Designing efficient distribution network charges in the context of active customers

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HIGHLIGHTS

• An efficient distribution network charges method is proposed.
• The method ensures network cost recovery and promotes efficient network investments.
• The method includes forward-looking peak coincidence network charge and fixed charge.
• Customers’ response is modeled to compare their reaction to network charge designs.
• Methods including network peak coincidence charge lead to optimal customer response.

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ABSTRACT

The transformation of electricity network users from passive to active agents, as a result of decreasing costs of distributed energy resources, requires several adaptions, one of which is revising the distribution network charges. Often current network charge designs do not ensure network cost recovery and lack to incentivize efficient network investments and usage. New network charge methodologies are required to guide and incentivize customers in an efficient way while maximizing system economic efficiency. This paper proposes an efficient methodology that ensures network cost recovery while promoting efficient usage of the network as well as efficient network investments. The proposed network charge design consisting of two components: a peak coincidence network charge (PCNC) and fixed charge. The PCNC is a forward-looking charge as it considers the cost of future network reinforcements required and assigned to customers during peak hours of the network utilization. Fixed charges allocate the residual of the network costs following Ramsey-pricing principles. This paper compares the outcome from economic optimum customers’ response to four different network charges: (i) volumetric charges (ii) fixed charges (iii) peak demand charge (iv) PCNC plus fixed charges. Two case studies for two different load profiles are simulated using linear programming to minimize their total costs within each charges design, considering the possibility of buying electricity from the grid and investing on onsite generation or curtail load. Finally, the paper highlights through the case studies how customer’s response is highly influenced by different network charge designs, and compares the consequences of these responses in terms of network cost recovery and total system costs. The paper concludes with practical issues that need to be considered for the implementation of the proposed network charges design.

1. Introduction

Traditionally passive electricity customers are becoming active consumers through Distributed Energy Resources (DERs), such as self-generation, demand side management and storage. These changes impose the necessity of redesigning distribution network charges to comply with an efficient network utilization and optimal customer response. In other words, network charges need to ensure network cost recovery in a fair matter while incentivizing efficient network investments and usage. Although the integration of DERs create challenges for Distribution System Operators (DSOs) in the operation of their networks; such as increase in the variability of power consumption, bi-directional energy flows, voltage instability, and reduction in power quality, yet they also create opportunities for the distribution networks

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to be managed more efficiently, by avoiding or deferring network reinforcement. Such opportunities could be attained by the network charges through efficient signals that incentivizes appropriate customer responses. The design of efficient network charges in the context of active customers is a challenging and crucial topic that is currently in a position of debate between regulators, DSOs, customers, and DER suppliers.

The urge to redesigning distribution network charges has been discussed in various researches [1–4]. In [2], European Distribution System Operators (EDSO) for smart grids advised on the need of clear incentives to convince customers to change their energy consumption habits. Moreover, they also indicated that network tariffs must be designed to ensure that consumers generating their own electricity still contribute with their fair share of the distribution network costs. Moreover, as EDSO stated in [3], customers should be able to self-generate and self-consume energy as long as the costs induced by their use of network services is reflected in their bill. However, since self-generation may lead to lower network usage and lower revenues to DSOs, and distribution network tariffs is a main tool to provide price signals to customers [4], thus, network charges should be updated to avoid such impacts. Furthermore, EDSO presented a number of key messages in [3] regarding the revision of current distribution network tariffs, to be more capacity based, and less volumetric based, in order to limit revenue uncertainty for DSOs. They also clarified that the traditionally-designed network tariffs can lead to inefficient network investments, reducing social welfare. Hence, distribution network charges require regular assessment to ensure efficient and fair recovering of network costs while sending appropriate signals to customers [1].

Electricity bills are composed of: Distribution Network (DN) charges, transmission network charges, energy prices,1 other regulated costs (e.g. renewable subsidies), and taxes. DN charges are usually set by national regulators, with exceptions to several countries: as in Spain, where the government sets it, in Sweden, where it is set by the DSO and supervised by the national regulator, in Norway where DSOs are given a large degree of freedom regarding how to design tariffs based on their allowed revenues, as discussed in [1], which reviews different practices in EU. Moreover, in Poland, DSOs set the tariff according to the rules defined in the Energy Law Act along with the Minister of Economy, and subject to the approval of the regulator [5]. Similarly, in Finland, each DSO has the right to set its own tariffs as long as it follows the rules set by the Energy Authority [6]. Traditionally, DN charges aimed to collect

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1 Energy prices are a result of markets, network charges are due to regulated decisions made by the competent authority.
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