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Towards a future with large penetration of distributed generation: Is the current regulation of electricity distribution ready? Regulatory recommendations under a European perspective

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ABSTRACT

The European Energy Policy promotes renewable energy sources and energy efficiency as means to mitigate environmental impact, increase security of supply and ensure economic competitiveness. As a result, the penetration levels of distributed generation (DG) in electricity networks are bound to increase. Distribution networks and distribution system operators (DSOs) will be especially affected by growing levels of DG. This paper reviews the current regulation of distribution in the European Union Member States, focusing on those aspects that might hinder the future integration of DG. Several regulatory issues that may hinder a successful integration of DG have been identified. Recommendations to improve the current situation are proposed. Regarding economic signals sent to DG, connection charges and cost-reflective use-of-system charges together with incentives to provide ancillary services are the key aspects. Concerning DSOs regulation, unbundling from generation and supply according to the European Electricity Directive, incentives for optimal planning and network operation considering DG, including energy losses and quality of service, and innovation schemes to migrate to active networks are the most relevant topics.

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1. Introduction

The European Union (EU) has perceived the need to implement a common energy policy, such as the existing common agricultural or trade policies. The EU Energy Policy intends to tackle three major challenges: environmental sustainability, security of energy supply and economic development (European Communities, 2007b). The Third Legislative Package that is currently being developed will presumably impose ambitious binding targets for green house gases emissions reduction, promotion of renewable energy sources (RES) and energy efficiency improvements. The co-generation of electricity and heat, or combined heat and power (CHP), is included as a relevant energy efficiency measure. The documents hitherto released propose to increase the share of RES in primary energy consumption in the EU up to 20% by 2020 (from less than 7% in 2007) and to improve energy savings by 20% during the same period (European Communities, 2006, 2008).

The electricity sector is a key element for the success of these policies. Hence, in order to reach the aforementioned goals, EU member states (MS) have implemented different support schemes for the generation of electricity from RES and (generally) CHP. The main mechanisms for the promotion of RES are feed-in tariffs (FITs), quota obligations with tradable green certificates, tenders and fiscal incentives. The most common approach is that of FITs either through fixed values of as a premium on top of electricity market price. This is also the support scheme used in the countries with higher shares of RES such as Spain, Germany or Denmark. However, there is no consensus yet as to what is the most appropriate mechanism for a successful and efficient development of RES. Furthermore, achieving the desired RES development relies not only on the support mechanisms but also on multiple other factors such as availability of resources, energy prices, administrative procedures or social acceptance of new technologies (Reiche and Bechberger, 2004). The combination of these elements and the details in the implementation process can explain the differences of RES growth in MS.

As a consequence of the support schemes, several new technologies, whose characteristics differ considerably from those of conventional electricity generation facilities, have been connected to electricity grids. Many of these RES and CHP technologies are susceptible of being applied in medium and small-scale. Therefore, the presence of distributed generation (DG), in electricity grids is progressively growing. Other terms sometimes used with a similar meaning are embedded generation, dispersed generation, decentralized generation or distributed energy resources (DER), although the latter usually includes demand

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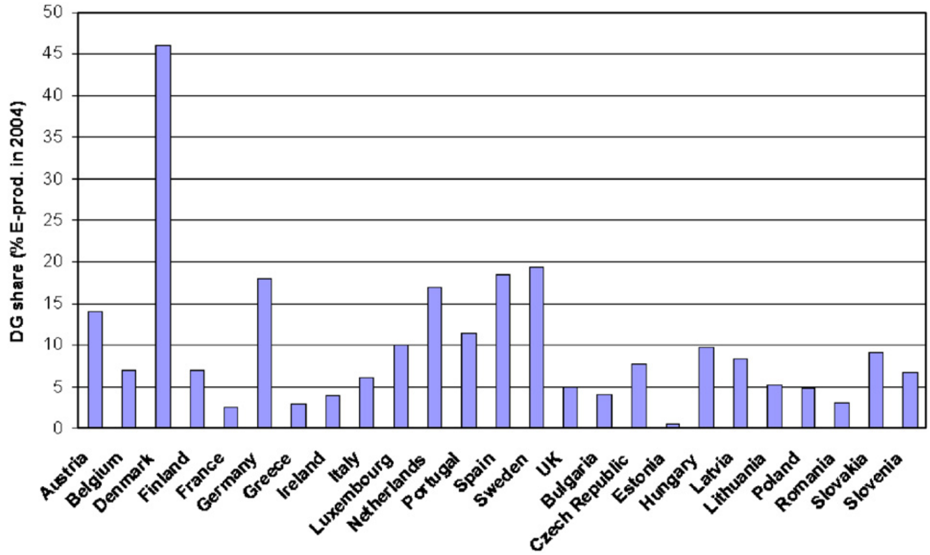

Fig. 1. DG shares in total electricity production in EU-25 countries (2004).

response. Traditionally, there has been lack of agreement on what exactly can be considered as DG and what cannot. This issue has been discussed by different authors (see Ackermann et al., 2001; El-Khattam and Salama, 2004; Pepermans et al., 2005), whereas the EU Electricity Directive (European Communities, 2003) states that DG are all power plants connected to distribution systems. On the ensuing, DG will be considered as facilities that provide (at least) active power whilst connected to the distribution system and with a rated capacity generally lower than 50 MW.

An additional driver for the development of DG is that of reducing electricity consumption at peak hours or selling power back to the grid. In order to do so, a net metering regulation must exist. This would be done by connecting very small generators (e.g., PV solar, microgeneration) directly to end-use consumers' side of the meter which would operate according to the price signals they receive. Consequently, the structure of distribution tariffs would potentially have a great effect of the behaviour of DG. This has been analysed in different studies for the United States (Marnay et al., 2008; Maribu et al., 2007). However, these cases will not be considered along this paper. In a European context DG mainly consists of RES and CHP generators receiving some form of support mechanism.[1] Consequently, the selling price normally exceeds the tariff value and small DG should be connected through a separate meter. Hence, from the DSOs viewpoint this agent would behave as two separate customers for tariffs purposes.

The share of DG in electricity production considerably differs along the countries (Fig. 1). EU-15 MS[2] have, as an average, higher shares of DG than new MS,[3] where these percentages do not go above 10% in any case. Some exceptions exist, being the most remarkable those of France or Greece where administrative barriers still hamper the growth of RES. On the contrary, DG accounted for nearly 20% of total electricity production in Germany, Spain or Sweden. Denmark is the European country with the highest DG share (above 45%). Note that low DG shares in new MS do not necessary imply low RES and CHP participation in electricity production. Most new MS have CHP shares similar to those of EU-15 countries and some have even higher RES shares in electricity production. However, high RES shares in electricity in new MS mainly consist of large hydro plants whereas the percentage of small-scale CHP is generally very low. For example, RES and CHP accounted for nearly 69% of Latvian total electricity production in 2004. Despite this fact, the corresponding DG share amounts to only 8.4% (Donkelaar et al., 2006).

Considering the previous definition of DG, i.e. generation connected to distribution networks, distribution system operators (DSOs) are the agents more closely involved in its system integration. DSOs are in charge of planning, operating and maintaining distribution networks. This definition implies that supplying energy to end consumers is not considered as a task of DSOs but that of the retailers, which may or may not be integrated within the same company. According to the European Electricity Directive (European Communities, 2003), in the EU DSOs must be at least legally and functionally unbundled from the rest of activities. The electricity distribution activity is a natural monopoly and as such, it is required to regulate somehow pricing and entry (Joskow, 2005). In spite of remaining as a regulated business, deregulation of electricity markets was accompanied by deeper changes in the traditional way to regulate distribution utilities. An adequate framework for regulating distribution should include the determination of efficient capital expenditures (CAPEX) and operational expenditures (OPEX), promote energy losses reduction and control the quality of service levels (Román et al., 1999).

Continuing policies promoting electricity production from RES and CHP will most likely lead to greater shares of DG in EU MS. Nonetheless, large-scale connection of DG in distribution networks faces numerous regulatory, economic, social and technological barriers. Moreover the impacts on the distribution activity will probably be considerable since, contrary to transmission grids, distribution networks were not originally designed to accommodate generation. Hence, their monitoring, control and operation greatly differs from of transmission grids, being it much more passive. In addition, due to higher uncertainties about the location of new generators as a result of unbundling, and the intermittent nature of some DG; new challenges for system operators and DSOs have arisen.

[1] Standby generation for critical loads would be an exception to this. Although this generally works in islanding mode in case of power outage and rarely injecting power into the network.

[2] Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain Sweden, UK.

[3] Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia.

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