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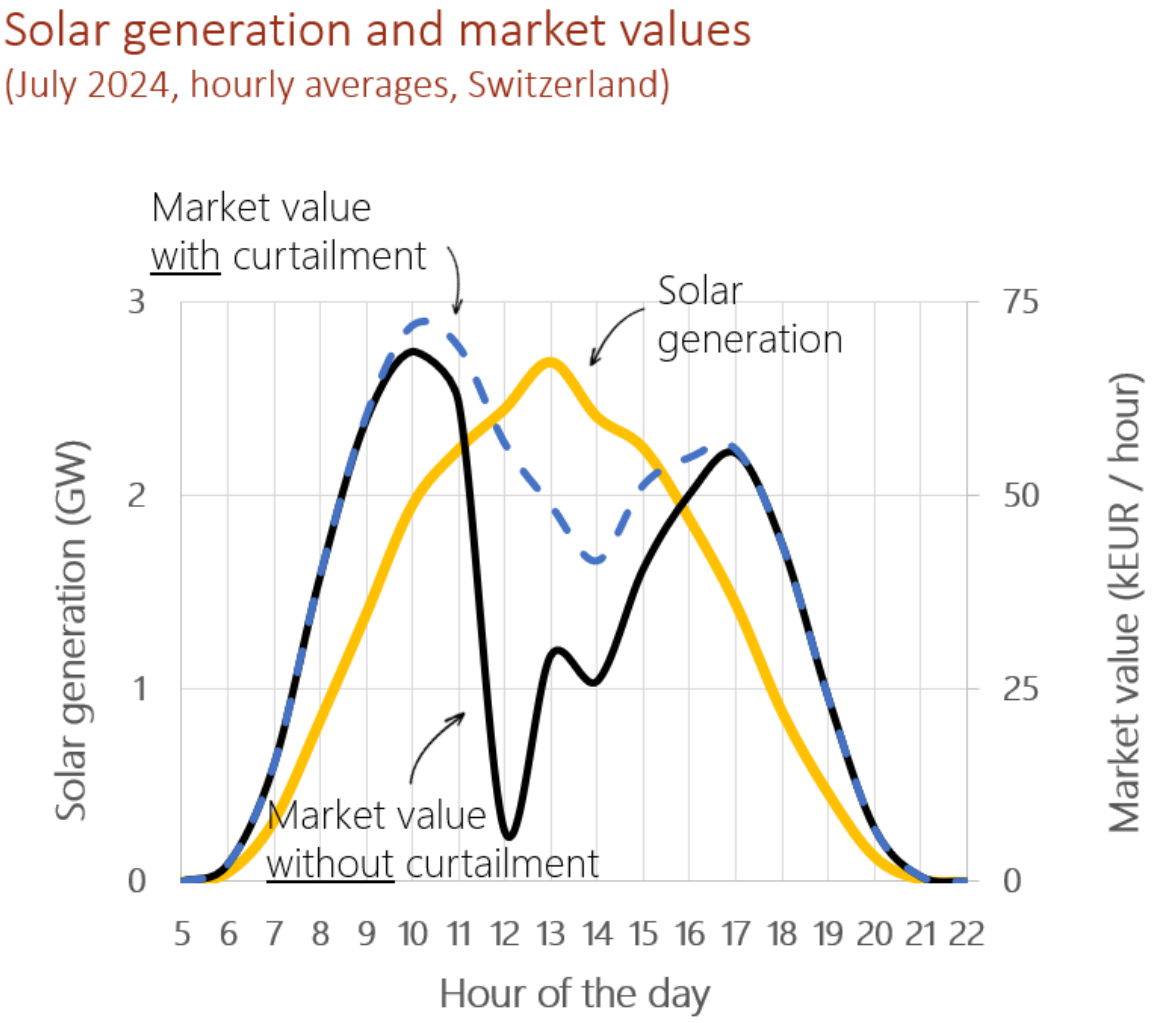
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Annual report of 15th October 2024

AGGREGATE

The value of aggregators in a flexible and decentralized Swiss energy system



Quelle: AGGREGATE Project, ZHAW WInterthur

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Grant recipient
ZHAW Zürcher Hochschule für Angewandte Wissenschaften
School of Management and law
Center for Energy and Environment
Bahnhofplatz 12
8401 Winterthur

Authors
Dr. Ingmar Schlecht, ZHAW, ingmar.schlecht@zhaw.ch
Héctor Ramírez Molina, ZHAW, hector.ramirez@zhaw.ch
Dr. Ali Darudi, ZHAW, ali.darudi2@zhaw.ch

SFOE Head of Programme: Anne-Kathrin Faust, anne-kathrin.faust@bfe.admin.ch
SFOE Project Responsible: Wolfgang Elsenbast, wolfgang.elsenbast@bfe.admin.ch

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The authors of this report bear the entire responsibility for the content and the conclusions drawn therefrom.

Zusammenfassung

In einem künftigen Elektrizitätssystem mit hohem Anteil erneuerbarer Energien und neuen Stromnachfrage-Anwendungen wird die Erzeugung allein nicht in der Lage sein, Angebot und Nachfrage auszugleichen. Die aktive Beteiligung dezentraler Energieressourcen ist notwendig. Aufgrund unvollkommener Information, begrenzter Rationalität und regulatorischer Hindernisse reagieren Haushalte jedoch oft nicht auf Preissignale. In diesem Umfeld können Aggregatoren eine wichtige Rolle spielen einzelne Stromverbraucher und Prosumer zu bündeln, um auf den Märkten für Strom und Systemdienstleistungen als Einheit aufzutreten. Eine solche Aggregation kann Effizienzgewinne bringen und den Wohlstand erhöhen, wenn regulatorische Arbitrage vermieden wird.

Seit dem letzten Jahresbericht haben wir uns auf die Aufgaben von AP2 (Marktmodellierung) und AP3 (Assessments) konzentriert. Außerdem haben wir an einer umfassenden Überarbeitung unseres Papiers zu Stromprofilverträgen für Privatkunden gearbeitet, die Anreize für Flexibilität bieten und zur Veröffentlichung in *Energy Policy* angenommen wurden.

Die Fortschritte können in die folgenden Kategorien eingeteilt werden: 1. Modellierung des Werts von Flexibilität (sowohl auf der Angebots- als auch auf der Nachfrageseite) und 2. Politische Maßnahmen zur Förderung der Flexibilität. Bei unserem Stakeholder-Workshop im September konnten wir unsere Ergebnisse präsentieren und hilfreiches Feedback einholen.

Summary

In a future electricity system with high shares of renewables and new demand entities, conventional generation alone will not be able to balance supply and demand. Therefore, active participation of distributed energy resources is necessary. Yet, due to imperfect information, bounded rationality, and regulatory barriers, households often do not react to price signals. In this environment, aggregators can play an important role in pooling prosumers to act jointly on power and ancillary services markets. Such aggregation can yield efficiency gains and increase welfare, while regulatory arbitrage must be avoided.

Since the last annual report, we have focused on the tasks of WP2 (Market modeling) and WP3 (Assessments). Also, we worked on a large revision of our paper on electricity profile contracts for retail customers that incentivize flexibility, which got accepted for publication in *Energy Policy*.

The progress can be categorised into the following categories: 1. Modeling on the Value of flexibility (both on the supply and the demand side) and 2. Policy measures to promote flexibility. At our stakeholder workshop in September, we were able to present our results and gathered helpful feedback.

1 Introduction

1.1 Background

The power sector has experienced tremendous change over the last decades, shifting from a centralized market based on large production units to a market with a multitude of actors of different sizes, a higher market share of distributed energy resources (DERs), and an increasing role of demand-side response (DSR). This trend is expected to accelerate in the coming years. At the same time, electricity consumers in households are often neither able nor incentivized to fully harness the flexibility potential embedded in their demand assets, such as heat pumps and electric vehicles, as they do not have access to market signals and informational requirements of flexibility usage are too high to be viable for individual entities.

In this market environment, aggregators may play a central role in pooling consumers, producers, and prosumers, leading to expected efficiency and welfare gains. Real-world electricity markets often lack the conditions of an ideal market, such as complete information, perfect coordination, rational behavior, and perfect regulation. As a result, they fail to realize direct price signals (e.g., due to fixed retail tariffs, Borenstein and Bushnell 2019, monopolistic retail settings and minimum size requirements for participation in wholesale markets). To address these issues, aggregators group multiple agents (consumers, producers, prosumers) and bundle them into one entity, which can participate in day-ahead, intraday, and ancillary service markets. In this way, aggregators act as intermediaries to leverage untapped flexibility and address the market failures outlined above, increasing overall economic efficiency by reducing peak residual demand and balancing the system through temporal and spatial harmonization of generation and demand profiles. However, regulatory and incentive structures must be well designed to lift the full flexibility potential of aggregation and avoid regulatory arbitrage.

1.2 Project Goals

The objective of the project is to identify the economic value of aggregators in a flexible and decentralized Swiss energy system and to provide guidance on a regulatory framework that reduces barriers to system-beneficial aggregation and avoids incentives for regulatory arbitrage.

In this context, this project aims to:

- review the regulatory framework aggregators are operating in,
- analyze the value of aggregators in providing a solution to the imperfect information of consumers to manage flexibility,
- derive recommendations for improving the regulatory framework to avoid opportunistic aggregation and enable beneficial aggregation.

2 Results

Since the last annual report, we have focused on the tasks of WP2 (Market modeling) and WP3 (Assessments). Also, we worked on a large revision of our paper on electricity profile contracts for retail customers that incentivize flexibility, which got accepted for publication in *Energy Policy*.

The progress can be categorised into the following categories:

- Modeling on the Value of flexibility
    - Flexibility on the supply side (Renewable curtailment)
    - Flexibility on the demand side (Heat pumps and EVs)
- Policy measures to promote flexibility

In the following subsections we discuss in more detail the outcome of each one.

2.1 Value of flexibility in Switzerland.

Flexibility. In view of the ambitious renewable energy targets set for the Swiss and European electricity systems, it is essential to build an electricity system that is flexible enough to adapt its operation to short-term fluctuations on both the supply and demand side. To achieve this, it is important to put in place regulatory and market policies that allow the efficient use of the currently untapped value of flexibility of the system. One of the first steps in this process is to assess the value that a flexible energy system would have in the future.

In this section, we show the results of our quantification of the value of flexibility in Switzerland. We consider both the supply and demand side of the Swiss electricity system and use different methodological approaches to quantify it. In Section 2.1.1 we summarize the results of the value of flexibility form the supply side while the demand side is presented in section 2.1.2.

2.1.1 Flexibility on the supply side: Curtailment

One of the consequences of current renewable support policies is the appearance of negative electricity prices, which affect the supply side of the system in particular. Low prices realize when the demand can be supplied by low-marginal cost electricity generators. This usually occurs during periods of low demand in which renewable generation, nuclear, or both, suffice to cover the demand. Low prices then incentivize producers to stop producing if the cost is below their marginal cost of production while consumers are incentivized to spike-up their demand. This market dynamic means that even during periods of very low electricity prices, negative prices should not be realized since no producer would be willing to produce at a loss but nevertheless, negative prices have become more frequent in Switzerland over the years (Figure 1).

The main reason for the emergence of negative prices is the widespread use of feed-in tariff (FiT) programs and similar fixed price remuneration of renewables, including in neighboring countries. These schemes were designed as a strong incentive for the installation of wind and solar capacity by either paying a fixed price for every unit of electricity produced (feed-in tariffs) or paying a premium over the market price of electricity (feed-in premium) during an agreed period, which usually spans many years. FiT programs were very successful in rapidly scaling-up the renewable energy capacity in the European electricity system but they also create an incentive distortion as non-price reactive producers are incentivized to maximize their production at all times independently of the system needs, reflected in the electricity price.

Incentive schemes resulted in the deployment of significant capacity of small-scale PV capacity and as they guaranteed a fixed payment per electricity unit injected into the grid, provide little incentive for producers to install additional control systems to limit the amount of electricity injected to the grid according to external signals (e.g., price-response, balancing).

As a result, most PV capacity today is not flexible and continues to produce even when there is an electricity oversupply in the system.

As a consequence, during sunny summer days, the low marginal cost of market-based PV drive electricity prices down while uncontrolled off-market PV capacity further reduces the market price to negative values. As expected, the occurrence of negative prices becomes more prevalent with increasing shares of off-market and uncontrolled PV capacity.

Another contributing factor is that during negative price periods, most prosumers fulfill their own demand with their own PV system's generation. This happens because they also face fixed electricity tariffs and are thus essentially blind to market prices, worsening the problem by not consuming electricity from the grid when the system needs more demand.

This issue also represents a concern from the system's perspective. In terms of the system stability, an oversupply of electricity is as bad as an undersupply and could even cause small or large-scale blackouts if the problem is not addressed at the European level, as it would, if not mitigated, can lead to over-frequency and the subsequent self-protection mechanism of grid-connected assets.

Apart from the technical problems in the system, producing electricity during negative price periods distorts the market and results in a societal loss, since the revenue of price-blind producers is

independent of the market and at the end, it is paid by consumers through taxes or additional fees on the electricity tariff.

Empirical approach

To quantify this loss, we analyzed PV generation and day-ahead electricity price data from the European Network of Transmission System Operators' (ENTSO-E) Transparency Platform (ENTSO-E, 2024) for the area of Switzerland from January 2020 to July 2024.

We calculated the electricity value for two different scenarios, one in which electricity generation is curtailed when the electricity price is equal or lower to zero and another one in which producers keep producing in disregard of the market price. The latter scenario reflects the current situation. The electricity value is computed according to the following equations:

$$v_{curt_t} = \begin{cases} 0 & if\ p_t \leq 0 \\ p_t \cdot pv_{gen_t} & if\ p_t > 0 \end{cases} \qquad \forall\ t \tag{1}$$

$$v_{nocurt_t} = p_t \cdot pv_{gen_t} \qquad \forall\ t \tag{2}$$

Equation (1) depicts the curtailment scenario where, if the day-ahead electricity price is higher than zero in any given period t, the value of electricity (v_{curt_t}) will be the total PV generation (pv_{gen_t}) multiplied by the electricity price (p_t), otherwise the value is equal to zero. Equation (2) describes the scenario in which PV producers do not react to electricity prices, and hence the value of electricity (v_{nocurt_t}) is negative during negative price periods. Finally, we determine the percentual relative value difference between both scenarios with Equation (3).

$$rel_diff_t = \frac{(v_{curt_t} - v_{nocurt_t})}{v_{nocurt_t}} \cdot 100 \qquad \forall\ t \tag{3}$$

Figure 1 shows the occurrence of negative prices in the Swiss Market zone from January 2020 to July 2024. The orange bars are the total hours in which negative price were realized in each month, while the yellow line marks the cumulative number of negative-priced hours. The blue line shows the value difference (%) between both scenarios.

It is evident that during the summer of 2024, negative prices spiked in both occurrence and value difference.

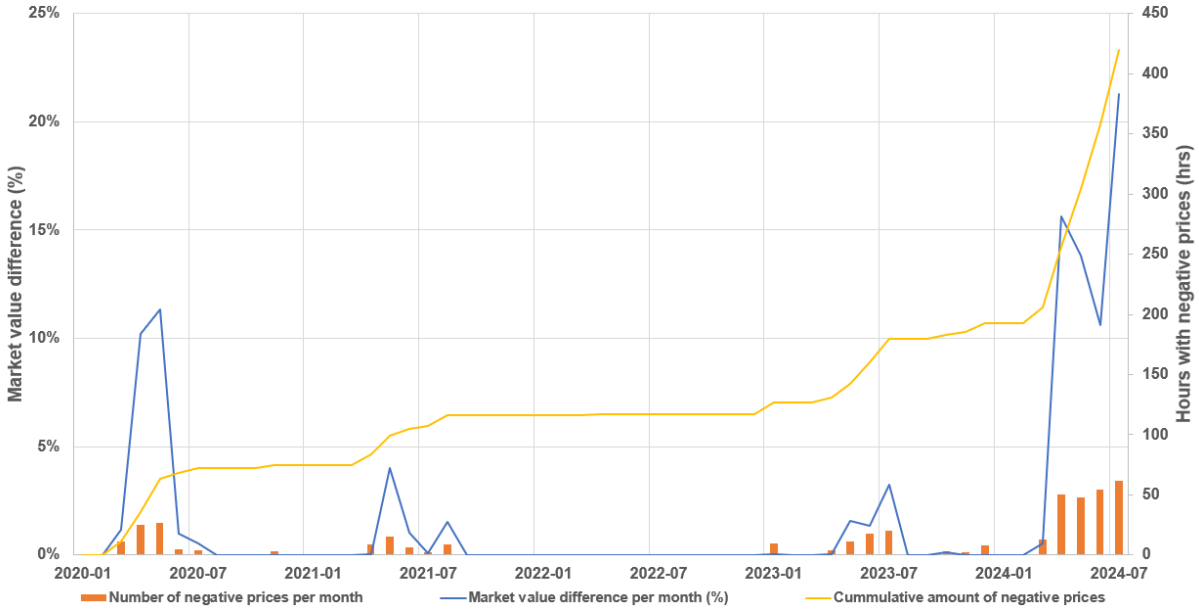


Figure 1: Negative prices in Switzerland (from 01.2020 to 07.2024)

To better understand the temporal dynamics of this phenomenon, we computed the average hourly market value during July 2024 for our two scenarios. The results are shown in Figure 2, where we see that the average hourly PV output (yellow line) follows the typical daily generation curve for solar PV, peaking around 13.00 hours at 2.68 GW. Next, the black line shows the market value of PV electricity without curtailment (Equation (2)), where we see a dislocation between generation and output at 10.00 hours. At this moment, the value of electricity peaks at 68.5 $kEUR/hour$ but, as solar-driven oversupply of electricity impacts the price negatively, its value sinks. Finally, the blue-dotted line shows the average monthly market value of electricity on the curtailment scenario. Here, the market value also peaks and starts to sink at the same time, however curtailing when prices are zero or lower limits the drop in market value significantly.

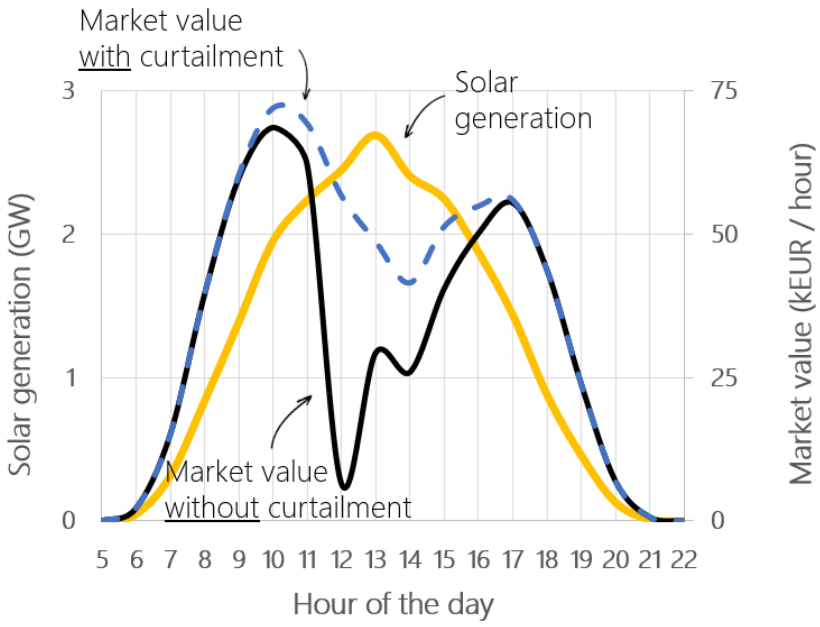


Figure 2. Average market value of curtailment for Switzerland in July 2024

It is important to note that the reason we do not see negative values in Figure 2 is because we are showing monthly averages. For a daily curve, if prices are negative in some periods, the electricity value is negative.

Table 1 shows the total solar generation (TWh), the average value for the curtailed and non-curtailed scenario (EUR/MWh) and the value difference between both scenarios (%) following Equation (3). We see that even when there is yearly variability in the value difference (due to meteorological factors, specific market dynamics, or both), there are years in which the value loss is significant, reaching up to 32.2% in 2024.

Table 1. Average yearly curtailed and non-curtailed electricity value of solar PV in Switzerland.

Year	Solar Generation (TWh)	Solar Value (EUR/MWh)	Curtailed Solar Value (EUR/MWh)	Relative difference in value (%)
2020	2.4	28.2	29.5	4.6
2021	2.5	85.5	88	2.9
2022	3	293.3	293.5	0.1
2023	3.5	85	88.3	3.9
01.2024 - 07.2024	2.7	38.3	50.6	32.2

2.1.2 Flexibility on the demand side: Smart charging and heating

In European electricity markets, residential retail contracts with fixed tariffs (i.e., time-constant prices) are still widely used. As a result, grid-connected flexible loads of residential consumers have little incentives to shift or reduce their load in response to price signals. To unlock the usage of flexibility there is thus a growing need to reform retail contracts by introducing incentives for demand response, such as dynamic prices.

However, to estimate the potential economic gains from such flexibilization of tariffs, it is important to quantify the value of the flexibility inherent in the Swiss system.

Our modeling approach to quantify the value of flexibility embedded in Swiss households combines two different models: the *Future Energy Market* (FEM), a market-focused techno-economic model of the European electricity market and *SwissStore* (Ramirez et al, 2024), a bottom-up energy model of the Swiss household sector.

FEM. The FEM model simulates investment, dispatch and trade within the European electricity market. Its objective function minimizes total system constants while meeting the system's technical constraints and its outputs are, among others, the future generation capacity mix, generation profiles and electricity prices for various scenarios.

Figure 3 shows the different components of the FEM model. The European electricity market is represented by Switzerland's neighboring countries and their neighbors. Each of these countries is represented by a single node with an aggregated power capacity mix by type and aggregated demand. The Swiss electricity market module is connected to the European market and it is modeled in detail, including individual power plants types, spatial variation for renewable generation potential (7 *Grossregionen*), sectoral demand (i.e., residential, industrial and commercial) and electricity storage. Additionally, fossil fuel prices, both for the EU and Switzerland, are integrated into the model.

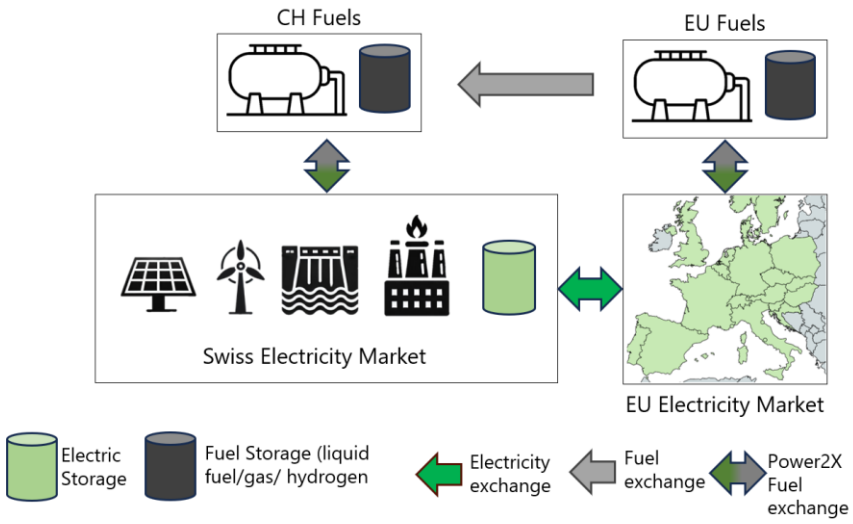


Figure 3. Schematic representation of the FEM electricity market model

SwissStore. SwissStore is a greenfield bottom-up investment model of the Swiss residential sector. The model integrates a large database depicting the Swiss residential sector, including individualized electricity and heating demand profiles plus a detailed techno-economic description of energy technologies to meet the household's (HH) electricity and thermal energy demand. Figure 4 shows the different components of SwissStore.

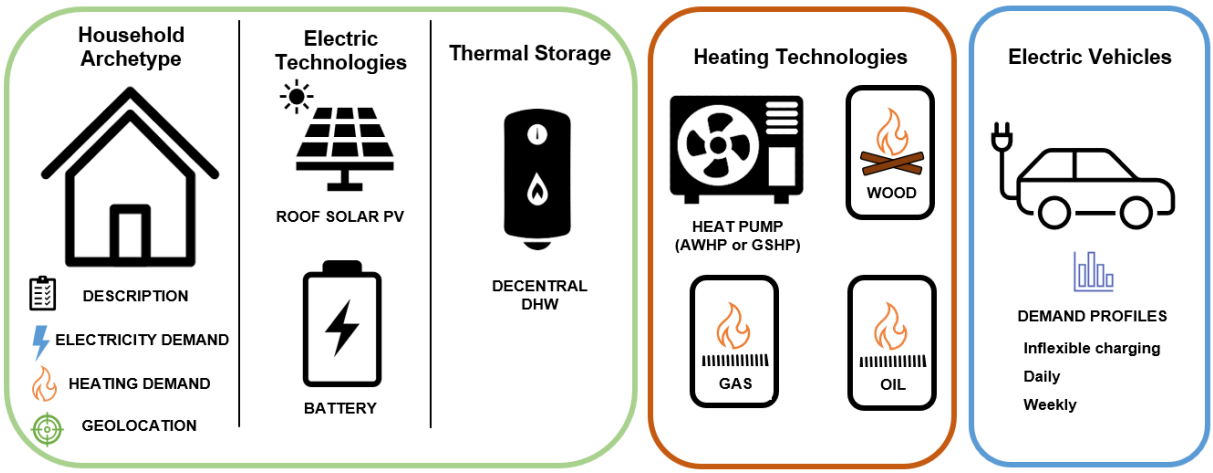


Figure 4. Schematic representation of the SwissStore residential energy model

SwissStore archetypes. The residential sector is characterized by more than 330,000 representative building archetypes accounting for more than 1,4 million residential buildings. Each archetype is modelled with a great level of detail and represents a group of buildings in a certain geographical location and share similar characteristics. The archetype characterization follows the guidelines of the Federal Register of Buildings and Dwellings (FRBD) of the Swiss Federal Statistical Office (FSO).

SwissStore demand profiles. Thermal heating demand is available for each archetype, based on their specific building characteristics and prognosed climatic conditions at their geographical location. Inflexible electricity demand (i.e., exogenous electric demand parameter) is computed based on the building type and specific average consumption per square meter. Electricity demand is available at an hourly resolution, while heating demand has been estimated at a daily resolution.

SwissStore technologies. Roof solar PV and electric batteries capacity are endogenous to the model and are considered flexible as their operation and optimal installed capacity vary according to the model's parameters, such as price signals and costs. SwissStore also includes different types of boilers (oil, gas and wood-fired) and heat pumps (air-source and ground-source, ASHP & GSHP). All technologies are described in terms of their technical characteristics and costs, both capital (CAPEX) and operational (OPEX).

SwissStore EVs. In the context of the AGGREGATE project, we expanded SwissStore as described in Ramirez et al (2024) by integrating electric vehicles (EVs). We use EV demand data from the EWG funded project NETFLEX (Ludwig & Winzer, 2022) and model three different flexibility EV charging scenarios (inflexible, daily and weekly).

SwissStore modularity. Given the modularity of the model, any combination of technologies can be set, including setting the PV or battery capacity to zero in order to explore the impact of a single technology in the system (e.g., heat pumps or electric vehicles).

SwissStore objective. The model applies a linear cost minimization function to the electricity system costs of each HH archetype (including the technologies' lifetime investment costs) and different technology combinations for the year 2050 at an hourly resolution. During the final stage, all costs are summed for each technology combination to determine the least costly overall (i.e., the optimal technology combination). Beyond technology combinations, the model also integrates overarching policy scenarios (e.g., carbon tax scenarios), fossil fuel price projections, different building retrofit rates and climate scenarios.

SwissStore efficiency. By modeling both the electricity and heating demand, SwissStore can capture the technological complementarities and potential efficiency gains that the foreseen electrification of the heating and mobility sectors could entail. In this analysis we put a special focus on the value of flexibility provided by heat pumps and EVs.

Model chain. We combine these two models to integrate the top-down market dynamics of the European electricity system with the bottom-up demand response of end-consumers in Switzerland. We achieve this by exposing consumers to different retail electricity tariffs derived from the market price timeseries output from FEM.



Figure 5. Model chain between FEM and SwissStore

FEM scenario. The electricity time series from FEM are scenario specific. Each scenario considers different assumptions in four dimensions, namely the Swiss electricity system, the European electricity system, available trade between Switzerland and Europe and finally, the weather year[1]. The prices we use for our simulation are summarized in Table 2.

Table 2. FEM's scenario assumptions

	Assumption	Remark
CH	EP 2050+	Zero Basis scenario
		No minumum generation target for RES
	7 *Grossregionen*	Region-specific renewable generation profiles
	Power plants	3 representative hydro power plants and 1 run of river
	Winter limit constraint	Disabled
EU	TYNDP 22	Global Ambition Scenario
	Power plants	1 per technology per country
Trade	NTC	Fully available
Weather year	1995	

HH sample. To test the integration of the models we executed a SwissStore with a randomized sample of 500 households for the year 2050. We implemented three different EV charging scenarios with an dynamic electricity tariff considering all price components (i.e, grid usage, taxes, etc), which is constructed with FEM's output. We also use the energy component of the price as a payment for the periods when EVs discharge and inject electricity into the grid.

EV scenarios. Regarding the EV flexibility scenarios, we first have an inflexible charging profile which meets the daily EV demand following a fixed charging profile[2]. The other two scenarios allow EVs to charge flexibly the aggregated daily and weekly EV demand. In this way, we can estimate how much value is derived from different flexibility time horizons.

[1] The weather year simulates the climatic conditions of a certain past year (e.g., one with extreme weather) when simulating future electricity systems. It hence affects demand and generation (e.g., heat pumo demand would increase in a cold year while solar PV generation would increase during a sunny year)

[2] We assume a fixed hourly profile in which charging starts at 18.00 until the daily EV demand is met.

Preliminary results. Preliminary results for the total EV charging of the 500 HHs is presented in Figure 6. Here we see that the aggregated EV's electricity demand increases as the flexibility time window also increases. This is also true for the aggregated discharged energy in Figure 7.

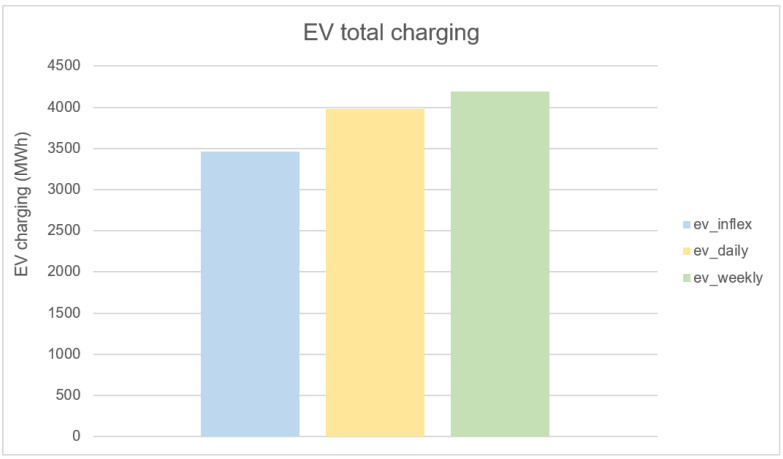


Figure 6. Total EV charging demand for different flexibility scenarios.

Mechanism. This is the result of HHs profiting from the flexibility potential of their assets. As they have access to dynamic price signals for both their consumption and injection to the grid, they charge their vehicles in times of low prices and discharge when prices are higher, while always meeting their mobility needs.

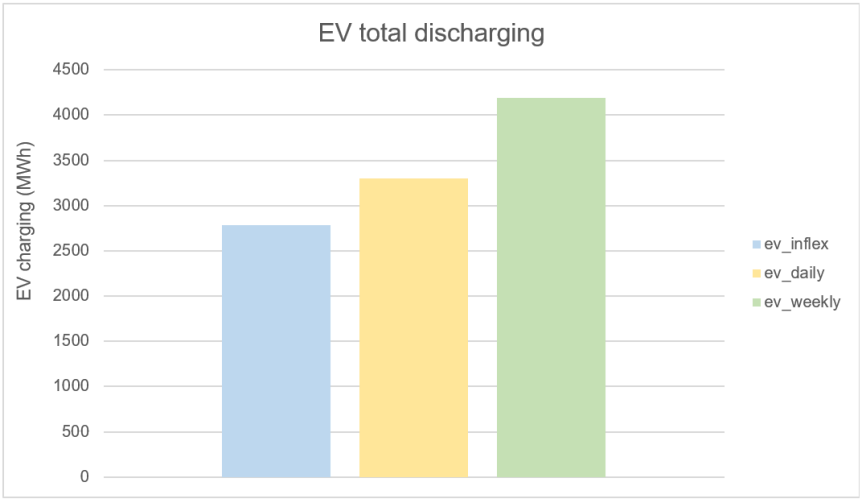


Figure 7. Total EV discharging demand for different flexibility scenarios.

Value. The aggregated value of EV flexibility for the sample of 500 HHs is shown in Figure 8. Here we show the value in terms of the total retail electricity price, i.e., considering all price components, and only with the wholesale price. We see a similar upward trend in with higher flexibility time windows in both, however the fixed costs of the retail tariff inflate the total value significantly.

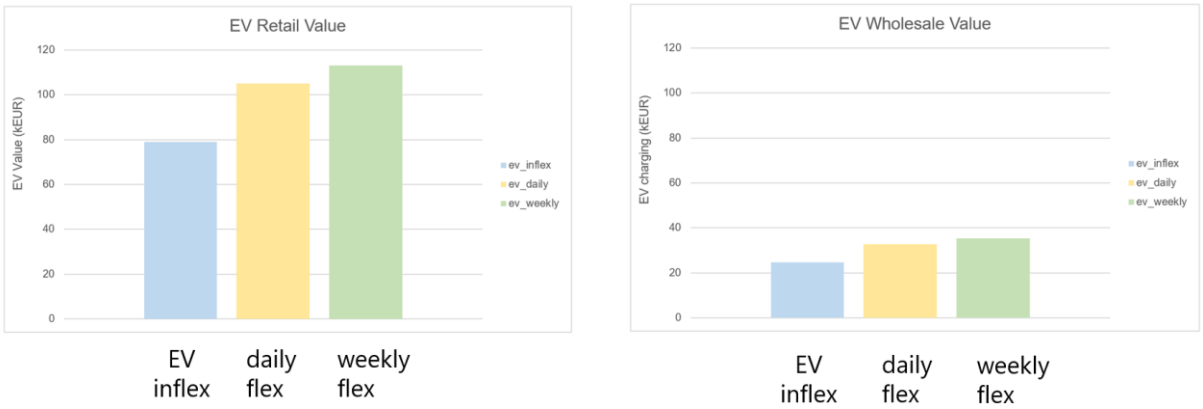


Figure 8. Total EV value (retail and wholesale) for different flexibility scenarios.

2.2 Policy measures to promote electricity flexibility in Switzerland.

In this section, we summarize the key findings of our report on “Policy measures to promote electricity flexibility in Switzerland - Considerations in the context of the Mantelerlass legislation”, in which we analysed the Swiss policy framework for decentral flexibilities. Our key results were the following.

We recommend four interventions to improve the use of flexible demand assets.

1. Incentives for DSOs
2. Spot-based energy tariffs
3. Dynamic grid tariffs
4. A real-time tariff publication platform
5. Device-specific suppliers

Incentives for DSOs

The regulatory framework for DSOs should include stronger incentives for DSOs to efficiently trade-off the usage of grid flexibility and further grid buildout. While the current NOVA principle, which stipulates that optimization of grid use is to be prioritized over grid reinforcement and grid buildout, is a good step in that direction, it remains hard to monitor for the regulatory agency ElCom. Regulation should be changed so it is in the self-interest of DSOs to make this trade-off efficiently. This requires changing from a cost-plus regulation to an incentive regulation (see the extensive literature on the subject, e.g. Joskow, 2014) and choosing the parameters of such regulation to incentivize the use of flexibilities.

Spot-based energy tariffs

We recommend mandating energy suppliers to offer spot-based energy tariffs. With spot-based we mean tariffs that are defined close to real-time, for example one day before delivery, so they can incorporate the structure (but not necessarily the level) of day ahead spot power prices. In Winzer et al. (2023b) we outline how profile tariffs enable such spot-based incentives for flexibility provision while protecting customers from changes in the level of prices and thus ensuring stable electricity bills for customers.

Dynamic grid tariffs

Grid congestions in the DSO grid are likely to be the most pressing reason why residential electricity flexibility will be urgently needed in the coming years. This is due to the foreseeable fast deployment of electric vehicles and heat pumps. While direct load control by DSOs presents a valid solution especially as a last-resort measure, it comes at the downside of being unable to take short-term preferences of customers into account adequately and balance the (time-variant) disutility of customers from such load control with the system need for them. Dynamic grid tariffs, that would be set in a similarly short-term manner as spot-based energy tariffs, for example day ahead, can do that. Customers facing such tariffs remain in control and are thus able to prioritize e.g. fast-charging when needed. An example of a highly dynamic grid tariff is Group-E’s Vario tariff (Groupe-E, 2023). We recommend mandating DSOs to introduce dynamic grid tariffs to foster demand flexibility.

Situational short capacity charges

An easier to implement interim solution is the introduction of situational short capacity charges (German: “situative kurze Leistungspreise”, see also Winzer et al., 2024, and Neon, 2024). They are capacity charges, so that they charge on a peak demand. They are situational (i.e. active only when a highly loaded grid can broadly be foreseen, such as only in winter evenings) and they are short (i.e. they look at the peak capacity only during a short time-period such as a multi-hour period and are charged for the single multi-hour period). This sets them apart from yearly peak capacity charges.

Platform publishing real-time tariffs

Digitalization and automation will play a vital role in the dissemination of dynamic tariff schemes, as constant monitoring of the electricity market and remote operation of flexible demand assets will be essential to its successful implementation. Therefore, a unified online platform where all stakeholders can have access to hourly tariffs and other important information can contribute to enhance the reach of these schemes and its transparency towards consumers. Especially, household energy management systems (EMS) are likely to access such a platform to optimize the consumer’s flexibility dispatch.

Device-specific suppliers

We also believe it is worth investigating the option of allowing aggregators to fully supply energy to specific devices (heat pumps and electric vehicles), as a step towards partial liberalization. The advantage of such device specific suppliers is that they can manage the full value potential of flexible assets, from energy procurement to balancing provision, without a problematic split of responsibilities. Device-specific suppliers also have the advantage of being able to reap economies of scale when specializing in managing a specific type of demand asset which they manage in all of Switzerland or even internationally and can thus consider the full set of restrictions of such specific assets, like the charging properties of a specific car type or of a specific heat pump with thermal storage. To enable device-specific suppliers, careful regulation is needed that avoids consumers cherry-picking over time, by switching to the competitive market in times of low wholesale electricity prices and reverting to the main supplier in times of high wholesale prices. In ongoing work, we are advancing this idea.

3 Next steps

Our work for the remainder of the AGGREGATE project will focus on a final report that summarizes the key findings of our project and documents the modeling results. We will also execute further simulations, including modeling the flexibility value of electric vehicles. Lastly, we will also run additional scenarios for which we will combine demand-flexible technologies (i.e., EVs, heat-pumps and PV) to investigate if there is added value in the combined operation of these technologies.

In the 1st quarter of 2025, we organize the 3rd and final project workshop, in which we will present our final findings and model results. From the workshop, we will gather feedback from our project partners to finalize the final AGGREGATE report.

4 National and International Cooperation

Our advisory group forms an integral part of our project and is our main cooperation vehicle for exchange with companies, industrial associations and the academics on our advisory board.

For our work on profile contracts for retail customers, we collaborated with Prof. Dr. Lion Hirth (Hertie School) and Dr. Christian Winzer (ZHAW Winterthur, SWEET PATHFNDR).

Furthermore, we continued our collaboration with the Competence Center for Thermal Energy Storage from the Lucerne University of Applied Sciences (HSLU) on quantification of heating demand to better estimate the flexibility potentials in the heating sector.

5 Communication

On September 20th, 2024, we conducted our second project workshop in Zurich. All the project's industry and academic advisors were invited to participate. The workshop featured three main presentations on results by the AGGREGATE team, summarizing the progress done so far. Active engagement by industry, associations, academics and the BFE enriched the workshop with fruitful exchange.

On August 28th, 2024, we presented for a keynote at the AEE Congress in Pratteln/Baselland with first results from AGGREGATE modelling of the value of supply-sided flexibility (PV curtailment) and regulatory conclusions.

Our co-author, Christian Winzer, also presented the paper on "Profile contracts for retail customers" in Paris at the CEEM Conference.

6 Publications

6.1 Paper publication: "Profile contracts for electricity retail consumers".

Continuing our joint with Christian Winzer (ZHAW, SWEET PATHFNDR) and Lion Hirth (Hertie School) on electricity tariff design, we published and got accepted the paper "Profile contracts for electricity retail customers" in the special issue of the Energy Policy Journal entitled "Future Electricity Tariffs" (Winzer et al, 2024).

In this paper we analyze the use of profile contracts to expose consumers to dynamic electricity tariffs, and hence to the right incentives to use their demand flexibly, while providing bill stability and protecting consumers against price risk. We show that profile contracts can bring electricity bill volatility to similarly low levels as fixed tariffs while providing full flexibility incentives from spot prices.

6.2 Policy report: "Policy measures to promote electricity flexibility in Switzerland".

In the context of the Mantelerlass legislation, we have prepared the report "Policy measures to promote electricity flexibility in Switzerland"In this report we discuss the current environment for the use of flexibility in the Swiss electricity system and the implications of the new Mantelarlass legislation.

7 References

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