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Forklifts at the Forking Point: Evaluating Technology Open Funding Schemes with Dominating Technologies

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ABSTRACT

The 'Federal Funding Scheme for Energy and Resource Efficiency in the Economy' (EEE) is a central programme to support companies in Germany with their transition towards climate neutrality. In its current incarnation, the EEE consists of six funding modules. A recent module introduced in May 2023 is a scheme offering funds to micro and small enterprises for investments in technological options that use electricity, and which replace or retrofit those operating on fossil fuels. This scheme is introduced as a funding opportunity with a low-level entry point for its target group. This contribution seeks to share first insights on the scheme's performance and covers the period until the end of 2023. It aims to give an overview of the funding module, a set of obtained indicators and, related to them, strategies how to deal with dominating technologies in a funding scheme. The latter is of particular interest because the scheme is per se technology open, i.e. a shift towards electricity is decisive for funding. Yet while this open setup allows for many fuel-shifts options, most of the submissions to the scheme concern electric forklifts as a replacement for fuel-driven models. The analysis of the scheme indicates that it is heading in the direction of its objectives, but its targeted values are not yet achieved. A point requiring attention is the dominance of forklifts. While the findings suggest that electric models appear substantially more energy-efficient than their conventional combustion-based counterparts, their substantial share raises the question whether corrective action is needed. While several corresponding strategies are outlined in the paper, further monitoring seems advisable given the compartively recent introduction of the scheme.

Introduction

Financial support schemes are an important instrument in energy policy making to enhance the uptake of energy-efficient technologies and to facilitate the transition towards a carbon neutral energy system. In 2019, the German Federal Ministry for Economic Affairs and Climate Action introduced the 'Federal Funding Scheme for Energy and Resource Efficiency in the Economy' (EEE) as a support scheme and as a follow-up to earlier, similar schemes (Neusel & Hirzel, 2025). The EEE is a multi-measure programme, i.e. it consists of different 'modules' that offer support for investments in energy- and resource-efficient solutions (Figure 1). Support is offered by providing grants and credits on diverse topics and with different levels of complexity. Target groups of the EEE are private-sector companies operating in Germany, contractors working for these companies, as well as municipal companies, and, with conditions, freelancers.

A recent addition to the EEE since May 2023 is a scheme aiming at the electrification in micro and small enterprises ('module 6'; hereafter: the 'Scheme')[1] (BAFA, 2025). The Scheme can be characterized as technology open, i.e. there is no prescription on investments in predefined technologies that limit the eligibility for funding. Rather, the Scheme sets functional requirements: Electrically powered technologies are funded if they replace or retrofit corresponding technologies which operate on fossil energy carriers, and which are decommissioned after acquiring the new solution. As micro and small companies tend to be faced with limitations in terms of financial capacities and know-how on energy efficiency measures (e.g. Trianni et al., 2013), the Scheme seeks to minimize administrative burdens by ensuring a simple, low-level entry point.

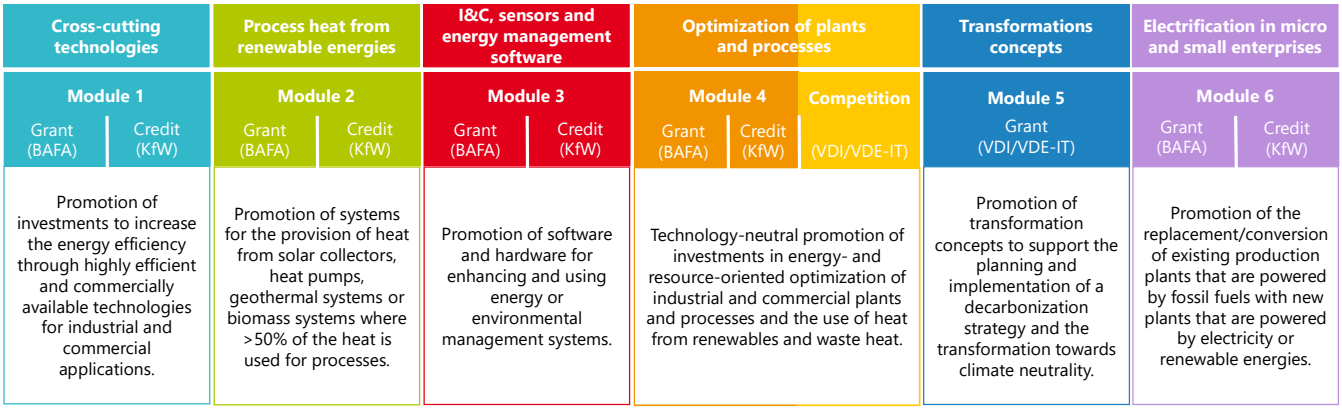

Figure 1. Overview of the EEE including the Scheme ('Module 6'). *Source*: Neusel, Hirzel, Weinert, et al., 2024.

The EEE and its modules, including the Scheme, are regularly evaluated regarding their efficiency and effectiveness, both to report on the use of public funds and to adjust the EEE, if need arises. These annual evaluations are conducted ex-post for each calendar year during the following year. Early information on the Scheme indicated a substantial share of the funding requests relating to forklifts, i.e. a situation where forklifts dominate the Scheme as a technology.[2] Forklifts are mostly used for logistics within company premises, mainly inside buildings, to move heavy loads. They are powered by diesel, gas or electricity. Models driven by internal combustion engines (ICEs) or by battery-electric (BE) solutions have both been used in industry for long. ICE models continue to dominate the market especially for high lifting loads (> 8000 kg). Yet BE models are advancing into these ranges, mainly due to more powerful and cheaper batteries. The initial costs of electric forklifts are higher than ICE models on the one hand, and costs for the charger and, where applicable, battery replacement, need to be considered. On the other hand, maintenance and operating costs are usually lower for BE models. BE models are also favourable in terms of perceived noise levels: BE models tend to be half as loud (approx. 65 dB) as ICE models (approx. 75 dB). The elimination of exhaust gases from ICE forklifts can additionally increase the comfort and reduce ventilation requirements in indoor areas and associated thermal losses.

Due to the high relevance of forklifts in the otherwise technology-open scheme, there is the question whether the Scheme is on track to achieve its objectives and what implications the forklifts have for the Scheme. Thus, the research question can be stated as follows: How did the technology-open electrification Scheme perform during the first evaluation period, what role do forklifts play in this context and how could their

[1] See: https://www.bafa.de/DE/Energie/Energieeffizienz/Energieeffizienz_und_Prozesswaerme/Modul6_Elektrifizierungsmassnahmen_KU/modul6_elektrifizierungsmassnahmen_ku_node.html

[2] The term 'domination' is considered here as a simple count of funding cases. Note that other definitions are also conceivable in the context of funding programmes, referring for example to financial KPI, or considering relative shares, e.g. by relating the share of GHG reductions of the largest group of technologies to the second largest group.

dominant role be addressed? The methodology for evaluating the Scheme will be presented with a focus on the dominating forklifts, followed by selected results for the Scheme and the forklifts, in particular. Implications and potential strategies for future modifications for the Scheme are then discussed, followed by the conclusions.

Background: The electrification Scheme for micro and small enterprises

In general, the Scheme's ambitions are to achieve a shift towards electricity in micro and small enterprises (Table 1). Its aims are specified within the general objectives of the funding directive for the EEE (BMWK, 2023a) and further specified in BMWK (2023b)[3]. According to the directive, the EEE should provide cost-efficient and effective support for investments which contribute to achieving climate protection and energy efficiency targets, in particular by increasing energy and resource efficiency and by deploying renewable energies for process heat. Furthermore, a simple and accessible funding model should be established and enhanced based on existing funding offers. The specific objectives of the Scheme are to support small businesses in reducing their demand for fossil fuels (in particular regarding gas and oil use) and to enhance their electrification. In quantitative terms, the Scheme seeks to achieve 8,000 funding measures during the period from 2023 to 2026, a reduction of annual gas demand by 0.6 TWh and of annual oil demand by 0.24 TWh and it should provide 0.17 TWh of process heat from electricity per year in that period.

Table 1. Overview for key features of the Scheme on the electrification in micro and small enterprises. *Source*: Based on Neusel, Hirzel, Heinrich, et al. (2024); for details, see the funding directive and related documents.[3]

General aims	• Offer cost-efficient and effective support for investments contributing to climate protection and to achieving energy efficiency targets • Offering a simple and accessible funding model
Specific aims	• Reduction of fossil fuels in small businesses (especially gas and oil) • Improving the electrification of small businesses • From 2023 to 2026: realizing 8,000 funding measures; reducing gas demand by 0.6 TWh/a, oil demand by 0.24 TWh/a; providing 0.17 TWh/a process heat from electricity
Target groups	• Size: Micro and small companies • Types: Private companies, municipal companies, state-owned companies, contractors (for eligible companies), freelancers (if premises are primarily used for their work)
Eligible action	• Replacing units powered by natural gas, coal, fossil oil or energy carriers derived from these with new units that are powered by electricity • Converting units powered by natural gas, coal or fossil oil or energy carriers derived from these by replacing components so that units can be powered by electricity
Requirements	• Investments must be at least 2,000 €; • System/components to be replaced/retrofitted in use for at least five years and still operational; • Systems to be replaced/retrofitted is unable to operate exclusively with electrical energy; and • Retrofits/replacements can only be operated with electricity (no hybrid systems with exceptions)
Funding rate	• Maximum funding limited to 200,000 €: • Grant line (operated by BAFA): 33 % of the eligible investments under de-minimis, 20 % under the General Block Exemption Regulation (GBER) • Credit line (operated by KfW): Identical as in grant line, but offered as repayment subsidy

It is characteristic of the Scheme that it does not aim directly at energy savings, but at changing away from fossil fuels towards electricity. Two ways of achieving this can be distinguished in an impact model (Figure 2): technological replacements (case I) or modifications of existing units (case II). In case I, the availability of funds leads to investments in electric replacement systems as a direct 'output' of the Scheme. Examples are

[3] A recent revision of February 2024 which is in force at the time of writing is not considered here.

investments in electric furnaces or forklifts. At the same time, it is necessary to decommission the old system. In terms of 'outcome', this leads to a new, electrically operated system that results in increased electricity consumption. On the other hand, the old natural gas-, coal- or oil-fired system is decommissioned, and the use of conventional energy sources is reduced. The resulting 'impact' is then a shift in energy consumption towards electricity, with the possibility of using renewable sources for this purpose and moving away from fossil energy sources. A simliar model applies to case II, but instead of a complete replacement, only components or parts of a system are changed to use electricity. Savings in final energy demand only occur if the electrically operated alternatives are more efficient than the original conventional systems. Consequently, there are no greenhouse gas emissions reduction targets for the Scheme, only energy saving targets for gas and oil.

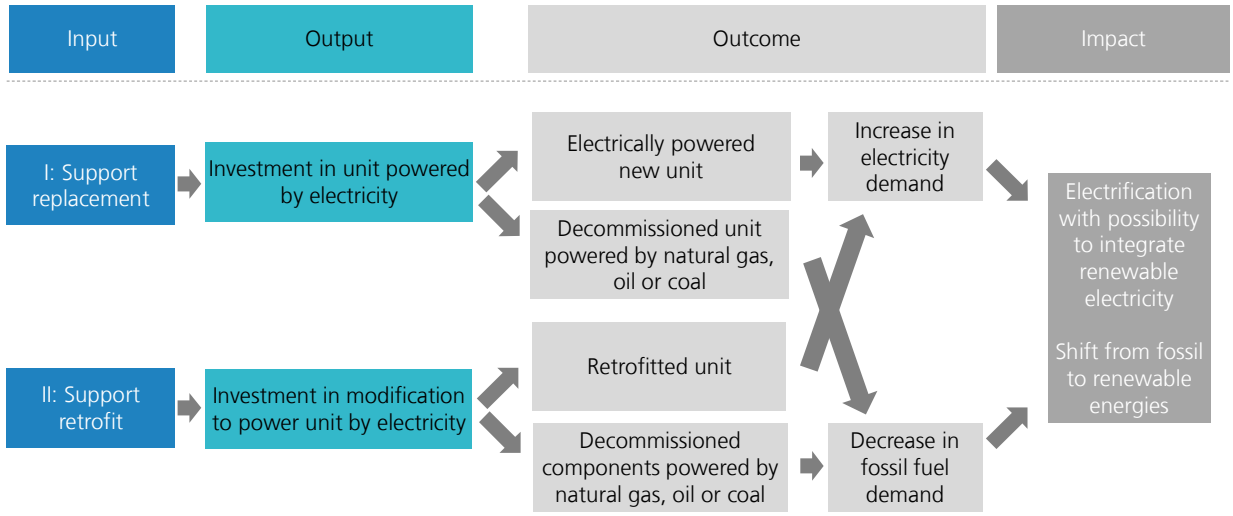

Figure 2. Illustration of the impact model for the Scheme. *Source*: Neusel, Hirzel, Heinrich, et al. (2024).

As for most other modules within the EEE, the Scheme is offered as a grant-based or as a credit-based line. The former is operated by the German Federal Office for Economic Affairs and Export Control (BAFA), the latter by the German development bank (KfW). While the grant line offers direct investment support, the credit-based line provides a low-interest loan that includes a subsidy to the repayments. For the grant line, the funding rate is at 33 % of eligible investments for funding under de-minimis and 20 % under the General Block Exemption Regulation (GBER)[4]. A corresponding repayment subsidy is included in the credit line. The maximum funding is 200,000 €. Within the credit line, the applicant's bank acts as a financing partner, i.e. it is involved in granting the credit.

Methodology

Overview of the evaluation methodology and data sources

A quantitative analysis of the Scheme is carried out which follows a standardized methodology for energy efficiency evaluations. Since the methodology has been covered in detail elsewhere, only a basic summary of the methodology is provided here for general understanding, based on the description given in Hirzel & Schlomann, (2022) and Neusel, Hirzel, Weinert, et al. (2024). For further details, the reader is referred to these publications and literature given therein. The methodological overview in this contribution focuses on the parts that are specific for the electrification Scheme.

[4] See: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=legissum:0802_4.

The general evaluation framework used for the EEE has nine steps, starting with an overview of the programme and its measures (Step 1), followed by setting common parameters (Step 2). Thereafter, an identification of targets and aspects relevant to evaluation takes place (Step 3). To monitor these elements, key performance indicators (KPIs) are introduced (Step 4). This is followed by obtaining the data required for the KPIs (Step 5), a review of this data (Step 6), data processing to first compute gross KPIs (Step 7) and then net KPIs (Step 8). Multi-measure programmes with several elements have one additional step to merge results into overall values (Step 9). The different KPIs are attributed to six groups (see also Table 3 in Neusel & Hirzel 2025):

- category 'G': KPIs related to aspects of 'general interest';
- category 'A': KPIs for reviewing 'target achievement';
- category 'B': KPIs for 'effect adjustments' mirroring free-rider, pull-forward and spill-over effects (gross/net values in Table 2);
- category 'C': KPIs adressing 'economic efficiency';
- category 'D': KPIs on the 'procedural implementation'; and
- category 'E': KPIs for 'specific knowledge interests' as a supplement.

Most of these indicators are quantitative (e.g. GHG savings in tonnes of $CO_{2\text{-eq.}}$), but some are qualitative (e.g. perceived ease from the perspective of recipients). Several sources of information are used to determine the KPIs and to walk through the analytical steps:

- **Administrative data:** Funding is only available if a funding request is submitted to the implementing agency. The application forms and documents include administrative data (e.g. contact details, legal information), information on the requested funds and related technical documents. The focus of this dataset is to ensure that all requirements of the funding are fulfilled, i.e. that eligiblility is given and that legal, technical and financial conditions are met.
- **Administrative costs:** Next to the data provided by those appyling to funding, indicators on economic efficiency partially include information on administrative costs, i.e. the cost incurred for running the Scheme by the implementing agency. These are directly obtained from the responsible agencies and broken down to individual modules based on typical efforts to processing funding requests.
- **Survey among successful applicants:** An annual survey is distributed to those submitting successful requests for funding as part of the evaluation. This survey seeks to complement the administrative data in many areas. The survey underlying this evaluation took place in May 2024 with an approximate duration of 20 minutes. While for the entire EEE, more than 10,000 invitations were sent out, 144 beneficiaries were specifically invited to the survey for the Scheme and 33 invited contacts completed it (response rate: 23 %). Note that the number of invitations is well below the number of individual applications because in roughly 100 cases, only general contact addresses of consulting agencies were available which were each only contacted once.[5] Note that the sample is not necessarily representative for the overall Scheme, e.g. in terms of sectors, products, sizes or regions covered.
- **Data sheets:** As a specific and additional part to the evaluation of the Scheme, data sheets for forklifts were collected and analysed in more detail. These datasheets concern both the new BE models as well as the old ICE models. Data sheets were partially included in the application documents, especially for the BE models. For the old conventional models and for missing sheets or those not specifying energy demand, internet research was done for the models which names were available from administrative databases or from other documents within the application.

[5] As a general policy in the EEE evaluation, sending out the survey is limited to one participation per contact and year since earlier experience with multiple mailings to the same contact tended to go unanswered.

Determination of energy-related KPIs

The determination of energy demand within the EEE is specific to its individual modules. In the case of the Scheme with its low-level entry point, administrative data does not include technical information on changes in energy demand and similar values on the shift from fossil fuels to electricity. For this reason, these values were quantified using a bottom-up approach. Due to the dominant role of forklifts on the one hand and diverse applications in the rest of cases, two approaches serve for the impact estimation.

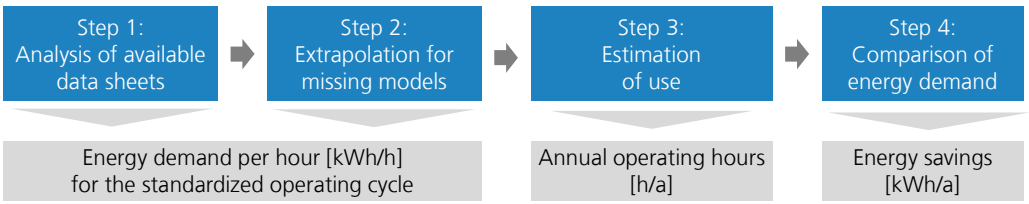

Figure 3. Determination of energy savings for forklifts.

The impact for forklifts as the first approach is analysed in four steps (Figure 3): The starting point are the data sheets for forklifts which are standardized according to German VDI standard 2198 on type sheets for industrial trucks. These standardized sheets include, among other things, information on hourly energy/fuel consumption values. These values are specifically given as entries 6.6 (electric motors) and 7.5 (combustion engines) in the standarzied data sheets. These values are based on standardized operating cycles: EN 16796-1 describes the test methods for certain forklifts and EN 16796-2 details test methods for operator controlled self-propelled trucks, towing tractors and burden-carrier trucks. The test cycle for determining energy consumption foresees repetitive uses of forklifts with 70 % of their maximum loading capacity. The cycle includes lifting and driving and the energy consumption of the forklift is determined for one hour of such operation. The hourly value is indicated here as $d_{BE,n}$ for BE models and $d_{ICE,n}$ for ICE models. The test cycle is intense and actual utilisation rates in industry and commerce are typically substantially lower. The available data sheets allowed to extract data on standardized consumption for 137 BE and 49 ICE models.

In a second step, data for the remaining forklifts was extrapolated. For this, average consumption value per loading capacity from available data sheets were scaled up based on the nominal loading capacity of the models. Where information on loading capacity was also missing, the median consumption of forklifts with given data was used. The conventional forklift's consumption values where either categorized as natural gas or diesel consumption if the type of propellant was known. In the remaining cases, a mix was assumed.

The obtained hourly values were then multiplied by annual operating hours in a third step. For this, funding recipients were asked qualitatively about the use of their forklifts in the survey. This included questions about the forklift's shift model (1-shift, 2-shift or 3-shift model per day, translating to 8, 16 or 24 hours of operation per day and expressed below by h_n) and about the intensity of use (very infrequent to intensive continuous use, translated to estimated shares of 10, 30, 60 or 90 % of the default cycle, denoted by α_n). The shift model was used to determine the theoretical daily full-load hours and the intensity of use to estimate the actual full-load hours. This value was then combined with an assumed number of operating days d_n. In this way, it was possible to obtain usage information for 27 cases from the survey, with their median being attributed to the remaining cases.

As a fourth step, the overall difference D in demand of each new electric forklift versus the conventional forklift was calculated by:

$$D = \sum_{n=1}^{N} \left(d_{BE,n} - d_{ICE,n}\right) \cdot h_n \cdot d_n \cdot \alpha_n \qquad \text{(equation 1)}$$

D: annual difference in energy demand for all forklifts [kWh/a]

$d_{BE,n}, d_{ICE,n}$: hourly energy demand for the cycle for BE or ICE forklift n [kWh/h]
h_n: daily operating hours of forklift n [h/d]
d_n: number of operating days of forklift n [d/a]
α_n: usage intensity of forklikt n [%]

In view of the foreseeably high share of forklifts in the Scheme, a key question for the future development of the Scheme is related to how to proceed with the forklifts. To better judge this question, a more detailed analysis of the funding cases was initiated. The main source of data for this analysis are the available data sheets from successful applications from the year 2023.

The second approach concerns 'non-forklift' applications. Due to the diversity of the remaining cases, the survey contacts were asked to provide information more directly, i.e. about the approximate annual consumption of the new and the old systems and – in cases they did not know – about the relevant energy sources. This information could potentially be useful if combined with default values for power readings and utilization hours per application.

Results

Overall results for the Scheme

A review of all cases in the grant line operated by BAFA provides insights into the structure of the Scheme and confirms that a share of 80% or 297 of all applications concern forklifts (Figure 4). The remaining 20% or 75 cases can be attributed to the following five categories (with examples):[6]

- Kitchen equipment and food processing (e.g. kettle, kitchen inventory, oven, smoking equipment)
- Manufacturing and processing (e.g. lathe, coater, welder, sieving machine)
- Garden and forestry (e.g. log splitter, lawn mower, robotic lawn mower)
- Other vehicles (e.g. excavator, go-kart, crane, tractor)
- Other devices (e.g. washing machine, mangle, high-pressure cleaner, infrared heater)

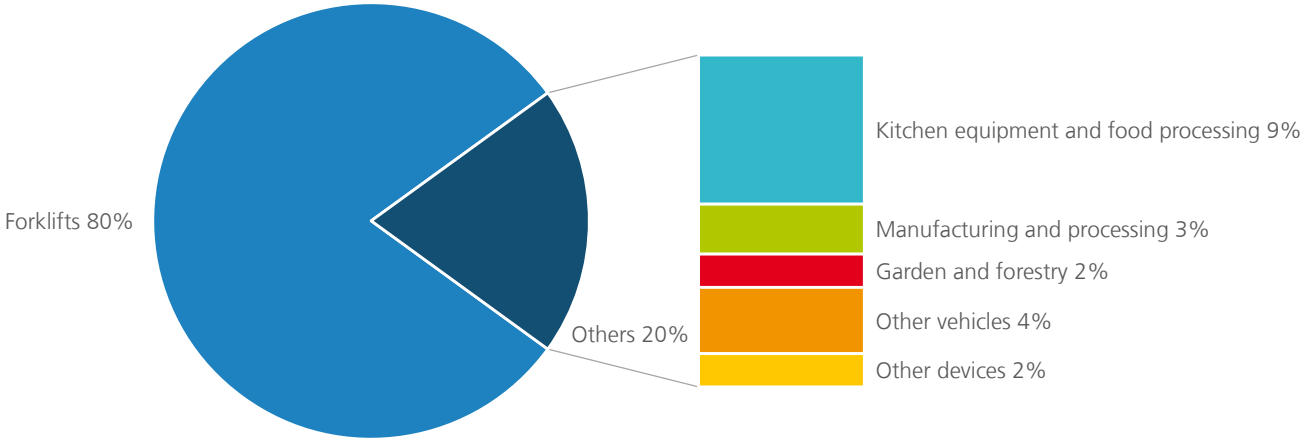

Figure 4. Distribution of 372 applications by topic in the Scheme's grant line. *Source*: Neusel, Hirzel, Heinrich, et al. (2024).

[6] Note that it is a breakdown by count of cases, regardless of whether they concern one or several units or devices. An atypical case illustrates that this might distort results, however: in one situation, twenty-two identical vehicles were covered by one case; in another situation, twelve identical vehicles were recorded as twelve separate cases.

Following the previously outlined methodology, the KPIs for the Scheme were determined. The overall results show that the Scheme constitutes a relatively minor module of the overall EEE, with only 2 % of its approvals and 0.4 % of its approved funding in 2023 (Table 2). In total, the Scheme accounts for 0.06 % of the total GHG savings of the EEE in this year. The lowest funding request was 4,000 € in the Scheme. Around 26 % of the funding cases had a funding request below 10,000 €. In 2023, the Scheme was almost exclusively used for the grant variant: 246 applications were approved for the grant line, compared to 5 in the credit line. In terms of gross GHG emissions, an average case saved about 4 tonnes of $CO_{2\text{-eq.}}$/a. The lower savings compared to the overall EEE, with about 155 tonnes of $CO_{2\text{-eq.}}$/a per approval in 2023, can be explained by the target group of small companies with their individually relative low emissions. Their energy consumption, and the resulting savings, are correspondingly low when compared to the average company in the EEE. It is important to note that due to insufficient responses in the survey, quantifying the impact for the 'non-forklift cases' was not possible. Under the assumption that the 'non-forklift cases' individually reduce carbon dioxide emissions, the overall GHG reductions of the Scheme would be underestimated. The relatively small savings due to the characteristics of the funding cases lead to a comparatively low lifetime funding efficiency compared to the aggregate of all modules (569 vs. 71 €/t $CO_{2\text{-eq.}}$, Table 2). However, to assess the effectiveness of a measure, the funding efficiency needs to be viewed in the context of the characteristics and objectives of a measure, such as its type and size and under consideration of the theoretical potential that could be realized. As mentioned before, the Scheme addresses companies with a low energy consumption in relative terms.

Table 2. Summary of key performance indicators for the Scheme and the overall EEE for the year 2023. *Source*: Neusel, Hirzel, Heinrich, et al. (2024).

Key performance indicator (Letters denote the group, see methodology)	**Unit**	**The Scheme (=module 6)**	**Entire EEE (=all modules)**
[G] Number of applications / approvals	[n]	392/251	14,130/13,759
[G] Number of approvals by funding line (grant/credit)	[n]	246/5	13,679/80
[A] Estimated reduction in GHG emissions (gross/net)	[kt $CO_{2\text{-eq.}}$/a]	1.19/1.10	2,128/1,872
[A] Estimated reduction in energy and resources costs (gross/net)	[M€]	0.2/0.2	614.2/506.4
[C] Approved funding / Triggered investments	[M€]	5.3/15.7	1,195.9/3,713.3
[C] Administrative costs	[M€]	0.1	11.0
[C] Funding efficiency (gross/net)[7]	[€/t $CO_{2\text{-eq.}}$]	569/611	71/79

An interesting observation is that, according to respondents in the survey, suppliers were the most important source of information about the Scheme. Regarding the implementation in procedural terms, most of the respondents (91 %) perceived the benefits of the Scheme in relation to the required effort as "rather good" or "good" and would rather recommend it. In general, they also tended to be satisfied or rather satisfied with the application process and the implementation from an administrative side. Howere, there is room for a higher user-friendliness of the online application forms and for making funding conditions easier to understand. Similarly, more support from the agency and easier means to get in touch with it were also underlined once funding requests are approved.

Technological analysis of forklifts in the Scheme

Available data sheets permit insights into differences in terms of the energy consumption of forklifts (Figure 5). First, as expected, it can be observed that energy demand tends to increase with a higher maximum loading capacity. Second, even for forklifts with the same maximum loading capacity and technology, there can be substantial differences in the energy demand for the default cycle. Third, electric forklifts have a substantially

[7] This is a lifetime-oriented value. In line with the methodological guideline, a lifespan value of 8 years is applicable for general technical measures in industry/in the transport sector.

lower energy demand per cycle than ICE models. Even when the upstream chains and their losses are considered, an BE model still appears superior in terms of energy efficiency: For the given examples and conditions, the demand of the BE models is about only one quarter of the ICE models' demand. Yet, losses of the battery and self-consumption of the charger would need additional consideration and are netiher covered in the default cycle or here. It should also be noted that the ICE models considered here might be older designs, since they should have been operated for at least five years according to the requirements of the funding directive.

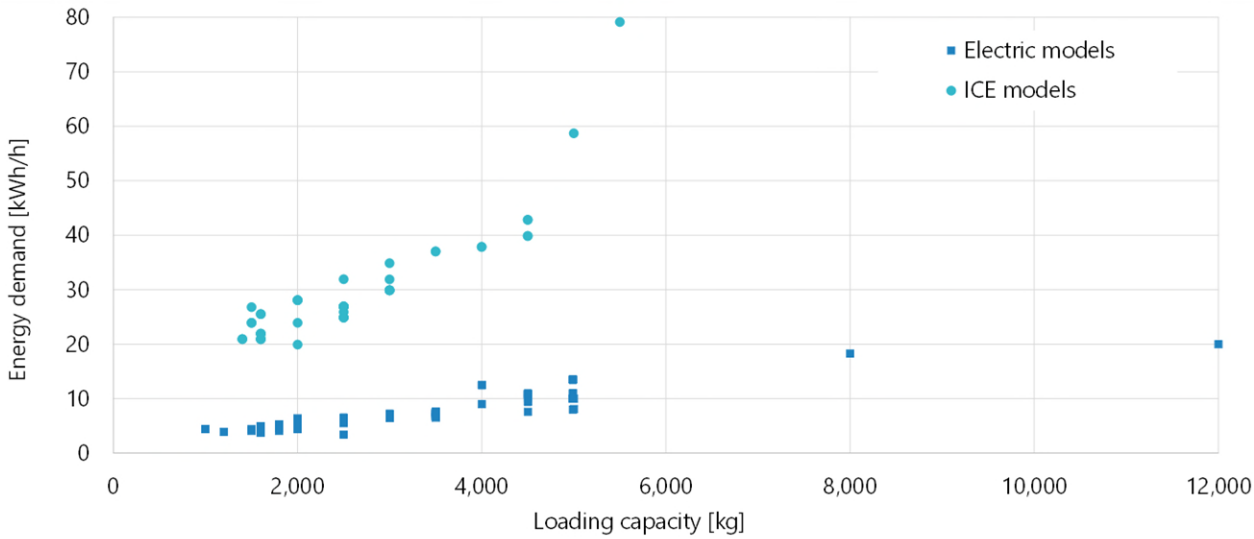

Figure 5: Illustration of energy demand relative to loading capacity for a sample of forklifts based on data sheets for electric and ICE model. *Source*: Analysis based on Neusel, Hirzel, Heinrich, et al. (2024).

Discussion

Limitations of the analysis

Uncertainties are hard to avoid in any evaluation. In the context of the evaluation of the Scheme, several observations are noteworthy. One is that the evaluation is the first analysis of the Scheme which might still be considered in its 'roll-out'. This means that practical processes, interpretations and awareness of the Scheme were still evolving. Such evolutions can, for example, be observed for more established modules in the EEE (Neusel & Hirzel, 2025): There can be relevant changes to the performance of a scheme over time, particularly during its first years. In the case of the Scheme, it should also be noted that it – as well as the entire EEE – was temporarily suspended in December 2023 due to a Governmental budget freeze following a ruling by the Federal Constitutional Court (BAFA, 2023). This will have had a higher impact on the Scheme than on other modules in the EEE since the Scheme was only started in May 2023, i.e. the evaluation period is generally shorter. Thus, quantitative KPIs might still substantially evolve in forthcoming evaluations of the Scheme.

It should also be noted that the dataset on which the evaluation is based does not provide detailed inputs for all cases. To accommodate for these gaps while still providing a proxy for the overall impact of the Scheme, several similarity assumptions were made. The median was used, for example, where datasheet values for energy demand or survey results were missing. Also, it should be noted that beyond the impact of the forklifts, the results from the other funding areas could not be estimated since no information on typical powers and operating hours could be obtained. Also, the data on energy demand for the forklifts is not exhaustive, especially for the decommissioned older models.

On the performance of the Scheme

Keeping the limitations in mind, a set of initial conclusions can be provided for the Scheme. In terms of target achievement, the Scheme appears to be behind its goals with regard to gas and oil savings and concerning the targeted number of cases. Furthermore, the provision of heat from electricity could not be quantified due to missing data. However, the implementation of the Scheme generally appears to be favoured by those using the Scheme even if – as for other modules – respondents also suggested that it could be easier to obtain support from the implementing agency which indicated transitory constraints of available personnel. Also, results suggest that the Scheme has achieved a sufficient level of ease-of-use within the EEE to attract small companies. Yet one observation is that a substantial number of applications has apparently been prepared by energy consultants. The initial observation that forklifts play a very important role in the Scheme has been confirmed by the analysis.

Strategies to deal with dominating technologies and their implications for the Scheme

As observed, forklifts are dominating the Scheme for electrification. i.e. more than half of the funding cases deal with this technology. Such domination may have direct implications for the efficiency and effectiveness of a programme. On the positive side, dominating items may mirror very active communities of sellers that make extensive use of the funding to market their products and to enhance the market diffusion of new technologies. From the perspective of programme administration, domination may also be a risk for a funding programme since the programme's KPI depend heavily on one item or technology. This means that a decline in demand may substantially affect KPIs. Such situations may get especially relevant when markets tend towards saturation, and the demand stagnates or even decreases. A strong role of certain technologies/items in funding may also signal progress towards cost effectiveness of the base technology, i.e. that the item or technology evolves from a niche product to be widely accessible on the market. The higher demand might mirror potentially higher free-rider effects. Offering subsidies for a longer time also may lead to a situation where prices are adapted to the availability of the market scheme, i.e. that seller skim funding or that market structures are set up that overly rely on the presence of funding. Thus, domination could indicate flaws in the design or implementation of a programme, i.e. requirements that not efficient or effective. A closer investigation of such situation is therefore advisable.

Cases of dominating roles of certain technologies can be found in different funding contexts. For example, compressed air systems were often observed in the funding of highly efficient cross-cutting technologies in the EEE (module 1). This resulted in a later modifications of eligibility criteria (Neusel, Hirzel, Heinrich, et al., 2024). Another example that can be referred to is the former funding of highly efficient cross-cutting technologies which is a predecessor to the EEE. It had been observed that at that time fairly recent LED technology met intense demand in the funding scheme (Hirzel et al., 2014).

While it is important to understand the underlying reasons for the dominance of technologies, the focus at this point is to reflect on strategies how to deal with these situations. As observed, the Scheme is dominated by forklifts. A key question is how such cases of dominating technologies can generally be dealt with and what implication such strategies might have.

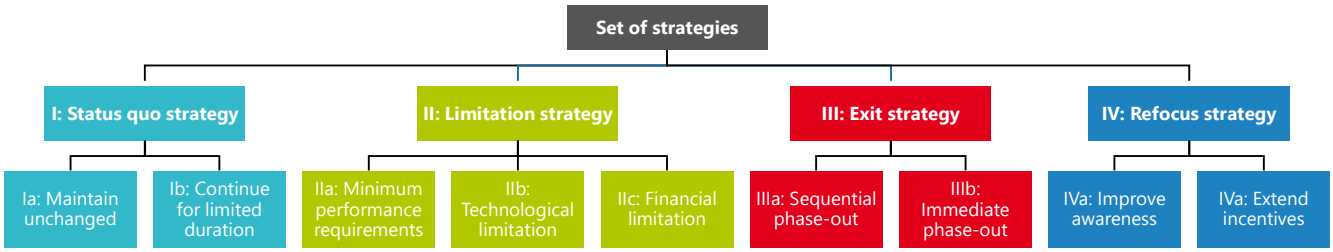

Figure 6. Strategies to deal with dominating technologies in funding programmes. *Source*: Own illustration.

Various generic strategies can be envisioned to deal with dominating technologies in funding schemes. A non-exhaustive set of them is outlined in Figure 6 and implementation examples for the Scheme in Table 3:

- **I: Status quo strategy**: This strategy seeks to continue the funding unaltered, i.e. to decide against any immediate action. This may either be to decide against any action, i.e. to accept dominance as is (Ia: Maintain unchanged), or to revisit the strategic decision board after a fixed duration, to include additional information and new insights in the future (Ib: Postpone decision).
- **II: Limitation strategy**: This strategy aims at reducing the uptake of the dominating technology to counter its dominance, yet to generally keep its funding. Ways to achieve this include introducing minimum energy performance requirements for the dominating technology, i.e. setting lower or upper ceilings for an energy service (IIa: Performance requirements), by establishing technological exclusion criteria, i.e. by excluding certain subgroups based on technological criteria (IIb: Technological limitation), or by correspondingly setting financial limits, i.e. setting financial thresholds such as upper or lower prices (IIc: Financial limitation).
- **III: Exit strategy:** Differently from the previous strategies, the idea here is to remove the dominating technology from funding. This can either be achieved by a gradual phaseout, i.e. gradually reducing the demand for the technology in question (IIa: Sequential phase-out), or by an immediate phase-out, i.e. removing the technology from eligible technologies (IIIb: Immediate phase-out).
- **IV: Refocus strategy**: While the previous strategies mainly looked at the dominating technology, the idea of this strategy is to enhance the uptake of other technologies instead of focusing on the dominating one. One way to achieve this is to improve awareness about the other funding opportunities, i.e. to spread the word and activate multiplicators focusing on other eligible technologies (IVa: Improve awareness), another to extend incentives for other technologies, i.e. make conditions for other technologies more favourable (IVb: Extend incentives).

Some of these strategies may also be combined and other can also be conceived: In case of programmes that are not technology open as the Scheme, other technologies may be added to the funding. Or it is conceivable to work on programme design itself, e.g. to fund certain technologies only for a subset of the target group, e.g. micro companies.

The various strategies have advantages and drawbacks. To illustrate the potential effect of the strategies on the Scheme, Table 3 provides an overview of specific implementation examples and their likely qualitative impact on key objectives of the Scheme. Elaboration such specific implementations are processes of their own. The determination of a ceiling for energy demand per loading capacity as a potential minimum energy performance criterion, for example, requires a deeper understanding of the energy performance of forklifts. Available data from the data sheets is limited and not all manufacturers include this voluntary information in their data sheets. A technical discussion with the manufacturers might therefore be advisable as part of the process. On a technological level, the discussion also becomes complex: The efficiency of the chargers for electric models, which is not covered by the default cycles, could play a role and there has been a substantial progress in energy efficiency in this area over recent years. Also, there is an efficiency potential for energy recuperation (Andersen et al., 2005). Forklifts perform frequent starts and stops as well as lifting and lowering operations. Modern lithium-ion batteries are more suitable for storing energy from energy recuperation than established lead-acid batteries. Thus, the question is not only how to improve efficiency by switching between ICE and BE forklifts, but also about the range of efficiency of electric forklifts. Furthermore, forklift operator may have a substantial influence on energy demand (Al-Shaebi et al., 2017); trainings and instructions for operators on efficient forklift operation could further reduce demand and costs.

Table 3. Expected impact of the objectives of the Scheme in the forthcoming evaluation period. *Source*: Own analysis.

Strategy	Implementation example	Number of applications	Reduction of gas/oil	Process heat from	Funding efficiency	Simplicity of design
I: Status quo strategy						
Ia: Maintain unchanged	No modification of the Scheme	O	O	O	O	O
Ib: Postpone decision	Postpone decision by 12 months	O	O	O	O	O
II: Limitation strategy						
IIa: Performance requirements	Upper ceiling for energy demand per load capacity kWh/h*kg to focus on highly efficient models only	↓	↓	O	↑↓	↓
IIb: Technological limitation	Exclude models below a loading capacity to enhance the uptake of electric model in classes where they are less established	↓	↓	O	↑↓	↓
IIc: Financial limitation	Electric models are only funded if the payback time of additional costs over ICE models is longer than specified	↓	↓	O	↑↓	↓
III: Exit strategy						
IIIa: Sequential phase-out	Gradually reduce the funding rate for forklifts towards zero	↓	↓	O	↑↓	↓
IIIb: Immediate phase-out	Remove forklifts as an eligible technology from funding	↓	↓	O	↑↓	O
IV: Refocus strategy						
IVa: Improve awareness	Activate sellers and other key multiplicators for electric ovens	↑	↑	↑	↑↓	O
IVd: Extend incentives	Increasing funding rate in the scheme for non-forklift technologies	↑	↑	↑	↓	↓
↑: Increasing O: Unaltered ↓: Decreasing ↑↓: Indetermined						

Taking such aspects into consideration may result in implementations of strategies of different complexity which in turn impact on the objectives of funding programmes such as the Scheme (Table 3). Given the high share of forklifts, a reduction of their number may substantially affect the KPIs and if specific rules are introduced, will also affect how simple the Scheme is for its target group. Therefore, a strategy that focuses less on the forklifts but rather at the other technologies may have a more positive contribution to the overall goals. Yet this requires success of these actions, and they may entail additional effort.

It is also important to consider that any implementation of a strategy is not independent of the general context. For example, it can be observed that the introduction of the Scheme shifted the demand for electric forklifts away from the other modules in the EEE, notably Module 4 which is technology-open, but which has stricter requirements. These include the preparation of an energy saving concept which is not required in the Scheme. Furthermore, synergies between funding modules may exist, i.e. the low-level entry and successful process in the Scheme might be an entry point for also making use of the other funding modules in the EEE. This underlines that dealing with dominating technology needs to take a broader perspective than just the Scheme alone.

Conclusions

The key question of this paper was how the technology-open electrification Scheme performs in the first evaluation period, what role forklifts play in this context and how their role could be addressed within the Scheme. To understand the performance of the Scheme, this paper presents the results of its evaluation on a first dataset encompassing the first seven months of activities within the funding Scheme. A particular focus was on a first set of KPIs and on understanding the role of forklifts as the dominant technology in the otherwise open Scheme. While a longer perspective is needed to verify the initial assessment, some observations can be made: In general, a substantial number of applications has been submitted, and the Scheme is heading in the direction required by its objectives. Yet the target values are not yet achieved after these first months. A point requiring attention is the dominance of forklifts in the Scheme. The high number of applications for forklifts raises the question of whether action is needed. Or – to phrase it differently – whether the funding of forklifts is at a forking point. The current answer would be: 'no'. Various strategies for dealing with dominating technologies have been discussed and their implications on the Scheme were qualitatively assessed. Since the Scheme is rather recent and was just established, further monitoring the evaluation of the Scheme seems an advisable strategy. Also, its modification might imply moving forklifts only from one part of the EEE to another. A modification of requirements for funding forklifts, e.g. by setting minimum requirements, could be considered in future revisions as a forking point, but it requires further elaboration and a check how this could be in line with the idea of a Scheme supposed to have a low-level entry point.

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