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IMPROVING DISTRIBUTION NETWORK REGULATION FOR THE ENHANCEMENT OF SUSTAINABLE ELECTRICITY SUPPLY[1]

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Overview

In European member states, the public goal of a sustainable electricity system is strived for through a number of technology-specific member state support schemes for renewables-based electricity generation (RES-E) and co-generation of electricity and heat (CHP). This drives the growth of distributed generation (DG) – generators connected to the distribution network – to significant levels. The transition to a more sustainable electricity supply system based on DG poses costs and benefits, and threats and opportunities for the system as a whole.

Firstly, the DSO is impacted through its capital (e.g. possible deferral of network investments) and operational expenditures (level of distribution losses in the network). ***Secondly***, since the distribution of electricity is a regulated monopoly in EU member states, the incremental changes in capital and operational expenditures might have a negative effect on DSO revenues. An overall negative impact of DG penetration might warrant a neutralisation in regulatory arrangements for the DSO. ***Thirdly***, the presence of DG in distribution networks could be used to improve the cost-effectiveness of network operations. In contrast with current practice – where DG is simply connected to the network and taken for granted – DG can be involved in the provision of system services such as reactive power balancing, frequency control and voltage control. But to enable this type of services, DSOs need to innovate their business.

Methodology

We have gained insight into the electricity system costs and benefits of a higher level of DG in distribution networks through a load flow model analysis (Cao *et al.* 2006) where different network and DG characteristics are taken into account. **(2)** A spreadsheet model representing the financial position of the DSO is used to analyse the incremental impact of DG penetration in the distribution network for a DSO subjected to incentive regulation (De Joode *et al.* 2007). An assessment of network regulation literature and current regulatory practices in EU member states was performed to identify different ways to compensate DSOs for the negative impact of increasing DG penetration if necessary. The spreadsheet model was applied to test the effectiveness of the compensation measures. **(3)** An assessment of required network innovations needed to include DG in DSO system

[1] This abstract is based on results of the DG-GRID research project. The DG-GRID research project is supported by the European Commission, Directorate-General for Energy and Transport, under the Energy Intelligent Europe (EIE) 2003-2006 Programme (contract no. EIE/04/015/S07.38553). The sole responsibility for the content of this document lies with the authors. It does not represent the opinion of the Community. The European Commission is not responsible for any use that may be made of the information contained therein.

operations was performed. In addition, different ways to incentivise DSOs to innovate were identified (Bauknecht *et al.* 2007).

Results

With DG on the distribution network a DSO does not have to increase capacity of the connection to the transmission network or may even be able to reduce investments required in case of equipment replacement. At low DG penetration levels, the need for capital expenditure decreases may be zero, but higher DG penetration progressively increases with higher DG levels. Energy losses may decrease when low levels of DG are entering the distribution network, but increase when DG penetration levels are higher. **(2)** We show that DSOs under currently implemented network regulation can be negatively impacted by increasing DG penetration, especially for cases with high DG penetration and high concentration of DG in the distribution network. Alternative regulatory arrangements can compensate DSOs for the negative impact. **(3)** Most DSOs have been risk averse resulting in low innovation businesses. Current regulation is not actively stimulating DSOs to innovate their network business since cost reductions from innovation need to be passed on end-consumers after each regulatory period. Alternative innovation incentive schemes can be input or output based.

Conclusions

Current distribution network regulation is not durable in dealing with the transition towards a more sustainable electricity supply system. Although low levels of DG penetration might be beneficial, increasing DG penetration has negative impacts on DSOs under current distribution network regulation. In addition, DSO opportunities considering the involvement of DG operators in system services provision can not be seized without sufficient innovation incentives for the DSO. We suggest a number of regulatory improvements that can deal with these deficiencies.

References

Bauknecht, D., U. Leprich, P. Späth, K. Skytte, B, Esnault (2007), *Regulating Innovation & Innovating Regulation*, Oeko-Institut, a report of the DG-GRID project.

Cao, D.M., D. Pudjianto, S. Grenard, G. Strbac, A. Martikainen, S. Kärkkäinen, J. Farin (2006), *Costs and Benefits of DG Connections to Grid System; Imperial College*, a report of the DG-GRID project.

De Joode, J. , A. J. van der Welle, J. Jansen (2007), *Business models for DSOs under alternative regulatory regimes*, ECN, a report of the DG-GRID project.

Key words

distributed generation, distribution network, network regulation