DISTRIBUTION NETWORK TARIFFS AND DISTRIBUTED GENERATION: NEED FOR AN INNOVATIVE METHODOLOGY TO FACE NEW CHALLENGES. APPLICATION TO A CASE STUDY

[Angela Picciariello, KTH, +46 8 790 7773, angela.picciariello@ee.kth.se]
[Javier Reneses Guillén, IIT-Comillas, +34 91 542-2800, javier.reneses@iit.upcomillas.es]
[Pablo Frias Marín, IIT-Comillas, +34 91 542-2800, pablo.frias@iit.upcomillas.es]
[Lennart Söder, KTH, +46 8 790 8906, lennart.soder@ee.kth.se]

Overview

The whole electricity sector is currently undergoing massive changes, due to the liberalization process and the changes in the regulatory regimes occurred in many countries. In particular, the distribution sector is facing new challenges, among the others the integration of an increasing amount of distributed generation (DG) in the distribution grids. In fact, the DG connected to the distribution grids is likely to affect the planning and operation of the grids themselves and, consequently, to cause additional costs and benefits for the different network users.

The distribution tariff design deals, at a first stage, with the *determination of the total allowed revenue* for the distribution business and, at as second stage, with the allocation of that revenue among the users of the distribution network, i.e. with the *decision on the tariff structure* to be adopted. This paper focuses on the second stage of the process. With this respect, some studies can be found in the literature about the guiding principles of tariff design and its traditional methodologies. Not much, however, has been studied regarding the new challenges posed by DG within the tariff design process, such as the need for new cost allocation methodologies in order for consumers and DG units to share the additional costs and benefits caused by DG. In reality, in fact, either *DG is still exemtped* from paying distribution tariff, which are, therefore, totally borne by consumers in many countries, or l*oad-tailored schemes* are being applied to DG, such as the problematic, but not uncommon, combination of volumetric tariffs with net metering.

This paper, therefore, investigates the broad range of different issues arising within the rate design process due to DG presence. A new methodology is proposed for allocating distribution costs among consumers and DG units.

Methods

The so-called Reference Network Models (RNMs) are used to run a *network planning optimization problem*, subject to capacity, voltage drop, quality of service and geographic constraints.

The optimization problem is first run without the DG units, and then with the DG units connected to the grid, in order to identify the additional grid costs/benefits imputable to DG. The optimization problem represents the cost-causality function to be used as a basis for designing the tariffs.

Since individual tariffs are not of easy implementation, clusters need to be obtained for loads and DG units.

As for the loads, after the determination of the different geographical homogenous areas and the network cost associated with each one, network cost allocation between energy and demand is done, i.e. a *location-dem*and and *location-energy* cost drivers are used; similarly, the main DG-related cost drivers are identified as the voltage level of the DG connection, the DG size and the connection node being a demand-dominated or a generator-dominated one.

The so-obtained tariffs contain a clear locational signal for the DG siting.

Results

- Identification of the main DG-related cost drivers, i.e. the voltage level of the DG connection, the DG size and the area of the connection being demand-dominated or generator-dominated.

- Formalization of a distribution tariff proposal, in order for DG and loads to share grid costs in an optimal way.

Conclusions

With an increasing level of DG penetration in distribution grids, distribution tariff design needs to take DG into account when determining the network charges to be paid by the different network users.

In order to do this in a correct way, new methodologies are needed, so as to efficiently combine a cost-causality approach with the practical issues arising when implementing distribution tariffs in reality.

A novel methodology, based on loads and DG clusterization on the grounds of their respective contribution to grid costs in the network planning process, has been proposed in the paper.

References

Cossent, R.; Olmos, L.; Gómez, T.; Mateo, C.; Frias, P. "Distribution network costs under different penetration levels of distributed generation," *European Transactions on Electrical Power*, vol. 21, no. 6, pp. 1869-1888, September 2011.

Mateo, C., Gómez, T.; Sánchez A.; González, J. P.; Martínez, A. "A Reference Network Model for large-scale distribution planning with automatic street map generation". IEEE Transactions on Power Systems, vol. 26, no. 1, 190-197, February 2011.

Rodriguez Ortega, M. P., Perez-Arriaga, J. I.; Rivier Abbad, J., Peco Gonzalez, J. "Distribution network tariffs: A closed question?". Energy Policy 36 (2008), 1712-1725.

Sotkiewicz, P. M.; Vignolo, M. "Towards a cost causation-based tariff for distribution networks with DG". IEEE Transactions on Power Systems, vol. 23, no.3, August 2007.

Li, F.; Tolley, D. L.; "Long-run incremental cost pricing based on unused capacity," IEEE Transactions on Power Systems., vol. 22, no. 4, pp. 1683-1689, November 2007.

"Network tariff structure for a smart energy system". EURELECRIC. May 2013.

"From Distribution Networks to Smart Distribution Systems: Rethinking the Regulation of European Electricity DSOs". THINK Project, Final report. June 2013.