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Regional distribution effects of different electricity network tariff designs with a distributed generation structure: The case of Germany

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ABSTRACT

The growing share of distributed generation and the corresponding need for grid extensions are anticipated to considerably influence electricity grid tariffs in the future. Depending on the regulatory framework and demand structure of the respective country, the necessary expansion measures being taken are disparately affecting different regions. With the underlying public support for the energy system transformation taking place across Europe crucial to its success, mechanisms to facilitate a cost-reflective and non-discriminatory cost distribution should be investigated. Based on a classification of critical factors responsible for regional discrepancies, we model and estimate residential customers' tariffs in Germany and their regional distributional disparities while assessing various reform measures. The findings show that the overall tariff rates in Germany and the already existing regional disparities are poised to increase substantially by 2025. A tariff corridor and deep first connection charges considerably limit tariffs and increase distributional equity amongst regions. A generation tariff alters the distribution and reduces the highest tariffs. An energy-based tariff that neglects the impact of prosumers further aggravates the regional distributional disparities. This paper gives insights into the challenges of cost allocation within electricity grids and intends to help to design an adequate and fair cost allocation mechanism.

1. Introduction

Within Europe, electricity grids are regulated in a very heterogeneous fashion. Most recently, the configuration of the respective regulatory designs has gained renewed attention in the wake of the growing need for investments in distribution networks. In this respect, the most prominent research in this area assumes the perspective of grid operators in fashioning regulatory mechanisms to ensure the most efficient grid operation while affording the necessary incentives to provide for investments in grid infrastructure.

Less emphasis, however, has been placed on the distributive impact of the infrastructure costs on end users. In the most traditional sense, grid operation and maintenance costs have been allocated to reflect the impact of the grid user on the network and thus assume a cost-reflective and non-discriminatory cost distribution. Within the predominantly centralized electricity generation structure that prevailed up to the most recent decade, in which electricity supply and the requirements of electricity grids were mainly driven by demand, this cost allocation framework was applicable. However, with the most recent developments with respect to the distributed nature of renewable power production and the growing need for investments in extending distribution networks to facilitate the integration of the installations, the merits of the customary cost recovery scheme are being reconsidered (Council of European Energy Regulators (CEER), 2017; Regulatory Assistance Project (RAP), 2014; Eid et al., 2014). This issue has come to the attention of policymakers in countries where significant increases in network charges are being compounded by sharp regional disparities in their scale. This development bears the potential to further strain public acceptance for the ongoing decarbonization of the energy system currently being pursued across Europe (Zoellner et al., 2008). Therefore, fashioning an adequate regulatory framework to curb this development is of critical importance in facilitating its success.

The research presented here provides an overview of the various cost recovery schemes across Europe while highlighting the critical aspects of the tariff structures that need to be addressed to manage cost growth and regionally disproportionate impacts. To highlight the critical individual structural characteristics of the cost recovery regime, we investigate the situation in Germany, where currently measures are being discussed to reform the existing allocation scheme (BMWi, 2017b). The analysis conducted estimates the increase in network charges in Germany over a ten-year timespan with a granular regional distribution of the charges and their respective growth. The resulting

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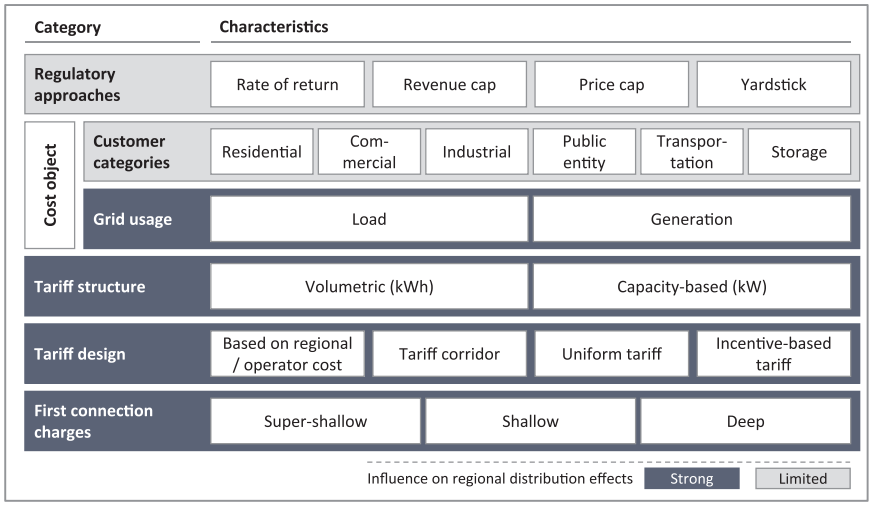

Fig. 1. Aspects and possible characteristics of grid remuneration concepts. Source: Own illustration.

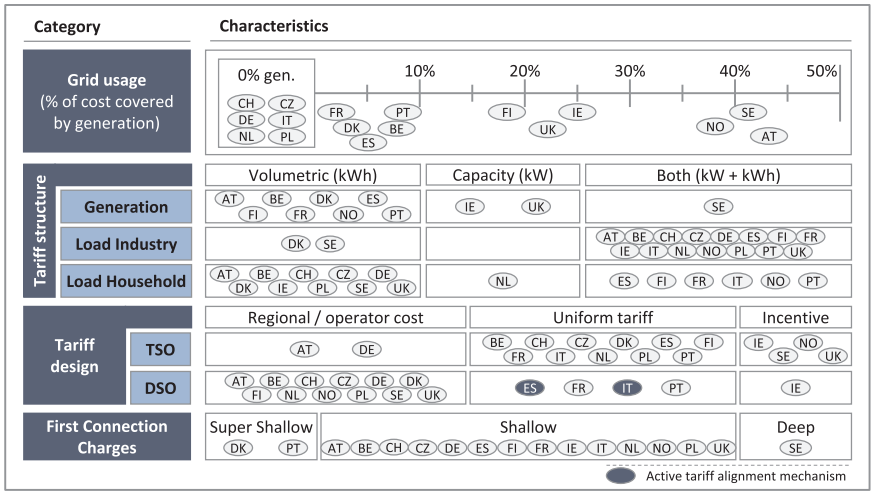

Fig. 2. Classification of grid cost remuneration concepts in 17 ENTSO-E countries, analysis restricted on continental territories, islands and overseas territories excluded. Source: Own illustration based on ENTSO-E (2016), Eurelectric (2013), Eurelectric (2016), European Commission (2015), Fronier Economics Ltd (2012), EY (2013), Cambridge Economic Policy Associates (2015), national regulators and TSO companies.

discrepancies in network charges are computed and the regional distribution of the allocated costs is examined. Subsequently, measures are evaluated to assess their impact on curbing regional disparities while discussing their implications for the regulatory nature of the cost recovery scheme as a whole. In this respect, the paper aims to raise awareness for potential network regulatory reforms that are needed to help facilitate a transformation to a distributed power system while in a first step providing more transparency about the specific dynamics at play. The findings should serve as a basis for further investigations into defining and designing recovery schemes for a decentralized electricity system that promote an efficient use of the network and remain non-discriminatory in nature.

The paper proceeds as follows. In Section 2, we outline the basic elements of network regulation and the cost recovery mechanisms prevalent in Europe and their relevant characteristics concerning aspects of their cost allocation. Section 3 lays out the reasons for examining the German case. Section 4 describes the methodology used in our analysis. Section 5 details the results of the analysis while Section 6 concludes and provides policy recommendations.

2. Electricity network regulation and cost recovery schemes

Electricity transmission or the provision of electricity network services constitute a natural monopoly, i.e. in economic terms it is characterized by a subadditive cost structure due to high fixed costs and relatively constant marginal costs. Under such a declining average cost structure, total costs are lower if only one company supplies total output (Cowan, 2006). As this monopoly position warrants regulatory oversight, system operators are subject to regulation with regard to the network tariffs they charge their customers.

The electricity grid is typically structured hierarchically into transmission and distribution networks. Transmission grids facilitate the transport of electricity over large distances and ensure system stability, reliability, resilience as well as balancing between different regions and countries. They also set the basis for liquid power markets serving a large number of producers and consumers. Distribution grids deliver electricity from the transmission grid to the end customer, connect distributed generators to the transmission grid and facilitate balancing between distributed supply and demand. Due to their different characteristics and their usually distinct ownership and operational makeup, certain regulatory aspects can differ between transmission and distribution grids.

In addition, there are several aspects to consider when it comes to the allocation of the considerable share of fixed costs tied to the provision of public infrastructure such as electricity grids. Fig. 1 lists different aspects of cost recovery schemes and features of their implementation while Fig. 2 gives an overview of recovery schemes in 17 ENTSO-E countries. Corresponding maps can be found in Fig. A.1–A.3