Effect of the GHG Quota for the Electromobility Market Ramp-Up in Northern Germany

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***Abstract*—This paper analyzes the significance of the 2021 tightened greenhouse gas (GHG) quota as instrument to enhance the market ramp-up of electromobility in Germany, which has seen significant momentum in recent years. First, the electromobility status in Germany is examined using public data. Reciprocal effects of the GHG quota and the electromobility market ramp-up are then analyzed in particular by a §37h BImSchG (Federal Immission Control Act) threshold model and a GHG quota revenue comparison for charging electricity since 2021. The analysis is supplemented by an online survey of charging point operators (CPOs) and targeted expert interviews. The paper shows that the politically desired market ramp-up of electromobility has proven to be ambitious, especially for battery electric vehicles (BEVs). The §37h BImSchG threshold value will be exceeded in most scenarios in 2026 by the electromobility market ramp-up, which will further tighten the GHG quota. The GHG quota's economic importance for CPOs in 2021 was approximately 42% of the charging electricity price. However, this importance has diminished due to the decline in value of the GHG quota (2024: 7%). CPOs primarily utilize the additional revenues from the GHG quota to expand charging infrastructure rather than directly passing them on to customers through higher electricity prices. To enhance the impact of the GHG quota as an environmental-economic instrument in the market ramp-up of electromobility in the future, it is essential to fortify market confidence through legal intervention.**

***Index Terms*--Battery powered vehicles, Electric vehicle charging, Environmental economics, Low carbon economy, Profitiability**

Introduction

Germany's renewable energy use in transport is about 7.5%, lower than in other sectors [1]. This is also low compared to the current target under the EU Renewable Energy Directive (RED) of 29% renewable energy in transport by 2030 (including multiple crediting factors) [2].

The primary environmental economic instrument in the German transport sector that is designed to achieve the RED target is the national greenhouse gas (GHG) quota. It compares the GHG emissions of fossil fuels with the GHG saving of renewable energies as a proxy for the share of renewable energies. The GHG quota requires distributors of fossil fuels to demonstrate an annually increasing share of reduced GHG emissions compared to fossil fuels in the fuel mix they sell. If required, they can also purchase these GHG emission savings as GHG quota contracts from distributors of renewable energies for the transport sector (e.g. charging point operators). These distributors in turn can sell their GHG emission savings compared to the fossil fuels sold in the transport sector as a GHG contract. As the GHG quota value collapsed to around a fifth between 2022 and the end of 2024, in particular due to significant allegations of fraud [3], this has also happened in proportion to the revenues generated [4], [5]. The GHG quota has an increase mechanism if the quantities of electricity traded via the GHG quota exceed an annually increasing threshold value (§37h BImSchG (Federal Immission Control Act) [6]).

One way to raise the share of renewable energy in the transport sector is electromobility. Germany aims for 15 million battery electric vehicle (BEV) cars in 2030 [7] and around a third of the mileage in heavy road freight transport [8]. The availability of public charging infrastructure is essential for electromobility. Therefore, in 2014, the EU commission set the aim of 0.1 charging points per BEV [9]. This aim has been modified to a total charging power of 1.3 kW per BEV [10]. Germany aims for one million public charging points in 2030 [8], [11]. With the GHG quota, the legislator wants to explicitly promote the needed expansion of charging infrastructure [12].

This paper will provide an overview of the reciprocal effects of the GHG quota for the market ramp-up of electromobility. Therefore, the following research questions are defined:

- A: What is the status of the market ramp-up of electromobility, particularly in Northern Germany, compared to Germany as a whole?
- B: How does the electromobility ramp-up affect the GHG quota?
    - What is the percentage share of electricity in the GHG quota?

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- Will the electromobility market ramp-up reach threshold values that automatically increase the GHG quota (§37h BImSchG)?
- C: How does the GHG quota affect the electromobility ramp-up?
    - What revenues are currently generated by the GHG quota for CPOs and BEV owners?
    - What is the economic value of the redistribution through the GHG quota for electromobility?
- D: What do CPOs use the revenue from the GHG quota for?

METHODOLOGY

A: *Status of the electromobility market ramp-up*

To assess the status of the market ramp-up of electromobility, data from the Federal Motor Transport Authority (KBA) for BEVs [13], the national public charging station register for charging stations [14] and population statistics [15] are used. The provided data is analyzed and put into relation. A special focus is on Northern Germany, i.e. the federal states of Hamburg, Schleswig Holstein, Lower Saxony, Bremen and Mecklenburg-Western Pomerania.

B: *Effect of electromobility on the GHG quota*

To determine the percentage share of electricity in the GHG quota, the different fulfillment options of the quota are compared based on German Customs statistics [16]–[18].

To assess whether the 37h BImSchG threshold values will be met, a model is calculated with different scenarios:

- <u>15ex scenario:</u> The aim of 15 million BEVs until 2030 by the German Government [7]. It is assumed that the aim value is achieved with exponential growth.
- <u>15lin scenario</u>: In contrast to the 15ex scenario, a linear growth is assumed.
- <u>13.4ex scenario</u>: In contrast to the 15ex scenario, vehicle manufacturers expect a total of 13.4 million BEVs in Germany by 2030 [19].
- <u>10.7ex scenario</u>: In contrast to the 13.4ex scenario, following the current path, the Federal Environment Agency (UBA) expects a total of 10.7 million BEVs in Germany by 2030 [20].

For each year, the number of BEV cars is multiplied by the average electricity consumption. For more detailed assumptions and procedures, see table V-VII in the appendix.

C: *Effect of the GHG quota on electromobility*

To address this sub-questions, the GHG quota model from [21], [4], [5] is updated (see table VIII in the appendix). The (historic) market value for the GHG quota in 2022 to 2025 is based on [22]–[25]. The historic prices for electricity at charging station are based on [26]–[28].

The statistics provided by German Customs regarding the GHG quota [16]–[18] are analyzed and correlated with the results obtained from the GHG quota model.

D: *Use of GHG quota revenues*

To analyze the use of the GHG quota revenues, an online survey was conducted in December 2024/January 2025 among all CPOs with more than two charging points in Northern Germany. In this survey, 24 CPOs responded. A matrix multi-point scale was used to ask about the revenues' use. In a second step, forecasts for the value of the GHG quota were requested.

Furthermore, the written comments from the hearing on the amendment to the 38th BImSchV 2024 [29] are evaluated, and expert interviews were conducted with CPOs, fleet managers, and sustainability officers to discuss the results.

RESULTS

A: *Status of the electromobility market ramp-up*

At the end of 2025, there are 1,588,313 BEV cars in Germany, which make up 3.2% of all cars. The proportion of BEVs is particularly high for luxury segments vehicles at 12.1% and SUVs at 9.2%, while it is low for small cars (2.8%), compact-segment cars (2.0%) and middle-segment cars (2.3%). There are hardly any BEV vans (0.4%) sports cars (0.01%) or motorhomes (0.01%) [13].

There are 284,028 BEV cars in northern Germany, which is 17.88% of all BEV cars nationwide [13]. This is slightly below the population share of 18.09% [15]. In Northern Germany there are 26,383 public charging points (total Germany: 148,471), which leads to a supply of 0.093 charging points per BEV (total Germany: 0.094). The highest supply in Northern Germany is in Mecklenburg-Western Pomerania with 0.139 charging points per BEV, the lowest supply in Lower Saxony with 0.085 charging points per BEV [14].

To achieve the aim of one million charging points by 2030, the existing amount of 148.471 [14] must increase by 36% annually. Reaching 15 million BEVs in 2030 would lead to a supply of 0.066 charging points per BEV. 10.7 million BEVs in 2030 (10.7ex scenario in B) means a supply of 0.093 charging points per BEV.

The supply of charging power in Northern Germany currently amounts to 1,031,139 kW (in Germany: 5,337,023 kW). This means 3.63 kW per BEV (total Germany: 3.36). The highest supply of charging power is in Mecklenburg-Western Pomerania with 6.17 kW per BEV, while Hamburg provides the lowest supply with 3,45 kW per BEV.

On average, every CPO in Northern Germany operates 11.9 charging points (Median: 2) compared to a national average of 13.7 charging points per CPO (Median: 2). Around one third operates one charging point [14].

In Germany, there are 3,143 BEV busses and coaches, which is 3.6% of the total amount of busses and coaches. There are 90,661 commercial BEVs (1.4%) with fewer BEVs in heavy-duty vehicle applications such as semitrailer tractors (0.3%) [13].

B: *Effect of electromobility on the GHG quota*

Comparing the achieved GHG emission savings of the fulfillment options considered for the GHG quota, the importance of electricity has increased from 0.2% in 2021 to 5.0% in 2022 and 7.9% in 2023 [16]–[18].

In 2023, 70% of the electricity allocated for the GHG quota was generated by vehicle owners (75% of all BEV owners participated) and 30% by CPOs [30].

TABLE I. EXCEEDING (RED)/UNDERCUTTING THE §37H BIMSCHG THRESHOLD VALUE IN GWH IN THE SCENARIOS ANALYZED

in GWh	2025	2026	2027	2028	2029	2030
§37h BImSchG threshold	*5,278*	*6,945*	*10,556*	*14,722*	*19,722*	*24,445*
15ex	-199	295	-240	-27	1,202	5,339
15lin	1,741	5,631	7,365	8,331	8,252	8,239
13.4ex	-255	82	-729	-986	-526	2,370
10.7ex	-363	-322	-1,635	-2,710	-3,554	-2,691

Table I (also figure 1 in appendix) shows that in all scenarios except for the 10.7ex scenario, the §37h BImSchG threshold for electricity will be exceeded in 2026, with linear growth of BEVs (15lin scenario) already in 2025. In the 10.7ex scenario the threshold will not be exceeded until 2030.

C: *Effect of the GHG quota on electromobility*

TABLE II. REVENUES FROM THE GHG QUOTA FOR CHARGING POINT OPERATORS 2021 - 2025

	2021	2022	2023	2024	2025
Average value of the GHG quota (in €/t_CO_{2eq})	450	450	240	100	125
Average revenues for grid electricity (in €/kWh)	0.144	0.194	0.084	0.033	0.047
Average price at charging stations (beginning of the year - excluding VAT (in €/kWh))	0.346		0.438	0.462	
GHG quota revenues in relation to charging price	42%		19%	7%	

Table II shows how the fall of the GHG quota value from 2022 to 2024 has reduced the GHG quota revenues for CPOs by around 82%. In 2025, the GHG quota revenues appear to have stabilized at a low level. In relation to the average price at charging stations at the beginning of each year, the economic effect of the GHG quota has fallen from 42% to 7%. Table IX (in the appendix) shows the resulting average revenues from the GHG quota for BEV owners based on table II. These vary in 2024 from 67 € for cars (M1) to 2,341 € for buses and coaches (M3). In 2025, revenues increased by around 43% proportionally to the increase in average revenues for grid electricity.

TABLE III. FINANCIAL IMPACT OF THE GHG QUOTA

	2021	2022	2023
Electricity amount in GHG quota (in GWh)	199	1,714*	3,222**
Electricity value in GHG quota (in €)	28,679,570	332,476,887	272,022,583

*In contrast to German Customs [17], the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMU) has stated that the total electricity included in the GHG quota for 2022 was 2.496 GWh [31]. This corresponds to a value of 484,167,041 €.

** In contrast to German Customs [18], UBA has stated that the total electricity included in the GHG quota for 2023 was 3,606 GWh [32]. This corresponds to a value of € 304,442,406.

Table III shows the value of electricity in the GHG quota. Compared to 2021, the amount and value of electricity in the GHG quota has increased significantly. From 2022 to 2023, the amount increased by around 88%, while the value decreased by around 20% due to the falling GHG quota value (table II).

D: *Use of GHG quota revenues*

TABLE IV. USE OF THE GHG QUOTA REVENUES

Extent	*No*	*Low*	*Moderate*	*Increased*	*Great*
Expansion of new charging infrastructure	26%	0%	11%	32%	32%
Reduction of the charging price	47%	6%	12%	24%	12%
Expenses for the operation of the charging stations	15%	10%	5%	20%	50%
No clear use	55%	0%	9%	9%	27%

Table IV shows that CPOs use the revenues from the GHG quota to an *increased* to *great extent* for the operation of the charging stations (64%) and expansion of new charging infrastructure (70%) and less for the reduction of the charging price (36%).

The CPOs estimate that the value of the GHG quota at the end of 2025 will be between 35 and 150 €/t_CO_{2eq}. The average value of all answers is 89 €/t_CO_{2eq} (more details see appendix figure 2). At the time of the survey, the current value was about 80 €/t_CO_{2eq}, whereas the 2024 average is 100 €/t_CO_{2eq}.

DISCUSSION

A: *Status of the electromobility market ramp-up*

The data analysis shows that expensive vehicles drive the BEV car market ramp-up, while the BEV car share of cheaper vehicles and in particular special vehicles is below average. In the commercial vehicle sector, the electromobility aim for 2030 is somewhat more ambitious (around one third) than in the car sector (around 31% BEVs) but also includes other alternatives such as FCEVs. Therefore, the BEV market ramp-up for commercial vehicles cannot be directly compared with cars. Commercial BEVs generally tend to lag behind the BEV car market ramp-up, due to the greater pressure of economic profitability [21].

Regarding the policy aims of charging points and BEVs, the number of public charging points is disproportionately high compared to the number of BEVs. Between 2025 and 2030, an annual increase of around 45% is required for BEVs, while the required annual increase for public charging points is lower at around 36% and thus seems more achievable. In terms of charging power, the EU aim of 1.3 kW/BEV is currently being clearly exceeded in (Northern) Germany.

In general, the situation in Northern Germany is comparable to the situation in Germany as a whole. It is notable that the sparsely populated rural federal states like Mecklenburg-Western Pomerania and Lower Saxony have both the best and the worst supply of charging infrastructure.

B: *Effect of electromobility on the GHG quota*

The share of electricity in the GHG quota is increasing. It should be noted that the GHG emission savings for electricity are counted multiple times towards the GHG quota several times due to a multiple crediting factor and that electricity has the highest multiple crediting factor with a factor of 3 (factor 3 also applies to renewable fuels of non-biological origin) [4]. However, the share of electricity in the GHG quota remains below the average share of renewable energy in the transport sector (18.1%) [33]. This is due to excluding the traction electricity from rail transport from the GHG quota, despite its large contribution to total electricity consumption in the transport sector [34]. The exact extent to which electricity in transport is covered by the GHG quota remains uncertain, as the available figures for the total amount of electricity in transport range from 8,041 GWh [33] to 13,307 GWh, with 10,852 GWh allocated to rail transport [35]. Theoretically, the federal government has the option of auctioning off electricity quantities not applied for in the GHG quota itself in accordance with Section 37d (2) sentence 1 no. 11 c) BImSchG, but has not done so yet [30].

If Germany meets its BEV cars target numbers, the GHG quota §37h BImSchG threshold will be reached in 2026, which will increase the GHG quota two years later (2028) by half to one and a half times the amount of the exceedance. This also applies if the BEV cars aim will be slightly missed (13.4ex scenario). The threshold value is only undercut in the 10.7ex scenario. The theoretical maximum increase in the GHG quota by 2030 based on the §37h BImSchG threshold is given as 44% [36], [37], compared to the 25.1% currently specified by law.

Exceeding the §37h BImSchG threshold value means an oversupply of GHG quota contracts. This is compensated for by an increase in the GHG quota, which in turn increases demand. Whether this adjustment leads to a rise or fall of the GHG quota value depends on how much the quota is increased. Legally, an adjustment is possible in both directions.

C: *Effect of the GHG quota on electromobility*

For all calculated revenues from the GHG quota, the revenues within a year proportionally depend on the value of the GHG quota. The penalty of 600 €/t_CO_{2eq} can be assumed as a practical maximum value for the GHG quota.

The economic relevance of the GHG quota for the market ramp-up of the public charging infrastructure has decreased, as revenues have fallen in absolute terms and as a proportion of revenues from the charging station business model. The CPOs in the online survey and in the expert interviews repeatedly expressed their dissatisfaction about this situation. In 2025, the GHG quota revenues appear to stabilize or recover slightly. It is unclear how many of the CPOs participate in GHG quota trading and are therefore affected by this. However, it can be assumed that large part of the publicly charged electricity volume is covered by the GHG quota, especially for CPOs with several charging points, while with low GHG quota revenues the effort may not be worthwhile for smaller CPOs (sub-question A: one third of the CPOs operates one charging point).

The GHG quota revenues are benefitting from both the rising value of the GHG quota and the falling GHG emissions from the electricity grid. After the GHG emission value for grid electricity in Germany specified by the UBA has risen slightly in recent years (from 428.4 g_CO_{2eq}/kWh in 2022 to 496.8 g_CO_{2eq}/kWh in 2024), it has fallen again to 446.8 g_CO_{2eq}/kWh in 2025. This increases the GHG emission savings from grid electricity and thus the potential revenues from the GHG quota. If the political expansion aims for renewable energies in Germany are achieved by 2030, the GHG emission savings from grid electricity in the GHG quota will increase more than they decrease due to the increasing share of required GHG emission savings (decreasing the reference value for GHG savings in the GHG quota calculation) (see also table VIII in the appendix). In addition, since 2024 it is easier to connect a charging point to a renewable energy generation system. This currently roughly doubles the potential additional revenues from the GHG quota in the short term as e.g. solar power has a lower specific GHG emission value compared to grid electricity [38]). By 2030, the specific GHG emission value for renewable energy systems and that of grid electricity will continue to converge and thus the corresponding potential revenues from the GHG quota will, too [5].

The economic relevance of the GHG quota for the market ramp-up of the BEVs is ambiguous. In 2023, 1,006,000 cars (M1), 50,000 light (N1), 61,700 (medium) heavy (N2 & N3) commercial vehicles as well as 2,300 coaches and buses (M3) participated in the GHG quota, which corresponds to 75% of all BEVs [32]. For BEV cars, light commercial vehicles and buses, the revenues from the GHG quota have fallen in recent years roughly in line with the fall of the GHG quota value. For BEV (medium) heavy commercial vehicles, a significantly higher estimated value than 2,000 kWh was set in mid-2023, meaning that the importance of the GHG quota has increased here. At the same time, interviews with experts have shown that deadweight effects can be assumed here, as a procurement process in commercial vehicle classes is often time-consuming in particular due to the low availability of BEVs. These increased GHG quota revenues from existing BEV commercial vehicles were not yet considered in the respective total cost of ownership (TCO), but this is expected to change.

To analyze the effect of the GHG quota on vehicle owners, TCO analyses can be carried out to determine whether the GHG quota significantly changes economic efficiency. In general, the purchase costs for BEVs are higher compared to conventional vehicles, while operation is cheaper [21], [39], [40]. For cars, it depends on the vehicle segment whether a BEV or a fossil fuel-powered vehicle is currently more cost-effective in terms of TCO [39]. At the same time, the additional revenues from the GHG quota are currently quite low at around 65-93 € per year. As the BEV car market ramp-up has so far tended to focus on higher-priced vehicles (sub-question A), it can be assumed that these low additional revenues were not the decisive reason for buying a BEV car. This may become more relevant in the future when the BEV car market ramp-up also reaches the lower-priced vehicle segments. In the case of commercial vehicles, companies are more cost sensitive. On average, commercial BEVs are already competitive in terms of TCO, even without a GHG quota. This is further increased by the GHG quota [40].

The redistribution through the GHG quota can be compared with the state subsidy programs, which also support the market ramp-up of electric mobility. Among the state subsidy programs, the funds for the purchase of commercial vehicles with climate-friendly drive systems for buses (462,078,000 €) and commercial vehicles (375,289,000 €) as well as the funds for the expansion of the public charging infrastructure (112,264,000 €), which are all paid from the national climate and transformation fund (revenues from the EU ETS and the national emissions trading system), should be mentioned here in particular [41]. In terms of financial significance for electromobility, these targeted state subsidy programs are comparable to the revenues from the GHG quota.

It is unclear where the differences in the data of the German Customs compared to the UBA come from, which should have the same data basis in retrospect. Depending on the data basis, a larger amount of electricity may have been taken into account in the transport sector than was available. One explanation could be that the estimated value for BEVs (as compensation for non-public charging) may have been set too high. This also leads to the question of the extent to which vehicle owners should be able to count their BEVs towards the GHG quota at all, given that the financially added revenues for BEV (car) owners so far have been rather low.

D: *Use of GHG quota revenues*

Regarding the use of revenues from the GHG quota, it was expected that it would be difficult to allocate a specific use for this. However, the CPOs have given a clear tendency. Only 36% reported that the revenues allocate to an *increased* or a *great extent* to no specific purpose. According to the CPOs, the GHG quota revenues are generally not being used to sell the electricity at the charging stations at lower cost. This can also be seen as domestic electricity is cheaper than electricity at charging points (which also has to co-finance the infrastructure costs) [26]–[28]. That the revenues are generally not being used to reduce the BEV charging price of electricity may also be due to the fact that electricity is already more economical than fossil fuels regarding drive efficiency [21], [42].

Compared to the current value of the GHG quota (end of February 2025: about 125 €/t_CO_{2eq} [22], [24]), the 2025 GHG quota value was rather underestimated at the end of 2024 by the CPOs with a roughly constant GHG quota value. The increase of the 2025 GHG quota value is likely to be primarily due to the German government's attempt to limit the oversupply on the market for 2025 and 2026 caused by possible GHG quota fraud by adjusting the law [29], which could also lead to the fall of the GHG quota at the end of 2024 [23], [43], [44]. Although the short term effect of this legislative adjustment was doubted by stakeholders in practice in advance [43]–[55], the increase in the GHG quota value compared to the average value for 2024 (100 €/t_CO_{2eq}) can be considered significant, while it is still quite low compared to the value for 2021/202 (450 €/t_CO_{2eq}).

The underestimation of the value increase in the GHG quota by CPOs may be since CPOs are often not directly trading with fossil fuels distributors; rather, this occurs via intermediaries who bundle the GHG quota of various suppliers, including CPOs [25]. Consequently, some CPOs may not have monitored the changes to the law and may not have been aware of them. Looking only at the CPOs who assume an increase in value, the estimated average is 115 €/t_CO_{2eq}. In comparison, the around 150 companies registered on the GHG quota trading platform Q-Bility estimate the GHG quota value in 2025 between 100 and 150 €/t_CO_{2eq} [56]. However, a final assessment of this estimate cannot be made until the end of 2025, as the value of the GHG quota fluctuates within a year.

The use of revenue from the GHG quota for BEV fleets in companies has not been systematically analyzed to determine whether it is used specifically for the company's internal electromobility strategy (as desired by the legislator) or whether it generally ends up in the company balance sheet for no specific purpose. Interviews with experts show that some company sustainability officers fear that trading in GHG quotas is more greenwashing for fossil fuel companies than a contribution to the market ramp-up of electromobility. This topic is addressed in [57] somewhat. In the case of private households, it is also difficult to allocate the GHG quota revenues to a specific expense due to the lack of accounting, so it is not discussed further here.

Confidence in a certain level of GHG quota revenues is crucial for planning security [48], [53], [58], [59] especially if the market ramp-up of electromobility depends on it. This seems to be the case in particular for CPOs that are increasingly frustrated with the GHG quota [47], [50], [52], [60], in addition to the regular charging infrastructure also for more innovative business models with GHG quotas such as in [5]. In addition to stabilizing the value of the GHG quota at a certain level through a statutory adjustment, this could also be an increase in the multiple charging factor of electricity from three to e.g. four, which would immediately increase the revenues from the GHG quota by 33% [5]. The next legal adjustment of the GHG quota is expected shortly with the implementation of the EU RED III legislation due to the stricter renewable energy target for the transport sector (implementation deadline: 21.05.2025) [2].

Conclusion

Compared to Germany, the electromobility market ramp-up in Northern Germany is well on track. In general, the national aims regarding the expansion of the charging infrastructure appear to be more achievable than the number of BEVs in 2030.

The importance of electromobility within the GHG quota is increasing, while the absolute and relative revenues from the GHG quota have fallen. Conversely, the GHG quota has also made a significant contribution to the economic viability of electromobility, particularly in the past, especially for CPOs that use it to finance and expand their charging infrastructure network. Since the loss in value of the GHG quota is probably due to fraud, a legal correction of the GHG quota appears necessary in order to restore planning security for achieving the electromobility aims by 2030. The extent to which the current adjustment of the GHG quota is in the short term successful will become more apparent in the course of 2025.

In the discussion, further questions arose that need to be investigated, such as the different data situation of the UBA and German Customs, a review of the estimated values for BEVs or the use of the GHG quota revenues by BEV owners. In addition, more detailed evaluations can be examined with a growing data base as detailed data is currently only available up to 2023 since the reform of the GHG quota in 2021.

Appendix

TABLE V. Assumptions for §37h BImSchG analysis

Item	Value	Context & Reference
Annual mileage of BEV car	13,750 km/year	[61]
Average energy consumption BEV car	2024 = 19.0 kWh/100 km 2025-2029 = Previous year's value - 0.35 kWh/100 km 2030 = 17.0 kWh/100 km	Vehicle manufacturer forecast value$_{2025\ resp.\ 2030}$ [19] * empirical correction factor (115%) [62] It is assumed that the efficiency improves linearly between 2024 and 2030.
Number of BEVs in the corresponding year	(Number at the end of the previous year + Number at the end of the year) / 2	As the number of BEVs changes over the year, the average of the previous year's value and the end-of-year value is taken as the annual value for BEVs

In the §37h BImSchG analysis it is simplified that, in addition to BEV cars, there won't be also BEVs in heavier vehicle classes, which have a higher electricity consumption. Around two thirds of final energy consumption in road transport is caused by individual passenger transport [35]. At the same time, it is assumed that 100% of BEV cars participate in the GHG quota, which is actually only around 75% [32]. It is simplified assumed that these two effects roughly cancel each other out.

TABLE VI. Market ramp-up of BEVs in the scenarios analyzed

Number of BEVs in million	*annual increase*	2024	2025	2026	2027	2028	2029	2030
15ex scenario	*+45%*	1.60	2.32	3.37	4.90	7.11	10.33	15.00
15lin scenario	*+2.23mil. BEVs*	1.60	3.83	6.07	8.30	10.53	12.77	15.00
13.4ex scenario	*+43%*	1.60	2.28	3.25	4.63	6.60	9.40	13.40
10.7ex scenario	*+37%*	1.60	2.20	3.01	4.14	5.68	7.80	10.70

TABLE VII. Quantity of electricity accounted for in the GHG quota

Quantity of electricity in GWh	2025	2026	2027	2028	2029	2030
§37h BImSchG threshold	*5,278*	*6,945*	*10,556*	*14,722*	*19,722*	*24,445*
15ex scenario	5,079	7,239	10,316	14,695	20,925	29,784
15lin scenario	7,019	12,575	17,920	23,053	27,974	32,684
13.4ex scenario	5,023	7,027	9,826	13,737	19,196	26,814
10.7ex scenario	4,915	6,623	8,921	12,012	16,168	21,754

In red are the values marked exceeding the §37h BImSchG threshold

TABLE VIII. GHG quota

Formula revenues from GHG quota	((FossilBaseValue * (1-GHGQuota$_{Year}$)) – (SpecificGHGEmissions$_{grid\ electricity}$ * SpecificDriveTrainFactor$_{battery\ electric\ drive}$) * GHGQuotaTradingContractValue$_{Year}$ * SpecificMutlipleCreditingFactor$_{electricity}$									
	2021	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Fossil base value in g_CO_{2eq}/kWh	338.76									
	94.1 $\frac{g\ CO_{2eq}}{MJ}$ (§ 3 38. BImSchV [63], assumed to stay equal) * 3.6 $\frac{MJ}{kWh}$									
GHG quota$_{year}$	6%	7%	8%	9.35%	10.60%	12.10%	14.60%	17.60%	21.10%	25.10%
	§37a(4) BImSchG [6]									
Fossil target value in g_CO_{2eq}/kWh	318.43	315.05	311.66	307.09	302.85	297.77	289.30	279.14	267.28	253.73
	FossilBasisValue * (1 - GHGquota$_{Year}$)									
Specific drive train factor battery electric drive	0.4									
	Annex 3 38. BImSchV [63], assumed to stay equal									
Grid electricity in g_CO_{2eq}/kWh	529.20	428.40	486.00	496.80	446.40	402.77	359.14	315.51	271.89	228.26
	[64]	[65]	[66]	[67]	[38]	Analogous to [4] and the political energy transition aims in §1 and §4a EEG 2023 [68] and annex 2 §4 of the Federal Climate Protection Act ("Bundes-Klimaschutzgesetz" - KSG [69], a value of GHG emissions of 141 g_CO^2/kWh for grid electricity is assumed. According to § 5 38. BImSchV [63], the actual 2030 value would be taken 2032 as average value for the GHG quota in. From 2023, a linear decline is assumed.				
Multiple crediting factor electricity	3									
	§ 5 38. BImSchV [63], assumed to stay equal									
GHG saving for grid electricity including multiple credit factor in g_CO_{2eq}/kWh	320.26	431.06	351.78	325.10	372.87	409.98	436.93	458.80	475.58	487.29

TABLE IX. AVERAGE REVENUES FROM THE GHG QUOTA FOR BEV OWNERS IN DIFFERENT VEHICLE CLASSES 2024-2025

	kWh/vehicle [70]	2024	2025
M1 & M2 (cars)	2,000	65 €	93 €
N1 (light commercial vehicles)	3,000	98 €	140 €
N2 (medium-heavy commercial vehicles)	20,600	670 €	960 €
N3 (heavy commercial vehicles)	33,400	1,086 €	1,557 €
M3 (buses and coaches)	72,000	2,341 €	3,356 €

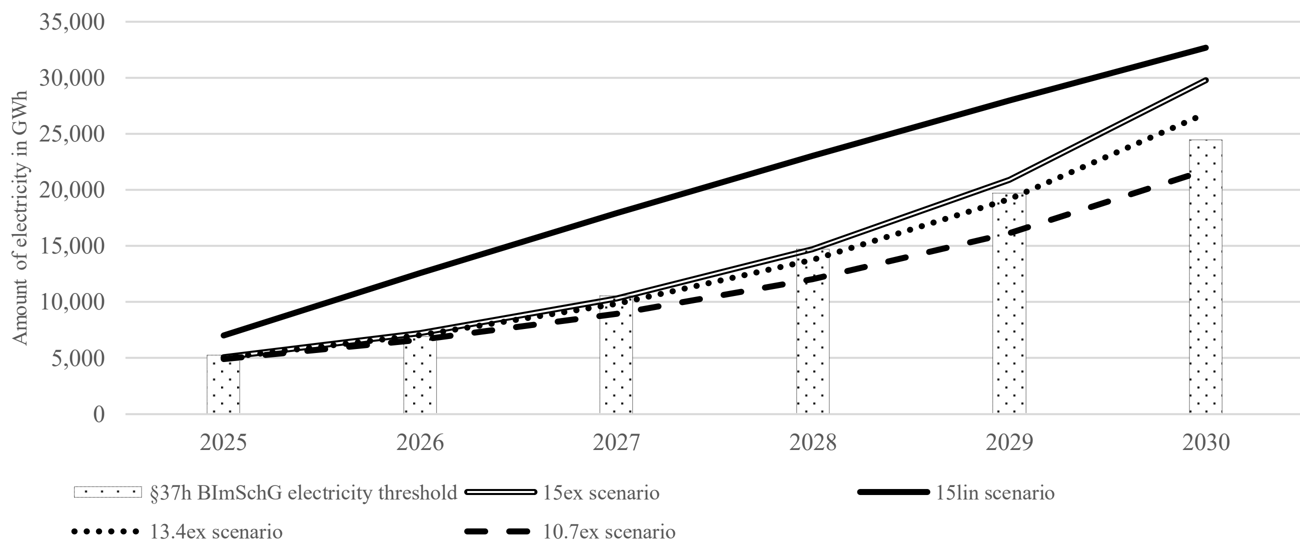

Figure 1: The §37h BImSchG threshold of the GHG quota compared to amount of electricity in the scenarios analyzed

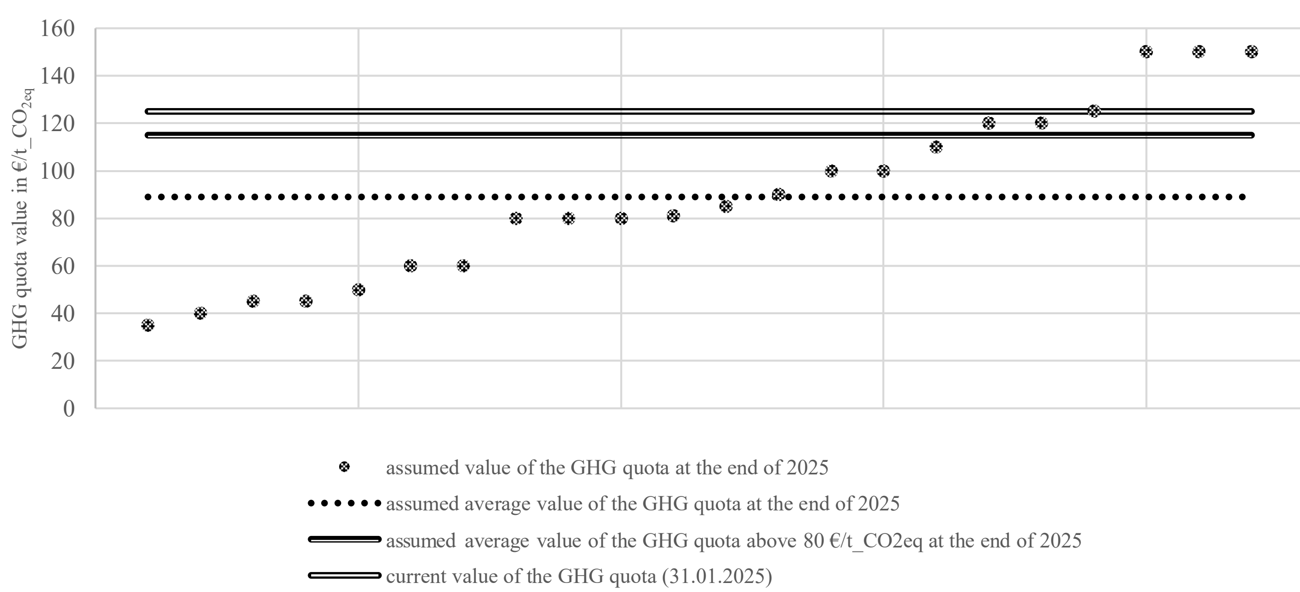

Figure 2: Value assumption of GHG quota at the end of 2025 sorted by size

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