EWG AGGREGATE

Electricity flexibility in Switzerland

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EWG AGGREGATE project

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EWG Research Program

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Overview

Two parts

- Quantification of flexibility potential
- Policy measures

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Quantification of the value of flexibility: Smart charging and heating

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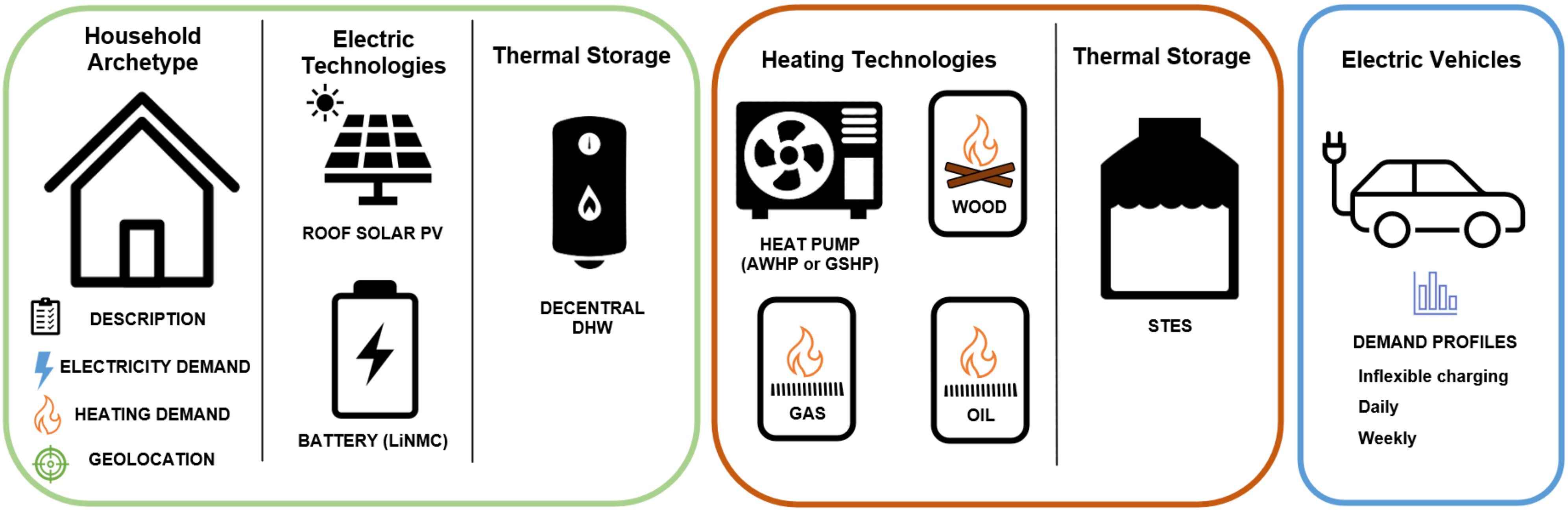
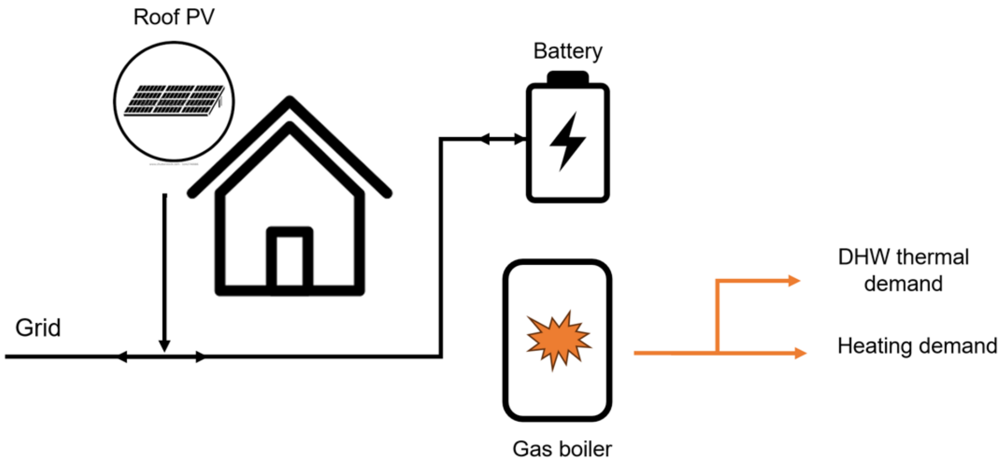
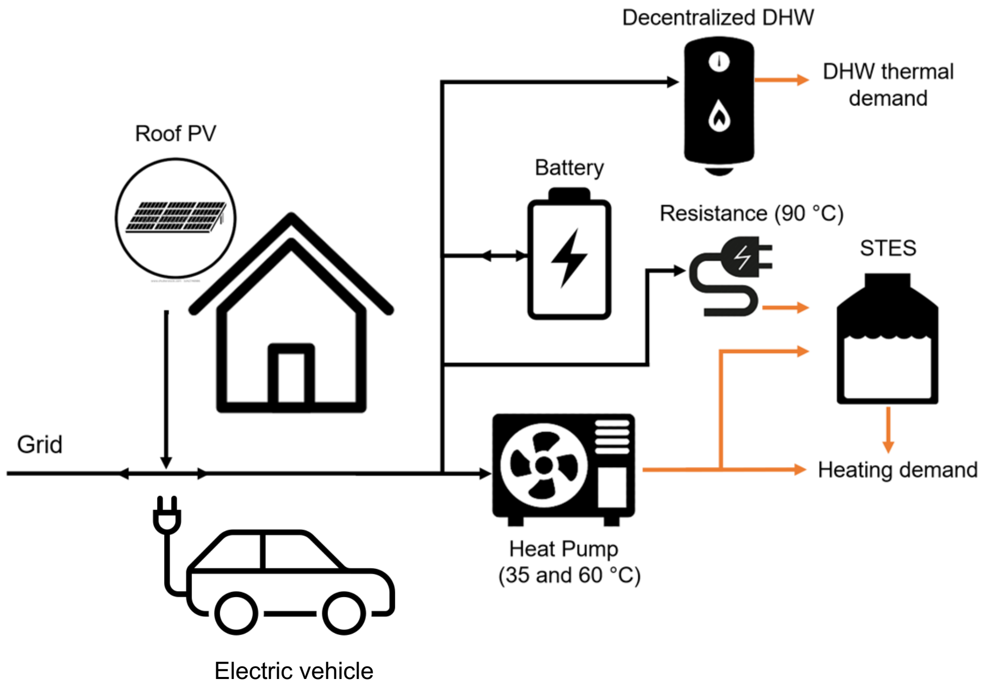
SwissStore: Modularity



SwissStore: Technology scenarios





SwissStore: Data 2050

Electricity tariffs: “Future Energy Market” (FEM) (Darudi et al, 2024)

- We use the electricity price output from the FEM market model
- We construct the retail tariff with all price components (i.e., grid usage, taxes)

EV demand: NETFLEX project (Winzer et al, 2022)

- We construct different EV charging scenarios
  - Inflexible charging
  - Daily charging
  - Weekly charging

SwissStore: Value of flexibility equations

EVs

$$ev\_flex\_value_t = \sum_t [(D\_EV\_EL_t * d\_price\_el_t) - (Q\_EV\_EL_t * q\_price\_el_t)] \quad \forall t$$

HPs

$$hp\_flex\_value_t = \sum_t [(D\_HP\_EL_t * d\_price\_el_t)] \quad \forall t$$

SwissStore: Implementation

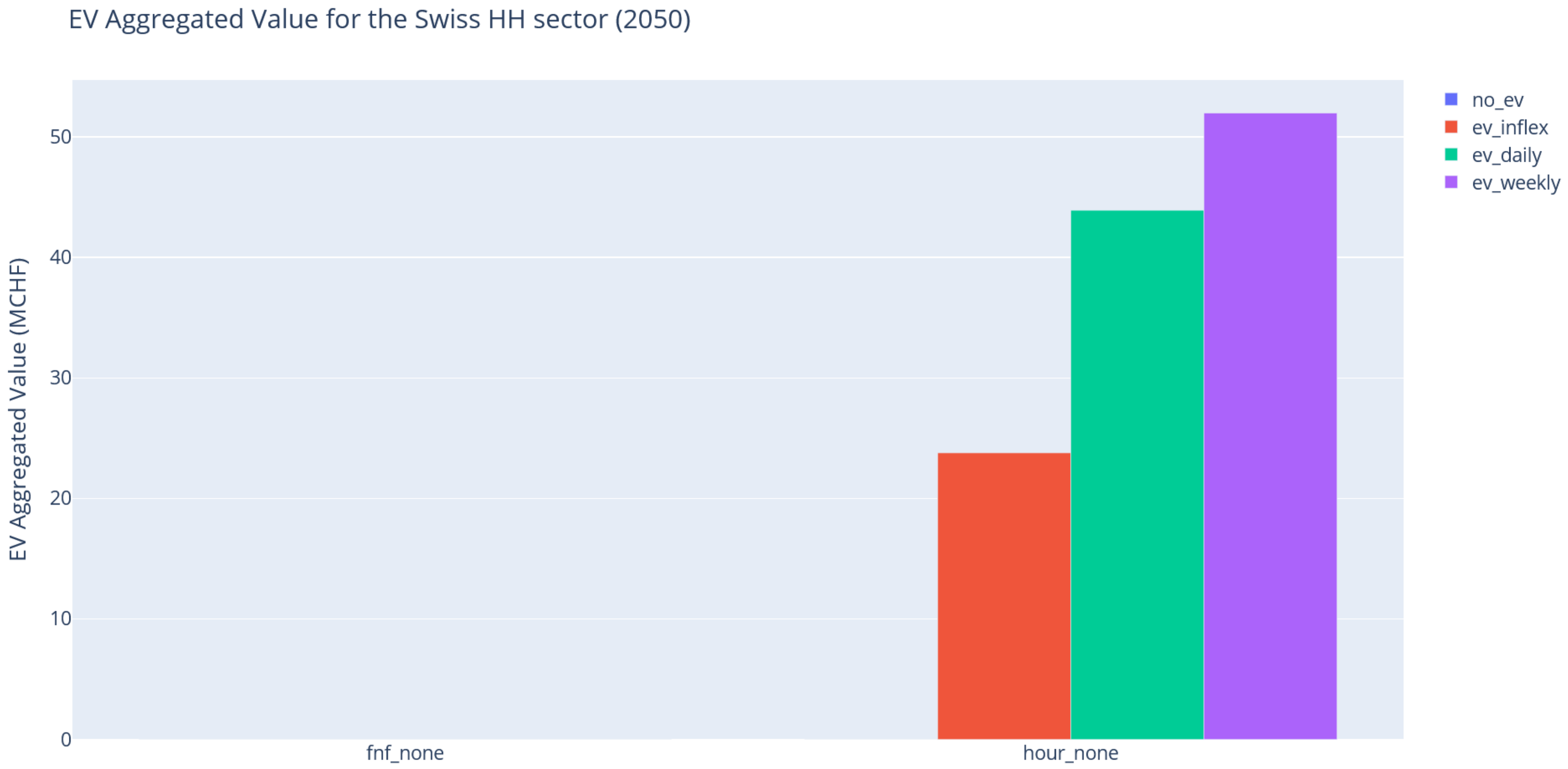
- We expose 500 randomly selected households to prices from the FEM model
- We assign an EV demand profile to each household
- We estimate the value of flexibility for end-consumers
- We scale the results according to future HP and EV deployment (EP2050+)
- We estimate the effect on PV technology deployment and system costs

SwissStore: Scenarios

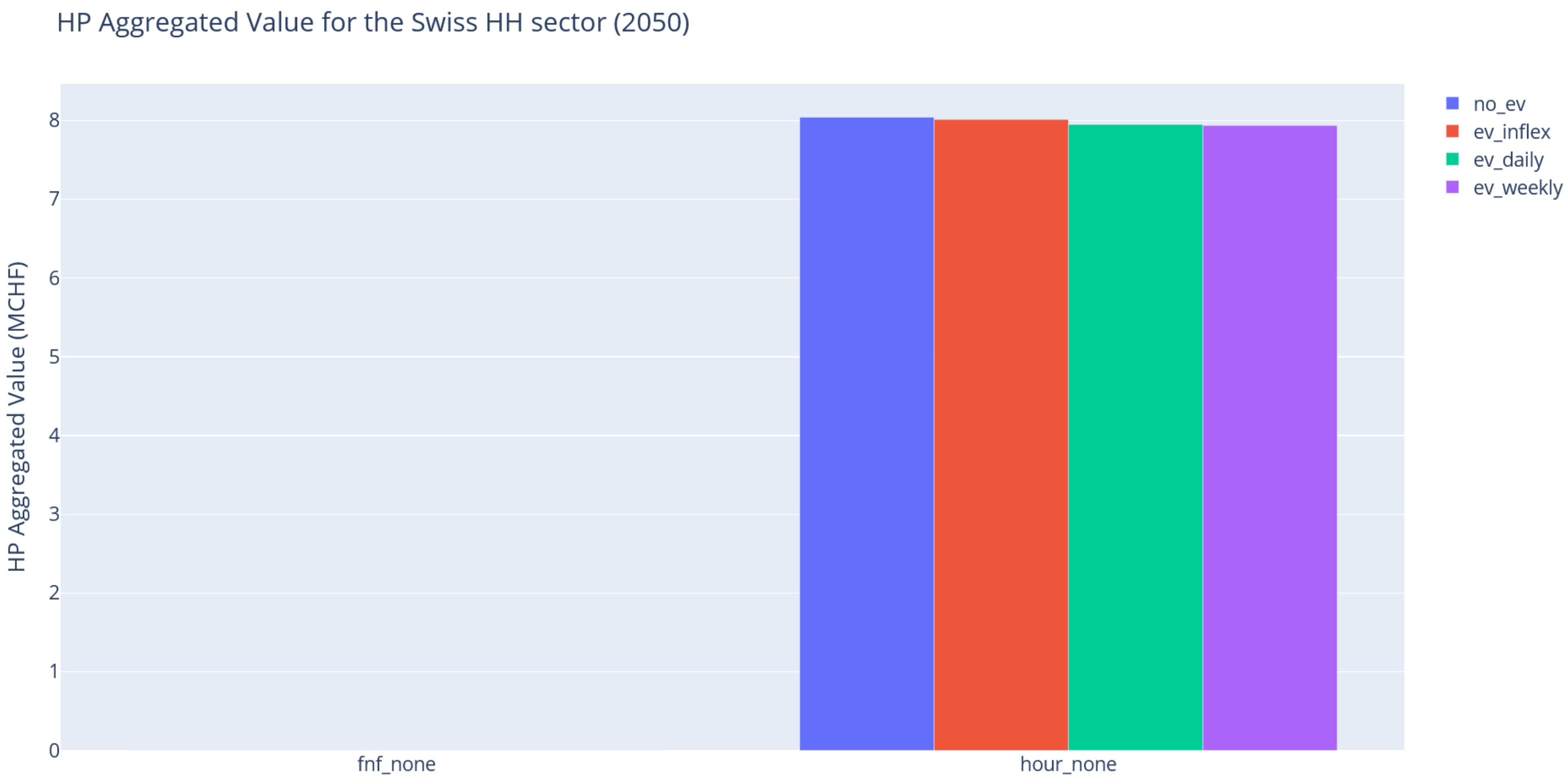
EV scenario	Description
no_ev	Building without EV
ev_inflex	Inflexible EV demand
ev_daily	Daily EV charging flexibility
ev_weekly	Weekly EV charging flexibility

Scenario	Tariff	Special scenario	Description
fnf_none	Flat - No FiT	None	Zero flexibility incentives
hour_none	Hourly - Hourly FiT	None	Full flexibility incentives

Value of EV flexibility: Preliminary model results



Value of HEAT PUMP flexibility: Preliminary model results



Interpretation of results

Key points we take away

- Flexibility provision adds value to end-consumers
  - Daily flexibility saves 46% of electricity costs compared to an inflexible charging profile
  - Weekly flexibility saves 54%

- Our model allows to quantify flexibility parameters for EVs and HPs and its economic value for the Swiss Household sector for:
  - Electric vehicles and heat pumps
  - Different electricity tariff designs
  - Multiple building aggregation levels
  - Technology and price scenarios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Policy measures to promote electricity flexibility in Switzerland
Photo by Jan Remund, https://flic.kr/p/2nthNZX, CC-BY

Introduction to flexibility

Flexibility as “serving a system need”

- Flexibility means adjusting operation based on system signals
- Improves overall economic efficiency of the power system
- Can be provided by all kinds of assets: demand, storage, supply

Three use cases of flexibility

- Energy: Align consumption with energy abundance
- Grid: Reduce network constraints
- Balancing: Provide balancing services

1. Energy: Align consumption with energy abundance

2. Grid: Reduce network constraints

3. Balancing: Provide balancing services

Demand flexibility – energy market

Dynamic pricing opportunities

- Flexibility can reduce costs by shifting usage to periods of low-cost electricity
- Significant savings possible by avoiding high-price, scarcity periods

Energy tariff challenges

- Risk of grid overload if dynamic energy tariffs aren't paired with dynamic grid tariffs
- Synchronizing flexible loads with system signals is essential to avoid congestion

Impact of renewables on pricing

- Increasing penetration of wind and solar affects wholesale electricity prices
- Flexibility offers the potential to adapt consumption to variable supply

Demand flexibility – grid constraints

New loads challenges

- EV charging and heat pumps add strain to distribution grids
- Swiss distribution grids, while robust, will require adjustments or expansion to meet new demand

Flexibility to avoid grid expansion

- Flexible loads can reduce the need for expensive grid buildout
- Optimizing flexibility will delay or avoid costly infrastructure investments

Incentivizing DSOs

- DSOs must be incentivized to prioritize flexibility over traditional grid reinforcement
- Regulatory frameworks should ensure cost-effective grid management

Dynamic network tariffs

→ Next slides

Grid tariffs

How to incentivize flexibility for grid relief?

Which is better?

- Capacity charge (per kWpeak)
- Dynamic energy charge (per kWh)

Capacity charges are inefficient

Effective price spike

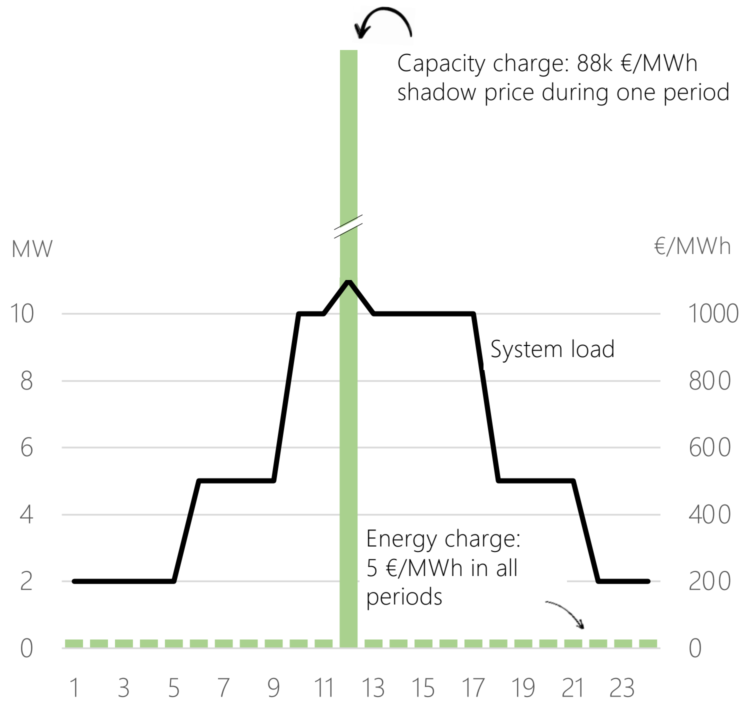
- Extreme incentive in the hour of highest consumption
- E.g., annual capacity charge of 22k €/MW → one price spike per year of 88k €/MWh during one quarter-hour
- Incentive to "flatten consumption" (even when there is no shortage)

Is it cost reflective?

- "Grids are fixed costs assets"
- but: "Individual peaks don't matter unless they if coincide with system peak"

→ Peak capacity charges are inefficient because they don't take into account system conditions

Shadow price of capacity charge



Capacity charges lead to inefficient incentives

Pricing individual peak is not optimal

- It’s the system peak that matters, not the individual peak consumption

We need more mid-day demand

- Run all devices then!
- …not a system that stops it

Die Leistungsspitze tief halten - so geht’s

Leistungsspitzen entstehen, wenn mehrere Geräte mit einem hohen Stromverbrauch zeitgleich verwendet werden. Um die Leistungsspitze tief zu halten, sollte man diese Geräte zeitlich versetzt in Betrieb nehmen – oder dann, wenn genügend Strom von der eigenen Solaranlage zur Verfügung steht.

- Geräte wie Waschmaschine, Tumbler und Geschirrspüler nicht zeitgleich mit Kochherd und Backofen verwenden: Die erwähnten Haushaltsgeräte haben tendenziell hohe Leistungsspitzen. Weitere solche Geräte sind z.B. Raclette-Öfen, Küchenmaschinen, Bügeleisen, Haarföhne und Staubsauger.
- Elektroautos mit kleiner Leistung über den ganzen Tag oder die ganze Nacht laden statt einer Schnellladung mit hoher Leistungsspitze. Das schont auch die Fahrzeugbatterie. Oder man richtet die Ladung nach Möglichkeit auf die eigene Solarstrom-Produktion aus.
- Ein möglichst grosser Eigenverbrauch der eigenen Solarstromproduktion lohnt sich doppelt: Der eigene Strom ist der günstigste und innerhalb der eigenen Produktion entstehen keine Lastspitzen.
- Nebst Geräten, die Wärme erzeugen, sind auch Geräte, die viel Kraft benötigen, stromintensiv. Im Gewerbe und in der Landwirtschaft sind dies elektrische Sägen, Hobelmaschinen, Fräsen, Schleifmaschinen, Jauchepumpen und Heugebläse. Wenn möglich solche Geräte zeitlich versetzt oder nicht auf voller Leistung einsetzen.

1.50 CHF/kW/month

https://www.ckw.ch/ueber-ckw/medienstelle/medienmitteilungen/2024/ckw-senkt-strompreise-per-2025-deutlich-und-praesentiert-neuartiges-tarifmodell

Dynamic grid tariffs!

Time-variant grid tariffs provide the right incentive

- Reflecting system conditions
- Grid-relief is valuable, when grid elements are near their peaks

Can be paired with short capacity charges

- If measurement is imperfect, «short capacity charges» can be helpful
- I.e. charge for peak of a 4-hour-period
- Can also be time-variant

Demand flexibility – balancing

Balancing market

- The balancing market is essential for correcting imbalances in the power system
- Residential flexible assets can contribute via aggregation

Role of balancing

- Fill the real-time gap
- Ideally, this is a small role – because previous markets can fulfill this more stably

Imbalance pricing and its role

- Key incentive for balancing groups to be in balance
- Penalizes real-time deviations (from schedules)
- Current Swiss system does not reward “beneficial” imbalances – i.e. that are opposed to the system imbalance
- Change is immanent: Swissgrid is working on reforming imbalance pricing

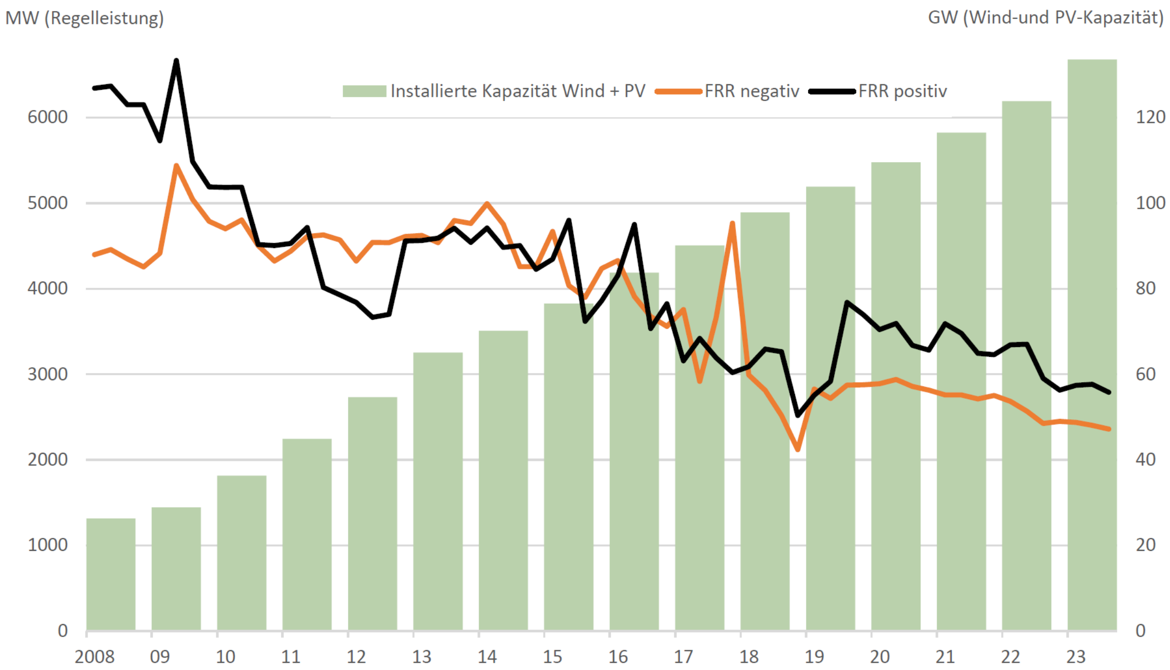
The German experience: Balancing needs do not increase

“The German balancing paradox”

- Balancing reserve needs have declined
- Despite massive renewables buildout
- It underlines the role of balancing as a “gap filler”

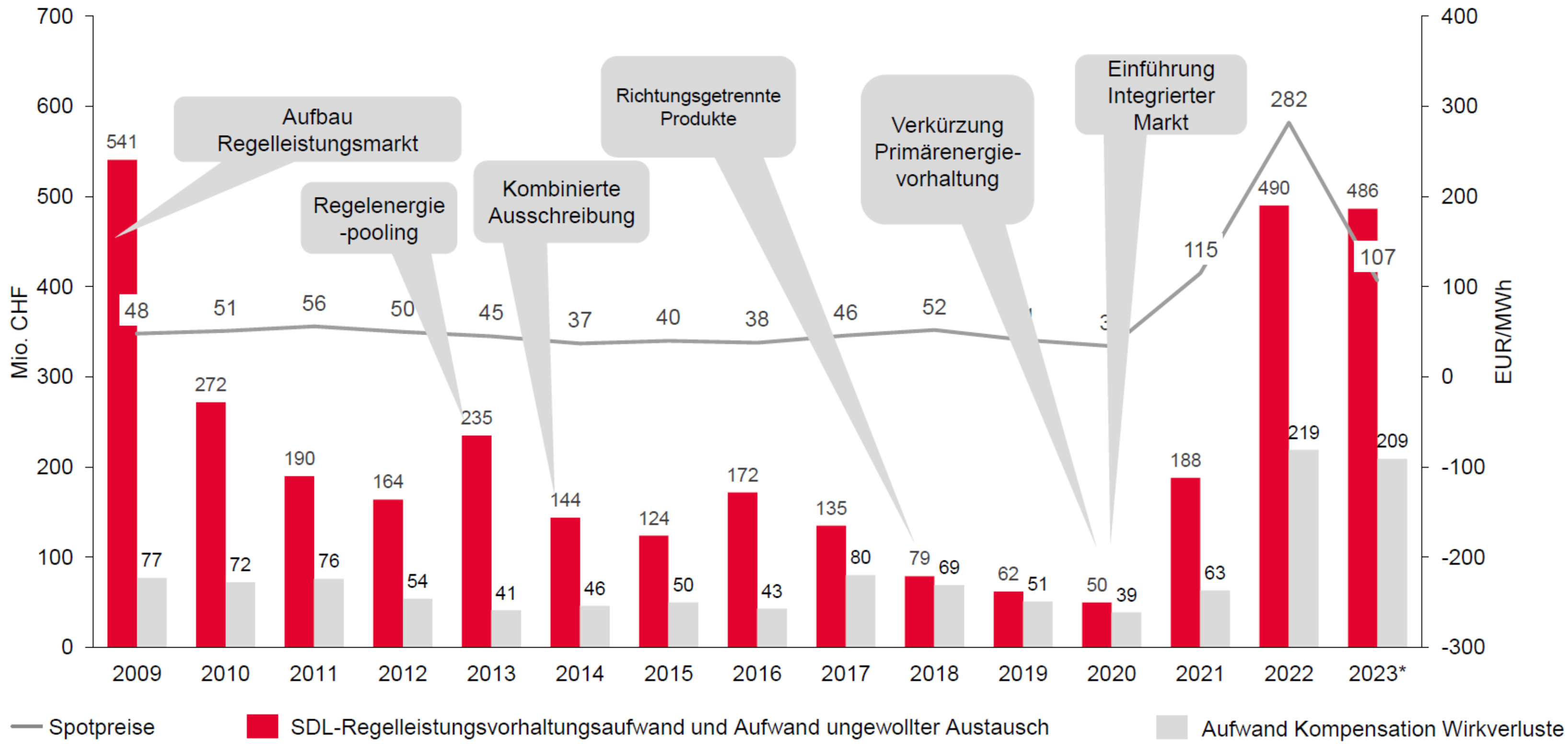
→ Mores renewables does not automatically mean more imbalances

Regelleistung vs. Wind- und PV-Kapazität



Switzerland: Increasing costs for balancing

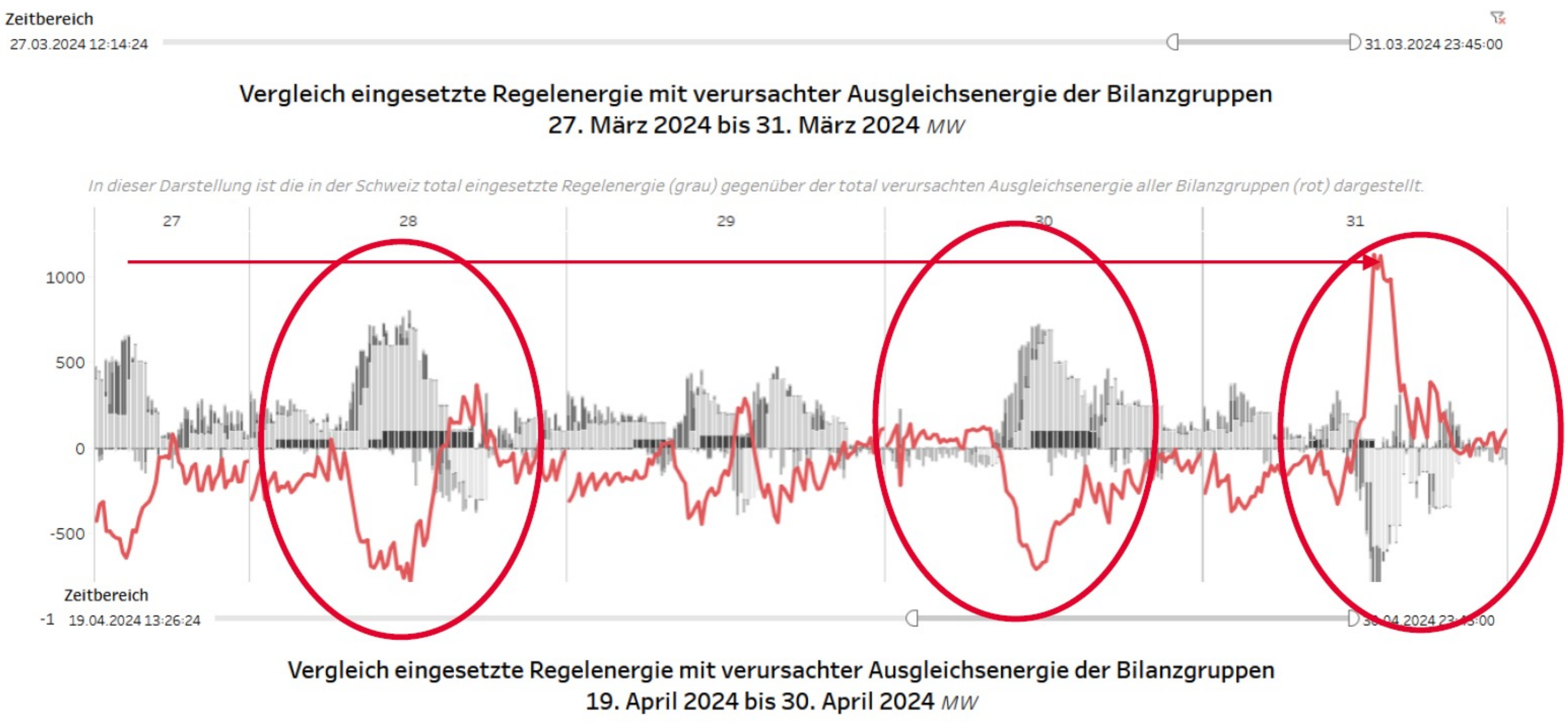
Historische Entwicklung Beschaffungsaufwand Regelleistung und Wirkverlustenergie



* Ergebnisse der Ausschreibungen für Regelleistung (PRL, SRL und TRL) sowie für die Energie zur Kompensation der Wirkverluste (KompWV) gemäss der veröffentlichten Angaben von Swissgrid

Source: Swissgrid, 2024

PV causes increasing challenges for the current imbalance pricing design



Source: Swissgrid, 2024

Demand flexibility – balancing

Aggregation and balancing

- Rather complicated “third party aggregator” model: Customer – Aggregator – Utility relationship
- Catch-up consumption from aggregated flexible assets can create new imbalances
- Can exacerbate system imbalances instead of resolving them

A small market

- Revenues on balancing markets are approx. 2% of overall energy traded
- Reform of imbalance pricing likely to reduce this further

Conclusion on balancing

- Balancing participation should be operated by the same entity who procures energy
- Demand flexibility is mostly needed elsewhere: Energy and grid purposes, not balancing
- More efficient imbalance pricing will likely lead to a shrinking market – this is good: the real time gap gets smaller

Recommendations for flexibility integration

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Recommendations for flexibility integration

Incentivizing DSOs

- Shift from a focus on grid buildout to flexibility optimization
- Incentive-based regulation to drive efficient use of flexibility

Introduce dynamic tariffs

- **Energy**: Mandate spot-based energy tariffs to expose flexible assets to real-time prices
- **Grid**: Dynamic grid tariffs to manage local grid constraints (accompanied by situational capacity charges)
- Transparency platform for automated access

Market opening & Stromabkommen

- Retail choice might be a game-changer for flexibility
- Smart tariffs attractive for EV and heat pumps