ELECTRICITY DISTRIBUTION NETWORK TARIFFS – PRESENT PRACTICES, FUTURE CHALLENGES AND DEVELOPMENT POSSIBILITIES

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ABSTRACT

In this paper, we discuss the pricing of electricity distribution. In the paper, the present practices concerning the forming of tariffs are examined. The possible directions and main future challenges of the energy sector can present challenges for the business of Distribution System Operators (DSOs). These change directions and challenges are examined and explained in the paper. The development opportunities from the alternative distribution network tariff structure and implementation possibility point of view are briefly discussed in the paper.

INTRODUCTION

The electricity distribution business is operated by the DSOs which fund their operation mainly by distribution charges. In the past, DSOs have had few incentives to considerably develop their pricing practices due to the local monopoly positions. The tariff structures of the DSOs especially in the case of smaller customers have been quite inflexible meaning that these customers have not had to the means to easily affect the level of their distribution fee. In the future, it is possible that this is going to change. The future challenges pressure the DSOs to re-evaluate their pricing practices in order to maintain the profitability of the distribution network business. There is ongoing research activity concerning the development possibilities of the small customer distribution tariffs. For example there is a case specific study going on, where real network, customer and cost data of Helen Electricity Network Ltd. are used. The study is described in [1].

The purpose of this paper is to discuss the present state of the pricing of electricity distribution and to explain some of the possible directions of future changes and main challenges of the distribution business.

This paper is structured as follows. In the next section, the bases of the pricing of electricity distribution are discussed. After that, generally used distribution network tariff structures are explained. In the fourth section, possible future changes of the energy sector are discussed. The fifth section discusses the main future challenges which might have an effect on the distribution network business. In the last section, some development possibilities of the distribution tariffs are reviewed.

PRICING OF ELECTRICITY DISTRIBUTION

The practice of forming electricity distribution network tariffs is about balancing between different pricing principles such as the cost-causality (i.e. matching principle) and simplicity while satisfying the non-discriminatory demands of the pricing.

The pricing process

The electricity distribution network tariffs have to cover all the expenses of the operation and the revenue has to be high enough also to receive reasonable profit for the capital invested into the electricity network.

The cost structure of the DSO consists of various cost elements such as depreciations of network assets, cost of losses and transmission use-of-system charges, customer and metering related costs and other operational costs. These different types of costs can be classified under different cost drivers such as power demand, energy demand and customer. The costs are then allocated to different customers or customer groups by a specified approach, one of which is explained in more detail in [2].

Pricing principles

There are various principles which are used in the pricing of electricity distribution. In the following some of the main principles are commonly explained.

A full-scale simultaneous realization of all the principles is not practically possible. For example, the full-scale realization of the cost-causation principle would lead to complex price lists which would be in a direct conflict with the demand of non-discriminatory pricing and the simplicity principle. In practical life, a balance between the realization of different pricing principles has to be found and compromises have to be made between them.

Cost-causation principle

Cost-causation principle here means the principle of allocating the costs to the customers who are seen to be responsible of them. This ideally means a situation where the customer pays only the costs that are incurred from delivering the energy to the customer and no subsidization between the customers would occur.

In practice, it would not be possible to form prices for all customers based on cost-causation because it would make pricing of the DSO complex. In addition, if the prices were customer specific in high detail (i.e. the length of the network and the location of the customer would be the defining factors of the distribution fee) the pricing would be in conflict with the non-discriminatory demand.

Non-discriminatory pricing

Electricity distribution tariffs should be fair to all customers of the DSO. The cost-causation principle is in a key role since it aims towards the minimization of cross-

subsidies between customers of different sizes and consumption behaviors. Another point of view for non-discriminatory pricing is that the customers are treated equally. This could mean e.g. that in Finland the geographical location of the customer in the distribution network cannot affect the bases of the distribution fee. The customers of the same tariff group pay the same unit prices regardless of their location within the network area of the same DSO. The customer buys the access to the whole national grid and is able to buy electricity from whichever retailer is willing to sell the electricity to the customer.

Simplicity

The simplicity principle here means that the price list and the structures of the tariffs of the DSO have to be clear for the customers to understand how the distribution fee is formed (i.e. the tariff structure should not be too complex). If the charge components of the distribution tariffs were to change often and depend on the consumption in some complex way, the customer would face challenges in trying to anticipate the changes in the distribution fee.

Other principles

In addition to the simplicity principle, the distribution network tariff structures should also be relatively similar with the tariffs of the energy retailer from the tariff system understandability point of view.

In practice, the distribution network tariffs have to be reasonable when compared to the general price level. In the past this has been realized by the DSO comparing their tariff prices with other DSOs having similar cost, network and customer structure and setting their prices close to the average prices. This can lead to problems in the future since the DSOs have to be able to secure adequate revenue to fund future investments and just following others will not necessarily be enough.

DISTRIBUTION NETWORK TARIFFS

Traditionally the distribution network tariffs and thus also the revenues of the DSO have been energy dependent. The present distribution tariffs of smaller and larger customers are discussed in the following.

Tariffs for small customers

In many European countries, the present distribution network tariffs for small customers consist of a fixed monthly charge and a charge dependent on the amount of distributed electricity (i.e. energy charge) [3]. During the past years, the DSOs have started to emphasize the fixed part (i.e. the fixed charge) more instead of the variable part of the tariff (i.e. the energy charge). This is not the best approach since the customer cannot affect the size of the fixed charge and the customers who use electricity evenly have to pay for the costs inflicted by peakier customers.

Tariffs for large customers

Larger customers such as industrial or large commercial customers use distribution network tariffs that are more flexible than the tariffs of small customers. The large customer tariffs typically consist of a fixed monthly charge, an energy charge and separate charges for active and reactive power. The power charges enable planning the use of various devices in a way that minimizes the simultaneous power demand.

FUTURE CHANGE DIRECTIONS

The future changes of the energy sector affect the business of the DSO. In this section, we discuss the effects of three extreme scenarios explained in the following.

Fig. 1 presents three possible development scenarios from the present state to three different extreme cases (A, B and C). On the horizontal axis, the transition line from energy-based distribution network tariffs (*EBT*) towards power-based distribution tariffs (*PBT*) is depicted. The vertical axis presents the transition from a situation where there is a minor amount or no small-scale energy production (e.g. photovoltaic production units) at the customer end (*Low Prod.*) to the situation where there is a considerable amount of electricity generation at the customer end (*High Prod.*). In case A it is assumed that the distribution network tariffs are to remain unchanged and there will be more energy production at the customer side. A development where there is more small scale electricity production on the customer side and where the DSO will change the pricing structure towards the power-based tariffs is presented as case B. In case C, it is assumed that there will be no production on the customer end and the DSO will change their tariff structures to be more power-based.

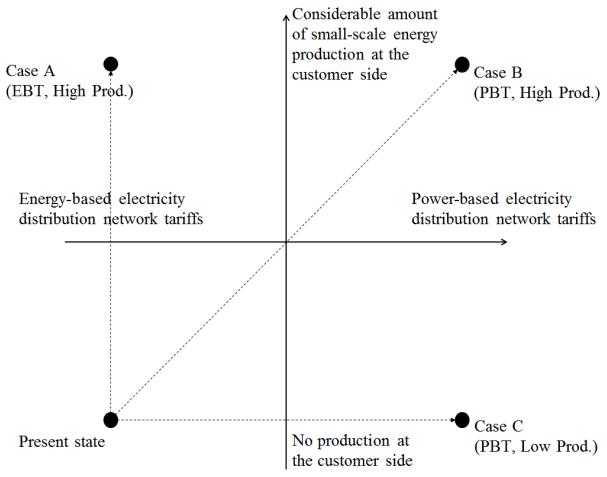

Figure 1. *Extreme scenarios of the future change directions from the distribution network tariff (EBT to PBT) and small-scale energy production (Low Prod. to High Prod.) point of view*

The pros (+) and cons (-) of the scenarios (A, B and C) are briefly examined in the following from the viewpoints of the customer, the DSO and the energy retailer.

Case A (EBT, High Prod.) - Customer:

+ Customers who have their own electricity production units will pay small electricity bills.
– Customers who do not have their own electricity production face higher electricity costs because fewer customers are left to pay for the costs of the energy system.

Case A (EBT, High Prod.) - DSO:

+ Energy production on the customer side can lower the simultaneous demand in the grid.
– Less energy moving through the grid will result in smaller revenue for the DSO.
– The power injected into the grid can be quite high during maximum production hours which may even create a need for strengthening investments.

Case A (EBT, High Prod.) - Energy retailer:

+ Different new business opportunities may arise from which the retailer can profit. For example the retailer can sell different ancillary services to the customer or buy the production from the customer to use it in various markets.
– The revenues of the energy retailers may decrease due to less electricity being sold.

Case B (PBT, High Prod.) - Customer:

+ Customers experience moderate changes in their electricity bills. If the customer has the ability to shift consumption evenly between the hours of the day, the power-based pricing will lead to smaller distribution fees while the customer has the opportunity to optimize their energy use to minimize the total electricity cost.
– Customers who do not have their own electricity production and are not able to respond to the price signal may face higher electricity costs.

Case B (PBT, High Prod.) - DSO:

+ The revenues of the DSO will not change dramatically since the pressure can be shifted from the energy charges to other tariff components. The strengthening investment needs of the grid may be postponed or even completely avoided in some cases.
– Very little cons. The implementation of new tariff structures and communication with the customer can be challenging in the beginning.

Case B (PBT, High Prod.) - Energy retailer:

+ The energy retailer can find new business opportunities and sell the customers ancillary services used in other markets.
– The energy retailer will not receive maximum benefits due to DSO tariffs when the customers try to minimize the total costs of electricity.

Case C (PBT, Low Prod.) - Customer:

+ Customers who have possibilities to lower their power demands will pay lower distribution fees.
– Some customers have high consumption peaks and the power-based distribution network tariffs will result in higher distribution fees.

Case C (PBT, Low Prod.) - DSO:

+ The revenues of the DSO will not change dramatically if the tariffs are formed correctly and consumption behavior changes are taken into account. Lower peak power demand may postpone the strengthening investment needs of the electricity network or they can in some cases be completely avoided.
– Very little cons. Individual changes in customer specific distribution fees may be quite large if the customers cannot change their consumption behavior.

Case C (PBT, Low Prod.) - Energy retailer:

+ Energy retailers will not experience massive changes to their revenues since the amount of sold electricity does not change much as there are no changes in the production. The customers are encouraged to consume electricity so that the consumption profile is even. This could make it easier for the retailer to optimize the electricity trading.
– The revenues of energy retailers may change when the consumption profiles change due to power-based distribution network tariffs if no actions are taken.

MAIN FUTURE CHALLENGES

The main future challenges of the field are described and explained in more detail in the following. The challenges are not yet reality but to ensure the profitability and sustainability of the electricity distribution business the DSOs will have to be able to handle them.

Distribution grid capacity and reinvestment needs

The present distribution grid on the whole European level is facing the rebuilding stage. Traditionally the grid is planned to withstand the highest estimated simultaneous load. For example in Finland, the distribution grids are quite strong due to e.g. electric space heating, water boilers, sauna and electric ovens which means that also in low voltage networks a three phase system is used. The grids are able to withstand the high load peaks which occur during winter when the heating demand is high.
One additional key challenge comes from the legislative point of view. In Finland, the legislation emphasizes the role of reliability of supply. The DSOs are pressured to make their networks more immune to weather and this typically means underground cabling. The costs from these legislative issues have caused pressure to the DSOs to raise the price levels of their tariffs to gather enough revenue in order to fund these improvement investments to be made into the network.

Small scale energy generation

Another key change factor is the increasing amount of small-scale energy production at the customer premises (i.e. photovoltaic production units). This has an effect on the amount of electricity distributed to the customers. This issue combined with the present structure of distribution

network tariffs can turn out problematic for the revenues of the DSOs. The amount of electricity delivered decreases due to the raising amount of distributed energy generation and thus the revenues of the DSOs also decrease. This development does not remove the responsibility of the DSOs of maintaining and developing the distribution networks to serve all the customer loads and productions. The costs of the network assets and operation may increase when responding to the changes in the operating environment.

Changes in the consumption

The changes in the customer behavior have to be taken into account when the DSOs re-evaluate their tariffs. Different large individual electrical appliances such as heat pumps and electric vehicles can challenge the electricity network in terms of power since they are probable to increase the consumption peaks. The simultaneous switching of the loads can cause quite a high demand which the network has to sustain. This becomes highly relevant in the case where the customers have more and more of energy retailer tariffs, where the price of the energy is linked e.g. to the day-ahead market price of the wholesale electricity market. If the energy price varies greatly from hour to hour, the customer would have the incentive to consume more electricity during the cheap hours as one optional demand response (DR) functionality. This would result in high simultaneous power demand that could be substantially higher than today. Simultaneous demand being a central cost driver for the DSO, this challenges the tariff structure of the DSOs.

DEVELOPMENT POSSIBILITIES

The listed future challenges should be considered in the future business of the DSOs. If the challenges were to be realized, the DSOs should have means to respond to the changes in the business environment in a suitable and effective way. As possible measures of responding to the challenges, the DSOs can either raise the unit prices of present tariff charge components or develop their pricing practice e.g. by changing the distribution tariff structure of small customers in some way. The former option would be a more passive response whereas the latter would be more active.

Alternative distribution network tariff structures

There has been much discussion about developing new distribution network tariff structures especially for smaller customers in the past few years. From various different tariff structures, the power-based tariffs (i.e. a tariff which has some kind of a power demand component in addition to the present tariff components) of smaller customers have been under active discussion and research lately. The extreme version of the power-based distribution tariff has been presented in [4] where the customer reserves a certain power capacity from the network and pays only a fixed monthly fee for it (i.e. the tariff structure consists solely of the power charge component).

Enabling technology

The actual implementation of alternative distribution tariffs especially in the case of smaller customers was not practically possible in the past due to the lacking functionality of the energy meters. The potential use of smart meters in the implementation of new tariff structures has been discussed e.g. in [5] from hourly measurements balance settlement and so called “software fuse” functionality point of view.

In addition to the smart meter point of view, various Home Energy Management Systems (HEMS) could also be used to implement different tariff structures. If more complex distribution tariff structures were to be implemented, the use of some kind of a device or a system is required, if not mandatory, because the customer is unlikely willing to do all the switching of loads manually in the long term.

CONCLUSION

In this paper, the present state of the pricing of electricity distribution is discussed. The paper provides a brief overview of present practices concerning the pricing of electricity distribution, possible changes in the energy sector, main upcoming challenges of the electricity distribution network business and development possibilities from the distribution network tariff point of view. Distribution network tariffs have a central role in the future of the energy sector and there is active ongoing research e.g. about the potential use of power-based distribution network tariffs of small customers.

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