# *MANAGING DISTRIBUTED FLEXIBLE LOADS VIA NETWORK TARIFFS*

Christine Brandstätt, Jacobs University Bremen, c.brandstaett@jacobs-university.de

## Overview

Technological innovation and ongoing transitions in the energy sector are introducing new loads and appliances in the electricity sector. Electric vehicles, heat pumps and batteries have the potential to add substantially to existing electricity consumption and network load. Furthermore these new loads are expected to fundamentally alter established consumption patterns. At the same time, this new consumption is, at least in parts, flexibile and can shift consumption for example during periods when the vehicle remains parked or the when buildings remain warm with the structures thermal lag. Therefore they can support the integration of volatile generation from renewable sources and help to increase the usage and restrain cost of grid infrastructure. Unlocking this flexibility potential, however, requires managing a comparatively large and divers set of distributed loads.

In theory this management can be explicit, with a central instance in charge of dispatch, or implicit, via incentives for operation decisions. The latter seems particularly promising for a distributed and liberalized setting. Thus the question arises how to manage distributed flexible loads via network tariffs. Use-of-system charges recurringly connect the network and its users. So far they mainly serve finance the infrastructure. The above described changes may call for a shift towards providing signals for efficient network use.

This paper draws on research funded by the German Federal Ministry of Education and Research (CoNDyNet project) and Stiftung Energieforschung Baden Württemberg. It analyses these incentives from various network tariff schemes such as load-, capacity- and energy-based charging but also more detailed charging aspects such as net metering, simultaneity-based and time-of-use charging for distributed flexible users. The paper is organised as follows: After the introduction the second section gives a brief overview about the different charging schemes, their background and applications. The third section describes the modelling of network tariffs and flexibility of distributed loads. In section four we present the modelling results, which in the final section allow us to draw conclusions on promising tariff schemes for distributed flexible loads and regulatory switches from one tariff scheme to another.

## Methods

- modelling network use of consumers with flexible load in distribution grids, particularly heat pumps and electric vehicles as a function of network tariff:

  We define a demand for the mobility or heat service over the course of a set of type days. Based on the thermal lag of the building or the storage capacity of the vehicle battery the actual electricity consumption is partially decoupled from this demand. Making use of this flexibility the user optimizes its cost in view of different network charges.

- modelling network cost as a function of individual network use:

  We obtain overall network load profiles as a sum of the individual consumer loads for a set of type days. Required network capacity and hence (expansion) cost is linked to overall network peak load.

- simulate individual network use and overall network cost in scenarios of different penetration with flexible users and varying network tariff schemes

## Results

First, the charges in network overall network utilization is assessed if the new loads are not or poorly managed and therefore operated unflexibly.

Second, we identify charging schemes that incentivize operation strategies which require lower network capacity and consequently lower network cost, or at least less expansion than in the unflexible case.

Third, we assess the dynamics of rising shares of new users in the grid. Increasing simultaneity of consumption lowers the ability of flexible users to restrain network cost and thus the value of flexibility. On the other hand an increased availability of similar flexibility reduces the incentives and hence the effect of some tariff schemes.

## Conclusions

The potential to imlicitly manage distributed flexible loads via network tariffs is demonstrated for the given scenarios. We find that particularly tariff schemes based on simultaneitly of loads are equipped to restrain network cost. Additionally, the paper provides valuable insights for the transition from one tariff scheme to another as well as for designing network tariffs for evolving systems.

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