Costing Network Services for Consumers with PV Self-Generation

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Overview

Consumers are increasingly adopting self-generation for a part of their electricity consumption thanks to the sharp decrease in solar production costs. Most European distribution grid tariffs are mainly related to the amount of energy withdrawn from the grid. The adoption of self-generation can consequently offer a substantial reduction of the network bill, which raises equity and efficiency issues, related to network costs allocation among customers. It also points towards a need for a better identification, costing and pricing of the different services provided by the grid.

Methods

In this paper, our approach adopts a costing perspective, based on a probabilistic methodology. We obtain the expected cost that is to be allocated to every client connected to any grid circuits of the Distribution System. This is a relevant first step from the perspective where distribution grid tariffs do not discriminate clients by location, as implemented by most companies [1] and by the French regulatory regime.

In order to estimate, for France, a sharing of network costs among customers with different grid services uses, this paper relies on a splitting of operational costs and capital amortization costs among network access, network sizing and energy losses :

- **Spatial network costs** are directly related to the geographical coverage of the grid. Conversely, these costs are considered independent from the energy consumption behaviour of customers. These costs are distributed evenly across all electrical point of delivery of a voltage level, whether grid users or transformers. Costs allocated to transformers are then redirected to point of delivery at lower voltage levels.
- **Network sizing costs** includes billable costs related to the services of guaranteed power, energy withdrawal and voltage quality. These costs are allocated hour by hour for a normalized calendar and then combined with the hourly load curve of customers. The time-of-use allocation is based on a peak-load method: peak demand levels are used as a proxy driver for the current and future sizing of transformer stations. However, a utility-wide probability distribution of peak periods is used to take into account of all situations in grid circuits.
- **Energy losses** are broken down in two parts : Joule heating losses and other losses as iron, dielectric or non-technical losses. The former type of losses are estimated by multiplying losses volume by electricity prices on the spot market during the relevant period. For other types of losses, an average annual price for electricity is used.

Power demand in lower voltage levels implies energy transit at upper voltage levels; therefore network sizing costs have to include all the voltage levels necessary to transport and to distribute electricity to the final grid user. As network sizing costs are allocated on an hourly basis for three different voltage levels (high, medium and low voltages), the hourly costs for delivering 1 MWh at a given voltage level is a weighted sum of these hourly costs at all upper voltages levels, taking into account the power load due to transit for lower levels and including energy losses.

Results

Once network costs have been allocated either on a per connection point basis, either on an hourly basis, it is possible to attribute network costs to a grid user based on its load curve and voltage level. Impacts of self-consumption on the allocation of network costs are therefore the difference between the attribution of costs for a customer before and after installation of solar panels. In this situation, annual fixed costs per connection point remain unchanged.

Network costs, which tariff bills will have to cover, are attributed to a consumer according to the likelihood that his use of the services provided by the grid may contribute to the need of future network investments. When a customer starts to self-consume his own electricity and require less energy transit, this likelihood may be reduced. It is important to understand that these results do not represent an average ‘value for the grid’ of self consumption, but an ‘allocation of billable costs’ based on consumer loads and utility-wide likelihoods of contributing to peaks.

Further, there are some simplifications that should be improved on in future works:

- The contrast in costs allocated to identical clients, with or without self-consumption is based on a cost allocation derived from the current network loads. An updating of these loads to account for a large additional development of self-consumption would reduce this contrast, while not reducing the total amount of costs to recover from the clients. Besides, in cases self-consumption develops by local clusters, the resulting high PV penetration rates may entail additional network reinforcement costs.
- Time related consumption behaviour changes with the installation of solar panels for self-consumption have not been implemented, as comprehensive data on this subject are not available.

In order to have a simple and common indicator of self-consumption impacts on the allocation of costs for different types of clients, the clients’ annual gains in cost allocations are presented on a per MWh basis of annual self-consumption. One should recall, however, and take into consideration for the analysis, that costs are very unevenly allocated over hours and seasons.

In the current situation of low self-generation penetration, a residential customer with self-consumption may be attributed less billable network costs averaging around 14€-16€ per self-consumed MWh. As mentioned, these value average local as well as seasonal heterogeneities, e.g. the gains per MWh are about three times higher during winter and four times lower in summer, reflecting seasonality in both hourly costs and in volumes of PV self-consumption.

For businesses and farms, adopting self-consumption reduces the attributed network costs to a lower value than for residential customers: around 12-13€ per self-consumed MWh for a user connected to the low voltage network, and 8€ for an industrial site connected to the medium voltage network.

Conclusions

The methodology developed in this study provides an estimate of billable network costs attributed to consumers according to their loads, with a focus on the difference between clients with or without self-consumption. While distribution network costs are local, our allocation provides utility-wide averages in order to compare with grid tariffs that do not discriminate consumers by location, not only for historical, but also practical reasons [8], such as social acceptability and price intelligibility.

These results are a first step; some simplifications and data we had to use tend to overvalue the gain for self-consumption, which would become quickly limited to energy losses in case of a widespread and fast development. Yet, the difference we obtain in costs for self-consumers and usual consumers is still considerably narrower than the actual decrease in network bill when a consumer adopts self-consumption, given the current network tariffs structure in most European countries [1]. This is consistent with other analyses that suggest that a typical self-consumer pays a network bill lower than his share of the costs when grid tariffs remain mainly related to the amount of energy withdrawn from the grid [2].

Such discrepancies raise distributive [2] and efficiency issues about consumption choices. Consumers face an increasing number of energy solutions for their heating, mobility, and other final needs. These solutions can be electricity powered or not, and rely on electricity supplied from the network or from or self-generation. Not considering that the tariff can induce substitution effects may lead to rising deadweight losses [3].

This could be corrected through a rebalancing of network tariffs towards lower rates for energy withdrawn and higher fixed rates –or as a substitute, higher price rates for guaranteed power or capacity– in combination with time-of-use prices according to season and time of day for the energy component of the tariff.

References

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