ASPECTS OF DEVELOPMENT NEEDS FOR DISTRIBUTION NETWORK TARIFFS IN THE CASE OF ENERGY COMMUNITIES AS NEW EMERGING USER TYPES

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Keywords: DISTRIBUTED ENERGY RESOURCES, DISTRIBUTION NETWORK BUSINESS, DISTRIBUTION NETWORK TARIFF, ENERGY COMMUNITY, PRICING PRINCIPLES

Abstract

This paper discusses distribution network pricing in the presence of energy communities (EC) as new emerging user types. ECs can take many forms and by utilizing distributed energy resources (DER), they can aim to effectively minimize electricity bills of their members. However, if ECs either operate over the public distribution network or have a connection to it, they will impose costs on the distribution system operator (DSO). According to the requirements set by the European legislation, it should be made sure that ECs contribute to the cost sharing of the distribution system. In this paper, we discuss items related to distribution network pricing and what kind of challenges ECs might impose on the business of DSOs. As present distribution tariffs are designed for traditional load customers, they might not be suitable for different types of ECs as such. Present tariffs might result in a free-riding problem, which is problematic, e.g., from equality and cost-reflectivity perspectives. This pushes DSOs to develop alternative pricing schemes so that the requirements set to pricing by the legislation and common pricing principles are fulfilled. There is a clear need for a more thorough quantitative research regarding distribution tariffs of ECs in the future.

1 Introduction

Recent developments in the European legislation create opportunities for customers to take part more actively in the electricity market activities in the member states than before. As customers are acquiring their own small-scale production units, such as solar panels, and investing into other energy efficiency solutions, they are on the way of becoming prosumers and active customers. Additionally, in cases where the customer does not have ideal conditions to acquire such elements, according to Directives (EU) 2018/2001 and (EU) 2019/944, they could form an energy community (EC) with other customers, where the participants acquire, share, and use joint distributed energy resources (DER), such as energy production units, energy storages, etc. [1; 2].

As the role of the customers is evolving from traditional load customers to being active participants in the electricity market, it affects how they are seen, e.g., from energy retail and electricity network perspectives. For instance, distribution system operators (DSO) are facing a new user type as customers of various sizes are beginning to form ECs in the distribution network, which bring new challenges into the operational environment. In the literature, various topics regarding ECs have been studied, but the aspect of how ECs might affect the business of the DSO through distribution network pricing has not been studied thoroughly. In this paper, our focus is on the distribution network tariff perspective regarding ECs and to discuss issues related to present distribution pricing of DSOs in the presence of ECs.

Discussion regarding the development of distribution network pricing has been active in the recent years. One of the discussed items has been the improvement of the cost-reflectivity of distribution network tariffs, especially in the case of tariffs applied to small customers [3]. The aim of the development is to link tariffs to the underlying costs of the distribution network business more accurately than today. This aspect regarding tariff development extends also to other user types. For instance, in the case of ECs, Article 16 of the Directive (EU) 2019/944 states, among other requirements, that ECs should be subject to cost-reflective network charges, and it should be ensured that ECs contribute to the cost sharing of the system in a balanced way [2]. Cost-reflective tariffs are a crucial element, since today, distribution network tariffs in many countries still emphasize volumetric charges (c/kWh). From DSO perspective, a significant portion of the costs of distribution system results from costs related to network capacity, not from costs related to energy volume. Tariffs, which emphasize volumetric charges, do not offer proper signals, which would reflect the underlying costs of the distribution network business [4]. Volumetric charges have a long history in distribution network pricing. For instance, in Nordic countries, after the unbundling of the electricity market activities, distribution tariff structures of small customers remained the same as during the time pre-unbundling because there was no visible need to change the pricing schemes and volumetric charges also encourage customers toward energy efficiency.

Although tariffs that depend on volumetric charges create incentives for the customers to find ways to lower their distribution fees, e.g., through investing into small-scale renewable energy production, such as solar panels, the costs of the DSO remain nearly at the same level, and they have to be recovered through distribution network tariffs. If no changes are made to the pricing and customers invest more on small-scale energy production, or form ECs, this would result in lower turnover for the DSO from these customers. To compensate for the gap in the turnover, unit prices of tariffs would have to be raised. This would mean that the customers, who do not have their own production units, or do not take part in ECs, are left to pay more and cross-subsidies between users, or user groups, might become stronger than today.

The operational environment is changing in terms of how distribution network is seen from different perspectives. The future role of the DSO is viewed as more of a neutral operator or facilitator, which offers its services to its customers and other market participants within its technical properties [5]. Novel user types, such as ECs, are one central element, which push DSOs to investigate their pricing to comply with requirements set by the legislation, such as those set in Article 16 of the Directive (EU) 2019/944 [2].

In this paper, through qualitative analysis, we provide answers to the following key research questions.

1. What different EC types have been identified?
2. How could ECs affect the business of the DSO?
3. What must be accounted for in pricing of network services so that distribution tariffs applied to ECs are feasible and follow the common pricing principles when different types of ECs exist in the distribution network?

This paper is structured as follows. In section two, different EC types are discussed, which answers the first research question. The third section comprises of a description of distribution network tariffs and relevant principles related to distribution network pricing. In the fourth section, issues regarding distribution network pricing, which occurs between ECs and DSO, are discussed. Sections three and four answer the second research question. The remaining two sections of this work provide discussion and conclusion to the paper simultaneously answering to the third research question.

2 Energy communities

In this section, different forms of ECs are discussed. Directive (EU) 2019/944 defines the term 'citizen energy community' as

”*a legal entity that:*

(a) is based on voluntary and open participation and is effectively controlled by members or shareholders that are natural persons, local authorities, including municipalities, or small enterprises;

(b) has for its primary purpose to provide environmental, economic or social community benefits to its members or shareholders or to the local areas where it operates rather than to generate financial profits; and
(c) may engage in generation, including from renewable sources, distribution, supply, consumption, aggregation, energy storage, energy efficiency services or charging services for electric vehicles or provide other energy services to its members or shareholders;” [2].

As it can be observed from the definition of the term citizen energy community, it is quite general in nature. As ECs can take many forms and they could be either physical or virtual depending on where their members are situated, which affects how they are treated in distribution network pricing. Table 1 presents a brief overview of different EC types, which however is not comprehensive and there might be other variations.

Table 1 Different types of ECs

Community type	Subcategory	Example
Physical	One property with multiple customers	Housing company
	Multiple properties and customers	Properties in a same street or block
	Closed network	Industrial or commercial area
Virtual	Single or multiple properties with single or multiple customers	Customers situated in different parts of the public distribution grid

2.1 Physical energy communities

Customers situated near each other could form a local EC, where they pool and share their DERs, such as energy production units and energy storage. The EC could be characterized as a physical EC, which means here that the participants utilize the same network assets and there is a clear connection between users inside the limits of the community interface. One practical example of this kind of a physical EC could be a block of flats with joint energy production units. This kind of an EC is discussed, e.g., in [6] as a local energy community operating within a housing company in Finland. The Finnish government issued a decree in December 2020, which states that, within the housing company, net metering should be done and used in billing [7]. This means that housing companies are able to benefit from acquiring joint energy production so that the electricity moved through the network inside the property boundaries would not be subject to distribution network tariffs or taxes, and only the consumption post-net metering, and the excess energy injected to the distribution grid outside the property boundaries, are billed through distribution network tariffs of the local DSO and taxed.

Alternatively, if the EC would operate over the distribution network owned by the local DSO, customers situated in the same area could form an EC (e.g., customers situated in the same block or street). This kind of an EC would solve a situation, where, e.g., the environmental conditions for solar energy production are suitable only on some of the properties inside the EC interface. However, Finnish legislation today does not allow to move the energy from the production unit between properties through the public distribution grid without paying network charges or taxes. Additionally, the net metering scheme would not apply to EC participants and volumetric charges would have to be paid for all the consumption, although the energy would be produced on the next property. In the future, it could be possible to expand the net metering scheme applied to housing companies today to these kinds of ECs with a joint connection point to the public distribution network (e.g., customers living in the same street, behind the same distribution transformer, or the same low voltage line). If net metering could be done inside the EC interface in a similar way to housing companies, it would strengthen the incentive for customers to join and form local ECs. This would also effectively mitigate the need to construct parallel networks to move the electricity from one property to another, which, in Finland, would also require a license from the national regulator. [6] Alternatively, instead of not billing internal flows inside the community interface, different pricing schemes could be developed to ease the sharing of energy inside the EC. In this case, the price level of the tariff could be relatively low compared to regular distribution network tariffs because the EC would utilize only local network assets, not the whole distribution network.

Lastly, ECs could own the network assets in its operational area and have a single connection to the public distribution network. For instance, this kind of an EC could comprise of industrial or commercial customers and their various DERs situated in a closed network with a joint connection to the public distribution network.

2.2 Virtual energy communities

Differing from physical energy communities, virtual energy communities are formed by members without a direct physical connection to one another. In this case, members of the EC could be situated further away from each other and the EC requires the public distribution grid to operate and to share resources among its members. For instance, members of a virtual EC could even be situated in different parts of the country and the EC would not have to be limited to operate inside the operational area of a single DSO. In this case, network charges would be paid to each DSO in areas, where the members of the EC are situated.

3 Distribution network tariffs

This section consists of a description and discussion regarding different pricing principles involved in the pricing of distribution network tariffs. Additionally, a description of present distribution tariff schemes is provided.

3.1 Principles involved in pricing

Distribution network business is a natural monopoly, where one operator provides distribution services to customers inside its area of responsibility. Because of this, the business is subject to regulation, which aims to protect customers from excessively high prices and to provide DSOs with the ability to cover the costs of operation and receive a reasonable rate of return for the invested capital. The goal of regulation and legislation is to realize multiple pricing principles, such as non-discriminatory, equality, cost-reflectivity, cost recovery, non-distortionary, transparency, predictability and intelligibility or simplicity principles. [8] Because there are conflicts between ideal implementation of some of the principles, realizing all of them simultaneously is not a realistic expectation. Tariffs are typically a result of a set of compromises, where some principles are weighed more than others to reach a suitable balance.

In short, tariffs should enable the remuneration of the costs in a manner, where each customer group would pay for the costs they impose on the DSO. As due to regulation, DSOs are entitled to collect a certain turnover during the regulation period. It is highly relevant that the collection of this turnover should be done in an equal way. The way how customers pay for the service should also be intelligible for the customers, and tariffs should not include significant cross-subsidies between customers or customer groups. Additionally, tariffs should encourage customers to efficient use of electricity. Energy efficiency has been one of the most important aspects in pricing. However, e.g., due to low energy but high-power load devices, the timing of electricity use has become an increasingly relevant aspect in distribution pricing.

In the recent years, cost-reflectivity aspect of small customer tariffs has gained a lot of attention in many countries, as changes in the operational environment (e.g., energy efficient load devices and small-scale energy production) challenge present pricing schemes. Lastly, the evolving role of the DSO as a facilitator and a provider of a neutral platform, pushes DSOs to investigate and develop their pricing.

3.2 Present pricing schemes

Today, DSOs in many European countries offer different distribution network tariffs for customers of different sizes. For smaller users, distribution network tariffs compose mainly of fixed base charges and volumetric charges, with possible Time-of-Use (ToU) features. In many countries, such as in Finland, volumetric charges are still in a significant role in determining the magnitude of the distribution fee. For instance, for an average household customer, approximately more than half of the distribution fee is formed by the volumetric charge.

Distribution network tariff structures applied to larger customers, such as commercial or industrial customers, are composed of a fixed charge, a volumetric charge with possible ToU features, and demand charges for active and reactive demands. A more versatile tariff structure offers better opportunities for larger users to affect the magnitudes of their distribution fees. Demand charges have been used for larger users in many countries for decades. However, as measurement devices used to determine billing demands are also becoming widely available to small customers through smart meter rollouts, DSOs have the tools available to develop tariffs of small customers and, e.g., to include separate charges in tariffs, which account for the demand of the customer in some way.

For customers who own energy production units, separate tariffs can be applied to the energy fed into the grid. For instance, in Finland, the national legislation defines that the distribution fee is based on energy volume and it also limits the average annual distribution fee for small-scale energy production to 0.07 c/kWh pre-tax. The price cap can be seen to operate as an incentive for small customers to acquire small-scale energy production units, such as solar panels. [9]

Recent developments regarding distribution network tariffs have focused mainly on developing tariff structures of small customers. To improve tariffs of small customers, development direction, where demand of the customer is included in the distribution tariff structure in some way, has been discussed actively in many countries. One potential development direction has been to include demand charges to small customer tariffs so that the tariffs would be linked to cost drivers of the distribution business better than today. Additionally, demand charges could mitigate cross-subsidies between prosumers and consumers, and they would also offer better means for customers to affect the magnitudes of their distribution fees. Various demand related tariff structures have been investigated in the literature [10].

4 Potential issues regarding tariffs in the presence of energy communities

This section consists of potential issues regarding distribution network pricing in the case of ECs. In tariff design, one way of determining distribution tariffs consists of two steps. In the first step, costs of the distribution business are distributed to different customer groups based on their expected demand. The second step consists of forming tariff structures, which would generate the target turnovers from customer groups. The first part of this section focuses on issues regarding the cost allocation. After this, issues related to tariff structures are discussed.

4.1 Aspects related to the allocation of costs between different customer groups

When ECs start to emerge, they will affect the business of the DSO in different ways. First, when costs are distributed to different customers groups in tariff design, the load profiles of customer groups are in a central role. For instance, in traditional cost allocation process, a significant portion of costs is allocated to customers groups based on their participation to the system peak demand at different main network levels. If the EC could actively lower its demand during the system peak demand, it should in some way be made sure that an adequate portion of costs is allocated to EC customer groups, although lowering the system peak demand is a wanted result and it should be rewarded. There might be a need to investigate alternative cost allocation methods, which would reward customers, such as ECs, for benefitting the system and simultaneously distribute the costs between customer groups so that no high cross-subsidies would be present. Additionally, the used tariff structures also affect how ECs will adjust their consumption patterns to minimize distribution fees. To highlight, it is important to apply appropriate tariff structures, which aim to realize general pricing principles, but it is also important to account for the effect of ECs when costs of DSO are distributed to different customer groups. The goal of taking these two aspects into account is to ensure that the costs are distributed to different customer groups in an equal way and that each customer group contributes to the cost bearing appropriately.

In the case of internal transfers, a part of the costs allocated to ECs would have to be separated from the total amount to determine tariffs for internal transfers. If no charges would be carried out from moving the produced electricity inside the EC interface, no separation would be necessary. Lastly, it should be studied if distribution tariffs are needed for energy fed into the public distribution network in the future and this aspect should be accounted for in the cost allocation.

4.2 Aspects related to distribution network tariff structures

As pointed out in the literature, such as [11], small-scale energy production paired with volumetric tariffs might prove problematic if a great number of production units are present in the network. In the case of ECs, highly volumetric distribution tariffs could prove challenging due to large amount of local energy production. This effect could be mitigated by applying alternative tariff structures, such as tariff structures that include demand related tariff components. However, in the case of energy storage, demand components should have to be designed so that the tariffs generate an appropriate turnover from the ECs.

A great number of ECs will inevitably push the DSOs to investigate their pricing, and there is a need to develop alternative pricing schemes for ECs. The reason for this is that, if present tariffs are applied to ECs with DERs, such as solar panels and energy storage, the overall turnover gathered from ECs might not be at a sufficient level and the cost burden is shifted to other user groups. The possible free-riding problem could be mitigated by appropriate tariff design and tariff structures to ensure that ECs contribute to the cost bearing of the distribution system appropriately. Avoiding network charges and shifting costs to other customer groups is not seen as a desired outcome, and different pricing schemes could provide a solution for this challenge [12]. If ECs could lower the costs of the DSO, e.g., by offering flexibility to the DSO, they should benefit from it financially. In network development, flexibility services could operate as an alternative tool for the DSO and they should be accounted for. However, flexibility services could be operated separately from distribution network tariffs, e.g., as ancillary services. Additionally, according to Article 16 of the Directive (EU) 2019/944, DSOs should cooperate with ECs to ease internal electricity transfers within the communities, which might affect how and for what ECs are billed through distribution network tariffs [2].

5 Discussion

Development of distribution network tariffs has been an actively discussed topic in the recent years. However, in the case of ECs, there seems to be a gap in the literature regarding how they would affect the business of the DSO, and what kind of solutions there would be for distribution network pricing for different types of ECs.

The main challenge is that, with even a small number of ECs, DSOs should apply cost-reflective tariffs to them, which ensure that different forms of local ECs contribute to the cost sharing of the distribution system appropriately. For instance, with the presence of DERs, present pricing schemes might not be best suited for ECs, since the tariff structures have been designed mainly for traditional load customers without DERs. If ECs become more common, DSOs should have appropriate tools, such as alternative tariffs, available to quickly adjust their pricing and adapt to the changing situation. There is a clear need for further research to study, which kind of alternative tariff structures could be applied to different forms of local ECs, and what the price levels of various tariff components would be.

6 Conclusion

This paper discussed aspects regarding distribution network tariffs in the presence of ECs. The European legislation states that ECs should contribute appropriately to the cost sharing of the system. Additionally, distribution tariffs should be cost-reflective. In the case of ECs as new user types, they challenge present pricing schemes of DSOs and push them to investigate their pricing. Distribution network pricing related themes, such as tariff structures applied to various kinds of ECs, have not been studied thoroughly, and there is a clear need to investigate these aspects more closely in the future.

7 References

[1] Directive (EU) 2018/2001 of the European Parliament and of the Council on the promotion of the use of energy from renewable sources

[2] Directive (EU) 2019/944 of the European Parliament and of the Council on common rules for the internal market for electricity and amending Directive 2012/27/EU

[3] Eurelectric, 'Network tariffs' (EURELECTRIC, 2016), pp. 1-13

[4] Passey, R., Haghdadi, N., Bruce, A., MacGill, I., 'Designing more cost reflective electricity network tariffs with demand charges', Energy Policy, 2017, 109, pp. 642-649

[5] Colle, S., Micallef, P., Legg, A., Horstead, A., 'Where does change start if the future is already decided?' (Ernst & Young, 2019), pp. 1-36

[6] Pahkala, T., Uimonen, H., Väre, V., 'Flexible and customer-centred electricity system; Final report of the Smart Grid Working Group' (Ministry of Economic Affairs and Employment, 2018), pp. 1-44

[7] Finnish law, 'Government Decree 1133/2020 on the determination and measurement of electricity supply amending the Government Decree' (in Finnish: 'Valtioneuvoston asetus sähköntoimitusten selvityksestä ja mittauksesta annetun valtioneuvoston asetuksen muuttamisesta 1133/2020')

[8] Council of European Energy Regulators, 'Electricity Distribution Network Tariffs CEER Guidelines of Good Practice' (CEER 2017), pp. 1-40

[9] Finnish law, 'Government Decree 65/2009 on the electricity market' (in Finnish: 'Valtioneuvoston asetus sähkömarkkinoista 65/2009')

[10] Honkapuro, S., et al., 'Development options and impacts of distribution tariff structures', (2017), pp. 1-86

[11] Council of European Energy Regulators, 'CEER paper on electricity distribution tariffs supporting the energy transition' (CEER, 2020), pp. 1-39

[12] Council of European Energy Regulators, 'Regulatory aspects of self-consumption and energy communities' (CEER, 2019), pp. 1-53