EVALUATING INCENTIVES OF DIFFERENT GRID TARIFF DESIGN OPTIONS

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Motivation

The electrification of the heating sector with heat pumps and the transport sector with electric vehicles will pose additional loads to electricity distribution grids. Furthermore, ongoing installations of PV systems add distributed generation that typically does not have a high temporal correlation with new and existing loads. Energy communities accelerate the expansion of distributed renewable electricity generation and benefit from grid tariff reductions, while not being grid-friendly per se. These trends pose challenges for distribution grid operators.

Many of the new distributed small-scale technologies can provide some kind of flexibility. For example, heat pumps can make use of the thermal inertia of buildings to shift loads to different times, or electric vehicles can use optimized charging strategies to increase the use of local production. Besides grid reinforcement and expansion, a grid-friendly operation of these distributed flexibilities can be a measure to tackle the challenges distribution grids are facing.

Grid tariffs can provide incentives for a grid-friendly operation of flexible technologies. In the ORANGE project[3], the effects of different grid tariff design options on the optimal operation of distributed flexible technologies for different use cases are evaluated quantitatively to analyze the incentives they provide and investigate their effects on peak distribution grid transformer loads and the electricity bill of end-users.

Methods

In the ORANGE project three grid tariff design options are defined and compared to the current constant volumetric tariff:

- **Peak**: a capacity-based tariff in EUR/MW for the annual peak load
- **Dynamic**: a volumetric tariff in EUR/MWh changing dynamically based on the state, i.e., the total load, of the distribution grids
- **Incremental**: a volumetric tariff in EUR/MWh that increases stepwise depending on the consumption.

To evaluate the effects of different grid tariff design options, the operation of different distributed flexibility options is simulated in the optimization framework Femto.jl[4] in six use cases, including two rural, two suburban and two urban distribution grids. For each use case a current and a future scenario are considered, differing in the available end user technology portfolio. All use cases include consumers and prosumers, energy community members and end users not participating in energy communities as well as end users with constant and dynamic supply tariffs. The operation of all technical components and demands of all end users is simulated in a daily rolling horizon optimization framework for one year considering quarter-hourly time steps and minimizing the total cost of electricity procurement for all end users, including electricity supply cost, grid cost, fees, and taxes. The resulting schedules are evaluated in terms of grid transformer consumption and feed-in peaks, total costs for end users and specific end user groups and compared to the respective numbers for the current grid tariff design.

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[3] https://projekte.ffg.at/projekt/4746343 (accessed 29.11.2023)
[4] https://codeberg.org/daschw-lab/Femto.jl (accessed 29.11.2023)

Results

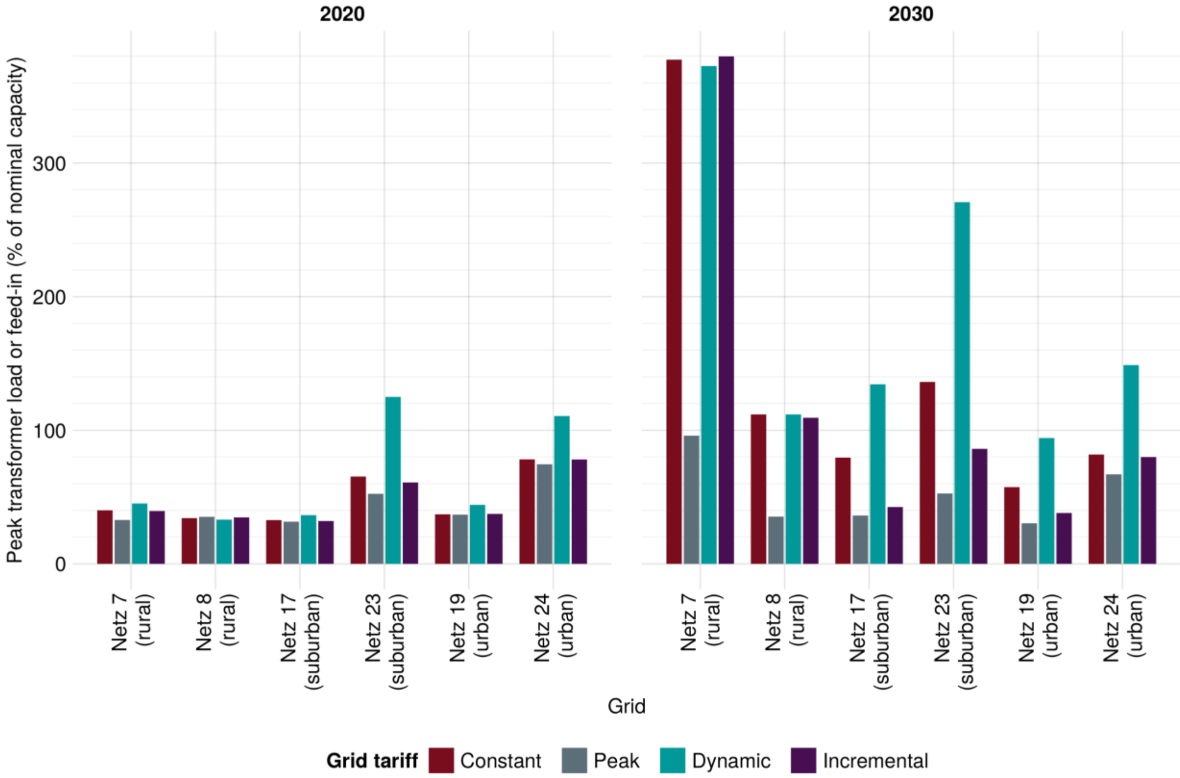

Figure 1: Annual peak transformer load or feed-in relative to the nominal transformer capacity for different use cases and grid tariff design options.

First results indicate that the structure of grid tariffs can have a significant impact on distribution grid peaks. Figure 1 shows the resulting annual peak load or feed-in at the distribution grid transformer stations resulting from optimal responses to different grid tariff designs in the considered use cases. **Dynamic** pricing in the grid tariff seems to increase maximal grid loads, while the **Peak** and **Incremental** tariff designs seem to provide more suitable incentives. The lowest annual peaks in the distribution grids are achieved with the **Peak** tariff in all scenarios. In the future 2030 scenarios the impact of grid tariff designs is significantly higher than in the current 2020 scenarios due to higher shares of distributed flexible technologies.