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Synopsis

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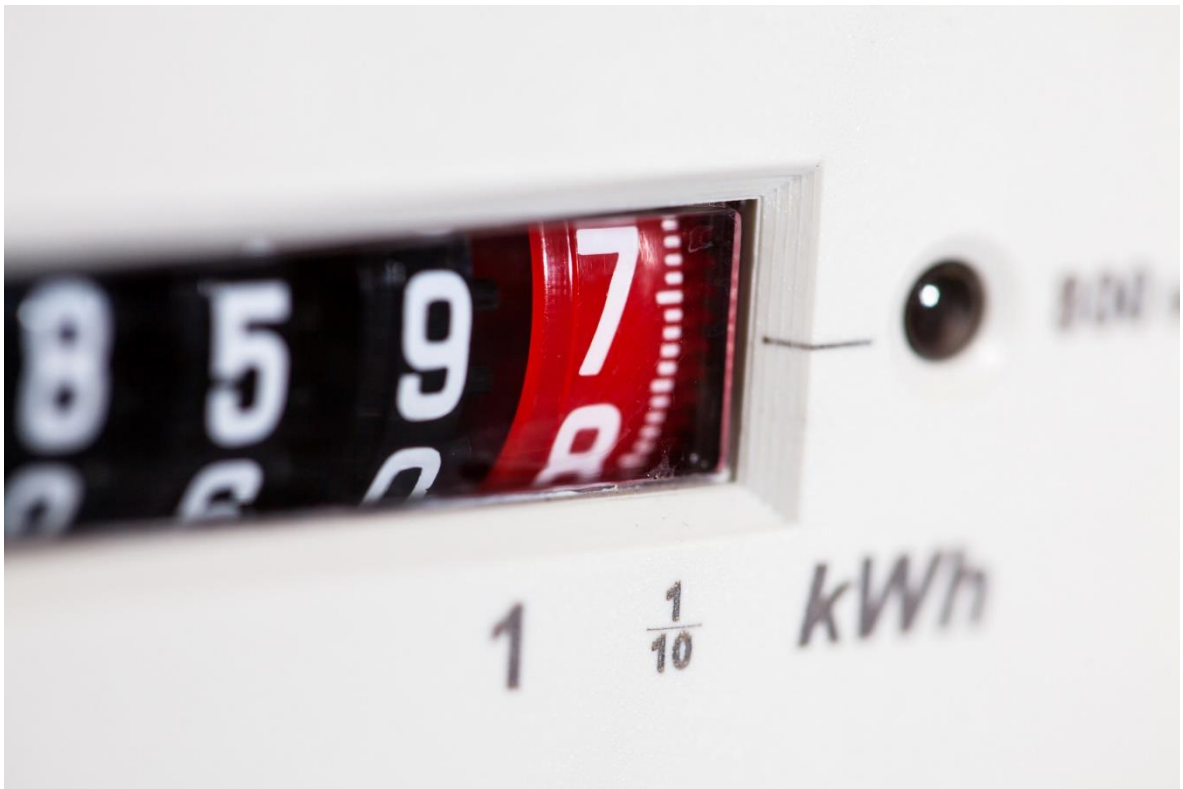
Evaluation of the Energy-efficient Construction and Refurbishment – Fuel Cell Grant (KfW 433) programme in the 2016–2020 funding period



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Evaluation of the KfW 433 programme

Evaluation of the *Energy-efficient Construction and Refurbishment – Fuel Cell Grant* (KfW 433) programme in the 2016–2020 funding period

Project Number 28890
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Commissioned by
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Group Profile

Prognos – providing orientation.

Those wanting to make the right decisions tomorrow need strong intelligence today. Prognos provides independent intelligence based on scientific research and with close links to practice. We have been conducting analyses for companies, associations, foundations and public entities since 1959. In close cooperation with our clients, we provide them with research, consulting and support, giving them the management scope needed for the future. The established Prognos AG models provide the basis for robust predictions and scenarios. Prognos is represented by around 150 experts in nine different locations: Basel, Berlin, Bremen, Brussels, Düsseldorf, Freiburg, Hamburg, Munich and Stuttgart. Our project teams work across disciplines, combining theory and practice, as well as science, business and policy. We have one major goal: to give you a head start when it comes to insight, competition and time.

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Table of contents

1 Background and programme design

One of the German Federal Government's key energy and climate policy goals is to make Germany's building stock largely climate-neutral by 2045. Highly efficient fuel cell (FC) heating devices for the combined generation of electricity and heat (combined heat and power, CHP) are one of the technical approaches available for achieving this goal. However, this technology has been introduced to the market only recently. Besides cutting fossil fuels, thereby reducing carbon emissions, this technology has higher power to heat ratios than conventional CHP plants. On the other hand, production costs are high, limiting the economic competitiveness of these systems.

In an effort to launch FC technology on the German market and spread its use, the *Energy-efficient Construction and Refurbishment – Fuel Cell Grant* (KfW 433) technology introduction programme was set up in 2016. The primary objective of the technology-related promotional programme is to establish FC technology on the market and to advance the technology. In this way, energy savings and reductions in greenhouse gas (GHG) emissions are also to be achieved.

The programme is financed by funding within the *Energy Efficiency Incentive Programme* (APEE). During the first phase of the programme, launched in August 2016, funding was provided to private owners of new and existing residential buildings. In mid-2017, the target group was expanded, enabling funding to be provided for non-residential buildings owned by companies, municipalities, and social and municipal institutions. The programme supports the purchase and installation of highly efficient stationary fuel cell heating systems (output class 0.25 to 5.0 kW_{el}), consultation by an energy efficiency expert, and system maintenance for ten years. Funding is provided in the form of an investment grant. It can be combined with the surcharge payment for CHP electricity under the Combined Heat and Power Act (CHP Act), up to the maximum aid intensity.

Prognos AG was commissioned by the Federal Ministry for Economic Affairs and Climate Action (BMWK) to evaluate the KfW 433 programme in the 2016–2020 funding period, thereby contributing to the monitoring of success under Section 7 of the Federal Budget Code (BHO) (analysis of target achievement, effects and economic efficiency). A further objective was to analyse the funding environment, as well as technological and market developments. For this purpose, besides analysing the funding data, the contributors conducted a survey among applicants and grant recipients, and held expert interviews with representatives from fuel cell system providers and trade associations. The evaluation is based on an indicator-based evaluation system, taking into account the requirements set out in the "Methodology guide for the evaluation of energy efficiency measures at the BMWK".

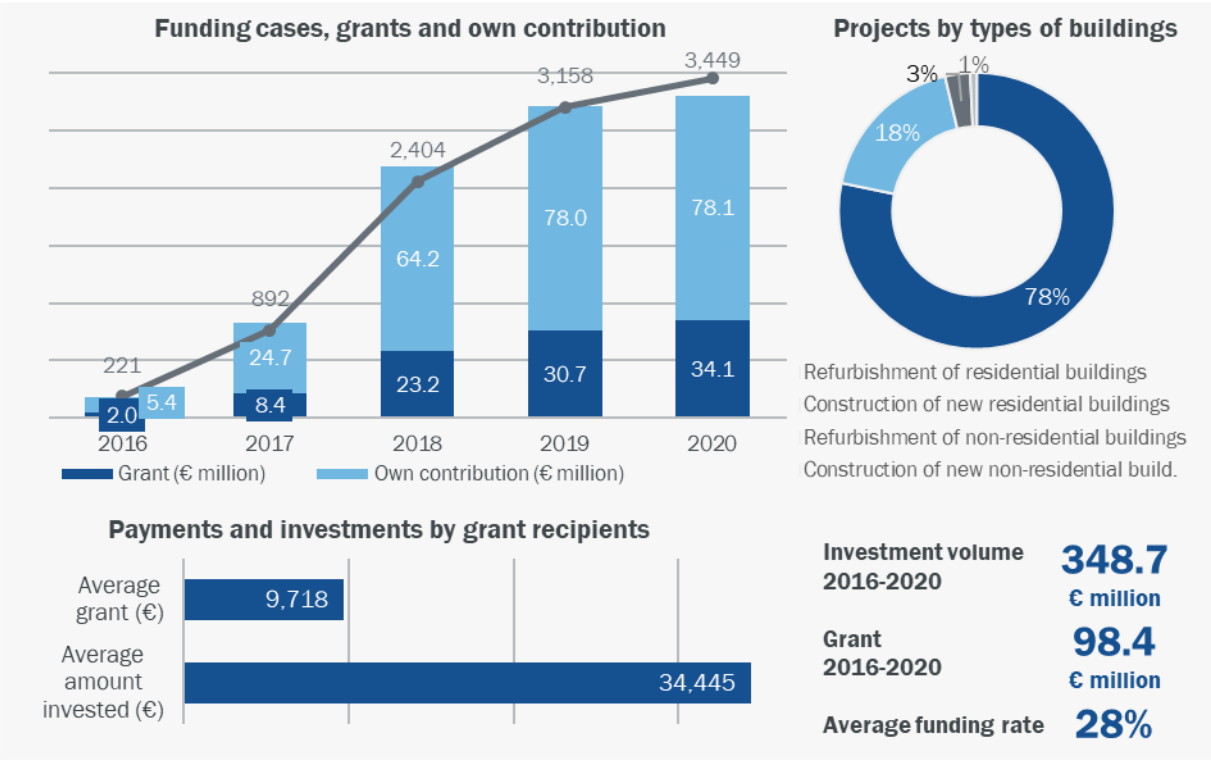
2 Overview of promotion under KfW 433 for the 2016–2020 period

Overview of promotion

A total of 16,000 grant applications for KfW 433 were made between 2016 and 2020. Of those, around 10,000 applications were claimed and paid out (funding cases). Around three-quarters of the unclaimed applications did not lead to the installation of a fuel cell heating device. In these cases, applications were generally made in the context of alternative planning for other heating technologies. The remaining one-quarter of unclaimed applications resulted in the installation of a fuel cell heating system, but funding could not be claimed within the provision deadline. The main reasons for this were the limited availability of fuel cell heating systems or of installers.

The grant recipients invested more than € 349 million in the installation of fuel cell heating systems funded under KfW 433. The BMWK supported these investments with a promotional grant totalling more than € 98 million. On average, the amount invested in each fuel cell heating device was € 34,400; the average grant was just around € 9,700. This corresponds to a funding rate of approximately 28 per cent.

Figure 1: Overview of promotion 2016–2020



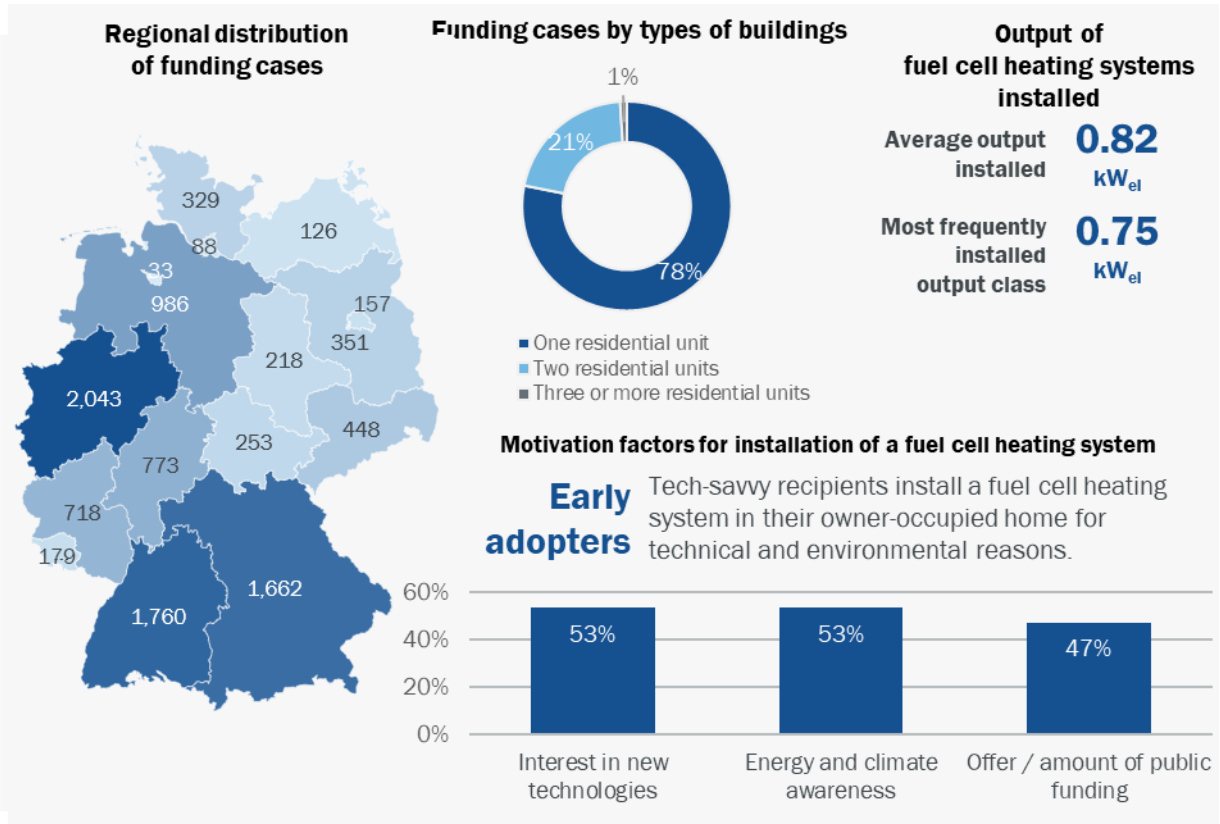
Source: KfW funding data, survey conducted by Prognos in 2020. Own analysis.

As to be expected with a technology introduction programme, the number of funding cases increased sharply from 2016 to 2020: around 2 per cent of funding cases were implemented in 2016, around 9 per cent in 2017, almost a quarter in 2018, and around a third just in 2019 and 2020. 80 per cent of all funding cases were undertaken in the refurbishment of residential buildings, and around 17 per cent in the construction of new residential buildings. Only three per cent of funding cases were for non-residential buildings, and especially their refurbishment.

Funding priorities

KfW 433 grant recipients came from all over Germany, corresponding largely to the distribution of GDP in the federal states. Densely populated federal states were slightly underrepresented; in contrast, federal states with a high ownership rate were overrepresented. In most cases, fuel cell heating systems involving proton exchange membrane (PEM) technology with an average electrical output of 0.82 kW were installed in detached and semidetached houses. The aim of the fuel cell heating device was usually to generate electricity and heat; in contrast, electricity grid feed-in plays only a minor role, based on the importance of grid remuneration. In non-residential buildings, the priority was on installing more powerful solid oxide fuel cell (SOFC) systems. However, they accounted for only around 10 per cent of the fuel cell heating systems that received funding. Virtually all of the fuel cell heating devices installed are operated with natural gas.

Figure 2: Regional distribution and characterisation of funding cases



Source: KfW funding data, survey conducted by Prognos in 2020. Own analysis.

The majority of grant recipients were tech-savvy early adopters with a high level of energy and environmental awareness who had a fuel cell heating system installed in their owner-occupied property, also having been motivated to do so by the grant. As such, the KfW 433 programme reached a recipient group that is important for the diffusion of innovative technologies, acting as ambassadors and opinion leaders for FC technology.

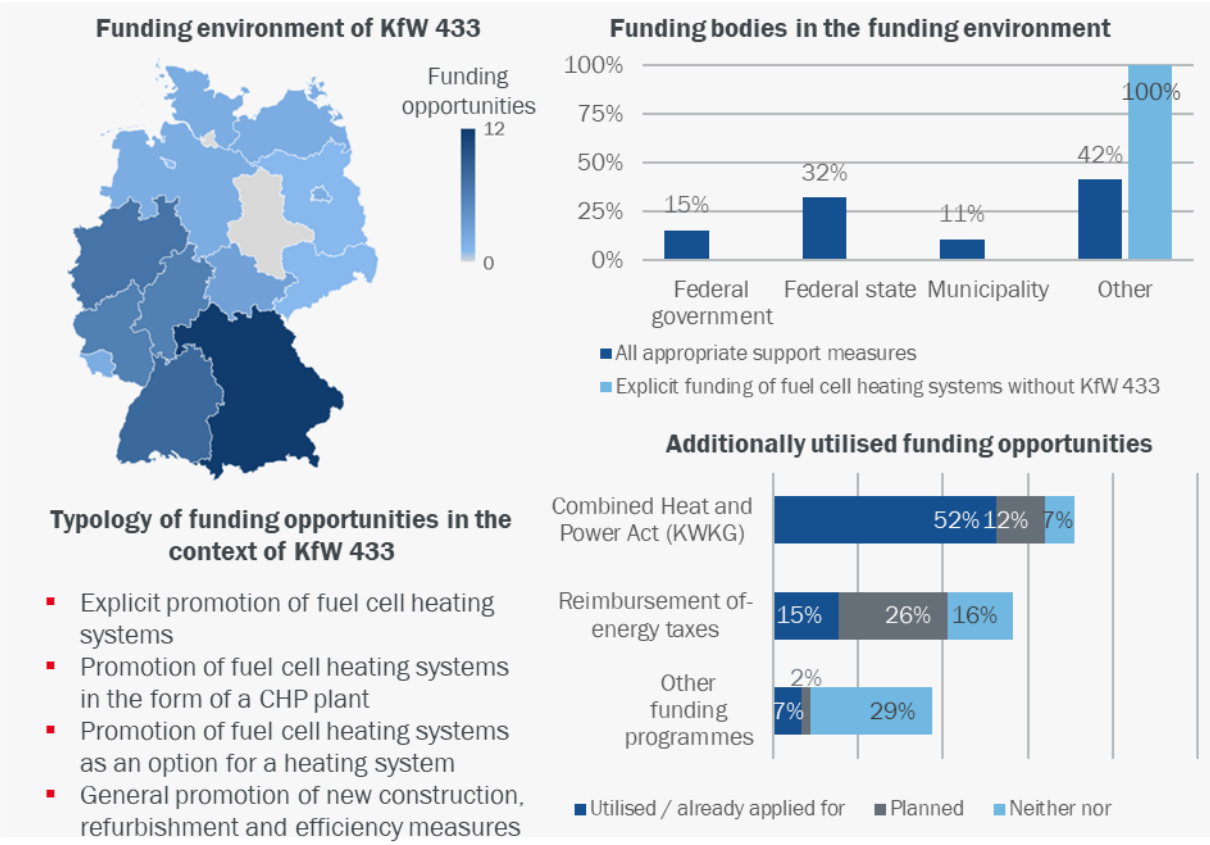
In around half of all funding cases, the installation of the fuel cell heating device was accompanied by the implementation of additional efficiency measures, which usually occurred within a year prior to installation of the system. These additional measures usually involved insulation of the building shell. Renewable energy systems such as photovoltaic or solar thermal energy systems were rarely among the additional efficiency measures. Engagement with the FC technology and the KfW 433 programme can indeed be considered as a catalyst for greater interest in energy efficiency measures.

3 Funding environment and synergies

The funding environment of the KfW 433 programme covers a wide spectrum, from the explicit support of FC heating units to general funding for new construction, refurbishment and efficiency measures. The support measures, which can often be combined, originate from the Federal Government, federal states, municipalities and regional actors, especially energy suppliers. The support measures are in place in the federal states of Bavaria, Baden-Württemberg, North Rhine-Westphalia, Hesse and Rhineland-Palatinate.

As a rule, every fuel cell heating device installed in Germany received funding via the KfW 433 programme. In this context, KfW 433 is usually supplemented by funding under the Combined Heat and Power Act (KWKG) and, to a slightly lesser extent, under the Energy Tax Act (EnergieStG) (reimbursement of energy taxes for fuels used). Regional support measures are important in their own right: they range from subsidies for replacing old heating systems or the purchase of fuel cell heating devices to longer-term, and therefore more cost-effective, energy supply contracts, in combination with the installation of such a system. When combined, support measures significantly increase the individual profitability of fuel cell heating devices, and enhance the position of FC heating systems in a competitive technology segment.

Figure 3: The funding environment of the KfW 433 programme, and funding synergies

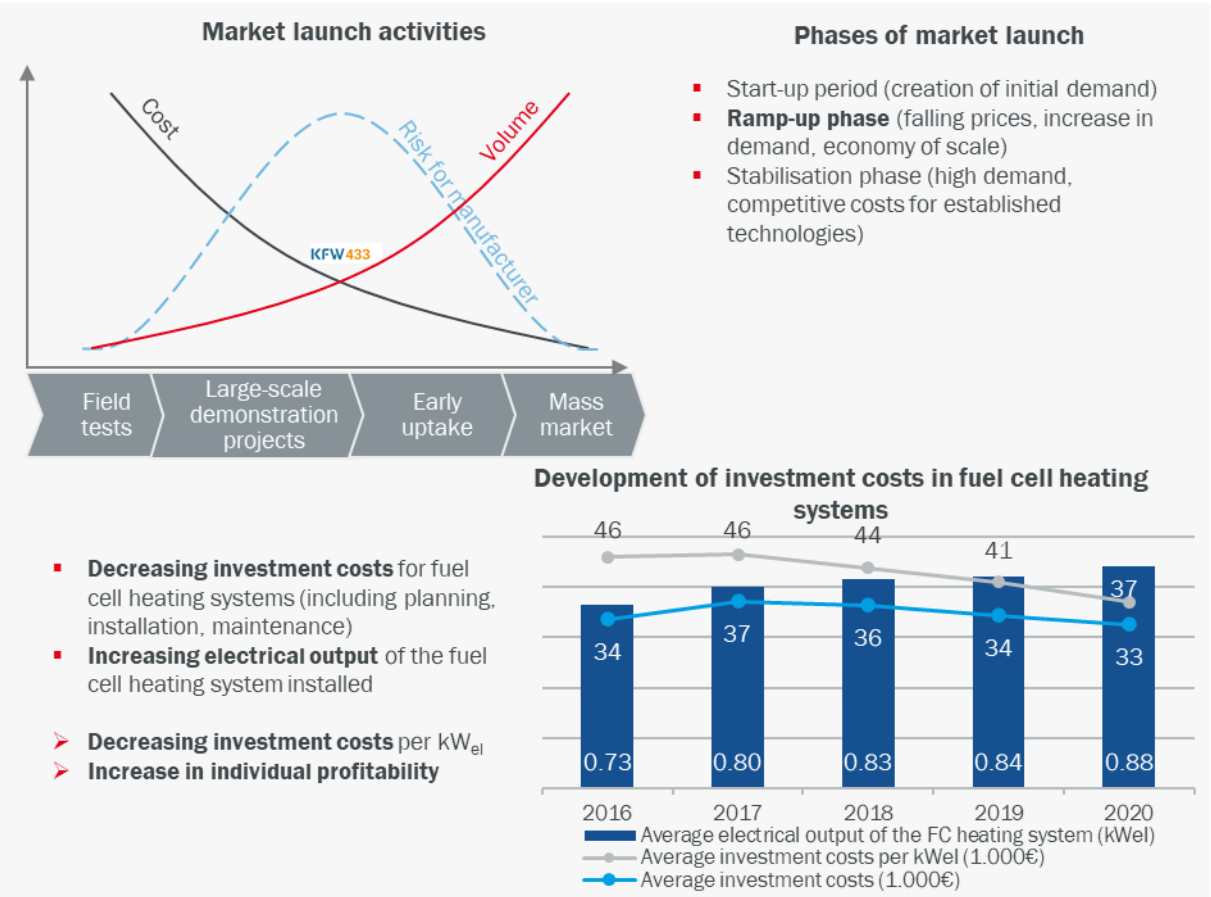


Source: Survey conducted by Prognos in 2020. Own research and analysis.

4 Technology and market development

The market for fuel cell heating systems in Germany grew significantly from 2016 to 2020, building on the impetus in promoting field tests for the purpose of launching the market. An application for funding under the KfW 433 programme was submitted for almost all fuel cell heating devices installed in Germany during this period. The German market for fuel cell heating systems is currently in the beginning of the ramp-up phase: there has been a significant increase in demand, and there have been cost degressions. Measured against the expectations of the study on the technology introduction programme, the KfW 433 programme is on track; the market ramp-up phase was a success.

Figure 4: Market development



Source: KfW funding data, survey conducted by Prognos in 2020. Own research and analysis.

The increase in demand enabled fuel cell system providers to take further steps, from manufacture to batch production. This resulted in production process advancement, leading to economies of scale and component optimisation. For end users, economies of scale were reflected by falling installation costs and consequently improved individual profitability.[1] Investment costs fell by around 16 per cent per kW_{el} installed from 2017 to 2020. In addition, the increased demand paved the way for further technological advancements, most notably an increase in stack life, an improvement in robustness and a reduction in maintenance expenditure. The prices of fuel cell heating devices are expected to decrease further in the future, resulting in an increase in the economic efficiency of such devices.

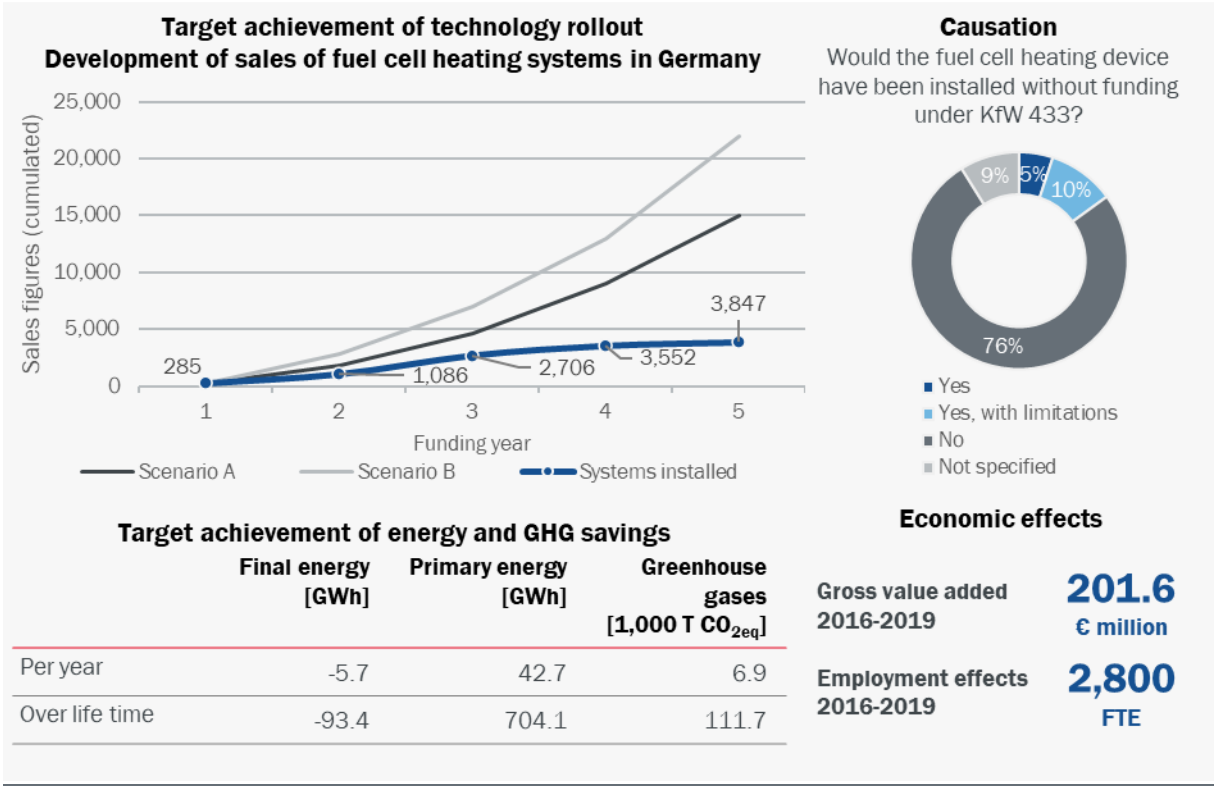
[1] Assumption: constant gas prices; rising gas prices since 2021/22 have significantly reduced individual-profitability.

5 Monitoring of success and benefits among recipients of KfW 433 funding

Monitoring of success (target achievement, effect, economic efficiency)

The technology and economic policy objective of the programme – introducing fuel cell heating products to the market – is achieved. The overview of promotion within the KfW 433 programme and the sales figures for fuel cell heating systems in Germany show that KfW 433 funding has played a significant role in the greater acceptance and establishment of FC technology in the market. There were only very few deadweight effects in the utilisation of the programme. The promotion under the KfW 433 programme is therefore assessed as being the reason for target achievement and for the effects occurring.

Figure 5: Target achievement and the effects of the KfW 433 programme



Target achievement of energy and GHG savings

	Final energy [GWh]	Primary energy [GWh]	Greenhouse gases [1,000 T CO_{2eq}]
Per year	-5.7	42.7	6.9
Over life time	-93.4	704.1	111.7

Source: KfW funding data, survey conducted by Prognos in 2020. Own calculation and analysis.

As the use of fuel cell heating devices in the building stock increases, the KfW 433 programme contributes to the Federal Government's energy and climate policy goals. It is mainly reflected in the reduction of primary energy consumption and of GHG. Although almost 93 GWh more final energy is used over the life time of the fuel cell heating systems, primary energy savings of almost

705 GWh are simultaneously generated over the same period. This equates to a saving of more than 120,000 tonnes $CO2_{eq}$. Consequently, the programme contributes to the targets set out in the National Action Plan on Energy Efficiency (NAPE).

The promotion was accompanied by additional economic effects. Overall, the funding stimulus increased gross value added by more than € 200 million over the period from 2016 to 2020. This was associated with the creation and safeguarding of around 2,800 full-time jobs.

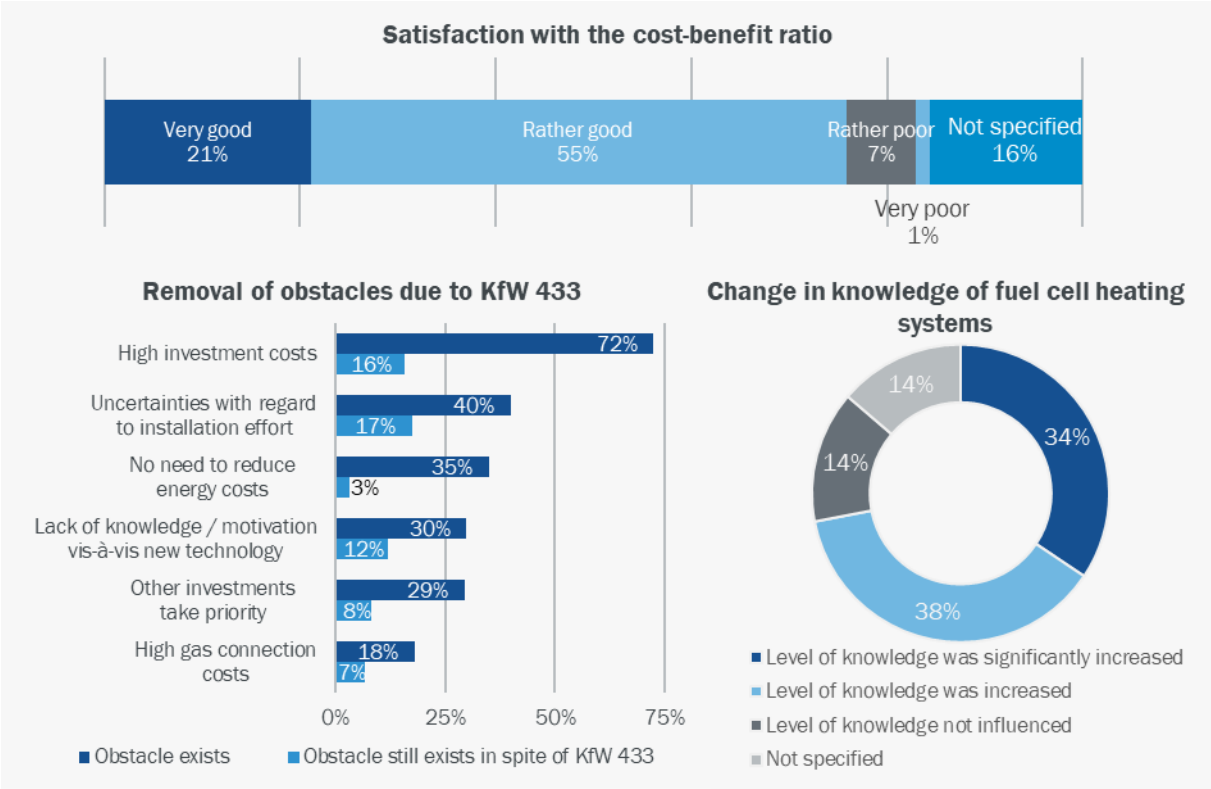
Funding under the KfW 433 programme was provided economically. The financial leverage effect over the evaluation period is around 3.5, i.e. one euro of funding stimulated an investment of € 3.50 by grant recipients. Considered over the life time of 16 years, the KfW 433 programme achieves a primary energy funding efficiency of around 14 cents per kWh and a GHG funding efficiency of around 1.23 cents per kg CO_{2eq}.

Benefits of the KfW 433 programme for recipients

In the period from 2016 to 2020, the KfW 433 programme was met with a high level of acceptance among grant recipients, manufacturers and energy service providers alike. The latter actively used KfW 433 for marketing purposes. A grant application was submitted for almost every fuel cell heating device installed in Germany.

Overall, the recipients were satisfied with the cost-benefit ratio. KfW 433 funding improved individual profitability, contributing to grant recipients' economic benefit. In addition, the funding enabled the recipients to overcome obstacles to decision-making regarding the installation of a fuel cell heating system. In addition to reducing investment costs, technical uncertainties were removed – due in part to the ten-year maintenance contracts – and the level of knowledge about FC technology was increased among grant recipients and installers alike. As a result, the promotion is key to the acceptance of fuel cell heating devices and the demand for such products in Germany, encouraging the use of FC technology and the development of the market.

Figure 6: The benefits of the KfW 433 programme among recipients



Source: Survey conducted by Prognos in 2020. Own calculation and analysis.

6 Summary assessment and options for action

Against the backdrop of the performance and impact assessment for the 2016-2020 evaluation period presented in the above sections, the *Energy-efficient Construction and Refurbishment – Fuel Cell Grant* (KfW 433) funding programme, launched in August 2016, is considered to be positive: to date, it has been characterised by high target contributions, strong causation, a multitude of positive impacts, and good economic efficiency. If the programme is continued, target contributions and impacts can be expected to increase further. After all, the ramp-up phase of the fuel cell market in Germany has only just begun.

The overall very positive performance record of the KfW 433 programme indicates that, for the purposes of the programme and its objectives, so far the right steps have been taken in the right format. There is no overarching need to adapt or further develop the programme in order to overcome any obstacles specific to the programme or external to it. However, a number of detailed adjustments or challenges and corresponding responses should be discussed in order to ensure that the performance of the programme is maintained or strengthened, where appropriate. These include:

Option for action 1: Challenge of the provision deadline

As can be seen from the analysis of funding that has been applied for but not claimed, (potential) grant recipients often find it a challenge to meet the provision deadline. And yet grant recipients are not always responsible for the failure to meet the deadline. Often the deadline cannot be met because of sector-related aspects such as the availability of tradespeople or the supply of fuel cell heating systems. It was therefore a correct and important step to temporarily extend the provision deadline in early 2020. It is important to observe whether and how the extension of the deadline will have an effect.

Option for action 2: Challenge of individual profitability and funding synergies (Combined Heat and Power Act, KWKG)

The individual profitability of fuel cell heating systems increases over the evaluation period. However, the system is still less competitive than other technologies that it is able or supposed to replace. For this reason, individual profitability is key to the attractiveness of – and demand for – fuel cell heating systems. Additional supplementary subsidies for investors therefore also play an important role in increasing individual profitability. In this connection, funding under the KWKG is an important element, which fuel cell system providers actively promote in their marketing. In the 2016–2020 evaluation period, the legal framework of the KWKG, and the additional funding associated with it, was amended. As a result, applications for funding under the KWKG were often delayed or not submitted at all, leading also to a delay in receipts. From the grant recipients' point of view, or that of those interested in installing a fuel cell heating device, this aspect reduces the attractiveness of fuel cell heating systems, planning security and the use of the KfW 433 programme. In the longer term, this could be associated with "negative marketing", jeopardising the successes achieved in terms of market development and, in particular, the further market ramp-up. Bearing this in mind, it seems advisable to ensure legal and enforcement security, and to enable administrative processes that result in the prompt processing of applications for funding under the KWKG.

Option for action 3: Challenge of stimulating demand through strategic partnerships

Advertising and marketing play an important role in sales, and therefore in developing the market. Key players such as fuel cell system providers and energy service providers have a vital self-interest in this area. They are "natural allies" of the promotional programme; almost all advisory talks about fuel cell heating systems make specific reference to KfW 433.

Moreover, energy suppliers, and especially gas grid operators, offer points of reference for the programme in their strategic considerations. They are potential partners for strategic marketing and advertising. After all, they are keen to secure their business model in the longer term, even under future conditions of largely abandoning fossil fuels. This is clearly illustrated by the fact that a multitude of regional support measures for the retrofitting of existing heating systems or for the installation of new fuel cell heating devices are launched by this group of stakeholders.

In view of the above, it would seem appropriate to generate additional interest among end users and/or other opinion leaders by means of strategic partnerships and/or coordination in the current market ramp-up phase. Conceivable formats include roadshows, participation in trade fairs or events at chambers of trade, and so on. Opinion leaders such as energy agencies or energy consultants could also be approached.

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