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Is the resource man coming home? : engaging with an energy monitoring platform to foster flexible energy consumption in the Netherlands

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Original research article

Is the Resource Man coming home? Engaging with an energy monitoring platform to foster flexible energy consumption in the Netherlands

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In this article we empirically study the notion of 'The Resource Man' put forward by Strengers (2014): a motivated and knowledgeable micro-resource manager, who uses domestic smart grid innovations to manage energy demand in a sustainable, affordable and grid-friendly way. To explore this notion, we analyse a case study where energy cooperative members engaged with an ICT-based monitoring platform focussing on three domestic energy-managing activities – energy monitoring, planning and sharing. We find that although this case provided the best prerequisites for the Resource Man to emerge, none of these activities was sustained during the project. This outcome underlines that the Resource Man perspective held by many actors in the energy industry has a narrow understanding of energy consumption and how it can be changed or made more flexible. We suggest that it is easier to understand householders' engagement with energy through the concept of energy practice or "e-practices". E-practices go beyond managing energy with smart devices, and can include being actively involved in an energy collective, generating, trading, storing or discussing energy. We argue that in general, domestic smart grid technology can play a potential but limited role in effecting changes to complex and interlinked daily practices.

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1. Introduction

Many industrialized countries are aiming to 'green' their energy systems, in other words make them more sustainable and less carbon-dependent, by applying renewable energy sources. The transition to a low-carbon energy system raises the issue of matching energy demand with an increasingly intermittent and decentralised supply. The current electricity grids are in many cases relatively old, built for centralised and controllable supply, and not equipped to deal with an actual transition without comprehensive investments [2]. Flexibility is a keyword in developing the existing infrastructure so that it can deal with increasing and shifting peaks in electricity supply and demand. We can see this flexibility in infrastructure solutions like improved grid management; increased grid capacity and ultimately electricity storage; but it also plays a role in the demand side of the energy system [3].

We usually think of managing the demand side of the energy grid by enhancing consumer insights into the amount of energy used and by influencing the timing of energy consumption. Information and communication technologies (ICT) have taken centre stage in this development of eco-feedback. In the Netherlands, grid operators are gradually introducing smart meters to every household, and rapidly increasing ranges of energy monitoring devices and apps that display the collated data are available [4]. Various ways of providing eco-feedback, for instance through in-home displays, have indeed helped users to reduce overall energy consumption to a certain extent [5–7]. ICT-based energy monitoring and managing devices are specific tools that enable a better understanding and control of domestic energy behaviour and decision making. These technologies operate on the basis that they provide new information and/or instructions to individuals, who, having received the information, will change their respective energy usage behaviour accordingly.

This individual, positivist and technology centred approach to understanding energy usage has been challenged by the social sciences [8–11]. Nevertheless, many 'smart energy' projects retain a strong technological focus and envisage homeowners as smart energy users, who can be persuaded to 'take control of' energy consumption through monitors and apps. Strengers' [1] image of the "Resource Man" aptly captures this ideal type of smart energy consumer, seen as being a motivated and knowledgeable micro-resource manager. The image epitomises the assumptions many actors in the energy industry make about the interests and behaviour of their users, whose energy-smart behaviour is enabled

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thanks to smart grid innovations. In the ‘resource biased’ energy industry’s eyes, the smart energy consumer is: “interested in his own energy data, understands it, and wants to use it to change the way he uses energy” [1]. Using ever more accurate energy data, he makes conscious and informed consumption decisions to be more economical and sustainable, and this performance data is shared and compared with other micromanagers.

This vision is quite different from the passive and carefree engagement most people (in the global North) have with energy in their daily lives, and can be challenged on many aspects [1,12]. Most critically, it disregards what people actually do in their homes, the heterogeneity of the prospective users and the actual interest in energy matters among all household members. Electricity in particular entails a “background relationship” whereby it is not experienced directly, but shapes the human experience through its “present absence” [13]. Energy is doubly invisible [14]: electricity and most of the delivering infrastructure are physically hidden from view, and the practices that consume electricity are usually part of inconspicuous routines and habits [15]. Devices to generate, monitor and manage energy at the household level make electricity visible by introducing information and the tools to react to it. This could be crucial for a future grid that arguably relies on its users being smart: flexible, responsible and engaged in the electricity system’s functioning.

Grid operators in the Netherlands are exploring this different engagement with energy and in the process, have turned to local energy cooperatives for examples of future smart energy users. These citizen groups engage with energy for a broad range of reasons: taking responsibility for combatting climate change, local economic development, self-sufficiency and reducing energy costs. Many are engaged in developing local generation capacity through solar PV and wind turbines, assisting participants in reducing energy usage, with some even becoming local sustainable energy retailers. Their activities signal an above average engagement with energy, and smart grid projects aiming to explore the active participation of end-users understandably often target these forerunners. Projects involving a local cooperative and smart grid devices can therefore provide empirical insights into Strenger’s idea of the Resource Man, and how the emergence of a rational and motivated energy resource manager plays out on the ground.

In this paper we explore a case study of such a smart grid pilot project in the Netherlands, collaboratively conducted by a grid operator, an energy cooperative and a software developer. The pilot project centres around an online platform that allows participants to monitor and share energy data and plan their usage beforehand to be more self-sufficient. The participants are also members of the local energy cooperative and many have solar panels on their own roofs. On paper, this case represents many aspects of the ideal domestic energy manager, and offers an opportunity to further explore the pros and cons of considering smart grid inhabitants as “Resource Men”. We investigate which energy management related activities actually emerge in this project, and how this has shaped energy consumption.

To do so, we will first describe the case study and the methods used, before briefly outlining why this case is suitable for empirically studying the idea of the Resource Man. We then move on to our empirical findings by detailing the project participants’ actual interaction with the energy platform and how this has in turn affected energy consumption. We close with a discussion and concluding section.

2. Case and methods

We analyse an ICT-based energy innovation, an online energy management platform, to study the emergence of energy management activities. The Dutch SSmE project (Samen Slim met Energie, *Together Smart with Energy*) is a collaboration between distribution system operator (DSO) Enexis, IT developer Shifft, and local energy cooperative DEH (Renewable Energy Haaren). DEH is a citizen group with about 200 members in Haaren, a municipality in the south of Netherlands. Since 2012 the group has been working towards their ultimate goal, namely make their municipality energy-neutral. They have set up activities to promote saving energy, increase renewable energy generation among members, and help residents explore home insulation and domotica. Membership of the cooperative has a voluntary and passive character with no responsibilities; people can simply choose to partake in projects and activities. In 2014, DEH and Enexis joined forces for the SSmE project, in order to develop an online platform supporting the use of community-generated solar electricity, by providing users information through a website and smart phone app. The goals were to reduce the total amount of energy consumed, improve the on-site usage of solar power, and strengthen the ties within this community of energy cooperative members [16]. Importantly, no special financial incentive system like flexible tariffing was implemented besides some small awards as gestures for ‘saving the most’ or ‘being most self-sufficient’. This was a deliberate strategy to keep the organisation of the pilot as simple as possible and explore people’s willingness to help achieve a self-sustaining community. By gathering data from smart meters and displaying information on multiple aspects of energy usage, the platform was meant to become a hub for managing energy in the home. In March 2015, DEH and their project partners officially kicked off the process by introducing the online energy management platform to 105 households in Haaren. The platform links DEH members spread out over four areas in the municipality, totalling about 13,500 inhabitants.

The SSmE platform was launched in March 2014 for a one year pilot. Our paper is based on the data gathered in the course of this pilot. During this time we were able to study the project closely by conducting in-depth fieldwork among participants and attending project meetings led by the working group. The research presented here is mainly framed within a qualitative methods approach. Though it includes quantitative data on energy consumption, the main data source was developed using qualitative methods including observations, interviews and other relevant statements. Enexis conducted the quantitative analysis, focusing on the results of thematic ‘intervention’ weeks. During these weeks, participants were urged to use the platform to achieve certain goals, like ‘reducing standby power’ or ‘being as self-sufficient as possible’. We attended ten project meetings and were both participants and observers of the work being done by the DSO, the energy cooperative representative and the IT developer. This enabled us to gain a great deal of insight in not only how the platform was supposed to function according to its designers, but also how it was actually received and used by householders.

Six months into the project we conducted a focus group interview with seven participants, most of whom were involved and knowledgeable cooperative members. Seven individual, in-depth interviews were conducted with platform users over the course of the pilot. These interviewees were sampled according to the average characteristics of the majority of DEH members: aged (well) above 40, with no young children living at home, well above average income and education, and often a professional or personal affinity with energy or engineering. All the focus group participants were men; two out of the seven individual interviewees were women. All the interviews were semi-structured, guided by a topic list which encouraged participants to discuss their experiences with SSmE, while giving them the opportunity to bring up aspects themselves. The interviews were recorded, transcribed and manually analysed, allotting the various activities of the original platform design into categories. The analysis included verbatim interview reports to enable insight into the empirical sources used and thereby present as accurately as possible the users' experiences with the SSmE project. The quotes in this article are labelled as follows: [GI] denotes a focus group quote, and [11–17] denotes individual interviews.

3. A project for Resource Man?

For a number of reasons, the project studied here very aptly illustrates the Resource Man line of thinking, namely that a resource manager has an interest in energy data, can understand it and interprets it to make economical and sustainable choices regarding energy usage, then shares this information and knowledge with community members. First of all, the project rests on the assumption that individual participants, when provided merely with information about energy usage, are willing and able to adjust their energy consumption pattern. Usage data is available in real-time, enabling the user to monitor the level of electricity consumption directly on the website or app, at any time and place. Secondly, the explicit goal behind providing energy data is to reduce the pressure on the local grid and use renewable solar power on-site. The introduction of solar panels had created new peak pressure on the local grid, because much of the generated solar power was fed back into the constrained local grid. This grid management issue was a strong driver for the project and is visible in the communication with the pilot participants. Asking users to consider the pressure they are putting on the grid assumes that the users know about, understand, and are willing to work towards this grid management goal. Combined with the absence of economic data and incentives, the assumed interest in energy matters becomes even more crucial. A third reason why this case is significant for the strongly rational management approach to energy behaviour, is that providing timing-of-use advice presupposes a degree of flexibility in energy consumption. The participants were thought to be able to react to this advice by using energy at a more suitable time, when renewable power is available. The participants' characteristics mentioned above, including the fact that one household member is often at home during the day, raised the expectation that compared to the average Dutch household, energy usage could indeed be relatively flexible. Furthermore, as many participants have their own solar generation capacity, they were thought to be more keenly interested in energy and self-sufficiency. Finally, the social embedding of the participants in an energy community was strongly emphasized in this project, adding another important characteristic to the ideal individual resource manager. Introducing social norms about energy usage by comparing peers or showing what the average household consumes, has proven to induce energy conservation, especially by above-average energy users [17–19]. Besides providing average usage figures (effectively setting a norm), SSmE also allowed users to make comparisons with others by selecting peers and requesting insight into their data. Individual energy data was to be shared and compared, solar generated power would be virtually shared with the community, and the knowledge gained about reducing and shifting energy demand was to be shared with other community members. This presupposes that their energy behaviour is a salient topic for participants to talk about and share with others, overruling their own privacy and that of their household members. In sum, considering the people and technologies involved in this project, many characteristics of the energy industry's ideal vision for the smart energy citizen [20], in other words an ideal Resource Man, were assumed to emerge from the implementation of this project.

4. Managing energy in the SSmE project

In this section we explain to what extent the SSmE platform was used for managing domestic energy patterns. The project partners co-designed the platform to enable three sorts of energy managing activities: monitoring energy consumption, planning energy consumption by using timing-of-use advice and communication with other participants. These functionalities reflect the three goals formulated for the project: reduce energy consumption, improve self-use of solar power and strengthen the ties within the energy cooperative. We will describe how the SSmE platform was designed to be used in these three activities of monitoring, planning and sharing, which shape the following analysis.

4.1. Monitoring energy consumption

The platform allows users to monitor their current electricity and gas consumption and review their historical consumption patterns. This information can be shared and compared with other users. The main aim of this function is to help users reduce their energy consumption by making it visible and ranking it in relation to their peers. This function specifically targets inconspicuous consumption by electronic equipment that is always switched on or left on stand-by, but tracking real-time usage can also highlight high-consumption devices to the user. The periodic ranking is based on the savings recently achieved (the previous week compared to the one before that), driving a continued incentive for the users to find savings.

The monitoring interface design relies on users having the skills to interpret and make use of the data presented. The snapshot above (Fig. 1) is intelligible for someone who knows their household's actual usage, understands how much 1341 W is, what the stopwatch timer can be used for, what the ranking is based on, and what the community bar represents. Underlying this is the expectation that by monitoring their energy consumption, the user will act on this gained knowledge and reduce their consumption.

In practice, the SSmE platform was used regularly to monitor energy consumption at the start of the project, often triggered by periodic news, emails or messages from the platform on the ranking of households' reduced energy consumption. Participants indicated that monitoring can indeed provide new insights and help to make some savings, but they also stressed the limited usefulness:

> *"It is fun to look at in the beginning, but you don't continue watching it endlessly. At some point it works, and you can do something with it, but then it stops". [GI]*

> *"By now I can pretty much predict how much my panels are generating, when the kids are home and when the washing machine is on, so I can safely estimate the usage. Then you slowly look less and less... You've learned how to use it. Your goal is accomplished." [GI]*

These quotes clearly show that the users do not yet state how they apply the information to make changes in their energy usage. Rather, they use the monitoring to simply get to know their energy consumption. Consequently, this knowledge about the energy usage itself, rather than the action resulting from it, has become the main focus of the monitoring. The slogan 'to measure is to know' (*meten is weten*) is commonly used in campaigns or for marketing monitoring solutions. However, knowing your energy consumption does not necessarily trigger changes in consumption behaviour. Furthermore, once people had gained insight in their energy usage, they did not see the point in continuing the regular monitoring. Nevertheless, the monitoring can have lasting effects; it just depends on whether consuming practices change based on

Fig. 1. Snapshots of the SSmE app (mock data and names). Real-time usage with a timer, ranking within community, 'my community' bar.

the information from monitoring, and how durable these changes are.

Generally speaking, there are two ways to reduce overall energy consumption: the consuming practice is not performed, or the way it is performed is changed so it becomes more energy efficient. The latter can, for instance, be made through changing lightbulbs or adding switches to cut back standby consumption. During the pilot, a week-long competition was arranged to focus on reducing as much standby power consumption as possible between 1 a.m. and 3 a.m. In this week, 79 out of 104 participants managed to cut back their electricity usage, totalling a combined reduction from the benchmarked 8195 W to 7146 W. The winner of this contest demonstrated her solutions in a promotional video: plug boxes with switches to turn off mobile chargers and television set equipment, as well as timer switches on the floor heating pump. The interventions do not strongly challenge the established ways of carrying out these activities. Watching television does not really change, only the handling of the television equipment when it is not in use; telephones are still charged, and the floor is still heated at the times required. Further changes in consuming practices (or not performing the practice at all) would increasingly challenge the established comfort and patterns of domestic life. Such changes relate to a variety of dimensions, including the emotional, cultural, financial and institutional embedding of these practices. Fundamentally challenging energy use levels is thus a complex endeavour. This might explain why – despite the provision of monitoring information – a significant number of participants did not make much use of, nor take action based on the information.

The project participants regarded monitoring as a means of gaining insight into the possibilities of saving energy consumption. Yet, as participants claimed to already use relatively little energy, many did not see the need and added value of monitoring:

> *"No, because we actually use very little [energy]. There are just the two of us at home. We don't have to keep any children under our thumb so to speak. And other than that, no we don't really look for savings, because we use so little." [I5]*

This claim is typical for (especially older) participants who, as solar panel owners and members of a local energy cooperative, often claim to be more engaged with their energy usage. Enabling monitoring might trigger more economical use of energy, but in this case, most participants felt they were already behaving economically.

The users' ranking (see Fig. 1) based on their energy savings, and showing average consumption, adds a social-comparative dimension to energy usage [21] that can drive members of a community like this to engage further with energy. It improves the user's knowhow on how well their household is performing compared to others, challenging or confirming their initial perception of their performance regarding energy sustainability. Furthermore it tells the users that the household *could* be performing better if they are not at the top of the list. And because the ranking is within a community of peers subscribing to the same goals for sustainable energy, this could also mean that users feel they *should* try harder to further reduce grid-fed energy use. The pilot study also did rankings during thematic weeks on saving and self-using energy. At project organization meetings it became clear, however, that performance can be determined in various ways, ranking absolute or relative reductions in energy usage, normalized for differences in individual household characteristics or not. This was complicated even further by the different composition of households' electricity usage and their initial performance. As some users were already relatively economical in their energy usage, they had fewer options to make further changes in their practices, and therefore could not score well in the rankings on reduced energy consumption. One user reported that he ranked on top in weeks when he happened to be out of town and thus did not charge his electric car at home, causing a great reduction in energy use compared to the previous week. Users noted these limitations and imprecisions, which, combined with the insight gained about their own energy consumption through initial monitoring, led them to be increasingly uncertain of the function's usefulness. Real time monitoring of consumption was often not feasible because of a slow performing platform, preventing users from figuring out the composition of their energy use in more detail:

> *"Sometimes it is really slow starting up and the home screen doesn't always show all the data it should... And about the costs and such, I don't know how reliable that is... I'm thinking: is that correct or not, so I don't really look at that very often. So I mostly look at the screen with my own usage and how much is fed back [to the grid]." [I5]*

In sum, the monitoring function failed to engage users in continuous monitoring and inducing subsequent action: the main assumption that insight in energy usage automatically triggers a change in behaviour was not evident. Besides, extra monitoring was regarded as not delivering more benefits because participants felt their energy behaviour was already optimized. Lastly, the range and measurement of factual insights gained from monitoring were regarded as unsatisfactory. Nevertheless, at a final SSmE project rating, the participants valued the monitoring aspect of the project most positively and the continued performance ranking did provide a trigger to check their own consumption and PV generation figures.

4.2. Planning energy consumption

The platform also encourages energy consumption planning. Currently planning is important because the successful cooperative efforts to create PV generation capacity among members has resulted in a new peak of unused solar power being fed back into the local grid. This peak is in fact even larger than the traditional demand peak when electricity is fed to households. The peak of solar power not used on-site exemplifies the potential issues that grid operators expect in a renewable energy system, and was a major reason to conduct this pilot. The online platform incorporates a function that aims to improve the consumption of electricity generated by solar PVs within the cooperative (see Fig. 2). Users receive current data on the self-sufficiency of the cooperative: how much electricity has been taken from the grid and how much has been fed back. When checked, this advice indicates if any solar electricity is available for use around that time; if this is not the case, a measure to reduce grid-fed consumption is provided. Additionally, members can plan their energy consumption based on predictions about consumption and PV generation within the cooperative. A graph shows the predicted solar generation and electricity usage within the community for the day and coming days.

The idea of a graphical display function was that participants regularly checking this advice would find ways to reduce grid-fed consumption and increase their consumption of cooperatively generated electricity. Solar electricity generation is introduced and made visible, indicating the right time to use energy more sustainably. Optimistically speaking, a dedicated energy manager would do some form of planning whereby this timing is the basis for scheduling consuming practices, aiming to use as much solar power on-site as possible. How flexible an energy user is, depends on the range of energy consuming practices that the user can fit into this new regime of timing energy usage.

One of the project's goals was to collectively increase on-site solar power usage, but throughout the project no differences in self-consumption were measured at the cooperative level. A special thematic week was arranged to raise awareness of the timing of use advice function (similar to the week for reducing night-time consumption). Even during this competitive event, the goal to increase the use of electricity generated within the cooperative was unobtainable, although individual efforts to increase the use of solar generated electricity are possibly obscured at this level of measurement. One reason found for the relatively low flexibility displayed during this pilot is that participants saw limited possibilities to shift activities from classic peak moments to the solar peak period. Flexibility of electricity usage depends on the practices that actually use electricity. In the Dutch case, most peoples' heating, cooking, and driving practices use gas and petrol rather than electricity. The electricity-using practices that participants regularly acknowledged and named as variable that could be shifted in time, are the use of the washing machine, tumble dryer and dishwasher. Less often mentioned are the charging of battery devices and using household appliances like the vacuum cleaner. Shifting the use of these larger appliances would have a significant impact on on-site solar usage, but did not occur widely or consistently in this case.

It should be noted here that electricity consuming practices are obdurate, for instance due to being bound up with natural rhythms (the need for lighting), organizational rhythms (cooking, leisure activities) and household composition (number and age of household members; not being at home during the day) [22]. These domestic practices also have established ways of doing (by whom), are routinized and interlinked with other practices and chains of actions. Standards such as not wanting to run the washing machine when away from home, or not leaving laundry in the machine to prevent smell, also contribute to the obduracy of these practices. This demonstrates the existence of messy realities of individual preferences, dependencies and responsibilities, even around seemingly easily 'plan-able' activities like washing.

A way to plan energy consumption is by introducing automation. Especially practices involving technology that is continuously switched on in the background are identified as suitable for automation and thus ideal targets for being made more 'smart' and flexible. Many participants showed interest in having these background processes controlled by software in such a way that the household uses more renewable energy without the user's active intervention.

> *"What could be done, what we could consider, are fridges and freezers. These could be steered so that they cool when power is cheap and turn off when it is expensive." [GI]*

> *"But I also think that with remote control and using big data, we can control appliances a lot better without needing too much interference." [GI]*

Thus smarter appliances can take over some of the planning activities otherwise left to the householder. However, as one inhabitant of a smart home mentioned, this technology can also break away from the background and create a feeling of 'limitation' [I6]. Automated decision making and control come with rules which may noticeably limit the user in moments of breakdown or deviation from the usual pattern. In the pilot, the decision to adhere to the newly introduced timing advice was still in the hands of the user, relying on very 'manual' and variable activities like washing to be shifted in time. Appliances like dishwashers are often programmable to run at specific times, potentially providing some of the automation that can help in timeshifting. But as stated above, these practices are set in such a way that a change in timing probably also means a readjustment of other practices, schedules or habits.

The idea of planning activities based on the price of energy was not new for many householders with a double meter; they have fixed lower tariffs between 21:00 and 07:00 and at weekends. Many participants indicated they plan certain activities like washing in this period, which is even more feasible with programmable appliances. On the one hand, this could be seen as a precedent for engaging in planning energy consumption with just a change in the preferred period. On the other hand, the double meter now works counter to the timing advice based on solar power generation. While for a long time householders were incentivized to use electricity at night, now grid operators want to entice them to instead use more power during solar periods.

> *"We used to be programmed to do as much as possible at night and now we should do as much as possible during the day. That's a bit strange." (Interviewee switched to one flat tariff) [I2]*

> *"We did not join in that. Not because... we are pretty selective in our electricity use. We turn on the washing machine and dishwasher with the night tariff, and we don't wash that often, maybe*

Fig. 2. Main text on the left: "Energy usage advice". Text in speech balloon: "Currently, no DEH energy is available. Save for example on lighting". Small text in speech balloon: "This advice applies until 11:00 tomorrow. After that, DEH energy will be available again." Text on the right: "Yes, I am following the advice" – "No, I am not following it".

twice a week. So that is not very much, there's not much we could do..." [GI]

SSmE participants with this double metering system faced competing incentives, and for now, many perceived the greatest benefit was using the night tariffs as much as possible. This is partially a matter of gaining economic benefits: making more use of solar power on-site is not financially beneficial if it is possible to feed it into the grid and be compensated at a later date through net-metering. At the same time, making use of night tariffs does yield an economic benefit, although the amount is low and even disputed [GI], because it also comes with a small extra fee. The question of economic benefit in relation to timing energy use is thus perceived in various ways, not always clearly in favour of using solar power when it is generated. The platform did not convey any economic indicators about energy, only the availability of solar power, and therefore did not help to resolve this issue. In addition, some participants found it counterintuitive to be encouraged to use electricity at certain times because this does not gel with the idea that it is better to use less energy.

One goal for the SSmE pilot was to see whether, without financial instruments, the participants would be willing to shift part of their consumption to solar peak hours. The emotional reward of being self-sufficient and running the household on renewable energy are important reasons for many users to be part of the energy cooperative and the pilot study. For some participants, these factors had a significant meaning and they applied them to several of their domestic activities:

"The basic idea is that you use your own energy. So like now can you switch on the vacuum cleaner, now the dishwasher, now the washing machine. So that they work on those solar panels. That really appeals to me." [I2]

There was no financial gain from using more of the community's solar electricity, and the main incentives at play involved appealing to the emotional value of a self-sufficient community, or setting a "good energy conduct" example for others. Project participants were aware of the grid management issues stemming from the strong uptake and feed-in of solar power. Yet, even when participants indicated they cared deeply about the sustainability aspect of their energy usage, this did not offset economic interests:

"[Money] is just one trigger. I feel very responsible for the environment, but it [sustainable action] has to earn me money. And solar panels do that." [GI]

Throughout the project, the participants as well as the project leaders spoke about the economic benefits being important to engage more "average" people: the average family with children and perhaps not so interested in energy and sustainability. At the same time, they recognized that even if economic gains were available, this would not automatically lead to challenging established ways of running the household. The current electricity system provides the comfort of not having to actively engage in this, and losing some of this comfort is not seen as desirable:

"Well, I think that without maintaining comfort levels, people will not join in [timeshifting]" [GI]

"People are willing to pay quite a lot for having comfort, you can see that in many things." [GI]

During the short period of this pilot, most participants did not deem self-sufficiency an important enough goal to challenge established patterns of consumption. In fact, the current pattern, whereby electricity usage happens outside the solar peak hours during the day, is not challenged by the financial mechanisms of net-metering and day/night tariffs. Net-metering effectively removes the need for self-use and does not cause solar PV owners to question their consumption patterns. The project under study deliberately did not introduce new financial mechanisms as it aimed to test for emotional and social drivers. In the end, the SSmE platform did not succeed in inducing a significant shift in the participants' energy consumption patterns. From a rationalist perspective, this would call for deeper restructuring of energy costs to be more variable or place more responsibility for energy management at the household level. Our findings suggest that financial costs and benefits of energy are just one factor that might help some users to further challenge their consumption patterns, but are of little interest or importance to others.

4.3. Sharing energy data and knowledge

One of the DEH cooperative's goals was to foster ties between its members and thereby create a stronger (energy) community. The energy management platform was therefore designed to also provide ways of communicating with other members, through a chat and message board. It was presented as a learning tool to gather and share the knowledge that users developed through their engagement with the platform. Participants who did well in the energy saving and self-use rankings could be approached by others to find out how they in turn could achieve similar results. Knowledgeable participants could assist their community members with applying the monitoring and timing advice to make changes to their energy consumption. The communication tools could also be used for organizing and reporting offline cooperative activities or discussing issues.

After nearly a year since the project's launch, the communication tools are not used a great deal. Initially, people showed interest because it was new and some users were still in the learning process of installing equipment, monitoring data and perhaps making interventions. But like the waning interest in monitoring and reducing energy usage, the need to talk to others also declined after time.

"But I'm noticing now the chat function is dwindling. When it was first launched there was quite some chatter and questions were asked." [I3]

One reason is that the cooperative and the smaller group of SSmE users are not as connected as the notion of a community might suggest. The users are mostly not well acquainted with each other, and although they share a common interest in generating renewable energy, for many this interest is not something that makes them start communicating with users they do not know.

"We should probably [contact other users] more, but I'm not so sure how. I don't really know that many people in DEH so maybe

we should... I think this is true for other people too: they don't know each other." [I5]

The lack of connection between cooperative and SSmE users was acknowledged before the pilot began: earlier research with members of this cooperative found that gaining new contacts and working together with others were relatively unimportant reasons for joining [23]. But the hope for this platform was that over time, interest in the issues at play would grow and foster increasing interaction and 'community feel'. For those users with a greater than average enthusiasm for or knowledge of energy management, the platform was an interesting way to engage with likeminded users. But without the trigger or invitation to take part in specific activities, the average user was not part of online discussions and learning, nor talked to other members about comparing, reducing or shifting energy consumption.

There are several explanations. In terms of skills, online interaction through forums and direct chat may still be an activity which some (especially older) participants have not developed. Some users indicated they prefer to talk and compare their energy performance with other participants offline (in person) instead of using online tools. Others indicated that they would like to talk about energy related topics and the platform with non-participants, especially family members and friends, which is not possible through SSmE.

"So you need some kind of impulse to get people back in and get the discussion going on there." [I3]

The users do not seem to see the point of communicating on the platform; there has to be something to talk about. The reasons for online interaction might have to be demonstrated by the cooperative through other means. It might take more 'teaching', for instance by experienced users who can introduce others to the ways and benefits of communicating online.

"But maybe DEH should.... keep organizing activities. But a bit more actively, so people can get to know each other." [I5]

This indicates that online channels may not be the best way to primarily create a bond and trust between cooperative members. Offline activities like cooperative meetings, excursions and workshops for children on energy-related themes seem to be better channels for connecting and sharing. This project's participants did not live up to the expectation that users are keen to engage in smart energy communication online.

5. Discussion and conclusion

In this article we set out to empirically study Strenger's idea of the Resource Man [1]. From the Resource Man perspective, domestic energy innovations enable producer-consumers to make their own energy demand levels sustainable, affordable and grid-friendly. This management of domestic energy usage is thought to be a rational affair, based on current and predicted energy data including economic and sustainability-related factors. Within the Resource Man perspective, ultimately sufficient data and the right incentives are assumed to result in flexible energy users and the successful recruitment of households to the larger project of managing the grid.

Strengers suggests several strategies with which the Resource Man is likely to engage [1]. Using the case of a pilot project testing an ICT-based monitoring platform, we posed the question: which activities would emerge as actually being performed by this engaged domestic resource manager. The online platform focused on three activities (energy monitoring, planning and sharing) that were to become part of domestic energy management. Given the characteristics of the project participants and the affordances of the platform, if the activities of the Resource Man were to be found emerging anywhere, this project offered a likely arena.

The vision of the Resource Man – a tech-savvy individual who, through smart appliances, can draw on detailed, personalized energy data, make rational decisions based on this, and act diligently on his gained insights – did not manifest itself in the SSmE project. Rather than diligent energy managers, participants became rather inattentive over time: Early in the pilot they performed all three activities enabled by the platform, however, their engagement soon diminished.

Most users performed monitoring for some time but did this less later on as it failed to provide new, additional knowledge and information. Continued monitoring was not expected to yield new insights in consumption patterns or solar power production. This was the main reason to discontinue monitoring, and earlier studies have come to similar conclusions [24]. Contrary to the image of an energy manager eager to regularly receive energy-based personalized data, users grew wary of the information. What is more, many felt they "knew more" than the insights of the monitoring data could provide, as they were convinced that they had already optimized their energy use. Planning based on timing-of-use advice was not done on a large scale either, and overall the project did not lead to measurable changes in the timing of energy usage at the community level. Apparently, inducing flexibility in electricity use patterns is difficult, and participants turned out to be rather inflexible, something which is not in line with the conduct of a Resource Man. The SSmE project participants could not live up to the vision of being engaged online communicators. Despite the possibilities offered by ICT, most of the participants refrained from sharing energy data and knowledge online. Besides, the option to compare individual energy behaviour data did not induce the promised competitive impulse. This suggests that online "energy communication" is less self-evident than commonly assumed and "gamification" (e.g. through competition) is not necessarily self-propelling.

The fact that the Resource Man vision did not manifest itself does not diminish the power this notion holds. The case study analysed here is an example of how strong assumptions associated with the Resource Man vision are entrenched in smart grid project design: users are assumed to want to monitor, plan and share their energy activities. One of the aims of managing these demand side activities is to increase the flexibility of users' energy consumption. In line with developments noted by Strengers [25], promoting flexible energy consumption is explicitly framed to be good for the electricity grid, and therefore represents a redistribution of grid management tasks to the energy community and households. This task incorporates feedback received from grid managers, who are in a position to mould this feedback to suit their interests. Though the feedback function in this project was designed to incorporate both the cooperative and the grid manager's goals, we could question how strongly the various interests are represented in the framing of feedback. In fact, just as in our case study project, grid managers in the Netherlands seem to be strongly influencing local sustainable energy projects according to their own grid management tasks. This works to both maintain their organization's role in the energy system as well as recruit local energy actors to be 'good energy citizens' [20]. The socializing of energy consumption [21] might appeal to the user and encourage more efforts to save energy. However, it also introduces notions about what is 'good' or 'responsible' energy conduct [26], or even the experience of social pressure regarding the responsibility of your own energy usage. Normative framings of energy consumption could also be expected to affect relations within energy cooperatives and within households, where the task of performing energy management might fall to specific individuals, who manage not only their own but also others' energy usage. As this seems to be a male oriented and dominated task [1], just as in our case study, it might cause gender-related tensions within the smart home [27].

Bulkeley, Powells and Bell [28] discuss the "realignment of relations between the grid, community and household" within smart grid development as a set of governmental programmes. Our case study could also be seen as an example of a (test) configuration in which governing proceeds by introducing "smart grid logics" at the household level, fostering self-government of energy conduct. As such, energy conduct is not only governed at the "top" by grid managing and rule-making practices but also at the community and household level. We would add that energy communities, beyond being governed, also play an active role in these processes of rule-making and technology development, for example in our case as co-developers of a platform also working toward its own goals. One implication is that visions of the Resource Man are not necessarily only endorsed top-down from industry to users, but can also be fostered by actors on the demand side.

One of the main critiques levelled at the Resource Man vision is that activities "intended for Resource Man overlook almost entirely what people actually do in their homes" [29]. Another is: an extremely narrow understanding of energy consumption and how it might change. Theories of practice [22,30,31] argue that rational and individualist approaches like that of the Resource Man are "excessively individualistic and fail to appreciate the ways in which variously, social relations, material infrastructures and context are intrinsic to the performance of social practices" [32]. The practice theory perspective has implications for how we consider consumption: "*. . . from the point of view of a theory of practice, consumption occurs within and for the sake of practices.*" [33]. Energy consumption is just what happens while going about our daily lives in our particular ways, it is not something we *do* specifically. The room for the individual to make changes to individual practices (and the energy these use) is linked with the great complexity of practices on which they depend. This obduracy of everyday practices was demonstrated in the case study; especially changing the timing of practices in the household faced complexity, routines and preferences. Thus changing energy usage patterns goes beyond designing the right incentives, providing the right data, and relying on the individual user to make the right and informed substantial changes.

A practice theoretical perspective also has consequences for how we think smart energy devices affect energy usage. The successful introduction of a functioning platform that facilitates planning, sharing and monitoring does not mean that changes in energy consumption patterns will actually take place. Changing consumption patterns requires more than a narrow focus on designing feedback, monitoring or planning devices. In our view, the devices for engaging with energy should be seen as the material elements of potentially emerging practices of energy managing. Naus et al. [34] find that energy managing practices "*. . .may be better conceptualized as an emergent bundle of practices or as a distributed set of tasks that together make up a practice of domestic energy management.*" In this sense it is more fruitful to see domestic energy management devices as the producers of information and meanings which could become part of the mode of organizing domestic energy usage. Looking beyond the notions of Naus et al., we propose that householders can engage in a wider range of energy practices – or e-practices as we like to call them – beyond the use of management devices: being active in an energy collective, generating and trading energy, storing energy, or discussing energy. It is through e-practices that energy is highlighted, made visible, problematized, managed, stored or discussed, which in turn produces insights that can be used to shape domestic energy conditions. This position recognizes the potential but partial role of domestic smart grid technology in effecting change in daily practices, as it only forms part of an e-practice. In line with earlier work on theories of practice [31], e-practices require the prospective user to integrate elements of skill and knowledge and elements of meaning with the technology itself. In our case study, these elements were present as the targeted users (energy cooperative members with solar panels) were relatively knowledgeable and interested in energy data, qualities which allowed monitoring and planning e-practices to emerge. In contrast, the Resource Man position simply assumes every prospective user has the right skills and interests to act as an energy manager; however, many average householders do not have all these skills and meaningful elements readily and willingly available. Our case also shows that even if all the elements are present for an e-practice to emerge, the complex and interlinked nature of the practices which consume energy can prevent the insights from monitoring or planning actually being applied to change energy use patterns. However, this does not mean that efforts should be directed to incentivizing households to engage with the different elements necessary for e-practices to emerge. As we have shown, even in a case that seems to offer a promising arena for resource men to perform, – they do not. This suggests that when looking for ways of changing patterns of energy usage, one has to look at other directions of which studying everyday practices could be a promising one. This is especially relevant for design processes. Though we do not believe in technological design fixes, a focus on and starting point with everyday practises is likely to inspire other visions and assumptions about the prospective users. Further research into the development processes and the representation of the eventual domestic users in the design of technologies – and their practices – could begin to provide answers to the questions how and which visions are fuelling the shape and emergence of these e-practices.

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