Energy Economics, Winter Semester 2025-6
Lecture 9a: Tariff Design

Prof. Tom Brown, Philipp Glaum
Department of Digital Transformation in Energy Systems, Institute of Energy Technology, TU Berlin

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Introduction to tariff design

Basic questions on tariff design

The focus here is on **electricity**, but many considerations apply to gas (and hydrogen).

- How should the **costs** for electricity, grids and subsidies be passed to **consumer tariffs**?
- How should we divide the **costs of the grid** between households, industry and government?
- How should the charges be **spread over time** - constant, time of use, dynamic or based on peak demand?
- Should **different regions** see different prices?
- How do we incentivise industry and household prosumers with rooftop PV, home batteries and flexible demand to **behave** in a way that reduces overall system costs?
- How can consumers **hedge** themselves against price spikes?

Basic principles of energy tariffs

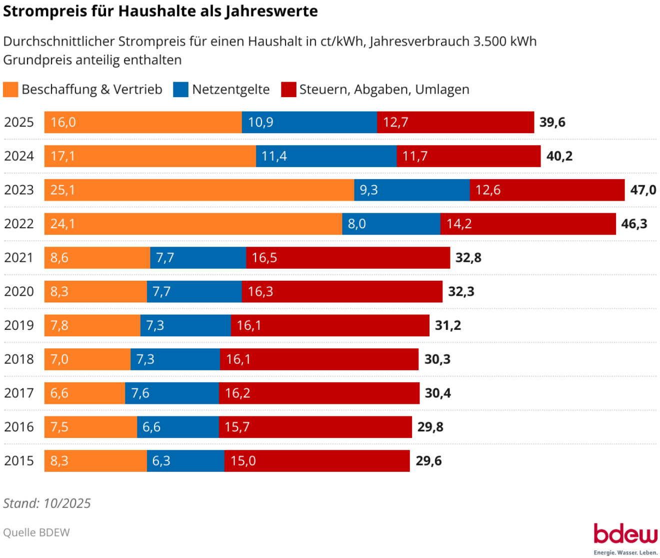
Energy tariffs should be

- **non-discriminatory**: ensuring equal access and charging structures to all actors (consumers and generators)
- **cost-reflective**: charges to the actors should reflect the costs they cause, thus giving them an incentive to behave in a system-friendly way
- **allow cost recovery**: the network operator should be able to cover their costs
- **transparent**: so that everyone can ensure the first 3 criteria are met

While non-discrimination and cost recovery are largely met today, cost-reflectiveness and transparency leave room for improvement.

Source: Lévêque, 2010

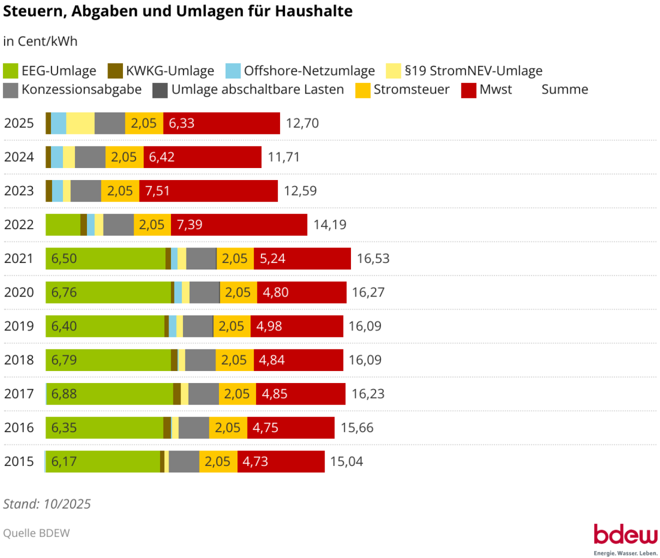
Retail price composition in Germany: household customers



- These costs are **averaged**, new customers see lower rates.
- Energy cost share is small compared to regulated network charges and state-induced taxes and levies.
- Energy peaks in 2022-3 during crisis.
- Network charges rise due to high investments needed for energy transition (and high energy costs).
- Transmission charges now also subsidised from federal budget.

Source: BDEW, 2025

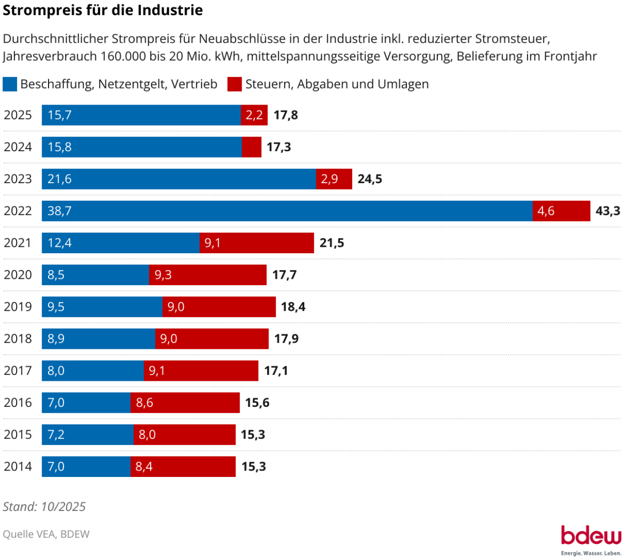
Households: Breakdown of taxes and charges



- EEG surcharge for renewable subsidies was moved from consumers to federal budget in July 2022 (during energy crisis).
- Discussion to reduce electricity tax from 2.05 ct/kWh to European minimum (0.1 ct/kWh for households).

Source: BDEW, 2025

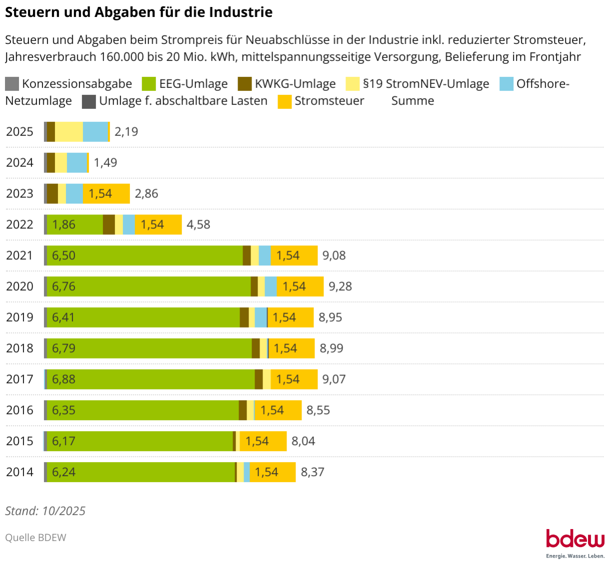
Retail price composition in Germany: industry customers



- Tariffs depend on the size of the industry and there are numerous exceptions.
- Costs lower than households.
- Taxes and levies have been reduced.
- Network charge reduced by transmission subsidy from federal government.
- Some peak charges, and some industry get reduced network charge for constant load.

Source: BDEW, 2025

Industry: taxes and levies



- EEG surcharge for renewable subsidies was moved from consumers to federal budget in July 2022 (during energy crisis).
- Electricity tax already reduced to European minimum (0.05 ct/kWh for industry).

Source: BDEW, 2025

Counter-example: Pakistan: Industry pays most of network charges

Time-varying tariffs

Why time-varying tariffs are desirable

Many consumers in Germany have constant tariffs that do not vary with the time of day.

There are several ways this can be bad:

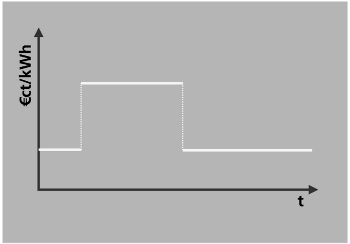
- Consumers don't have any incentives to **align their demand** with low-price hours and avoid high-price hours.
- Electric vehicles and heat pumps may consume power at times when there is **local grid congestion** even though they could just as easily run a few hours before/after.
- Behind-the-meter home batteries have no incentives to **reduce the midday PV peak** (thus reducing grid loading) but instead charge first thing in the morning until they are full.

Alternative to constant per-kWh tariffs

- **Peak pricing**: Combination of per-kWh energy charge and per-kW charge based on peak hour of demand in a month/year. Since grid costs are proportional to peak demand, this gives correct cost reflection.
- **Time of Use pricing**: Per-kWh energy charge varies in a predetermined way for different hours of the day (e.g. night/day), but in the same way each day.
- **Dynamic pricing**: Per-kWh energy charge varies with the spot market price.

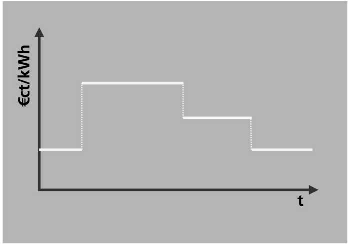
There are many combinations and elaborations of these alternatives and all are implemented somewhere on the globe; can apply to energy, network charges or taxes.

Examples of time of use (ToU) and dynamic tariffs



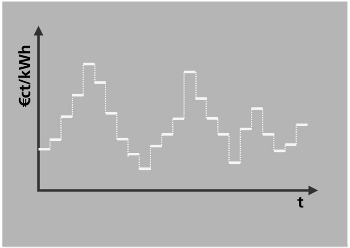
Two-tier Time of Use (2-tier ToU)

Each time period is assigned to a price level. Within one day, two price levels are possible. Price levels and time periods are set for a whole year.



Three-tier Time of Use (3-tier ToU)

Each time period is assigned to a price level. Within one day, three price levels are possible. Price levels and time periods are set for a whole year.



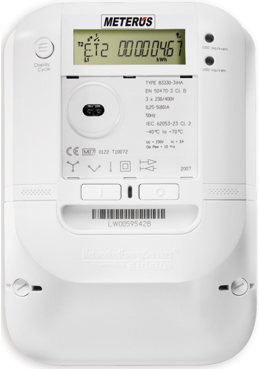
Day Ahead Pricing (DA)

Tariffs based on the day ahead spot market prices. The spot market price can be passed on directly to the customer, but certain min/max limits can also be set. Price levels and time periods are set the day before after market clearing.

Source: Stute & Kühnbach, 2023

Smart meters for time-based metering, also for control

The old cumulative meters could only add up total consumption and was read periodically (e.g. once a year). **Smart meters** can record consumption by the minute, and some also track electricity prices and allow the local DSO to intervene (e.g. §14a EnWG allows a lower tariff for heat pumps if the DSO can turn it off in certain hours).



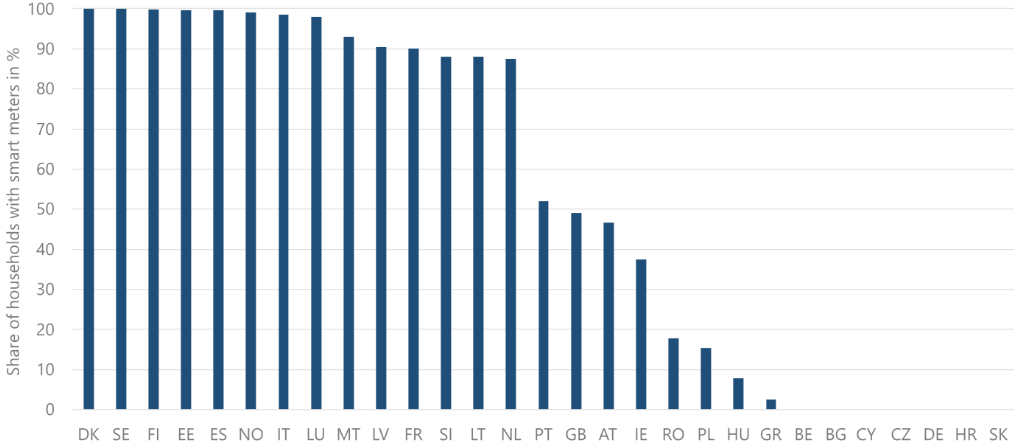
Smart meters

- Old analogue electricity meters could only cumulate the total consumption (e.g. yearly)
- Modern **smart meters** combine the ability to measure and store the (sub-)hourly consumption, enabling dynamic tariffs, but also allow communication through a gateway, e.g. to allow the grid operator to interrupt load
- German 2023 law requires all customers to have the option to install a smart meter with dynamic tariff from 2025 ("soweit technisch machbar und wirtschaftlich zumutbar")
- By 2032 all customers with demand $>$ 6000 kWh/a (i.e. those with heat pumps or electric vehicles) are required to have one

Source: Wikipedia

Smart meter rollout in Germany

Although $\sim$ 20% of Germany's 50 million metering locations are modern $\Rightarrow$ measure hourly demand, in 2021 only 160,000 had smart meter gateway for communication.



Source: FfE, 2023

Example: Germany: Energy-intensive incentive for baseload

Large industrial consumers ($\sim$ 20% of German demand) get a discount of up to 90% on network fees if they have a smooth consumption for at least 7000 hours a year.

This means they have no incentive to reduce consumption when prices are high or the network is congested, nor to raise their consumption when prices are low and it can help the network.

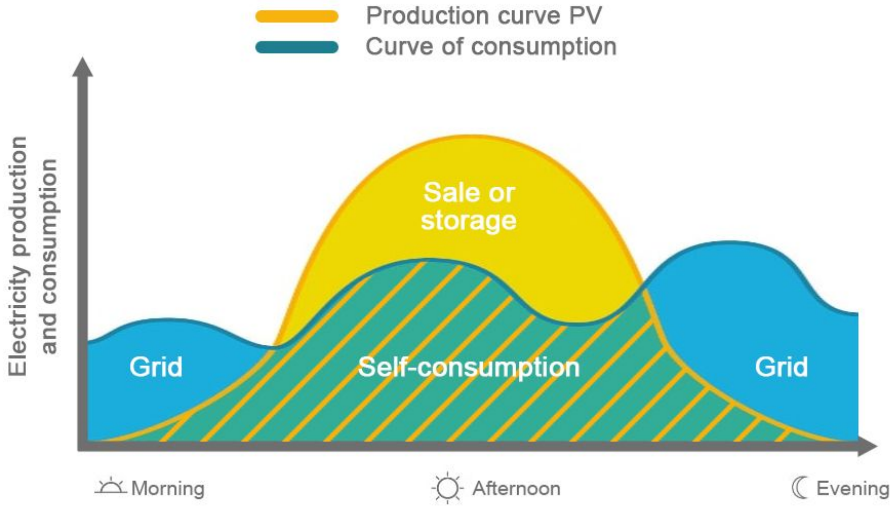
Currently several reform suggestions made by BNetzA.

Prosumers and self-consumption incentives

Prosumers and self-consumption incentives

- A **prosumer** is a consumer who may also be producing electricity from rooftop solar or wind, a home battery or an electric vehicle, as well as pro-actively managing demand from their electric vehicle or heat pump.
- Since public electricity is typically more expensive (e.g. 30 ct/kWh) than the levelised cost of rooftop solar (e.g. 10 ct/kWh) there are strong incentives to cover some demand with your own generation: **self-consumption**.
- The incentive strongly depends on: how time-varying the electricity tariff is, whether there is remuneration for solar feed-in, whether a battery is present.
- Only part of demand can be covered locally, so the consumer is still reliant on the public grid (e.g. during the winter). Lower consumption makes it harder to recover network charges, leading to higher charges, more incentive to self-consume: a **utility death spiral**.

Example of self-consumption with rooftop PV



Source: eida

Examples of self-consumption with rooftop PV and battery

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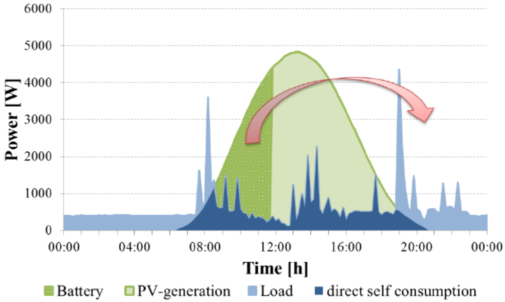
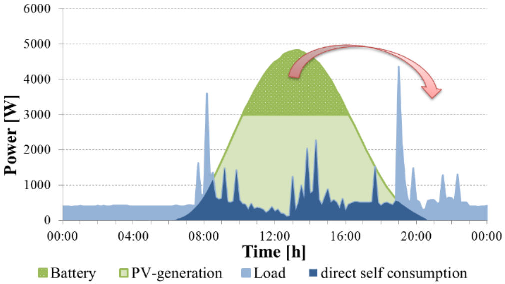
Batteries can extend the self-consumption into the evening. With a constant grid price, they have no incentive to control when they charge. **Uncontrolled charging** (left) leaves the peak PV feed-in unchanged, potentially over-loading the grid. Using the storage to **shave the PV peak** (right) reduces the grid load.





Source: Moshövel et al, 2013

How to design self-consumption policy?

System-unfriendly behaviours are encouraged by constant pricing.

There are several strategies to improve incentives:

- Expose consumers to **dynamic pricing**: this incentives them to reduce grid consumption at peak hours and reduce feed-in at low-price hours.
- **Peak charging** for grid capacity to reduce high feed-in/consumption.
- Allow **DSO to intervene for flexible loads** (i.e. electric vehicles and heat pumps) if local lines and transformers become overloaded (cf. §14a EnWG).

Regional prices

Example: Norgepris: Norway returns from dynamic zones to flat price

Example: Italy: PUC

Hedging against price spikes

Strategies for protecting consumers

Implementing dynamic pricing allows consumers to change their consumption patterns to save money. However, it also exposes them to high price episodes that may be particularly worrying to poorer households.

- **Hedging contracts**: Essentially sell consumers a future connected to their profile. This offers a fall-back; they still are incentivised to react to spot prices. Disadvantage: complexity.
- **Subsidise power plant fuel costs**: In the 2022 energy crisis, the Spanish government subsidised down the gas price for gas power plants, which reduced the electricity price. Also discussed for hydrogen-based power plants in Germany's 2024 Kraftwerksstrategie. Disadvantage: costly, distortive (led to high exports from Spain to France).
- **Revert dynamic pricing**: Norway in 2025, in response to consumer concerns about high prices, particular in Southern Norway (influenced by high prices in continental Europe) offered a **Norgespris** fixed over all times and regions of 40 øre/kWh (50 øre/kWh with VAT).