Regulatory Review and Barriers for the Electricity Supply System for Distributed Generation in EU-15

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Abstract — When distributed electricity supply surpasses a particular level, it can no longer be ignored in planning and operation of the electricity networks. Therefore, improvements of the regulatory framework of the electricity networks are required along with the growth of the electricity supply from distributed generation.

This paper reviews the current regulation of the grids with respect to distributed generation in EU-15 Member States and compares the different systems. Several barriers are identified.

Index Terms — Distribution of electric power, Planning, Power distribution, Power generation, Power generation economics, Power system economics, Regulators, Technology assessment.

I. INTRODUCTION

In recent years, distributed generation (DG) has received increasing attention as it can contribute to the various goals of EU energy policy. Enhanced security of supply, a reduction in greenhouse gas emissions, efficiency gains and more flexibility in investments are some of the major benefits associated with DG.

So far the creation of the internal power market within the EU has been concentrated on central generation, which is fed into the high voltage network. Less has been done to create a common regulatory framework for DG, which is often fed into the medium and low voltage distribution network.

The current state of DG development in each Member State (MS) results from a complex interplay of EU legislation, national policies, and general conditions in the respective countries. EU legislation has been setting broad framework conditions, which also address DG. Distributed electricity supply from renewable energy sources (RES) and combined heat and power (CHP) should be considered in the operation and planning of the electricity infrastructure. Furthermore, costs and benefits to the distribution network induced by the various distributed generation technologies should be taken into account in the electricity network regulation.

The implementation, though, is left to a large extent to the discretion of the individual MS, which have adopted direct, indirect or market-oriented support mechanisms to promote DG. This allows them to take the special characteristics (e.g. geographical conditions and fuel mix) of their countries into account.

The design of electricity network regulation can undermine the promotion of DG. National governments may use support schemes to ensure that DG is employed and environmental benefits are achieved and thus mitigate the barriers to incorporating DG within economic regulation of electricity networks. However, removing the barriers in the regulation is more economic efficient. In practice, current electricity network regulation often does not consider regulatory mechanisms to ensure effective participation of DG in the internal electricity market. This could become a serious barrier for the deployment of DG and complicate the achievement of European and national sustainability targets.

This paper reviews the current regulation of the grids with respect to distributed generation in EU-15 MS aiming at identifying the major barriers for further penetration of DG.

II. THE DG-GRID PROJECT

This work is part of the research project DG-Grid [15] with support from the EU Energy Intelligent Europe 2003 – 2006 Programme. The objective of this project is to improve the interface between DG and the electricity supply system to promote the deployment of RES/CHP through the development of regulatory guidelines. This includes both improving coordination between DG and the network operator (DSO - Distribution System Operator) within the existing framework and implementing new network and regulatory structures in the medium-term. The work presented in this paper is the first step in this direction. This is work in progress. The final project results will be available in 2007.

III. NATIONAL AND EU LEGISLATION

European energy policy pursues three major objectives, as stipulated in the White Paper « An Energy Policy for the European Union » [1]: overall competitiveness, the security of supply, and environmental protection (sustainability). The EU promotes DG since it positively contributes to these goals by means of a diversification of the fuel mix and emissions reductions through the deployment of environmentally friendly technologies. Moreover, the Commission recognizes RES and CHP as an important option to cope with increasing

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electricity consumption while realizing efficiency gains [2].

Yet, there has been no common European legal framework on DG so far. DG is rather encompassed by several provisions of EU energy law. First, there is the Electricity Directive [5] which creates the basic conditions for a liberalized market including essential elements such as unbundling and third party access. In particular, Art. 6(3) of the Directive emphasizes that the authorization procedure shall take into account the limited size and potential impact of small and distributed generation. Art. 14 of the same Directive mentions the possibility of priority access and the necessary consideration of DG in network planning.

The RES [4] and the CHP [6] Directives envisage national support schemes, being subject to review and evaluation by the Commission. According to the Subsidiarity Principle, the EU leaves the implementation of these Directives to the discretion of the Member States so that the latter can take policy decisions which best accommodate their national circumstances.

There are no common standards for national policies. Member States apply different support schemes, from direct and indirect support to market-oriented mechanisms. Hence, the current status of DG development in each individual Member State is the result of a complex interplay of EU legislation, national policies, and general conditions (e.g. fuel mix, market characteristics) in the respective country.

Policy recommendations need to take into account both the need for different national promotion schemes during the transition phase while seeking to establish a level playing field in the long term. Simultaneously, the interplay of the different national regimes may not lead to unnecessary distortions in the Internal Energy Market (IEM).

It is possible to identify common requirements for further deployment of DG by looking at the interplay of the EU legislation, national policies, and general conditions for DG. This may lead to policy recommendations for improvements of the regulatory framework of the electricity supply systems that are required along with the growth of the electricity supply from distributed generation.

IV. LEGISLATION, ECONOMICS AND INTERCONNECTION BARRIERS

Effective promotion of DG is only feasible if certain requirements are met: first, there are technical prerequisites, such as network capacity, balancing conditions and the consideration of the controllable and uncontrollable DG share. Secondly, the provision of the necessary legal conditions is vital, encompassing unbundling, the adoption of incentive mechanisms for distribution system operators (DSO), and the regulation of third party access and connection charges. Last, certain economic requirements need to be in place. This applies to access to the power market, the level of connection charges, and the anticipated benefits for the DG operators. At present not all requirements are fulfilled.1

The different legislative, economic and interconnection aspects of implementing DG are intertwined. The economics of the DG-Operator is influenced by the network regulation and the energy policy, e.g., a DG-operator has to pay connection and use of system charges (for transport and system services), and the DG-operator receives revenues from a support scheme.

Setting charges by the DSO is bound to regulation. Furthermore, the DSO receives certain incentives for economic efficiency (and technical performance). The DSO purchases transport and system services from the transmission system operator (TSO). Mechanisms and charges are often also regulated.

A. Presence of DG

DG presence indicates the share of DG in the system. When the amount of DG surpasses a particular level, it will influence the electricity network infrastructure and can no longer be ignored in planning and operation.

The present market shares of DG in the individual countries within the EU-15 differ quite a lot. The capacity of DG in some countries covers only a low percentage of their total generation capacity while it covers almost half of the generation capacity in other countries (Fig. 2). Denmark, Germany, The Netherlands, Portugal, and Spain are the Member States with the highest share of DG capacity. These countries with currently large shares of DG are mainly the countries that have been supporting DG for a longer period. In Denmark DG CHP in connection to district heating in the small towns has been supported since the 1980ies. In addition, wind power and other RES production have also been supported. Therefore, the large share of DG has been deployed before the liberalization of the power markets. Since new deployment of wind turbines mainly is made off-shore in

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1 The general potential barriers within these three categories have been identified and documented in several studies [9], [13], [14].
large wind parks, the present share of non-controllable DG is not expected to increase in the near future.

Fig. 2. DG share in total electricity capacity. Source [15].

The fuel mixes differ between the Member States. In a country like Denmark, a large share of the DG is natural gas fired CHP for district heating. In countries like Finland and Sweden biomass fired industrial CHP is widely used. Finally, wind turbines are being deployed in most countries. Together with small-scale hydropower and photo voltaic, wind power is producing the largest share of the non-controllable DG generation with the EU. Whereas small thermal and CHP units, gas or biomass fired, can be regarded as controllable DG which implies that they are a more reliable power base not subject to strong fluctuations.

B. Distribution System Operators and Unbundling

The role of the DSO describes the regulatory incentives such as the state of unbundling, licence conditions, economic incentives for the DSO to promote DG, and technical performance aspects. It is important that the DSO has incentives to facilitate the deployment and operation of the DG plants – not only by efficient investment and operation of the network, but also by a favourable regulation.

Prior to liberalization, the electricity sector was largely in the hands of vertically integrated undertakings. Unbundling implies the separation of the various components of production, distribution and service in order to introduce greater elements of competition to these segments of an industry [16]. A lack of unbundling bears the risk that DSOs discriminate in favour of their (former) group companies. Obstruction tactics towards new market entrants can take a variety of ways: e.g. transmission or distribution system operators may claim a lack of capacity, charge excessive transport fees, delay access by long negotiations, litigation, and manipulation of price [12]. Moreover, insufficient unbundling may give rise to hidden cross subsidies within the vertically integrated companies, and to non-transparent network tariffs. This in turn may constitute an entry barrier for DG operators trying to penetrate the market.

Several kinds of unbundling exist: ownership unbundling, legal unbundling, management unbundling, and unbundling of accounts. Ownership unbundling is the most far-reaching one. It implies the complete separation of assets so that the previously integrated company is split up into independent economic entities. The other kinds of unbundling decrease respectively in scope.

The EU has set legal unbundling as the minimum requirement for DSOs². Other than for their accounts, DSOs first need to implement this requirement by July 2007 [7]. Therefore, progress has been very mixed across the EU-15. Eight Member States have already introduced legal unbundling of DSOs (see Table I). In six countries there has only been accounting or management unbundling so far, and in Greece there has been no unbundling of the DSO at all.

Interestingly, in the three Member States with the highest shares of distributed generation, namely Denmark, the Netherlands, and Spain, legal unbundling is already in place (See Table I and II). The Netherlands will even introduce ownership unbundling.

<table>
<thead>
<tr>
<th>Country</th>
<th>Unbundling³</th>
<th>No of DSO</th>
<th>DSOs with less than 100,000 connections</th>
<th>% of connections in this category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>L 138</td>
<td>n.a.</td>
<td>50%</td>
<td></td>
</tr>
<tr>
<td>Belgium</td>
<td>L 30</td>
<td>20</td>
<td>7.2%/19%⁴</td>
<td></td>
</tr>
<tr>
<td>Denmark</td>
<td>L 120</td>
<td>112</td>
<td>43%</td>
<td></td>
</tr>
<tr>
<td>Finland</td>
<td>A 94</td>
<td>88</td>
<td>53%</td>
<td></td>
</tr>
<tr>
<td>France</td>
<td>M 166</td>
<td>160</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>Germany</td>
<td>A 950</td>
<td>900</td>
<td>n.a.</td>
<td></td>
</tr>
<tr>
<td>Greece</td>
<td>N 1</td>
<td>0</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Ireland</td>
<td>M 1</td>
<td>0</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Italy</td>
<td>L 170</td>
<td>n.a.</td>
<td>n.a.</td>
<td></td>
</tr>
<tr>
<td>Luxembourg</td>
<td>M 11</td>
<td>10</td>
<td>n.a.</td>
<td></td>
</tr>
<tr>
<td>Netherlands</td>
<td>L 20</td>
<td>0</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Portugal</td>
<td>A 11</td>
<td>10</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td>Spain</td>
<td>L 308</td>
<td>300</td>
<td>2%</td>
<td></td>
</tr>
<tr>
<td>Sweden</td>
<td>L 184</td>
<td>179</td>
<td>40%</td>
<td></td>
</tr>
<tr>
<td>UK</td>
<td>L 15</td>
<td>3</td>
<td>n.a.</td>
<td></td>
</tr>
</tbody>
</table>

Progress in unbundling may further DG penetration especially in countries where there is a high degree of vertical integration combined with a non-diversified fuel mix. This is e.g. the case in Greece where there are still significant problems to unbundle the previous monopolist and where the fuel mix relies to a large extent on lignite. Unbundling may also enhance DG penetration in France where the main share of electricity is generated by nuclear energy. In France DG amounts to only 2.1 percent of national electricity capacity and is essentially held by municipalities. The latter constitute also independent distributors whereas EdF distribution

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² This does not prevent the operation of a combined TSO/DSO as long as it is independent in terms of its legal form, organisation and decision making from other activities which do not relate to transmission or distribution system operation and meets requirements of Art. 17, Directive 2003/54/EC.
³ L = legal, M = management, A = account, N = no unbundling.
⁴ 7.2% in Flanders and 19% in Wallonia.
operates the main part of the network (around 95 percent). Due to this prevailing market structure, unbundling is an essential prerequisite to ensure non-discriminatory access to the network.

Even though the EU has set requirements for the unbundling process, many DSOs might be exempted. DSOs with less than 100,000 connections, or serving small isolated systems, are exempted from the requirement of legal unbundling according to the EU Electricity directive [5].

The exemption for DSOs with less than 100,000 connections means that a relatively large share of the DSOs is exempted from the EU requirement of legal unbundling (see Table I). Small-scale wind power and similar DGs are often deployed in the medium and low voltage net and in rural areas which in many cases also are the areas with DSOs with less than 100,000 connections. The missing requirement for unbundling in these areas might cause a barrier for new entrance of DG.

Naturally, effective national policies can delimit the detrimental impact of insufficient unbundling on DG market penetration. Support mechanisms such as purchase obligations and priority access for the promotion of DG automatically also counteract the use of obstruction tactics by incumbent electricity companies. However, in order to abolish any competitive advantage resulting from cross subsidization, legal unbundling is of utmost importance.

C. Market Access and Economic Aspects

Market access describes the support schemes, the access to selling the energy at different markets, and balance conditions. It is a presupposition for the successful deployment of DG. The Commission identified market structure and a lack of integration as one of the main obstacles to competition [2] arising from consolidation in the electricity industry. Only in the Nordic markets and in the UK, the largest electricity producer holds 15 to 20 percent of capacity. In all the other Member States this number is much higher, amounting e.g. to 85 percent in Belgium, France and Ireland, and even to 100 percent in Greece [8]. Naturally, concentration in the generation market, often connected to economies of scale and scope, renders it very difficult for the smaller DG operators to compete on equal terms in price. In addition, there may be other obstacles in the individual Member States, such as restrictions on the eligibility of market access for DG, a lack of market transparency, the fulfillment of technical or economic market operation requirements, authorization problems, and high trading fees on the power markets. National support mechanisms aim at fostering market penetration of DG in order to enhance their competitiveness towards the large electricity generators.

Support mechanisms for DG do not only differ between the countries, but may also differ between the different DG technologies in each Member State. The most used support mechanism is the feed-in tariffs – either as a fixed tariff or as a time dependent tariff (Table II).

Feed-in tariffs have been very effective in promoting DG in many Member States. However, with an increasing share of DG in the national supply system the feed-in system is not efficient. The generation is made accordant to the tariff levels and not accordant to the actual demand for power. Therefore, some Member States have replaced their feed-in systems with more market-based systems, e.g., quota systems or price premiums, where the support follows the demand for power. An example is Denmark that has a large share of DG CHP. Until recently, the DG CHP plants received a fixed feed-in tariff with three time dependent steps. This created problems with excess production in some hours. From January 2005 the tariff structure changed to a price premium, i.e. the support follows the supply through the spot market prices, which gives incentives to adjust the supply when there is excess production or excess demand.

### TABLE II

<table>
<thead>
<tr>
<th>Country</th>
<th>Current share</th>
<th>Support mechanism</th>
<th>Access to balancing markets</th>
<th>Capacity payments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>M</td>
<td>F</td>
<td>y</td>
<td>n</td>
</tr>
<tr>
<td>Belgium</td>
<td>L</td>
<td>Q</td>
<td>y</td>
<td>n</td>
</tr>
<tr>
<td>Denmark</td>
<td>H</td>
<td>P</td>
<td>y</td>
<td>y</td>
</tr>
<tr>
<td>Finland</td>
<td>M</td>
<td>I/T</td>
<td>y</td>
<td>y</td>
</tr>
<tr>
<td>France</td>
<td>L</td>
<td>F</td>
<td>n</td>
<td>n</td>
</tr>
<tr>
<td>Germany</td>
<td>M</td>
<td>F</td>
<td>y</td>
<td>n</td>
</tr>
<tr>
<td>Greece</td>
<td>L</td>
<td>I/F</td>
<td>n</td>
<td>y</td>
</tr>
<tr>
<td>Ireland</td>
<td>L</td>
<td>T/B</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Italy</td>
<td>L</td>
<td>Q/F</td>
<td>y</td>
<td>n</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>L</td>
<td>F</td>
<td>n</td>
<td>n</td>
</tr>
<tr>
<td>Netherlands</td>
<td>H</td>
<td>F</td>
<td>y</td>
<td>n</td>
</tr>
<tr>
<td>Portugal</td>
<td>H</td>
<td>F</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Spain</td>
<td>H</td>
<td>F/P</td>
<td>y</td>
<td>y</td>
</tr>
<tr>
<td>Sweden</td>
<td>M</td>
<td>Q</td>
<td>y</td>
<td>y</td>
</tr>
<tr>
<td>UK</td>
<td>M</td>
<td>n</td>
<td>n</td>
<td>n</td>
</tr>
</tbody>
</table>

The non-existence of a common EU support mechanism for DG implies that the economic conditions for DG differ between the Member States. This gives more incentives to deploy DG in Member States with gentle support systems, than to deploy in areas with DG resources or excess demand for power, e.g., if a wind turbine is deployed in a wind calm area with high support, instead of in a windy area. This is not economically efficient.

With respect to market access to the individual market, many Member States are providing at present access for the

\[5\] H = high when share of DG is larger than 20% of the national electricity capacity, M = medium when the share is between 10% and 20%, L = low when the share is less than 10%.

\[6\] F = Feed-In tariff, Q = quota system, P = price premium, I = investment grant, T = tax reimbursement, B = Bidding system.
DG to the spot markets. However, the access is often limited to a minimum capacity which de facto limits the DG’s use of the markets. In addition, the time period between the clearing of the market and until the actual delivery takes place is often up to 12-36 hours. For wind power and other DG with uncontrollable generation, this implies that the actual and expected delivery differ, which causes extra balancing costs.

The majority of the Member States gives the DG-operator direct access to the balancing market, i.e. they can submit bids to the balancing market. However, this access is often limited to a minimum capacity which limits the DG’s use of the balancing market.

Many Member States have implemented capacity payments for DG similar to the capacity payments to their centralized generators. However, also here minimum capacities are required in many Member States in order to receive the capacity payment. In practice this implies that a large share of the DG does not have access to the balance market, and they do not receive capacity payments.

This is a barrier for the deployment of DG, since they de facto have limited market access and limited revenue opportunity.

D. Interconnection Access

Network access describes the authorization procedure for getting a network connection, charges for connection and use of system, and technical requirements.

Long and complex authorization procedures and requirements for connections to the low voltage network may hinder easy connection of DG units in many Member States. The time-lag that is needed to carry out a deployment project, from the first moves made about a site until the moment the electricity sales starts, vary a lot from one Member State to the other, but also within a Member State from one region to the other and even from one project to the other.

Average lead times for the planning phase of DG in Europe are situated between 1.5 years and 4.5 years [10]. Southern countries tend to have longer lead times than others. In addition, not all deployment projects receive a deployment and connection permit to the local distribution network. The success rate for wind power is in the worst case down to only one out of ten DG projects that receive a permit to deploy.

V. DOMINATING BARRIERS

The previous discussion of market and network access revealed that the implementation of DG faces different kinds of barriers. Often, these barriers are inter-related across the split in the regulatory framework of the DSO, namely the market access and the network access.

This section summarizes the major barriers in the different Member States. Within the DG-Grid project [15] a questionnaire survey that asks for the major barriers for DG has been conducted.

When asked about the major barriers for DG the Member States answer differently. The different answers reflect the present major barrier. Other barriers may exist as well and old barriers may have been removed by efforts the regulators have done to facilitate the deployment of DG.

Lack of incentive for the DSO constitutes a major barrier in most Member States. Many national legal regimes still do not include any explicit incentives for DSOs to incorporate DG in the planning and operations of networks. Often, the DSOs maintain a passive operation philosophy rather than treating DG as an active control element in the operation and planning of their network. Many DSOs regard DG as an additional complexity and thus fear additional costs. Moreover, as for example in Austria, some DSOs also try to secure sites for their own affiliated companies which impedes penetration of new market entrants even more.

Connection charges are regarded as a major barrier to DG deployment in most of the Member States according to the conducted survey [15]. There are different problems in relation to them: first, in some countries connection charges are relatively high, in particular if they are based on deep connection costs. This implies a potential discrimination of new market entrants. Especially if the DSO has a lot of freedom in determining the connection and use of system charges, such as in Sweden and Finland, it bears the danger that some type of DG may be discriminated. Secondly, a lack of transparency concerning the calculation of charges constitutes another barrier. Last, the regulatory regimes on connection charges vary a lot from Member State to Member State. E.g. in Belgium the tariff is subject to approval by the federal regulator. However, in Austria, there is uncertainty with regard to pay-back on grid investments whereas use of system charges are strictly regulated based on benchmarks, and in Finland there are only some general instructions on the structure of the charges by the regulator.

Aggravation of market access is another main obstacle identified by the Member States. Here, entry barriers can take a variety of ways: a high degree of concentration on the power markets and economies of scale of incumbents render it very difficult for small DG units to establish themselves on the market. Moreover, there are high trading fees on the spot markets. The fulfillment of market operation requirements may further hinder the access to wholesale markets.

Procedural barriers to network access mainly consist of delays, the longevity and complexity of authorization procedures. Here, a special case is Germany which until July 2005 was the only country that had no regulated network access. Rather, conditions had to be negotiated between the involved parties. There was an agreement between industry associations that laid down the principles of network access and calculating grid charges. As a consequence, network access has been a main obstacle to the development of competition. The lack of regulated access has also been a problem for DG.

Naturally, for DG deployment adequate physical infrastructure, i.e. the network, is a basic condition to connect new sites. One major problem is the limitation in the
network’s capacity to absorb new generation. Problems of voltage control may arise, as for example in Greece and Spain, when new units are connected to the grid. Weak balancing mechanisms are to be taken seriously as they eventually may endanger the short-term security of supply in the case of interruptions due to failures. In addition, technical difficulties can lead to network connection delays, as e.g. in Ireland, which is detrimental for new DG operators.

VI. FINAL REMARKS

A pessimistic reading of the former sections could easily lead to the conclusion that promotion of distributed generation in Europe is subject to a number of important obstacles and, therefore, not very likely to work. In this concluding section we wish to provide a more balanced view of the areas which in fact have succeeded to become a relative large share of the generation capacity in Europe.

The share of DG in Europe is increasing and the regulation policies are changing. In addition, many barriers have already been removed by efforts the regulators have done to facilitate the deployment of DG.

Several of the problems discussed in the section on barriers must be considered as being temporary. This is particularly the case with respect to the obstacles of missing unbundling that often are created by different national traditions. Many Member States are going further than the EU directive and demand that even small DSOs are legally unbundled. These regulation efforts will be implemented in the years to come.

Other obvious examples are different rules for access to the distribution network and markets. So far this has especially been an obstacle for DG entrants and therefore, also for the development of the DG share.

Acceptance of the positive externalities of DG and its public good aspect has to be implemented in the entire system – from DSO to regulating authorities.

To the extent that this is achieved - which is no simple enterprise as there are still many vested interests present - the remaining national barriers protecting the incumbent utilities are likely to become much smaller.

Other obstacles to the implementation of DG can be of a more permanent nature if adequate policy measures are not taken. One example is lack of network investments and reinforcement of the distributed grid.

So far the EU policies have only indirectly been treating DG as one mean to achieve other policy goals, e.g. RES targets and security of supply. With a creation of a common EU policy framework for DG, the regulation for DG would be more focused at promoting DG.