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Prepayment metering: Household experiences in Germany

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Abstract

Poor households in Germany and those that are close to the poverty line are more likely to suffer from increases in electricity costs. One consequence of this is the increasing number of cases in which the supplier disconnects a household's power. According to the Federal Network Agency (*Bundesnetzagentur*), a total of almost 359,000 interruptions of the electricity supply were caused in 2015 due to outstanding payments. In order to avoid disconnection from the electricity grid, more and more utility companies have begun to offer prepayment meters (PPMs) to their customers as a response to outstanding payments and a growing number of customers owing debts to their energy supplier. The phenomenon of an increasing number of households affected by energy poverty in Germany is new, and thus the number of PPMs is still low. As a result, experiences in this context are – compared to other countries (e.g. Great Britain) – far from extensive, and political awareness of the problem is low. This paper presents the findings of Germany's first scientific survey on experiences with the use of PPMs.

KEYWORDS

Energy poverty, fuel poverty, prepayment meter, access to electricity, energy policy, social equity

1. INTRODUCTION

The residential consumption of electricity is an important part of total household consumption, but also contributes to well-being and social participation. The availability of electricity can be considered as "social power" and the basis of social organization [1]. On the individual level it opens up possibilities: "the energy available to man limits what he can do, and influences what he will do" [2]. If you want to invite neighbours to your birthday party or watch a football match on TV with friends, you need electricity. For this reason the lack of access to electricity leads to circumstances that do not allow for participating in the lifestyles, customs and activities that define membership of society[3]. Furthermore, electricity is a necessary condition for using appliances at home such as cookers, washing machines, TV sets and computers. Affordable, reliable and constant utility services are basic necessities for households in modern, socially responsible societies and are a central requirement for human development.

The increase of household expenditure on electricity in Germany by about 95 per cent between 1997 and 2017 [4] has led to rising debts to utilities, resulting in interruptions of the electricity supply. Many low-income households and those living near the poverty line suffer from increased electricity costs and a loss of real income. Taking inflation into account, the purchasing power of the money at their disposal decreases. Increases of state welfare payments in Germany have not been sufficient to keep pace with increased energy costs [5]. Comparing the evolution of various incomes with the evolution of electricity prices in recent years (see Figure 1), it becomes clear that pensioners and welfare recipients are particularly affected by increased electricity prices.

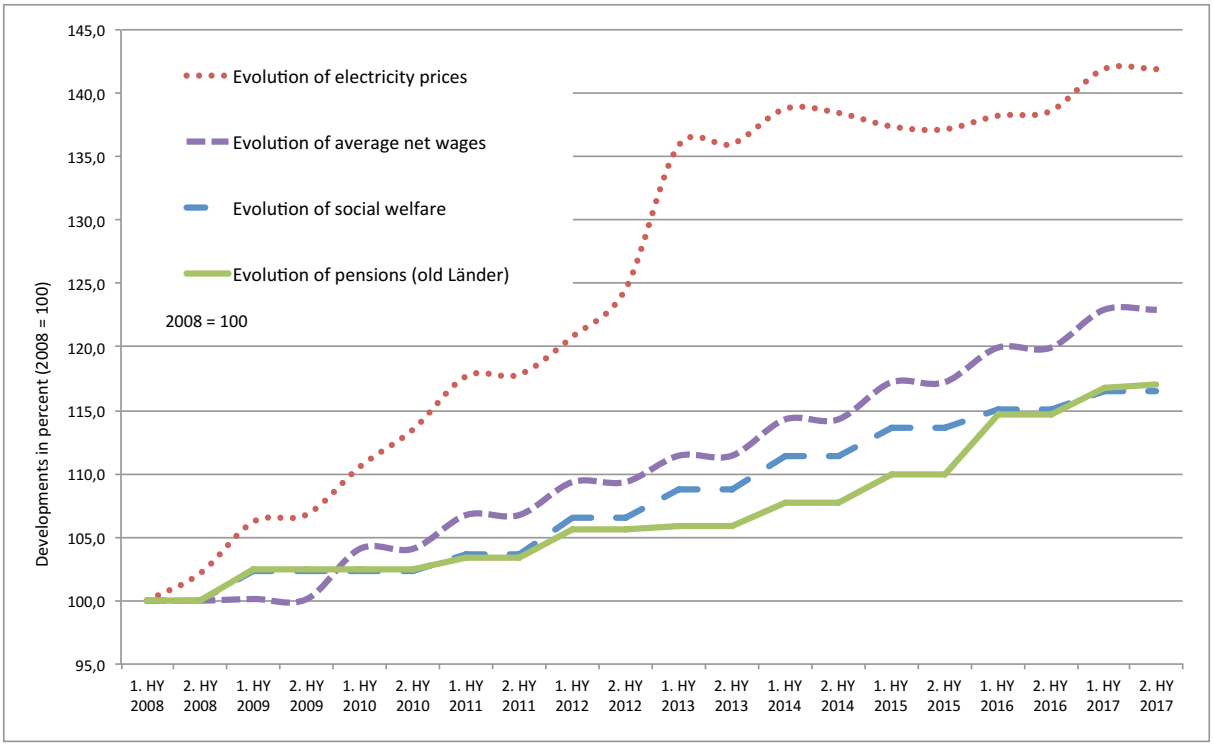

Figure 1: The evolution of electricity prices, average net wages, social welfare spending, and pensions

Data sources: [6] [7] [8][9]

From 2008 until 2013 the rise of electricity prices was particularly high compared to the evolution of average net wages, social welfare and pensions. Between 2011 and 2014 electricity prices rose by around 18% from 25.3 euro cents to 29.8 euro cents [6]. As a result of these developments, during this period power disconnections increased by 12.7 per cent [10].

According to Kreider/Sommer [11], the unemployed, pensioners, students and single parents with two or more children under the age of 6 are particularly vulnerable to energy poverty.

However, there is no official definition of energy poverty in Germany. The first study on energy poverty in Germany was written by Heindl [12], who gave a good overview of commonly used methods for measuring energy poverty. Isherwood/Hancock [13] proposed that households that spend more than 10 per cent of their disposable income on energy can be described as energy-poor households. Disposable income is considered a key economic indicator on the household level and describes the household's budget available after income taxes. The justification for the 10 per cent threshold is that the median of energy expenditure on disposable income was 5 per cent at the time of the study [13]. The threshold is therefore double the median. Since this may also include households with a very high income but also a high energy consumption for luxury applications, Hills [14] developed the Low Income High Cost (LIHC) principle to determine energy poverty. According to this principle, energy poverty exists if the household's equivalised income falls below the OECD at-risk-of-poverty threshold, and the equivalent energy expenditure is higher than the median in this field. The equivalised income is a recalculation by taking differences in household sizes and composition into account. This way it is possible to consider that households with many members are likely to need a higher income to achieve the same standard of living as households with fewer members. Using France as an example, Imbert et al. [15] confirmed that these indicators can also be used in other countries with good data availability. Deller [16] provided an EU-wide map of energy affordability using energy expenditure shares. The

map reveals that shares of energy expenditure in the EU vary widely. Deller concludes that these variations suggest that a single expenditure-based EU-wide metric of fuel poverty would be problematic.

Although there is no standard definition of fuel poverty or energy poverty, the definition of energy poverty used in this text is the inability to attain a socially and materially necessitated level of domestic energy services [17], and is linked with difficulties in affording basic levels of energy needed in households for cooking, lighting and other appliances due to low income levels [18] [19].

Prepayment meters (PPMs) are often seen as a way to provide electricity to customers with high energy debts. The concept is similar to prepaid mobile phones: customers purchase credit at an outlet, which they use to top up their meter. PPMs are widely used in Great Britain, where the number of customers paying for their electricity by prepayment doubled from 7 per cent in 1996 to 16 per cent in 2015 [20]. To date, more than four million British households use prepayment for electricity [21]. Usually, these meters are installed to manage customer debt. In the second quarter of 2017, around 39 per cent of UK consumers who were in debt repaid via a PPM [22]. A higher price per kilowatt hour or a fixed amount per month is usually paid for debt repayment. Studies in the UK prove that PPM customers are generally more likely to be fuel poor or vulnerable to becoming fuel poor. This leads to external costs for the individual and society as well, through reduced living standards, or even physical or mental health issues [23]. For the societal acceptance of the German energy transition it is of great importance to take social aspects into account. The process of transition must therefore not be at the expense of vulnerable households. Investigating the issue of who will benefit from new energy systems, who will lose, and whose lives and livelihoods will be put at risk are aspects of social exclusion [24]. Such social exclusion may go hand in hand with electricity debts and even with using a PPM. Higher price schedules and fewer competitive pricing choices discriminate against PPM users and significantly expose them to the main disadvantage of PPMs: the risk of self-disconnection. If the credit runs out, energy supply is usually shut off.

In accordance with Article 3 (7) and (8) of the Electricity Markets Directive (2009/72/EC) [25], appropriate measures against energy poverty must be taken for vulnerable consumers. For this reason, several agencies in EU Member States record and monitor the number of disconnections among non-prepayment customers. Unfortunately, no comparable effort is made to capture the extent (and the drivers) of self-disconnection among prepayment customers. Self-disconnection is an inherent part of the technical peculiarity of PPMs. When the credit is used up, the power supply usually ends, which de facto corresponds to a self-disconnection. If a customer fails to recharge his PPM in time because they are ill or on holiday, the credit may be used up and the power supply will be interrupted. The widespread use of PPMs should therefore not lead to a disguising of the problem or even to a superficial success in the fight against energy poverty. Therefore, it is essential to obtain sound empirical knowledge on the extent and consequences of self-disconnection. This is particularly important because, in Germany, there is no assessment process to help determine the household's circumstances (including whether there is a serious risk to health from self-disconnection) before any PPM is installed for debt-related reasons.

Research in the fields of welfare and consumer protection has unanimously recommended that PPMs should only be installed if customers agree. Currently, the supplier can also install it without the customer's consent. However, it would be important for the customer to choose between the installation of a PPM and power disconnection by the supplier.

The most urgent wish of users – across all studies – refers to the costs for the PPM. As such, the additional costs should be kept to a minimum. The cost-neutral use of PPMs has therefore been recommended. This also applies to special charges, such to release the meter after self-locking or to recharge the credit. Cost neutrality increases potential customer satisfaction and acceptance. It is also conceivable that the additional costs could be allocated to network fees and thus paid by all customers.

The problem of energy poverty has received little attention in Germany up to this point. In the UK, by contrast, research focusing on energy poverty has been conducted for around 35 years [11]. Several studies in the UK have explored the extent and the drivers of self-disconnection and have been summarised by Brutscher [26]. According to this summary, it can be concluded that the results from these studies vary significantly. It is therefore unclear whether or not self-disconnection is a widespread phenomenon, and whether financial constraints are at the core of most self-disconnections [26]. Nevertheless, due to the absence of the need to pay annual supplementary compensation because of electricity debt (exact monthly consumption billing) and better cost control, PPMs are viewed positively by the majority of consumers [21].

In Germany, the provider of PPMs is usually the relevant primary supplier, i.e. the energy supply company that supplies most household customers in the local distribution grid with electricity or gas. The rights and obligations arising from the status of the primary supplier of electricity are regulated in Germany by the Basic Electricity Supply Ordinance [27]. This ordinance regulates the conditions under which customers must be supplied with electricity. The primary supplier has special obligations in the context of competition in the liberalised German energy market. While other utilities may refuse to serve a customer due to a lack of creditworthiness, the primary supplier is initially obliged to give every household access to the energy grid. If another energy supplier fails, the primary supplier must ensure further supply. The requirements to be met in order to allow the primary supplier a meter disconnection are regulated in Section 19 (interruption of supply). Nevertheless, even a slight delay in the payment of €100 is a sufficient reason to enforce a disconnection and thus interrupt the supply. In Germany, the installation of a PPM is therefore usually initiated by the primary supplier. In the case of high electricity debts, customers have the choice of being completely disconnected from the supply or accepting a PPM.

In spite of this, PPMs are increasingly in use in the EU [28]. Some of the aforementioned problems, especially those related to the higher effective costs of PPMs, have also been identified in the Netherlands, where a consumer association noted that lower income consumers usually face higher price schedules, either due to having to provide security deposits, or due to the use of a PPM [21]. Some postal surveys have investigated the advantages and disadvantages of PPMs from a consumer perspective, and have explored the rates of self-disconnection in New Zealand [29,30]. O'Sullivan et al. [25] noted that the use of PPMs in New Zealand is more expensive than other means of payment. However, in New Zealand as well as in the UK, there was a high level of satisfaction with meter usage, mainly due to cost control in electricity consumption. According to Faruqui et al. [31], PPMs in combination with displays installed in the home can also reduce power consumption by up to 14 per cent [21].

While the studies mentioned here have been carried out in other countries, little is known about consumer perspectives of PPMs in Germany. This is also due to the fact that PPMs are not at all widespread in Germany. A comparison of the situation in the UK (where 16 per cent of customers have a PPM) with that in Germany reveals that the number of PPMs installed in Germany is much lower, at around 20,200, which is approximately 0.05 per cent of households [10]. This article presents the results of an empirical study in several cities in

North Rhine-Westphalia, with the intention of contributing to closing the existing knowledge and research gap. On behalf of the Ministry for Environment, Agriculture, Conservation and Consumer Protection of the State of North Rhine-Westphalia, the study investigated how users of PPMs deal with the technology, and what influence the PPM has on user behaviour. This article also addresses fundamental research questions on the satisfaction of PPM users in order to derive opportunities for improvement. Our interview partners were therefore asked about the problems they have encountered in their daily use of PPMs, and about their ideas for change. It was also investigated whether PPMs lead to greater cost transparency, providing an incentive to save energy, and whether the interviewees have taken measures to use energy more conscientiously and more efficiently.
In the following sections, a description is first given of the methodological process adopted and the reasons for choosing to use semi-structured interviews. This is followed by a presentation of the interview results, and an assignment of the results to the research questions in the discussion. Next, conclusions are drawn and political needs for action are derived from the results. Finally, avenues for further research are pointed out.

2. METHODS

The aim of the study was to examine user behaviours of households with PPMs in Germany. The focus was on finding out how consumers deal with this type of electricity purchase, and what effects the use of a PPM has on electricity consumption. In the context of this study, carried out on behalf of the Ministry of Environment, Agriculture, Nature and Consumer Protection of North Rhine-Westphalia, semi-structured interviews with current users of PPMs were conducted in several cities of North Rhine-Westphalia in the period from autumn 2016 to winter 2016/17. As Germany's most populous federal state, North Rhine-Westphalia is particularly interesting with regard to the issues discussed here. In its poverty report, the Paritätische Wohlfahrtsverband stated that North Rhine-Westphalia, and the Ruhr area in particular, is a "problem region in terms of poverty policy". In an annual comparison from 2005 to 2015, the poverty rate of North Rhine-Westphalia rose significantly, from 14.4 per cent to 17.5 per cent, which is the highest increase in Germany [32]. In the Ruhr area like in no other German region of this dimension, the poverty rate increased about 24.7 per cent from 16.2 per cent in 2005 to 20.2 per cent in 2015. Every fifth inhabitant of Germany's largest conurbation affected by structural transformation of the old industries like mining and steel with its more than five million inhabitants must be counted among the poor [32]. At the same time, as part of a state-of-the-art model project, there have also been special efforts in North Rhine-Westphalia (NRW) as well as political and entrepreneurial initiatives to counteract energy poverty [33]. In a project carried out by the state entitled "NRW fights energy poverty" (*NRW bekämpft Energiearmut*), the NRW Consumer Counselling Centre, together with local utilities and Caritas in NRW, has been tackling the complex problems of energy poverty and energy disconnection with a comprehensive information and consulting campaign. The aim is to secure the long-term energy supply of low-income households and reduce energy poverty and energy disconnections effectively and sustainably.

Semi-structured interviews were chosen because interviews with guidelines are a suitable tool for exploratory use and hypothesis generation in a largely unexplored area [34,35], since the research subject (here, households with a PPM) has not yet been clearly outlined in all dimensions. Due to the lack of previous research and the small number of cases, standardised research methods alone would not have been suitable. The guidelines, which also included semi-standardised elements with concrete answer specifications, primarily served as a framework to enable comparative data collection as well as presentation of the results of the

interviews conducted [36]. The semi-structured interviews form a database of the experiences of 40 households. The interviews included quantitative parts concerning volumes and costs of electricity consumption, as well as qualitative issues regarding consumer perspectives, problems associated with prepayment meters and suggestions for improvement. The interview guidelines were designed on the basis of studies from other countries in order to have a reference figure despite the low number of cases.

Although an expense allowance of €20 per interview was offered, it was nonetheless difficult to get in touch with interview partners. With the support of PPM-providing utilities, social organisations and debt counselling, access was gained to PPM users. The problem of access to the affected households is similar in other countries. For example, in New Zealand, the United Kingdom and Austria, qualitative surveys were conducted with users of PPMs on the basis of semi-structured interviews as well. In New Zealand, 12 interviews were conducted [37], 30 in the UK [38] and ten in Austria [39]. In-depth statistical analyses are not validly feasible for such small numbers of cases. The present analysis is therefore limited to a presentation of the frequency distributions. The results are not representative due to the small number of cases, but clear tendencies can be shown. The interviews were conducted in person with the users of PPMs in the customer centres of the energy suppliers and during home visits. The semi-structured interviews enabled the collection of valuable additional information that could not have been integrated into a rigid corset of a fully structured questionnaire. In this way, it was possible to gain detailed insights into the everyday life of PPM households, and problems were identified that had not been considered during the development of the interview guidelines. One example of this is the fact that, in the case of consumer insolvency proceedings, energy suppliers are better placed than other creditors due to their installation of a PPM, since they can collect old debts via the PPM. Other creditors do not have this possibility. The settlement of debts is also contrary to the purpose of insolvency, namely to pay off debts while securing a minimum subsistence level.

3. RESULTS

The survey of households using PPMs provided significant insights into the circumstances surrounding this not yet common method of purchasing electricity in North Rhine-Westphalia. About half of the households surveyed had been using a PPM for less than two years; only five households had used a PPM for longer than five years. This was usually because the supplier had changed back to the usual procedure after the old debt was paid, or the financial development of the household budget had improved significantly.

A clear indication of the cost-transparent effect of a PPM seems to be the fact that nearly all households surveyed (97 per cent) knew their monthly expenditure on electricity. Compared to the average knowledge among the German population of household monthly expenditure on electricity of 84 per cent [40], which is the same level as was found in a reference survey of low-income households [41], this is a much higher proportion. Cost transparency was perceived by most users of PPM in NRW as one of the greatest benefits (see Figure 2). Multiple responses were possible.

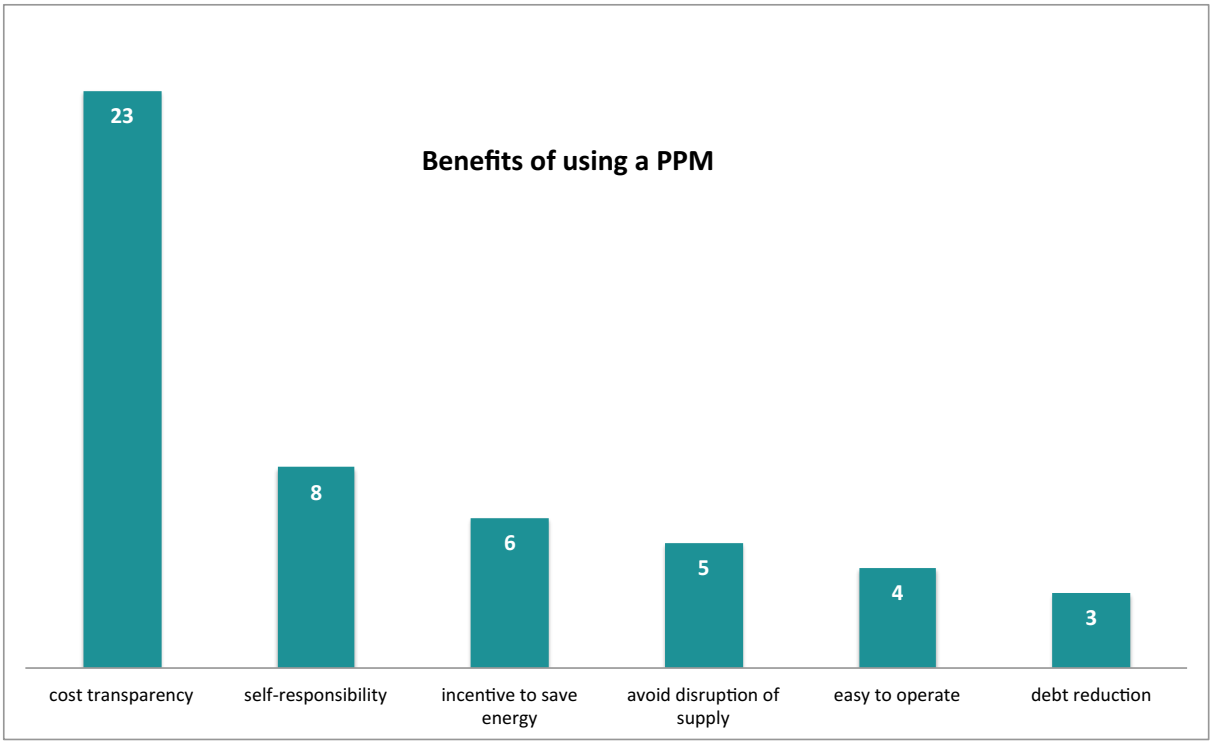

Figure 2. Benefits of using a PPM identified by NRW PPM consumers

However, the cost transparency of the PPM is only apparent. The survey revealed that some users nevertheless have extremely high electricity bills. The reason for this is not high consumption, but the combination of different functions of the PPM applied by the energy suppliers.

One function is the repayment of existing old debts of electricity through an increased price per kilowatt hour for the customer. Only three households viewed the debt reduction via the PPM as a benefit. The price to be paid is therefore usually significantly higher than the usual basic supply price. In individual cases, the PPM is also used for the purchase of both gas and electricity. This mixing of functions is problematic, and actually leads to a lack of transparency of the unadulterated electricity costs. Although users know how much credit they have available, it remains unclear how much of it is used to pay off debts, other utilities or actual electricity expenses. Therefore, the composition of costs being paid via the PPM remains unclear and the hidden costs for the mentioned additional functions are not clearly visible from the customer's point of view. These aspects incur high costs for customers, and make the PPM a symbol of a neoliberal consumption and distribution logic in which ethical issues take a back seat [39]. Surprisingly, only three households interviewed criticised the PPM system, arguing that the system of reconciling old debts would have to be changed. Considering the electricity prices, which in some cases are clearly above the normal basic supply rate because of debt repayments, this is a very small number. Furthermore the households surveyed described their perceived self-responsibility by using a PPM as a benefit. This goes along with the PPM being an alternative for power disconnections and to decide how much of the budget is spent for charging the PPM at a time instead of paying a monthly rate. Other called benefits like the PPM as an incentive to save energy, avoiding a disruption of supply, an easy operation and the reduction of debt play a minor role for the surveyed households.

Nevertheless, results indicated a high level of customer satisfaction. 80 per cent of the households surveyed said they were “satisfied” or even “very satisfied” with their use (see Figure 3). These high levels of satisfaction were due to the fact that the use of a PPM

prevented power disconnections and that there was the absence of a high additional payment once a year in addition to monthly costs. Most of the households surveyed (69 per cent) would again opt for a PPM. The high rate of recommendations reflects the situation. Many stated that they would only recommend a PPM if the energy debt would lead to a power disconnection otherwise. The recommendation is thus restricted to a particular group of people. The fact that some people would not choose a PPM again, even though they were satisfied with it, shows that the system also has all sorts of disadvantages. At least 10 per cent of users were very dissatisfied with their PPM.

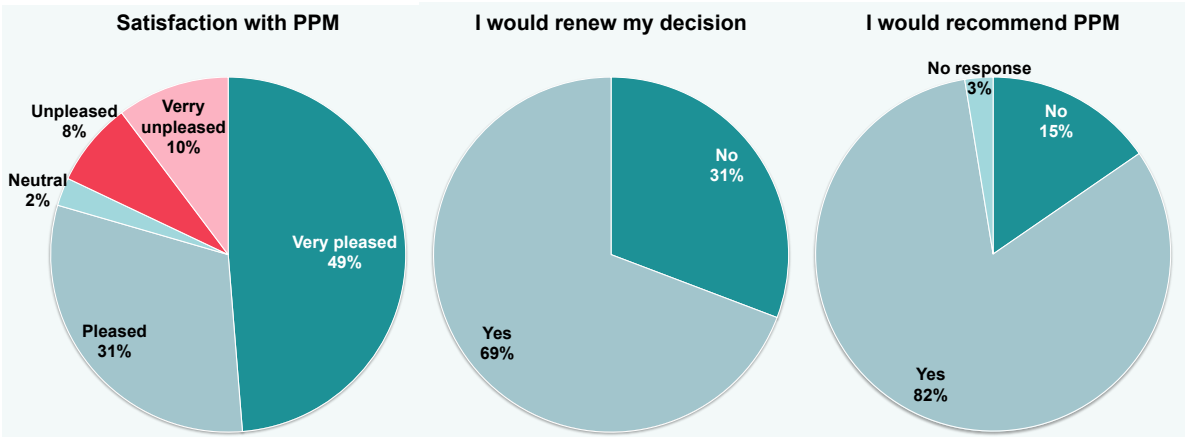

Figure 3. Customer satisfaction with PPMs

One particularly disadvantageous aspect comes in the form of additional costs to recharge the PPM during the opening hours of the supplier's customer centre. In none of the supply areas where interviews were conducted were payment options available except for in person at the customer centre of the energy supplier, even though online payment options or payment at, e.g. kiosks or supermarkets exist for other energy customers. The added time spent and the transport fees further burden PPM customers.

In an assessment by the BDEW's Center for European Economic Research, the researchers initially assumed that having a PPM would mean "a certain social stigmatization of the PPM customers" [42] in apartment buildings, which would make PPMs unattractive. This often-cited assertion that PPMs in rented houses would constitute a social stigma for the affected parties was disproved by the survey. On the contrary, the households affected did not report any problems regarding this issue. In fact, reactions from the social environment were actually rather appreciative. Over the course of the interviews, respondents seemed not to understand why there even could be any reactions from their social environment. On several occasions, respondents emphasised that they would even tell friends about the new meter with pride.

Despite the generally positive feedback from users, there were also suggestions about how the existing system could be improved. Criticism mainly focused on the idea that the recharging process itself takes too much effort. Better accessibility and more charging stations were the most frequently mentioned suggestions for improvement. For example, additional recharging stations at banks were proposed in the vicinity of ATMs. Depending on the type of PPM installed, technical problems were also mentioned. The minimum amount of payment of €20 currently required by some utilities was seen as a problem, as customers preferred to recharge with smaller amounts as a result of their financial capabilities, even though this would increase their cost in the long run.

Respondents were annoyed that a self-induced power disconnection would set in after the customer centre had closed. However, regulations among the utilities differ from each other.

The fact that customers can change neither the price schedule nor the provider was criticised by two people. One person found the additional financial and time-related costs for bus trips to the customer centre as well as the visit at the customer centre itself annoying.
One major benefit, according to the subjective perception of the interviewees, is the power saving effect, which corresponds to the display of the remaining credit. 85 per cent stated that the meter had induced electricity savings. 79 per cent of respondents stated they were now more concerned with their electricity consumption. There is a reason why this value is somewhat lower than the assumed saving effect. Ultimately, some households found the PPM less burdensome because they were no longer so concerned about electricity consumption, seeing it now as "better under control". Savings were primarily achieved by more careful handling of electrical appliances or by shutting them off completely (see Figure 4). Different device operations do not exclusively mean careful handling of the devices like watching less TV. Households also stated that they changed their nutrition from cooking a meal to cold dishes. How far this affects their health cannot be answered by our study.

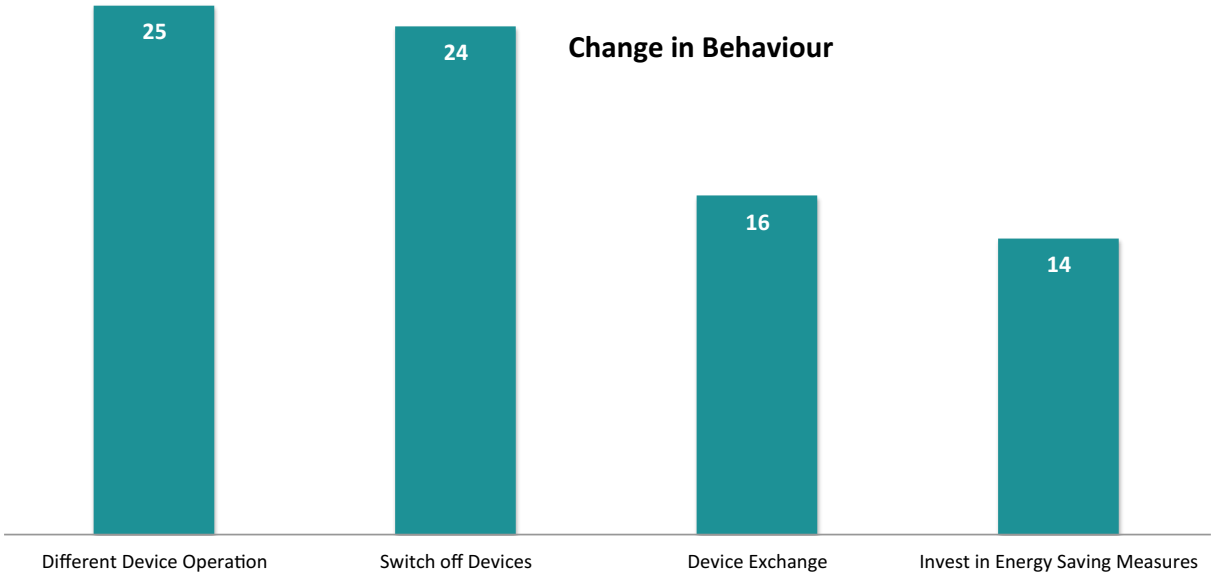

Figure 4. Behavioural changes in PPM users' electricity consumption

Sixteen of the households surveyed had exchanged large electricity-consuming appliances for others, noting that they had paid particular attention to electricity consumption when buying new ones. At least 14 of the households surveyed had invested in a power saver, such as disconnectable plug connectors and timer switches. Some households had also taken a whole series of measures to reduce their electricity consumption. Especially no-cost measures have been applied. The interviewees also reported how the savings were monitored by the meter in real time, which led to direct control of success. The visualisation of the electricity costs on the display builds a major tool in the saving effect. The PPM users experience being rewarded and become even more motivated in saving electricity. The saved energy costs do not become effective after the annual account, but lead directly to a financial discharge. In spite of the fact that the price per kWh was much higher, the electricity costs rose in only 41 per cent of the surveyed households. 31 per cent of the surveyed households registered lower electricity costs. More than half of the households said they had had lower electricity consumption than before. For 31 per cent, electricity consumption was unchanged.
Electricity costs were perceived to be much more transparent, and households reported being more concerned with the topic of electricity consumption, but nearly 50 per cent did not know

the price per kilowatt-hour. The assessment of their own electricity consumption as well as the consumption of individual appliances was essentially not based on unit kilowatt hours, but on consumption in euros. Some interviewees could say exactly how much money they need for a certain purpose (for example, preparing a meal or taking a shower). The consumption in kilowatt-hours, on the other hand, was not known to them.
A total of 41 per cent stated that they would like more support for electricity savings through consultations. Households that did not have this desire usually felt well informed or did not see any electricity savings potential in their household. One third of the respondents had already received energy advice, but only relatively few had conducted a consultation on their own (e.g. on the internet). Sixteen percent of households had already consulted their energy supplier.

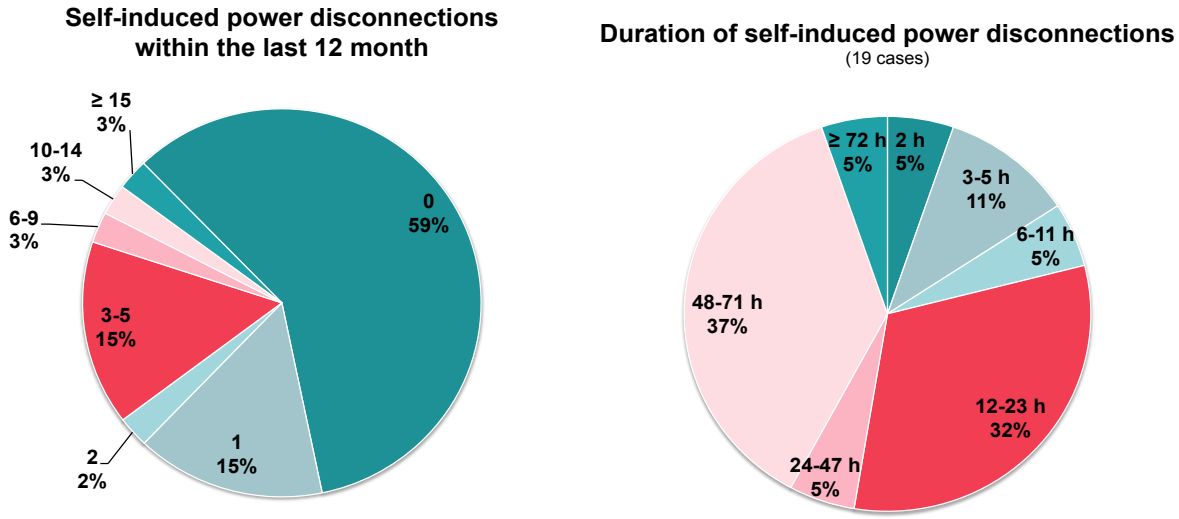

Figure 5. Number and duration of self-induced power disconnections

Self-induced power disconnections played a role in 41 per cent of the households. Often, the interviewees stated that this only occurred in the initial days, but it quickly led to a learning effect. More than one quarter of the respondents indicated that they had had more than three self-induced power disconnections in the last year; however, these usually only lasted a few hours, and in only 5 per cent of the cases did they take more than three days. In about half of those affected, the self-induced power disconnection lasted up to 23 hours. This is significantly longer than the systems outside Germany, where less than half of the self-induced power disconnections lasted only a maximum of two hours. The most common reasons given for self-locking were self-induced reasons (13 entries). However, limited opening hours were also a frequent reason. A statistically relevant correlation between the frequency and the duration of self-induced power disconnections could not be proven. However, this may also be due to the low number of cases.
Nevertheless, this study detected no major negative impacts of self-induced power disconnections. A total of 28 households, including those whose power disconnections occurred more than 12 months ago, found the power disconnection to be only a minor restriction. None of the households in the survey described the refrigerator not working to be a negative effect. Not having light (5), the ability to shower (4) or the ability to cook (2), were cited as negative effects, however. In one case, a slight injury occurred from stumbling in the dark. In general, self-induced power disconnections can have severe implications for elderly people, families with small children, and especially people whose lives depend on electricity-supplied technologies. Therefore, it is reasonable to examine the situation of households before the implementation of a PPM and to re-examine their situation during its use.

4. DISCUSSION

PPM systems represent innovative solutions to the problem of accessibility of utility services. In the survey, a very high level of user satisfaction was determined. Nevertheless, although the PPM is common in some European countries, its application is still controversial. Among the main arguments for its dissemination are the avoidance of energy debts, which also benefits utilities in the debt collection sector. The advantage of cost transparency for the users of PPMs is given only if energy debts are balanced in another way. A display with the remaining credit keeps households more aware of their electricity expenditures, and may therefore lead to energy savings. One weakness of the present study is that it is not based on measured consumption figures. It was only possible to ask the interview partners about estimates, which may be quite erroneous. A detailed long-term study with measured changes in energy consumption and detailed surveys on changed user behaviour would be very useful to fill in the gap of knowledge in this field.

Arguments against PPMs are based on higher costs for the technologies and the risk of self-induced power disconnections among users with low incomes. However, this research shows that self-induced power disconnections, which occur when users forget to recharge their PPM, play only a minor role. The households surveyed quickly learned how to use the PPM, and were interested in avoiding power interruptions themselves. From a customer perspective, PPMs have many advantages and help these customers to avoid power disconnections as well as the debt that results from them. However, it was also noticed that regulation by state intervention is urgently required, since electricity suppliers demand significantly higher prices for electricity from PPM customers to reduce their outstanding liabilities, and moreover they are not obliged to install user-friendly systems to load the PPM.

5. CONCLUSION AND OUTLOOK

One major conclusion of this study is that households with PPMs improve their cost awareness and user behaviour to save electricity. Increased cost transparency plays a very important role in this context. In most cases, the PPM motivated households to invest in the low-hanging fruit of energy-saving technology (such as switchable power strips, the deployment of timers and the use of LED energy-saving lamps). However, there is also a danger that energy savings will be made that will have a very severe impact on everyday life and lead to a considerable loss of comfort. Overall, despite the disadvantages involved, the interviews revealed a very high level of customer satisfaction.

There is no evidence that the reservations against PPMs in Germany are justified [42]. In addition, PPMs contribute significantly to a cost overview and to a more conscientious and economical use of energy.

The knowledge of spending on electricity achieved by the PPM is a very important indicator for the incentive to save electricity. The group of households with PPMs is much better informed than the German average. In the interviews, it became clear that certain aspects of knowledge of households with PPMs is very detailed. Individual respondents were well acquainted with individual electricity applications. Households had also taken a number of initiatives to reduce their electricity consumption. User behaviour often changed. When purchasing new appliances, the respondents pay attention to their energy consumption. Against this background, it is clear that PPMs have a conservation effect. Nonetheless, the survey shows that even more support needs to be given to the development of electricity-saving effects. Such support could be provided by technical solutions (such as in the UK), or by outreach. For example, an analysis of the load profile, which shows the real-time energy use in bar-chart format by day (30-minute increments), week or month, and an in-house display that shows real time usage in €/h and kWh, could help to reduce stand-by losses. A

more specific indication of how electricity consumption is allocated to individual electricity applications could also show which devices waste a lot of electricity [20].
However, it also became clear to us that a regulatory framework is needed. So far, the PPM market in Germany is completely unregulated. As a result, suppliers can charge high rates via the PPM, which is used to eradicate legally existing debt for the energy supplier, not exclusively for electricity but also for gas or water usage. In addition, in the present form, power disconnection can be obscured. The Federal Network Agency publishes an annual report on its activities and submits it to the European Commission and the European Agency for the Cooperation of Energy Regulatory Authorities, according to the Energy Industry Act (Section 63). However, the locks of household customers covered in this report do not include the self-induced power disconnections caused by PPM, even though this would be easy to implement technically. At the very least, the report should have to record the number of PPMs installed.
There is another drawback regarding access to credit recharging facilities. In the investigated cases, there is only one option, at each customer centre. Households are therefore dependent on their opening hours. Technically, there are alternatives; however, they have not yet been used for reasons of cost. Therefore, at least a legal regulatory requirement with regard to self-locking on weekends and public holidays would be pertinent. Some energy suppliers already have a corresponding regulation, which was also very much appreciated by PPM users.
Overall, there is a legislative need for regulation because the households concerned have a particular dependent relationship with the energy supply company. The utility company can completely determine the terms of the contract, since households are almost without protection from the alternative of a power disconnection, which would have more far-reaching consequences for them than the conditions imposed on the use of the PPM. It is therefore all the more important that consumer protection rules are adopted for this (presumably increasing) circle of households.
With regard to the principle of state-wide or nationwide acceptance, it seems appropriate that the legislature would define clear uniform maximum costs for credit balances. A distinction must be made between monthly charges and the cost per kilowatt hour.
For comparison, in Austria, the legislature allows energy companies to charge a maximum of €1.60 per month for a kilowatt hour of electricity. For PPM customers, access to favourable price schedules and changes in pricing should be possible. This is necessary for reasons of fairness. In addition, respondents stated they would appreciate the chance to compare the PPM electricity price schedule with offers from other electricity suppliers. It should also be possible for them to switch providers.
Another important recommendation is that only the current electricity costs should be billed via the PPM. The additional billing of gas and water costs must be avoided by all means. This is the only way to ensure that electricity costs are 100 per cent transparent, generating electricity savings. The burden of recharging credit and any associated transactional costs should be minimised. Buying credit online, possibly by using a smartphone app, would be the easiest way for prepayment customers. For those who do not use online technologies, it would be ideal if nearby stores, post offices or similar facilities would offer recharging. Proximity to the home is highly important. Optimally, billings can take place without accessing the PPM, e.g. in the case of illness or absence for several days.
Notification of the available credit in kilowatt hours and euros should also be transmitted independently of the proximity to the PPM (e.g. via phone app) as soon as customers fall below a certain credit amount. For recharging, online offers could be considered. However, these are more suitable as a supplement, because not all user groups are savvy in web-based commerce, do not have a banking account with an online payment system, or do not have

their own internet access. This could also apply to access to their own mobile phone. For this reason, publicly accessible recharging terminals could be one way to effect a payment.
The minimum amount should not be more than €15 for online credit balancing. Interviews have shown that this amount represents an acceptable mediation proposal between the interests of customers and suppliers [41]. Significantly higher amounts could prevent users from using online services. For the supplier, the use of online services results in separate costs per recharge. Therefore, they will be inclined to set a minimum amount. It also makes sense to offer an in-house display. In the apartment, the customer can be informed about the current credit balance in euros and kilowatt hours, and also see other aspects, such as past consumption development, forecasts and other useful information. The possibility of linking to a smartphone app is welcomed, but the product's use should also be possible without it. Any installation of a PPM should also be accompanied by energy-saving advice.
In terms of consumer protection, the scope of "self-induced power disconnections" should be anonymous. This allows the development of the social situation of households to be recorded, and the results can be incorporated into monitoring reports. The self-induced power disconnections system should only be possible during predefined periods of time. The reason for this is, on the one hand, to facilitate timely recharging and, on the other hand, to prevent the current supply being interrupted at critical moments. It might be helpful to combine the PPM with a load limiter. Low-energy applications, such as lighting, would then continue to work.
If the apartment is heated using electricity, care must be taken that the household electricity and the heat flow and thus the heating costs are collected separately. Otherwise, a PPM may not be recommendable. The repayment of existing electricity debts should also not take place via the PPM. Debt would have to be repaid in other way. In this case, the supplier would have to try to settle the payment arrears in a conventional way – without the "pressure". At the very least, an upper limit on claims on old debts must be established. Such a model is currently in place in France, where a 14-month period for the collection of previous claims is established by law. This approach would increase acceptance in welfare and consumer protection organisations as well as among customers affected.

Most studies about energy poverty agree that there are three main drivers that work in combination: poorly insulated homes, rising energy prices and the stagnation of disposable income due to austerity policy or the economic situation in general [43]. The installation of PPMs is no panacea against energy poverty, but a PPM can often be useful in debt situation to avoid disconnection. One consequence of using a PPM, however, could be that of self-discrimination or self-disconnection, where consumers endanger their health and well-being and that of their families to save money by choosing to use less energy or by switching off the energy supply. This is still merely an assumption that has to be proved. More detailed investigations should therefore be carried out in the future. Moreover, a comparative analysis of PPM households with and without electricity consulting would be pertinent in order to be able to further leverage the conservation potential of PPMs, which is mainly based on increased cost transparency, better and more intelligent consumption, or more purposeful use of electricity.

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