales relating to the DNOs' preparation of connection quotations. Therefore, it is recommended that **DNOs are required to submit binding connection quotations to DG and RES developers, including cost apportionment proposals for reinforcement works, within 60 days of application**.

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[107] e.g. overhead lines, switchgear, cables, etc

[108] To ensure that market price fluctuation for switchgear and other connection equipment are reflected in the published cost structures

[109] For the purpose of this study, those systems below 10 kW in power rating (e.g. domestic micro-generation systems)

[110] Assuming they comply with agreed technical regulations, such as those in place in the UK

5. It is also recommended that **prospective DG and RES developers be given the right to access the network technical parameters of DNOs' systems** in order to facilitate the optimal placement of new generation plant within distribution networks.
6. It is recommended that **annual connection charges levied by DNOs are solely used as a means of recovering the costs of maintaining the DNO's assets involved in the connection of the generator**, and are not used by DNOs to recover other "deep" costs associated with the initial connection of the generator. These annual connection charges shall be published and subject to regulator approval.
7. It is important that there are clear arbitration methods in place, with clearly-defined and enforced response times to oversee cases of disputes relating to connection charging practices. It is therefore recommended that **regulatory bodies within Member States are given the responsibility for arbitration, in conjunction with the power to impose changes to connection charging costs and practices where necessary**.

9 REFERENCES

[1] Directive 2003/54/EC of the European Parliament and of the Council of 26 June 2003 concerning common rules for the internal market in electricity and repealing Directive 96/92/EC

[2] 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 electricity market

[3] Directive 2004/8/EC of the European Parliament and of the Council of 11 February 2004 on the promotion of cogeneration based on a useful heat demand in the internal energy market and amending Directive 92/42/EEC

[4] Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings

[5] "The share of renewable energy in the EU – Country Profiles – Overview of Renewable Energy Sources in the Enlarged European Union" (Commission Staff Working Document SEC(2004) 547, 26 May 2004)

[6] "Proposal for a Directive of the European Parliament and of the Council concerning measures to safeguard security of electricity supply and infrastructure investment", European Commission COM(2003) final, 10 December 2003

[7] "Annual Report on the Implementation of the Gas and Electricity Internal Market" (European Commission report COM(2004) 863 final, 5 January 2005)

[8] "Decentralised Power Generation in the Liberalised EU Energy Markets – Results from the DECENT research project" (Wolfram Jörss et al, ISBN 3-540-40133-4)

[9] "Charges for Connection to the Distribution System", Revision 4, 18 May 2004 (ESB Ireland) http://www.esb.ie/esbnetworks/standards_codes/charges.jsp

[10] "Guide to the Process for Connection to the Distribution System, Revision 1, February 2002 (DTIS Unit of ESB's Distribution Department)

[11] "Roadmapping of the Paths for the Introduction of Distributed Generation in Europe", March 2004 (DGFER project report), http://www.elep.net/files/DGFER_Road_Map.pdf

[12] "A Benchmarking of 9 European Member States Policies Towards Distributed Generation", January 2004 (N Boccard as part of the SUSTELNET programme)

[13] "Recommendations for Institutional Policy and network Regulatory Frameworks Towards Distributed Generation in EU Member States", 5 November 2004 (M ten Donkelaar & F van Oostvoorn, ECN Policy Studies as part of the ENIRDGnet programme)

[14] "The integration of Wind Power into competitive electricity Markets: The case of transmission grid charges" (Celine Hiroux, ADIS Research Centre, Paris)

[15] "Liberalisation of the electricity sector and development of distributed generation: Germany, United Kingdom and France" (Phillipe Menanteau, Grenoble University and CNRS, France) presented at the ENER Forum 5, Bucharest, Romania, 16-17 October 2003

[16] "Analysis of how large scale DG affects network business – Information on technical and economic aspects when the share of DG increases, the "Eltra case" (J Eli Nielsen, Eltra, July 2003 as part of the CODGUNET programme)

[17] "The impact of electricity network organisation, regulation and pricing on renewables and distributed generation – Inventory of the situation in Finland" (Bettina Lemström, VTT Energy, Finland)

[18] "Electricity (Connection Charges) Regulations – A consultation document" (OFGEM, June 2002)

[19] "Distributed Generation: Price controls, incentives and connection charging" (OFGEM, March 2002)

[20] "Central Networks East - Connection Charging Methodology" (Central Networks, 1 April 2005)

APPENDIX 1 – SUMMARY OF CONNECTION CHARGING APPROACHES

"Shallow" Connection Charging

In this case the connection charge only covers the cost of equipment necessary to connect the generator to the nearest point on the local grid network (at the appropriate voltage level), regardless of whether the grid at the connection location has the capacity to accommodate the generator. The grid owner will meet any grid reinforcement costs that are incurred to accommodate the generator, and these are generally recovered through Use of System or other tariffs. In effect, this means that the costs to a developer of connecting a generator are, by and large, the same regardless of the location of the connection point[111].

Whilst shallow connection charging is attractive to the developer given it provides a significant degree of transparency of the likely connection costs, and it minimises the actual grid connection capital outlay of a new scheme, it does not provide locational signals to generators. The lack of locational signals can potentially lead to the inefficient siting of generators from the perspective of the overall energy delivery system.

"Deep" Connection Charging

In the case of deep connection charging, *all* costs associated with the connection of the generator are borne by the generator. This includes the costs of the physical connection itself to the nearest point on the local grid network along with any downstream network reinforcement costs that arise as a consequence of adding the generator to the network. In paying this single up-front charge there is generally no requirement for the DG or RES scheme to pay charges relating to the ongoing use of the network following the start of commercial operation.

Deep connection charging has two very significant disadvantages from the perspective of DG and RES schemes. Firstly, the costs borne by the generator relating to the network connection are potentially much higher than the equivalent costs determined by a shallow connection method. Secondly, there is a high degree of uncertainty relating to the network reinforcement costs that will be borne by the generator given that each new connection application is assessed separately, and the methodology for assessing the technical modifications to the network is often non-transparent [8].

Mixed or "Shallowish" Connection Charging

As is suggested in its name, this approach is a hybrid of the deep and shallow methods. In essence, the generator bears the cost of the physical connection to the nearest point on the local grid network (as it does in both the shallow and deep connection methods), along with a proportion of the costs of network reinforcement that arise as a consequence of adding the generator to the network. The difficulty, of course, is in defining the exact proportion of reinforcement costs that the generator is required to bear. Attempts have been made in some Member States to develop transparent calculation methods for shallowish connection charges[112], and these are typically based on an assessment of the proportional use of any new infrastructure investments by a newly connecting generator.

"True" Connection Charging

In this case the cost incurred by the generator for a new connection would be equivalent to the cost of connecting the generator to the nearest point (and voltage level) on the electricity grid network at which the grid has sufficient capacity to accommodate the generator without reinforcement. The main drawback with this method is that the nearest point of connection not requiring network reinforcement could be a significant distance from the generator, and therefore it could be more beneficial to opt for a physically closer connection point and pay reinforcement costs.

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[111] Assuming connection at the same voltage, and requiring the same assets (cable, overhead line, switchgear, etc) to make the connection to the grid

[112] The UK is a good example (see section 5.15)

APPENDIX 2 - SUMMARY OF KEY FEATURES IN EU-15 MEMBER STATES

AUSTRIA	
Connection charge approach:	
- What is the general connection charge philosophy?	There is a deep connection charge approach in Austria. The generator pays for the connection and an additional entry charge for the possible upgrade of the grid.
- If "shallow" what is the financial compensation mechanism for the DNO?	-
- If "deep" what proportion of the total grid investment costs is typically paid by the generator?	Cumulative annual entry charges must not be higher than 30% of average annual grid investment costs.
Implementation:	
- How is the connection charge method implemented?	The Decree of The National Regulator (e-control) SNT-VO 2003 lays out the rules for charging grid fees and specifies charges that are "adequate and according to customary market conditions".
- How transparent is this system?	Transparency is limited, as the regulator does not monitor utility practice.
Connection costs and charges:	
- On what basis are connection costs calculated?	The connection charges are calculated on an individual basis by the utilities, the main factor being the location of the new DG plant.
- Are the calculation methods published?	The grid companies publish neither model contracts nor calculation methods. However the above-mentioned regulatory Decree states that grid companies have to "present necessary costs in a transparent and understandable manner".
- To what degree are connection charges the result of negotiation between the DNO and plant developer?	High - negotiation is an integral part of the process
- Is there a Use of System or "entry" charge for generators?	The entry charge serves to upgrade the grid (see above)
- What range of connection charges would a DG typically pay? (in € and as a % of installation costs)	The highest share is reported in the wind power sector, where in most regions in addition to the actual connection costs an entry fee of €100,000 per MW (i.e. around 10% of the investment) has to be paid.
Impact on DG and RES	The non-transparent nature of the system makes it hard to draw conclusions. Furthermore the approaches differ according to DG technology and region. The highest impact is on wind power. At the same time Austria experiences a boom in wind power construction, which indicates that for actual deployment connection charges pay a minor role compared with, for example, support mechanisms.

BELGIUM	
Connection charge approach: - What is the general connection charge philosophy? - If "shallow" what is the financial compensation mechanism for the DNO? - If "deep" what proportion of the total grid investment costs is typically paid by the generator?	 Predominantly shallow charging Cost recovery via tariff system -
Implementation: - How is the connection charge method implemented? - How transparent is this system?	 Belgian Royal Decree of 11 July 2002 details the general approach to connection charging and the associated tariff structures. The procedure is based on the costs of two technical studies plus connection tariffs. DNOs publish their tariffs on the website of the Belgian Energy Regulator (CREG). These tariffs are subject to CREG approval. High level of transparency
Connection costs and charges: - On what basis are connection costs calculated? - Are the calculation methods published? - To what degree are connection charges the result of negotiation between the DNO and plant developer? - Is there a Use of System or "entry" charge for generators? - What range of connection charges would a DG typically pay? (in € and as a % of installation costs)	 Connection charges are based on published tariffs. These vary from DNO to DNO but are usually a function of the connection voltage and power rating, the distance to the connection point, and other technical parameters. Yes, on the website of the Belgian Regulator CREG Low – most charges are based on published tariffs There does not appear to be an entry charge for generators Typically 5-10% of total installation costs for a small cogeneration installation
Impact on DG and RES	DG and RES have developed quickly since market liberalisation, unhindered by adverse interconnection regulations. The high level of transparency relating to the connection charging system is beneficial to the deployment of DG and RES.

DENMARK	
Connection charge approach: - What is the general connection charge philosophy? - If "shallow" what is the financial compensation mechanism for the DNO? - If "deep" what proportion of the total grid investment costs is typically paid by the generator?	 Shallow charging Cost recovery is achieved via the tariff structure (Use of System) -
Implementation: - How is the connection charge method implemented? - How transparent is this system?	 DNOs are required to publish prices and conditions. These must be notified to the Danish Energy Regulatory Authority. High level of transparency
Connection costs and charges: - On what basis are connection costs calculated? - Are the calculation methods published? - To what degree are connection charges the result of negotiation between the DNO and plant developer? - Is there a Use of System or "entry" charge for generators? - What range of connection charges would a DG typically pay? (in € and as a % of installation costs)	 (i) "Environmentally benign" and CHP plants are only required to pay for the assets needed to connect to the 10-20 kV network, regardless of whether the DNO selects a higher connection voltage. (ii) Wind turbines pay similar costs to CHP plants, except that they are only required to pay the costs of connection up to the boundary of specific planning zones allocated for turbine construction. Upon request of the DNO Low – most charges are based on published tariffs Yes. The UoS charges comprise energy, capacity and annual fee components. Around 5-10% of the total power plant installation costs
Impact on DG and RES	Positive

FINLAND	
Connection charge approach:	
- What is the general connection charge philosophy?	No standard approach. Can be shallow or deep depending on the particular DNO. Have to be "reasonable" and "non-discriminatory".
- If "shallow" what is the financial compensation mechanism for the DNO?	Normally cost recovery is achieved via Use of System tariffs, although this depends on the particular DNO
- If "deep" what proportion of the total grid investment costs is typically paid by the generator?	No consistent approach applies
Implementation:	
- How is the connection charge method implemented?	Finnish law requires DNOs to publish the prices of services, including connection to the network. Finland's Energy Market Authority (EMA) supervises the pricing of services, but action is only taken after a complaint.
- How transparent is this system?	"Medium" level of transparency
Connection costs and charges:	
- On what basis are connection costs calculated?	Either (i) a fixed fee per MW, (ii) the actual cost of connection, including in some cases network reinforcement
- Are the calculation methods published?	Typically not
- To what degree are connection charges the result of negotiation between the DNO and plant developer?	Depends on the DNO
- Is there a Use of System or "entry" charge for generators?	Depends on the DNO
- What range of connection charges would a DG typically pay? (in € and as a % of installation costs)	Varies considerably depending on the DNO and the connection charging approach used
Impact on DG and RES	Neutral (at best). The DNOs have significant influence on connection cost structures, and the regulator only acts following the receipt of a complaint.

FRANCE	
Connection charge approach:	
- What is the general connection charge philosophy?	"Shallowish" connection charging. DG and RES schemes are generally required to pay for the costs of their grid connection, plus network reinforcements at the connection voltage only.
- If "shallow" what is the financial compensation mechanism for the DNO?	Unclear
- If "deep" what proportion of the total grid investment costs is typically paid by the generator?	Only those costs incurred at the connection voltage
Implementation:	
- How is the connection charge method implemented?	French legislative decrees N° 2002-1014 & N° 2001-365 define the general tariffs and rules. However, the connection procedure for new generators is long and complex. It is essentially a two-step process comprising studies and final implementation, and is based on a waiting list system.
- How transparent is this system?	The system architecture itself is now reasonably transparent, and is being improved. However, DG and RES owners often do not get a reliable connection cost estimate until the project is nearly finalised.
Connection costs and charges:	
- On what basis are connection costs calculated?	Connection charges are calculated on the basis of the DNO's detailed technical assessment. These are based on the "minimum technical solution" evaluation method.
- Are the calculation methods published?	No
- To what degree are connection charges the result of negotiation between the DNO and plant developer?	Low - small generators currently have very little scope to negotiate
- Is there a Use of System or "entry" charge for generators?	No
- What range of connection charges would a DG typically pay? (in € and as a % of installation costs)	Depending on the voltage level, connection charges are typically 10-20% of the installation costs for most projects. For a 2 MWe CHP plant, estimates of €300,000 are often cited.
Impact on DG and RES	The complexity of the procedure, together with the absence of financial transparency is a big hurdle for DG projects. The situation has improved recently, but is still far from being satisfactory.

GERMANY	
Connection charge approach:	
- What is the general connection charge philosophy?	There is a shallow connection charge philosophy for DG in Germany. According to the *EEG* law of 2002 the plant operator pays for the connection and the DNO for upgrading.
- If "shallow" what is the financial compensation mechanism for the DNO?	The above costs are passed to customers via increased UoS charges.
- If "deep" what proportion of the total grid investment costs is typically paid by the generator?	-
Implementation:	
- How is the connection charge method implemented?	The *ENWG* legislation of 2005 defines the rules for unbundling and grid access. It provides for "adequate, non-discriminatory and transparent" conditions.
- How transparent is this system?	As the state regulator is not fully operative yet, transparency is currently limited.
Connection costs and charges:	
- On what basis are connection costs calculated?	Connection costs are calculated on an individual basis, the main factor being the location of the plant.
- Are the calculation methods published?	Neither model contracts nor calculation methods are published by the grid operators
- To what degree are connection charges the result of negotiation between the DNO and plant developer?	Generally low – shallow charging applies so reinforcement costs are DNO responsibility
- Is there a Use of System or "entry" charge for generators?	No
- What range of connection charges would a DG typically pay? (in € and as a % of installation costs)	The absolute costs of connection for DG are generally rather low (meter, cables, labour) due to the shallow connection approach. Their share of the overall investment costs increases for smaller plant sizes.
Impact on DG and RES	The shallow connection charging approach generally has a positive impact on DG deployment in Germany

GREECE	
Connection charge approach:	
- What is the general connection charge philosophy?	Fundamentally the Greek system is based on a deep connection charging methodology at distribution level. However it is expected that future distribution connection philosophy will move towards a more "shallow" approach.
- If "shallow" what is the financial compensation mechanism for the DNO?	In the future it is anticipated that there will be cost recovery via Distribution Use of System charges.
- If "deep" what proportion of the total grid investment costs is typically paid by the generator?	100%, except for wind energy where the producer is entitled to subsidies of up to 50% of the cost of reinforcement (these are considered to be investment subsidies for RES rather than a discount as such in terms of connection charges).
Implementation:	
- How is the connection charge method implemented?	Greek Law 2941/2001 details procedures for the licensing of RES systems. More generally, a very lengthy connection procedure has been established. Detailed information is hard to come by, but charging itself is currently the subject of negotiation between the applicant and the Public Power Corporation (PPC).
- How transparent is this system?	Currently the level of transparency is low, although a more transparent connection charging methodology is expected to be included in the future Distribution Network Operating Code (DNOC).
Connection costs and charges:	
- On what basis are connection costs calculated?	The terms and conditions for connection are generated by the DNO, although due to lack of transparency the exact basis upon which calculation costs are derived are difficult to determine.
- Are the calculation methods published?	No
- To what degree are connection charges the result of negotiation between the DNO and plant developer?	High - negotiation is an integral part of the process
- Is there a Use of System or "entry" charge for generators?	-
- What range of connection charges would a DG typically pay? (in € and as a % of installation costs)	No reliable data exists.
Impact on DG and RES	The present system of connection charging has a negative impact on DG and RES, primarily due to the lack of transparency. Furthermore, the negotiation process between the DNO and a new generator gives the DNO a significant amount of influence on the commercial success of a new installation.

IRELAND	
Connection charge approach: - What is the general connection charge philosophy? - If "shallow" what is the financial compensation mechanism for the DNO? - If "deep" what proportion of the total grid investment costs is typically paid by the generator?	 Deep charging - 100%
Implementation: - How is the connection charge method implemented? - How transparent is this system?	 Mixture of government legislation and ESB (Electricity Supply Board) policy High transparency (through published ESB procedures and costs)
Connection costs and charges: - On what basis are connection costs calculated? - Are the calculation methods published? - To what degree are connection charges the result of negotiation between the DNO and plant developer? - Is there a Use of System or "entry" charge for generators? - What range of connection charges would a DG typically pay? (in € and as a % of installation costs)	 ESB connection charging policy states that generators pay "100% of the costs of connection (including reinforcements)" No. Indicative connection charges (excluding reinforcement) are published by ESB. The costs of reinforcement are determined by ESB following an application, but are based on the "least cost technically acceptable solution" principle. Low – there is little scope for generators to challenge ESB quotations No Varies significantly depending on the reinforcement costs. The costs of the assets needed to connect the generator to the network (i.e. excluding reinforcement costs) are of the order 3-8% of generator installation costs.
Impact on DG and RES	Generally negative

ITALY	
Connection charge approach: - What is the general connection charge philosophy? - If "shallow" what is the financial compensation mechanism for the DNO? - If "deep" what proportion of the total grid investment costs is typically paid by the generator?	 Italy generally has a deep connection charging philosophy. - The general practice seems to be that the generator is responsible for all costs resulting from the connection of the new plant. Network reinforcement is only paid by the DNO in cases where the connection is shared by a number of producers or where a DNO chooses a different solution to the least cost technically acceptable solution.
Implementation: - How is the connection charge method implemented? - How transparent is this system?	 There is no legislation that currently covers connection charging in Italy. However, the Italian Regulator (AEEG) is planning to issue a binding resolution on this matter soon. A consultation document was published in March 2005. The transparency of the current connection charging system is low. The future AEEG resolution is expected to require DNOs to publish costs and indicative technical solutions for generator connections.
Connection costs and charges: - On what basis are connection costs calculated? - Are the calculation methods published? - To what degree are connection charges the result of negotiation between the DNO and plant developer? - Is there a Use of System or "entry" charge for generators? - What range of connection charges would a DG typically pay? (in € and as a % of installation costs)	 The "least cost technically acceptable solution" principle generally applies. Not at the moment. Low/Medium – deep charging applies and costs are determined by the DNO - There is no typical connection charge for DG in Italy as the deep charging approach means that the costs for a particular installation have to be assessed individually.
Impact on DG and RES	The existing connection charging principles and lack of transparency are considered to present a barrier to the development of DG and RES in Italy.

LUXEMBOURG	
Connection charge approach:	
- What is the general connection charge philosophy?	In general Luxembourg applies a deep connection charge methodology. The DNO is responsible for determining the connection costs on a case-by-case basis.
- If "shallow" what is the financial compensation mechanism for the DNO?	-
- If "deep" what proportion of the total grid investment costs is typically paid by the generator?	100%
Implementation:	
- How is the connection charge method implemented?	The conditions for network access are the responsibility of the Luxembourg Regulatory Authority (ILR).
- How transparent is this system?	Very little transparency
Connection costs and charges:	
- On what basis are connection costs calculated?	Determined on a case-by-case basis through a process of negotiation between the generator and the DNO.
- Are the calculation methods published?	No
- To what degree are connection charges the result of negotiation between the DNO and plant developer?	High - negotiation is an integral part of the process
- Is there a Use of System or "entry" charge for generators?	There does not appear to be
- What range of connection charges would a DG typically pay? (in € and as a % of installation costs)	Difficult to establish due to lack of transparency and the fact that Cegedel (the main DNO) has been unwilling to divulge case study details.
Impact on DG and RES	The lack of transparency in connection charges and procedures gives a negative overall impact on DG and RES.

PORTUGAL	
Connection charge approach:	
- What is the general connection charge philosophy?	Portugal currently follows a deep connection charge philosophy
- If "shallow" what is the financial compensation mechanism for the DNO?	-
- If "deep" what proportion of the total grid investment costs is typically paid by the generator?	The generator's contribution is negotiated between the DNO and the generator
Implementation:	
- How is the connection charge method implemented?	Connection charging is partially regulated by the Director General for Geology and Energy (DGGE). For RES and CHP, connection conditions and administrative procedures are defined in Laws DL 189/88 and DL 312/2001. However in practice the exact conditions have to be negotiated between the DNO and generator, and the process itself can be very time consuming. Simplified licensing procedures have been developed for micro-generation systems of maximum capacity 150 kW, but the technical details relating to the connection point are still subject to negotiation with the DNO.
- How transparent is this system?	The part of the procedure for which the DGGE is responsible is relatively transparent, although time consuming. However, there is very little transparency regarding the costs levied by the DNO, and these can be high.
Connection costs and charges:	
- On what basis are connection costs calculated?	Licensing costs are clearly defined as a function of the capacity of the power plant. The costs of the physical connection to the grid and any network reinforcement costs are determined by the DNO (EDP). Due to lack of transparency the basis for these calculations is unclear.
- Are the calculation methods published?	No
- To what degree are connection charges the result of negotiation between the DNO and plant developer?	High - negotiation is an integral part of the process
- Is there a Use of System or "entry" charge for generators?	-
- What range of connection charges would a DG typically pay? (in € and as a % of installation costs)	These are highly dependent on the specific conditions, but a figure of 15% of the total installation costs appears fairly typical.
Impact on DG and RES	EDP currently has monopoly power enabling it to reclaim significant proportions of reinforcement costs from generators. The deep charging system and low transparency are considered to be a considerable barrier to the development of DG and RES.

SPAIN	
Connection charge approach:	
- What is the general connection charge philosophy?	A deep connection methodology is generally followed in Spain. Generators connected to the distribution system pay for all necessary network reinforcements.
- If "shallow" what is the financial compensation mechanism for the DNO?	-
- If "deep" what proportion of the total grid investment costs is typically paid by the generator?	100%
Implementation:	
- How is the connection charge method implemented?	Procedures regarding access to the transmission and distribution system are established in the Royal Decree 1955/2000. Additional dispositions for RES and CHP are laid out in RD 2818/1998, and an entirely separate Decree (1663/2000) relates to PV connected to the low voltage grid. Whilst this legislation provides general guidelines, the whole process in Spain is effectively based on negotiation between the generator and the DNO.
- How transparent is this system?	Although the framework for grid connection in Spain is generally well defined, the agreement of connection charges is essentially a negotiation process. This leads to a low level of connection cost transparency for DG and RES.
Connection costs and charges:	
- On what basis are connection costs calculated?	Unclear given the lack of transparency. Believed to be based on the "least cost technically acceptable solution" principle.
- Are the calculation methods published?	No
- To what degree are connection charges the result of negotiation between the DNO and plant developer?	High - negotiation is an integral part of the process
- Is there a Use of System or "entry" charge for generators?	-
- What range of connection charges would a DG typically pay? (in € and as a % of installation costs)	Varies considerably, depends on the conditions at the connection point
Impact on DG and RES	The impact on DG and RES is mixed. Whilst the framework for grid connection is generally well defined, the reliance on a deep charging method can constitute a significant obstacle, especially in areas where grid reinforcements are required. This is further complicated by the process of connection charging itself being generally a negotiation between generators and the DNO.

SWEDEN	
Connection charge approach:	
- What is the general connection charge philosophy?	Generally deep connection charging applies
- If "shallow" what is the financial compensation mechanism for the DNO?	-
- If "deep" what proportion of the total grid investment costs is typically paid by the generator?	100%
Implementation:	
- How is the connection charge method implemented?	The Swedish Electricity Act provides the base framework from which connection charges are theoretically derived. In practice the calculation of connection charges is the responsibility of the DNO. However, the Swedish Energy Agency has recently set up a working group to review industry practices for setting connection fees and to agree a standard basis for the calculation of these fees. Consultation proposals were published in late 2004.
- How transparent is this system?	The current system has very little transparency. It is hoped that the new arrangements (once agreed) will create a much more transparent process.
Connection costs and charges:	
- On what basis are connection costs calculated?	Deep costs, believed to be derived on the principle of lowest cost technical solution.
- Are the calculation methods published?	No
- To what degree are connection charges the result of negotiation between the DNO and plant developer?	Low/Medium – deep charging applies and costs are currently determined by the DNO
- Is there a Use of System or "entry" charge for generators?	-
- What range of connection charges would a DG typically pay? (in € and as a % of installation costs)	Difficult to quantify given the deep connection charge method, but a figure of around 10% appears fairly typical.
Impact on DG and RES	Generally negative given the lack of transparency and the significant influence of DNOs in setting connection charges.

THE NETHERLANDS	
Connection charge approach:	
- What is the general connection charge philosophy?	Connections up to 10 MVA are shallow, regulated and averaged. Connections with capacity over 10 MVA are negotiated on a case-by-case basis and follow a deep charging philosophy.
- If "shallow" what is the financial compensation mechanism for the DNO?	Costs are either incorporated into Use of System charges or absorbed by the DNO.
- If "deep" what proportion of the total grid investment costs is typically paid by the generator?	Subject of negotiation between the generator and the DNO.
Implementation:	
- How is the connection charge method implemented?	Connection charges are defined in the Network Code set up by the Dutch energy regulator (DTe). These cover a range of different connection types.
- How transparent is this system?	For connection capacities up to 10 MVA the implementation of connection charging is very transparent. For connection capacities over 10 MVA the process is less transparent as these are dealt with on a case-by-case basis by negotiation between the DNO and the generator
Connection costs and charges:	
- On what basis are connection costs calculated?	The Electricity Tariff Code specifies the basis of general tariffs. The DNO tariffs are derived from these general tariffs. Connection charges for connections up to 10 MVA comprise the capital and maintenance costs of the physical connection to the grid system only. Connections costs for installations over 10 MVA are negotiated case-by-case.
- Are the calculation methods published?	Yes, for installations below 10 MVA. No, for installations over 10 MVA.
- To what degree are connection charges the result of negotiation between the DNO and plant developer?	Low – below 10 MVA (published tariffs) High – over 10 MVA
- Is there a Use of System or "entry" charge for generators?	
- What range of connection charges would a DG typically pay? (in € and as a % of installation costs)	
Impact on DG and RES	The high level of penetration of DG in The Netherlands would indicate that the impact of the existing regulatory regime and connection charging philosophy has been positive for DG and RES. This is particularly the case for installations below 10 MVA. Above 10 MVA deep charging applies, making the situation less favourable for DG and RES.

UNITED KINGDOM	
Connection charge approach:	
- What is the general connection charge philosophy?	"Shallowish" charging (i.e. an intermediate mechanism between shallow and deep)
- If "shallow" what is the financial compensation mechanism for the DNO?	Cost recovery via Use of System and other tariffs
- If "deep" what proportion of the total grid investment costs is typically paid by the generator?	Varies according to published calculation criteria. In the examples found, generators typically have to contribute 20-60% of the network reinforcement costs.
Implementation:	
- How is the connection charge method implemented?	DNOs are required to publish their terms and conditions for generator connection as part of their Licence terms. These are subject to regulator (OFGEM) approval.
- How transparent is this system?	High level of transparency
Connection costs and charges:	
- On what basis are connection costs calculated?	Generators pay 100% of the costs of assets needed to connect them physically to the network. These costs correspond to costs of the "minimum scheme" consistent with "sound engineering practices". Additionally generators typically pay a contribution to any network reinforcement costs, limited to one voltage level above that at which the generator is connected. The calculation method uses "Apportionment Rules" that are intended to provide locational signals and recognition that others may gain benefit from the installed assets. These are published by DNOs and are subject to regulator approval.
- Are the calculation methods published?	Yes, by the DNOs
- To what degree are connection charges the result of negotiation between the DNO and plant developer?	Low – deep charging based on published calculation methods
- Is there a Use of System or "entry" charge for generators?	No, UoS charges are based on exported energy
- What range of connection charges would a DG typically pay? (in € and as a % of installation costs)	8%-12% seems fairly representative
Impact on DG and RES	Neutral

APPENDIX 3 – KEY PARAMETERS BY MEMBER STATE

	Predominant DG connection charge philosophy	Level of transparency in the system	Are there published connection cost calculation methods?
Austria	Deep	Low	No
Belgium	Shallow	High	Yes
Denmark	Shallow	High	Yes
Finland	No standard approach	Medium	No
France	Shallowish*	Medium	No
Germany	Shallow	Low	No
Greece	Deep	Low	No
Ireland	Deep	High	No
Italy	Deep	Low	No
Luxembourg	Deep	Low	No
Portugal	Deep	Medium	No
Spain	Deep	Low	No
Sweden	Deep	Low	No
The Netherlands	Shallow	High	Yes
United Kingdom	Shallowish*	High	Yes

* Intermediate step between deep and shallow charging. For example, the generator only pays the reinforcement costs at the connection voltage.