Funding measured energy savings: first findings on performance-based "Energy Savings Meter" funding scheme

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Abstract
German energy policy aims at halving the country's primary energy demand by 2050[1]: an objective which should translate into more significant reductions in final energy demand than the reductions observed in the past. Although energy reduction potentials are high, they are fragmented and therefore currently hardly accessible to energy service companies. At the same time, digitisation offers new opportunities to deliver energy services at low costs. However, it appears that current digital services are not yet as linked to energy savings as they could be. Well-designed digitised energy services might visualise energy consumption and save both costs and energy. Moreover, energy savings might further be promoted if customers received direct information about economic potential, offers for implementing energy saving measures or applying for funding.

The German Federal Government has thus launched a pilot scheme for an innovative digitised energy savings programme in 2016 – the "Energy Savings Meter" – which the authors are currently supervising, administrating and evaluating, respectively. Eligible companies propose "smart" energy services to end customers in the residential, commercial and industrial sectors. As the overall energy consumption is measured, the programme addresses absolute energy savings and also taps savings to be made from behavioural patterns. This represents a policy development that favours actual savings over deemed savings and introduces what we believe to be a unique combination of performance-related funding and support for a new kind of digitised energy service.

The paper analyses related price-based and performance-oriented funding schemes in scientific literature. In a second step, it explores potential savings linked to an advanced type of digital energy service. It then describes the "Energy Savings Meter" funding scheme, derives its objectives, and analyses the current market of digital services for energy efficiency in Germany. In conclusion, the paper discusses preliminary findings from the programme which are primarily taken from funding applications.

Introduction
German energy policy aims at halving the country's primary energy demand by 2050. It is generally agreed that, in order to reach this target, significant reductions in final energy demand are necessary, thereby going far beyond the reductions observed in the past. Just as in many other European countries, German funding for energy efficiency has therefore been increased in the past years (Janeiro et al., 2016). At the same time, questions are arising as to the true outcome of the efficiency schemes which have been funded. Critics argue that actual savings generally remain far below the savings estimated in basic calculations (e.g. Wade and Eyre 2015). In order to achieve the energy and climate targets, real energy savings are needed and it now seems timely to focus more on savings than on investments in energy efficiency technology. Novel funding mecha-

1. Compared to 1990.

nisms could therefore be a means of generating additional and reliable energy savings.

Today, large parts of the economic potential of energy savings still remain untapped while market barriers persist. Subsidies alone are often not sufficient to overcome those barriers. Unfortunately, energy service companies have not reached their full potential, especially in fragmented market areas such as private households or small commercial entities. These are hard to reach and transaction costs are often prohibitive. On the other hand, considerable progress has been made in digital energy services. New business models based on energy services could therefore address those fragmented sectors that traditional energy service companies have hitherto been unable to reach.

A new funding scheme that unites the need for performance-orientation and digitisation is the German "Energy Savings Meter". It links a performance-related subsidy based on measured energy savings to the funding of digital energy service products. In this paper, we show that the "Energy Savings Meter" could usefully unite a focus on performance with support for the development of new energy services. To achieve this, we first analyse related price-based and performance-oriented funding schemes in scientific literature. In a second step, we look at potential savings linked to an advanced type of digital energy service. We then describe the funding scheme Energy Savings Meter and derive its objectives. We analyse the current market situation of digital services for energy efficiency and how current services would have to evolve in order to correspond to the "Energy Savings Meters". Finally, we discuss preliminary findings about the programme, which are primarily taken from funding applications.

Project background

The German Federal Ministry for Economic Affairs and Energy (BMWi) launched the "Energy Savings Meter" ("Energieeinsparzähler") pilot programme in May 2016. The Federal Office for Economic Affairs and Export Control (BAFA) acts as project management agency. The pilot programme is designed to tap the benefits of digitisation for energy savings. It supports firms or consortia of firms that unlock energy savings potentials for their clients.

In May 2016, the BMWi and the BAFA commissioned an accompanying project entitled "Evaluation and monitoring of the funding scheme Energy Savings Meter". Besides technical guidance, support and communication of the "Energy Savings Meter", it delivers background analyses and explores additional questions through expert-led workshops. Work Package 1 of the project comprehends a concurrent evaluation of the funding scheme, led by ifeu – Institut für Energie und Umweltforschung (Institute for Energy and Environmental Research). Co2online gGmbH is the overall project manager and main contractor, whereas Ökotec Energiemanagement GmbH and ifeu are subcontractors.

As the "energy savings" meter is a new and innovative type of energy savings programme, we hope to be able to provide some useful insights for other programmes, even though the targeted energy savings remain to be demonstrated. The "Energy Savings Meter" should be seen as an interesting additional programme, the aim of which is to carefully test and evaluate this new kind of scheme.

Uniting performance-oriented funding and digital energy services

PRICE-BASED FUNDING SCHEMES REWARDING ENERGY SAVINGS

Among market-based approaches, quantity instruments can roughly be distinguished from price instruments. Concerning energy efficiency policy, quantitative measures determine the amount of energy to be saved, while the market leads to a price to be paid, e.g. for energy efficiency obligations. Conversely, a price instrument defines the price to be paid for energy savings and lets the market determine the quantity to be saved, for instance via energy taxes or energy efficiency feed-in tariffs. There has been a long debate about price vs. quantity instruments since Weitzman (1974) and there is certainly no best single way to conceive energy efficiency instruments. Therefore, we will limit our discussion to price instruments that are most closely related to the Energy Savings Meter and only insofar as they apply a fixed remuneration to quantified energy savings, namely energy efficiency feed-in tariff (FiT) systems – sometimes also called "negawatt" approaches. While the amount of energy savings achieved by such a system is hard to control, it could – if working properly – mobilise market forces in searching, finding and optimising energy saving potentials.

To our knowledge, there is very little evidence of such energy efficiency feed-in tariffs implemented as a policy instrument in reality. However, there is some experience of related instruments, as Neme and Cowart (2013) point out: similar policy instruments range from standard offer efficiency programmes in the US during the 1990s to a few pay-as-you-save programmes today. Tradable white certificates and energy efficiency bidding in capacity markets might be comparable (though to a lesser extent). More specifically, design options for energy savings feed-in tariffs have been described for quite some time (e.g. Thomas and Irrek 2006, Pehnt et al. 2007, Bertoldi et al. 2013, Neme 2013).

Feed-in tariff systems as price instruments

After the success of the feed-in tariff system for renewable electricity generation in Germany, it was an obvious step to transfer this system in order to promote energy efficiency. Consequently, Pehnt et al. 2007 describe a so-called "negawatt" scheme that is conceived along the lines of the German feed-in tariff system for renewables in electricity (for an earlier outline cf. Irrek/Thomas 2006). Central points of the scheme are market actors responsible for certified quantities of saved energy. As in feed-in tariff systems, a market actor would be obliged to "buy back" certified amounts of energy saved at pre-defined tariff rates. The cost of the scheme would be covered by a levy on energy carriers borne by all energy consumers, similar to the German Renewable Electricity feed-in tariff system ("EEG-Umlage"). The system aims at generating cost-effective energy savings. To this effect, the tariff rates outlined are low, the idea being that the energy savings themselves already pay off at least part, if not all, of the investment required for generation (Pehnt et al. 2007). One possible application of the system is the establishment of rebate programmes for energy efficient products. In addition, the scheme described is expected to promote energy services.

Bertoldi et al. (2013) go one step further in integrating smart meter technology into the FiT schemes they discuss. They close the loop by providing feedback options for end customers. The challenge is to correctly determine the savings achieved as there is a need to establish a difference between real energy consumption and a reference situation. Bertoldi et al. (2013) further insist on the importance of providing proper feedback for end customers, tailored to their needs and delivered frequently. Subsequently, the main focus of their system is often on billing information combined with feedback and target setting using information based on smart meter data. Overall expenditure could be limited by putting a cap on total remuneration which could then be allotted on a first come, first served basis or through tendering (Bertoldi et al. 2013).

Neme and Cowart (2013) address several questions concerning the design options for an energy savings feed-in tariff. They insist on the importance of an open competitive market for the energy efficiency services from qualified entities.

Some central elements have been proposed on the basis of the schemes described in industry literature.

Measurement of energy savings

There has to be a sensible balance between the expense incurred for measurement and the accuracy of consumption data. Pehnt et al. (2007) suggest keeping measurement simple and using deemed savings or standardised values instead. In spite of technical progress made since 2007, Neme and Cowart (2013) recommend adopting a broader approach and including not only measured energy savings, but also deemed energy savings on well supported estimates, as costs could otherwise be prohibitive, e.g. in private households. Conversely, Bertoldi et al. (2013) require the recording of actual consumption with smart meters and evaluation against a reference situation (baseline) (Bertoldi 2013).

Complex saving measures vs. cherry picking

A central challenge in all energy efficiency FiT systems is cherry picking. A negative example would be paying high remunerations to lighting retrofits that deliver a fast return on investment. Market actors decide both on the nature of the efficiency measures and on their complexity and thoroughness. Cherry picking may lead to lock-in effects, an instance being light renovations which have the effect that future deeper renovations would not be economically viable anymore. In addition, it drives up total costs for society if low-cost measures are rewarded with a high price through an energy efficiency FiT. Different options are proposed to tackle the issue: Pehnt et al. (2007) maintain that the FiT system should best be used as a complement to existing funding schemes, as cherry picking can hardly be prevented – and low remuneration lessens the costs of cherry picking for society. Therefore, additional sector and technology-specific programmes should coexist and should address more complex measures through a combination of advisory services and investment funding. In contrast, Neme and Cowart (2013) recommend varying the pricing structure depending on savings technologies, depth of savings, end uses, and market segments. Incidentally, that is the approach of renewable energy feed-in tariffs that remunerate solar energy differently than wind energy.

Legal constraints

One reason for European member states not to implement energy efficiency feed-in tariffs may be that such systems could be considered as aid granted by a Member State which distorts or threatens to distort competition by favouring certain companies. Systems of aid can only be admissible in exceptional cases: as a general rule, according to Article 107 of the Treaty on the Functioning of the European Union, state aid is incompatible with the single market. However, such systems regularly have to be reported to and approved by the European Commission. This often takes a lot of time and can discourage policymakers. Moreover, the General Block Exemption Regulation's (GBER) derogation is only of little help. Although Article 38 ff. about investment aids for energy efficiency measures state that investment aid enabling companies to achieve energy efficiency is compatible with the internal market and therefore exempted from the reporting requirement, certain conditions must be fulfilled. For instance, only extra investment costs required to achieve a higher level of energy efficiency are deemed to be eligible. Those extra investment costs are regularly determined as follows: the cost of investing in energy efficiency is identified by a similar, less energy-efficient investment that would have been credibly carried out without the aid. The difference between the costs of both investments constitutes the eligible costs. This means that energy savings are linked to an investment and put in relation to the costs of the receiving company. In addition, there is an aid intensity limit of 30 % of the eligible costs. The limit may be increased by 20 percentage points for aid granted to small companies and by 10 percentage points for aid granted to medium-sized companies. Funding schemes based purely on remuneration of energy savings may therefore usually be subject to notification of and approval from the European Commission.

In the EU, a rare exception of an actual funding scheme directly rewarding energy savings that was not based on costs is a British pilot scheme, the Electricity Demand Reduction Pilot Scheme. The scheme was indeed subject to approval of the European Commission. It is auction-based and links energy consumption reductions to the reduction in peak demand in winter. Successful organisations will be required to deliver peak capacity savings across Great Britain from November to February. Savings can be made by making improvements to buildings or electrical equipment. Participating organisations bid in the amount of capacity they are able to offer and a price at which they are willing to provide it. The first auction took place in January 2015. The pilot scheme's second phase auction was held in January 2016 (DECC 2015). However, the scheme was not considered a success as only £6 million of the allocated £20 million budget was spent in the two auction rounds, and critics claimed the scheme was exceedingly restrictive while also being too complex (Howard 2016).

DIGITISATION FACILITATES SAVINGS AND MEASUREMENT

When funding energy efficiency, there is also the question of business models that could overcome persistent barriers and disseminate investments. Digital energy services represent one potential business model. As much progress has been made in measurement and data treatment using digitisation, digital energy services may lead to new possibilities for energy savings and promote the market for energy services in general.

New possibilities for energy savings

Firstly, better data allows better prediction of energy savings. Reliable predictions could enhance trust and acceptance and thus convince customers to take up energy efficiency measures. In that respect, Batey and Mourik (2016) identify accountability and reliability as key success factors for energy efficiency.

Secondly, enhanced user consumption feedback may lead to higher energy savings. Technical progress made may permit a move one step further away from conventional energy consumption feedback. There has been quite extensive experience with feedback systems, in particular in the US, but evaluations of conventional feedback systems without added services currently only find energy savings in the order of 1–5 % (Wade and Eyre 2015; for the US Agnew et al. 2013 find energy savings of 1–3 %). More frequent feedback (monthly instead of quarterly) leads to only slightly higher savings (Agnew et al. 2013).

By contrast, expectations for savings delivered by enhanced products are high (see e.g. Granderson & Lin 2016, Armel et al. 2013). New technology will permit more precise feedback at the appliance level, together with personalised recommendations for appropriate savings measures or adapted products. Armel et al. (2013) analyse such systems for electricity consumption and are very optimistic about the outcomes in terms of energy savings. According to them, disaggregation, i.e. "a set of statistical approaches for extracting end-use and/or "appliance level" data from an aggregate, or whole-building, energy signal" will be the means to leverage important energy savings in the residential and commercial sectors. Although based on studies that often contained only small samples, they argue that electricity savings of over 12 % and up to 20 % would be achievable through disaggregation and associated services (Armel et al. 2013).

At the building level, building information systems that go beyond conventional feedback systems and include "web-based analysis software, data acquisition hardware and communications systems to store, analyze, and display whole-building, system-level, or equipment-level energy use" (Granderson and Lin 2016) could provide similar benefits: a better understanding of user behaviour and discrepancies between deemed and real consumptions in buildings, and consequently better modelling of energy efficiency measures. Users could benchmark their energy use, automatically detect anomalies in energy consumption, analyse peak loads, and quantify energy savings achieved. Evidence shows large savings of up to 20 % within a sample of buildings, mostly of enterprises or part of campus implementations. It remains to be investigated whether such savings can be reproduced in smaller implementations (Granderson and Lin 2016).

Hence, it is highly interesting to intensify the use of digitisation for energy efficiency. Real-time feedback at the appliance or equipment level, automatic detection of anomalies, customised recommendations and associated services seem more favourable for tapping considerably higher energy savings potentials than conventional feedback systems. However, in Germany, the development of corresponding IT-based energy services, especially those with disaggregation algorithms, is still in its infancy and the services are not yet widely available (see section Energy saving meters: current market situation). The development of such tools and systems is costly, and the willingness to pay by end users is still uncertain. It also seems unreasonable to set high hopes for continuous and broad energy savings through digital solutions with little public funding, especially in the buildings sector.

Impetus for energy services

Digital energy services could also provide fresh impetus for the energy service market in general and for energy service companies (ESCOs), particularly those which implement energy efficiency projects. While the German ESCO market is one of the most developed in Europe, there is still much room for growth as the market potential is estimated to be about ten times larger (Bertoldi et al. 2014).

For many fields of business, energy services are associated with high or even prohibitive transaction costs which block the extension of ESCO markets, especially for smaller projects (Boza-Kiss et al. 2015). A greater standardisation due to digitisation could substantially lower transaction costs. In addition, digitised services could facilitate project replication much better than is the case for traditional energy services. In this way, these services could allow economies of scale and contribute to growth in more decentralised sectors with small projects, such as the residential sector. Bertoldi et al. (2014) conclude that "the more smart technology is used in buildings and facilities, the better services at a lower cost can be offered by ESCOs."

That could also be true for a particular form of energy services: energy performance contracting (EPCs). It concerns energy efficiency improvement measures which are verified and monitored and paid for in relation to a contractually agreed level of energy efficiency improvement (or other performance criterion) (Energy Efficiency Directive 2012/27/EU). Energy performance contracting is therefore seen as an advantageous solution for energy savings delivered by the market. Unfortunately, due to the highly complex nature of the projects, they remain relatively rare and mostly target large projects with considerable savings. Digitised offers with better possibilities for quantifying energy savings could be much more standardised, have lower transaction costs, and could thus allow EPCs to be introduced to business fields with a larger amount of several smaller projects.

A hybrid solution: the funding scheme "Energy Savings Meter"

The "Energy Savings Meter" combines the funding of a digital energy service with a remuneration based on energy savings achieved. It funds energy services which comprise hardware and software for

- Continuous measurement of energy consumption
- Determination of energy savings based on a before and after measurement
- Visualisation of the data
- Determine the energy consumption on a device specific level, where possible (e.g. via disaggregation)
- Providing individualised information on energy savings potentials and value-added services.

While the programme remunerates the achieved savings, half the amount of funding is based on cost, namely on the cost of the development, production and deployment of the digitised energy service as described above. Half of the funding is conditional on the achieved savings and is disbursed in the form of remuneration per kWh of energy saved. In this way, the applicants get security of funding for the development of their products while also being subject to performance-related incentives. The costs of energy savings measures themselves, e.g. device replacement or building refurbishment, are not taken into account. However, these costs can be eligible for other technology-specific funding programmes. Figure 1 illustrates the operating principle of the "Energy Savings Meter".

MEASUREMENT OF ENERGY CONSUMPTION AND ESTABLISHMENT OF THE BASELINE

The establishment of energy savings achieved is a core element of the programme. How are these savings determined? For the scope of the programme, energy savings are defined as the difference between energy consumption before the Energy Savings Meter and the current measured energy consumption. Adjustments are made in order to take into account influencing factors. This means that the measured energy consumption is compared to a reference situation: the baseline.

The projects' underlying measuring concept is essential. In total, three kinds of measuring concepts are permitted: for residential customers and small companies an easy measuring concept can be applied, in which the baseline can be as simple as the mean value of the last three annual energy bills. If relevant, a weather adjustment is compulsory. As a result, behavioural changes in energy consumption are recorded in full.

For non-residential customers, the measurement concept will be more complex. The baseline must be derived from the adjusted mean value energy consumption of the last three years. Adjustments must be made with respect to weather conditions and other influencing factors, where relevant. In addition to the simplified measuring concept described above, further specifications are required: system boundaries and influencing factors have to be defined, and changes in framework conditions must be communicated.

Most industrial customers and some other customers will need to set up an alternative measuring concept that goes beyond the concepts described above. For production facilities, in order to ensure a comparable level of data reliability, customers or service providers will need to record data on input (e.g. electricity and gas consumption), benefits (e.g. production output), and other influencing factors (e.g. outdoor temperature, raw material quality). The baseline will be established using statistical models. Particular attention must be paid to system boundaries in order to ensure that results are not distorted.

SERVICES SUPPLIED TO THE CONSUMER

The "Energy Savings Meter" emphasises services supplied to the end customer. Funded projects are designed to enable consumers to understand their energy consumption patterns. Therefore, they need to carry out a clear allocation of energy consumption, either via direct measurement, disaggregation algorithms, or any other method. Obtained data should be visualised and explained, ideally in real time. The projects should therefore enable consumers to see which devices or systems are particularly energy-intensive. Where possible, they should diagnose malfunctions and anomalies and alert consumers accordingly.

On that basis, projects should provide consumers with individual recommendations on how to save energy, as well as motivate them to realise the gains. Energy savings may occur either through behavioural changes, maintenance or optimisation of energy-consuming products or systems, or through investment in more efficient products or systems. In order to achieve the savings, projects should also provide additional services: such as guidance concerning financial support possibilities and offers for device or system replacement. The aim is also to further develop ESCOs and energy performance contracts.

The success of a project also depends on the capability to monitor energy savings, and on a high level of IT security and

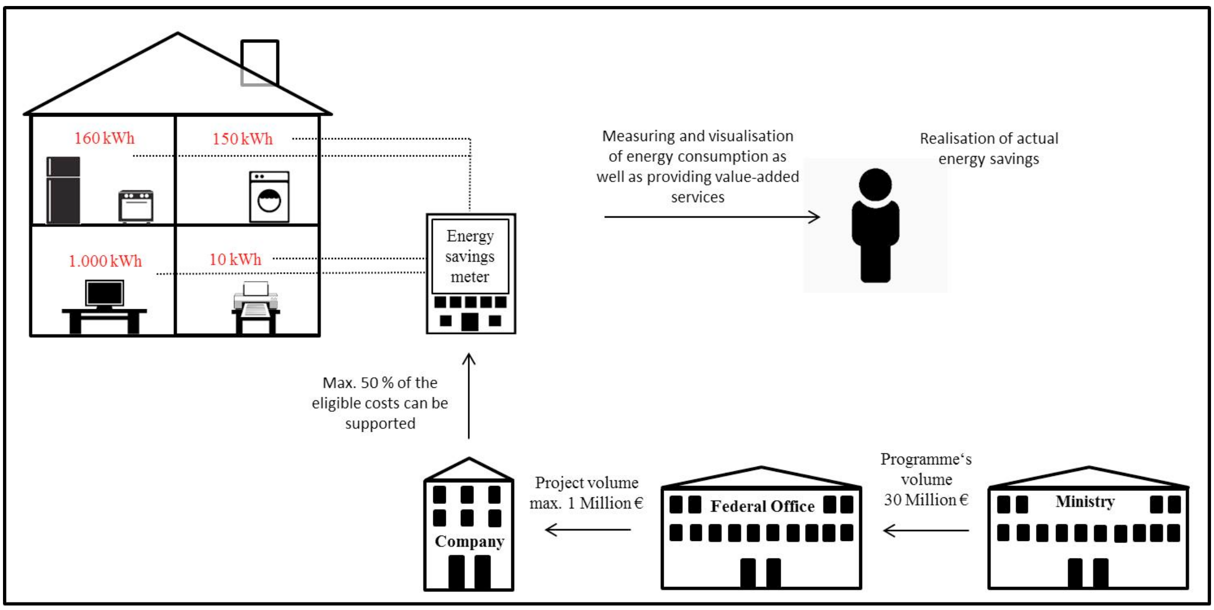

Figure 1. Systematics of the "Energy Savings Meter" pilot programme – example showing residential sector.

data protection. In view of the ongoing energy transition, it is conceivable that the "Energy Savings Meter" could be further developed in order to make a more significant contribution to load management, or to integrate renewable electricity generation into the system (for example, thinking along the lines of a prosumer market as outlined by Parag (2015)).

FUNDING AND PERFORMANCE-BASED REMUNERATION

For each single project, the subsidy may amount to at most one million euros over a maximum duration of five years. Basically, 25 % of the eligible project development costs can be supported. The share may be higher for small and medium enterprises (SMEs) for whom funding goes up to 35 % of the eligible costs. The additional open source option also gives rise to an increase of the funding. Including the open-source model, up to 50 % of the eligible project costs can be supported, in accordance with Article 25 of the GBER. Furthermore, funding per kWh saved can increase through additional options such the usage of a smart meter gateway, or a contribution to load management if the project is "load management-ready". The open-source option aims at sharing data and information and strives to promote improvements in the technological and methodological basis of energy savings quantifications. Smart meter gateways are rewarded in view of IT and data security. The "load management-ready" option looks beyond and rewards steps taken in terms of facilitating the energy transition, in particular the integration of intermittent renewable power generation. It must be noted that the funding is granted for the digital infrastructure needed for analysing and providing feedback to the individual user, not for investment into individual energy savings measures such as replacing a device, insulating a pipe or replacing a boiler.

As stated, half of the support volume depends on project performance in terms of actual energy savings. Table 1 indicates the performance-related remuneration depending on the type of customer, the energy carrier and the options included. The performance-related funding is capped, so that additional savings do not receive further remuneration. The other half is granted as a fixed funding amount for project development. In addition, applicants may request a marketing support of up to 200,000 euros.

Monitoring and evaluating the "Energy Savings Meter"

In terms of the evaluation, one of the advantages of the programme is the generation of individually measured values for all approved projects. While savings have to be estimated against an individual baseline of each consumer using an Energy Savings Meter, the extensive measurement data will permit relatively robust quantitative statements compared to programmes based on estimated or deemed savings. However, in contrast to most funding schemes, there are many qualitative specifications to be examined. This is due to the fact the scheme is a pilot programme and is also aimed at developing successful Energy Savings Meters products in addition to pure energy savings.

Specifically, the evaluation of the programme comprises:

- An evaluation of whether the programme's objectives have been attained (achievement of objectives)
- An evaluation of whether the programme's measures have been both adequate and causal for achieving the objectives (adequacy and causality)
- An evaluation of the programme's cost-efficiency, i.e. whether the programme measures and their operationalisation have been cost-effective (cost efficiency).

OBJECTIVES OF THE PILOT PROGRAMME

We derived the following main objective from the pilot programme: harnessing the benefits of digitisation to achieve energy savings. In particular, this comprises the following sub-objectives:

- Making cost-efficient digitised energy consulting accessible for consumers
- Improving the technological and methodological basis of digitised energy savings quantification
- Enabling novel and innovative energy efficiency services to save electricity, natural gas, heat, and cool energy.

Cost-efficient digitised energy consulting is crucial for consumers, especially in the residential sector. The aim of the programme is therefore to promote the energy market to consumers who do not currently use or have access to competitive energy services. These services will require reliable quantification of energy savings. Therefore, improving the technological and methodological basis of digitised energy savings quantification and putting them into practice is a key element in the objectives of the pilot programmes. The programme's third sub-objective – enabling novel and innovative energy efficiency services to save energy – is also aimed at strengthening the market for energy efficiency. Smart home devices often focus on security and amenity aspects. Hitherto, the field of energy efficiency has not been the major aim or objective of

Table 1. Performance-related remuneration of the Energy Savings Meter programme.

	Residential customers	Other customers
Electricity savings	28 ct/kWh	15 ct/kWh
Natural gas, heat or cool energy savings	5 ct/kWh	
Increase of remuneration due to additional options		
Options smart meter gateway, load management-ready, open source	2 ct/kWh each	

Source: BAFA (2016a).

such devices. It is hoped that innovative services can activate this business field.

Each of the described sub-objectives can consist of several more specific aspects. Thus, it becomes possible to apply indicators which in turn allow an evaluation of the achievement of the programme's objectives. For instance, consider sub-objective (1). We determined one essential aspect to be the increased distribution of Energy Savings Meters. As indicators to assess the extent to which this aspect is met, we analyse whether a broad distribution across customers and sectors as well as energy carriers or uses has been achieved. To this end, the granted applications are taken as basis.

In addition to the objectives described, the following further objectives can be derived top-down from overarching systems, such as the Energy Concept issued by the German Federal Government in 2010 and the National Action Plan on Energy Efficiency ("NAPE") issued in 2014. These comprise:

- A contribution to making Germany one of the most energy efficient economies in the world
- A contribution to achieving the climate change mitigation targets
- Tapping energy saving potentials
- Tapping electricity saving potentials
- Reducing energy costs.

Likewise, respective indicators are applied. For instance, the extent to which objective (2) has been achieved is measured by the reduction in greenhouse gas emissions in annual tonnes per CO_2 equivalent.

ENERGY SAVING METERS: CURRENT MARKET SITUATION

The market analysis describes the status quo of the German market, the primary market under consideration here, for Energy Savings Meters and respective software products that measure and visualise energy consumption. It comprises products largely comparable to Energy Savings Meters as well as software tools for the residential, commercial and industrial sectors.

Residential sector

For the residential sector, the authors analysed a sample of 29 products released by 27 companies. Remarkably, the analysed products focus on smart home applications rather than energy savings measures. Products primarily address consumer behaviour with smart living tools such as modern conveniences (individual adjustment of lighting, motion detectors, smart window shutters, or comfortable control of video and audio systems, etc.) and security solutions (security alarm systems, smoke detectors, etc.). Measurement und visualisation of energy consumption is often just a by-product with little or no details or individualised device detection or feed-back mechanisms implemented. In fact, studies show that a quite large share of German consumers owns some sort of device which could be summarised under the term "smart home product": about 25 % use such products; 50 % of those stress that the improvement of their individual energy efficiency was an important criterion for the purchase decision (GfK 2015). Nevertheless, there are only a few companies whose products focus on energy savings; most of them are small and medium-sized companies. 90 % of the companies with up to 50 employees were founded in 2010 or after. Larger companies in this field are often energy suppliers. The major international IT companies have been active in this field, but are not actively present in the German market anymore. For instance, Google launched a software project named "Google PowerMeter" to help consumers track their home electricity usage, but decided to cease it in September 2011 after two years of operation. Due to a lack of consumer uptake, "Microsoft Hohm", which enabled consumers to analyse their energy usage and provided energy saving recommendations, was also discontinued in May 2012. Up to this point, analysed products on the market met the Energy Savings Meter's requirements only in part. There is room for improvement, specifically with regard to the required baseline and associated energy efficiency services. Overall, disaggregation of energy consumption of devices does not play an important role in marketing. Analysed products focus on the collection and visualisation of electricity and heating energy consumption data only. In addition, smart heating control systems make up a large share of analysed products. Other products simply provide an app service with which customers can scan or photograph their current energy meter reading or transmit it manually. Thus, customers can keep track of their consumption and potentially adjust their energy tariff. Product costs are low; generally below 200 euros.

Commercial and industrial sector

Energy management plays an increasingly important role in the industrial and commercial sectors. Many companies are already obligated to carry out periodic energy audits under the German Energy Service Act ("Energiedienstleistungsgesetz"). The Energy Agency of Nordrhein-Westfalen therefore published a survey-based energy management software overview of 97 products released by 89 companies (Energieagentur NRW 2016). However, one must take into account that the data on which the overview is based has been provided by the companies themselves, opening up scope for interpretation when analysing the data. Bearing this in mind, the status quo of energy management software is well on track even if there is still a large potential to be tapped with regard to the pilot programme's requirements. As in the residential sector, the structure of companies in this field is characterised by small and medium-sized firms. Half of them employ a staff of 50 or less. A large number of products were released some time ago. Only 17 % of the products have been on the market for less than two years. 79 % of the companies offer additional services in the field of energy management, especially with regard to the development of technical concepts such as energy meters. Product costs are in the range of 5,000 to 10,000 euros. In terms of technical detail, the findings are ambiguous: in fact, the majority of products are able to deseasonalise consumption and to detect other influences such as production volume. It remains unclear to what extent the products are able to detect consumption on a device-specific basis. On the other hand, plausibility checks of data are rare. In addition, it is not clear whether and to what extent products can monitor energy savings achieved.

INITIAL FINDINGS FROM GRANT APPLICATIONS

The Federal Office for Economic Affairs and Export Control granted the first three applications since the start of the programme in May 2016 and is currently processing eleven further applications (BAFA 2017, pers. comm., 10 January). The authors had access to the essential information for the granted requests. In addition, some general information on submitted applications was disclosed.

Initial findings from applications granted

Initial findings from applications granted are limited to the very small sample of three applications. However, the following section contains a brief description of the projects. It also refers to prominent aspects within these applications which follow the objectives of the programme described above.

Brief description of the projects

One beneficiary plans a service for housing companies which is designed to reduce heating costs. As part of the project, the efficiency of boilers will be made visible, malfunctions and weaknesses will be revealed, and proposals for optimising will be put forward. This is aiming to achieve significant natural gas and heat energy savings.

Another beneficiary plans to install a large number of smart energy meters in the residential and service sector in order to tap savings potentials by disaggregation of electricity consumption, visualisation via app, and providing individual recommendations on the basis of the metered energy consumption.

Likewise, the third project aims to tap electricity savings potential by installing smart energy meters in small and medium enterprises (SMEs) and collecting and sharing specific information about savings potentials for the targeted fields of business. The project shall demonstrate sector-specific savings potential, for instance via determination of sector-specific benchmarks for i.e. the logistic sector, bakeries, hotel industry, retail and animal breeding.

Preliminary findings on the achievement of the programme's objectives

The programme's main objective – harnessing the benefits of digitisation to achieve energy savings – comprises three sub-objectives. With respect to the first – cost-efficient digitised energy consulting made accessible for consumers – we determined three different aspects which must be considered:

1. Cost efficiency of the products, especially in terms of product and transaction costs
2. An increase of diffusion of Energy Savings Meter both throughout different customers and sectors as well as among the different energy carriers or uses
3. Products' usability for consumers, especially with respect to the degree of complexity when operating and in terms of placing trust in data security.

Given that the particular projects have not yet started, an evaluation of the cost efficiency of the products is not possible at this stage. Furthermore, all three beneficiaries plan to implement their projects mainly in the residential and/or commercial sector, with some end customers in manufacturing and the agricultural sector. Likewise, a wide distribution among the different energy carriers, or uses, is also intended. However, the first three granted applications suggest that saving electricity and natural gas is the main focus of applying projects. The aspect of products' usability for customers cannot be evaluated at this stage as the projects have not started yet.

With respect to the programme's second sub-objective – improving the technological and methodological basis of IT-based energy-savings quantification – it becomes apparent that the development of energy savings quantification technologies and methodologies is likely to be further promoted by the beneficiaries' plan to provide and share information on this subject to the public. Examples include the identification of consumption patterns of specific devices or the sharing of benchmarks and consumption data via an open-source model.

With respect to the programme's third objective – enabling novel and innovative energy efficiency services to save electricity, natural gas, heat and cooling energy – we determined two different aspects which must be considered: on the one hand, projects must be innovative with regard to energy efficiency services. On the other hand, the energy savings potential must be tapped. The degree of innovation cannot be evaluated yet, and of course, there are no findings in relation to measured energy savings at this stage as projects are only to be set up in 2017. However, it already appears that the few applications granted show various promising elements as to their degree of innovation:

- Alleviate split incentives, e.g. in a landlord-tenant-situation where the landlord bears the cost of an energy efficiency investment while the tenant benefits from lower energy bills. Passing on part of the performance-based funding to the landlord will lessen this market failure, according to one project proposal.
- Allow benchmarking of energy consumption in small and medium enterprises (SME) through benchmarks for target business sectors by collecting sector-specific data.
- Use gamification in order to improve consumer engagement.

Furthermore, beneficiaries estimate that their projects will tap an energy savings potential of between 10 % and 30 %.

Further tendencies derived from submitted applications

While it would be premature to draw conclusions at this early stage, the general information about the pending requests allows us to discern some approximate trends. With a mean requested funding amount of close to 800,000 euros, projects tend to be relatively large. But there is also a leverage effect: project development costs reach on average 2.2 million euros (BAFA 2017, pers. comm., 12 January). Target sectors are fairly well balanced between non-residential and residential sectors. So far, the industrial sector has not yet appeared as a target. Energy carriers are fairly balanced as well: while most projects target electricity savings, almost as many address natural gas or heat consumption, whereas cold energy projects remain rare. Most projects intend to achieve energy savings of between 10 % and 30 %, two projects plan energy savings of up to 60 % and 80 % respectively. Approaches to achieving the savings include innovative and complex products as:

- Energy advice and management: IT-based energy counselling using disaggregation of electricity and heat consumption, community-based and branch-specific counselling

- "Smart sufficiency": IT-based adaptation to user's needs
- Technical system optimisation
- Quality control of efficiency measures (BAFA 2017, pers. comm., 10 January).

A true evaluation of the programme's effects including cost efficiency and innovation will be possible when measured energy savings and developed services can be assessed in relation to the funding spent. Nonetheless, it is possible to comment on the design of the scheme. In general, due to the design of the programme, no-cost or low-cost savings measures with high return on investment rates such as behavioural change, improved production procedures or maintenance will be stimulated. That may be regarded as picking the "low hanging fruits" in the first place as market actors tend to focus on cheap ways of saving energy. Concurrently, funding amounts also allow for more complex measures. Future evaluations will specify which type of savings measures have been induced by the programme. Furthermore, by funding innovative new products and business opportunities, the scheme aims to develop a market for energy services which could in turn lead to market-driven expenses and to refinancing energy savings at a later date.

Conclusions

To our knowledge, the "Energy Savings Meter" funding scheme introduces quite a unique combination of performance-related funding and support of a new kind of digitised energy efficiency devices and services. While it is too early to draw definite conclusions as the funding scheme was first published only in May 2016, the scheme shows some promising elements.

Firstly, it addresses real energy savings in two senses:

- It remunerates only measured energy savings compared to a reference situation – the baseline. Consequently, compared to other funding schemes, there is much more certainty with respect to achieved energy savings.
- It embraces behavioural changes and measures, and thus addresses and monitors rebound effects. Consequently, compared to other funding schemes, it heightens the perception of absolute savings.

In addition, for the first time in Germany, the programme develops a reliable method for identifying and remunerating measured energy savings. Secondly, the programme essentially promotes unique energy services. It contributes to making energy services suitable for mass-market use and could thus provide fresh impetus for energy services and possibly energy performance contracts. By lowering transaction costs and allowing economies of scale, it could permit them to access fragmented fields featuring small projects – e.g. residential sector and small commercial entities. Moreover, it delivers a valuable database for targeting energy efficiency potentials through future policymaking.

Of course, cherry picking of commercially advantageous energy efficiency measures is inherent in this kind of scheme where no fixed measures are prescribed. On the other hand; the programme could spark the market's search function for large, yet untapped energy efficiency potentials. For more complex savings measures, a complementary approach is needed: in-depth renovations and measures with long payback times will continue to be addressed through other instruments or funding schemes.

For future scale-ups of the programme, it is important to consider the subsidy amounts involved in this funding scheme. Today, the "Energy Savings Meter" is a pilot programme, future evolutions of the programme could benefit from lower costs and could potentially permit gradually lowering funding in relation to the energy savings achieved.

The programme further develops the funding landscape for energy efficiency and allows testing and evaluating of this new kind of scheme and the services and energy savings it could induce. The authors will continue to monitor the programme and report on the final outcomes of the funding scheme.

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