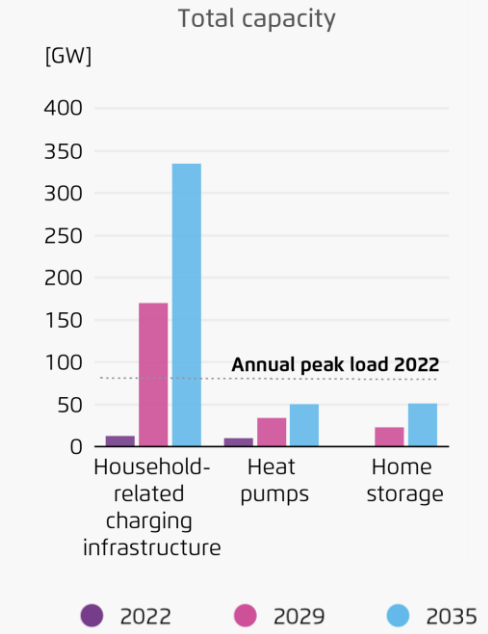
Utilising household-related flexibilities

How electric vehicles, heat pumps and home storage systems can reduce electricity costs for everyone

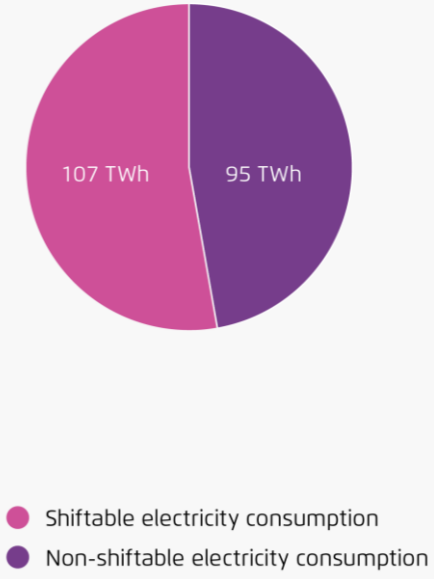
Katrin Schaber, Agora Energiewende

New flexible assets on demand side are conquering the market and add considerable flexibility potential in households.

Development of household-related flexible consumption facilities



Household electricity consumption 2035



- → Maximum supply capacity of the new consumers significantly exceeds the maximum annual load
- → Report shows that household-related flexibilities totalling 100 terawatt hours can be activated in 2035
- → The increasing share of wind and solar power generation is an advantage as it means that, e.g. surpluses can be utilised well

Agora Energiewende has analysed the effects of four electricity tariff models on the operation of household-related flexibilities.

The study: Utilising household-related flexibilities

- → **Forschungsstelle für Energiewirtschaft e. V. (FfE)** has carried out detailed grid modelling
- → The entire German low-voltage level, to which households are connected to, was mapped with the help of typical networks
- → Load flow simulation determine the grid expansion requirements, while taking into account four tariff models
- → Modelling results were supplemented by an overall system cost analysis by Agora Energiewende
- → Regular dialogue with an **advisory group** consisting of representatives from the energy industry (distribution system operators, aggregators, manufacturers)

Methodology

The four tariff models differ to the extend in how they take the current wholesale power price and grid utilisation into account.

Composition of the dynamic electricity tariff per scenario

Scenario	Procurement price	Grid fees	Time frames of grid fees
lowFlex	constant	constant	–
Flex	dynamic*	constant	–
Flex-ToU	dynamic*	time-variable	static
Flex-dynToU	dynamic*	time-variable	dynamic

Time-variable grid fees:

- Peak and off-peak times are defined in advance
- Price time series varies between different days, regions, seasons; but are identical for each DSO area (larger regions)
- Similar to price module 3 from §14a EnWG

Dynamic grid fees:

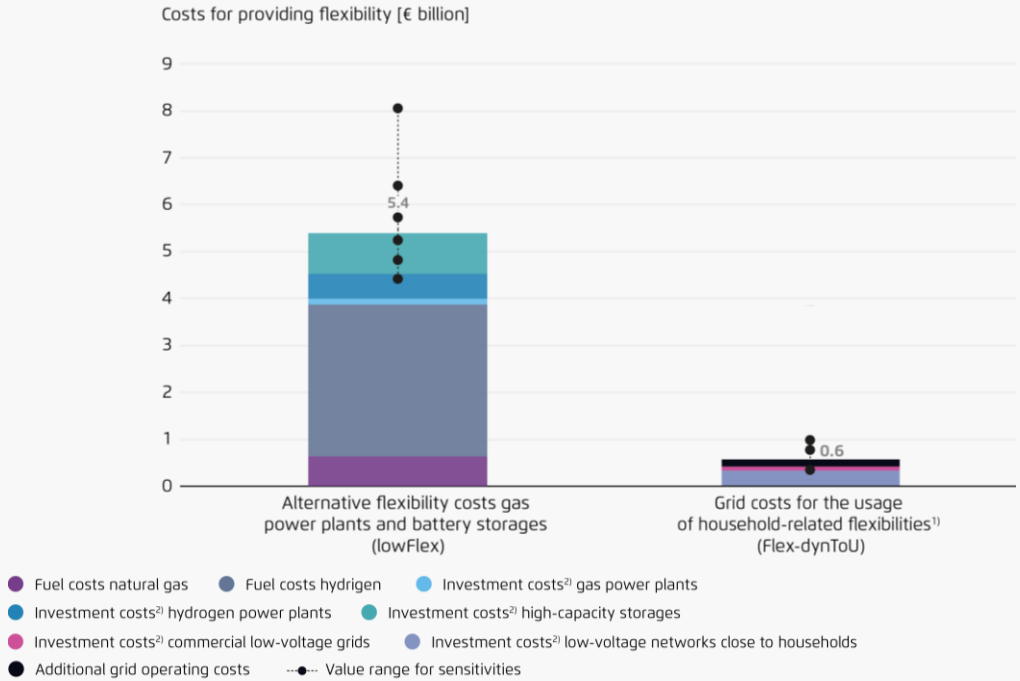
- Peak and off-peak times are defined at short notice
- Price time series results from utilisation forecast at the local grid transformer, different for each LV grid
- According to BNetzA-movie = fully dynamic grid fees

*dynamic procurement price = direct transfer of the wholesale power price. Dispatch prices from the *Climate Neutral Electricity System 2035* study are used for this purpose, which are used as an approximation of short-term wholesale electricity prices.

Results

Dynamic electricity tariffs can provide flexibility at lower costs than flexible power plants.

Cost comparison of the flexibility options in 2035 (annuities)



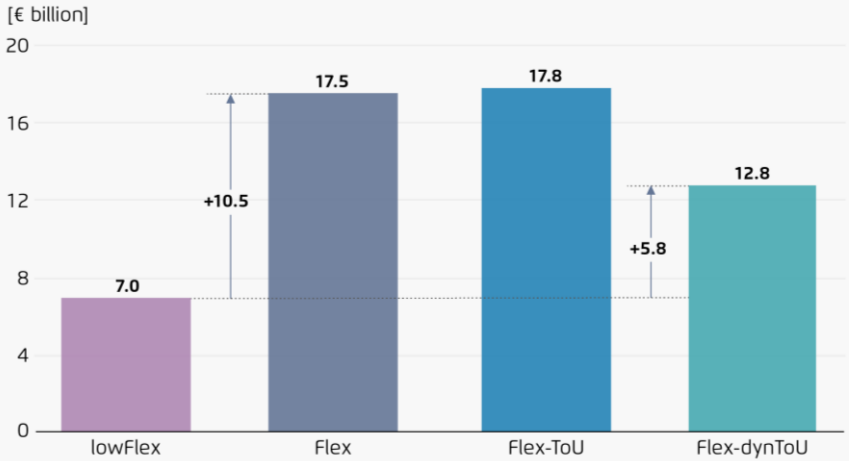
→ Activation of load-shifting flexibility in households

- saves 20 Terawatt hours of power generation / year
- reduces the need for expensive fuels
- increases the need for distribution grid expansion (see next slide)
- Additional grid expansion costs are limited thanks to dynamic grid fees

→ Savings of 4.8 billion euros in 2035 alone

Dynamic grid fees can effectively reduce grid expansion costs during the ramp-up of electric vehicles, heat pumps and home storage systems.

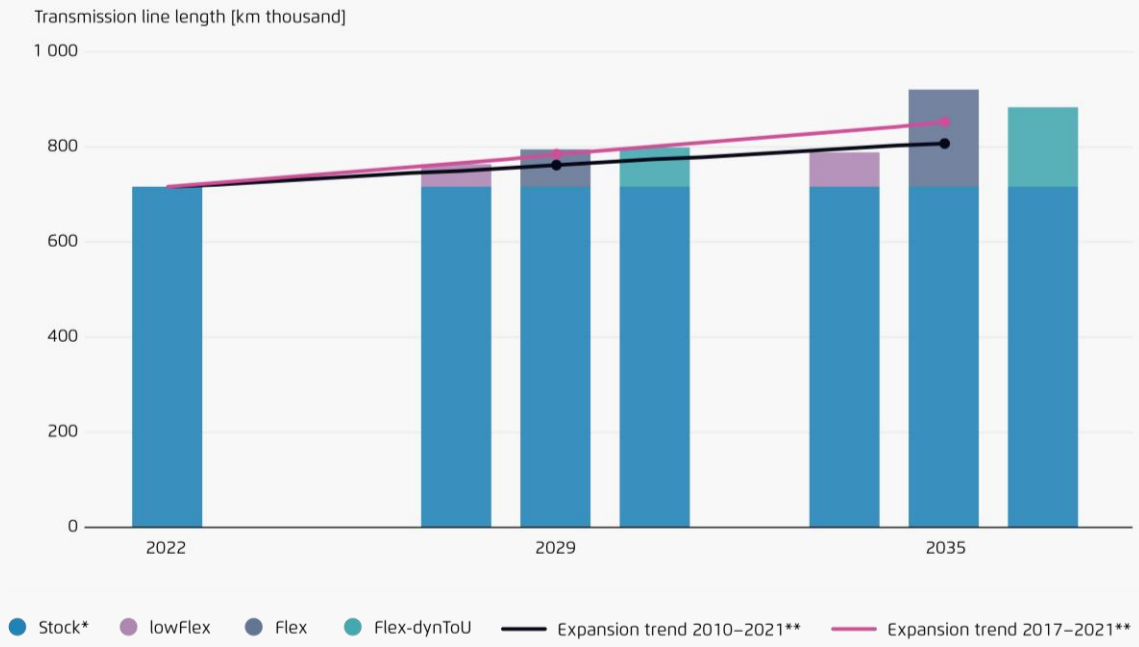
Grid expansion costs in the low-voltage grid until 2035



- → Additional demand leads to higher grid expansion costs in all cases, even if there are no price incentives for the provision of flexibility
- → Load shifting, incentivised solely by dynamic wholesale power price signal leads to significantly higher grid expansion costs
- → Dynamic electricity tariffs + dynamic grid fees significantly reduce expansion costs
- → Time-variable grid fees:
  - Not suitable for reducing grid expansion costs in the long term,
  - but can be a first step towards implementing dynamic grid fees

Dynamic grid fees lead to grid expansion in the low-voltage segment, which remains feasible.

Grid expansion requirements compared to the historical expansion trend



- → Thanks to dynamic grid fees: expansion speed at a historic level is sufficient
- → Nevertheless: expansion of the pipeline infrastructure by a quarter by 2035
- → Transformers: Expansion requirements significantly reduced in 2035 due to dynamic grid fees
  - only one in seven local grid transformers within the "Flex-dynToU" scenario by 2035
  - one in four within the "Flex" scenario

Results at a glance:

1 **Electric vehicles, heat pumps and home storage systems can provide 100 terawatt hours of flexible electricity demand in 2035, saving the electricity system 4.8 billion euros alone in that year.**

2 **Dynamic electricity tariffs (including dynamic grid charges) activate household-related flexibility while reducing the need to expand the electricity grids.**

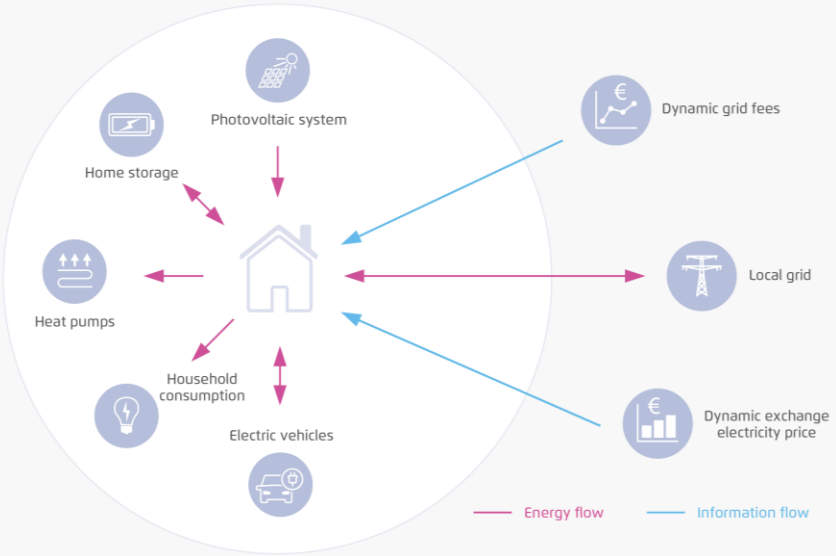
3 **The digitalization of the distribution grids enables the introduction of dynamic electricity tariffs (including dynamic grid fees).**

4 **Consumers save on their electricity bills and can play an active role in shaping the energy transition.**

Appendix

Modelling the effects of integrating household-related flexibility in the distribution grid.

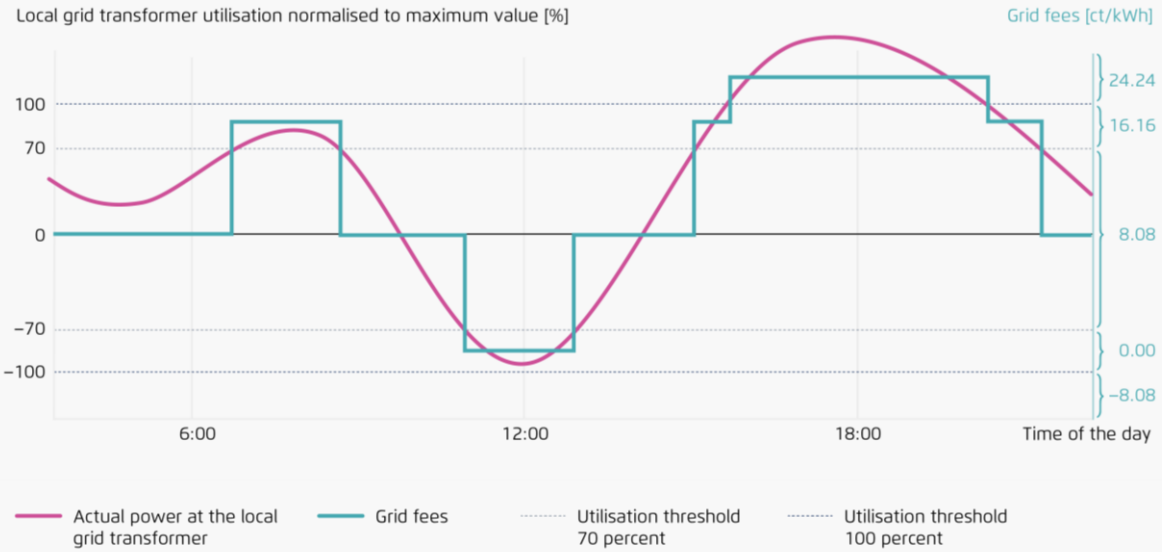
Overview of financial optimisation at the house grid connection



- → Characteristics of the German low-voltage grid were mapped with the help of type grids
- → Household-related flexibilities were allocated spatially, based on the ramp-up figures from the Agora study *Climate-neutral electricity system 2035*.
- → Detailed participation quotas were defined and financial optimisation was modelled for each house connection
- → The load flow simulation was carried out to determine the grid expansion requirements, taking four tariff models into account
- → The effects of grid congestion management were also modelled in accordance with Section 14a EnWG on the need to expand the grid

Dynamic grid charges effectively reflect local grid utilisation.

Schematic representation of the determination of dynamic grid fees as a function of local grid transformer utilisation



Dynamic grid fees

→ Basis: Utilisation forecast of the local grid transformer

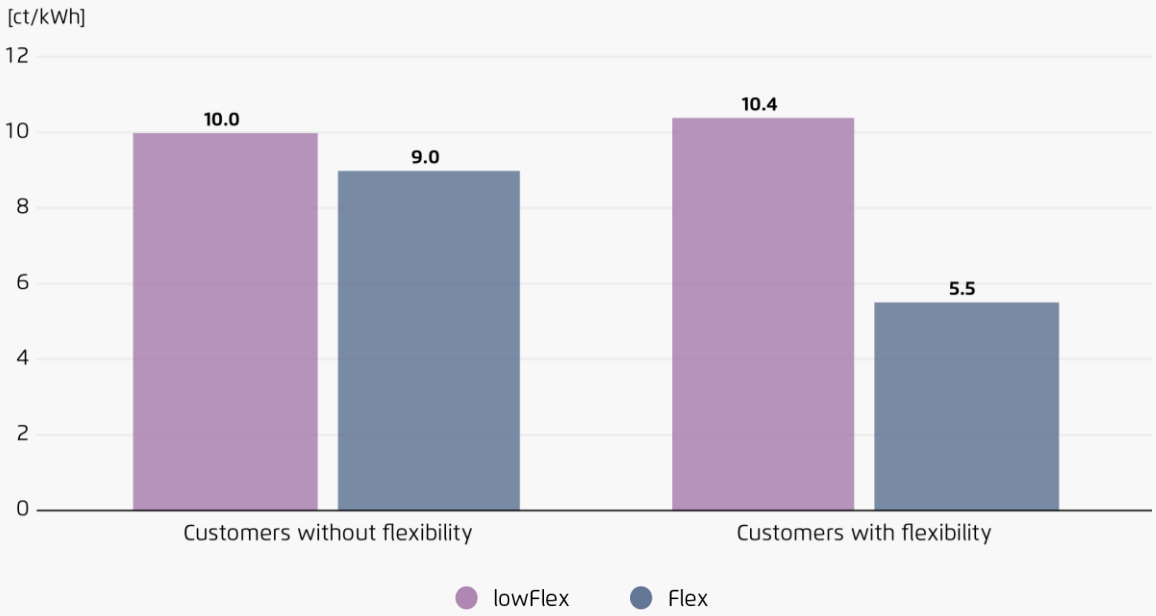
→ Input parameters:

- Measured values of the transformer
- Customers' consumption schedules and forecasts,
- Weather data
- Exchange electricity price

→ Grid fee levels in appropriate relation to the average exchange electricity price spread

All customers benefit from the activation of household-related flexibility.

Average procurement prices of customers with and without flexibility in the year 2035



- → Activating flexibilities reduces the electricity procurement price for all customers
- → Customers with flexible consumption behaviour also save grid fees of 11 percent per kilowatt hour
- → 4-person household with flexible heat pump use can save 600 euros per year with dynamic electricity tariffs (incl. dynamic grid fees)
- → All customers benefit from lower network expansion costs and better network utilisation

Arguments against the introduction of dynamic grid fees – our point of view

Dynamic grid fees cannot be implemented in the following years.

- → Determination of the grid status in accordance with § 14a EnWG stipulation
- → Network-oriented control from 1st January 2029
- → Smart meter rollout is included in the study and is considered feasible by the members of the monitoring group
- → **With preparation, implementation is feasible from 2030**

Lead time too short for consumers to react to price signals.

- → Exchange electricity price for the dynamic electricity tariff is fixed the day before
- → Dynamic grid fees are also roughly fixed the day before and change only slightly thereafter (check-in system)
- → It must be possible to deviate from the innitial schedule
- → **Since machines make decisions and not humans, short-term action is not a problem**

Wholesale price signals will be larger so that the overall price signal will have no effect.

- → Jumps in grid fees must be selected in the order of magnitude of the expected price differences on the electricity exchange
- → Sufficient if the grid fee spread is similar to the average daily price spreads on the electricity exchange
- → **Study shows that a balanced relationship is possible**

Implementation

Recommendation: The Bundesnetzagentur (NRA) and distribution system operators should implement dynamic grid charges.

Goal: nationwide introduction of dynamic grid fees –
linked to the use of dynamic electricity tariffs – by 2030

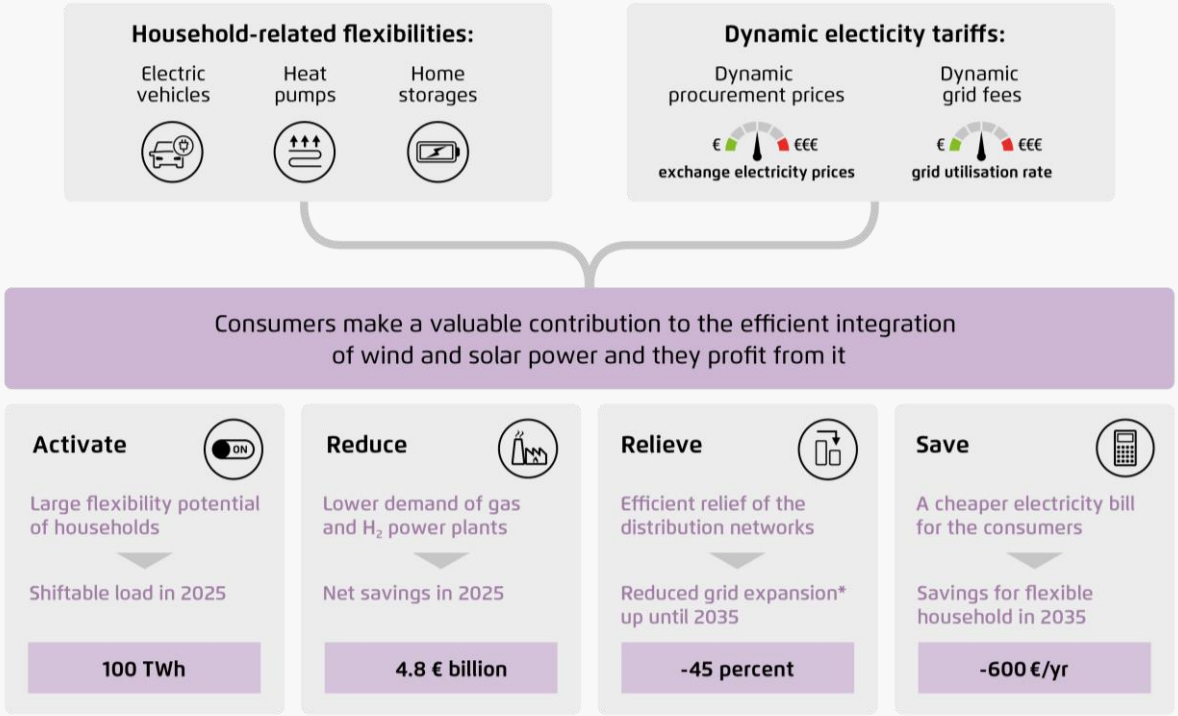
Implementation

The Bundesnetzagentur is responsible for implementing dynamic grid fees:

- Creation of a roadmap for the gradual nationwide implementation of dynamic grid fees
- Create incentives for distribution system operators who already implement dynamic grid fees in 2027
- Ensure controllability of systems from the very beginning
- Distribute costs according to the polluter-pays principle and do not penalise households without flexibility potential

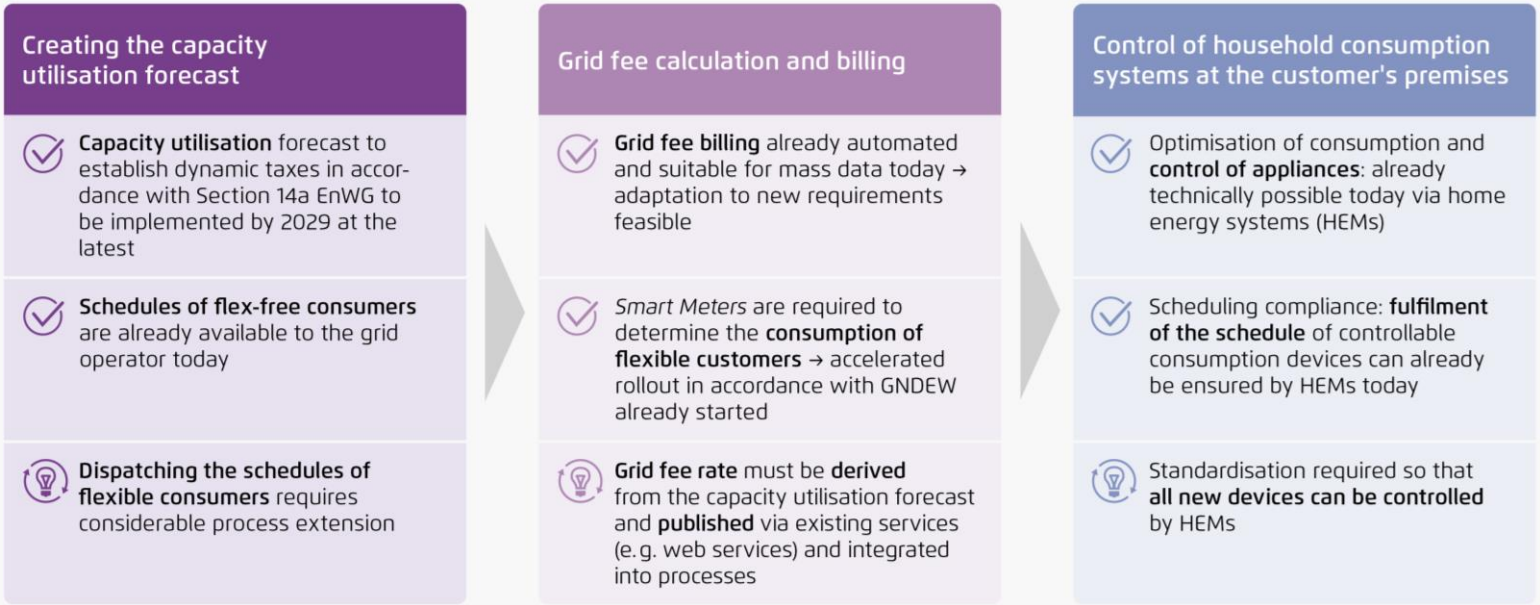
Distribution system operators are the most important player in the implementation process

The implementation is worthwhile.



The integration of dynamic grid fees is possible, as most of the necessary steps have already been taken.

Necessary process components including progress made so far and additionally required development



Outreach

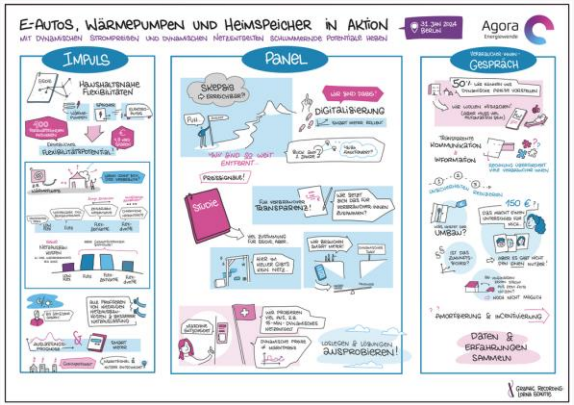
We have presented and discussed the study findings to the leadership of the Regulatory Authority, at a dedicated event and on multiple other occasions

Appointment at the Federal Network Agency

- → Meeting in Bonn
- → High level attendance by the President, Vice President and various department heads
- → 15 employees in total, the majority of which attended in person
- → Followed by lunch with the President and Vice President

Agora-organised presentation / discussion event on the study

- → Active participants from most of the relevant areas
- → 110 participants on site and 350 participants online
- → Link for more information (German)



Press review – strong media footprint including „Der Spiegel“

SPIEGEL Wirtschaft

Abonnement Anmelden

Menü › Wirtschaft › Verbraucher & Service › Strompreis › Strom: Flexible Tarife dürften Kosten für Verbraucher massiv senken

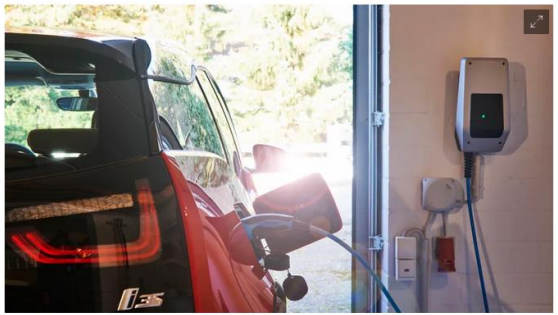
Energiewende

Flexible Tarife könnten Stromrechnung von Privathaushalten halbieren

Im Strommarkt der Zukunft können Privathaushalte kräftig Geld sparen – wenn sie ihren Verbrauch ans schwankende Angebot anpassen. Eine Studie zeigt erstmals, wie gewaltig die Potenziale bis 2035 sind.

08.12.2023, 16.53 Uhr

Artikel zum Hören • 3 Min Anhören



Elektroauto lädt in Garage: Flexibilität im Stromsystem Foto: Martin Bäumel Fotodesign / IMAGO

STROMNETZ

Flexibilität ist Trumpf

Eine Studie und ein Positionspapier gehen der Frage nach, wie Flexibilitäten der Haushalte künftig genutzt werden können, um das gesamte Stromsystem zu entlasten.

Grüne Energie: Private Haushalte sparen bis zu 600 Euro im Jahr an Stromkosten

15.12.2023, 15:48 Uhr
Von: Amy Walker

Agora-Studie

Hälfte des Haushaltsstroms lässt sich flexibilisieren

STROM Add-on 13.12.2023 15:32 von Stefanie Dierks Merkliste drucken

Elektrofahrzeuge bieten hohes Potenzial zur Nachfrageverschiebung, so eine Studie (Foto: 1KOMMA5Grad)

Berlin (energate) - Das Wohl und Wehe des Stromsystems hängt zukünftig zu einem großen Teil von der Einbindung

NEWS

11 Dec 2023, 13:27 Sören Amelang

Electric cars, heat pumps can make 10% of German electricity demand flexible by 2035 – report