CHALLENGES IN DIFFERENTIATING LOCALLY GENERATED RENEWABLE AND GRID-SOURCED ELECTRICITY IN STORAGE SYSTEMS FOR V2G: A SIMULATION-DRIVEN STUDY BASED ON THE GERMAN MISPEL REGULATORY FRAMEWORK

Florian F Sehr[1]*, Steffen Daniel[1], David Reiners[1], Wolfgang Duschl[2], Viktor Grinewitschus[1]

[1]EBZ Business School, Springorumallee 20, Bochum, Germany
[2]Bayernwerk Netz GmbH, Lilienthalstraße 7, Regensburg, Germany
**f.sehr@ebz-bs.de*

Keywords: MiSpeL Pauschaloption, Vehicle-to-Grid (V2G), flexibility, battery storage, bidirectional charging, regulatory framework

Abstract

The grid-, market- and system-supportive use of decentralised electricity storage systems and electric vehicles with bidirectional charging requires suitable regulatory conditions. The MiSpeL Pauschaloption developed by the German Federal Network Agency is intended to enable the mixed charging of storage systems with PV electricity and electricity from the grid, followed by feed-in to the public grid. This paper uses an optimisation-based simulation model to analyse the effects of the 2025 Consultation Draft and the Revised Working Version 2026 on different prosumer configurations with stationary battery storage systems and/or bidirectional charging infrastructure with an associated electric vehicle. The results show that, in cases with high PV surplus feed-in, the original Consultation Draft can create financial benefits solely by changing the accounting concept, without storing electricity from the grid and feeding it back into the grid. This creates a false incentive, as financial relief can occur without the market-supportive storage operation that the regulation is intended to promote. The indifference range introduced in the Revised Working Version 2026 of the Pauschaloption significantly reduces this effect. At the same time, however, it increases the offsetting threshold and therefore the barrier to the economically viable intermediate storage of electricity from the grid. Under the Revised Working Version, storing grid electricity for subsequent feed-in is rarely economically beneficial in EV-only configurations, but more frequently in combined EV -battery systems, while battery-only results strongly depend on household demand. For electric vehicles with bidirectional charging, the largest additional potential mainly results from the time-shifted feed-in of PV electricity and reaches up to around EUR 600 per year in the analysed cases. Overall, the results show that the fixed remuneration limit of 500 kWh/kWp and the indifference range can only partly reflect different consumption levels, self-consumption patterns and system configurations.

1 Introduction

1.1 Motivation and Regulatory Challenge

The transformation of the energy system towards a climate-neutral electricity supply requires not only the expansion of renewable generation capacity but also greater flexibility in electricity generation and consumption. Since electricity generation from photovoltaic and wind power plants cannot easily be adjusted to match current demand, shifting electricity consumption over time and storing electricity are becoming increasingly important. Electricity storage systems can store surplus electricity during periods of high renewable generation and provide it at a later time. Traditionally, pumped-storage power plants have mainly been used for this purpose. However, battery storage systems are becoming increasingly important due to the growing use of lithium-ion technology and decreasing storage costs. In general, a distinction can be made between residential and commercial battery storage systems, large-scale battery storage systems, and batteries in electric vehicles.

Compared with pumped-storage power plants or large-scale battery storage systems, which typically store mainly electricity from the public grid, storage systems that are charged with both electricity from the public grid and electricity from renewable energy plants create an additional metering challenge. In such mixed-use storage systems, different electricity quantities fed back into the grid need to be distinguished. This applies in particular to the distinction between electricity from a renewable energy plant that has been stored and is eligible for remuneration, and electricity previously imported from the public grid that may be considered for levy offsetting when it is later fed back into the grid. The situation becomes more complex when, in addition to storing grid electricity and renewable electricity, a

significant amount of electricity is consumed locally. For a combination of a renewable energy plant and a storage system, it is already possible to charge the storage system exclusively with renewable electricity within a calendar year. This so-called Exclusivity Option is regulated in Section 19(3a) EEG. Under this option, charging the storage system with electricity from other sources, for example from the public grid, must be prevented. For an electric vehicle, however, this is not practicable. Therefore, the Exclusivity Option is not a suitable operating mode for bidirectional EVs. A bidirectional EV, like a residential battery storage system, can instead be operated as a mixed-use storage system that may be charged with both electricity from a renewable energy plant and electricity from the public grid. In this case, however, electricity from the storage system may not be fed back into the public grid.

This regulatory gap is intended to be addressed by the MiSpeL framework of the German Federal Network Agency (BNetzA). MiSpeL introduces a new regulatory approach for the market integration of decentralised storage systems. Its basic principles may also be relevant for other European countries with comparable support schemes and state-induced price components for electricity consumption. In particular, MiSpeL is intended to allow storage systems to be charged with electricity from both renewable energy plants and the public grid and subsequently to feed electricity back into the public grid without generally losing the eligibility of the renewable energy plant for remuneration. Within the same system configuration, both feed-in eligible for remuneration and feed-in eligible for offsetting can therefore be distinguished. [1] For feed-in quantities classified as eligible for offsetting, the levy burden on the corresponding grid import is reduced in accordance with Section 21 EnFG. This approach can also be applied to other state-induced price components [2]. Regarding the reimbursement of grid fees, it is partly argued that market-oriented storage operation under MiSpeL should at least not cause additional grid loading, since grid fees are used to finance the grid infrastructure [3]. Without suitable differentiation and a regulatory reduction or exemption of state-induced costs, storing electricity from the grid is hardly economically attractive. Grid electricity imports are subject to taxes, levies, charges and grid fees, which need to be considered or reimbursed accordingly when the electricity is later fed back into the grid to enable economically viable operation [4]. At the same time, insufficient differentiation rules can create false incentives if electricity quantities are classified as eligible for remuneration or eligible for offsetting even though no corresponding storage or trading activity has taken place.

The EEG distinguishes between the MiSpeL Abgrenzungsoption under Section 19(3b) EEG and the MiSpeL Pauschaloption under Section 19(3c) EEG. Under the MiSpeL Abgrenzungsoption, the share of the fed-in electricity that is eligible for remuneration is calculated, whereas under the MiSpeL Pauschaloption, a fixed share eligible for remuneration is applied. This study focuses on the implementation of the MiSpeL Pauschaloption. According to Section 19(3c) EEG, the MiSpeL Pauschaloption is limited to configurations with solar installations with a total installed capacity of no more than 30 kW and therefore mainly targets private prosumers. According to the law, up to 500 kWh/kWp of feed-in is eligible for remuneration. On 18 September 2025, the BNetzA published a first consultation draft of the MiSpeL framework (V1) [5] and subsequently published a revised working version (V2) on 5 August 2026 [6].

Previous studies often focus on electric vehicles with bidirectional charging without integrating local PV systems and mainly investigate revenue potential and participation in different electricity and flexibility markets, for example in [4]. When PV systems are included in the analysed systems, the regulatory challenge of distinguishing between electricity quantities eligible for remuneration and electricity quantities eligible for offsetting is often avoided. One approach is to consider self-consumption optimisation and arbitrage trading separately or only sequentially rather than simultaneously, as for example in [7]. Another study considers the relief from taxes, levies and grid fees for electricity fed back into the grid and analyses its impact on the economic viability of bidirectional charging. When PV self-consumption optimisation and spot market trading are combined, the presented model formulation does not show an explicit regulatory allocation of the electricity fed back from the vehicle to energy quantities previously taken from the grid or from the PV system [8].

A first simulation-based analysis of the MiSpeL regulations is available for the 2025 Consultation Draft. Conzelmann and Bergner model the MiSpeL Abgrenzungsoption and the MiSpeL Pauschaloption for stationary PV battery storage systems [9]. The study is based on the 2025 regulatory framework and therefore does not yet consider the changes to the MiSpeL Pauschaloption introduced in the Revised Working Version 2026. In addition, the previous analysis focuses on stationary battery storage systems. A comparative analysis of the MiSpeL Pauschaloption including bidirectional EVs and different prosumer configurations is still missing.

1.2 Objective and Research Questions

The aim of this study is to analyse the effects of the MiSpeL Pauschaloption on different prosumer configurations with PV systems, stationary battery storage systems and bidirectional EVs. Both the original Consultation Draft and the current Revised Working Version of the MiSpeL Pauschaloption are considered. The main focus is on how the remuneration limit and the offsetting threshold affect different household configurations. In particular, the study analyses how asset sizing, different forms of flexibility use and self-consumption optimisation affect electricity quantities eligible for remuneration and offsetting, as well as the economic results. The study also analyses whether households with high self-consumption rates, for example through solar charging or Vehicle-to-Home (V2H), reach the thresholds relevant for levy offsetting.

In the published Revised Working Version of the MiSpeL framework, an indifference range is introduced between the remuneration limit and the offsetting threshold. Within this

range, feed-in quantities are considered neither eligible for remuneration nor eligible for offsetting. The study therefore also analyses how this indifference range affects the allocation of feed-in quantities.

The main research questions of this paper are:

- How does the switch to the MiSpeL Pauschaloption change the regulatory allocation and economic evaluation of identical energy flows compared with existing accounting concepts?
- Which additional marketing and flexibility options does the MiSpeL Pauschaloption enable compared with existing operating and marketing concepts for decentralised storage systems?
- What differences arise between the Consultation Draft and the Revised Working Version?
- Under which system and consumption configurations does the MiSpeL Pauschaloption enable or limit the market-based storage of grid electricity and its subsequent feed-in to the grid?
- What requirements result from this for HEMS strategies and operational feasibility?

2 Methodology

The analyses in this study are based on the optimisation-based simulation model EBZ OptiTwin. A basic description of the model and the underlying optimisation approach can be found in [10]. For the analysis of the MiSpeL Pauschaloption in this study, the existing OptiTwin model was extended by the required calculation rules of the first Consultation Draft and the Revised Working Version.

In the following, the main regulatory framework and the functioning of existing metering concepts for PV storage systems and the MiSpeL Pauschaloption are first explained. The OptiTwin simulation model used in this study is then described, with a particular focus on the model extensions implemented to represent the MiSpeL Pauschaloption.

2.1 Regulatory Framework and MiSpeL Pauschaloption

The MiSpeL framework is intended to enable decentralised storage systems to be charged with electricity from both a PV system and the public grid without losing eligibility for remuneration under the EEG. The stored electricity can later either be fed back into the public grid or consumed locally. In principle, four main energy flows can be distinguished within this mixed storage use, each of which has a different regulatory classification. The terms *generation* and *consumption* of electricity within the storage system are used here according to the MiSpeL terminology:

1. locally generated PV electricity is stored as electricity consumed by the storage system and later used as electricity generated by the storage system for self-consumption,
2. locally generated PV electricity is stored as electricity consumed by the storage system and later fed into the grid as electricity generated by the storage system and eligible for remuneration,
3. electricity imported from the public grid is stored as electricity consumed by the storage system and later used as electricity generated by the storage system for local consumption, and
4. electricity imported from the public grid is stored as electricity consumed by the storage system and later fed back into the public grid as electricity generated by the storage system

2.1.1 Conventional Storage Operation and Exclusivity Option: With the metering concepts available so far, not all four energy flows can be realised at the same time. When electricity is fed back into the grid from a storage system charged with both PV and grid electricity, it is not possible to clearly distinguish between electricity from the PV system that is eligible for remuneration and electricity previously imported from the grid. Therefore, the storage system must either be prevented from discharging into the grid or from charging from the grid. While both options are possible for stationary battery storage systems, preventing grid charging is not practicable for a bidirectional EV, as the vehicle also needs to be charged from the grid, for example during winter. For comparison, the metering and accounting concepts available so far are described in the following subsection. This allows energy flows 1 and 2.

2.1.2 Exclusivity Option and Mixed Storage: If the storage system is charged exclusively with electricity from a PV system that is eligible for remuneration, and an energy management system (EMS) ensures that no electricity from the public grid enters the storage system, the storage system may discharge into the public grid. Under the Exclusivity Option according to Section 19(3a) EEG, the electricity fed into the grid from the storage system remains, in principle, fully eligible for remuneration. Within supported direct marketing, the storage system can therefore be used to store PV electricity and feed it into the public grid at a later time.

If, by contrast, the storage system is not prevented from charging from the public grid, it may store both PV electricity eligible for remuneration and electricity from the grid. In this case, a later grid feed-in from the storage system can no longer be clearly assigned to the eligible PV electricity, so EEG remuneration under the Exclusivity Option is not possible. At the same time, without a suitable differentiation method, the electricity imported from the grid for storage cannot be clearly identified. Therefore, relief or offsetting of the state-induced price components (SIP) is also not possible. This allows energy flows 1 and 3.

2.1.3 MiSpeL Pauschaloption: Under the MiSpeL framework, it should become possible to feed electricity from mixed-charged storage systems back into the public grid. This is intended to allow all four energy flows described in Section

2.1 for the first time. The MiSpeL Pauschaloption uses a simple approach based on a single-meter metering concept, as shown in Fig. 1. A stationary battery storage system, a bidirectional charging point, or a combination of both storage technologies can be used as the storage unit. According to the terminology of the German Federal Network Agency, the term "bidirectional charging point" also includes the connected electric vehicle as a mobile storage system. The battery storage system can be AC-coupled, as shown in Fig. 1 or DC-coupled, as shown on the right.

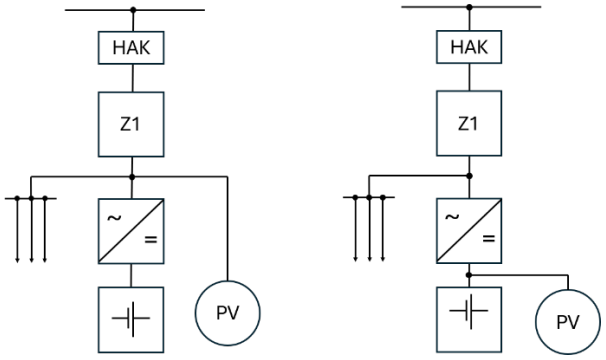


Fig. 1: Single-meter metering configuration for the MiSpeL Pauschaloption considering AC- and DC-coupled battery storage systems

Since the single-meter metering concept records only grid import and grid feed-in, the physical origin of the feed-in measured at meter Z1 cannot be clearly determined. In particular, it is not possible to distinguish whether the fed-in electricity comes directly from the PV system or from the storage unit. The MiSpeL Pauschaloption therefore allocates the grid feed-in mathematically to three categories: feed-in eligible for remuneration, an indifference range, and feed-in eligible for offsetting. According to Section 19(3c) EEG, a maximum of 500 kWh/kWp multiplied by the installed PV capacity can be considered as feed-in eligible for remuneration and remunerated with the market premium under the EEG. Above this remuneration limit, the further allocation follows the rules of the MiSpeL Pauschaloption.

For grid feed-in that is eligible for offsetting under the MiSpeL Pauschaloption, the levy burden on the corresponding grid import is reduced in accordance with Section 21 EnFG. Due to legal references, the electricity quantities determined under Section 21 EnFG and the MiSpeL framework can also be taken into account for other price components. This applies in particular to grid fees under Section 118 EnWG and the surcharge under Section 19 StromNEV. The determination of these electricity quantities may also be applied accordingly for electricity tax purposes under Section 11a StromStV.

The combined relief from these price components considered in the simulation is referred to in the following as SIP reimbursement for simplicity. This is a summarising term and does not represent a single uniform legal entitlement to relief.

From a hardware perspective, the simplified allocation based on the single-meter metering concept provides a simple way to integrate decentralised storage systems into the market. A separate measurement of all power flows within the household is not required.

The following sections briefly describe the main differences between the two versions of the MiSpeL Pauschaloption published so far. This study considers only standard cases with a PV system that is eligible for remuneration. Special configurations, such as systems with several generation units or installations not eligible for remuneration, are not considered, as the focus is on analysing the basic principles of the MiSpeL Pauschaloption.

2.1.4 Consultation Draft 2025 (V1): The basic principle of the MiSpeL Pauschaloption is that the measured grid feed-in up to the remuneration limit can be classified on a lump-sum basis as in principle eligible for remuneration. For the final determination of the feed-in that is actually eligible for remuneration, only periods in which the applicable value (AW) does not fall to zero under the rules of the Solarspitzengesetz are taken into account. For this purpose, the share of annual grid feed-in occurring during periods with AW > 0 is determined relative to the total annual grid feed-in. The previously determined base value of the grid feed-in in principle eligible for remuneration is then multiplied by this share. As a result, the feed-in eligible for remuneration is reduced accordingly if part of the grid feed-in occurs during periods with AW = 0. If the PV system is subject to the Solarspitzengesetz, the AW is zero during periods with negative prices on the day-ahead market. The market premium is calculated in accordance with Annex 1 EEG as the difference between the applicable value (AW) and the relevant market value. For the MiSpeL Pauschaloption, the annual market value for solar power is used. The market premium cannot become negative. If the annual market value for solar power is higher than the applicable value, the market premium is zero.

The remuneration limit for the respective system configuration is calculated, as shown in (1), by multiplying the limit of 500 kWh/kWp by the installed PV capacity. Here $P_{PV,Peak}$ denotes the installed capacity of the PV system.

$$E_{\mathrm{P}} = P_{\mathrm{PV,Peak}} \cdot 500\,\mathrm{kWh/kWp} \qquad (1)$$

The Consultation Draft specifies that every kilowatt-hour of feed-in above the remuneration limit is considered eligible for offsetting, provided that an at least equal amount of grid import occurs within the same calendar year.

2.1.5 Revised Working Version 2026 (V2): The main difference between the Consultation Draft and the current Revised Working Version concerns the determination of electricity quantities eligible for levy offsetting. The remuneration limit of 500 kWh/kWp of installed PV capacity remains unchanged in the published Working Version (V2). Above this limit, an indifference range is introduced in which feed-in quantities are classified as neither eligible for remuneration nor eligible for offsetting. According to the

BNetzA, this range is intended to reflect a certain degree of uncertainty in determining whether specific electricity quantities are actually eligible for offsetting or not [6]. The sum of the remuneration limit and the indifference range forms the offsetting threshold. To determine the grid feed-in in principle eligible for offsetting, the total grid feed-in during all quarter-hour periods with a non-negative spot market price within the calendar year is first determined. The offsetting threshold is then subtracted from this annual energy quantity. Only the amount above this threshold is considered in principle eligible for offsetting. The grid feed-in actually eligible for offsetting is additionally limited by the total grid import within the calendar year. The size of the indifference range mainly depends on the respective system configuration of the household. If a battery storage system is present, the ratio between storage capacity and installed PV capacity is particularly important for determining the size of the indifference range, as shown in Eq. (2). The indifference quantity is determined depending on the respective system configuration. Three configurations are distinguished: a household with a PV system and battery storage, a household with a PV system and a bidirectional charging point, and a household in which both storage technologies are combined with a PV system.

$$E_{\mathbf{indiff}} = \begin{cases} \mathbf{0.1} \cdot \dfrac{\boldsymbol{kWh}}{\boldsymbol{kW}} \dfrac{\boldsymbol{P_{PV,Peak}}}{\boldsymbol{E_{Cap,Batt}}} \cdot \mathbf{E_P}, & \text{Batt.-Only} \\ \mathbf{0.5} \cdot \mathbf{E_P}, & \text{EV-Only} \\ \boldsymbol{E_P} \cdot \mathbf{min}\left(\mathbf{0.1} \dfrac{\boldsymbol{kWh}}{\boldsymbol{kW}} \dfrac{\boldsymbol{P_{PV,Peak}}}{\boldsymbol{E_{Cap,Batt}}}, \mathbf{0.5}\right), & \text{Batt.+EV} \end{cases} \quad (2)$$

The size of the indifference range in kWh depends on the respective system configuration and is calculated according to Eq. (2). Here, E_P denotes the remuneration limit, $P_{PV,Peak}$ the installed PV capacity, and $E_{Cap,Batt}$ the storage capacity of the residential battery storage system. If the household has only a bidirectional charging point and no additional battery storage system, the indifference range is fixed at 50% of the remuneration limit, corresponding to 250 kWh/kWp. Levy offsetting therefore applies only after the offsetting threshold of 750 kWh/kWp has been exceeded.

Tab. 1: Remuneration limit (upper value) and offsetting threshold (lower value) in [kWh] as a function of installed PV capacity and battery storage capacity for a household with a battery storage system as a flexible asset

PV \ Battery	30 kWh	15 kWh	10 kWh	4 kWh
5 kWp	2500 2542	2500 2583	2500 2625	2500 2813
10 kWp	5000 5167	5000 5333	5000 5500	5000 6250
20 kWp	10000 10667	10000 11333	10000 12000	10000 15000
30 kWp	15000 16500	15000 18000	15000 19500	15000 26250

For the Battery-Only case, Tab. 1 shows the respective remuneration limit (upper value) and offsetting threshold (lower value) depending on the system size. The values shown correspond to the system configurations used in this study.

In general, for a constant battery storage capacity, the indifference range increases with increasing PV capacity. For a constant PV capacity, it decreases as the battery storage capacity increases. The MiSpeL Pauschaloption is not applicable to systems without a PV system; therefore, this case is not considered in the study.

2.2 OptiTwin Simulation Model

For the simulations in this paper, OptiTwin was used, which in its basic structure had already been applied in [10]. OptiTwin is an optimisation-based simulation tool specifically developed to represent prosumer households. The focus is on analysing and optimising the use of flexibility while considering aggregator-supported market participation. For this study, the model was extended by the equations required for the MiSpeL Pauschaloption. These adaptations mainly affect the metering concept module of the model, while the basic equations of the model core remain unchanged.

2.2.1 Representation of the MiSpeL Pauschaloption in the model: The core of representing the MiSpeL Pauschaloption in the simulation is the allocation of grid feed-in to three virtual categories: green electricity export eligible for remuneration, the indifference range, and grid feed-in in principle eligible for levy offsetting. The allocation is performed for the calendar year as a whole. Fig. 2 shows the relevant energy flows within the model and the virtual allocation of the grid export.

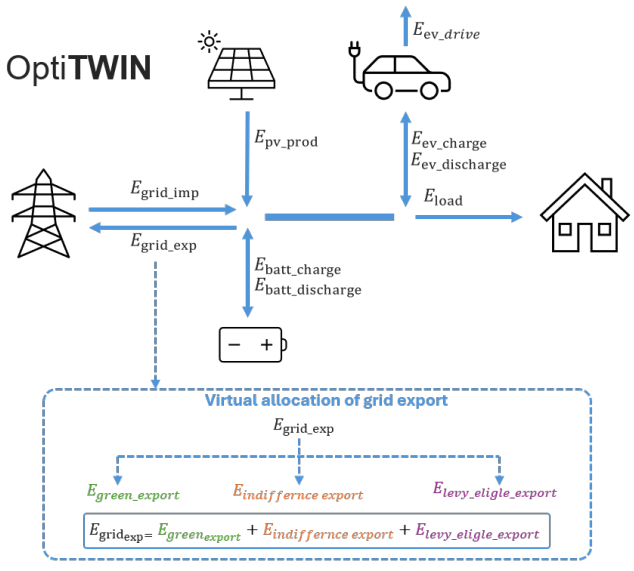


Fig. 2: OptiTwin simulation model with virtual regulatory allocation of grid export quantities

The calculation of the annual sums follows the current set of equations of the Revised Working Version 2026 (V2) of the MiSpeL Pauschaloption. The corresponding feed-in quantity

$E^{\text{year}}_{\text{grid_exp_SP+}}$ is determined, as shown in (3) based on the quarter-hourly power values, which are converted into energy quantities using the conversion factor $k_{\Delta t}$ for the respective time resolution. Only time steps for which the spot market price $C_{\text{grid,el,DA},t} \geq 0$ are included.

$$E^{\text{year}}_{\text{grid_exp_SP+}} = k_{\Delta t} \sum_{\substack{t \in T \\ C_{\text{grid,el,DA},t} \geq 0}} P_{\text{grid_exp}}[t] \tag{3}$$

On the import side, the total grid import within the calendar year $E^{\text{year}}_{\text{grid_imp}}$ is determined via meter Z1 using Eq. (4), independently of the spot market price.

$$E^{\text{year}}_{\text{grid_imp}} = k_{\Delta t} \sum_{t \in T} P_{\text{grid_imp}}[t] \tag{4}$$

To calculate the grid feed-in in principle eligible for offsetting, the remuneration limit E_{P} and the applicable indifference range E_{I} are first subtracted from $E^{\text{year}}_{\text{grid_exp_SP+}}$, as shown in Eq. (5).

$$E_{sald,\text{diff}} = E^{\text{year}}_{\text{grid_exp_SP+}} - (E_{\text{I}} + E_{\text{P}}) \tag{5}$$

If the difference between the relevant grid feed-in and the offsetting threshold is negative, the offsetting threshold is not exceeded. Therefore, according to Eq. (6), the electricity quantity in principle eligible for offsetting is limited to a minimum value of 0 using a max function.

$$E_{\text{sald,year}} \leq \max\left(E_{sald,\text{diff}}, 0\right) \tag{6}$$

If $E_{\text{sald,diff}} > 0$, an electricity quantity in principle eligible for offsetting is available. The electricity quantity actually eligible for offsetting is limited by this difference according to Eq. (6) and by the total grid import within the considered year according to Eq. (7).

$$E_{\text{sald,year}} \leq E^{\text{year}}_{\text{grid_imp}} \tag{7}$$

The electricity quantity eligible for remuneration with the market premium $E_{MP,\text{year}}$ is determined as the minimum of the energy fed into the grid during periods with a positive applicable value (AW) and the remuneration limit E_{P}.

$$E_{\text{grid_exp_AW+}} = k_{\Delta t} \cdot \sum_{\substack{t \in T \\ AW > 0}} P_{\text{grid_exp}}[t] \tag{8}$$

$$E_{MP,\text{year}} \leq \min\left(E_{\text{grid_exp_AW+}},\ E_{\text{P}}\right) \tag{9}$$

Since both an increasing electricity quantity eligible for remuneration $E_{MP,\text{year}}$ and an increasing electricity quantity eligible for levy offsetting $E_{\text{sald,year}}$ improve the objective function, the respective upper limits are fully used in the optimum.

The objective function minimises the annual energy costs of the household. These consist of the costs of electricity purchased on the day-ahead market $E^{buy}_{DA}[t] \cdot C_{DA}[t]$, plus the applicable taxes, charges, levies and grid fees $E_{grid_imp}[t] \cdot (C_{SIP}[t] + C_{VAT}[t])$, and minus the revenues from marketing electricity fed into the grid on the day-ahead market $E^{sell}_{DA}[t] \cdot C_{DA}[t]$. The accumulated annual purchasing and marketing costs are additionally reduced by the monetary benefits resulting from the electricity quantities determined under the MiSpeL Pauschaloption as eligible for remuneration and eligible for levy offsetting. These electricity quantities are included in the objective function according to Eq. (10). Storage costs are not monetarily evaluated within this study.

$$\begin{aligned} \min \Bigg\{ \sum_{t \in T} \Big(& E^{buy}_{DA}[t] \cdot C_{DA}[t] - E^{sell}_{DA}[t] \cdot C_{DA}[t] \\ & + E_{grid_imp}[t] \\ & \cdot (C_{SIP}[t] + C_{VAT}[t]) \Big) \\ & - E_{\text{sald,year}} \\ & \cdot \left(C_{\text{SIP,erst}} + C_{\text{VAT,erst}}\right) \\ & - E_{MP,\text{year}} \cdot C_{\text{MP}} \Bigg\} \end{aligned} \tag{10}$$

2.2.2 Specific Implementation of V1: For the Consultation Draft of the MiSpeL Pauschaloption (V1), the total grid feed-in is considered independently of negative electricity market prices. In the simulation, feed-in during periods with negative spot market prices practically does not occur and is therefore neglected in this study to reduce complexity. For this reason, Eq. (10) is valid for both V1 and V2 of the MiSpeL Pauschaloption.

As described in Sec. 2.1.4, the Consultation Draft V1 differs from the Revised Working Version V2 in several respects. To represent these differences, corresponding adjustments are made in the simulation model. In particular, the indifference range considered in Eq. (5) is set to 0 for V1. In addition, the two versions differ in the treatment of grid feed-in during periods with an applicable value of AW = 0. However, the PV systems considered are subject to the rules of the so-called Solarspitzengesetz [11]. Under these rules, the applicable value is reduced to AW = 0 during periods with negative electricity market prices. Since the optimisation model allows curtailment of PV generation during periods with negative spot market prices, such grid feed-in practically does not occur in the simulations. Therefore, the different rules of V1 and V2 for periods with AW = 0 do not have a significant effect on the scenarios considered.

2.3 Simulation Setup and Assumptions

2.3.1 Simulation horizon: The simulations in this study are based on a full-year optimisation with a temporal resolution of 15 minutes and without a rolling horizon. A rolling-horizon

approach would require additional assumptions about the expected feed-in and grid import quantities until the end of the year. To separate this forecast effect from the analysis of the regulatory mechanisms, the calendar year is optimised with perfect foresight.

2.3.2 Direct Marketing of Electricity Feed-In: To use the MiSpeL Pauschaloption, all PV systems, electricity storage systems and charging points behind the feed-in point must be assigned to a form of direct marketing. To receive the market premium under the MiSpeL Pauschaloption, the total grid feed-in at the feed-in point must be balanced in a separate balancing group or sub-balancing group in accordance with Section 20 sentence 2 EEG. In this study, the electricity quantities are marketed on the day-ahead spot market based on the electricity market prices of 2024. An additional marketing fee is not considered.

2.3.3 PV Generation and Load Profiles: Since the feed-in of PV electricity has a direct influence on electricity market prices through the merit-order principle, and high PV generation tends to be associated with lower spot market prices [12], real solar irradiation data from the same year as the day-ahead prices are used for the simulation. This preserves the actual temporal relationship between PV generation and electricity market prices. The irradiation data were obtained from the Climate Data Center of the German Weather Service (DWD) [13], for Cologne, postal code 50667, with a temporal resolution of 10 minutes. The data were interpolated to 15-minute values and then converted into a PV generation time series using pvlib [14] for a PV system with a tilt angle of 40° and a south-facing orientation. In all simulated scenarios, PV generation can be curtailed if necessary, for example to avoid grid feed-in during periods with negative spot market prices.

2.3.4 Regulatory Assumptions: The PV systems considered are in principle eligible for remuneration and are subject to the rules of the Solarspitzengesetz. Therefore, during periods with negative electricity market prices, the applicable value is AW = 0 [11]. Electricity quantities determined as eligible for offsetting under the MiSpeL Pauschaloption are relieved from the relevant levies in accordance with the applicable rules of the EnFG. For the economic evaluation in this study, these electricity quantities are additionally assumed to be fully relieved from grid fees, electricity tax and VAT. The concession fee remains unaffected and continues to be charged on grid import. These combined reliefs are considered as SIP reimbursement in the simulation. The households considered participate in grid-oriented control according to Section 14a EnWG, Module 1. Participation in Module 2 is not possible under the MiSpeL Pauschaloption because no separate meter is available for the controllable consumption device. The detailed monetary assumptions used for the economic evaluation are summarised in Appendix Table A1.

2.4 Simulation Scenarios and Reference Cases

In this study, the two versions of the MiSpeL Pauschaloption are compared with each other and with existing metering and accounting concepts. The aim is to analyse under which system and operating configurations the four energy flows described in Sec. 2.1 can be realised and which limitations apply. Different system configurations with a PV system, a bidirectional EV and a stationary residential battery storage system are considered. The installed PV capacity, storage capacity and annual household electricity consumption are varied. The household electricity demand is represented by a standard load profile (SLP H0), which is scaled to annual consumption values of 2,500, 4,500 or 7,000 kWh depending on the analysed system configuration. The PV systems considered have installed capacities of 5, 10, 20 and 30 kWp. In addition, different operating strategies are analysed for both the electric vehicle and the stationary battery storage system. In the simulations, the storage efficiencies are considered dynamically as a function of power.

2.4.1 Reference Accounting Concepts: In this study, both the financial effects of a pure change in the accounting concept and the potential of an operating strategy adapted to this concept are analysed. For the first analysis, the simulated energy flows of the respective reference strategy are kept unchanged and are additionally accounted for according to the rules of the MiSpeL Pauschaloption V1 and V2. The resulting cost differences are therefore caused only by the changed accounting rules. For the second analysis, separate optimisations are carried out in which the respective accounting rules are directly included in the optimisation model. The optimiser adapts the operating strategy to the respective remuneration and offsetting rules. In this way, both the financial effect of the accounting rules and the resulting changes in energy flows, as well as the additional economic potential of an adapted operating strategy, are considered.

Tab. 2 shows the scenarios considered. It indicates whether charging the storage system from the grid and feeding electricity back into the public grid are permitted. For the scenarios using the MiSpeL logic, the applicable indifference range is also given. The remuneration limit is 500 kWh per kW of installed PV capacity in all MiSpeL-based cases. The offsetting threshold is calculated as the sum of the remuneration limit and the indifference range. In case C, the indifference range is assumed to be infinitely large. Therefore, even above the remuneration limit, no feed-in quantities are considered eligible for offsetting and no SIP reimbursement occurs.

Tab. 2: Storage Operating Modes from a Regulatory Perspective

Usecases \ characteristics	Remuneration limit	Indifference range	grid discharge	grid charge
A: Mixed Storage w/o grid discharge	-	-	-	x
B: Exclusivity Option w/o grid charge	-	-	x	-
C: MiSpeL w/o SIP reimbursement	500 kWh /kWp	infinite	x	x
D: MiSpeL V1	500 kWh /kWp	0	x	x
E: MiSpeL V2	500 kWh /kWp	MiSpeL V2	x	x

2.4.2 PV System with Residential Battery Storage: One of the use cases considered is a single-family house with a PV system and a stationary residential battery storage system. In addition to the parameters described in Sec. 2.4, the battery storage capacity is varied. Storage capacities of 4, 10, 15 and 30 kWh are analysed. The maximum charging and discharging power is defined according to a C-rate of 0.5 h^{-1} , resulting in 2, 5, 7.5 and 15 kW, respectively.

2.4.3 PV System with Bidirectional Charging Point: For the configuration with a PV system and a bidirectional charging point, an electric vehicle with a net battery capacity of 65 kWh and a maximum charging and discharging power of 11 kW is considered. The driving profile corresponds to the Work From Home profile of a non-commuter, similar to [10]. Different operating strategies are analysed, which differ in the timing of vehicle charging and in the use of the vehicle battery for household supply. With Direct Charge, the vehicle is charged as early as possible after connection until the specified target state of charge is reached. With Smart + Solar Charging, the charging times are optimised based on the available PV generation and electricity prices. Discharging the vehicle battery for household supply or grid feed-in is excluded for both strategies. Vehicle-to-Home (V2H) extends the optimised charging strategy by allowing electricity from the vehicle battery to be used for household supply. Feed-in from the vehicle to the public grid remains excluded. In addition, the MiSpeL scenarios described above are analysed. In these scenarios, feed-in from the electric vehicle to the public grid is also permitted, and the operating strategy is optimised while considering the respective accounting rules.

2.4.4 PV System, Residential Battery Storage and Bidirectional Charging Point: For the combination of a PV system, stationary residential battery storage system and bidirectional charging point, the rules for determining the indifference range described in Sec. 2.1.5 apply under MiSpeL V2. Residential battery storage capacities of 4, 10, 15 and 30 kWh are analysed in combination with PV systems with installed capacities of 5, 10, 20 and 30 kWp. The annual household electricity consumption is 4,500 kWh, and the net capacity of the vehicle battery is 65 kWh. The Work From Home driving profile is also used for this configuration. Direct energy transfers between the residential battery storage system and the vehicle battery are excluded in the model.

3 Results

This section is divided into three parts. First, the change from the conventional accounting concept for PV surplus feed-in to the MiSpeL Pauschaloption is analysed. Next, the economic potential of time-shifted PV feed-in is investigated. This serves as a reference potential for the additional benefit of MiSpeL. The reference case uses an accounting concept based on MiSpeL but without levy offsetting. Market-price-driven storage of grid electricity followed by feed-in back into the grid remains possible if the spread on the electricity market is large enough for the transaction to be economically viable even without subsequent levy offsetting and SIP reimbursement. However, this option is hardly used in the analysed simulations. Therefore, the reference case mainly represents time-shifted PV feed-in. Finally, in Sec. 3.3, the MiSpeL variants V1 and V2 are compared with each other and with the case of time-shifted green electricity feed-in.

3.1 Accounting Concept Change from PV Surplus Feed-In to the MiSpeL Pauschaloption

For the evaluation, a prosumer household optimised for self-consumption is considered first. The storage system is operated as Mixed Storage according to Tab. 2. Electricity can be imported from the grid in a price-optimised way, stored temporarily and used for local consumption when required. PV electricity can also be stored for self-consumption.

3.1.1 Battery-Only: The import and export energy quantities for the three different accounting concepts, PV Surplus, MiSpeL V1 and MiSpeL V2, are shown in Fig. 3. The arrow between the accounting concepts shows the change in costs when switching from one concept to another. Positive values indicate higher costs, while negative values indicate lower costs. The energy management operates identically in all three variants. Only the accounting concept is changed. The comparison is shown for the household consumption levels analysed in this paper.

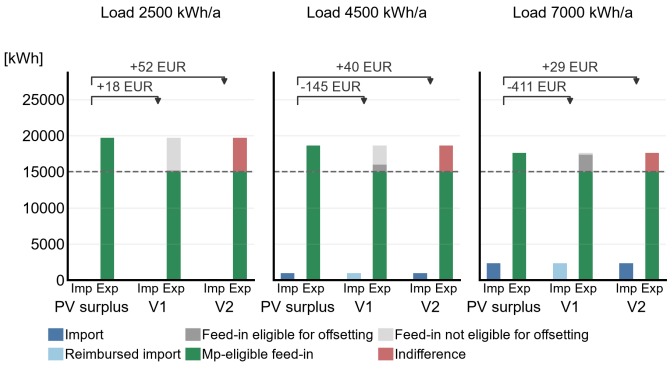


Fig. 3: Change in accounting concept for a 30 kWp PV system with a 4 kWh battery across different household consumption levels

It can be seen that, in all configurations considered, the energy exported to the public grid exceeds the remuneration limit of 15,000 kWh. Under PV surplus feed-in (PV Surplus), the three households receive the market premium for the entire amount of electricity fed into the grid, including quantities above the remuneration limit. Under MiSpeL V1, feed-in quantities above the remuneration limit that were previously considered eligible for remuneration are classified as in principle eligible for offsetting. However, only the share shown in dark grey is actually offset, because the quantity eligible for offsetting is additionally limited by the respective grid import according to (7). The light-blue area represents the grid import for which the previously defined SIP reimbursement is considered as a result of levy offsetting. While this effect is limited for the small household due to its already low remaining grid import, almost the entire grid import of the two larger households can be relieved accordingly. In the simulation, for the household with an annual electricity consumption of 7,000 kWh, the change in accounting concept can result in savings of up to

€411 without any change in operating behaviour or storage of grid electricity.

Fig. 3 also shows the classification of the energy quantities under MiSpeL V2. The introduced indifference range largely prevents the offsetting described above in the examples shown. At the same time, however, the feed-in quantities within the indifference range are no longer eligible for remuneration. For the small household, this affects around 4,500 kWh, for example. Depending on the applicable value, the loss of the market premium within the indifference range can lead to significantly higher revenue losses, particularly for existing PV systems, than the range of €29 to €52 shown here.

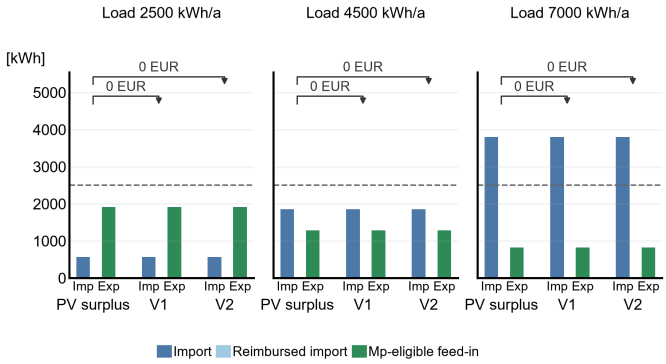


Fig. 4: Change in accounting concept for a 5 kWp PV system with a 4 kWh battery across different household consumption levels

Fig. 4 shows the same situation for a smaller PV system. Due to the low PV generation relative to the household loads, grid feed-in remains below the remuneration limit of 2,500 kWh in these cases. Therefore, neither MiSpeL V1 nor MiSpeL V2 results in a different allocation of the energy quantities compared with PV surplus feed-in. The comparison therefore shows that the effects of the MiSpeL Pauschaloption depend strongly on whether, and to what extent, grid feed-in exceeds the respective remuneration limit.

3.1.2 EV-Only : When considering a prosumer household with an EV, three additional scenarios arise compared with the Battery-Only case due to the possible vehicle charging strategies: Direct Charge, Solar + Smart Charge and Vehicle-to-Home (V2H). These are analysed within the mixed-use storage operation with self-consumption optimisation. Fig. 5 also shows the change in accounting concept for a household with an annual electricity consumption of 4,500 kWh and different PV system sizes. Across all PV system sizes considered, Solar + Smart Charge increases self-consumption compared with Direct Charge, while V2H enables a higher level of self-consumption than Solar + Smart Charge. As self-consumption increases, the additional financial effect of switching to MiSpeL V1 becomes smaller. Higher self-consumption reduces PV feed-in to the public grid, and therefore less feed-in above the remuneration limit is classified as eligible for offsetting. At the same time, this reduces the electricity quantity for which SIP reimbursement is possible. Increasing self-consumption therefore reduces the financial benefit that can result from switching the accounting concept to MiSpeL V1 due to unjustified offsetting. This relationship is particularly visible in the EV-Only scenarios because of the different charging strategies, but it also applies in principle to the Battery-Only scenarios. There, too, higher self-consumption reduces grid feed-in above the remuneration limit and therefore the potential for offsetting.

Accounting under MiSpeL V2 with the indifference range largely solves this problem for the EV-Only case, because no levy offsetting occurs in the analysed cases due to the large indifference range. As in the Battery-Only scenarios, the change in accounting concept even results in a small disadvantage, because the market premium is no longer paid for part of the feed-in within the indifference range. However, this disadvantage can become significantly larger for substantially higher applicable values (AW).

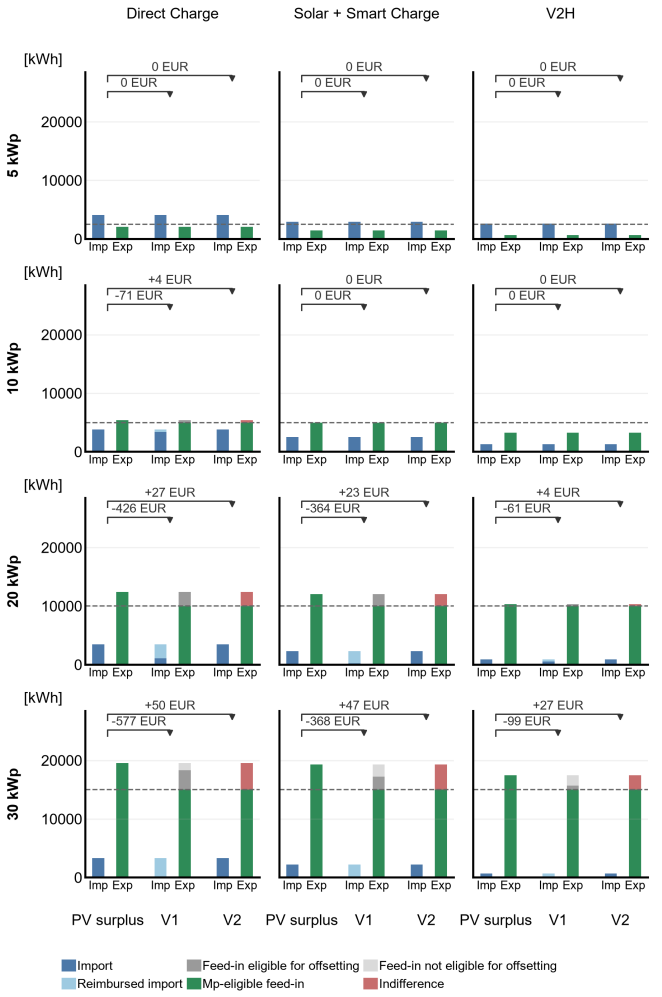


Fig. 5: Imported and exported energy for prosumer households with 4,500 kWh annual consumption by charging strategy and PV size. € values indicate differences in annual household electricity costs.

3.2 Potential of Time-Shifted PV Feed-In

The previous analysis considers a change in the accounting concept while keeping the EMS operating strategy unchanged. In the following, it is analysed how an operating strategy adapted to the accounting concept affects the economic viability of time-shifted PV feed-in. In the Battery-Only scenario, the battery storage system is therefore operated as a

pure green electricity storage system under the Exclusivity Option, see Tab. 2 (B). Since an electric vehicle cannot be operated under the Exclusivity Option because grid charging is required, for example during winter, the vehicle battery is instead considered as a mixed-charged storage system. As described in Tab. 2 such a storage system is not allowed to feed electricity back into the public grid. To nevertheless enable an economic comparison with time-shifted green electricity feed-in, feed-in up to the remuneration limit of 500 kWh/kWp is assumed to be eligible for remuneration in the simulation, based on the MiSpeL Pauschaloption, see Tab. 2 (C). Levy offsetting and SIP reimbursement are excluded in this comparison scenario. Since grid electricity arbitrage without SIP reimbursement is hardly used in the simulations, the operation practically corresponds to time-shifted green electricity feed-in.

3.2.1 Battery-Only: Three operating strategies are compared for the stationary battery storage system: self-consumption optimisation without feed-in from the storage system (A), operation as a green electricity storage system with feed-in and without grid charging (B), and the MiSpeL Pauschaloption without SIP reimbursement (C). Fig. 6 shows the differences in annual energy costs between cases (B) and (A), and between cases (C) and (A). This represents the economic potential that can be achieved almost exclusively through time-shifted PV feed-in.

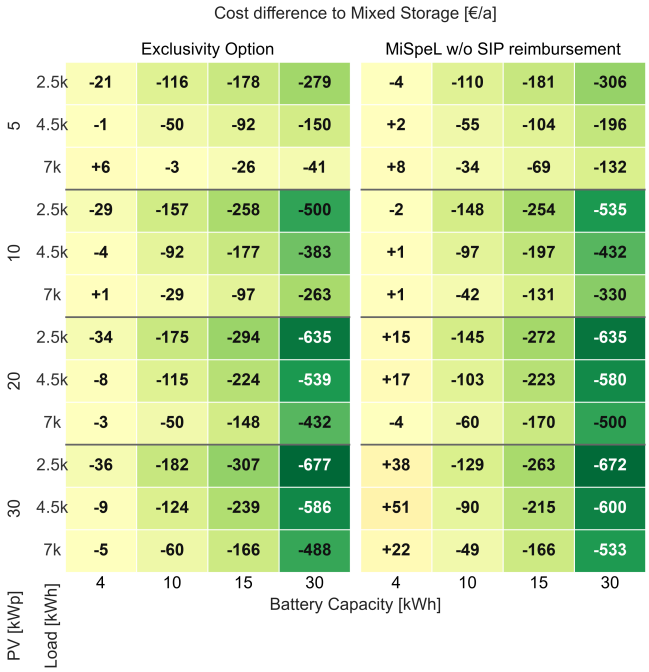


Fig. 6: Cost difference in [€/a] between self-consumption optimisation (A), the Exclusivity Option (B), and MiSpeL w/o reimbursement (C) for different prosumer households. Negative values indicate cost savings relative to A.

The financial benefit compared with self-consumption optimisation is small for both operation as a pure green electricity storage system and comparison case C without SIP reimbursement when using small battery storage systems of 4 kWh. Across all PV system sizes considered, the benefit is up to €36. For larger battery storage systems, the potential increases clearly with increasing PV system size and reaches several hundred euros per year. In these configurations, a larger amount of PV electricity can be stored and fed into the grid during periods of high electricity market prices, thereby increasing marketing revenues. In general, for large battery storage systems, feed-in under MiSpeL without SIP reimbursement (C) provides a small financial benefit compared with operation as a green electricity storage system (B). However, this benefit decreases for low household electricity consumption. For medium storage capacities and lower household consumption, operation as a green electricity storage system (B) tends to be more advantageous. Two opposing effects influence this result. Under the MiSpeL Pauschaloption without SIP reimbursement (C), energy flow 3 is possible in addition to energy flows 1 and 2 described in Sec. 2.1: electricity imported from the public grid can be stored during periods of low electricity market prices and later used for local consumption. In addition, case C also generally allows electricity previously imported from the grid to be fed back into the public grid. Even without SIP reimbursement, this can be economically viable if the spot market price spread is sufficiently large. This additional flexibility is not available when operating as a pure green electricity storage system (B) and can lead to lower costs, particularly when grid import is higher. At the same time, in case C only feed-in up to the remuneration limit of 500 kWh/kWp is considered eligible for remuneration, whereas under the green electricity storage case, PV electricity fed into the grid above this limit can also receive remuneration. Particularly for large PV systems and small battery storage systems, the remuneration limit is exceeded more frequently. As a result, the benefit of the additional flexibility can be partly or fully offset by lower market premium revenues. Overall, case C therefore tends to be more advantageous when grid import is higher, while operation as a green electricity storage system (B) can be economically more favourable when feed-in quantities are higher.

3.2.2 EV-Only: For an electric vehicle, a different reference case is used. Since operation as a pure green electricity storage system is not possible, the MiSpeL Pauschaloption without SIP reimbursement (C) is compared with a mixed-use storage system without feed-in to the public grid (A). In addition, compared with the stationary battery storage system, the influence of the selected charging strategy is analysed for the electric vehicle. Therefore, the comparison shown in Fig. 7 is carried out separately for Direct Charging, Solar Charging and V2H. Since V2H is the only one of the three charging strategies that enables energy flows 1 and 3 from Sec. 2.1 due to the storage function, this strategy generally results in the lowest total costs. However, Fig. 7 shows that operation under the MiSpeL Pauschaloption without SIP reimbursement enables additional savings for all PV system sizes considered. This is mainly because PV electricity can now also be stored and fed into the public grid at a later time. This additionally enables energy flow 2 from Sec. 2.1. The additional cost benefit increases with increasing PV capacity, although the increase becomes clearly smaller between 20 and 30 kWp because the additional revenue potential is limited by the power and capacity of the vehicle battery. The results show

that the additional grid feed-in without SIP reimbursement can provide a clear economic benefit compared with vehicle operation limited to V2H. In the simulations considered, this benefit is mainly based on time-shifted PV feed-in. If the benefit of bidirectional charging itself is to be analysed, the comparison with Solar Charging is particularly relevant, because this shows the additional benefit of the ability to feed electricity back into the grid.

Overall, the results show that in case C (MiSpeL Pauschaloption without SIP reimbursement), annual savings of up to €634 can be achieved compared with V2H. These savings are in a similar range to those achieved with a large stationary battery storage system with a capacity of 30 kWh.

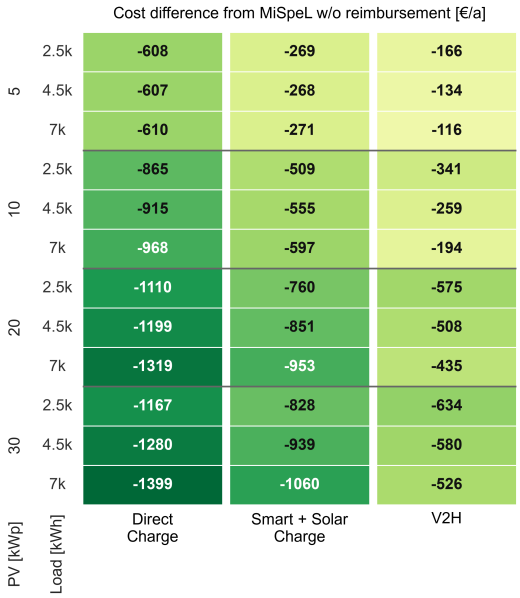


Fig. 7: Cost difference [€/a] between Mixed Storage without grid discharge (A) (Direct Charging, Smart + Solar Charging, V2H) and MiSpeL w/o reimbursement (C) for different prosumer households. Negative values indicate cost savings.

3.3 *Potential of Operating Strategies under MiSpeL V1 and V2*

The financial potential of the MiSpeL Pauschaloption depends strongly on how the EMS operating strategy is adapted to the respective accounting rules of V1 and V2. The interaction between the offsetting threshold, household electricity consumption, PV system capacity, EV capacity and availability, and battery storage capacity is particularly important. Over the full year, the optimiser evaluates whether it is economically more advantageous to exceed the offsetting threshold and thereby use levy offsetting for the feed-in of electricity previously imported from the grid, or to remain below the threshold and instead optimise self-consumption, time-shifted grid import, time-shifted PV feed-in and, where applicable, arbitrage without SIP reimbursement. The decisive factor is how much additional feed-in is required to reach the offsetting threshold and whether the offsetting benefits that can subsequently be achieved outweigh the economic disadvantages of the additional feed-in that was not eligible for offsetting before the threshold was reached. This relationship is illustrated in Fig. 8 for a household with a 20 kWp PV system and a bidirectional electric vehicle without an additional residential battery storage system. For MiSpeL V1, shown on the left, the offsetting threshold of 10,000 kWh is exceeded for the 20 kWp PV system, making economically viable storage of grid electricity possible. In the case shown on the right, the indifference range introduced under MiSpeL V2 prevents the higher offsetting threshold from being reached. As a result, economically viable storage of grid electricity does not occur. It can also be seen that the range classified as indifferent under MiSpeL V2 receives neither market premium remuneration nor levy offsetting. Under MiSpeL V1, by contrast, the household additionally benefits from offsetting that is not based on actual storage of grid electricity. As a result, the grid import subject to SIP is lower than under V2.

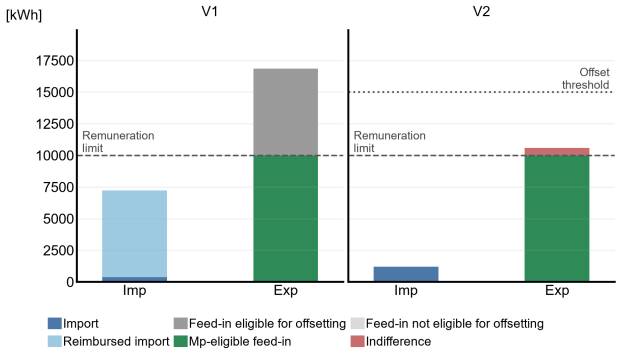


Fig. 8: Annual grid import and export for an EV-only household with a 20 kWp PV system and a household consumption of 4,500 kWh under MiSpeL V1 and V2. The dashed line indicates the remuneration limit; the dotted line indicates the offsetting threshold.

To illustrate the additional storage of grid electricity, Fig. 9 shows, for the same system configuration, the charging and discharging power of the electric vehicle at the grid connection, together with PV generation and the day-ahead price for the period from 13 to 21 May 2024.

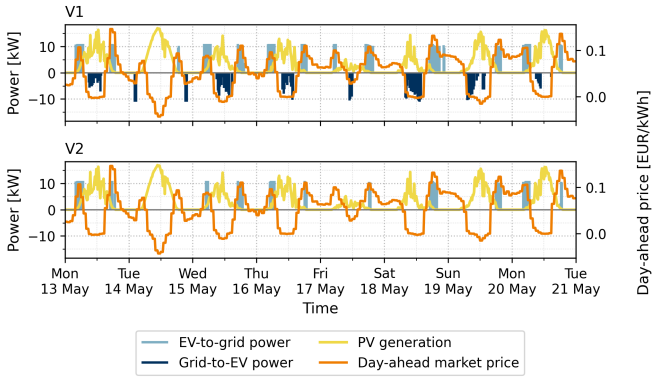


Fig. 9: EV charging from and discharging to the grid under MiSpeL V1 (top) and V2 (bottom) for an EV-only household (4,500 kWh) with a 20 kWp PV system from 13 to 21 May 2024. PV generation and day-ahead market prices are shown for comparison.

Under MiSpeL V1, market-price-oriented charging from the grid followed by feed-in back into the grid is clearly visible.

Under V2, comparable grid charging is largely absent during the period shown, while electricity from the vehicle continues to be fed into the grid. This illustrates the stronger focus on time-shifted PV feed-in.

3.3.1 Battery-Only: Fig. 10 shows the annual costs (large number) and the battery cycles (small number) for the operating strategies defined in Tab. 2. The "S" indicates configurations in which the offsetting threshold is exceeded. Under MiSpeL V1 (D), this is the case in 11 of the 16 analysed system configurations, whereas under MiSpeL V2 (E) it occurs in only 6. Under MiSpeL V1, additional storage of grid electricity is particularly not economically viable when grid feed-in remains below the remuneration limit of 500 kWh/kWp due to a high self-consumption rate. Under V2, the indifference range must additionally be exceeded before offsetting becomes possible. In the configurations without offsetting, the system therefore continues to optimise mainly for self-consumption and time-shifted PV feed-in. The economic result is almost the same as in the comparison case without offsetting (C). The additional revenues that could be achieved through offsetting are not sufficient to create an economic incentive to deliberately increase feed-in to a level at which the offsetting threshold is exceeded. For the results not shown graphically, with annual household electricity consumption of 2,500 and 7,000 kWh, the offsetting threshold under MiSpeL V2 is exceeded in 12 and 3 of the 16 analysed system configurations, respectively.

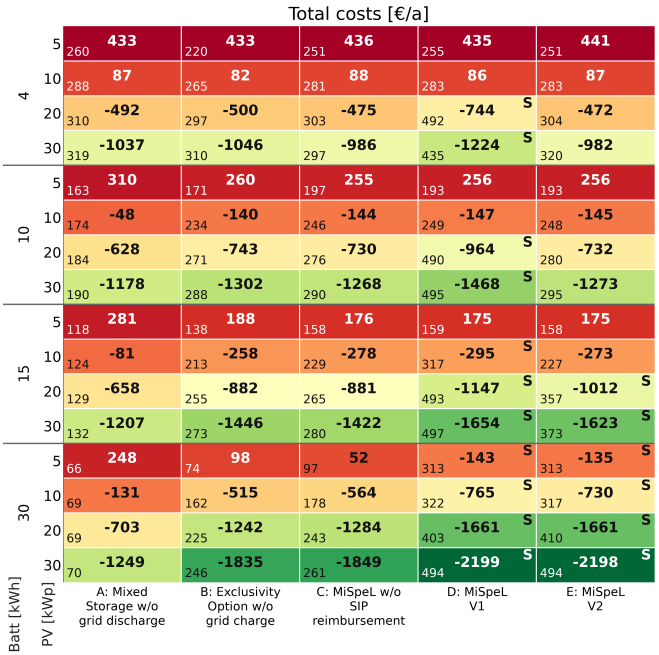


Fig. 10: Annual costs [€/a] for different prosumer households with varying battery and PV system sizes at 4,500 kWh/a household consumption under different operating and accounting strategies. Small numbers indicate annual battery cycle counts. "S" indicates that the offsetting threshold is exceeded.

This shows the influence of household consumption: for the same PV system, higher self-consumption reduces the remaining PV feed-in. As a result, more additional feed-in is required to exceed the offsetting threshold, and exceeding the offsetting threshold is economically advantageous in fewer configurations.

Since neither battery degradation costs nor an additional minimum spread are considered in the optimisation model, even small financial benefits can lead to a significantly higher battery throughput. This can be seen, for example, for a PV capacity of 10 kWp, an annual household electricity consumption of 4,500 kWh and a battery storage capacity of 15 kWh: Compared with operation without SIP reimbursement (C), MiSpeL V1 (D) reduces annual energy costs by only €17, while the number of cycles increases from 229 to 317. The additional 88 cycles therefore correspond to a financial benefit of only around €0.01 per additional kilowatt-hour of battery throughput.

3.3.2 EV-Only: Fig. 11 shows the annual costs of the different operating strategies of the electric vehicle. Under MiSpeL V2 (E), the offsetting threshold is exceeded in only one of the 12 analysed configurations due to the high indifference range of 250 kWh/kWp applied to the electric vehicle. Only for the configuration with a 5 kWp PV system and an annual household electricity consumption of 2,500 kWh is additional grid electricity imported and fed back into the grid via the EV to reach the range eligible for levy offsetting. The high capacity of the EV battery makes it possible to exceed both the remuneration limit and the indifference range through additional import and export of grid electricity and to achieve a positive economic result.

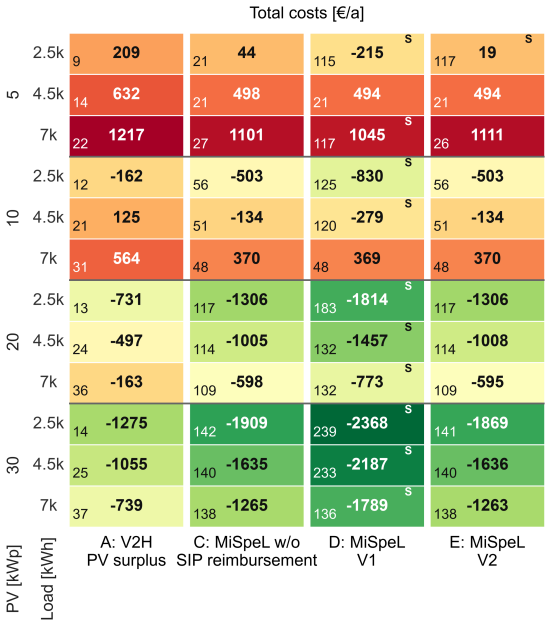


Fig. 11: Annual costs [€/a] for prosumer households with different PV sizes, household consumptions and EV charging strategies. "S" indicates that the offsetting threshold is exceeded. Small numbers indicate annual battery cycle counts.

The additional 96 cycles result in savings of €25 compared with MiSpeL without SIP reimbursement (C). In all other cases, no grid import quantities are offset. Under MiSpeL V1 (D), the indifference range does not apply, so the offsetting

threshold can already be exceeded at lower feed-in quantities. This is the case, for example, for the configurations with 10, 20 and 30 kWp and an annual household electricity consumption of 4,500 kWh, making trading with stored grid electricity economically attractive. Compared with V2, the annual costs under V1 are therefore €145 lower at 10 kWp, €449 lower at 20 kWp and €551 lower at 30 kWp. For the cases in which no offsetting occurs under V2, the economic result is almost identical to the reference case without offsetting (C). MiSpeL V2 (E) therefore provides an additional economic benefit compared with reference case C without SIP reimbursement in only one of the analysed EV configurations.

3.3.3 EV + Battery: For the combination of an electric vehicle and a battery storage system in a prosumer household, the indifference range under MiSpeL V2 corresponds, according to Eq. (2), to the smaller of the two indifference ranges applicable to the respective individual configurations. Compared with the EV-Only configuration, this results in a smaller indifference range in most of the cases analysed. To investigate the associated economic effects, the combination of an electric vehicle and a residential battery storage system is compared with the EV-Only configuration. In addition, a hypothetical case (E*) is considered in which only the electric vehicle is available as a storage system, but the indifference range of the respective combination of EV and residential battery storage is applied.

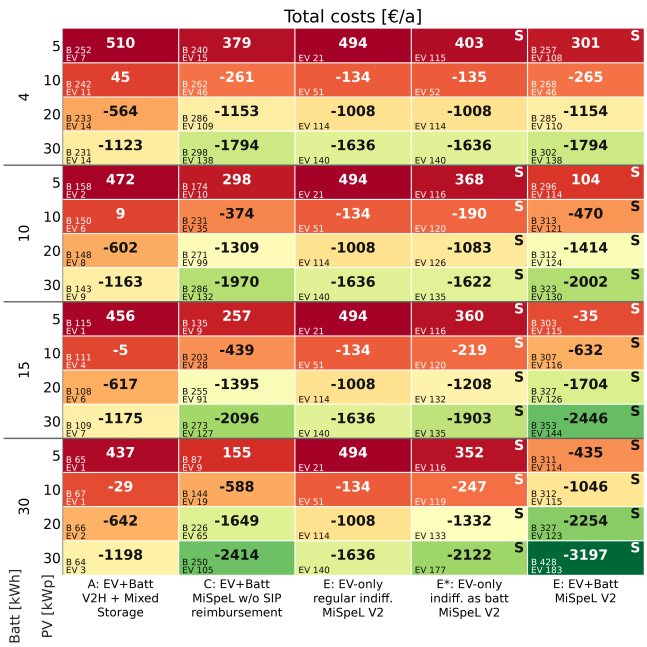


Fig. 12: Annual costs [€/a] for different prosumer households with varying battery and PV system sizes at 4,500 kWh/a household consumption. Results are shown for different operating and accounting strategies. Small numbers indicate annual cycle counts for the EV battery and the stationary battery. "S" indicates that the offsetting threshold is exceeded.

This makes it possible to separate the influence of the changed indifference range from the additional operational benefit of the residential battery storage system. The annual energy costs are shown in Fig. 12. Self-consumption optimisation and the EV-Only configuration under MiSpeL V2 are used as additional reference cases.

In the hypothetical comparison case (E*), the offsetting threshold is exceeded in 13 of the 16 analysed configurations. The reduced indifference range makes it easier to use levy offsetting and therefore improves the economic conditions for storing grid electricity compared with the regular EV-Only configuration (E). In particular, when a high residential battery storage capacity is assumed, the indifference range used for the calculation becomes small, resulting in clear additional cost savings. For the analysed configurations with large PV systems, the relevant grid feed-in is already close to the offsetting threshold in the reference case. Therefore, only a small amount of additional feed-in is required to exceed the threshold, so a smaller share of the additional feed-in occurs without levy offsetting.

If the residential battery storage system is additionally included physically in the model (E), further operational possibilities arise. The stationary battery is available independently of the presence of the electric vehicle and can be used for trading, self-consumption and time-shifted PV feed-in.

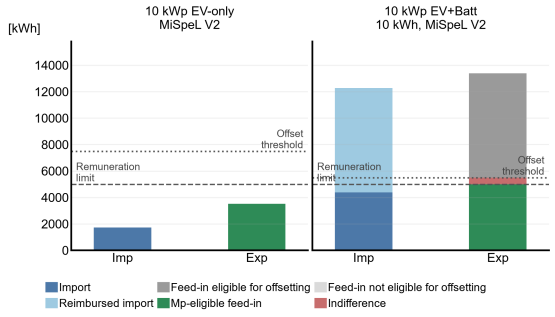


Fig. 13: Annual grid import and export under MiSpeL V2 for an EV-only household (left) and an EV-plus-battery household (right), illustrating the effect of adding a stationary battery on energy flows and eligibility for offsetting.

This is illustrated, for example, for an annual household electricity consumption of 4,500 kWh and a 10 kWp PV system, as shown in Fig. 13. By adding a residential battery storage system with a capacity of 10 kWh, the indifference range is reduced from 2,500 to 500 kWh compared with the EV-Only configuration. The annual feed-in from the electric vehicle increases from 2,080 kWh to 7,660 kWh, while an additional 2,770 kWh is fed into the grid from the battery storage system. Overall, this results in a financial benefit of €336 per year compared with the EV-Only configuration. By adding the residential battery storage system, the offsetting threshold is exceeded in 13 of the 16 analysed cases (E). In most of these cases, there is also a clear financial benefit compared with the combined configuration without SIP reimbursement (C).

4 Conclusion

The results show that the indifference range introduced in the Revised Working Version 2026 (V2) reduces an important false incentive of the Consultation Draft (V1). Under V1, levy offsetting can occur even without actual storage and subsequent feed-in of grid electricity. In the analysed scenarios, this pure accounting effect resulted in cost benefits of up to €577 per year. The newly introduced indifference range largely prevents this effect under V2. At the same time, however, it increases the offsetting threshold and can therefore make the economic use of actual storage of grid electricity more difficult.

Stationary battery storage systems can already store PV electricity and feed it into the grid at a later time under the Exclusivity Option, so that a substantial part of the economic potential can already be used without MiSpeL. The MiSpeL Pauschaloption additionally enables optimised grid import during periods of low electricity prices and, in principle, the later feed-in of this electricity. However, the additional potential is partly reduced by the loss of the market premium above the remuneration limit of 500 kWh/kWp compared with conventional PV surplus feed-in. Depending on the applicable value, this can lead to relevant revenue losses, particularly for existing PV systems. Under MiSpeL V1, the offsetting threshold is exceeded in 11 of 16 analysed configurations with stationary battery storage systems for an annual household electricity consumption of 4,500 kWh, whereas under V2 this is the case in only 6 of 16 configurations. The results also show a clear influence of household electricity consumption. At a lower annual consumption of 2,500 kWh, the offsetting threshold under V2 is reached in 12 of 16 configurations, while at a higher consumption of 7,000 kWh this occurs in only 3 of 16 cases. The results therefore show that, in addition to PV capacity and battery storage capacity, household electricity consumption has a major influence on whether the conditions for offsetting, and therefore for economically viable storage of grid electricity, are reached. However, the storage of grid electricity followed by feed-in into the public grid is economically viable in only a few configurations. In some cases, the current Revised Working Version of the MiSpeL Pauschaloption further reduces the economic viability compared with the original Consultation Draft.

For prosumer households with an electric vehicle, the MiSpeL Pauschaloption mainly enables time-shifted PV feed-in, which is not possible without MiSpeL for a vehicle battery charged with both PV and grid electricity. In the analysed configurations, time-shifted PV feed-in provides an additional economic potential of up to around €600 per year. Under V2, however, storage of grid electricity followed by feed-in back into the grid provides an economic benefit under the model assumptions in only one of the analysed EV-Only configurations. The main reason is the comparatively large indifference range, which prevents the offsetting threshold from being reached in most cases and therefore prevents levy offsetting.

For the combination of a bidirectional electric vehicle and a battery storage system, the indifference range is generally smaller in the analysed cases because the lower value of the two storage technologies is applied. For an annual household electricity consumption of 4,500 kWh, the offsetting threshold is therefore exceeded in 13 of the 16 analysed configurations, allowing the flexibility of the electric vehicle to also be used for levy offsetting. This demonstrates the high sensitivity of the results to the size of the indifference range. The derivation and selection of this threshold should therefore be investigated further, particularly for combined battery storage and vehicle configurations.

Overall, the results show that the current design of the MiSpeL Pauschaloption enables a simplified differentiation of electricity quantities, but the combination of a fixed remuneration limit and the indifference range prevents economically viable storage of grid electricity in many configurations. A corresponding economic incentive arises only in a few cases, particularly for larger system configurations. In particular, the indifference range defined in V2 as a function of PV and storage capacity only reflects different consumption and self-consumption situations to a limited extent. The results also show that the remuneration and offsetting thresholds based on annual energy quantities require forward-looking operational planning. A HEMS strategy based only on current measurements and electricity prices can only consider to a limited extent whether, and at what point during the year, exceeding the offsetting threshold will be economically reasonable. The system configuration and household electricity consumption are therefore particularly important.

A possible further development should examine whether the remuneration and offsetting thresholds can be adapted more closely to the respective system and consumption configuration without giving up the advantage of the single-meter metering concept. The aim should be to achieve an indifference range that is as small as possible, prevents false incentives and does not unnecessarily restrict economically reasonable storage activities. For larger controllable consumers, for example within the scope of Section 14a EnWG, it could be investigated whether additional measurement of consumption would allow a more precise definition of the thresholds and, where appropriate, a reduction of the indifference range, thereby justifying an additional metering point. It should also be examined whether the remuneration limit of 500 kWh/kWp defined in Section 19(3c) EEG could be made more flexible and partly increased for different prosumer configurations. Future studies should further investigate through simulation how the remuneration and offsetting thresholds can be better adapted to different self-consumption rates. In particular, the additional financial benefit per additional storage cycle should be analysed in more detail.

5 Acknowledgements

Funding: This study was supported by the Federal Ministry for Economic Affairs and Energy of Germany (BMWE) in the context of the research project BDL Next and funded under the funding code 01MV23013I.

Portions of this manuscript were linguistically revised and translated with the assistance of ChatGPT (OpenAI). All AI-assisted suggestions were critically reviewed, verified, and edited by the authors, who assume full responsibility for the content.

6 References

[1] Bundesnetzagentur: 'Konsultation von Eckpunkten: Festlegung zur Marktintegration von Speichern und Ladepunkten (MiSpeL)' (Bonn, 17.09.2025)

[2] Papke, A., Hilpert, J.: 'Bidirektionales Laden von Elektrofahrzeugen' (Würzburg, 05.12.2024)

[3] Duschl, W., Spennemann, F., Moskal, T., Fendt, M.: 'Brief Report by the German sub-working group WG 3a: "Legal and sublegal framework for Germany" in the "Coalition of the Willing on Bidirectional Charging"' (2024)

[4] Kern, T., Dossow, P., Roon, S. von: 'Integrating Bidirectionally Chargeable Electric Vehicles into the Electricity Markets', *Energies*, 2020, **13**, (21), p. 5812

[5] Bundesnetzagentur: 'Marktintegration von Speichern und Ladepunkten (MiSpeL) – Anlage 2: Pauschaloption: Eckpunkte zur Konsultation' (Bonn, 17.09.2025)

[6] Bundesnetzagentur: 'Marktintegration von Speichern und Ladepunkten (MiSpeL) – Anlage 2: Pauschaloption: Arbeitsstand vom 05.08.2026' (Bonn, 05.08.2026)

[7] Kern, T., Dossow, P., Morlock, E.: 'Revenue opportunities by integrating combined vehicle-to-home and vehicle-to-grid applications in smart homes', *Applied Energy*, 2022, **307**, p. 118187

[8] Vollmuth, P., Wohlschlager, D., Wasmeier, L., Kern, T.: 'Prospects of electric vehicle V2G multi-use: Profitability and GHG emissions for use case combinations of smart and bidirectional charging today and 2030', *Applied Energy*, 2024, **371**, p. 123679

[9] Conzelmann, G., Bergner, J.: 'Solarspitzengesetz: Potentials for Energy Optimization of Multi-Use Battery Storages: Preprint, PV-Symposium 2026' (2026)

[10] Sehr, F.F., Reiners, D., Beblek, A., Grinewitschus, V.: 'Potential of bidirectional charging from the customer's perspective considering metering concepts, § 14a ENWG modules 1-3, and grid fee exemptions on temporarily stored energy', *IET Conf. Proc.*, 2026, **2025**, (36), pp. 132–141

[11] Bundesrepublik Deutschland: 'Gesetz zur Änderung des Energiewirtschaftsrechts zur Vermeidung von temporären Erzeugungsüberschüssen: Solarspitzengesetz' (21.02.2025)

[12] Benhmad, F., Percebois, J.: 'Photovoltaic and wind power feed-in impact on electricity prices: The case of Germany', *Energy Policy*, 2018, **119**, pp. 317–326

[13] 'Climate Data Center (CDC) – Open Data', https://opendata.dwd.de/climate_environment/CDC/, accessed September, 2026

[14] Anderson, K.S., Hansen, C.W., Holmgren, W.F., Jensen, A.R., Mikofski, M.A., Driesse, A.: 'pvlib python: 2023 project update', *JOSS*, 2023, **8**, (92), p. 5994

Appendix

Tab. A 1: Monetary and regulatory assumptions used for the economic evaluation

Parameter	Value / assumption
Day-ahead electricity price	EPEX Spot, 2024
Market premium	1.1 ct/kWh
Additional direct-marketing fee	0 ct/kWh
Grid fees	10.02 ct/kWh
KWKG	0.275 ct/kWh
Offshore	0.656 ct/kWh
Section 19 StromNEV surcharge	0.643 ct/kWh
Electricity tax	2.05 ct/kWh
Concession fee	1.666 ct/kWh
VAT	19%